NORTH AMERICAN RIVER OTTER

Husbandry Notebook, 4th Edition; Chapters 1 - 6

(Photo: Dave Mellenbruch)

NORTH AMERICAN (Nearctic) RIVER OTTER *(Lontra canadensis)* Husbandry Notebook, Section 1 Chapters 1 - 6©

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"Alacris ad ludos est."

"It is quick to play"

(Albertus Magnus, 13th Century teacher and naturalist)

North American River Otter Husbandry Notebook
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In the days when the earth was new and there were no men but only animals the sun was far away in the sky. It was so far away that there was no summer. It was so far away that the trees and the grasses did not grow as they should.

He-Who-Made-the-Animals saw how it was that there was not enough sun to heat the earth, and so he fashioned a snare. The Sun did not see the snare in his path, walked into the snare and the snare held him fast.

The sun was close to the earth. In fact, the snare held the sun so close to the earth that there was no night. Day after day the sun shone and the earth dried and the grasses withered. There was not enough food or water for the animals and they desperately called a council. "Sun," the animals said, "You give too much heat to the earth."

"Set me free from this snare" the Sun said, "and I will go away."

"But if you go away, then there will not be enough heat." "Set me free," the Sun said, "and I will come to the edge of the earth in the morning and in the evening; then at noon-time I will stand straight above the earth and warm it then."

The animals sat around the council fire and they said, "Who is going to set the sun free?"

"I shall not do it," Wildcat said. "Whoever sets the sun free must go so close to the sun that he will be burned to death." Lynx said, "Whoever sets the sun free must chew the leather thong that holds him; the sun will burn him to death before he can do it." "I shall not do it," said the deer, the wolf and the raccoon.

"I shall do it," Otter said. "How can you do it?" said the animals. "You are too small, your teeth are for fish, and your fur has already burned away." None of the other animals liked the otter because he played too much. They did not think he was brave.

"Let him try," Bear said. "He will burn to death, but we will not miss him. He is of no use to us. He looks silly now that his fur is gone." The animals laughed.

Ignoring the taunts, the otter set off to the place in the sky above the earth where the sun was held by the snare. Otter took many days to get to the sun. The sun burned him. The sun was so bright; Otter had to close his eyes. When he reached the sun, Otter began to chew on the leather thong that held the sun. His skin was burning and blistering, his eyes were hot stones. But, Otter did not stop chewing.

Suddenly he chewed through the leather. The animals saw the sun rise into the sky. The animals felt the cool winds begin to blow on the earth. Otter had freed the sun from the snare.

Time passed. Otter lay in the center of the council ring. There was no fur at all left on his body. His skin was burned and scorched and his flesh was falling off his bones. His teeth were only blackened stumps.

He-Who-Made-the-Animals also stood in the center of the council ring. "Otter," he said, "the animals will not forget what you have done for them. I will see that they do not forget," and he gave Otter new strong teeth, tireless muscles, keen eyesight, and a powerful tail to help him in his hunting and in his play. He did not have to give him bravery. But he gave him new fine fur that was like down on his skin, and a second coat of fur to guard the first so that he would not get cold in water or in winter. Then he gave him joy so that he would always be happy in his otter's life, and Otter has so remained until this day.

An Otter Legend derived from the Cree Indians
Contributed by John Mulvihill
The River Otter Journal Vol. VIII, No. 2, Autumn 1999

Contributors

4th Edition

Thank you to all who contributed to the 1st and 2nd editions as well as the 1997 Husbandry Survey. Some of this information is still part of this edition. However, the 2nd edition is available on the IUCN Otter Specialist Group website and the original Otter Lore and other deleted sections can be found there.

Contributors to this new edition include: Helen Bateman, Gwen Myers, DVM, Melanie Haire, Tanya Thibodeaux, David Hamilton, Brian Helton, Lynn Hougle, Jennifer Mattive, Kristina Smith, Mike Maslanka, M.S., Barbara Henry, M.S., Monica Anderson, Nicole Barker, Rachael Chappell, Julie Christie, Kristin Clark, Erin Dauenhauer-Dacota, Erin Erbren, Bethany Gates, Katie Jeffrey, Maggie Jensen, Brett Kipley, Marcy Krause, Tara Lieberg, Hilary Maag, Christine Montgomery, Melissa Newkoop, Melanie Pococke, Josh Prince, Nancy Ramsey, Tami Richard, Karen Rifenbury, Jan Sansone, Ashley Snow, Alicia Striggow, Maicie Sykes, Janée Thill, Marla Tullio, Jen Wilson, Andrea Dougall, Victor Alm, Courtney Lewis, Bill Hughes, Jennifer Galbraith, and the Otter Keeper Workshop Attendees (2004, 2006, 2008, 2010. 2012). Thank you to the zoo and aquarium people who contributed photos and to the professionals who gave permission for use of their photographs: Dave Mellenbruch, Haley Anderson, Graham Jones, Gary Woodburn, Debbie Stika, and Herb Reed.

USER GUIDE

INTRODUCTION

***Lontra canadensis* is most commonly known as the North American river otter but also will be referred to here as the N.A. river otter, NARO, and Nearctic otter.**

As soon as the first edition of the North American River Otter Husbandry Notebook was completed additional information became available – that is the way projects of this nature all work. I have no doubt it also will be true for this edition. Each edition should be used as a beginning point when looking for an answer to a particular otter problem or question. Our approach to captive husbandry should be as dynamic as the animals in our care. **This 4th edition includes updated information. Since publication of the last edition significant work has been done on otter reproductive physiology, contraceptive recommendations have changed, and there have been some changes made to recommended routine veterinary care. These changes as well as additional enclosure, training and enrichment information have been included in this digital update of the NARO husbandry notebook. All deleted information and sections (e.g. North American River Otters in European Institutions) are still available in the 2nd edition. The 2nd and 4th editions are available at otterspecialistgroup.org, Otters in Zoos, etc. link (OZ Task Force – Otters in Zoos, Aquariums, Rehabilitation, and Wildlife Sanctuaries).**

Where possible, all measurements and weights have been put into the English and metric systems. This is not true for the weights tables, however. There is some duplication from one chapter to another; some information on a given topic may only appear in one location. This is inconsistent but an attempt was made to at least provide some basic information on pertinent topics where appropriate so a reader would not have to go to all of the sections however, it is recommended. For example: there is pup development information in the Reproduction section and Hand Rearing.

Many thanks go out to all of the people who have shared ideas with me over the years, too many of you to name here, however, your contributions have all been helpful and have been incorporated in some way in this manual. This new notebook has been split into three sections allowing the inclusion of more photos while trying to keep the file sizes manageable. They are as follows:

SECTION 1

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SECTION 3

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CHAPTER 1 TAXONOMY

Introduction

The scientific name for the North American otter was *Lutra canadensis*; it is now *Lontra canadensis*.

> *"The generic name **Lutra**, proposed by Brisson in 1762, is the Latin name for otter. The specific name **canadensis**, proposed by Schreber in 1776, refers to Canada, with the Latin suffix, ensis, meaning 'belonging to' because the species was first described from Canada. The common name otter has a northern European origin; in Old English, otor; in Middle English, oter; in Swedish, utter; in Danish, odder; in German, otter."* (Baker, 1983)

The ongoing discussion regarding the generic status of the New World otters appears to have been settled, at this point, in favor of *Lontra* as proposed by van Zyll de Jong in 1972. This is largely due to increased acceptance of van Zyll de Jong's analysis and the recent work of Klaus Koepfli and Robert K. Wayne at U.C.L.A (Koepfli 1998a, Koepfli and Wayne 2003).

Current Otter Taxonomy and Common Names

ORDER	Carnivora
FAMILY	Mustelidae
SUBFAMILY	Lutrinae
GENUS	*Lontra* (Gray, 1843)
SPECIES	*canadensis* (Schreber, 1776)
SUBSPECIES	*L. c. canadensis, L. c. kodiacensis,* *L. c. lataxina, L. c. mira* *L. c. pacifica, L. c. periclyzomae* *L. c. sonora*

The generic designation of *Lontra* instead of *Lutra* was widely adopted in the late 1990's. *Lontra* is now accepted for all of the new world river otter species (which includes the N. A. otter, Neotropical otter, Southern otter, and Marine otter), by ISIS, the IUCN/SSC Otter Specialist Group, The Wildlife Society, Society of Mammalogists and other recognized organizations.

COMMON NAMES

In 1776 Schreber created an engraving of an animal he called the "American otter". This name became the North American river otter and more recently the species has been referred to as the Nearctic otter; other English names include; otter, common otter, water dog, river otter, land otter and Fisher (this usage most likely started as a deliberate falsification). Common names in other languages include: Fischotter (German), loutre (French-Canadian), nutria norteamericana (Spanish), and lontra canadese (Italian). Native American names include: Neeg-keek (Chippewa), Ku-tet-tahx (Potawatomi), Cuilinguq (Yupik Eskimo), Kolta (Klamath), Nannocks (Wasco), Neekeek (Cree, Ojibway, Sauteax), Nit-sook (Naskapi), Nop'-e-ay (Chipewyan), Oshan (Choctaw), Pah-hua-pe'na (Keresan), Pahtsugo (Piute), Pat-cukee (Comanche), Pe-tang (Yantkton Sioux), Ptan (Ogallala Sioux), Saquenu'ckot (Algonquian), See-hah (Zuni), Un'-chuch (Montagnais), and Xyinixka (Biloxi) (Native American names taken from Melquist et al. 2003 citing original sources).

HISTORICAL OTTER TAXONOMY

Lontra (Lutra) canadensis, Schreber 1776 Synonyms:

Mustela hudsonica, Desmarest 1803
Mustela canadensis, Turton 1806
Lutra hudsonica, Cuvier 1823 and many others
Lutra brasiliensis, Harlan 1825 & Godman 1826*
Lutra vulgaris variety *canadensis,* Wagner 1841
Lutra braziliensis, De Kay 1842
Latax lataxina, Gray 1843
Latax canadensis Gray 1865
Lontra canadensis Flower 1929*

* Harris (1968) indicates these terms were used improperly by the individuals indicated, when doing further research, be alert to this kind of incorrect usage.

SUBSPECIES

Harris (1968) listed 20 subspecies:

Lutra canadensis canadensis	*L.c pacifica*	*L.c. sonora*	*L.c. vancouverensis*
	L.c. degener	*L.c. interior*	*L.c. mira*
L.c. nexa	*L.c. periclyzomae*	*L.c. texensis*	*L.c. yukonensis*
L.c. brevipilosus	*L.c. evexa*	*L.c. kodiacensis*	
L.c. optiva	*L.c. preblei*	*L.c. vaga*	
L.c. chimo	*L.c. extera*	*L.c. lataxina*	

Toweill & Tabor (1982) and Hall & Kelson (1959) list 19 subspecies, leaving out *Lutra canadensis mira*, which they list as *Lutra mira* (the Prince of Wales Island otter).

In the 1981 edition of *The Mammals of North America*, Hall revises the 1959 (Hall & Kelson) listing of 19 subspecies as follows:

1959 EDITION	1981 EDITION
Lutra canadensis canadensis *L. c. degener* *L. c. kodiacensis*	*Lutra canadensis canadensis* Schreber 1776 *L. c. kodiacensis* Goldman 1935
L. c. interior *L. c. lataxina* *L. c. texensis* *L. c. vaga*	*L. c. lataxina* Cuvier 1823
L. c. mira *L. c. vancouverensis*	*L. c. mira* Goldman 1935
L. c. brevipilosus *L. c. evexa* *L. c. extera* *L. c. nexa* *L. c. optiva* *L. c. pacifica* *L. c. preblei* *L. c. yukonensis*	*L. c. pacifica* Rhoads 1898
L. c. periclyzomae	*L. c. periclyzomae* Elliot 1905
L. c. sonora	*L. c. sonora* Rhoads 1898

Van Zyll de Jong's 1972 suggested subspecies revision agreed with Hall's 1981 revision with one difference; van Zyll de Jong incorporated the 20th subspecies listed by Harris (1968), *L. c. chimo* in *L. c. canadensis*.

Mammal Species of the World, A Taxonomic and Geographic Reference (1993) edited by Wilson & Reeder lists the North American river otter as *Lontra canadensis*. Twenty-two subspecies synonyms given are: *americana* Wyman 1847; *atterima* Elliot 1901; *brevipilosus* Grinell 1914; *californica* Baird 1857; *chimo* Anderson 1945; *degener* Bangs 1898; *destructor* Barnston 1863; *evexa* Goldman 1935; *hudsonica* Merriam 1899; *interior* Swenk 1920; *kodiacensis* Goldman 1935; *lataxina* Cuvier 1823; *mira* Goldman 1935; *mollis* Gray 1843; *nexa* Goldman 1935; *optiva* Goldman 1935; *pacifica* Grinnell 1933; *paranensis* Elliot 1901; *preblei* Goldman 1935; *vaga* Bangs 1898; *vancouverensis* Goldman 1935; *yukonensis* Goldman 1935

Taxonomic Overview – a Summary

The following overview of the taxonomic treatment of North American river otters (*Lontra [Lutra] canadensis)* is not exhaustive, but should be viewed as an historical introduction to otter systematics.

> *"The subfamily* (Lutrinae) *comprises 13 extant species for which four to eight different genera have been recognized and variously divided into two or three tribes. The oldest fossil otters are found in early Miocene deposits, represented by the genus **Mionictis**, dating approximately to 20 million years ago, …*
>
> *" Previous systematic studies have relied primarily on the overall similarity of cranial and dental characters to infer relationships of otters. However, despite using similar morphological characters, different methods of systematic analysis have led to a number of taxonomic revisions of the Lutrinae during this century. Studies based on classical systematic approaches (Pohl, 1919; Pocock, 1921), evolutionary systematics (Simpson, 1945; Sokolov, 1973; Davis, 1978; Willemsen, 1992), phenetics (van Zyll de Jong, 1972, 1987), and cladistics (van Zyll de Jong, 1987) have reached different conclusions regarding relationships."*
>
> Koepfli & Wayne, 1998

THE EVOLUTIONARY APPROACH: DAVIS' TREATMENT

In 1978 J. Davis reviewed the previous taxonomic treatment of the *Lutrinae* and published his work utilizing behavioral characteristics and baculum type as key indicators of Lutrine taxonomic standing.

Due to the "*plasticity*" of otter behavior, behaviorally based taxonomic criteria are not regarded as reliable. However, Davis proposed that the use of otter vocalizations was dependable because, "…*the plasticity of behavior is far less evident in the vocalizations of otters*". Some calls are common to all species (warning growl) but others, such as the contact and affectional calls, "…*appear to be peculiar to each of the monotypic genera, and closely similar among the species within each of the polytypic genera _Aonyx_ and _Lutra_."*

Characteristics of the Tribes of Lutrinae (Davis, 1978)

Lutrini

> *"**Morphological*** – Penis completely internal, no preputial button. Baculum slightly curved, not tapered markedly, with a sharp distal bend, like a hockey stick. Bend is dorsal in New World species, ventral in Old World species. All digits are strongly clawed. Webbing between digits extensive.
>
> ***Behavioral*** – *Sociable; pairing more or less casual and limited to breeding season; male not permitted near cubs. Anxiety call an aspired H!. An affectional call a low, staccato, usually*

monotoned guttural or nasal chuckle Hunh-hunh-hunh-hunh. Contact call a monosyllabic, uninflected chirp."

Aonychini

***"Morphological** – Penis tip protrudes beyond abdominal wall as a preputial button, except in Enhydra. Baculum moderately curved, shaped like a baseball bat, heavy at proximal end, tapering distally with a grooved distal knob. Digits may be heavily clawed (Pteronura, Lutrogale, Enhydra), weakly clawed (A. cinerea), or clawless (A. capensis) except for digits 2, 3, and 4 of hind paws, which bear small grooming claws. Interdigital webbing variable in extent, least in clawless, greatest in clawed species.*

***Behavioral** – Social; pairing is more or less permanent; male participates in rearing young from early age with the exception of Enhydra where pairing is casual with no male parental role. Anxiety call an aspired H!. Contact call a rising and falling circumflex chirp. No chuckle; affectional call is circumflex in at least some species."*

Hydrictini

***"Morphological** – Penis completely internal, no preputial button. Baculum slightly curved, shaped like a baseball bat in general outline, heavy at proximal end, tapering distally, with a grooved distal knob. Fore and hind digits strongly clawed. Webbing between digits extensive.*

***Behavioral** – Sociable; pairing is more or less casual; male not permitted near young cubs. Anxiety call as aspired F!. Affectional call a burbling series of metallic chirps, reminiscent of the Lutra chuckle but inflected and not nasal or guttural. Contact call mono-or di-syllabic but not inflected."*

THE PHENETIC APPROACH: VAN ZYLL DE JONG'S TREATMENT

At one time, phylogenetic relationships were difficult to study in the *Lutrinae* due to the limited number of useful characteristics. As van Zyll de Jong put it: " *The only characters readily available for a study of all species of otters are those that may be derived from traditional museum specimens, which consist of skulls and skins. Postcranial elements have a less than complete representation in collections. As many species of otters are now rare or endangered, the possibility of obtaining additional material is poor." (van Zyll de Jong, 1987)*

To conduct his phenetic analysis of 12 otter species from seven genera, van Zyll de Jong analyzed a large number of skulls, a limited number of skins, and a limited number of postcranial specimens. A variety of "*…bivariate relationships of the skull and dentition were analyzed allometrically and the overall similarities of nearly all species of* ***Lutrinae*** *were estimated using taxonomic distance."* In addition, he made a number of "*…other qualitative and descriptive comparisons*". On the basis of all these comparisons, he concluded that, "*…there are probably four recent species of river otter in the Western Hemisphere, corresponding to the North American* ***Lutra canadensis****, the Neotropical* ***Lutra annectens-enudris-platensis*** *group (****Lutra longicaudis****), the Chilean* ***Lutra provocax,*** *and the southern Pacific coastal form* ***Lutra felina****." "Evidence further suggests that the relationship of the American river otters with* ***Lutra lutra*** *and other Old World species of that genus is not as close as was formerly assumed. Aside from differences in skull and dentition, the marked differences in the known bacula may be regarded as significant evidence of their distinctness." (van Zyll de Jong, 1972)*

In 1987, van Zyll de Jong again addressed the *Lutrinae* concluding, "*…the New World river otters (****Lontra****), is a monophyletic group phylogenetically linked to the African and Asian clawless otters (****Aonyx*** *and* ***Amblonyx****). The other group, their Old World ecological counterparts (****Lutra****), constitutes a different clade.* ***Enhydra*** *and* ***Pteronura*** *are the most divergent of the living otters, the former being closer to the* *clawless otters and the latter to the smooth-coated otter (**Lutrogale**), which in turn is phylogenetically close to the Old World river otters (**Lutra**).*"

Wilson and Reeder (1993) published these comments on van Zyll de Jong's treatment of otter taxonomy: *"van Zyll de Jong argued that the New World otters represent a single radiation and questioned whether **Lutra** (sensu stricto) or **Aonyx** was the closest sister group. There has been no published work to refute his hypothesis, although it has not received general acceptance. Hall (1981) chose not to question the monophyletic nature of the group, but to lower it to the subgeneric rank, feeling that the characters where not sufficient enough to warrant generic distinction. Regardless of the 'morphological gap' between the monophyletic New World otters and the Old World otters, if **Lutra** (sensu stricto) is the closest sister group, then inclusion within **Lutra** could be maintained. However, if, as van Zyll de Jong (1987) suggested, **Aonyx** is the closest outgroup, then recognition at the generic level is necessary."*

ANALYSES OF OTTER PHYLOGENETIC RELATIONSHIPS USING MITOCHONDRIAL DNA SEQUENCES: KOEPFLI AND WAYNE APPROACH (KOEPFLI & WAYNE 1998)

> *"Mitochondrial DNA sequences provide independent information that can be used to corroborate or falsify phylogenetic hypotheses derived from morphological data."* Koepfli and Wayne, "*obtained the complete nucleotide sequence of the cytochrome **b** (**cyt b**) gene to investigate the following phylogenetic"* controversy: *"monophyly or diphyly of the river otters classified in the genera **Lutra** and **Lontra**…"*
>
> "*Phylogenetic analyses consistently recovered the same clades but the hierarchical relationships among these clades varied depending on how the data matrix was weighted. The trees based on maximum parsimony and maximum- likelihood indicate that…the otters are divided into three clades, one containing the North American river, neotropical and marine otters; another containing the sea, Eurasian, spotted-necked, cape clawless and small-clawed otters; and one containing the giant otter." (Koepfli & Wayne, 1998)*

The work of Koepfli and Wayne further showed that the North American and Eurasian otter lineages diverged approximately eleven to fourteen million years ago; sometime during the middle Miocene. In addition, the three *Lontra* species (only the North American, Neotropical and Marine otters were studied; no samples from the southern river otter were available), were shown to form a "*well supported monophyletic grouping in all of the phylogenetic analyses."* Additional information on the phylogenetic work carried out by Koepfli and Wayne available in their 1998, 2003, and Koepfli et al. 2008 publications.

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CHAPTER 2 DISTRIBUTION

Introduction

Historically, along with the beaver and timber wolf, the Nearctic river otters occupied one of the largest geographic areas. This was an area that is estimated to have encompassed roughly 20 million km^2. Their range extended from 25° 08' N latitude in southern Florida to 68° 20' N latitude in northern Alaska and from 55° 30' W longitude in eastern Newfoundland to 162° 49' W longitude in western Alaska (Right map).

River Otter Distribution during the time of European settlement.
From Polechla 1988 & Hall 1981

River Otter Distribution
circa 1977
From Deems & Pursley 1978

By the late 1800's through the first half of the 1900's, the river otter rapidly disappeared from much of its former range. This disappearance was due to a variety of factors including over-trapping and hunting, general habitat degradation which included: pollution, agricultural development, and the drainage and canalization of water systems. By the late1970's, Nilsson & Vaughn (1978) estimated that the river otter was found in only 33% of its former range [in the U. S.]. By 1977 their distribution was <75% of the historic range. See map to left.

Due to the efforts of conservationists and restrictions on trapping beginning in the 1970's and 1980's the otter has gradually reclaimed much of its former range. Wetland conservation, the Clean Water Act, and trapping restrictions also contributed resulting in a river otter distribution increase to roughly 75% of their historic range by 1988; making the river otter one of the success stories of the North American wildlife conservation movement.

SUBSPECIES

►*Lontra canadensis canadensis* is found in: Newfoundland (some recognize these otters as the subspecies *L.c. degener*; the animals found here are the smallest form), Illinois, Wisconsin, Michigan, Minnesota (northeastern corner), the eastern seaboard states, Ontario, Quebec, New Brunswick, and Nova Scotia.

Type subspecies. *"Rhinarium naked, broad, with a large ascendant central point above, a very small descendant central point below; the hind feet with four small, calloused, circular rugosities on the sole near the heel; the soles with tufts of hair beneath the toes; moustachial pads well developed; skull flattened dorsally; rostrum wider, premaxillary area shorter, than in L. lutra"* (Harris 1968).

►*Lontra canadensis kodiacensis* is found on Kodiak and Afognak islands, Alaska. A smallish subspecies, the subspecific distinction is based on a combination of cranial details (Harris 1968).

►*Lontra canadensis lataxina* is found in the southeastern U.S., central plains and Gulf of Mexico states. In recent times this subspecies has been used for reintroduction and restocking projects in some states where it is believed not to have been found historically.

Total weight ranges from 7.25 kg. to 10.4 kg. (16 to 23 lbs.). Total length ranges from 1130 – 1270mm (44 to 50 in.) "*Usually smaller and lighter in colour, than the typical form; soles of its feet less hairy; skull small, teeth relatively massive*." The tail may be proportionally longer than in other forms. "*Southern specimens may be lighter than northern ones*" (Harris 1968).

►*Lontra canadensis mira* is found in the Alexander Archipelago, Alaska (including the Prince of Wales' Island). This is the largest of the subspecies with a massive, broad, and somewhat angular skull (Harris 1968).

►*Lontra canadensis pacifica* is found throughout Alaska, Yukon and Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, and parts of Ontario. In the U.S. it is found in northern California, Oregon, Washington, Idaho, Montana, Wyoming, North Dakota, South Dakota, most of Minnesota, parts of Colorado, northern Utah, and northern Nevada. Usually lighter in color than the other forms. The inferior surface of the feet and webs are generally almost naked (Harris 1968).

►*Lontra canadensis periclyzomae* is found on the Queen Charlotte Islands, Windfall Harbor, Admiralty Island, and Savok Bay area in Alaska. This form is significantly smaller than *L.c. mira* which is the largest North American river otter form.

►*Lontra canadensis sonora* is found in parts of Arizona, Nevada, southeastern California, southern Utah, and New Mexico. This subspecies has nearly disappeared (Nowak 1991). Fish and Wildlife experts in New Mexico and Colorado believe it to be extirpated in their states. This is a large subspecies; weight ranges from about 8.8 kg. to 11.3 kg. (19 lbs. to 25 lbs.), and a total length up to about 1348mm (53 in.). This form has a very long hind foot (Harris 1968).

Lontra canadensis – Subspecies Map

***Lontra canadensis* Subspecies**

1. *L. c. canadensis*
2. *L. c. lataxina*
3. *L. c. pacifica*
4. *L. c. sonora*
5. *L. c. mira*
6. *L. c. periclyzomae*
7. *L. c. kodiacensis*

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CHAPTER 3 STATUS

> *"During the late 1800's and early 1900's, the synergistic effect of wetland destruction, pollution, and overexploitation for furs was devastating to North American river otter populations. Additional otter losses were due to road kills, accidental drowning in fishing nets and 'incidental take during beaver trapping'."* (Foster-Turley et al. 1990)

The beginning of the 20th century saw the introduction of conservation measures that prompted the initial recovery of the river otter in some areas. These measures included, restricted trapping and hunting seasons, increased public awareness and education, and, the preservation of wetlands. These early efforts have been aided in the latter half of the 20th century by habitat restoration in some areas and re-stocking/translocation projects.

"The reintroduction and restocking of beavers from the 1920's to the 1950's also had a positive influence on otter populations." Because beaver dams increase wetland area and otters frequently use beaver lodges as denning sites, the otters benefit from a, *"..facultative commensalism with beavers"* (Foster-Turley 1990).

In the 1970's, Nilsson & Vaughn (1978) estimated that the river otter was found in only 33% of its former U. S. range. The causes of this were listed as: intensive trapping, pollution, destruction of habitat by clearing land, draining marshes, and channelizing streams.

In 1971 Ed Park published these results from a survey he conducted of all the U. S. states and Canadian provinces where otters had historically occurred:

> *"Otters are evidently still plentiful enough in the East to warrant a trapping season in most of the Atlantic Coast states from Maine to Florida, and in the Gulf Coast states, including Texas, which also admits "no large population present in the state." The three Great Lakes states of Michigan, Minnesota, and Wisconsin have adequate otter populations, as do the northwestern states of Washington, Oregon, Nevada, Idaho, Montana, and Wyoming."*
>
> *"…From Colorado: "No otter have been observed in Colorado for many years." Indiana: "The last authentic record of the presence of otter in the state was of one shot by a hunter in Posey County on December 7, 1942." Oklahoma: "There are no otters in Oklahoma." South Dakota: "No otter or otter literature." West Virginia: "West Virginia sustained a small population of otter until approximately 15 years ago."*
>
> *"Many other states report the otter as rare. A report from North Dakota said, "Two reports of otters in North Dakota in recent years indicate that this valuable furbearer may not be entirely extinct within the state." A report from Iowa read, "Otter is a pretty rare item in Iowa in recent decades. Occasional one turns up in nets of commercial fishermen in Mississippi river along NE border."*
>
> *"So, while many states still claim to have a few otters, they are almost gone from the vast central part of our country – from North Dakota to Texas and from West Virginia to Utah."*
>
> *"Canada and Alaska, of course, still have many otters, with trapping seasons in Alaska and all the Canadian provinces."*
>
> (Park 1971)

Jenkins (1983) adds: *"Today the otter is essentially absent from the interior of the U.S. and the arid southwest where it was always rare. There can be little doubt that habitat destruction, unregulated trapping, and water pollution eliminated otters over wide areas of the interior of the country and in the more industrialized parts of North America."*

Although in the1990 Otter Action Plan the IUCN Otter Specialist Group considered the North American river otter as a species receiving adequate protection, they made several suggestions for areas needing study, these suggestions included: *"Critical evaluations of current status determinations are of highest priority for this species, especially in states and provinces where harvest is permitted."*

A telephone survey of the Fish and Wildlife Agencies of Canada and the 49 U.S. states with historic otter populations was conducted by Reed-Smith in 1994. At that time much of the status data was anecdotal or based on experience and "gut feeling" versus definitive status surveys. Subsequent to this a questionnaire status survey was conducted by Serfass (2000) and a web search survey by Reed-Smith in 2012 (see N. A. River Otter (Lontra canadensis) – U. S. Wild Population Status – Table).

In 1994 many of the states that allowed trapping had very small harvest limits; the bag limit was essentially set to cover incidental trapping of otter by beaver trappers. (This was not universally true, some states and Canada reported heavier trapping of otter.) Due to the decline of the fur market over the last decade or two, several states indicated that interest in otter trapping was minimal. Because of this lack of interest in fur trapping in general, some states had seen a dramatic increase in beaver populations. The increase in beaver numbers had often resulted in a concomitant increase in the otter population due to the improved river otter habitat created by the beaver.

During and since the 1994 survey results show the beginning of a reversal in the decline of the fur market. Many states and all of the Canadian provinces reported a rise in otter pelt value, in some cases tripling, at least doubling, over the previous two to three years (1992 – 1994). To a large extent, the price jump was believed to be due to an increased interest in otter pelts in the world fur market, particularly in Asia. As of 1995 most states were still reporting limited intentional trapping of otter however, Canada reported more active otter trapping. Pelt prices rose and fell somewhat during the late 1990's, became quite high in the early 2000's and is still (2012) at a fairly high level.

In recent years several states have reinstated an otter trapping season, including several states where reintroductions or stocking programs took place. The otter is considered a fur-bearer species in the United States so management to allow for trapping was most likely part of most state plans. At this time some states are doing a good job of monitoring trapping but, efforts could likely be improved upon in some areas. The price for an otter pelt in 2012 averaged about $70 with tanned skins or full pelts going for $249 or more (http://www.fursource.com/otter-fur-pelts-tanned-skins-p-375.html).

Editor's note: Trapping is very controversial; I personally do not condone it. However, as a wildlife professional I recognize that trapping fees, etc. are important resources to state management of wildlife. Also, trapping is an activity with a long tradition in many states. Some states are open about wanting a trapping season; others justify it by positioning otter populations as in danger of becoming too large and wiping out fish resources. This is not a sound assessment as populations are under many natural controls including habitat availability and environmental dangers such as injury, predation of young, roads, habitat loss, habitat fragmentation, dogs, etc. Some states have carried out diet analyses that indicate otters are taking far more crayfish than anticipated and that their overall impact on the status of game fish populations is minor. However, due to pressure from sport fishermen, based on the perception otters are impacting fish populations, otters have been trapped out of some watersheds. Caution should be exercised when portraying river otters as responsible for extensive fish depredation as a justification for trapping seasons.

N. A. River Otter (Lontra canadensis) – U. S. Wild Population Status - Table				
STATE	IUCN OAP 1990	REED-SMITH 1994	SERFASS (2000)	REED-SMITH (2012)
Alabama	HP, SP	HP, SP	HP, IP	HP, US
Alaska	HP, SP	HP, SP	HP, SP	HP,
Arizona *	HNP, SP	HNP, SP, T	HNP, SM-RE, SS	HNP, DP, SS
Arkansas	HP, IP	HP, IP	HP, IP	HP, IP presumed
California	HNP, SP	HNP, SP, SS locally,	HNP, SP	HNP, SS
Colorado *****	HNP, DP	HNP, US, E	HNP, E	HNP, T, US
Connecticut	HP, SP	HP, IP	HP, IP	HP, SP
Delaware	HP, SP	HP, SP	HP, SP	HP, SP
Florida	HP, SP	HP, SP	HP, SP	HP, SP
Georgia	HP, IP	HP, IP	HP, IP	HP, SP
Idaho	HNP, SP	HNP, IP	HNP, SP-IP	HP, SP
Illinois *	HNP, US	HNP, IP, E	HNP, T	HNP. IP
Indiana *	Extirpated, US	HNP, E	HNP, E	HNP, SS, IP
Iowa*	HNP, IP	HNP, SP, SM, T	HNP, IP, T	HP, SP
Kansas *	HNP, IP	HNP, IP, SM	HNP, IP	HP, SP
Kentucky *	HNP, IP	HNP, IP, PM	HNP, IP, PM	HP, SP
Louisiana	HP, SP	HP, SP	HP, SP	HP, SP
Maine	HP, SP	HP, SP to IP	HP, SP	HP, SP
Maryland *	HP, IP	HP, IP	HP, IP	HP, SP
Massachusetts	HP, SP	HP, IP	HP, SP	HP, SP
Michigan	HP, SP	HP, SP	HP, IP	HP, SP
Minnesota*	HP, SP	HP, IP	HP, SP	HP, SP
Mississippi	HP, SP	HP, SP to IP	HP, IP	HP, SP
Missouri *****	HNP, IP	WL	HP, IP	HP, SP
Montana	HP, SP	HP	HP, IP	HP, SP
Nebraska *	HNP, IP	HNP, IP, E	HNP, E	HNP, E, IP
Nevada	HP, SP	HP & HNP (county dependent), SP	HP, SP	HP & HNP (allowed in 5 counties)
New Hampshire	HP, IP	HP, SP, U to C	HP, SP	HP, SP
New Jersey	HP, SP	HP, SP to IP	HP, SP	HP, SP
New Mexico*	HNP, US	extirpated	extirpated	SM, U
New York *****	HP, IP	HP, IP	HP, SP	HP & HNP, SP
North Carolina *	HP, IP	HP, SP to IP	HP, IP	HP, SP
North Dakota	HNP, IP	HNP, regarded as extirpated	HNP, extirpated ?	HNP,SM, SS
Ohio *****	HNP, SP	HNP, IP, E	HNP, IP, E	HNP & HP (by zone), SP
Oklahoma *	HNP, IP	HNP, IP	HNP, IP	HP, SP
Oregon *	HP, SP	HP, IP	HP, SP	HP, SP
Pennsylvania *****	HNP, SP	SS, IP	HNP, SS, IP	HNP, SS, IP
Rhode Island	HNP, IP	HNP, IP, PM	HNP, IP	HNP,
South Carolina	HP, SP	HP, SP	HP, IP	HP, SP
South Dakota*	HNP, US	HNP, US, T	HNP, T	HNP, T
Tennessee *	HNP, IP	HP & HNP, T in part, SP to IP	HP & HNP, IP, T	HP, SP
Texas	HP, IP	HP, SP	HP, IP	HP, SP
Utah *	HNP, US	HNP, US, SM, SS, SM	HNP,SP, SS	HNP, SM, PM
Vermont	HP, IP	HP, SP, C	HP, SP	HP, SP
Virginia*	HP, SP	HP, IP to DP dependent on area,	HP, SP-IP	HP, SP
Washington	HP, SP	HP, IP to SP dependent on area	HP, IP	HP, SP
West Virginia *	HNP, IP	HNP, PM	HNP, PM	HP, SP
Wisconsin	HP, IP	HP, SP to IP, C	HP, IP	HP, SP
Wyoming	HNP, IS	HNP, US to DP, PS, SM	HNP, PM	HNP, U, SS

LEGEND: HNP – Harvest Not Permitted**; HP** – Harvest Permitted**; SP** – Stable Population**; DP** – Declining Population**; US** – Unknown Status**; IP** – Increasing Population**; E** – State Endangered Species List**; T** – Threatened**; SS** – Species of Special Concern/Risk**; PM** - Protected Mammal,**; WL** – Watch Listed**; SM** – Small Population**; U** - Uncommon**; C** – Common**;** * **Reintroduction, Restocking, or translocation projects have taken/are taking place/ or are under consideration.**

State Specifics

The most current update was done utilizing the states' websites. Some were user friendly; others made it more difficult to locate trapping information. Most sites do not provide an assessment of current population trends so an assumption was made that at a minimum, were trapping is allowed, the population is stable.

Alabama: Little known about state distribution but considered of Least Conservation Concern. Trapping permitted during season which runs between November 10 and February 28.

Alaska: Harvest is permitted. Studies to better assess sustainable harvest level and population status are on-going. Otter season is broken down by region (known as Unit) as follows: Unit 1 – 4: December 1 – February 15; unit 5: November 10 – February 15, units 6, 9 to 11, 13, 14A & B, 16, 17, 18: November 10 – March 31; units 7, 14C, & 15: November 10 – February 29; unit 8: November 10 – January 31; units 12, 19 – 25,26A, 26B, 26C November 1 – April 15; There is no bag limit in any of these areas. (Taken from 2011- 2012 Alaska Trapping Regulations; http://www.adfg.alaska.gov/index.cfm?adfg=wildliferegulations.main). Fish & Game supported research in the early 2000's into better ways to assess river otter populations and sustainable trapping levels; one conclusion they reached is:

> *"The effects of oil contamination and logging on habitat use, movements, and food habits of river otters indicate these animals are sensitive to disturbance by humans. River otter response to these types of human disturbances and to others, such as harvest, construction of dwellings, and heavy recreational use, are important management considerations that need to be addressed."* (Golden 2004)

Arizona: Several otters from Louisiana were introduced in 1981 to 1983. Historically the L. c. sonora subspecies occurred in the Colorado and Gila rivers and their major tributaries. Listed as a state species of concern.

Arkansas: Hunting and trapping are permitted within season. Hunting and trapping seasons are: November12 – February 29 with a limit of two per day for hunting. No information could be found online regarding the status or assessment methodology.

California: Species listing does not appear to have been updated since 1998. No information available on population status.

Colorado: The state has an online otter observation report form intended to use citizen reports of sightings to assist with their management plan. Between 1976 and 1991 roughly 114 to 122 otters were released into Colorado. An additional 67 otters were released by Utah into the Green River near the Colorado border some of which may have crossed over. Survival of these released otters was approximately 60% for the first 3 months. No reliable methodology has been developed to assess current population status or increase.

Connecticut: Trapping is permitted, with a bag limit of 8, from November 4 – December 31 and January 1 – March 15.

Delaware: Trapping is permitted from December 1 – March 10. No information available on bag limit or methodology used to assess otter status.

Florida: Trapping is permitted from December 1 to March 1 (which means pups may be left in dens) with no bag limit. No information available on the Fish and Wildlife site regarding status of population or methodology used to assess sustainability of harvest.

Georgia: Trapping is permitted from December 1 to February 29 (which means pups may be left in dens) with no bag limit. No information available on the Fish and Wildlife site regarding status of population or methodology used to assess sustainability of harvest.

Idaho: A trapping season was reinstated in 2000. The season runs from November 1 (in some areas it begins October 22) – March 15 with a per person quota of 2. During the 2011 – 2012 trapping season 94 of a harvest quota of 125 were taken.

Illinois: Otters were listed as Threatened in 1977 and reclassified as Endangered in 1989. A restocking program was carried out between 1994 and 1997 when 346 Louisiana otters were released. This led to an upgraded listing to Threatened in 1999 and a delisting in 2004. The state Fish and Wildlife web site appears to be positioning the otter population as approaching saturation. This is likely a prelude to reinstating a trapping season.

Indiana: Between 1995 and spring of 1999, 300 otters were released in the state leading to a delisting as Endangered and their status as a species of special concern. At this time documentation from accidental mortality finds & sightings indicate an increasing population.,

North Dakota: On the state list of 100 Species of Conservation Priority; given a Level II listing which means they are in need of conservation but have support from other programs.

> *"Historically, river otters occurred in aquatic habitats throughout North Dakota. A combination of unregulated trapping, loss of wetlands and riparian habitat and susceptibility to pollutants resulted in the near-extirpation of otters from the state. In recent years, the number of otter sightings has increased, according to the NDGFD. However, it is not known if otters have re-colonized their former range or if a viable population exists in North Dakota."* (Hagen et al. 2005)

Threats facing otters in ND include:

- *"Habitat: The greatest threat to river otters is destruction or modification of riparian habitat for the purposes of economic or housing developments, recreation, or for conversion to cropland.*
- *Other Natural or Manmade Factors: Aquatic habitats where river otters have been sighted and other water bodies throughout North Dakota have documented pollution issues (i.e., dissolved oxygen, sediment, nutrient and heavy metal levels) that could impact survival of otters by reducing prey availability or impairing reproduction. River otters are susceptible to human-caused mortality, including incidental trapping and collisions with vehicles. In 2004, five of six reported otters were human-caused mortalities."* (Hagen et al. 2005)

Iowa: By the early 1900's there were very few otter sightings in most of the state. A small remnant population was known to exist along, and adjacent to the Mississippi River in northeastern and central Iowa. Reintroduction efforts were begun in 1985 and continued through 1990 with a total release of about 222 otters. In 1997 and 1998 otters were released into two additional watersheds. The river otter was delisted from the state threatened list in 2001 but still received some protected status until the first trapping season in 2006 – 2007 (with a statewide limit of 400 and an individual bag limit of 2). Between 2002 and 2004 some otters were live trapped and translocated to under-populated areas within the state. The statewide quota was raised to 500 for the 2008 – 2009 season (7 November – 31 January) with an individual bag limit of 2; this was increased to a statewide quota of 650 and a personal bag limit of 3 for the 2011-2012 season. http://www.iowadnr.gov/Portals/idnr/uploads/Hunting/2010_logbook.pdf shows maps of each county and trapping takes.

Kansas: As has been reported from much of the otter's historic range the river otter had mostly disappeared from Kansas by the early 1900's; the last reported otter was trapped near Manhattan in 1904. Otters (17 animals) were released into the state from 1983 to 1985. Beginning in 2011there is a provisional trapping season from 14 November to 31 March with a statewide limit of 100 otters and a per person limit of 2.

Kentucky: The 2011 – 2012 trapping season ran from 4 November – 29 February (which means females may have cubs in the den). Between 1991 and 1994 335 otters were released in the eastern and central portions of the state. The first experimental trapping season was opened in 2004 and between 2006 and

2008 a study was contracted to assess the otters' status within the state. Currently the bag limit is 6 per individual; hunting with guns and dogs is permitted.

Louisiana: The most recent trapping season ran from 20 November 2011 to 31 March 2012 (which means females may have cubs in the den). No information could be found regarding bag limits on the state's website.

Maine: The most recent trapping season ran from 30 October to 31 December 2011 statewide. During the 2010 season 754 otters were taken; dating back to 2003 the highest number of otter taken in one year was the 2005 season with a harvest of 1,041. There is no state bag limit during the trapping season.

Maryland: Most of the state has an open (no limit) trapping season for otter. There is a proposed, limited (bag limit of 1) for the last two counties where otter populations were the lowest. This proposal is to take into account accidental trapping in beaver sets. In the 1990's otter were trapped within the state and translocated to a three-county area where their numbers had dwindled throughout the 19th century and early 20th century.

Massachusetts: Trapping is permitted from 1 November to 15 December. Otter trapping is permitted statewide with no state quota or individual bag limit.

Michigan: Trapping is permitted from 25 October to 15 April in the Upper Peninsula (Unit A) with a bag limit of three. Unit B season runs from 1 November to 15 April with a limit of 2 and in Unit C (lower third of the state) runs from 10 November to 31 March with a limit of one otter per trapper.

Minnesota: Trapping is permitted 27 October to 5 January in the northern zone, there is no season posted for the southern zone for otter. They estimate that roughly 2,000 otters are trapped each year from a population of about 12,000.

Mississippi: Trapping is permitted, without a bag limit, between 1 November and 28 February (which means females may have cubs in the den).

Missouri: Trapping is permitted between 15 November and 20 February (which could mean cubs left in the den). There is no limit. During the 1980's and 90's over 800 otters were introduced into the state.

Montana: Trapping is permitted statewide between 1 November and 15 April with a bag limit of two otters per person.

Nebraska: In 1986 the river otter was given a state listing of Endangered. Between 1986 and 1991 otters were released into seven sites. The Nebraska Fish and Game website was one of the easier to use and offered some interesting facts about the disappearance of the river otter nationwide:

> "*The take of river otters listed in the records of fur trading companies, including the famous Hudson's Bay and Northwest companies, indicate that otter harvest peaked in about 1800 when some 65,000 otters were taken in North America. Otter take gradually declined to a low of about 4,500 in 1904, about the time otters disappeared from Nebraska. Unregulated trapping was probably the most important factor leading to the complete disappearance of otters from Nebraska. For about the next 75 years, few otters were reported from Nebraska, and none were verified." In 1977, an otter was inadvertently trapped along a tributary of the Republican River in Furnas County. Otters continued to be reported in various parts of the state, mainly in the Republican River drainage. Because otter sightings were infrequent and no concentrations of animals were ever found, it is likely the animals observed since 1977 were transients rather than part of an established population. Although otters are endangered and fully protected* [no longer protected] *in Nebraska and are uncommon in neighboring states, they are relatively abundant in Alaska, most of Canada, the Pacific Northwest, the Great Lakes states and most states along the Atlantic Coast and Gulf of Mexico. Currently, about half the lower 48 states, Alaska and all the Canadian provinces have otter trapping seasons. In some recent years, more than 50,000 otters have been taken in North America. The otter harvest in Louisiana sometimes exceeds 10,000*

animals, usually surpassing that in any other state. Although otters are common in many areas, their population densities, as predators near the top of the food chain, never approach those of animals lower on the food chain."

Nevada: Trapping is allowed in five counties only. The season runs from 1 October to 31 March.

New Hampshire: There is a trapping season the timing of which varies somewhat with the location in the state; either 15 October or 1 November to 10 April. The seasonal bag limit is 10 per trapper.

New York: Trapping is permitted in areas of the northeast and southeast of the state. The northeast season runs from 1 November to 7 April and in the southeast from 10 November to 28 February. There are no bag limits in these areas.

New Mexico: River otters were believed extirpated from New Mexico with only an occasional sighting of what were believed to be transient animals from neighboring states. Lobbying for reintroduction of the otter began in the 1980's with a feasibility study begun in the early 2000's and approved in 2006. The first reintroductions of otters were slated to occur in 2008 but may have been put on temporary hold. At this time they are considered a protected fur bearer species.

North Carolina: Trapping is permitted, dependent on location within the state, between 1 November or 1 December and 28 February. Despite the statement on their website that trapping season is designed to take females when young are independent this is most likely inaccurate as young may be born as early as February and will still be dependent on the female. The website does not list bag limit.

Ohio: Trapping is permitted in two zones between 26 December and 29 February. Trapping is not permitted in Zone A (roughly the western half of the state), a bag limit of one is allowed in the central region (Zone B) and a limit of three is allowed in the eastern portion of the state (Zone C). Beginning in 1986, 127 otters were released over the next 7 years. After reintroducing otters the first trapping season was held in 2005 – 2006.

Oklahoma: Trapping season, open in certain counties, runs from 1 December to 29 February with a season limit of two. There are rule change proposals under consideration for the 2012 – 2013 season that would open otter trapping statewide and raise the limit to 4. Otters were reintroduced to the state in the late 1980's.

Oregon: Trapping is permitted from 15 November to 15 March throughout the entire state except one county and all areas closed to beaver trapping. No information available on bag limit.

Pennsylvania: The otter is listed on the state's list of Species of Greatest Conservation Need as a species of Maintenance Concern because the population is still re-establishing itself after becoming extirpated and then reintroduced beginning in the 1980's.

Rhode Island: Harvest is not permitted; unable to locate species status.

South Carolina: Harvest is permitted from 1 December to 1 March (which means dependent young could be left in the den). No information on quotas could be found.

South Dakota: Listed as a State Threatened Species.

Tennessee: Trapping allowed from the Friday before Thanksgiving until 15 February (which means dependent young could be left in the den). There is no bag limit.

Texas: Trapping is permitted, difficult to find details.

Utah: River otter were never very common in Utah and have been legally protected since 1899 when the reduction of the population from historic levels was first reported. Trapping is not permitted and in 1989 otters were first reintroduced into the state. This re-stocking of otters has taken place periodically throughout the years since.

Vermont: Trapping is permitted between 27 October and 28 February.

Virginia: Trapping is permitted from 1 December to 29 February (which could leave dependent cubs in the den). There is a bag limit of 2 west of the Blue Ridge and no bag limit in counties east of the Blue Ridge.

Washington: Trapping is permitted from 1 November to 31 March with a bag limit of 12.

West Virginia: The river otter was first given protection in 1925. While occasionally observed through the late 1950's it is believed the population was too low to be self-sustaining. West Virginia was one of the first states to successfully reintroduce otters. This introduction effort ran from 1984 to 1997 (245 otters). A trapping season was proposed for the 2011/2012 year which ran from 5 November to 29 February with a possession limit of one.

Wisconsin: Trapping season varies slightly with location; typically ranges from early November to 31 March in the southern and central part of the state and until 30 April in the northern part of the state.

Wyoming: River otter are considered an uncommon non-game species and given a listing of NSS4 (native species of special conservation status, level 4) in the 2009 state atlas and relisted as NSSU in a 2010 listing. The following map shows believed distribution of the species within the state. (http://gf.state.wy.us/web2011/Departments/Wildlife/pdfs/SWAP_NORTHERNRIVEROTTER0000518.pdf

Raesly (2001) published the results of her status survey done in 1998.

Table: N. A. River Otter (Lontra canadensis) – Canadian Wild Population Status
(IUCN/SSC Otter Action Plan 1990, Reed-Smith 1994/95, IUCN/SSC Otter Action Plan 2000)

PROVINCE	IUCN OAP 1990	REED-SMITH 1994	REED-SMITH 2001 & 2012
Alberta *	HP, SP	HP to HNP dependent on area, SP to IP dependent on area.	HP, to HNP dependent on area, SP to IP.
British Columbia	HP, SP	HP, SP	HP, SP
Manitoba	HP, SP	HP to HNP dependent on area, SP, U to C	HP, SP, C
New Brunswick	HP, SP	HP, SP	HP, SP
Newfoundland	HP, SP	HP, SP, C	HP, SP
Northwest Territories	HP, SP	HP, SP(?)	HP, SP
Nova Scotia	HP, SP	HP, SP	HP, SP
Ontario	HP, SP	HP, SP	HP, SP
Prince Edward Island	extirpated	extirpated	extirpated
Quebec	HP, SP	HP, SP	HP, SP
Saskatchewan	HP, SP	HP, SP, C	HP, SP
Yukon	HP, SP	HP, SP	HP,SP

LEGEND: **HNP** – Harvest Not Permitted**;** **HP** – Harvest Permitted**;** **SP** – Stable Population**;** **DP** – Declining Population**;** **US** – Unknown Status**;** **IP** – Increasing Population**;** **E** – State Endangered Species List**;** **T** – Threatened**;** **SS** – Species of Special Concern**;** **PM** - Protected Mammal,**;** **WL** – Watch Listed**;** **SM** – Small Population**;** **U** - Uncommon**;** **C** – Common**;**
***- Restocking or translocation projects have taken/are taking place.**

Cites Listing and IUCN Red Listing

In 1977 N. A. river otters were listed as an Appendix II species by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). This species is currently listed as Least Concern by the IUCN/SSC.

"*Appendix II: Species are not presently threatened with extinction, but may become so unless their trade is regulated. Import permits are not required, but an export permit or re-export certificate must accompany each shipment. Export permits can be issued as long as the export will not be detrimental to the survival of the species. Re-export certificates are required for species previously imported.*

"■ All CITES wildlife shipments must enter and leave the U.S. through customs ports designated by FWS, unless an exception is obtained. Shipments must comply with the International Air Transport Association Live Animal Regulations (IATA) and CITES Transport Guidelines.

"■ CITES establishes procedures to regulate the import and export of species threatened by trade. The treaty covers animals and plants, whether dead or alive, or any readily recognizable part or derivative of that animal or plant.

"■ The ESA (Endangered Species Act) *designated the Interior Department both the management and scientific authority for CITES in the U.S. The FWS/Office of Management Authority reviews the effects of wildlife and plant trade and issues or denies permits. The FWS/Office Scientific Authority determines whether the issuance of the permit will not be "detrimental" to the survival of the species." (AZA 1994)*

Otter/human Relationship

First and foremost, river otters are frequently confused with sea otters. Stand at any otter exhibit in any zoo or aquarium and you will soon hear comments similar to these: "*I love otters." "It is so much fun to watch them float on their back and use a rock to break open a clam then run and slide in the snow or mud!"* Confusion like this is not the fault of the zoo visitor. It comes from the high profile of the sea otter, a focus only on the word otter, and a basic unfamiliarity with wildlife. It is the job of zoos and aquariums to change this.

Otters in the wild are appreciated, tolerated, persecuted, or trapped; it all depends on where the otters are and who you are talking to. Otters can be viewed as pests by home owners, boat owners, and anglers. They can have serious economic impact on fish ponds, they are not looked on kindly by some beaver trappers, and of course, they are trapped themselves for their beautiful fur. Thus far, with some sound conservation measures passed in the late 1960's and 1970's the river otter has been a true conservation success story despite all the previous mentioned people who may not be too happy to have an otter visit their stream, river, or lake. However, this could change quickly, especially if pollution continues to go unchecked, wetlands continue to disappear, and habitat fragmentation accelerates. (See also Native American Tales and Legends)

Ex-Situ Status and Studbook Information

The N. A. River Otter Studbook Keeper, David Hamilton (General Curator, Seneca Park Zoo), has provided the following information (Hamilton 2012). As of 2 July 2012 there were 270 (145.125.0) river otters held in 110 AZA institutions participating in the studbook. Studbook information is continuously updated and refined to provide the most accurate current and historical record of the *ex-situ* Nearctic otter population.

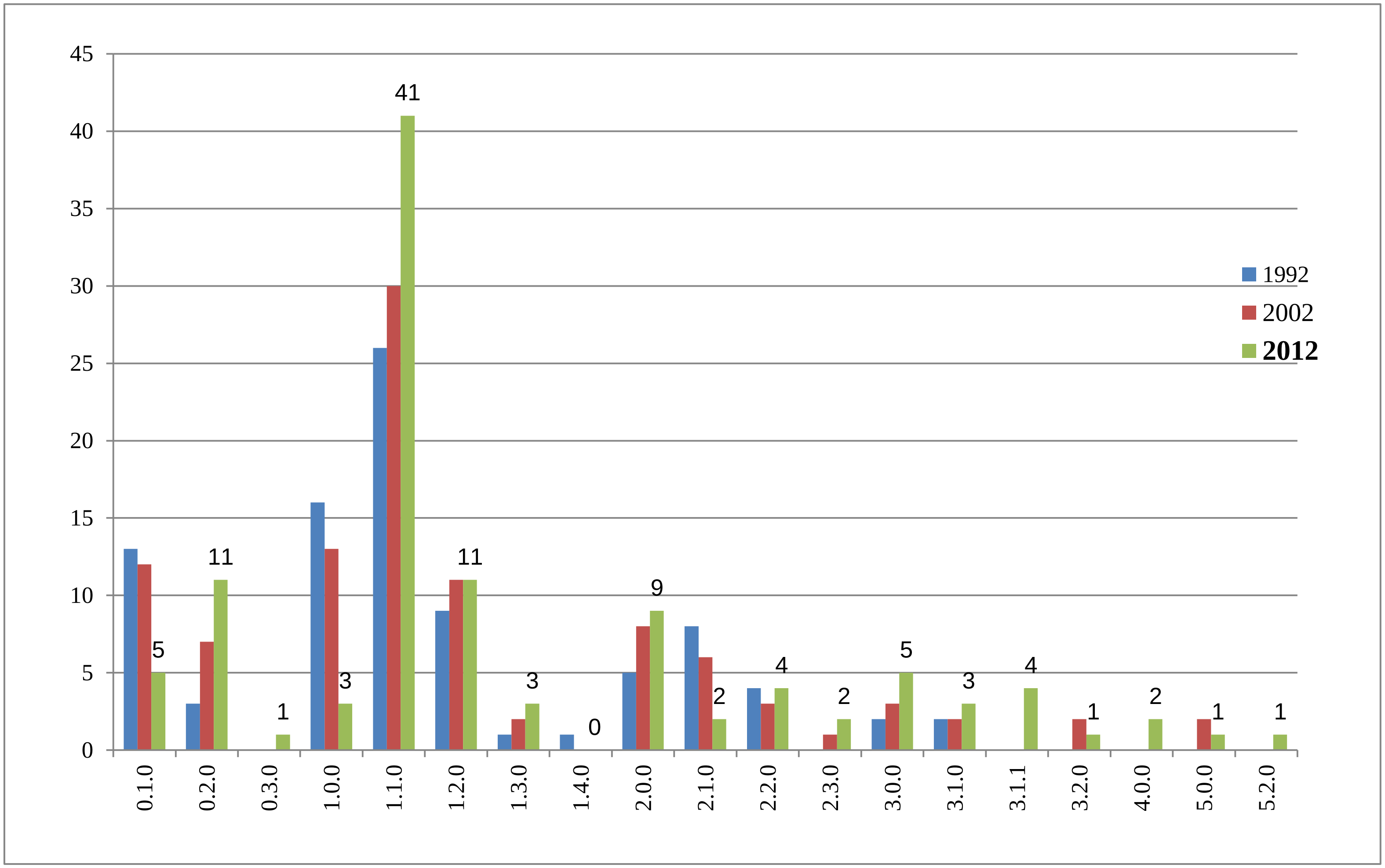
GROUPINGS HELD

Snapshot of otter groups held in AZA institutions on 01 January of each 10 year period. The data is presented in chart and then graph formats.

Otter Group Held (M.F.U)	# Institutions 1/1/1992	# Institutions 1/1/2002	# Institutions 1/1/2012
0.1.0	13	12	5
0.2.0	3	7	11
0.3.0	0	0	1
1.0.0	16	13	3
1.1.0	26	30	41
1.2.0	9	11	11
1.3.0	1	2	3
1.4.0	1	0	0
2.0.0	5	8	9
2.1.0	8	6	2
2.2.0	4	3	4
2.3.0	0	1	2
3.0.0	2	3	5
3.1.0	2	2	3
3.1.1	0	0	4
3.2.0	0	2	1
4.0.0	0	0	2
5.0.0	0	2	1
5.2.0	0	0	1
Total Institutions	90	102	109
Year	1/1/1992	1/1/2002	1/1/2012
Total Otters M.F.U (total)	99.88.0 (187)	123.105.0 (228)	142.127.0 (269)

M.F.U = Males.Females.Sex unknown

Nearctic Otter Group Composition (male.female.unknown) Held by AZA Institutions as of 01 January of each 10 year period.



DAM INFORMATION
71 reported dams, with 175.147.50 (372) offspring (not including 406 offspring of UNK/MULT dams)

Litter Size
Median size: 3 Mean size: 2.657

Litter Size	Frequency	Percentage
1	30	21.43
2	30	21.43
3	45	32.14
4	28	20.00
5	7	5.00
Total	140	100.00

Dam Age at First Reproduction
Median age: 4.983 Mean age: 5.35

10 Youngest Dams Age at First Reproduction:

Studbook ID	Age At Birth	Dam's Birth Date	Estimate	First Offspring's ID
2216	1.988	3/5/2004	None	2250
1321	2.001	1/1/1979	Year	1391
1291	2.721	6/1/1977	Year	1366
2376	2.776	4/1/2007	Day	2391
1171	2.979	4/2/1972	None	1240
1848	3.023	1/22/1995	None	1951
1591	3.034	3/1/1988	Month	1699
2300	3.064	3/2/2007	None	2411
1712	3.091	11/22/1991	None	1827
1408	3.19	1/1/1982	None	1494

10 Oldest Dams Age at First Reproduction:

Studbook ID	Age At Birth	Dam's Birth Date	Estimate	First Offspring's ID
1559	11.874	4/7/1987	None	1985
1606	10.163	1/1/1989	Year	1988
1162	10.111	1/1/1972	Year	1415
1285	10.015	4/1/1977	Month	1559
1831	9.969	12/31/1994	Month	2218
1431	8.246	1/1/1983	None	1703
1579	8.126	1/1/1988	Year	1887
1999	8.044	12/15/1999	None	2333
1986	7.951	2/20/1999	None	2276
2209	7.904	5/1/2003	Month	2439

Dam Age for All Reproduction

Median age: 6.097 Mean age: 6.562

10 Oldest Dams to Have Reproduced

Studbook ID	Age At Birth	Dam's Birth Date	Estimate	Offspring's ID
1377	13.966	4/1/1980	Month	1810
1893	13.057	3/1/1996	None	2366
1393	12.999	1/1/1981	Year	1800
1285	12.983	4/1/1977	Month	1655
1285	11.967	4/1/1977	Month	1618
1377	11.937	4/1/1980	Month	1731
1559	11.874	4/7/1987	None	1985
1893	11.069	3/1/1996	None	2287
1618	11.064	3/20/1989	None	2040
1606	10.163	1/1/1989	Year	1988

10 Dams with Most Offspring

Studbook ID	# of Offspring
1893	25
2216	25
1377	20
1940	19
1712	16
1541	14
1647	11
1618	10
1710	10
1859	9

10 Shortest Inter-birth Intervals

(Intervals are calculated from the last of a litter to the first of the next litter.)

Studbook ID	Interval (Days)	Offspring1	Birth Date	Birth Date Est.	Offspring2	Birth Date	Birth Date Est.
1616	327	2139	4/1/1994	None	1849	2/22/1995	None
1377	339	1597	4/30/1988	None	1620	4/4/1989	None
1616	346	1779	4/20/1993	None	2138	4/1/1994	None
1712	346	1829	12/25/1994	None	1867	12/6/1995	None
1859	346	2074	3/17/2002	None	2147	2/26/2003	None
1291	352	1369	2/20/1980	None	1398	2/6/1981	None
1893	354	2047	3/24/2001	None	2048	3/13/2002	None
2216	354	2303	3/2/2007	None	2371	2/19/2008	None
2216	356	2403	3/9/2010	None	2432	2/28/2011	None
1969	356	2126	3/28/2003	None	2185	3/18/2004	None

Birth Seasonality

First of litter must have a birth date estimate of None, Day, or Month to be counted.

Month	Number of Litters	Percentage
January	14	10.07
February	22	15.83
March	62	44.60
April	24	17.27
May	1	0.72
June	0	0.00
July	0	0.00
August	1	0.72
September	0	0.00
October	0	0.00
November	2	1.44
December	13	9.35
Total	139	100.00

Sire Information

57 reported sires, with 143.118.37 (298) offspring (All ages are at dam conception)

Sire Age at First Reproduction

Median age: 5.216 Mean age: 6.279

10 Youngest Sires Age at First Reproduction:

Studbook ID	Age At Estimated Conception	Sire's Birth Date	Estimate	First Offspring's ID
1241	0.934	3/26/1975	None	1280
1741	1.136	11/1/1992	Month	1825
2316	1.93	1/3/2006	Month	2344
1526	1.958	4/5/1986	None	1618
1754	2.04	2/1/1993	Month	1887
2147	2.059	2/26/2003	None	2271
1521	2.097	3/1/1986	Month	1625
2149	3.012	2/26/2003	None	2300
2130	3.014	2/15/2001	Day	2225
2230	3.053	2/28/2005	Day	2345

10 Oldest Sires Age at First Reproduction:

Studbook ID	Age At Estimated Conception	Sire's Birth Date	Estimate	First Offspring's ID
1581	17.136	1/1/1988	Year	2249
1537	14.99	4/1/1987	Month	2126
1313	14.163	1/1/1978	Year	1759
1184	13.216	1/1/1973	Year	1557
1904	12.227	1/1/1997	Year	2411
1766	11.962	3/17/1993	None	2253
1532	11.222	12/1/1986	Month	1985
1175	9.344	7/16/1972	Year	1427
1604	9.164	1/1/1989	Year	1988
1161	9.112	1/1/1972	Year	1415

Sire Age for All Reproduction

Median age: 7.084   Mean age: 7.864

10 Oldest Sires to Have Reproduced

Studbook ID	Age At Estimated Conception	Sire's Birth Date	Estimate	Offspring's ID
1581	17.136	1/1/1988	Year	2249
1720	16.222	1/1/1992	Year	2366
1263	16.214	1/1/1977	Year	1810
1604	16.175	1/1/1989	Year	2254
1537	16.044	4/1/1987	Month	2190
1766	16.005	3/17/1993	None	2413
1537	15.964	4/1/1987	Month	2185
1480	15.214	1/1/1985	Month	2023
1537	14.998	4/1/1987	Month	2127
1537	14.99	4/1/1987	Month	2126

10 Sires with Most Offspring

Studbook ID	# of Offspring
1720	25
2149	22
1604	16
2098	11
1741	11
1263	10
1609	10
1466	10
2130	10
1580	10

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CHAPTER 4 IDENTIFICATION & DESCRIPTION

Historically otters, as a group, are old; their body shape has remained relatively unchanged for 30 million years. They have not undergone any drastic evolutionary changes, but instead show a number of subtle modifications on the basic carnivore body form.

Physical Description

> *"In general body conformation, the northern river otter resembles a long cylinder that reaches its greatest diameter in the thoracic region. The head is rather blunt, small, and somewhat flattened. It is characterized by a bulbous nose on the end of a short muzzle, small rounded ears set well back, and eyes set high on the head and closer to the nose than to the ears. The neck is thick and cylindrical. Legs are short and stocky, and the feet are pentadactyl and plantigrade, with interdigital webs. The tail is relatively long, thick, and pointed."* (Toweill & Tabor, 1982)

SKIN

The integument, or skin, is important to maintaining body temperature. Three qualities are important to preventing hypothermia:

1) Glands produce a lipid squalene to enhance water-repellent quality of the fur.
2) The skin contains piloerector muscles.
3) The skin contains more subcutaneous fat, important for insulation, than terrestrial mammals. (Original sources cited in Melquist et al. 2003)

Average skin thickness has been reported to be 2 mm on the tail and body and 0.9 mm on the feet" (Baitchman and Kollias 2000).

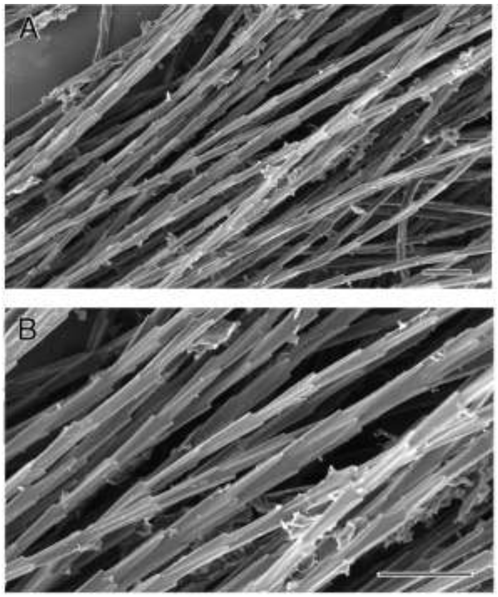
COAT

The otter's fur is held in high regard in the fur trade and is considered a standard by which durability and quality are judged (Obbard 1987). Only the sea otter's pelt is considered to exceed the river otter's in luster, durability, hair density, and softness. The fur consists of long, lustrous guard hairs and short, dense, wool-like hairs which trap air and act as insulation.

Fur density

"…the under-fur gives the impression almost of being the skin itself, so dense is the hair." This statement made by Hans Kruuk in his 1995 book *Wild Otters Predation and Populations* is as true for *L. canadensis* as it is for *L. lutra*. Addy de Jongh (Kruuk 1995) calculated 50,000 hairs per cm^2 for *L. lutra*. Tarasoff et al. (1972) give a figure of 57,833 hairs/cm^2 for the mid-back area of *L. canadensis*. The guard hair is thick at 17 – 20mm (.6693 - .7874 inches); the under-fur is 8 – 9mm (.315 - .3543 inches). *"Average hair density has been reported to be 62,144 hairs/cm^2 on the tail, 58,250 hairs/cm^2 on the body, and only 1,648 hairs/cm^2 on the foot* (Baitchman and Kollias 2000).

Harris (1968) cites Schreber (1776) as describing the difference between the European and North American otters in part as: *"Over and above their [larger] size, pelts from American otters are distinguished by the greater fineness of the hairs, the greater amount of the undercoat, and the colour…"*. The river otter pelt is considered the standard by which quality and durability of other furs are judged (original references in Melquist et al. 2003).



Hair structure

"The cuticle surface structure of the under-hairs and base of the less-abundant guard hairs are distinctively shaped to interlock, with wedge-shaped fins or petals fitting into wedge-shaped grooves between fins of adjacent hairs."

"The fins of one hair loosely insert into the grooves between fins of an adjacent hair, thus permitting the hairs to form a web-like pattern that keeps water from the otter's skin and decreases heat loss. Also, the grooves between fins trap air bubbles, which help increase the thermal insulation of the otter's coat."

"A common otter behavior, next to their playfulness, is their constant grooming. This behavior is another important aspect of an otter's heat-sparing abilities. In addition to the interlocking structure of the underhairs, these hairs are coated with a thin layer of body oil from the otter's sebaceous glands, thus providing another barrier to water. The fins of the underhairs are also aligned away from the body, which is consistent with the direction in which otters run their paws through their hair during this self-grooming, thereby ensuring that their claws do not get caught on the fin-like projections."

(Weisel et al. 2005; Taken from: University of Pennsylvania School of Medicine (2005, September 4). Otter Adaptations: How Do Otters Remain Sleek And Warm. *ScienceDaily*. Retrieved September 21, 2008, from http://www.sciencedaily.com /releases/2005/08/050819124510.htm) Photos: *John W. Weisel, Chandrasekaran Nagaswami, Rolf O. Peterson, University of Pennsylvania School of Medicine; Michigan Technological University; NRC Research Press*

As described in the Weisel et al. article (2005), insulative and waterproof qualities of the coat are maintained by frequent grooming. It is important the otters are given ample dry grooming substrates to encourage good coat maintenance. Water adhering to the tips of the guard hair beads off and causes the coat to form spikes upon leaving the water. See also Kuhn & Meyer (2010)

The otter's coat as insulation

Tarasoff (1974) and Kruuk (1995) discussed the relative merits of fur versus blubber as an insulator in cold waters. Although blubber is far more efficient as an insulator, its low specific weight would cause a problem for the small otter trying to swim submerged. Also, the added weight would prove a serious impediment to an animal like the otter that spends so much of its time traveling over land. Thus, the otter has solved the insulation problem with a thick coat of fur. A layer of air is trapped within the dense under-fur and the guard hairs; these air pockets are maintained by the otter's frequent grooming.

> *"The pelage of the river otter provides it primary means of insulation. The density of the hairs, sebaceous gland secretions, and air trapped by the underhairs all reduce heat loss by preventing water-to-skin contact. The feet may be an important source for heat loss because of their relatively thin skin and sparse hair. Body fat is of secondary importance for insulation and is distributed only in areas that require additional thermal protection, such as the tail, which has an increased surface area."*(Baitchman and Kollias 2000)

It has been shown that the "*…thermal conductivity of fur is 20 to 50 times greater when wet than when dry…(and that) it is therefore vital for otters to maintain the air holding capacity of fur, even at the cost of* *considerable effort…"* (Kruuk 1995). Kuhn (2009) discusses coat characteristics of the otter and its role in heat loss.

Coat coloration
Coloration of the dorsal pelage of river otters is classified slightly differently by the fur industry and naturalists, respective color categories are:

- Extra dark = jet black
- Dark = dusky brown
- Dark brown = dark grayish brown;
- Brown = dark grayish brown-fuscous
- Pale = burnt umber
- Extra pale = hair brown
- Piebald = "white with burnt umber-raw umber spots
- Albino or lucistic = white

Molt
Many observers have noted that there are normally two molts a year; spring and fall; however, others report only one molt, in the spring. Because the spring molt, or shed, can extend over a long period of time it is possible that the fall shed is actually the completion of the earlier spring molt (Jackson 1961 & personal observation).

> Harris (1968) describes the molts in this fashion: *"…there is a very quick and almost imperceptible moult in September, preceded by a slightly singed appearance. The spring moult, however, is a more elaborate affair, starting at the end of March with a paling of the hair tips on the head and shoulders. This is accompanied by a ravenous appetite. The first fur to be shed seems to be that along the upper center line of the tail, the side edges of the tail shedding next. At about the same time or very shortly afterwards the area immediately behind the shoulder-blades starts, as does the face. Here it begins immediately above the eyes, in more or less circular patches, and temporarily gives the animal a very curious piebald appearance. Moult of the throat, chest and stomach soon follows. By this time the guard hairs on the body have paled almost exactly to the colour of the underfur…Once the shedding starts it proceeds fairly rapidly…"* (Harris 1968)
> *"Differences in length and density of the fur are related to climate, with northern forms having the longest and most dense pelage. Similarly, western and southern forms tend to be lighter in color than northern and eastern forms."* (Toweill & Tabor 1982)

Ben-David et al. (2000) & Blundell et al. (2002) found that river otters involved in a captive study in Alaska shed their under fur from May to August and their guard hair shed between August and November.

SIZE

Head and Body Length (Head to rump)
661mm – 1270 mm (26 in. to over 50 in.) (Harris 1968)
22 - 31 inches (Walker et al. 1964) (55.88 - 78.74 cm)
26 - 30 inches (Burt & Grossenheider 1952) (66.04 – 76.2 cm)
23 - 36 inches (Wilson 1959) (58.42 – 91.44 cm)

Tail Length
305 mm – 457 mm (12 in. – 17 in.) (Harris 1968)
The tail comprises roughly 40% of the total body length (Melquist & Hornocker 1983). Toweill & Tabor (1982) put the tail length at about one third of the total length.
14 – 19.5 inches (35.56 – 49.53cm) (Park 1971 citing Wilson 1954, 1959, 1961)
12 to 20 inches (30.48 – 50.8cm) (Hall & Kelson 1959)

Total Length
35 – 54 inches (Park 1971) (88.9 cm – 1.3716 m)
1000 mm – 1530 mm (3.28 – 5.02 ft.) (Foster-Turley 1991)
1100 mm – 1525 mm (Harris 1968)

35 - 51 inches (3.61 – 5 ft.) (88.9 cm – 1.295 m) (Hall & Kelson 1959)
42 - 54 inches (1.067 – 1.3716 m) (Cahalane 1947)
89 – 137 cm (2.9 ft. – 4.5 ft.) (Melquist et al. 2003)

Maximum length reached at four to five years of age.

Weight

4.5 – 11.3 kg. (Harris 1968) (10 lbs. – 25 lbs.)
5 – 15 kg. (Hall 1981) (11 lbs. – 33 lbs.)
8 kg. (mean) for females; 9.8 kg. (mean) for males in Alaska (Bowyer et al. 2003).
The ideal weight for all animals will vary and should be established on an individual basis. Subcutaneous fat is not widely distributed but is located primarily at the base of the tail and caudally on the rear legs. Smaller deposits are located in the axillary regions and around the external genitalia" (Baitchman & Kollias 2000). Below is a table listing body mass and total length by sex and age classes of river otters captured in non-oiled areas of Prince William Sound, Alaska, USA, 1996-1998 (Ben-David et al. personal communication).

The photo shows an example of otters close to an ideal weight. (Photo: Jessie Cohen, National Zoo).

See Chapter 7, Animal Management, Weight for weight range photos. These should be considered as a guideline only.

	Body Mass (kg)			Total Length (mm)	
Sex and Age Classes	*n*	$\bar{x}$	SE	$\bar{x}$	SE
Males					
Yearlings	6	7.3	0.6	1171.0	27.9
Adults	34	9.8	0.2	1287.0	8.7
Females					
Yearlings	0	—	—	—	—
Adults	17	8.0	0.2	1232.0	13.7

Sexual Dimorphism

All subspecies are somewhat sexually dimorphic with the males generally larger than the females. Melquist & Hornocker (1983) found that adult males, on average, were 17% heavier than adult females. They cite an average weight of 7.9 kg. (17.4 lb.) for females. Melquist et al. (2003), state that weights and measurements indicate that females are between 3% and 21% smaller than males of a similar age (original references cited by Melquist et al. 2003).

Keep in mind that not all males are larger than females and, as stated above, target weights for all animals should be based on their size, activity level, age, and individual characteristics – not on any of the published norms or mean weights. Length and weight vary a great deal between some subspecies.

Regional Differences

There appears to be a clinal decrease in size from north to south, but this does not appear to be so going from west to east (Toweill & Tabor 1982). *"Differences in length and density of the fur are related to climate, with northern forms having the longest and most dense pelage. Similarly, western and southern forms tend to be lighter in color than northern and eastern forms."* (Toweill & Tabor 1982)

DENTITION

3/3 Incisors 1/1 Canines 4/3 Premolars 1/2 Molars x 2 = 36 Total

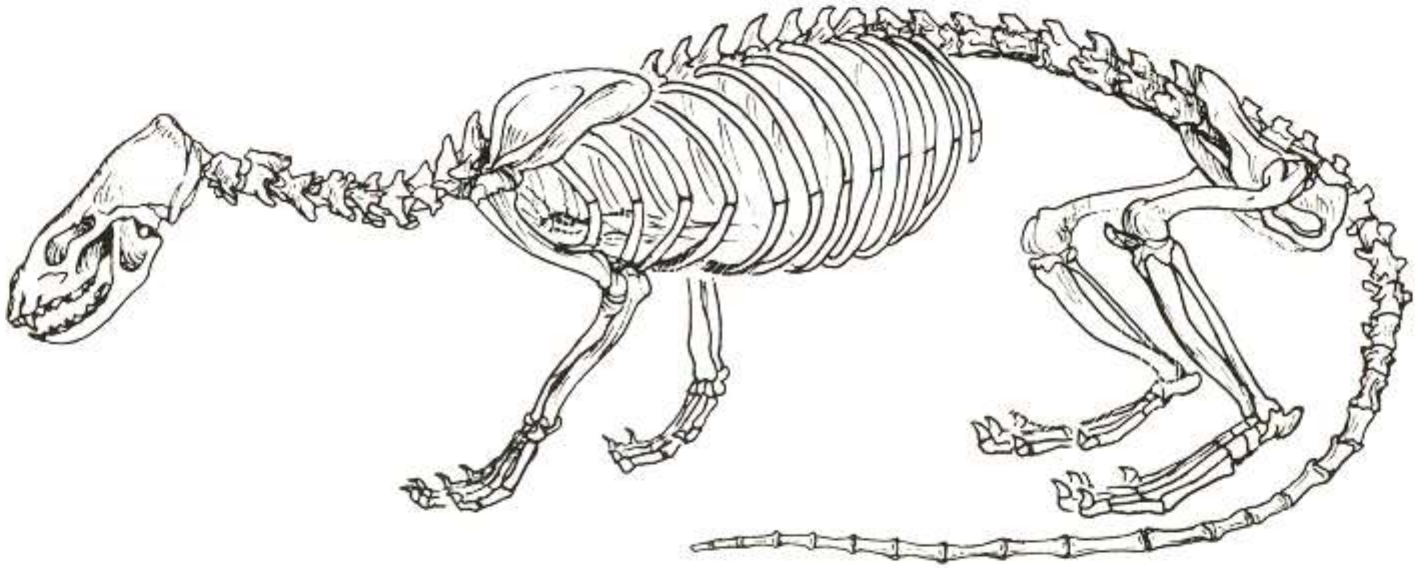
The teeth are adapted for crushing; the upper fourth premolar and lower first molar, and the carnassials are adapted for shearing (Toweill & Tabor 1982). Supernumerary premolars have been reported (Toweill & Tabor 1982). Layering in the cementum of the teeth and tooth wear can be used to age animals.

SKELETAL ADAPTATIONS

In addition to adaptations mentioned elsewhere (See Aquatic Adaptations), river otters have the following characteristics:

- The fore limbs are highly mobile on the chest wall because they do not have a clavicle.
- *"Both the metatarsals and phalanges are elongated, and a generous web of skin exists between the digits of the hind feet, so that the foot becomes twice as wide when the digits are spread. The length of the individual digits of the river otter are IV=III>V=II>I."* (Taylor, 1989)
- Normally 52 vertebrae, including 14 rib-bearing vertebrae. There are 7 cervical, 14 thoracic, 6 lumbar, 3 sacral, and 22 caudal vertebrae.
- Chevron bones are found from the 4th caudal vertebrae on, and are associated with greater vascularization of the tail.

River Otter Skeleton



Illustrations by Michael Clark
From: Chanin 1985, The Natural History of Otters, page 4.
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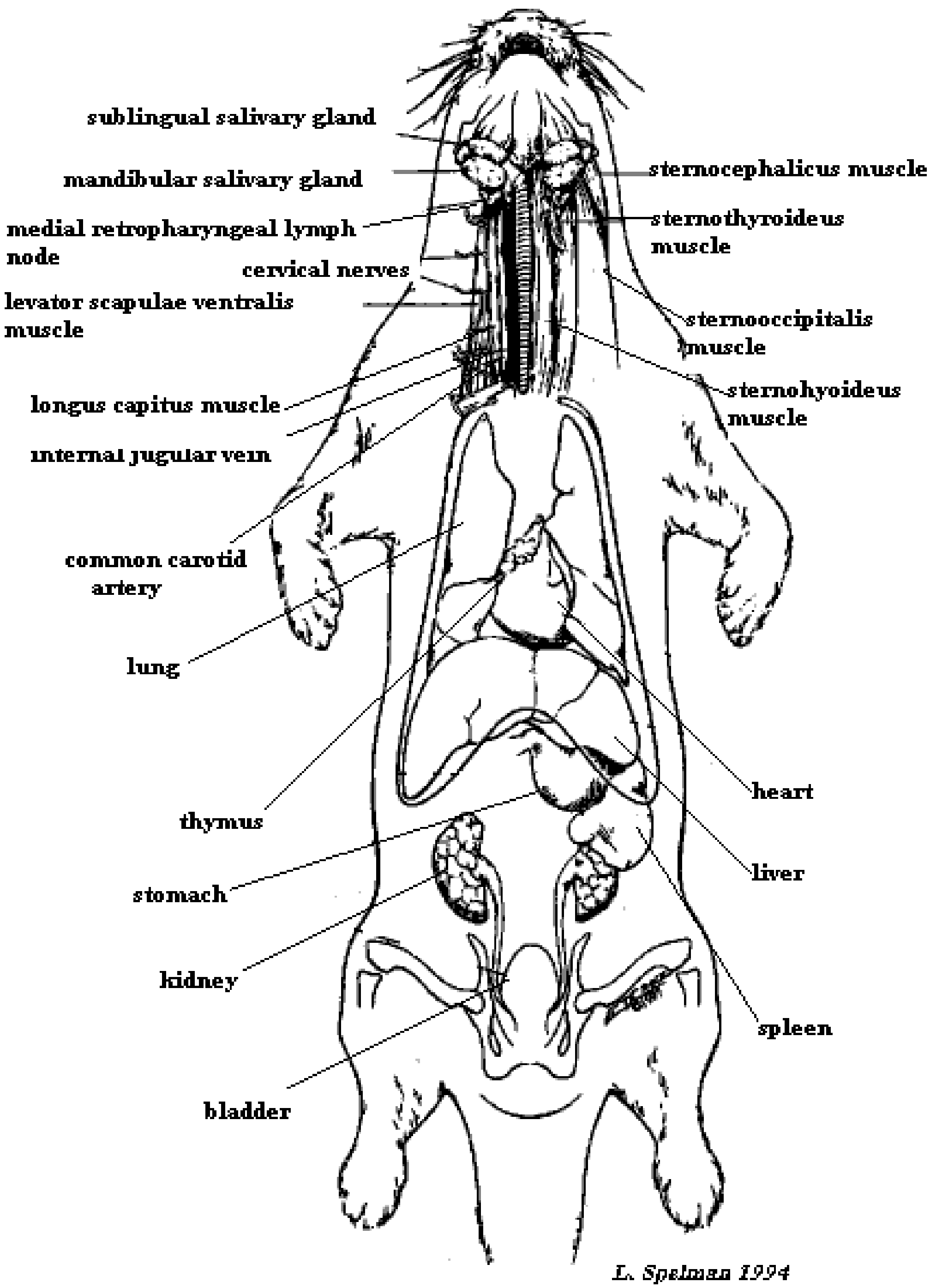
GENERAL ANATOMY



Digestive Tract

The intestines are lined with a mucoid substance which is believed to help protect them from sharp edged foods, i.e. fish spines, etc. This mucous is frequently passed with the feces (Harris 1968). *"Otter intestines (are) lined with about ¼ "* (6.35 mm) *of mucous for protection from fish spines and other sharp edged foods…"* (Wilson 1954).

In addition to scats, otters produce a `jelly-like' secretion which varies in color from white to yellow to green, brown and black.

Davis et. al. (1992) and Spelman et al. (1997) report that gastrointestinal transit time for a fish meal took anywhere from 2 to 4 hours with a mean of 202 minutes. In 1951, Liers tested otters previously fed a bland diet and found that the exoskeletal remains of crayfish were passed about one hour after consumption.

OTTER SCAT

Otter feces can be varied in color, dependent on what they have been eating, particularly in captivity. In the wild the otters' scat is generally dark in color with identifiable bits of fish scale or the exoskeleton of insects, etc. Scat is frequently deposited as scent marks in prominent locations throughout an otter's home range. It is frequently accompanied by a jelly-like or mucoid substance that can vary in color from yellow-green-brownish to quite dark. Ormseth & Ben-David (2000) found that on average, otter scat weighed 39.5 g (± 2.1 SE; n = 99 scats)

"Fresh dropping were black with a strong characteristic odor….heavy mucous was mixed throughout…" (Greer 1955)

"The average (scat) *is approximately ¾" in diameter and characteristically in 2, 3, or 4 curved segments each about 1 ½ to 3" long…"* (Greer 1955) (3.81 – 7.62 cm)

SCENT GLANDS

Anal glands release a strong smelling, creamy, substance when an otter is sprainting (defecating), scent marking, frightened, or angry. This anal secretion is whitish when from young animals and darkens as the animal ages. Plantar glands located on the bottoms of hind feet (see Feet) also are believed to be used for scent marking.

FACIAL CHARACTERISTICS

(Photo: Debbie Stika)

Eyes
Directed forward allowing for binocular vision

Vibrissae
Numerous, long, thick vibrissae located on the muzzle are used for locating prey in dark, murky waters. (See Senses)

Rhinarium
The nose pad is naked and black. The shape, something resembling the ace of spades, or inverted triangle, is characteristic of this species. (Harris 1968, Coues 1877))

Mustache Spots
Scott Shannon (personal communication) refers to these unique marks as "*moustachial maculations"*. These spots which appear after about one year of age are unique to each individual, although, not all individuals develop them. Generally they are dark in color but S. Shannon has seen "*orange colored markings"* on several individuals in his study population in Northern California (personal communication). Once an animal has reached adulthood these mustache spots can be useful as visual identifiers. However, an individual's spots can change slightly over time so this method should only be used for identifying animals in which these changes can be monitored and traced.

FEET

Pentadactyl and plantigrade. "*Skin and fur are thinnest on the feet, with the skin of the foot less than half the thickness of that on the torso. The skin of the foot is not highly vascularized compared with other aquatic mammals such as the sea otter and pinnipeds*" (Baitchman & Kollias 2000). *"Both the metatarsals and phalanges are elongated, and a generous web of skin exists between the digits of the hind feet, so that the foot becomes twice as wide when the digits are spread. The length of the individual digits of the river otter are IV=III>V=II>I."* (Taylor 1989)

(Photo Above: G. Myers, top of foot)

(Photo Left: J. Reed-Smith, plantar pads)

Metatarsal and metacarpal pads are absent, but plantar, palmar, and digital pads are present on all feet. There are 3 or 4 small, rough protuberances on the plantar surface of each hind foot. These plantar glands are seen in several other North American mustelids and are believed to function as chemical transmitters and possibly to prevent slipping (Melquist & Dronkert 1987).

The claws are sharp and probably aid in gripping. The hind feet are generally larger than the fore and the hind legs are longer leading to the typical hump-backed gait when traveling across land. The soles of the feet have tufts of hair under the toes (in some subspecies). Also see skeletal adaptations.

PHYSIOLOGICAL VALUES

Normal Heart Rate

137 – 170 beats/minute (Grassmere Wildlife Park now Nashville Zoo @ Grassmere, TN)
130 – 178 beats/minute; baseline = 152 beats/minute (Spelman 1999)
120 – 160 beats/minute (Hoover 1985)

Normal Body Temperature

A range of 37.5° to 40°C or 99.5° to 104°F, for otters involved in a translocation project, was given by Serfass (1994). (The upper end of this spectrum should be considered pathologic if it continues very long. An animal's normal temperature may reach this height after the exertion and stress associated with being caught.)

Rectal Temperature Range: 38.1 – 38.7°C; baseline = 38.4°C (100.58 – 101.66°F) (Spelman 1999); 35.28°C – 38.89°C (95.5°F - 102°F) n=8 (Ben-David unpublished information)
A core body temperature range of 35.86°C to 40.37°C (96.55 – 104.66°F) was recorded by Kruuk et. al. (Kruuk 1995) for *Lutra lutra*. The mean for inactive otters was 38.14°C (100.65°F).

Basal Metabolic Rate

Toweill and Tabor (1982) cite work done by Iversen in which he reported that the BMR of mustelids over 1kg can be expressed by the equation: $M = 84.6W^{0.78}$ (+0.15). M = basal metabolic rate in kcal/day and W = body weight in kg. *"This is about 20% higher than expected from the mammalian standard curve described by $M = 70\ W^{0.75}$."* Although Iversen's study used *Lutra lutra* (the Eurasian otter), it is assumed the data is valid for *L. canadensis* as well.

"…mustelids typically have basal metabolic rates about 20% above the standard curve." (Estes 1989)

KARYOTYPE

"The diploid (2n) number of chromosomes is 38. Thirteen pairs of autosomes are metacentric or submetacentric, while six pairs are acrocentric or subacrocentric." (Toweill & Tabor 1982)

AQUATIC ADAPTATIONS

Blood Adaptations

The blood of Nearctic river otters has a fast clotting time and a high number of thrombocytes which enables clotting even under water. Also, the oxygen carrying capacity of their blood is higher than that of terrestrial mammals (Melquist et al. 2003 citing Brandes et al. 1983).

Respiratory System

Respiratory rate ranges from 10 – 60 breaths/minute (Spelman 1999). See Coat and Maximum Dive Time

Historically and in current literature you frequently see quotes like the one following which was offered in the original versions of the NARO Husbandry Notebook: *"River otters appear to undergo bradycardia while submerged. Despite this ability to conserve oxygen, the maximum time an otter can remain submerged is approximately 4 minutes"* (Melquist & Dronkert). See Dive Time below for more accurate dive times. According to Dunstone (1998) the early studies on the physiology of diving involved "*forced submersion*". They also discuss studies conducted on mink by Stephenson et al (1988) in which they found that mink diving in familiar tanks did not exhibit bradycardia. *"However, when the animals encountered a novel situation, or were diving in an unfamiliar environment, they showed a reduction in heart rate that may therefore be associated with a fear response. The possibility cannot be excluded that the animals are consciously able to initiate the development of a bradycardia if the situation – for example, sustained pursuit of a fish or escape from a predator – requires it."* (Dunstone 1998) In short, it is likely that otters undoubtedly store enough oxygen in the lungs, blood and muscles for a typical dive but experience bradycardia when pushed as a result of fear or necessity.

Lungs

An increase in relative lung size as an adaptation for aquatic life has been described by investigators (Toweill & Tabor 1982).

> *"Aquatic mammals possess structural modifications in their lungs and bronchial trees, which vary according to dive depth and duration. The tracheal length-width ratio decreases from river otters to sea otters to phocid seals, presumably permitting more rapid and compete air exchange with the lungs before and after diving in the more highly adapted aquatic forms. The tracheal rings of river otters and sea otters are partially calcified, whereas those of phocid seals are entirely cartilaginous, thus permitting flexibility under the pressure of deep diving."*

Lungs are triangular in shape; the right lung, which is 19.3% larger than the left, has four lobes versus two lobes for the left. This reduction in lung lobulation is theorized to be an adaptation to aquatic life (Tarasoff & Kooyman 1973).

Trachea
The otter's short trachea, (about midway in length between that of terrestrial and marine mammals; mean length is 23.2% of body length), is believed to possibly aid air exchange and increase ventilation of the lungs (Tarasoff & Kooyman 1973a).

DIVE INFORMATION

Maximum Dive Time

There are a number of varying opinions as to how long river otters can stay submerged. At the short end, the IUCN/SSC Otter Specialist Group lists 30 – 40 seconds (IUCN 1992). The longest dive time of 6 to 8 minutes are listed in Grzimek (1975) and the Smithsonian Book of North American Mammals (1999). These times are most likely unsubstantiated observations, which have been repeated throughout the literature, of animals that went under water and found air pockets. Field (1970) timed dives for periods ranging from 68 to 263 seconds. Kruuk (1995) lists dive times for *L. lutra* of 96 seconds, but says it was, *"…quite rare to see dives lasting longer than 50 s* (seconds)." Ben-David et al. (2000) state: *"Dive duration for otters chasing fast schooling-fish was significantly lower (14.2 ± 2.3 seconds; n = 10) than when they were chasing slow non-schooling-fish (16.3± 1.6 seconds; n = 12) suggesting higher levels of oxygen consumption during these chases. The aerobic dive limit for otters would be 54.1 seconds for animals with normal hemoglobin contents."*

The longest dive recorded during studies in Prince William Sound, Alaska was 88 sec. but dives of this length occurred in only 0.3% of 2,293 dives; of 441 closely observed dives, the duration was recorded as 21 ± 1 sec., mean ± SE (Ben-David unpublished data). In light of documented evidence the maximum dive time of 4 minutes previously listed in this manual is likely in extreme situations only; **a maximum dive time would more probably range from 50 seconds to something just over 1 minute**.

Dive Depth

There is more information available on *L. lutra* than *L. canadensis* due to the work of H. Kruuk and his students in Scotland. Kruuk (1995) states that the Eurasian otter generally doesn't dive deeper than 3 meters (9.84 ft.) but has been known to dive as deep as 14 meters (45.93 ft.). There is at least anecdotal information that N. A. otters prefer to fish at shallower depths as well. .

HEAT CONSERVATION

River otters rely on their fur and the layer of air trapped by the undercoat to conserve body heat (see Hair Structure). This layer of air prevents penetration of cold water to the skin and may secondarily serve to aid in floatation (Estes 1989). The integument, or skin, is important to maintaining body temperature. Three qualities are important to preventing hypothermia:

1) Glands produce a lipid squalene to enhance water-repellent quality of the fur.
2) The skin contains piloerector muscles.
3) The skin contains more subcutaneous fat, important for insulation, than terrestrial mammals. (Original sources cited in Melquist et al. 2003)

LOCOMOTION

Hump-backed gait when traveling overland. Propulsion in the water is accomplished by paddling with the feet and thrusting with the tail and vertebral column; the latter is especially important when swimming underwater. A dog paddle with the head above water is typical when the animal is swimming slowly. Paddling modes include forelimb, hindlimb, and all limb paddling. Underwater swimming is accomplished by pulling the front legs next to the torso then undulating the body and tail; the hind legs are used to steer and help propel them during this type of swimming.

On snow or muddy banks otters will frequently slide (toboggan) on their stomachs. Often popularly seen as play behavior in zoos (Crandall 1964, Harris 1968), it has been reported as primarily being an efficient means of transportation (Field 1970, Beckel-Kratz 1977, Melquist and Hornocker 1983, Chanin 1985, Fish 1994, Melquist et al. 2003) in scientific literature. However, Stevens and Serfass (2005) documented three otters intentionally, repeatedly sliding down a snowy hill interspersed with play bouts. While sliding in snow, they have been reported to fold back their front legs and push themselves up a 20 to 25° grade using only their hind legs (Field 1970).

Otters in captivity have been known to climb trees and there is at least one report of an otter found high up a cliff face (stuck) in a river canyon (personal communication anon.).

Jumping

Reuther (1989) discusses two studies done on the jumping ability of *Lutra lutra* in Germany. It was determined that an otter could jump from the ground to a platform 130 cm (4.26 ft.) high, leap from the water onto a platform 90 cm (2.95 ft.) high and cover a distance of 160cm (5.24 ft.) when jumping from one platform to another.

Top Speed on Land

Up to about 18 mph (29 km/h) was reported by Nowak (1992) and confirmed by Severinghaus & Tanck (1948) who determined a top land speed for the otter of 15 to 18 mph (24 – 29 km/h) using a combination of gliding and running.

Top Speed in water

Six to 7 mph (10 to 12 km/h). (Harris 1968)

MALE CHARACTERISTICS

Males begin producing viable spermatozoa at about two years of age when they mature sexually. However, in the wild, it is believed they are not successful breeders until they are about five years of age. The male's baculum increases in length until age three and weight until age six. It has been postulated that the baculum may not be developed enough to induce ovulation until the male reaches this older age (Melquist & Dronkert 1987).

Data collected from captive breeding over the last decade contradict this hypothesis, at least for the captive population; there have been a number of successful births sired by two year old males. AZA studbook data records successful reproduction by three males under the age of two years; it should be remembered that this data could be suspect, but should still be noted. It may be that in the wild these young males cannot successfully compete against older, more experienced males. It also is possible that due to the smaller size of their baculum, these young males require a longer period of intromission to successfully stimulate ovulation. Due to their inexperience, subordinate role, or position as a territorial interloper, they are not able to maintain the same length of intromission time in the wild. In captivity, there is no competition, generally, thus an inexperienced animal can take as long as he needs to get it figured out!

Males experience seasonal elevations (late winter to early spring) in testosterone, lasting for approximately 3 months with peak levels for 1 month (Bateman et al. 2009). The timing of this peak appears to vary with the latitude of the holding institution, and/or latitude of animal's origin. Sperm production occurs only during these elevated testosterone periods which corresponds to observed increase in size and decent of testes. Research looking at fecal testosterone levels by Bateman et al. (2009) indicates:

> *"In male NARO, elevations in fecal testosterone levels were observed during the late winter–early spring months. The timing of seasonal increases was coincident with the increasing amount of daylight occurring after the winter solstice. Testosterone levels peaked for each male (n=58) at different times of the year, apparently corresponding to the geographic latitude of the housing institution. As latitude increased, peak testosterone values appeared to occur later in the calendar year. For all NARO males, testosterone levels were elevated above baseline for an average of 101.80±8.97 days with peak levels being maintained for 25.50±7.51 days."*

The Bateman et al. study also looked at seminal fluid and sperm production using electroejaculation and blood serum.

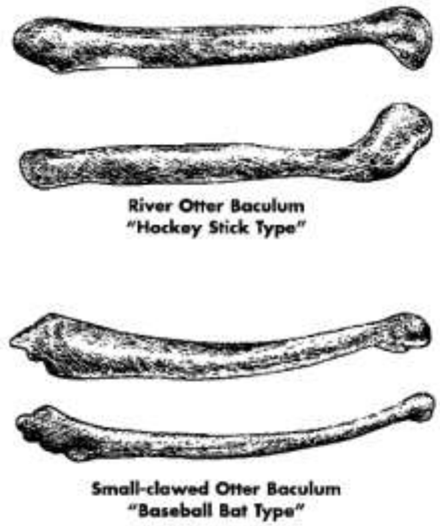
> *"For this study, four male NARO were subjected to electroejaculation on a total of 16 occasions. Seminal fluid was recovered during 100% of the collection procedures. In three of the four males collected multiple times based on season, no semen was recovered in the summer or fall months and only small ejaculate volumes (i.e. 3–10 ml) were obtained during the winter period. Peak sperm recovery and seminal quality occurred in the spring months, with most ejaculates (75%) containing in excess of $80x10^6$ motile spermatozoa. Testosterone and semen volumes differed ($P<0.05$) among seasons of the year, with peak values in serum testosterone occurring in the winter and semen volume in the spring. Testicular volume was also significantly higher ($P<0.05$) in winter than summer or fall months. Trends of higher sperm concentrations (million motile/ml; $P=0.066$) and total sperm per ejaculate ($P=0.094$) were observed in the spring compared with the other seasons. Across seasons, serum testosterone levels were positively correlated with testicular volume ($r=0.84$, $P<0.05$) and with fecal testosterone concentrations ($r=0.82$, $P<0.0001$); fecal testosterone concentrations were also correlated with testicular volume ($r=0.79$, $P<0.0001$)."*

In conclusion, Bateman et al. (2009) state:

> *"Longitudinal monitoring of endocrine and seminal traits simultaneously in NARO males found that fecal testosterone levels were correlated with seasonal changes in serum testosterone concentrations and testicular volume. Of importance, our results showed that electroejaculation was an effective method for semen recovery in NARO during the breeding season. Spermic ejaculates were obtained only coincident with periods of elevated testosterone, with the highest quality semen recovered during the spring. Semen samples collected during the spring months had ample semen volume (~600* µl*) and contained large numbers of spermatozoa (~90 million/ejaculate) with good motility (~90% progressively motile) and morphology (~70% normal). In contrast, only minimal seminal fluid or spermatozoa were recovered from collections performed in other seasons. During periods of basal testosterone, testicular volume also was markedly smaller and the testes appeared to be positioned closer to the abdominal wall than seen during periods of peak testosterone and semen production. Interestingly, serum testosterone and testicular volume were higher in winter months, whereas sperm concentration and semen volume were higher in the spring. These seasonal differences may be indicative of the lag time between starting sperm production and producing mature spermatozoa ready to be ejaculated. These findings are typical of those seen in other seasonally breeding mammals [Bronson, 1985], including another mustelid, the badger [Ahnlund, 1980], and other carnivore species [Brown et al., 2001] and are consistent with our observations of pronounced reproductive seasonality in female NARO."*

Their findings confirm the season fluctuation in size of males' testes reported by Toweill & Tabor (1982) and observed by professionals working with *ex-situ* Nearctic otters.

Otter Baculum



Illustrations by Michael Clark
From: Chanin 1985, The Natural History of Otters, page 8
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Male penis
(Photo: D. Hamilton)

Basal Seminal Characteristics of North American River Otters

(Bateman 2012)

Characteristics	Mean ± SEM	Range
Testicular volume (cm^3)	32.67 ± 2.11	24.03 – 51.55
Semen Volume (µl)	514.16 ± 138.58	283 - 1960
Sperm motility (%)	78.75 ± 3.98	60 - 90
Normal sperm morphology (%)	72.85 ± 5.06	32 - 89
Concentration (x10^6 motile/ml)	202.26 ± 26.54	26.6 - 415.8

FEMALE CHARACTERISTICS

Females are also sexually mature at about two years of age. Liers (1951) did report one female who bred successfully at 15 months and AZA studbook data reflect a female just under two years of age giving birth.

The ovaries and uterus continue to grow until about 2 years old. The uterus is bicornate. *"Adult females…may develop an os clitoridis, the female counterpart to the male os baculum. The os clitoridis is a cartilaginous structure in females less than two years old, but may ossify in older individuals."* (Toweill & Tabor 1982)

Induced ovulators (Bateman et al. 2009 report one case of apparent spontaneous ovulation in a female housed with another female who experienced a pseudo-pregnancy), *L. canadensis* experiences delayed implantation. *"The exact duration of neither the inactive (unimplanted) nor the active (implanted) stage of pregnancy is known"* (Toweill & Tabor 1982). (See Gestation) Since their writing, records research conducted by Reed-Smith (2001) and studies conducted by H. Bateman et al. (2009) have shown that the total gestation (unimplanted and implanted phases) can range from 309 to 367 (Reed-Smith 2001) or 302 – 350 (Bateman et al. 2009). Both estimates were based on date of last observed breeding. The duration of active implantation appears to be roughly 68 to 74 days (Bateman et al. 2009).

Mammae

Four total, two pairs; inguinal.

Estrous

November to May; in general, estrus appears to be dependent on latitude. The period lasts roughly 42 to 46 days, average 35 days (Bateman 2012) with peaks of receptivity every six days or so. (See Reproduction for more detail)

The "“post-partum” estrus is said to begin immediately after parturition and last the same 42 to 46 days (Melquist & Hornocker 1983 citing Liers 1951; Hamilton & Eadie 1964; Lauhachinda 1978). This estrus actually is the normal estrus cycle and not a true “post-partum” estrus; it can begin two to four weeks post-partum (Bateman et al. 2009, Bateman 2012). In captivity behavioral signs of this estrus do seem to appear two to four weeks after parturition, if they manifest themselves at all. In the wild some females give birth annually, others every other year. In captivity whether or not a female breeds annually depends on a number of management factors and appearance of a behavioral estrus. See Reproduction.

Florida – Estrus is usually observed in November or December (Unpublished captive data).

N. California - S. Shannon reports estrus may begin at the end of March but that he never sees it later than the third week of April (Personal communication).

Michigan – Estrus is usually seen in April or May, more rarely in early June (Personal observation).

Prince William Sound, Alaska – G. Blundell reports: *"The earliest estrus I've seen in south-central Alaska (Prince William Sound) was on April 24, all the other females that I've handled have been in May -- latest estrus May 26. Dates are consistent for three years of handling wild otters in that area."* (Personal communication).

Delayed Implantation

It is unclear precisely why female North American river otters experience delayed implantation. A variety of theories have been formulated, generally dealing with the synchronization of breeding and parturition to make it easier for males to locate estrus females, or, a neutral hold-over of a previously useful evolutionary adaptation. Thom et al. (2004), Lindenfors et al. (2003), and Ferguson et al. (2007) discuss the maintenance of delayed implantation in modern mustelids/carnivores and possible reasons for this including its association with highly seasonal environments. See Chapter 6 Reproduction.

Robbins (1993) explains why delayed implantation: *"The energy requirements and food intake of pregnant females are from 17 to 32% higher than nonreproducing females. However, only 10 to 20% of this additional energy is retained as new tissue by the developing uterus with the rest of the energy lost as heat. Because most of the energy metabolized by the gravid uterus is lost as heat, lengthening the gestation period by slowing the growth rate will disproportionately increase the total energy cost per unit of fetus production, which may explain why most delays during pregnancy are not via a reduced growth rate but occur prior to the initiation of growth (i.e., delayed fertilization or implantation)."*

Total Gestation

290 – 380 days (Liers 1951); 240 – 360 days (Duplaix-Hall 1975); 309 – 367 days (Reed-Smith, 2001); 302 – 350 days (Bateman et al. 2009).

Actual Gestation

60 – 63 days (Lancia & Hair 1983); 50 days (Toweill & Tabor 1982); 68 – 74 days (Bateman et al. 2009).

Parturition

Parturition occurs November to May, with peaks in March or April at northern latitudes and December or January at more southern latitudes (see Reproduction for date estimates associated with latitude). However, January births in New York can be found in the historic captive record. (ISIS N. A. River Otter data base) Although not always true, multiparous females generally have their litters clustered around the same date, i.e. April 20, April 24, April 22, and April 12th every other year; April 10, 1993 and April 10 1997.

Inter-birth Intervals

The shortest inter-birth intervals, for litters born to the same female in consecutive years, range from 327 to 386 days (number of days based on last of a litter to the first born of the next litter) (D. Hamilton personal communication).

Otter Milk

Water – 62%, Fat – 24%, Protein – 11%, Carbohydrates – 0.1%, Ash – 0.75%. (Toweill & Tabor 1982) *No indication was given by the authors at what point in the lactation cycle the milk was tested. (See Hand-rearing)

Litter Size

One to six pups have been reported, generally two to three. An interesting anecdotal observation is that there appears to be females that tend to produce large litters habitually, and others that routinely produce small ones.

Daily Activity Cycle

Generally Nearctic otters are considered crepuscular or nocturnal. Some investigators report dawn/morning hours as their most active (Melquist & Hornocker 1979; Toweill & Tabor 1982). In their 1983 publication Melquist and Hornocker reported that the otters in their Idaho study area were more diurnal in winter and tended to be nocturnal the rest of the year. Personal observations of otters in Yellowstone National Park indicated that morning hours until about 10:00 or 11:00 am and late afternoons were active times for otters, at least those animals whose home ranges included areas characterized by some human disturbance (winter snow mobilers). See also Activity Cycle under Behavior.

Feeding Style

Predominantly piscivorous or ichthyophagous; their diet of fish is supplemented with crustaceans, birds, small mammals, amphibians, and invertebrates. Otters are considered to be a *"single-prey loader"* (Houston & McNamara 1985); which means they must bring each prey item to the surface to consume it. There is a report of otters eating blueberries in Alaska (Merilees 1981) but consumption of fruits, etc. in the wild is probably rare.

Otters prey on a wide range of species however, Toweill and Tabor (1982) concluded after reviewing a number of field studies that there are, *"…certain patterns of fish vulnerability to otter predation… The most important is that fish are preyed on in direct proportion to their availability (i.e., occurrence and density) and in inverse proportion to their swimming ability."* They propose three concepts central to otter predation: *"(1) otters do not select a particular species of fish when hunting, (2) slow-swimming species of fish are more vulnerable than fast-swimming species, and (3) injured or weakened fish are more vulnerable to otter predation than healthy, vigorous fish. In practical terms, these patterns imply that abundant, slow-swimming fish species will be selected more often…"* These species include: suckers (*Catostomus sp.*), redhorses (*Moxostoma sp.*), carp (*Cyprinus sp.*), chubs (*Semotilus sp.*), daces (*Rhinichthys sp.*), shiners (*Notropis sp.*), squawfish (*Ptychocheilus sp.*), bullheads and catfishes (*Ictalurus sp.)*, sunfishes (*Lepomis sp.*), darters (*Etheostoma sp.*), mudminnows (*Umbra limi*), and sculpins (*Cottus sp.)*. The faster swimming species such as, trout and pike, are not caught as often as their numbers in the water would suggest. (Toweill & Tabor 1982)

The N. A. river otter is mouth oriented, i.e. prey is caught with the mouth. Generally, food items are taken to shore to be consumed. Some observers report that the otter eats its fish head first, others tail first. My personal observations have been that small to medium sized fish are eaten tail-end first most frequently but can be eaten in either direction. Generally, food items are taken to shore to be consumed, especially large prey.

They have a high metabolic rate for land mammals and are considered to have an efficient digestive system (Toweill & Tabor 1982). BMR (Basal Metabolic Rate) for many mammals equals 70 x Body mass in kg to 0.75 power however, Iversen determined that the BMR of otters can be expressed by the equation: $M = 84.6W^{0.78}(+0.15)$. M = basal metabolic rate in kcal/day and W = body weight in kg. *"This is about 20% higher than expected from the mammalian standard curve described by $M = 70\ W^{0.75}$."* (Iversen 1972; Toweill & Tabor 1982; Kruuk 1995; Estes 1989)

Due to this high metabolic rate, food passes through their digestive tract quickly, within one to three hours. Davis et. al. (1992) and Spelman et al. (1997) report that gastrointestinal transit time for a fish meal took anywhere from 2 to 4 hours with a mean of 202 minutes. In 1951, Liers tested otters previously fed a bland diet and found that the exoskeletal remains of crayfish were passed about one hour after consumption.

Most feeding activity seems to occur between dawn and midmorning (Toweill & Tabor 1982). Hoover & Tyler (1986) report that the N. A. river otter spends 41 – 62% of their time engaged in foraging and feeding activities. Other studies have reported most foraging occurring at night.

LONGEVITY

In the wild otters live a maximum of about 10 to 13 years. Mortality rates for wild otters increase at three to five years, the reasons for this are unknown (Polechla 1989). Historically, longevity in captivity is given as 25 years (Melquist & Dronkert 1987), and 23 years (Park 1971, Nowak 1991). While these figures are supported by an entry of a 25 year old animal in the N. A. river otter studbook, the median age is 12.3 years with lifespans of 16 to 20 years fairly common (D. Hamilton personal communication).

SENSES

Auditory

Well developed. Toweill & Tabor (1982) suggest the variety of sounds used for communication further support this. (See Communication)

Vocalizations

Everyone has their own way of characterizing vocalizations; you may not agree with the labeling of a particular call, listed following are those calls found in the literature and heard by the author.

Call	Usual context/meaning
savage, snarling growl	angry or disturbed
explosive snort	alarm call, similar to cough, made by expelling air through the nostrils (Park 1971)
scream	frightened, uneasy, threat
low growl	threat
bird-like chirp	call note, contact call between dam and pups; may be made by injured animals calling group members. (Ben-David per. com.)
grunt or cough	startled, feel threatened, response to pups chirp
whoop	contact call made by dam to pups, made by dam when searching for pups
un-huh, un-huh	could be same as grunts or chuckles
caterwaul	used by female during mating
grunts or chuckles	pups soliciting dam; animals soliciting food from keepers, general contact call or greeting (huh, huh, huh) 'hm! hm! hm! as deep as possible (Harris 1968)
chuckle	low-keyed, used above and below water to communicate good feelings. *"To imitate it, close the lips & utter huh! huh! huh! as deeply as possible in rapid groups of several sounds at a time."* (Park 1971)

The ears are small and protected by a valve, comprised of anterior and posterior ridges, which can be closed under water.

Olfactory

Little is known, but it is believed to be acute due to the extensive use of scent markings, or spraints for communication. *"All otter species have large nasal fossae and well-developed turbinates, suggesting a keen sense of olfaction; however, the otters' olfactory lobes are small relative to other mustelids"* (Estes 1989). (See Scent Glands under Identification/Description & Communication)

There is speculation that an animal may be able to determine the identity and sex of the individual who left the spraint simply by smelling it (Estes 1989). Rostain et al. (2003) conducted scat scent preference tests in a group of wild-caught (later returned to their locations of origin) male Nearctic otters at the Alaska Sea Live Center. They tested for: spraints as signals of species identity; spraints as a form of male-female communication allowing males to recognize sexual partners; and to test if spraints are used as a territorial signal or form of intra-group communication. Their results suggested that*, "…olfactory signals in L. canadensis probably communicate species and sexual identity."*

Tactile

Touch is highly developed. Researchers have found the coronal gyrus of the brain to be enlarged, *"…suggesting highly developed receptor fields in the head, probably associated with the numerous and stout facial vibrissae"* (Toweill & Tabor 1982). The characteristically long vibrissae are believed to be very sensitive and may aid in locating prey in murky water.

Manual dexterity also is highly refined but not relied on as heavily as is seen in some of the other otter species, i.e. Asian small clawed otter. Park (1971) recounted a case of an otter manipulating *"a small lead pellet underwater…"* which led him to conclude they are highly dexterous. For the most part, N. A. river otters use their face and facial vibrissae to locate food (Park 1971).

Taste
Little is known.

Visual
"Visual senses are not acute in the otter. Otters are nearsighted, an adaptation for underwater vision, but apparently can detect movement at considerable distances" (Toweill & Tabor 1982).

The following information comes from Estes (1989):

Underwater vision presents three basic problems; *"…the need for increased light-gathering capacity; …need to accommodate the spectral shift in light quality toward the blue-green wavelengths (found particularly in scoptic, low light conditions);…need to modify the eyes' light-focusing capacity underwater because of refractive differences that occur at the water-corneal compared with the air-corneal interface."* These are problems faced by the otter that could be accommodated structurally in three different ways: 1) an increase in corneal convexity, 2) increase in the focusing capacity of the lens, and, 3) increase the length of the eye.

Estes refers to work done on the Oriental small-clawed otter (*Aonyx cinerea*, now *Amblonyx cinereus*) which indicates a high degree of flexibility in their focusing ability in air and water with a slight selection for high visual acuity on land. It is theorized that the *Lontra (Lutra)* species require more visual acuity underwater because they capture their prey with their mouths versus the *Amblonyx (Aonyx)* pattern of using the forelimbs to feel for invertebrate prey. Further, he states that the underwater focusing mechanism of *Lontra* species is achieved by the distortion of the lens due to well-developed sphincter and ciliary muscles.

"The optical difficulty of focusing in both air and water is considered to be one of the primary environmental influences on the adaptive radiation of the vertebrate eye (Walls 1942). Vision underwater is confounded by the similar refractive indices of the cornea and water. As a result the cornea can no longer contribute to the focusing power of the eye. Since, in terrestrial animals, the cornea is the principal refracting surface of the eye, underwater such an eye would focus the image behind the retina, resulting in blurred vision. Submergence thus causes longsightedness (hypermetropia). To maintain its acuity in water, the eye of an amphibious mammal must have greater focusing or dioptric power. In optical terms this means a higher lens curvature" (Dunstone 1998).

Dunstone (1998) cites work by Walls (1942) indicating that the otter has adapted to this need for greater focusing power by evolving *"well developed sphincter iridis muscle*(s)" which serve to compress the outer edge of the lens thereby producing, *"an area of high curvature and hence powerful focusing ability."* The work of Ballard et al. (1989) has shown that the N. A. river otter eye is capable of roughly 54 diopters of accommodation. To put this in perspective they point out that, young primates, *"which are acknowledged to have the greatest accommodative ability of any terrestrial mammals, could only produce 10 diopters"* (Dunstone 1998). Based on these findings they determined that the otter has equivalent visual acuity on land and in the water in bright light conditions.

Park (1971) decided that the otter's sight on land was not that good with motion needed to attract the animal's attention. However, he believed their short-range vision was excellent. He based this on the ability of an animal he observed to find a shot gun pellet hidden in the pebbles on a pool floor.

Based on work done at the Otter Zentrum in Germany on Lutra lutra, Kasprzyk (1990) determined: *"The results of aerial and underwater studies on the colour vision of Lutra lutra indicate the highest spectral sensitivity for the colour blue, a reduced sensitivity for green and a very little sensitivity for red and yellow."*

Mortality

There is no question that the future of river otter populations is dependent on man. In addition to the impacts of pollution and loss of habitat (see general bibliography), trapping, domestic dogs, roads, and railroad tracks that run through otter habitat are known hazards. To date there is not enough known about what kind of impact the last three have on otter populations.

There are few natural enemies of the river otter; most of these dangers, such as coyotes, are encountered when traveling overland (personal observation of attack that did not end in the otter's death). There are reports (substantiated* and unsubstantiated**) of predation on river otters by: alligator*, American crocodile**, bald eagle*, orca*, gray wolf*, coyote**, domestic dog*, red fox* (juvenile otter), bobcat*. Mountain lion*, black bear**, brown bear**, and wolverine** (Melquist et al. 2003 cite original sources).

There seems to be a peak in otter deaths at about three to five years with nine to ten years considered a good longevity for wild otters. Otters in captivity can live to 20+ years but this is not typical. See Section 2, Chapter 10 (Health Care) for *ex-situ* mortality information.

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CHAPTER 5 BEHAVIOR, SOCIAL ORGANIZATION, NATURAL HISTORY

Natural History

HABITAT

> *"Otters are found in both marine and freshwater environments ranging from coastal to high mountainous elevations. Density appears greatest in the least disturbed food-rich coastal regions, including estuaries, the lower portions of streams, and coastal marshes…and inland where lowland marshes and swamps interconnect with meandering streams and small lakes.*
>
> *"The availability of certain key components (including shelter, food, and water) determine the duration and intensity of habitat use. Riparian vegetation adjacent to lakes, streams, and other wetland areas is a key component of otter habitat. It may attract beavers, which in turn create ponds, bank dens, and lodges that are later used by river otters. Melquist and Hornocker (1983) documented the importance of beavers in creating foraging and denning sites for otters, and several states have correlated good river otter habitat with the activities of beavers.*
>
> *"Fallen or partly submerged trees and logjams created during the spring runoff provide shelter and foraging areas for both the river otter and its prey. Cavities among tree roots, dense shrubs, and tall grass provide escape cover and temporary resting sites. The conditions created by adequate riparian habitat probably increase the likelihood that an area will be used.*
>
> *"In coastal areas, rugged, rocky, indented shorelines associated with short intertidal lengths provide favorable foraging, feeding, and resting sites. However, river otters tend to avoid extensive shorelines that have long intertidal lengths and are devoid of large trees and other riparian vegetation. Otters in coastal southeastern Alaska avoided 5- to 20-year-old clear-cut areas.*
>
> *"In the temperate regions of North America where winters are severe (i.e. lakes and streams freeze over and snow accumulates to considerable depths), certain habitats are used only seasonally. In mountainous areas, river otters vacate high elevation streams and lakes during winter and move into the valleys."*
>
> (Melquist & Dronkert 1987)

In summary, the availability of temporary dens, resting sites, key activity areas, suitable vegetation cover, and adequate food influences otter habitat use considerably. Sometimes this leads to conflict with man, particularly since areas otters find attractive such as lake shores, streams, and river banks also are highly desirable locations for human development. In the future, this conflict could prove to be the most severe threat to the continued survival of river otters.

HUMAN/OTTER HABITAT CONFLICT

There is no easy answer to the questions: "*How do I get otters to leave my fish pond or boat dock alone?*

Generally, otters will leave an area in a few days' time; if food is prevalent, or if the area provides good denning/resting sites, the animals may incorporate your location into their home range. The best response is to sit back and enjoy the rare pleasure of the otters' visit. If this is not an option you can try: getting a dog; putting a radio on a timer; removing the attraction for the otters, at least temporarily; erect an electric fence otter high until they are dissuaded from visiting. The latter is being tried in S. Africa around sport-fishing lakes where it has met with some success; on a small scale this could be accomplished with a typical battery run farm Fencer unit. In the Rehabilitation chapter of Section 3 an article by Clio Smeeton of Cochrane Ecological Institute offers advice if an otter needs to be trapped and moved. Appendix A offers a list of articles dealing with otter exclusion techniques.

Fish in man-made ponds can be given some protection by providing them with cover in the pond. This can be accomplished by placing dead-fall into the pond which offers hiding spots for the fish. Some small commercial fish ponds have tried constructing "otter barriers" down the middle of the pond. These are made from palm fronds, bamboo, or anything similar that will allow the fish to swim through but prevent the otters from pushing through. The otter is forced to go up and over or get out of the pond and go around. This provides the fish enough time to hide, or allows them to swim back to the other side while the otter is maneuvering the barrier.

Unfortunately, otters fall victim to road accidents because of our mutual attraction to these water environments. The extent of otter road kill/injury is not known at this time and should be studied in the future.

ACTIVITY CYCLE AND SEASONAL MOVEMENTS

River otters are generally crepuscular or nocturnal. Some researchers have reported observing active otters during daylight hours in areas remote from human interference. In 1983 Melquist and Hornocker reported that their Idaho study animals were more diurnal during the winter, while confining most of their activity to crepuscular and/or nocturnal hours the remainder of the year. The editor has observed otters active during the day, in winter, in Yellowstone National Park.

> *"Although northern river otters may be active at any time of day, most activity occurs from dawn to midmorning and during the evening* (Melquist & Hornocker 1979). *"The peak of feeding activity apparently occurs from dawn to midmorning"* (Toweill & Tabor 1982).

During his fifteen plus years of observing five generations of otters living on the northern California coast, Scott Shannon has found them to be diurnal and undisturbed by the nearby harbor and presence of man (Personal Communication).

Martin et al. (2010) concluded the otters in their Minnesota study area were likely visiting latrines or moving between resting/foraging sites during the bimodal periods (2200 to 2300 H, or just after sunset during their study, and ~0400 H or just before sunrise) when they exhibited up to 3x more movement than during the rest of the diel period. Their radio telemetry data indicated the otters in their study area were primarily nocturnal foragers.

Seasonal activity patterns are not well understood beyond the fact that otters are active year around. Females with young pups are less active than they are the rest of the year when the pups are older or they are without young. Yearling males and females travel further on a daily basis in summer and fall than adult females (which would coincide somewhat with the period of dispersal). It is likely that adult males range over areas at least as large as the yearly males (Melquist & Hornocker 1983). Blundell et al. (2002) offers further detailed evaluation of dispersal. Melquist and Hornocker (1983) concluded that: *"Nulliparous females and parous females without young would likely travel more extensively with a male during the breeding season than would a lactating female"*. (See also Daily Activity Cycle under Identification)

Daily Movements

Melquist & Hornocker (1983) reported daily moves for individual otters ranging from 2.4 km (1.49 miles) (average for family groups in winter) to 42 km (26.1 miles); this maximum daily distance recorded, 42km (26.1 miles) was for a dispersing yearling male. They documented the daily movements of a number of individual otters in Idaho through the use of biotelemetry. Their study produced the following information:

> *"The most notable conclusion is that there was considerable variation in the mean distance between consecutive-day locations for individuals from each class and between classes (these were age/sex classes). There was no apparent seasonal trend in the extent of movement for any of the age classes except that independent juvenile males and family groups moved significantly less during the winter."*

Martin et al. (2010) report that, "*male otters moved at greater rates than females, and males moved at greater rates during the breeding season than during winter and summer. The greatest rates of movement by male otters were during breeding season when movement rates were approximately 24% greater than for females and were 18- 25% greater than for males during other seasons".* Females moved more during breeding season and during summer (likely coinciding with increased energy needs due to the presence of young). See also Home Ranges & Activity Cycle and Seasonal Movements.

SIGNS OF OTTER IN THE WILD

Signs of otter in the wild have been described by numerous authors, including: Mowbray et al. 1977, Polechla 1987, Liers 1951 and others. This list is taken from Polechla's (1987) glossary of otter sign.

Haul outs – "*Worn trail from the water's edge…usually scattered with fish scales, bones and scats."*
Bedding sites – "*Concentric impressions on the ground left by sleeping otters."*
Rolling sites – Areas flattened out by *"frolicking"* otters.
Scrapes – *"Areas scraped bare by otter usually used more than once…Food remains and scats are absent."*
Dens – *"Holes in bank," beaver lodges, or natural or artificial cavities used by otters."*
Tracks – Footprints, generally 8.255cm (3.25 inches) wide show five distinct claw-toed marks with webbing.
Single scat – *"Not associated with haul outs or obvious feeding sites…"*
Scent posts – *"A site about five feet square with several digging and scratching sites located within it."* As a rule no evidence of bedding sites, food remains or scats are found at scent posts.
Slides – The trough created by the otter's body when sliding through mud or snow often accompanied by otter tracks. (Photo: http://www.dec.ny.gov/animals/9355.html)

HOME RANGES

> *"A river otter's home range includes the area in which the animal lives, reproduces, and generally satisfies its life requirements. The shape of a home range will vary because it is determined primarily by drainage patterns.*
>
> *"…prey availability, habitat, weather conditions, topography, the reproductive cycle, and conspecifics influence home range use and size. However, all portions of the home range are not equally used. Strong site attachment for activity centers, which often determines seasonal home range limits, may be the primary reason for the existence of river otter home ranges.*

"River otter home ranges vary considerably between the sexes and among the different age classes. Adult males probably have the largest home ranges, especially during the spring breeding season. Lactating females have the most restricted home ranges during spring".
(Melquist & Dronkert 1987)

"Otters exhibit different spacing mechanisms, degrees of sociality, and habitat selection in different portions of their range. In mountain streams and lakes of Idaho, home ranges were defined largely by local topography and overlapped extensively within and among sexes. Otters exhibited varying degrees of mutual avoidance and tolerance depending on the seasonal dispersion and availability of food and shelter (Hornocker et. al. 1983; Melquist & Hornocker 1983). Family groups of otters in coastal southeastern Alaska used adjacent but generally non-overlapping lengths of shoreline (Woolington 1984), but males in a similar coastal environment exhibited larger and partially overlapping ranges (Larsen 1983)." (Reid et. al. 1994)

Researchers have reported other seasonal variations in the size of home ranges, i.e. an increase in size from autumn to winter in Idaho (Melquist & Hornocker 1983).

(Home range) *"…spacing is variable and might be related to physiological and environmental factors. Intra- and intersexual home range overlap was extensive in Idaho, where potential confrontations appeared to be resolved through mutual avoidance. The concept of territory as `any defended area' may not apply to river otters because in Idaho they defended their own personal space without reference to fixed spatial boundaries. Considerable mixing and extensive home range overlap were documented in Louisiana and for reintroduced otters in Missouri."* (Melquist & Dronkert 1987)

In southeastern Alaska Woolington (1984) and Larsen (1983) found that family groups of otters, *"…used adjacent but generally non-overlapping lengths of shoreline…"* (Woolington 1984); but that males occupying similar types of shorelines utilized, *"…larger and partially overlapping ranges"* (Larsen 1983).

In Alberta, Canada, annual home ranges varied in size from 15.8km^2 (6.1 miles^2) (adult female with young) to 271.9km^2 (105miles^2) (an adult male) (Reid et. al. 1994). They also found that annual home range overlaps were more extensive for males than for females and that the males' ranges overlapped those of both females and other males. They also found: *"Groupings appeared to be more common during the open-water season and early winter. By midwinter and through the breeding season, otters seemed to move and den more often alone."* In Alaska, Bowyer et al. (1995) found that otters inhabiting coastal environments had home ranges along the shoreline varying from 20 to 40 km (12.5 to 25 miles long).

In general, wherever otters are found, activity centers are important. Because the land/water interface is important home ranges frequently assume a linear shape to incorporate shorelines and activity centers.

Activity Centers

"Activity centers were areas where an otter had been located at least 10% of the time during a specific season. Activity centers were considered preferred locations within the home range" (Melquist & Hornocker 1983). In captivity as well as the wild otters show a tendency to use certain areas for specific activities. These activity centers include:

Pulling out places, Landings or Haul-outs – Locations where otters leave the water to rub and groom themselves. These areas are frequently the site of scent markings using urine or feces (Liers 1951, Melquist & Hornocker 1983).

Holt – Denning locations, generally opportunistically use dens dug by other species, beaver dams, root systems, natural hollows, etc. The otter will enlarge a previously dug den or hole (Liers 1951).

Slides – A bank or hill area otters use frequently for sliding, especially into the water.

Latrines – Sprainting sites where feces and urine are deposited by more than one otter. Because otters do not appear to defend a physical territory in the classic case but, instead defend personal space, it is speculated that latrines may serve to announce an animal's presence in an area.

> *"As part of their social behavior, river otters mark specific locations along the coast, known as latrine sites (Testa et al. 1994, Bowyer et al. 1995, Kruuk 1996). In these sites, which can be 5 - 20 m* (16.4 – 65.6 ft.) *in radius and are typically 25 – 300 m* (82 – 984 ft.) *apart ([approximately] 160 latrines/100 km* [62.13 miles] *of shoreline), river otters deposit feces and urine, as well as excretions from their anal glands. Although the social function of these latrine sites is not clearly understood (i.e., marking to establish social dominance, marking of feeding sites, etc.; Kruuk 1996), direct observations and removal of feces suggest that the visitation rate to latrine sites is high (Testa et al. 1994, Bowyer et al. 1995; M. Ben-David, personal observation). The distribution of latrine sites along the coast is dependent on several habitat variables. Otters show preference* (in Alaska) *for sites that have shallow, tidal slopes with large rocks and shallow, vegetated slopes with high overstory cover (Bowyer et al. 1995).*

Scent posts – Similar to latrines. Scent posts are often located near den entrances, slides, runways or other frequently used places. They are most frequently seen on elevated sites like fallen logs, rocks, or small mounds (Park 1971).

Natal Den Characteristics

Gorman et al. (2006) monitored 8 (>2 years old) radio tagged females during the natal denning season in Minnesota (March – May). They report: "*Females began denning in March, with a mean initiation date of 31 March, and used natal dens for a mean of 49 days (SE=3). Two females used man-made brush piles as dens, four used small limestone caves, one used a cavity in the roots of a big-toothed aspen (Populus grandidentata), and one used a beaver (Castor canadensis) bank den. Dens were located a mean of 316 meters* [346 yards] *(SE=79) from the nearest body of water and averaged 61 meters* [200ft.] *(SE=15) of elevation higher than the nearest body of water. Seven of eight females placed dens outside of their normal activity areas, and all females appeared to select sites that were protected from flood events*."

FEEDING BEHAVIOR

Otters are predominantly piscivorous or ichthyophagous (fish eating). However, there is seasonal variation and otters inhabiting areas with an abundance of crustaceans may rely heavily on them at times.

> *"Foraging otters investigate the hiding places of potential prey, capture slow-swimming species by direct pursuit, and probe muddy and weedy substrate for aquatic insects. Otters tend to forage for themselves, although apparent cooperative fishing has been noted…"* (Beckel 1982).

A. Beckel (1982) also states that the animals she observed *"…usually remained near each other while foraging, but did not dive together or appear to coordinate their hunting efforts."* Her data suggested that although animals frequently remained near each other while foraging, animals hunting alone generally had higher success rates. Beckel did not observe any sharing of food or any fighting over food. More recent studies of river otters inhabiting marine ecosystems in Alaska have shown that groups of animals, (generally males but a few females without young join in) forage together for pelagic fish (Blundell et al. 2002).

> *"Catchability is a key factor in the prey consumed; slow-swimming fish and any prey unable to escape detection will be selected first. Numerous other factors influencing the diet include season, time of day, prey abundance and behavior, competition for the resource (by both conspecifics and other species), water characteristics such as flow and temperature, and size and relative proportions of prey. River otters normally avoid carrion."* (Melquist & Dronkert 1987)

Contrary to the fears of many fishermen, otters can be beneficial to game fisheries due to their tendency to take the less desirable and competing species. As a rule, *"…fish are preyed on in direct proportion to their* *availability (i.e. occurrence and density) and in inverse proportion to their swimming ability"* (Toweill & Tabor 1982). Crustaceans, primarily crayfish and crab, are important food sources in areas where they occur. At certain times of the year it has been found they can constitute 100% of the otters' diet (Melquist & Dronkert 1987).

"Reptiles and amphibians, particularly frogs (Rana sp.), are commonly eaten by otters" (Toweill & Tabor 1982). Melquist & Hornocker (1983) commonly found insects in otter scats. Small birds, i.e. fledglings, ducks, and young mammals also are taken occasionally.

> *"The importance of avian prey varies…frequency of occurrence was greatest during summer (when waterfowl broods are vulnerable) and autumn (when waterfowl crippled by hunters are likely to be scavenged). Predation on ground-nesting colonial birds along the Pacific coast and on coastal islands may be substantial and can be a major cause of nesting failure."* (Melquist & Dronkert 1987)

The river otter will generally take its prey to land to be consumed. It will emerge entirely from the water, or simply rest the front half of its body on the bank, log, rocks, etc. Prey, such as fish, is caught with the mouth then held in the front feet while being eaten. Crustaceans may be routed out with the front feet, but more often the muzzle is used.

Social Organization

SOCIAL SYSTEM

River otters are believed to be more social than most mustelids based on the findings of a number of different researchers (Shannon per. com., Beckel 1982, Ben-David per. com., Blundell 1999, Blundell et. al. 2000, Landis 1997, Rock et. al. 1994, Reid et. al. 1994, Johnson & Berkley 1999).

Although, few behavioral studies of free-ranging otters have been carried out (there are studies in progress that should produce additional ethological information), those researchers that have studied them document a variety of social groupings (13 combinations by Melquist & Hornocker 1983, Blundell et. al. 2000, S. Shannon per. com.). In general, *"…the basic social group (family) consists of an adult female and her juvenile offspring"* (Melquist & Dronkert 1987).

"Most studies have concluded that adult male river otters do not function as part of a family group; however instrumented males have been observed in groups of up to seven unidentified, adult-sized otters" (Beckel 1982). Beckel concluded, based on observations of unmarked otters, that the adult male is readily accepted into the family. She does not clarify how she determined this. There are no documented reports of males accompanying a female with pups. Home (1982) described family groups as being led by adult males although the method of determining sex and group composition was unspecified.

"Bachelor groups of adult males have been observed outside of the breeding season…as have unidentified groups of river otters ranging from 9 to 30 individuals" (Beckel 1982).

Due to the illusive nature of this species it is difficult to definitively answer the question of the male's participation in family life. A number of recent researchers (Blundell, pers. com.; Shannon, pers. com., Rock et al. 1994) and members of the general public, report seeing groups of adult sized otters, sometimes accompanied by what are believed to be sub-adult animals. Whether these are single sex male groups, females and offspring, or an actual family grouping is not always determined. Generally, the conclusion has been that they are single sex groupings (males), or females traveling with sub-adult offspring. It is generally accepted that the adult male has little to do with rearing the pups in the wild. However, in captivity, males have proven to be very attentive and gentle with pups once the dam allows him near the young.

Based on data collected from 55 radio-tracked otters during a study which included social organization of coastal otters, Blundell et al. (2000) reported that, *"Approximately 44% of females were asocial, whereas only 24% of males were not social. Males were social 45% of the year and 65% of that time were found in all-male groups, whereas females were only social 25% of the year and were in mixed-gender groups 85% of that time."* Blundell believes these groups of males are taking advantage of the seasonal occurrence of schools of pelagic fish. Females unaccompanied by young have been seen to join these foraging groups (Blundell et al. 2002). In 2004, Blundell et al. reported further on the association of large male groups observed in the marine otters in Prince William Sound, Alaska. They observed that these large aggregations were composed primarily of males but that some males remained solitary year around.

> *"By using DNA microsatellite analysis and radiotelemetry, we were able to reject the hypothesis that social groups of otters were kin based. In addition, we found no evidence of kin avoidance, as would be expected from low dispersal and high local competition. Sociality conferred no reproductive benefits or costs to otters; number of offspring and number of relatives in the population did not differ between social and solitary animals. Solitary males were not older or larger than were social males, and there was no relation between male's size and number of offspring, indicating that sexual selection did not mask a potential relation between sociality and reproductive success. Among coastal river otters in this region, sociality could be explained by the benefits obtained from cooperative foraging on high-quality schooling pelagic fishes. Such benefits did not require association with kin, resulting in no selection pressure for kin-based groups."* They concluded that their prediction that the degree of sociality would fluctuate with the abundance of schooling pelagic fishes requires further research.

"River otters exhibit considerable plasticity in their social behavior. Flexibility may permit otters to exploit variable habitats with diverse seasonal and spatial patterns of resource availability. Otters reintroduced into vacant habitat exhibit a variety of group associations" (Melquist & Dronkert 1987. This information, cited by these authors, originally comes from a variety of sources.) As Melquist and Hornocker stated in 1983, *"…river otters appear to be far more sociable and tolerant of conspecifics than previously thought."*

Reid et. al. (1994) reported that in their study *"…adult females with juveniles, and adult males together, were the two most frequently documented groupings."*

Mr. Noel Kindler, of the Louisiana Fish and Wildlife Department, reports that groups of two or more otter families (i.e. dam and her pups) have been seen not infrequently. These groups have been seen to travel and forage together (pers. com. 1994).

Scott Shannon, who has studied five generations of otters living on the northern California coast, has observed as many as eight non-related males living and fishing together. He also reports a strict segregation of adults along sexual lines (except during breeding season or before a female is sexually mature), and social groupings (matriarchal clan) not observed by other researchers (Personal communication).

In captivity, care needs to be taken when introducing a new animal into a group, especially with females; however, in recent years several facilities have had success with this type of introduction. (See Captive Management.)

Most common social groupings

In short, the most commonly seen groups of otters in the wild are females with pups and all male groups (which may or may not be accompanied by immature females or non-reproductive females). Also seen but, less frequently are two females traveling, or foraging with associated pups. Reports of male and female pairs are verified only as occurring during breeding season.

Otter Behavior

GENERAL BEHAVIOR

These behaviors have been described by a number of authors; all of them have been observed by this author in captive animals and many in wild otters.

Wrestling

Beckel (1982) observed wrestling in the captive groups and the free-ranging otters she studied. In fact, it was the most commonly observed social behavior between free-ranging otters. This behavior has the appearance of play but likely also serves to establish the involved animal's relative strength.

Muzzle-Touching

Seen in captive and free-ranging otters (Beckel 1982). There appears to be a significant increase in the frequency of this activity during the breeding season. This behavior is interpreted as a gesture of reassurance or friendly intentions.

Social Grooming (Allo-grooming; Mutual grooming)

Social grooming is seen in free-ranging as well as captive otters, however, it probably occurs more frequently in captive animals. Male-male, female-female, and male-female pairings are all observed to groom one another. Beckel (1982) reports that 86% of all social grooming is directed to the head and neck area, so it may also play a role in hygiene (this is the hardest area for an otter to groom itself). It is theorized that social grooming may play a role in *"…establishing and maintaining social relationships among all group members, possibly making the animals more familiar with each other"* (Beckel 1982).

Foraging

This is not truly a social behavior however, Beckel (1982) reports observing animals frequently foraging in the same area. They do not appear to be cooperating, and although they seem to be less successful, they seem to capture larger fish when there is more than one otter hunting in the same general area. Group foraging for schooling pelagic fish has been reported by Blundell et al. (2002, 2004).

Resting

Otters are frequently seen sleeping, or resting, in physical contact with other conspecifics.

Fighting

This is generally noisy, accompanied by a lot of screaming. In the wild, otters do not frequently fight, more commonly they exercise avoidance of other individuals.

Communication

River otters are less vocal than other *Lutrinae,* however, they do communicate via some auditory as well as olfactory and tactile signals. Visual signals are thought to be of minor importance. (See Senses for additional communication information.)

Auditory

Shrill chirp, soft chuckle, scream, and a caterwaul (from females only during copulation) were reported by Liers (1951a). A low grunting noise was added by Harris (1968). Melquist references, *"…a 'grunt'. (*See Senses for additional vocalizations.)

Olfactory

> *"Olfaction apparently plays a major role in otter communication. Northern river otters possess anal scent glands, and scent may be released from these glands in times of fear or rage. Otters also maintain 'scent posts' throughout their territory."* (Toweill & Tabor 1982)

Scent posts have been described as *"...sites 1 to 2m* (3.28 – 6.56 ft.) *with digging and scratching sites but no food remains, scats, or beds"* (Toweill & Tabor citing Mowbray 1979). *"Marking by defecation, urination, and possibly anal sac secretion was observed primarily at activity centers and foraging sites. Otters marked sites at various times during foraging sessions and generally just before leaving a site"* (Melquist & Hornocker 1983).

Melquist and Hornocker (1983) also reported that scent marking was probably the most important mode of inter-group communication. Any site can be used for the deposition of scent but, it is believed the natal den area is not marked to prevent its discovery by adult males. In captivity, females have been known to defecate in the water while pups are very young and at least one male defecated in the water during times of the year he was avoiding the female or when she was being particularly antagonistic.

Tactile

The facial vibrissae are known to be important in detecting prey in murky water. It has been proposed that the frequent muzzle-touching and mutual grooming seen, at least in captive animals, may serve a social function (Beckel 1982). Also, *"...wrestling, a behavior often characterized as play, may be a means of assessing relative strength and dominance"* (Melquist & Dronkert 1987).

L. canadensis is a 'contact species' ...; group members maintain no individual distance and are not only tolerant of physical contact, but also seek it. Group members sit and sleep together, often piled one on top of the other, and tend to maintain proximity at other times as well" (Beckel 1982).

Visual

"Few visual displays have been recorded. With their short muzzle and ears and their more or less uniform coat of hair, otters are poorly adapted for visual display-based communication. A 'threat-face' characterized by pulling the ears back and a gape display is used." (Toweill & Tabor 1982)

Beckel (1982) describes these visual signals: **Open-mouth scream** – the teeth are slightly bared; the scream is both a threat and a defensive vocalization; **Open-mouth relaxed face** – this occurs when otters wrestle or are trying to initiate wrestling.

Visual signals also consist of postures, such as the supine position adopted by a pup after scolding from the dam (Liers 1951a). A subordinate or defensive animal will adopt a supine position on its side or back when being harassed by a dominant or more assertive animal. A more assertive/aggressive/dominant animal will place its front feet on a supine animal; this gesture is followed by nuzzling, or a bite. The **Latrine dance** is the treading of the back feet (usually six to eight times) with the tail arched while defecating or urinating. It often attracts other animals that then sniff the latrine and deposit their own urine/feces/anal gland scents (personal observation). (See Behavioral below)

Behavioral

- **Face-Pawing**
  "This behavior...appears to communicate a readiness to engage in affiliative interactions" (Beckel 1982). Further, Beckel reports that rolling onto their back and pawing at another otter's face frequently resulted in social grooming; if this face-pawing behavior was carried out more vigorously, wrestling usually ensued.
  When face-pawing or muzzle-touching is done gently by the initiator while lying on the back the behavior may help inhibit aggression.
- **Roll-Over**
  A submissive animal may roll onto its side or back when approached by a more dominant animal.
- **Step-On**
  A dominant animal places its front feet on a submissive animal while it is lying on its back or side. Not infrequently the submissive animal is screaming. Dominant animal follows up this behavior with a nuzzle or quick bite.
- **Nuzzle/nuzzling**

One animal rubs its face on another.

- **Mounting**
  This refers to mounting occurring outside of the breeding season. It has been observed as male-male, female-male, and male-female mounting. Male-male mounts are an expression of dominance; this also may be true of female-male mounts.
- **Anal-Anogenital Sniffing**
  The frequency of this behavior may increase during breeding season. Beckel (1982) did not observe this behavior in the free-ranging groups she studied.

PLAY

> *"The river otter's playful reputation is unparalleled. Highly intelligent and active, inquisitive and quick, the river otter possesses characteristics conducive to play. Provided with a comfortable environment and adequate food and protection, captive and tame otters have ample time to indulge in playful activities. Play behavior does not appear nearly as prevalent among wild, free-ranging otters, even though such behavior may have important survival implications."* (Melquist & Dronkert 1987)

The otter's memory is reported to be exceptional (Liers 1951, Harris 1968).

> *"Much of their active time is spent exploring new surroundings or objects, often in the form of apparent play. Northern river otters have been taught to retrieve objects from land and water, to capture and retrieve fish, and to hunt other animals."* (Toweill & Tabor 1982)

As is true for most mammals, play-like behavior is more frequently observed in immature otters. In captivity, otters can be seen chasing, wrestling, and bounding in what appears to be a playful fashion. Also, otters will manipulate, or carry around objects in a manner reminiscent of play. Stevens and Serfass (2008) reported on an apparent "play bout" of sliding and gamboling in the snow by three otters at a latrine.

> *"An otter swimming downstream and meeting a twig floating on the surface will nonchalantly push the twig ahead of it for a time expertly balancing that twig with its broad nose whether swimming above the water or below it. It fondles pebbles the drops them, picks them up and carries them, loses them, finds them, hides them, searches for them, and eventually abandons them as something new attracts its attention."* (Park 1971)

All of us who work with otters can relate to each of these statements. There is no doubt that otters are active, inquisitive animals; quick to learn and quick to "play". For these reasons, in captivity it is important that an effective, well thought out enrichment program is in place and implemented. There are a number of enrichment options listed in the Enrichment chapter of this notebook but don't forget the simple things! Small river stones, leaf piles, straw or leaves to carry, dirt to dig and role in, and twigs or rocks to push or carry around often prove to be favorite "play-things" and can occupy an otter for hours.

BODY CARE

"The most common means of body care in otters is rubbing and rolling, whether in sand, grass, snow, or whatever else is available and relatively dry. This activity is commonly associated with considerable scratching, and both activities apparently serve to clean the animal's fur and thereby maintain its insulative qualities, as well as to dry the otter quickly after its emergence from the water. Areas used for this activity, called 'rolling sites', 'scrapes', 'haul-outs', or 'landings'. (Mowbray et. al. 1979, Melquist & Hornocker 1979, Toweill & Tabor 1982), *are among the most common evidence of otter activity."*

"Otters typically have particular 'toilets' (Greer 1955) *near regular landings for defecation purposes, although single scats may be deposited near rolling areas, scent posts, or on logs or points extending out into the wate."* (Toweill & Tabor 1982).

BREEDING/REPRODUCTIVE BEHAVIOR

Receptive females may advertise their condition by marking at haul-outs and scent stations. [However], *"...the location of the natal den does not appear to be advertised or disclosed to other river otters"* (Melquist & Dronkert 1987).

When the female is receptive, copulation generally occurs in the water (but also can occur on land) and can last 15 to 30+ minutes taking place repeatedly over the course of a few days personal observation of bouts lasting 60 min.+). Although there does not appear to be any pair bonding, a male may spend a few days with a receptive female with copulation occurring repeatedly during that time. Zoological institutions that do not normally house their pairs together due to aggression, report an abatement of this during the breeding season.

A female in estrus will spend more time rubbing and marking her exhibit/surroundings. A 'courting' pair of otters will spend more time in chase/play behavior, mutual grooming, muzzle-touching, and nuzzling. Beckel (1982) reports that muzzle-touching was common in all the captive groups (n=7) she studied and was observed among free-ranging animals. There was a definite increase in this activity going into, and during, the breeding season. She also observed an increase in the amount of social grooming between adult males and females during the breeding season. A non-receptive, or uninterested, female will chase the male away or roll onto her back, scream, and/or paw at the male's face.

Otters are not reported to dig their own dens, (at least, not typically), but will take advantage of what is available. Abandoned beaver lodges are a favorite. They also have been reported to use hollow trees and logs; abandoned nutria dens; log jams; drift piles; piles of rock; abandoned, or little used buildings, and duck blinds. Captive otters have been known to fashion their own nests when given the opportunity. In captivity, it is important to give a dam more than one nesting choice, plenty of nesting material, and privacy for her and the pups.

"The natal area is infrequently used by the female and her offspring during other seasons" (Melquist & Hornocker 1983). Also, *"...female otters generally do not use the same natal den each year"* (Melquist & Dronkert 1987). See natal dens under Parental Care.

Just prior to parturition, many institutions report that their females refuse to leave their nest boxes and do not eat. There are always exceptions to this such as the JBZ female that quickly consumed all of her AM feeding then one hour later sat outside her nest box and gave birth to her first pup (this was her first litter, since that time she exhibits more typical anorexia prior to parturition). Liers (1951) reported the birth process as lasting three to eight hours. For additional information see the Chapter 6 Reproduction Section.

PARENTAL CARE AND BEHAVIORAL ONTOGENY

General Maternal Behavior

Dams are generally very solicitous mothers and solely responsible for care of the litter. The female will vigorously defend the natal den/holt and pups from exhibit mates or passing otters in the wild. There are numerous reports of 'helper' otters accompanying a female and pups; or of two adult animals traveling with pups (which is generally believed to be two females with pups and probably gave rise to reports of males joining the family group) (Rock et al. 1994, Landis 1997). However, it is not known when during the pups' development the females join forces, or for how long the association lasts. (Scott Shannon studying otters in Trinidad Bay, N. California has found a matriarchal situation in the population he followed for over seventeen years. Several females live in close association with one another, all related.)

Natal Dens

Females frequently use dens dug by other animals as natal holts. These natal dens are generally removed from water; Reid et. al. (1986) reported one female utilized an abandoned fox den 300 meters (984.25 feet) from the shore. The pups were moved closer to water when about three to four weeks old. Liers (1951) reported natal dens located 150 yards (137.16 m) from water and 150 feet (45.72 m) above high-water (female 1) and ½ mile (.085 km) from the water and about 500 feet (152.4 m) above high-water (female 2).

Swimming Lessons

Otter pups must be taught how to swim. In captivity, females may begin these lessons earlier (day 38 plus or minus a few days, later may be more typical), than in the wild (it could be swimming lessons this early in the wild have gone unobserved, but unlikely); lessons are very short to begin with and lengthen as the pups gain control of their body and limbs. Young pups most resemble hairy-corks bobbing in the water. Females will decide when it is time to teach the pups to swim but these early lessons should be monitored to be sure she stays vigilant and takes pups out of the water before they tire. The depth of the water does not seem to matter but provisions should be made to ensure it is possible for pups to pull themselves out of the water, or have something to rest their weight on.

Hunting

In the wild the dam will release food for the pups to catch, in captivity an experienced mother will carry food to her pups, or allow them to eat first, when they are old enough to begin eating solids. Inexperienced dams may not be so generous and pups may have to be separated during feeding times. (See Social System, Feeding Style, Diet & Nutrition)

General Paternal Behavior

Liers (1951) reported that, if given the opportunity, many males will assist in caring for the pups. However, the dam usually will not allow any other animals near the pups until they are about three months old. Several facilities have successfully reintroduced the male when the pups were three months or older. These males have all been very gentle and playful with the pups. Those facilities that leave the male in the exhibit have found the same thing once the female allows the male near the pups. Note: It is recommended that pups are proficient swimmers before reintroduction of the male to the family group. (See Developmental Stages – Reproduction)

Behavioral Ontogeny

> *"…helpless at birth, young otters begin to open their eyes by the age of 21 to 35 days, and by 25 to 42 days they begin playing with each other and with their mother. The pups may be introduced to the water by the age of 48 days and may venture out of the den on their own by the age of 59 to 70 days. By 49 days, young begin to use a specific, localized area for defecation. At the age of 63 to 76 days, they begin eating solid food, although weaning does not occur until about 91 days."* (Toweill & Tabor 1982) (See also Reproduction Section & Pup Development)

Dispersal

Pups will usually emerge from the natal den or nest box at about 2 months of age. Weaning generally does not begin until about three months. *"Young otters are self-sufficient by five to six months, but the family remains intact for at least seven to eight months, or until just prior to the birth of a new litter"* (Melquist & Dronkert 1987). The phenomenon of 'helper' otters has raised the question that these individuals may be elder daughters of the female with young pups. It is unclear if this daughter has stayed with her mother or simply shared a home range and occasionally spends several days with the new family group. In captivity, a few facilities have left multiple females together when one has pups; the dam has tolerated the other female's presence.

Melquist & Hornocker (1983) found that juveniles would disperse at 12 to 13 months of age, usually in April or May. However, the extent of dispersal was highly variable, with some individuals not dispersing at all. Dispersal does eventually occur before sexual maturity. They concluded: "*Dispersal appeared to be an inherent trait stimulated by certain physiological changes unrelated to those accompanying sexual maturity. Although dispersal and the exploration of new areas without dispersing coincided with the breeding season, dispersing otters were not sexually mature. This would suggest that other physiological changes, probably related to day-length, stimulated dispersal. A lack of evidence linking dispersal with density-dependent factors also indicated that dispersal was an inherent trait." "…not all otter dispersed,* *suggesting an unequal development of the dispersing tendency among individuals. The failure of some otters to disperse also suggests that sub-adult otters were probably not forced from the natal area by the adults*." *(Melquist & Hornocker 1983)*

In conclusion, dispersal may occur as early as about eight months of age or not until closer to sexual maturity (15 to 24 months, Liers 1958). In general though, it is believed that young animals leave the dam by 12 to 13 months of age.

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CHAPTER 6 REPRODUCTION

Breeding: Season, Physiology, & Behavior

BREEDING SEASON

Monestrus; season ranges from November to May (rarely early June at latest). These otters are seasonal breeders. Females mature reproductively as early as 12-15 months (rare reports of successful breeding at this age) to two years of age (typical). They are believed to be induced ovulators and experience delayed implantation (Chanin 1985; Reed-Smith 2001, personal observation, Bateman et al. 2009). Recent evidence suggests that this species also may be capable of spontaneous ovulation (Bateman et al. 2009). See also Chapter 3 *Ex-Situ* Status for litter size, Dam/Sire age at reproduction (oldest and youngest), inter-birth interval.

There is evidence that breeding season varies somewhat with latitude. In general, breeding occurs in late spring (late March, April, and May, to early June*) at northern latitudes, and during late November, December, January, or February at more southern latitudes (Reed-Smith 1997, Bateman et al. 2009). The first editions of the notebook reported that: "As with all things otter, in captivity, there have been exceptions to this rule reported. For example, while living in Minnesota, Liers (1951) reported December estrus in some of his females, also, there are a few historic records of December/January breeding in New York." Based on the work by Bateman et al. (2009) at C.R.E.W. it is now likely that these otters originated at more southerly latitudes. One study, (Crait et al. 2006), speculated that breeding season may be influenced by seasonal availability of food resources; however, the authors of this study speculating on the influence of food availability acknowledge there could have been other things occurring, and their sample size was small. * Breeding in June in was reported from Yellowstone Lake, Wyoming (Latitude 44° 23') by Crait et al. (2006). See Estrous Cycle & Length below, Chapter 5 Breeding/Reproductive Behavior, Chapter 4 Female and Male Characteristics, and Chapter 3 Dam and Sire Information

ESTROUS CYCLE & LENGTH

Previously it was reported that the estrus period lasts approximately 42 - 46 days, unless mating occurs (Chanin 1985). Bateman et al. (2009) found that "…*peaks in fecal estrogen values occurred only during the defined breeding season from December to March*". They also report, "…*the estrus phase of their [females] cycles [N=11] was observed just once per year with an average duration of 15.33±1.98 days (range: 6–54 days). The average duration of estrus elevation coincident with observed breeding (n=4) was a 22.00±1.22 day (range: 19–24 days).*" During this time, observations of *ex-situ* populations suggest peaks of maximum receptivity are roughly 3-6 days apart with intervals of only mild receptivity during which the female may completely reject the male (Liers 1951; Reed-Smith 2001). The work done by Bateman et al. calls into question the estrus duration of 42 to 46 days traditionally cited; this is an area that should be researched further. Worth noting is the slightly longer estrus (21-23 days) reported in breeding versus non-breeding females (14-17 days); also the widely varying range of estrus duration (6-54 days) reported in the Bateman et al. (2009) study.

A "post-partum" estrus occurs soon after parturition of a similar duration of a typical estrus. Hamilton & Eadie (1964) give this estrus as occurring not long after parturition. Most zoos that have observed "post-partum" estrus see behavioral signs one to two weeks after parturition. Bateman et al. (2009) report: *"The time from parturition to first postpartum elevation in estradiol averaged 19.00±8.06 days (range 2-38 days)."* Bateman et al. (2009) also state that while in other species an estrus occurring shortly after parturition is properly termed a "*post-partum estrus*", in *"…the NARO the timing of this estrus also* *corresponds to the expected seasonal cyclicity seen in this species. These findings indicate that lactation, estrus, and the early stages of the subsequent pregnancy may occur simultaneously in the NARO, a characteristic shared by another mustelid the European badger (Rowlands and Weir 1984)."*

The Bateman et al. (2009) studies reported some additional interesting results from fecal hormone studies:

> *"In the observed pregnancies and pseudopregnancies (n= 12), the date of initial progesterone increase ranged from September 4 to January 14, and the timing was not correlated (r=0.53, P>0.05) with the female's geographic latitude (range: 27–41°N) at the time of the pregnancy or pseudopregnancy. However, the date of the progesterone increase was correlated (r=0.66, P<0.05) with the female's geographic latitude at the time of her own birth (range: 27–42°N)."*

The finding of a possible genetic component tying the timing of progesterone elevation in pregnant and pseudopregnant females to the female's birth latitude (instead of to their geographic location) is significant and requires further study. This may potentially impact *ex-situ* population management practices (transfers of animals to create breeding pairs).

SIGNS OF ESTROUS

Females may show any, all, or occasionally none, of the following signs of estrus: vulvular swelling; a slight pinking of the vulva area; increased rubbing, rolling, and allo-grooming; increased interest in the male or the male's quarters; increased interaction between the female and the male to include chasing, tumbling, mutual-grooming, sleeping together (obviously will only be apparent in pairs that do not normally do this), chuckling to the male; genital sniffing of the male by the female and vice-versa, and, of course, copulation. (Photo: pinking and swelling of vulva)

A vaginal discharge associated with estrus is not typically reported. Female river otters are prone to urogenital infections which frequently cause a milky, milky-blood-tinged, or slightly off-colored discharge which has been interpreted as a possible indicator of estrus. If this kind of discharge is seen the female should be closely observed and the condition monitored by a veterinarian. (See also Health Care.) However, some institutions report slight blood spotting associated with estrus. See also Copulation Characteristics.

> *"When our breeding female is in estrus, she starts to spend a lot of time watching the male through the screen door and pawing at the door. If she is not quite receptive when they are put together, she screams at the male, rolls on her back to prevent mounting, and runs to a safe place away from him. When she is receptive, both otters rub across the exhibit on their bellies, and she does not roll onto her back when the male approaches. Most of the observed breeding has been in the deep pool, and lasts for extended periods of time (up to 70 minutes). When the female is no longer in estrus, she will not tolerate the male being anywhere near her. She will scream and run aggressively towards him."* (Debbie Jackson, Sr. Animal Keeper, Little Rock Zoo)

MALE SEXUAL CHARACTERISTICS

Males mature sexually at about two years; the production of spermatozoa begins at this age. The male's testes begin to enlarge and spermatozoa production begins sometime in October/November, (or earlier at more southern latitudes) and testes remain distended until the end of the breeding season (Liers 1951;

Reed-Smith 2001). Bateman et al. (2009) have shown that male testosterone levels increase seasonally (late winter to early spring) to coincide "…*with the increasing amount of daylight occurring after the winter solstice*." Testosterone levels peaked at different times of the year corresponding with the male's latitudinal location; *"As latitude increased, peak testosterone values appeared to occur later in the calendar year*" (Bateman et al. 2009). They found that *"for all NARO males, testosterone levels were elevated above baseline for an average of 101.8±78.97 days with peak levels being maintained for 25.50±7.51 days*."

It is believed by many who worked extensively with *ex-situ* otters that they are not successful breeders until about five years old (Liers 1951). The reason for this is thought to be the continuing development of the baculum for the first six years. (It increases in length until age three and weight until age six.) It has been postulated that the baculum requires this greater length and weight to induce ovulation. The results of the 1993 N. A. river otter breeding survey showed four of nine breeding males to be four years old, and one that was three years when their first litters were born (the other four were over six years of age). The exact explanation for this early breeding success is unclear but may have something to do with easy access to the females and lack of competition from older, more experienced males. Data on breeding males accumulated since the 1993 survey does not alter these findings. Studbook data shows four males breeding successfully at less than 2 years of age. Of these four records, two are old enough the data may be suspect. See Chapter 3 Sire Information and Chapter 4 Male Characteristics.

FEMALE SEXUAL CHARACTERISTICS

Generally, females also mature sexually at two years of age; although, Liers (1958) mentions one female who was bred at the age of 15 months.

The ovaries and uterus continue to grow until about two years of age. The uterus is bicornate (two horned) (Toweill & Tabor, 1982). *"Adult females…may develop an os clitoridis, the female counterpart to the male os baculum. The os clitoridis is a cartilaginous structure in females less than two years old, but may ossify in older individuals"* (Toweill & Tabor, 1982). Two pairs of mammae are the norm. As previously stated females are induced ovulators and experience delayed implantation. However, Bateman et al. (2009) reported pseudo pregnancies in females that were not housed with males leading them to speculate this species may be capable of spontaneous ovulation under certain conditions. See Chapter 3 Dam Information, Chapter 4 Female Characteristics, and earlier in this chapter.

AGE OF SEXUAL MATURITY

Both males and females are sexually mature at the age of two years; several authors believe that males may not reach full breeding potential until they are 5 to 6 years of age. However, for management purposes pups over one year of age should be monitored or removed from the adult pair. Breeding between a dam and her 13 month old son was observed. It did not lead to pregnancy but the female did experience a pseudopregnancy (personal observation). (See Male and Female sexual characteristics)

OVULATION RATE

"The average ovulation rate for northern river otters has been reported to range from 2.40 to 3.02" (Toweill & Tabor, 1982).

COPULATION CHARACTERISTICS

Although copulation generally takes place in the water, it also can take place on the land. The copulatory act is vigorous, noisy, and can be lengthy with intromission lasting up to 60+ minutes. A pair will copulate repeatedly over a period of an hour or two then take a break for several hours before starting again. Copulation generally occurs several times over successive days.

"The male approaches the female from the rear, holds the female by the scruff of the neck with his teeth, and bends the posterior part of his body around and below the broad tail of the female" (Toweill & Tabor, 1982, Liers 1951). If the female is not receptive, or interested, she may roll on her back and paw at the male; nip and scream at him; or bite him then run away.

DELAYED IMPLANTATION

Lontra canadensis females experience delayed implantation. The fertilized egg stops developing at the blastocyst stage and floats freely in the uterus for a number of months before implanting in the uterine wall.

Total gestation lasts from ~317 to 370 days reported by Liers (1951) and Reed-Smith (2001) or 302-351 (average 333.3 ±15.7) days reported by Bateman et al. (2009); actual gestation is about 68-73 days (average 71.67±1.48) (Bateman et al. 2005, 2009).

The reason for delayed implantation in the N. A. river otter is not really understood. It is always assumed that there must be an adaptive advantage to delayed implantation, but this is not necessarily the case, at least in modern times. It is possible that at one time there was an evolutionary advantage bestowed on river otters by delayed implantation --- perhaps coordination of breeding season with parturition made it easier for males to locate females (see below) or allowed pups to be delivered when food was most abundant. This could still be argued for animals found at higher latitudes but may not be as important to animals found in the southern part of *L. canadensis'* range (however, there can be seasonal fluctuations in resources at the southern latitudes). It may be that this trait is simply evolutionarily neutral; it is no longer advantageous or disadvantageous. Thom et al. (2004), Lindenfors et al. (2003), and Ferguson et al. (2007) discuss the maintenance of delayed implantation in modern mustelids/carnivores and possible reasons for this including its association with highly seasonal environments. See Chapter 4 Female Characteristics.

R. A. Mead cites the work of G. B. Stenson in which Stenson theorizes that embryonic diapause (delayed implantation) in the river otter allows the synchronization of births without a similar synchronization in mating. *"This would allow mating to occur over a relatively long period of time. Alternatively, Stenson proposed that delayed implantation might have temporally synchronized parturition and breeding. Stenson believes this might be of advantage in that lactating females would be much more restricted to the vicinity of their dens, making it easier for males to locate estrous females at this time."* (Mead, 1989)
(See female sexual characteristics.)

"The energy requirements and food intake of pregnant females are from 17 to 32% higher than non-reproducing females" (Robbins 1993). Only 10 to 20% of this increased consumption is actually utilized by the female, most of the metabolized energy is turned into heat and lost. Therefore, *"...lengthening the gestation period by slowing the growth rate will disproportionately increase the total energy cost per unit of fetus produced, which may explain why most delays during pregnancy are not via a reduced growth rate but occur prior to the initiation of growth (i.e. delayed fertilization or implantation)* (Robbins 1993).

EMBRYOS AND INTRAUTERINE MORTALITY

Once the egg is implanted, embryonic growth proceeds rapidly (Huggett & Widdas, 1951). Data suggests intrauterine mortality levels are low (Tabor & Wright, 1977; Mowbray, et. al., 1979).

GESTATION

Total gestation:	285 – 380 days (Liers, 1951)
	245 – 360 days (Duplaix-Hall, 1975)
	309 – 367 days (Reed-Smith 1997 captive survey)
	302 – 351 days (ave. 333.3±15.7) (Bateman et al. 2009)
Actual gestation:	60 – 63 days (Lancia & Hair, 1983)
	50 days (Toweill & Tabor, 1982)
	68 – 73 days (Bateman et al. 2009)

INTER-BIRTH INTERVAL

Due to delayed implantation there is at least a years (theoretically this could be 10 to 11 months but there are no records of intervals less than 327 days [Hamilton 2012]) interval between litters. In some areas of the river otter's range a two-year interval appears to be more common. Tabor & Wright (1977) determined that most females breed annually in Oregon. Mowbray, et al. (1979) discovered that only 25% of the females in Maryland had bred the year before. Lauhachinda (1978) concluded the majority of female otters in Alabama and Georgia probably breed in alternate years.

The 1993 *Lontra canadensis* Breeding Survey indicated that most zoos were breeding their females every other year; this was primarily due to management practices and no observable signs of the "post-partum" estrus in many captive females. At the time of the survey, and in the years since, there has continued to be a few facilities that breed river otters every year. To my knowledge these are primarily facilities that allow the male to stay in the enclosure with the female and pups, but not all of them

***TABLE : EX-SITU* POPULATION BREEDING PARAMETERS OF *LUTRA CANADENSIS* IN NORTH AMERICAN ZOOLOGICAL FACILITIES 1980'S THRU 2000'S**

(Reed-Smith & Polechla 2002, Bateman et al. 2009)

Lutra canadensis	
Estrus cycle	Monoestrus; can occur Nov-May* based on latitude (rarely June) Post-partum elevations in estradiol levels occur 2 – 38 (ave. 19 ± 8.06) days after parturition (Bateman et al. 2009)
Estrus length	42-46 days unless mating occurs; "…the estrus phase of their cycles [N=11] was observed just once per year with an average duration of 15.33±1.98 days (range: 6–54 days). The average duration of estrus elevation coincident with observed breeding (n=4) was 22.00±1.22 days (range: 19–24 days)." (Bateman et al. 2009) Receptivity peaks roughly 6 days apart have been reported but not reflected in Bateman study.
Ovulation	Unclear if they are induced ovulators (Bateman et al. 2009), but suspected; may also ovulate spontaneously (Bateman et al. 2009)
Copulation frequency	Several times a day for a few days
Copulation duration	20-70+ minutes, varied. Shorter bouts typically not successful.
Copulation position	Dorsal/ventral most common, also ventro/ventral.
Copulation location	Most frequently in the water, also seen on land
Copulation initiated by	Both. Female advertises, cooperates only when she is ready. She may initiate with invitations to play chase.
Age at 1st breeding	Sexually mature by 2 yrs. Several 2 yr. old males and a few <2 years; a 1.5 yr. old female have bred successfully.
Breeding behavior	Female may rub, mark or vocalize to advertise; male/female may initiate w/ play, chase, splashing, genital sniffing, or "butterfly stroke".
Gestation	Total gestation: 332-370 days, documented for 12 litters. 285-380 (Liers 1951); 302-351 (ave. 333.3 ±15.7) days (Bateman et al. 2009) Actual gestation: 68 – 73 (ave. 71.67±1.48) days (Bateman et al. 2009)
Pseudopregnancy	Pseudopregnancies seen with and without breeding and does not always result when breedings are unsuccessful. The period of elevated progesterone ranges from 68 to 72 days as in true pregnancies. (Bateman et al. 2009)
Pair management	Most facilities separate the male from the female, for his safety. A few leave the male in exhibit with female and she keeps him away from pups until they can swim well. One facility offered pair selection; females showed preference for certain males.
Group management	Sire can be reintroduced to female and pups after pups are swimming well. Generally done at about 3-6 months.
Signs of parturition	Females may show visible weight gain, teats may show through coat, increased nesting behavior, change in attitude to keeper &/or male. She may go off food as parturition nears.

Pupping boxes	Pupping boxes should be filled with dry bedding (straw or hay). A choice of birthing boxes should be available.
Contraception	See Contraception below and Section 2, Chapter 10 Health Care

Pup Birth and Female Behavior

BIRTH SEASON

Parturition may occur from November through May, however, the peak time appears to be March or April in the northern latitudes (40º - 50ºN) and January to February at more southern latitudes (23º- 30ºN). There are always exceptions, if not, they would not be otters. It is not known what role, if any, captivity played in the early births seen in some of the more northern latitudes. In these cases the females may have come in pregnant from more southern latitudes, or, the pair may have originated at more southern latitudes and been housed inside at their current location. What this does mean is that we cannot be certain that a female in New York will not give birth in January if she comes from southern latitudes. However, early births at the more northern latitudes should be considered rare or outliers.

The recent work carried out by Bateman et al. (2009) at C.R.E.W. (Cincinnati Zoo) indicates: "*A similar influence of latitude* [as that seen in other Mustelids and male river otters] *appears to affect the seasonality of reproduction in female NARO, with estrus and breeding occurring earlier in the year at southern latitudes than at northern latitudes [Humphrey and Zinn, 1982; Crait et al., 2006; Gorman et al., 2006]. We suspect that the timing of implantation following diapause also might be affected by latitude. In this study, for example, parturition was noted in December for a female housed in Florida (latitude: 27° N), whereas a female in Massachusetts (latitude: 42° N) gave birth in March. These observations are consistent with those seen in European badgers (Meles meles), another mustelid with obligate delayed implantation. In Sweden, wild badgers living at higher latitudes (58–60° N) were found to give birth 1 month later compared with badgers located at lower latitudes (44° N and 50–52° N) [Ahnlund, 1980; Rowlands and Weir, 1984]. However, our data also suggest that seasonality of NARO may include a genetic component influenced by the dam's birth location. In pregnant and pseudopregnant NARO, the timing of the initial progesterone rise was positively correlated with the female's original birth location (i.e. latitude) but not with their current geographic location.*

The Latitude and Known or Estimated Birthing Dates table can provide a guideline as to when births are likely at your latitude. The Latitude and Litter Birth Date graphs which follow depict the known birth dates, by month, of litters listed in the N. A. River Otter Studbook (information provided by D. Hamilton). Again, the outliers are likely births to females that arrived pregnant at that particular location. This information is currently under evaluation to assess dam and sire's latitude of origin and is scheduled to be published.

Latitude and Known or Estimated Birthing Dates

Table: ***Lontra canadensis*** **Latitude & Anticipated Birthing Season (H = Harris, 1968, B = Breeding Survey 1993; R = Review; E = Estimate** [given as Peak, actual births may occur a month earlier or later; typically not later than May except for the far north**])**				
Zoo	City (Region)/State (Country)	Latitude	Birth Dates	Outlier
Abilene Zoological Gardens	Abilene, TX	32° 26' N	Feb/March (E)	
Akron Zoological Park	Akron, OH	41° 4' N	March/April (E)	
Alameda Park Zoo	Alamagordo, NM	32° 53' N	Feb/March (E)	
Alexandria Zoological Park	Alexandria, LA	31° 18' N	Feb/March (E)	
Alaska Zoo	Anchorage, AL	61° 13' N	March/June (E)	
North Carolina Zoological Park	Asheboro, NC	35° 42' N	Feb/March (E)	
Western NC Nature Center	Asheville, NC	35° 36' N	Feb/March (E)	
Bear Hollow Wildlife Trail	Athens, GA	33° 57' N	Feb/March (E)	
Capron Park Zoo	Attleboro, MA	41° 56' N	March/April (E)	
The Maryland Zoo in Baltimore	Baltimore, MA	39° 18' N	Feb/March (E)	
BREC's Baton Rouge Zoo	Baton Rouge, LA	30° 27' N	February (B) Dec/Jan (R)	
Oregon High Desert Museum	Bend, OR	44° 3' N	March/April (E)	
ZooMontana	Billings, MT	45° 46' N	March/April (E)	
Binghamton Zoo at Ross Park	Binghamton, NY	42° 5' N	March/April (E)	
Birmingham Zoo	Birmingham, AL	33° 30' N	Feb/March (E)	
Dakota Zoo	Bismarck, ND	46° 48' N	March/April (E)	
Miller Park Zoo	Bloomington, IL	40° 29' N	Feb/March (E)	
Connecticut's Beardsley Zoo	Bridgeport, CT	41° 10' N	March/April (E)	Jan. (B)
Chicago Zoological Park	Brookfield, IL	41° 49' N	March/April (E)	
Prospect Park Zoo	Brooklyn, NY	40° 47' N	Feb/March (E)	
Buffalo Zoological Gardens	Buffalo, NY	42° 55' N	March/April (E)	
Caldwell Zoo	Caldwell, TX	30° 31' N	Dec/Jan (E)	
Calgary Zoo	Calgary, Canada	51° 1' N	April/May (E)	
South Carolina Aquarium	Charleston, NC	32° 47' N	Feb/March (E)	
Tennessee Aquarium	Chattanooga, TN	35° 2' N	Feb/March (E)	
John G. Shedd Aquarium	Chicago, IL	41° 50' N	March/April (E)	
Lincoln Park Zoological Gardens	Chicago, IL	41° 50' N	March/April (E)	
Cincinnati Zoo & Botanical Garden	Cincinnati, OH	39° 8' N	Feb/March (E)	
Clearwater Marine Science Center	Clearwater, FL	27° 57' N	Dec/Jan (E)	
Cheyenne Mtn Zoological Park	Colorado Springs, CO	38° 50' N	Feb/March (E)	

Table: *Lontra canadensis* Latitude & Anticipated Birthing Season
(H = Harris, 1968, B = Breeding Survey 1993; R = Review; E = Estimate [given as Peak, actual births may occur a month earlier or later; typically not later than May except for the far north**])**

Zoo	City (Region)/State (Country)	Latitude	Birth Dates	Outlier
Texas State Aquarium	Corpus Christi, TX	27° 48' N	January (B) Dec/Jan (E)	
Landry's Downtown Aquarium	Denver, CO	39° 45' N	Feb/March (E)	
Denver Zoological Gardens	Denver, CO	39° 45' N	Feb/March (E)	
Blank Park Zoo of Des Moines	Des Moine, IA	41° 35' N	March/April (E)	
Detroit Zoological Institute	Detroit, MI	42° 20' N	March/April (E)	
Zoo New England / Franklin Park Zoo	Dorchester, MA	42° 17' N	Mar/April (E)	
National Mississippi River Museum & Aquarium	Dubuque, I	42° 31' N	Mar/April (E)	
Lake Superior Zoological Gardens	Duluth, MN	46 ° 39' N	April/May (E)	
Northwest Trek Wildlife Park	Eatonville, WA	46° 52' N	April/May peak (E)	
Erie Zoological Gardens	Erie, PA	42° 7' N	March/April (E)	
Mesker Park Zoo	Evansville, IN	37° 58' N	February (B) Feb/March (E)	
Fort Wayne Children's Zoological Garden	Fort Wayne, IN	41° 7' N	March/April (E)	
Fort Worth Zoological Park	Forth Worth, TX	32° 43' N	Feb/March (E)	
Lee Richardson Zoo	Garden City, KS	37° 58' N	Feb/March (E)	
John Ball Zoological Garden	Grand Rapids, MI	42° 58' N	Late April (B, R) Mar/April (E)	
NEW Zoo	Green Bay, WI	44° 31'	March/April (E)	
The ZOO, Northwest Florida	Gulf Breeze, FL	30° 21' N	Dec/Jan (E)	
ZooAmerica (No. American Wildlife Pk.)	Hershey, PA	40° 17' N	Feb/March (E)	
Houston Zoo, Inc.	Houston, TX	29° 45' N	Dec/Jan (E)	
Hutchinson Zoo	Hutchinson, KS	38° 3' N	Feb/March (E)	
Tautphaus Park Zoo	Idaho Falls, ID	43° 30' N	Mar/April (E)	
Jackson Zoological Park	Jackson, MS	32° 17' N	Feb/Mar (E)	
Kansas City Zoo	Kansas City, MO	39° 6' N	Feb/March (H) March/May (E)	
Wildlife Prairie State Park	Kickappo Twnsh., IL	40° 45' N	Feb/March (E)	
Bays Mountain Park	Kingsport, TN	36° 32' N	Feb/March (E)	
Knoxville Zoological Gardens	Knoxville, TN	35° 57' N	Feb/March (E)	
Los Angeles Zoo & Botanical Gardens	L. A., CA	34° 3' N	Feb/March (E)	
Potter Park Zoological Gardens	Lansing, MI	42° 43' N	Mar/April (E)	End Jan (H)
Folsom Childrens Zoo	Lincoln, NE	40° 48' N	March/April (B)	

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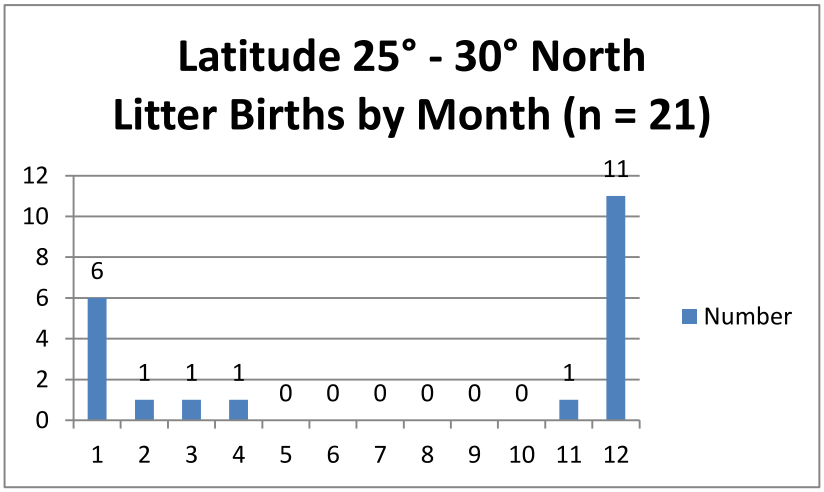
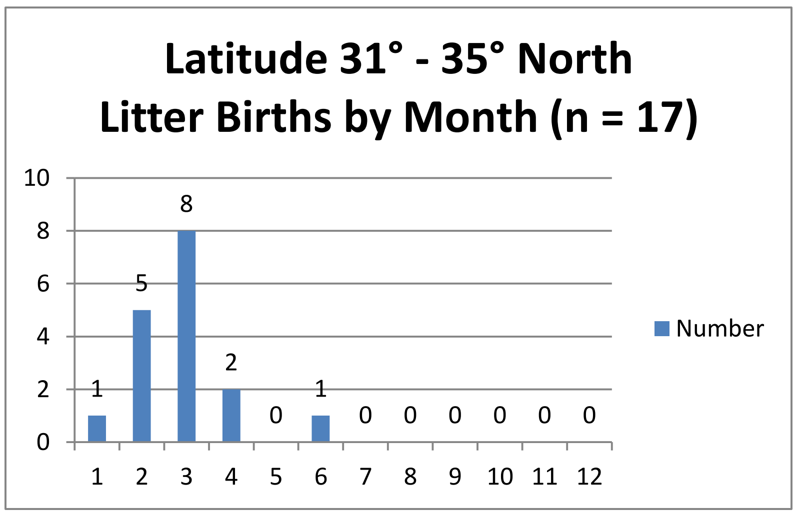
Zoo	City (Region)/State (Country)	Latitude	Birth Dates	Outlier
			Feb/March (E)	
Little Rock Zoological Gardens	Little Rock, AR	34° 44' N	March/April (B) Feb/March (E)	
Ellen Trout Zoo	Lufkin, TX	31° 20' N	Feb/March (E)	
Henry Vilas Zoo	Madison, WI	43° 4' N	Mar/April (E)	
Brevard Zoo	Melbourne, FL	28° 5' N	Dec/Jan (E)	
Trevor Zoo	Millbrook, NY	41° 47' N	Mar/April (E)	
Milwaukee County Zoological Gardens	Milwaukee, WI	43° 2' N	March (B) Mar/April (E)	
Minnesota Zoological Garden	Apple Valley, MN	44° 59' N	March/April (B)	
Roosevelt Park Zoo	Minot, ND	48° 13' N	April/May (E)	
Montgomery Zoo	Montgomery, AL	32° 22' N	Feb/March (E)	
Biodome de Montreal	Montreal, Canada	45° 30' N	March/April (E)	
Brookgreen Gardens	Murrells Inlet, SC	33° 33' N	Feb/March (E)	
Audubon Zoo	New Orleans, LA	29° 57' N	Dec/Jan (E)	
Virginia Living Museum	Newport News, VA	36° 58' N	Feb/March (E)	
Elmwood Park Zoo	Norristown, PA	40° 7' N	March/April (E)	
Maritime Center at Norwalk	Norwalk, CT	41° 7' N	March/April (E)	
Provincial Wildlife Park	Nova Scotia, Canada	45° 6' N	March/April (E)	
Oakland Zoo	Oakland, CA	37° 48' N	Feb/March (E)	
Oklahoma City Zoological Park	Oklahoma City, OK	35° 28' N	Feb/March (E)	
Omaha's Henry Doorly Zoo	Omaha, NB	41° 15' N	March/April (E)	
NC Aquarium at Pine Knoll Shores	Pine Knoll, NC	34° 58' N	Feb/March (E)	
Pittsburgh Zoo & Aquarium	Pittsburg, PA	40° 27' N	Feb/March (E)	
Oregon Zoo	Portland, OR	45° 31' N	March/April (E)	
Columbus Zoo and Aquarium	Powell, OH	40° 0' N	Feb/March (E)	
Pueblo Zoo	Pueblo, CO	38° 15' N	Feb/March (E)	
NC Aquarium On Roanoke Island	Roanoke Island, NC	35° 52' N	Feb/March (E)	
Seneca Park Zoo	Rochester, NY	43° 9' N	Spring (B) March/April (E)	
Fort Rickey Children's Discovery Zoo	Rome, NY	43° 12' N	Mar/April (E)	
Sacramento Zoo	Sacramento, CA	38° 34' N	March (B) Feb/March (E)	
Salisbury Zoological Park	Salisbury, MD	38° 21' N	Feb/March (E)	
San Diego Zoo	San Diego, CA	32° 42' N	Feb/March (E)	

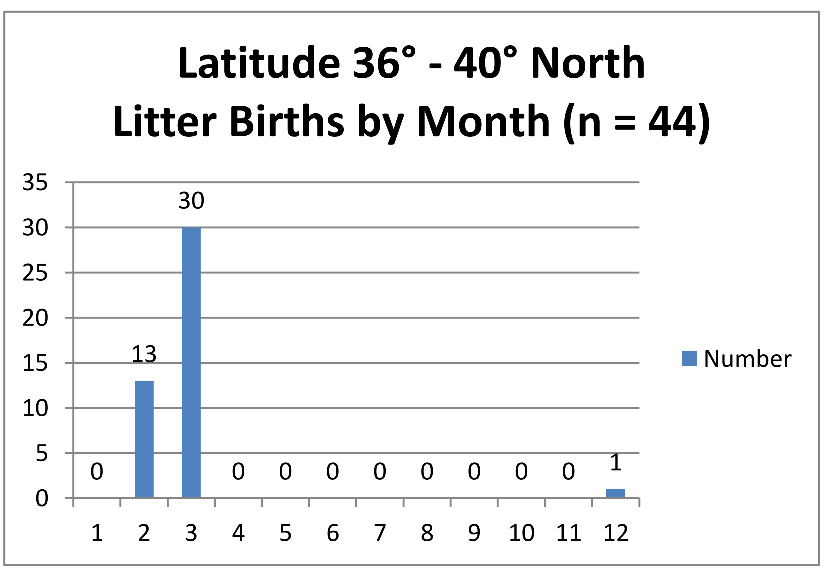
Table: *Lontra canadensis* Latitude & Anticipated Birthing Season (H = Harris, 1968, B = Breeding Survey 1993; R = Review; E = Estimate [given as Peak, actual births may occur a month earlier or later; typically not later than May except for the far north**])**				
Zoo	City (Region)/State (Country)	Latitude	Birth Dates	Outlier
San Francisco Zoological Gardens	San Francisco, CA	37° 47' N	Feb/March (E)	
CuriOdyssey, aka: Coyote Point Museum	San Mateo, CA	37° 33' N	Feb/March (E)	
Lehigh Valley Zoo	Schnecksville, PA	40° 40' N	Feb/March (E)	
Woodland Park Zoological Gardens	Seattle, WA	47 ° 37' N	April/May (E)	
Seattle Aquarium	Seattle, WA	47 ° 37' N	April/May (E)	
Silver Springs Park	Silver Springs, FL	29° 12' N	Dec/Jan (E)	
Calvert Marine Museum	Solomons, MD	38° 19' N	Feb/March (E)	
Henson Robinson Zoo	Springfield, IL	39° 48' N	Feb/March (E)	
Dickerson Park Zoo	Springfield, MO	37° 12' N	Feb/March (E)	
Saint Louis Zoological Park	St. Louis, MO	38° 37' N	February/March (B), (E)	
Stamford Museum & Nature Center	Stamford, CT	41° 3' N	Mar/April (E)	
Rosamond Gifford Zoo at Burnet Park	Syracuse, NY	43° 2' N	Early April (B) March/April (E)	
Tallahassee Museum of History and	Tallahassee, FL	30° 26' N	Dec/Jan (E)	
Florida Aquarium	Tampa, FL	27° 57' N	Dec/Jan (E)	
Tampa's Lowry Park Zoo	Tampa, FL	27° 57' N	Dec/Jan (B) (E)	
Topeka Zoological Park	Topeka, KS	39° 2' N	Feb/April (E)	
Toronto Zoo	Toronto, Canada	43° 40' N	April (B); March/April (E)	Nov .(B)
Tulsa Zoo & Living Museum	Tulsa, OK	36° 9' N	Feb/March (E)	
The Wild Center	Tupper Lake, NY	44° 13' N	March/April (E)	
Arizona-Sonora Desert Museum	Tucson, AZ	32° 13' N	Feb/March (E)	
Texas Zoo	Victor, TX	32° 12' N	Feb/March (E)	
Virginia Aquarium&Marine Science Ctr	Virginia Beach, VA	36° 51' N	Feb/March (E)	
Cameron Park Zoo	Waco, TX	31° 32' N	Feb/March (E)	
Chahinkapa Zoo	Wahpeton, ND	46° 15' N	April/May (E)	
Smithsonian National Zoological Park	Washington, D.C.	38° 53' N	Feb/March (E)	Dec/Feb (H)
NY State Zoo at Thompson Park	Watertown, NY	43° 58' N	Mar/April (E)	
Turtle Back Zoo	West Orange, NJ	40° 47' N	Feb/March (E)	Jan/Feb (B)
Palm Beach Zoo at Dreher Park	West Palm Beach, FL	26° 42' N	Nov/Jan (R) Dec/Jan (E)	
Oglebay's Good Children's	Wheeling, WV	40° 3' N	Feb/March (E)	

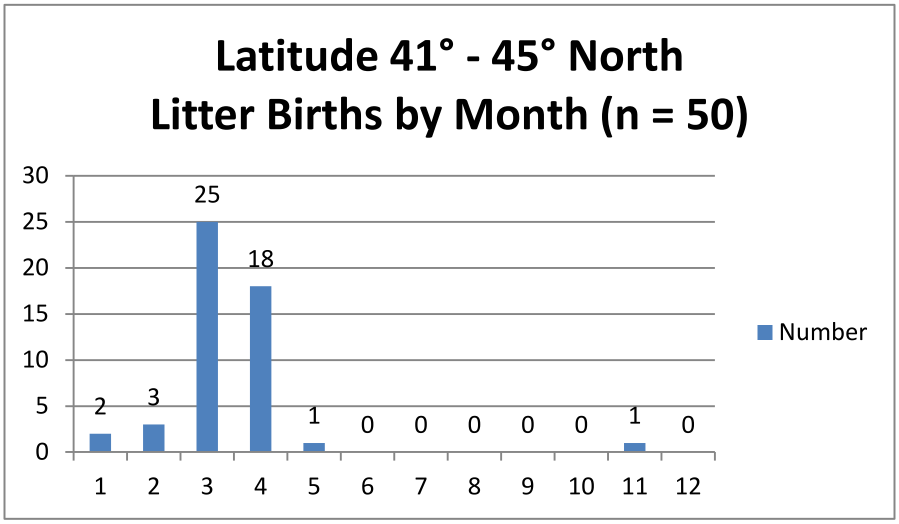
Table: *Lontra canadensis* Latitude & Anticipated Birthing Season (H = Harris, 1968, B = Breeding Survey 1993; R = Review; E = Estimate [given as Peak, actual births may occur a month earlier or later; typically not later than May except for the far north**])**				
Zoo	City (Region)/State (Country)	Latitude	Birth Dates	Outlier
Zoo				
Sedgwick County Zoo	Wichita, KS	38° 28' N	Feb/March (E)	
Brandywine Zoo	Wilmington	39° 44' N		
Science Center & Environment Park	Winston-Salem, NC ?	36° 5' N	Feb/March (E)	
ECOTARIUM	Worcester, MA	42° 15' N	March/April (E)	
	Homosassa Springs, FL	28° 48' N	December/January (B) Dec/Jan (E)	
	California	34° - 42°	March/April (H)	
	Bristol, England		April (R)	
	Florida	26° - 30°	February (H) Dec/Jan (E)	
	Manhattan, KS	39°	March/April (B) Feb/April (E)	
	Manitoba, Canada	50°	Late April (H) April/May peak (E)	
	Michigan	42° - 46°	Peak March/April (H); March/April (E)	
	Winnona, Minnesota	44°	March/April (E)	Jan. (H)
	Minnesota	44°	Early spring (H) March/April (E)	
	New York City	41°	March/April (E)	Jan. (H)
	New York State	41° - 45°	Mid-end March (H); March/April (E)	
	North Mackenzie	62° - 67º	?Jan/March (H) May/June (E)	
	Oregon State	42° - 46°	April/May (H) March/April (E)	
	Memphis, TN	35°	March (B), Feb/March (E)	
	Nashville, TN	36°	February (B) Feb/March (E)	
	Texas State	28° - 34°	End February (H) Dec/Mar (E)	
	Texas State	28° - 34°	February/March (B) Dec/Mar (E)	
	Utah State	37° - 41°	Mid-April (H) Feb/March (E)	
	Virginia	37° - 39°	April/May (H) Feb/March (E)	
	Virginia	37° - 39°	March (B) Feb/March (E)	

Latitude and Litter Birth Dates by Month









Latitude Map for North America

PSEUDO PREGNANCY

In 1996 a thirteen-month-old pup was videotaped attempting to breed his mother just before he was sent out to another facility. The adult male was never seen attempting to breed the female. In the spring of 1997 the female began putting on weight, spending time in her denning box and the on-exhibit holt, all normal pre-parturition behaviors or occurrences. This continued through April and May. During this time, no signs of abortion, parturition, or consumption of pups were noticed (night dens and on-exhibit holt was checked daily for blood or signs of fetal tissue). The female went well past her typical delivery time of late April then came into estrus in May. Some breeding attempts were observed beginning May 10th but actual breeding did not occur until 28, 29 May and 12, 13, and 23 June. It is believed that the female experienced a false pregnancy in 1997 due to the sterile breeding attempt by the sexually immature pup in 1996. Pseudo pregnancies also were reported in a female housed only with another female by Bateman et al. (2009).

PRE-PARTUM WEIGHT GAIN

Pregnant females show a weight gain in the last ~60 days pre-partum that cannot be explained by diet increases. During the course of five pregnancies, two females showed the following weight gains: 1.1kg, 1.2kg, 2.3kg, 1.2kg, and 3.1kg (2.43lb, 2.65lb, 5.07lb, 2.65lb, and 6.83lb). Total gestations have ranged from 361 days, 356 days, 351 days, to 324 days for one female to 313 days and 314 days for their other female. Females at the Lowry Park Zoo and John Ball Zoo showed a weight gain, but there are no records of the exact gain (generally two to three pounds (.90 – 1.36 kg) for the JBZ female).

N. A. River Otter Adult Weight - Table
Lowry Park Zoo

Date	1.0 #100262 Oscar	1.0 #100437 Elvis	0.1 #100419 Katie	0.1 #100408 Okie
15 Feb. 1995				23.2 lbs.
23 Feb. 1995	19.3 lbs.	18.7 lbs.	20.1 lbs.	
28 July 1995			24.0 lbs.	
29 July 1995	20.0 lbs.			18.0 lbs.
04 Aug. 1995		26.0 lbs.		
15 Oct. 1995			26.0 lbs.	21.0 lbs.
18 Nov. 1995			26.5 lbs.	22.0 lbs.
03 Dec. 1995			28.0 lbs. *****	23.0 lbs.
24 Dec. 1995			25.5 lbs.	
31 Dec. 1995				23.0 lbs.
28 Jan. 1996				24.0 lbs.
01 April 1996			26.0 lbs.	23.0 lbs.
27 April 1996	20.5 lbs.	27.0 lbs.		
12 July 1996		30.0 lbs.		
28 Sep. 1996	23.5 lbs.	33.5 lbs.	24.0 lbs.	21.0 lbs.
10 Nov. 1996	22.5 lbs.	30.0 lbs.	24.5 lbs.	20.0 lbs.
12 Dec. 1996		28.0 lbs.	26.5 lbs. *****	24.5 lbs.
17 Jan. 1997	26.0 lbs.	24.0 lbs.	29.0 lbs.	27.0 lbs.
04 April 1997	20.0 lbs.	22.5 lbs.	23.5 lbs.	22.0 lbs.
13 Nov. 1997	20.0 lbs.	23.5 lbs.	21.5 lbs.	21.0 lbs.
28 Nov. 1997	28.0 lbs.	25.0 lbs.	26.5 lbs.	23.0 lbs.
18 Mar. 1998	19.4 lbs.	22.0 lbs.	22.7 lbs.	18.0 lbs.
17 Oct. 1999		26.0 lbs.		19.0 lbs.
13 Nov. 1999	22.0 lbs.	24.5 lbs.	24.0 lbs.	18.5 lbs.
27 Nov. 1999			25.5 lbs.	
08 Dec. 1999			27.0 lbs. *****	
02 Feb. 2000	22.0 lbs.	21.5 lbs.		
06 Feb. 2000	22.0 lbs.	20.0 lbs.	28.0 lbs.	
19 Mar. 2000	21.5 lbs.	23.0 lbs.	25.0 lbs.	
22 April 2000	20.0 lbs.	22.0 lbs.	23.0 lbs.	19.0 lbs.

*** Female gave birth after this weigh date and before the next weight was taken.**

DIET AND A PREGNANT OR LACTATING FEMALE

"The energy requirements and food intake of pregnant females are from 17 to 32% higher than non-reproducing females" (Robbins 1993). Only 10 to 20% of this increased consumption is actually utilized by the female, most of the metabolized energy is turned into heat and lost (Robbins 1993).

An increase of 10 to 20% in a pregnant female's diet should be considered during the last trimester and an increase of 30% of base diet offered during early lactation. The female's diet throughout lactation should be monitored closely and increased as necessary. (See Diet & Nutrition) An increase in the fish portion of the diet generally should precede the proportional increase in the rest of the diet.

SIGNS OF IMMINENT PARTURITION

The female may exhibit a number of different signs including: increased 'nest' building, aggression towards exhibit mates or keepers, depressed appetite, frequent floating in the pool, refusal to leave the nest box, restlessness, or lethargy. No pregnancy associated pelage changes have been noted but abdominal distension has always been noted and usually mammary development. No pre-partum discharge has ever been noted.

In one institution, prior to parturition, the female increased her nest building activities; pulling pine needles, sticks and leaves into the den. Her mammary glands did not show until the day of birth. After giving birth, she was very aggressive towards the male and any keepers that approached the den. She would not leave the den completely for feeding until ten days after birth. This pre-partum behavior will vary between females and between successive litters for a single female. There are reports of females showing no signs of immanent birth with no obvious physical changes to a more typical reporting of mammary development at least one week prior to birth which is associated with increased nesting, and behavioral changes such as lethargy, increased appetite, and aggression towards enclosure mates or keepers.

Getting Ready for Parturition

There are several steps that may need to be taken; including provision of multiple denning boxes/locations, removal of the male from the enclosure, separating the male and female by alternately allowing them onto exhibit, etc. The next several pages provide an example of one institution's protocol. See Appendix A for Columbus Zoo's Impending Birth Plan Template.

(Photo: Pittsburgh Zoo)

Photo: Scott Shelley, Columbus Zoo and Aquarium

Columbus Zoo North American River Otters Birth Plan 2012

This document is reviewed annually and changed to fit the current circumstances and/or animals involved. This current version was designed for management of an experienced female; inexperienced females may require a more hands-on approach, at least initially. It is important that a birth plan is developed to anticipate the individual animal's needs, personality, enclosure situation, institutional policies, and care-giver experience with the expectant female.

OVERVIEW:

1.1 North American otters are currently housed at the N. A. Wetlands exhibit. Although they still had their 2010 pups during the breeding season of 2011, there is still the possibility she could be pregnant. Audrey and Babar were together during the breeding season, and there was confirmed breeding observed on April 5, 2011 (the pups had been removed from the exhibit for the day and taken to the hospital for pre-ship exams). Based on a gestation of 302-362 days, we were thinking that puts us at possible dates between **February 1 and April 2, 2012**. All three of her past litters have come in March (3/3/06, 3/13/08, 3/19/10).

Helen Bateman emailed, "Since your river otter, Audrey, has given birth before I am going to suggest that you use her last parturition date as your guide for this year. Females tend to stick very close to the same parturition date from year to year - but there is a possibility it could fluctuate by a week or two. So you would be looking at an estimated potential birth of **March 6th - April 2nd.** And given her history I would concentrate on mid-March".

Previous pregnancies timeline:

- Breedings were observed throughout the month of March.
- Fecal samples were collected November through mid-January for analysis.
- Increased defecation in the pool December and January.
- Audrey kicking Babar out of dens December and January
- Audrey showed increased appetite December through February.
- All three pregnancies resulted in birth during early to mid-March.
- Eyes began opening at 32 days.

- First swimming lessons at 37 days.
- Lots of playing and exploration by early summer.
- Male (Babar) reintroduced to Audrey and pups in exhibit
- Pups transferred to new homes by early fall.

GOALS:

To once again have Audrey give birth and successfully rear her own litter, but with the acceptance of the keeper staff when necessary. In the past Audrey has been very cooperative in letting Keepers monitor the pups health and progress.

STAFF ASSIGNMENTS:

Keepers:

- Will be responsible for: preparing/reviewing this birth plan
- Preparing the "otter pup prep box"
- Setting up an incubator at wetlands
- Seeing that the dens are ready and the area is cleaned up
- Work with the Media Dept. to see that the 3 cameras, monitor, and DVR are installed and ready to go by Feb.1
- Observations of any behavioral changes from Audrey, towards Babar or otherwise, should be noted in a tablet at Wetlands
- Continue to monitor Audrey's health and behavior and make recommendations based on these observations
- Review overnight video recordings where necessary
- Take turns with observations and/or 24 hour care (pre- or post-birth) as needed/scheduled
- Communication of observations to co-workers, curators and vets.

Curatorial Staff:

- Review and approve Birth Plan
- Receive daily updates from keepers and vets on observations and progress.
- Assign shifts as needed on 24 hour care.
- Will make decision with input from keepers and vets on if we need to pull the pups for first health check or hand rearing.
- Will contact other institutions should advice and/or recommendations be needed.
- Will make recommendations and organize transfer of pups as needed.
- Will be there to give the keeper staff whatever they may need to appropriately accomplish their jobs and make them happy.

Animal Health Staff:

- Review Birth Plan
- Receive daily updates from keepers on observations and progress.
- If there are concerns with the general thriftiness of the pups after 12 hours, they will be pulled for a well-baby check.
- Will make recommendation based on input from keepers and curatorial staff if we need to pull the pups for hand rearing.
- If pups are pulled, will do a physical exam to determine health and will recommend whether to hand raise or put back with mother.
- May be needed to assist in 24 hour care if pups are in critical condition.
- If pups are doing well with mother, pups should be pulled at 2 weeks for physical exams and returned to mother as quickly as possible.

REPRODUCTIVE HISTORIES:

Babar: 1.0 ISIS # 972073
* Captive born on 3/17/93 at the St. Louis Zoo.
* Arrived at the Columbus Zoo on 11/17/97, at 4 ½ years of age.
* He was introduced to the Columbus Zoo's 7 year old female, "Birdie" (912073), in Jan. 1998. Numerous breedings were observed in 1999 and 2000. The female exhibited denning and other pregnancy behaviors, but no births occurred in 1999 or 2000.
* Columbus Zoo transferred "Birdie" to another institution and received 0.1 "Audrey" on loan from the Nashville Zoo (see below for her history).
* Babar successfully sired 3 litters with "Audrey" : 3 pups in 2006: (only 1 survived): 3 pups in 2008 (1.2): and 3 pups in 2010 (3.0). See Audrey below.

Audrey: 0.1 ISIS # 204095
* Was wild born in Feb. 2001 (est) and parent raised in Kentucky. (some of the paperwork says she was hand-reared later by rehabbers) She was obtained by the Nashville Zoo from Kentucky rehabbers. She was housed with an older male and breeding was observed in Spring 2004.
* Introduced to current cagemate "Babar" (1.0) November 2004
* Gave birth to 3 pups on 3/3/2006: 1st was stillborn, 2nd pup died 3/3/06, 3rd pup pulled and sent to a surrogate mother at another institution to be placed with her pups. Audrey did not nurse the pups although she was very attentive to them.
* Gave birth to 3 pups on 3/13/2008: This time Audrey was able to raise all three pups on her own. She was a very attentive mother and seemed to do all the right things including teaching them to swim at 37 days old!
* Gave birth to 3 pups (3.0) on 3/19/2010:Audrey again raised all three pups on her own.

** The first date we have **noted** for breeding was April 5, 2010 (the pups were taken to the hospital for a pre-ship exam) So, based on a gestation of 302-362 days, we were thinking that puts us at possible dates between February 1 and April 2 , although, the male was in the exhibit and breeding could have occurred earlier than this.

PRE-PARTUM PREPARATIONS FOR 2012:

- **2 months before** – Have a plan in place and supplies ready should we need to again move the male out of the area. If this is necessary, Babar will be moved to Polar Building/maternity side.
- Needed modifications:
  - hotwire mesh panel needs to be re-hung outside of Door #
  - board or something on inside of that transfer door, as a failsafe, to keep his feet from getting "pinched" should brown bears bang on that door
  - hallway transfer chute between maternity and brown bear needs closed and secured so cannot be mistakenly opened
  - 2' wide piece of "Sintra" placed 2' high on front of indoor *and outdoor* caging to prevent climbing/falling
  - top made for food chute to prevent climbing out
  - recycled plastic 2x4 pieces under transfer door frames where he could possibly get under
  - pool steps very steep – a log or plastic ramp needed to get in and out of pool
  - signs placed on brown bear side as a reminder not to use the hallway transfer. (will be locked down as well)

- **1-2 months before** - Notebook placed at wetlands to jot down any notes reflecting on her behaviors
- **1 month before** - Media department to install 3 cameras, 1 over each of the dens. These are connected to a video monitor in the keeper area (separate room from otter room) with a DVR for recording activity. This will enable us to monitor the birth and behaviors 24 hours a day, without disturbing the otters during this sensitive time.
- **1 month before** – Maintenance will install a plywood wall in front of public viewing den to give Audrey more seclusion. A window in this will give keepers ability to check on her without going in back.
- **1 month before -** Prepare a plastic container labeled "OTTER PUP PREP BOX" and fill with the following items: (for health checks and if hand-rearing necessary).

Volufeeder	Volufeeder nipples(red,yellow, peach)
Pet nurser	eye dropper
vinyl gloves	blankets
scrub shirts	hot water bottle
heat pad	thermometer
KY gel	alcohol wipes
Esbilac – Canine	Pedialyte
sterile water	infant record sheets
flashlight	Scale

  - ✓ Latest copy of the "N.A. River Otter Husbandry Manual"
  - ✓ A copy of the "2012 N.A. River otter Birth Plan"
  - ✓ A copy of the "Birth Plan Tracking Summary" outline to follow

PLAN:

- **Audrey functions best if there is little change to her routine**
- Increase her diet 1-2 months before expected parturition *if* showing an increased appetite.
- Due to her last 2 births being in the back den, we assume, and will plan that that is where she will be the most comfortable having her pups. Bed both back pens and give otters access to all day.
- Some things to watch for that may indicate we need to think about moving Babar out would be; aggression towards pups or Audrey, interference with maternal care such as nursing, sleeping, transferring pups or any other undue stress on mother or pups that is causing diminished care for the pups.
- When birth appears imminent, we will set up a 24 hour/7 day staff watch using the monitors outside the otter room. Notes should be kept of all observations – note if mother aggressive or ignoring pup(s), pups nursing, mom grooming pups, are pups active with strong vocalizations, etc.
- If the male needs to be moved, we will continue giving her access to the front and back dens with the tunnel open. We will not use the 2 den boxes in the yard at this time.
- Only full-time keepers who she is familiar with should be servicing the area
- After the birth is confirmed, she appears to be done having the pups, and they are nursing, we need to BRIEFLY pull the pups to confirm they are successfully nursing and that Audrey is producing milk.
- Other reasons we may consider pulling the pups would be:
  - i. Audrey's lack of interest in 1 or all of the pups
  - ii. Aggression towards 1 or all of the pups
  - iii. Pups do not appear to be nursing
  - iv. Pup(s) appear weak or in distress
- Do not need to dump the pool. Audrey has shown that she has control and will take them there when she/they are ready. Pups can crawl out using the log or the overflow. Would be more worried about a pup falling into an empty pool.

SIGNS OF COMING PARTURITION:

(Could include any, all, or none of these signs)

- Increased aggression towards cagemates and/or keepers, increased nest building, decreased appetite, swollen nipples, frequent floating and stooling in pool, refusal to leave den, restlessness, excessive grooming of genital area. At this time a birth watch schedule should be set up.
- Notify Curators, Hospital staff, and keeper staff of any of these signs

AFTER PARTUITION:

- Immediately after birth notify-
    i. Vet staff
    ii. Curators
    iii. Keeper staff
    iv. Animal Nutrition staff (to be on their toes should anything dietary be immediately necessary)
- Note time of birth and any relevant details in the notebook.
- Write the "Birth Plan Tracking Summary" (see outline to follow)
- We will not intervene unless there is a problem (such as: if mother is aggressive or ignoring pups, pups not nursing, pups seem weak when they vocalize, etc.). It was decided that we would do a 24 hour check. If it is deemed necessary: Weigh them, mark them, be prepared to tube them. The procedure should not take more than 10 minutes, total. Gloves should be worn when handling the pups. It will then be decided when the next check will be depending upon the findings on the initial well check. Keepers on the watch should review the tapes and talk to the previous watchers about their shift. Our goal of course is to have mom rear them and this may mean we need to help her along by supplemental feedings. Have the husbandry manual available for reading while keepers are on watch, there is much information on mother reared babies including weight gain and development. The incubator at wetlands should be turned on at any time now in case of emergency hand rearing.
- Otter moms will often move their pups, so she should have access to all three dens.
- If Curator/vet staff decides animal(s) to be pulled and hand reared, staff previously identified with hand-rearing experience or as designated care givers should be notified. Once pups are feeding on the bottles and a routine/schedule is established the keeper staff can assist with the care.
- Each morning, the tapes from night before should be reviewed by a keeper.
- Cleaning of the pens may or may not be done for 2 or 3 weeks after birth depending on the comfort of the mother and pups. Luckily Audrey was very comfortable with her normal keepers transferring her and removing the pups for exams and cleaning of the pens with her last two litters.

HAND-REARING:

If pup(s) are pulled to be hand-reared, the "OTTER PUP PREP BOX" should have all the necessary items and instructions.

If Curator/vet staff decide anima(s)l to be pulled and hand reared, appropriate staff should be contacted, including any with hand-rearing experience. Once pups are feeding on the bottles and a routine/schedule is established the keeper staff can assist with the care.

Contact Numbers:

Veterinarians, veterinary technicians
Appropriate Curators
Registrar
Keepers

Nursery staff if appropriate
Security
IT or photography staff

WEIGHT HISTORY SAMPLE FOR 0.1 AUDREY:

COLUMBUS ZOO AND AQUARIUM

Report Date	Zoo ID	House Name	Common Name	Current Weight	Previous Weight	Weight Difference	Gender	Initials
12/5/2004	204095	Audrey	River Otter	19 lbs	No Entry	0.00 lbs	Female	SS
6/21/2005	204095	Audrey	River Otter	18 lbs	19 lbs	(1.00) lbs	Female	JZ
8/22/2005	204095	Audrey	River Otter	19 lbs	18 lbs	1.00 lbs	Female	as,df
Comments: last weight was on 6/21/05								
11/7/2005	204095	Audrey	River Otter	17 lbs	19 lbs	(2.00) lbs	Female	SS
Comments: Very hungry!! put in yesterday for diet increase.								
11/18/2005	204095	Audrey	River Otter	19 lbs	17 lbs	2.00 lbs	Female	DF
Comments: scale might have been off going to re-weigh on the 19th								
11/19/2005	204095	Audrey	River Otter	19 lbs	17 lbs	2.00 lbs	Female	DF
Comments: this weight is accurate!								
2/12/2006	204095	Audrey	River Otter	22 lbs	19 lbs	3.00 lbs	Female	SS
3/30/2006	204095	Audrey	River Otter	19 lbs	22 lbs	(3.00) lbs	Female	SS
Comments: 22 lbs. is when she was pregnant in Feb								
5/10/2006	204095	Audrey	River Otter	16 lbs	19 lbs	(3.00) lbs	Female	JZ
Comments: Diet increase will start tomorrow.								
9/18/2007	204095	Audrey	Otter, NARO	17.5 lbs	19 lbs	(1.50) lbs	Female	SS
Comments: The previous weight was actually 16# but we believe there was trouble with the scale. We have since used a new scale.								
1/15/2008	204095	Audrey	Otter, NARO	19.5 lbs	17.5 lbs	2.00 lbs	Female	SS
2/4/2008	204095	Audrey	Otter, NARO	20.4 lbs	19.5 lbs	0.90 lbs	Female	SS
2/23/2008	204095	Audrey	Otter, NARO	22.3 lbs	21.4 lbs	0.90 lbs	Female	ss
Comments: previous weight was on 2/15 and weight before that was 20.4 on 2/4								
5/6/2008	204095	Audrey	Otter, NARO	20.5 lbs	22.3 lbs	(1.80) lbs	Female	ss dp
5/27/2008	204095	Audrey	Otter, NARO	19.8 lbs	20.5 lbs	(0.70) lbs	Female	SS, JZ

PARTURITION

Otter births are seldom witnessed; Liers (1951) reported that the birthing process takes three to eight hours. He also states that the dam stood on all four feet for the births he observed. I don't know how obvious signs of contractions are – the one birth I witnessed was quick and not accompanied by any obvious contractions. About two hours after consuming her morning diet, the female sat down, began licking her genital area and delivered a pup within a period of minutes. Because she was not under observation prior to this, it can be assumed she had been in labor for a while, but it is unknown how long contractions may have been occurring.

One institution reports that their female exhibited changes in appetite after giving birth, with a sporadic decrease both before and after parturition, usually starting one to two months before and continuing one to two months after. This led her to come for meals only once per day and periodically refusing food entirely during this four month period. A prolonged refusal to eat should not be anticipated and should lead to examination of the female.

POST-PARTUM WEIGHT LOSS

Little information is available. The Minnesota Zoo recorded a loss of 0.8 kg. within the first 24 hours for one female.

LITTER SIZE & SEX RATIO AT BIRTH

One to six pups have been reported; generally a litter consists of two to three. No information could be found on the sex ratio at birth. Between 1969 and May 2000 there were approximately 61 litters bred and born (litters born to females bred in the wild are not included here) with a sex ratio of 63.52.34 (males.females.unknown sex) (Reed-Smith 1994-1995, 2001). A review of the records by Reed-Smith (1994) and Bateman et al. (2009) indicates that a female will frequently give birth within a two week window of previous births; some females have given birth on the same day in alternating years.

(Photo: Graham Jones, Columbus Zoo)

Pups and Pup Development

NEONATAL MORTALITY

As with most animals, mother neglect, injuries from the mother's exhibit mates, cold, and dampness must be watched for. Facilities responding to the 1994 Breeding Survey listed the preceding reasons, or unknown, for most neonatal deaths. K. Petrini reported being notified of a neonate's death due to kidney stones (1994).

YOUNG OTTER NAMES

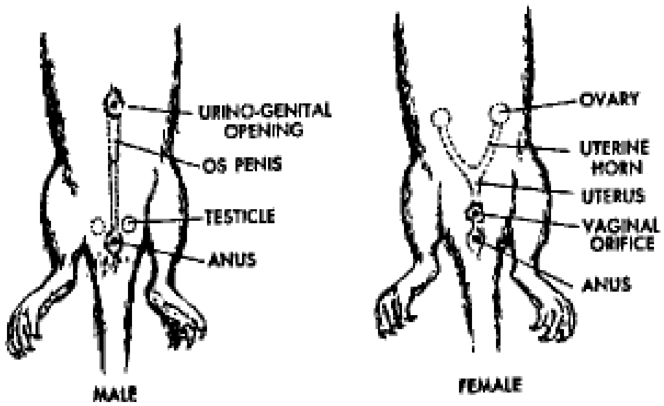
Most commonly pups, cubs, less frequently kits.

NEONATE CONDITION

Otter pups are born completely dependent on the bitch. Pups are born fully furred, generally a silky dark brown to grayish-black in color. Eyes and ears are closed but the auditory canals are open at birth. Pups are toothless at birth. Young otters are capable of making a chirping contact call from day of birth.

SEXING PUPS

Sometimes sexing of young animals can be difficult. If you sex them just after birth, you may want to re-check when they are a few weeks old.



Reprinted with permission from the Wildlife Society, 1980.

Female otter pup (Photo: Herb Reed, New York State Zoo Volunteer)

DEVELOPMENTAL STAGES

This time line is intended as a general guideline only. The information all comes from the 1994 Breeding Survey (except where noted). Additional captive information provided by Debbie Jackson of the Little Rock Zoo, Lowry Park Zoo staff, and communication with a number of other U.S. and International facilities. See also Section 2 Chapter 8.

Pup Development Stages – Table
N. A. River Otter

Eyes open	Day 31 to 35 (Liers, 1951)
	Day 29 to 33 – eyes beginning to open (JBZ)
	Day 36 to 40 – eyes open, not focusing (GR, JBZ, LR)
	Day 21 to 35 (Toweill & Tabor, 1982)
	Day 50 (GR) i.e. appeared to be opening
Eyes focus	Day 50 - 60 eyes focusing
First walk	Day 36 unsteady (range 35 – 42 days)
Pelt change	Day 46 – beginning to show light hairs around the face (Johnstone, 78)
	Day 26 – muzzle hairs lightening (JBZ); range 28 – 56 days
Leave the nest box	Day 38/50 (JBZ) carried by mother (see swim); range 38 – 70 days
	Day 49 (LR) left the box by themselves
	Day 59 to 70 leave nest box on their own (Liers, 1951)
First play	Day 25 to 42 begin playing together (Liers, 1951)
	Day 49 (LR) playing together
First swim	Day 15 (LR) female put pup into pool
	Range ~ 28 – 58 days
	Day 58 (GR) in female's water tub
	Day 28 to 55 (LR) lessons got longer by day 42
	Day 62 (JBV) pups putting heads under water
Localized latrine use	By around day 49 (Liers, 1951)
First solid food	Day 57 & Day 66 (JBZ – 2 litters)
	Day 59 (GR)
	Day 60 (LR)
	Range ~42 – 56 days
Total nursing time	Three to four months (Nowak, 1991); may begin ~75 days
Weaning age	Day 91 – or about that time (Liers, 1951)
	Day 73 – Female separated so pups can eat
	Day 75 – started weaning (GR)
First molt	Day 119 – began molting for 1st time

FIRST SWIM

Otter pups must be taught how to swim. In captivity, females may begin these lessons earlier (day 38 plus or minus a few days up to 45+ days), than in the wild (it could be that early swimming lessons in the wild have gone unobserved); lessons are very short to begin with and lengthen as the pups gain control of their body and limbs. (Young pups most resemble hairy-corks bobbing in the water.) Females will decide when it is time to teach the pups to swim but these early lessons should be monitored to be sure she stays vigilant and takes pups out of the water before they tire.

The depth of the water does not seem to matter but provisions <u>should be made</u> to ensure it is possible for pups to pull themselves out of the water. Like the adults, young animals do seem to enjoy playing or exploring in shallow water so if possible shallow water tubs, water bowls, stream beds, etc. should be provided, especially as they are learning to swim.

PUP WEIGHTS

Weekly weights have been taken from the 1994 Breeding Survey responses. Because facilities weighed their animals on varying schedules, weights listed for a given day may be from as much as three days before or after the day listed. The Institutional charts reflect exact day weights taken. (See Hand-rearing for additional weight data.)

N. A. River Otter Pup Weights – Weekly Increments - Table

Day	Weight (grams)
Birth Weight	132 (Toweill & Tabor, 1982)
	120 – 160 (Melquist & Dronkert, 1987)
	135 – 170 (LR)
	111 – 146 (FL)
Day 7	266 – 33 (LR)
Day 14	499 – 544 (JBZ – 1993 litter)
	532 – 671 (JBZ – 1995 litter)
	428 – 496 (LR)
Day 21	687 (MIN)
	566 – 687 (LR)
	721 – 912 (JBZ)
Day 28	930 (MIN)
	907 – 910 (JBZ) – 1993 litter
	952 – 1180 (JBZ) – 1995 litter
	756 – 890 (LR)
Day 35	1045 (MIN)
	1115 – 1230 (GR)
	997 – 1043 (JBZ) – 1993 litter
	1232 – 1562 (JBZ) – 1995 litter
	1030 – 1151 (LR)
Day 42	1343 (MIN)
	1230 – 1290 (GR)
	1200 – 1300 (JBZ) – 1993 litter
	1215 – 1428 (LR)
Day 49	1161 (MIN)
	1339 – 1478 (GR)
	1473 – 1649 (LR)
	1736 – 2072 (JBZ) – 1995 litter
Day 56	1656 – 1814 (JBZ) – 1993 litter
	1742 – 1907 (LR)
Day 63	1914 – 2247 (LR)
Day 70	1678 – 1996 (JBZ) – 1993 litter
	1845 – 2419 (GR)
	2410 (LR)

N. A. River Otter Pup Weights – Table Institution 1			
Day	**Weight**	**Day**	**Weight**
Day 19	620 – 685g	Day 47	1339 – 1478g
Day 24	770 – 850g	Day 60	1523 – 1702g
Day 31	940 – 1065g	Day 73	1845 – 2419g
Day 37	1115 – 1230g	Day 86	2150 – 2240g
Day 39	1230 – 1290g	Day 112	3400 – 3540g

N. A. River Otter Pup Weights (Males /n = 6) Table Institution 2			
Day	**Weight**	**Day**	**Weight**
Day 16	499 – 544gr.	Day 57	1.588 – 1.724kg.
Day 28	907 – 910gr.	Day 59	1.633 – 1.814kg.
Day 33	998 – 1.089kg.	Day 63	1.588 – 1.814kg.
Day 35	997 – 1.043kg.	Day 65	1.656 – 1.814kg.
Day 41	1.200 – 1.300kg.	Day 72	1.678 – 1.996kg.
Day 45	1.270 – 1.452kg.	Day 190	4.990 – 5.443kg.
Day 55	1.588 – 1.724kg.	Day 253	7.212kg.
Day 56	1.542 – 1.678kg.		

N. A. River Otter Pup Weights (Females /n = 4) Table Institution 2	
Day	**Weight**
Day 22	660 – 730gr.
Day 25	720 – 795gr.
Day 28	850 – 900gr.
Day 35	1.10 – 1.15kg.
Day 42	1.25 – 1.35kg.
Day 48	1.460 – 1.600kg.
Day 55	1.665 – 1.775kg.
Day 61	2.125 – 2.325kg.
Day 240	6.577 – 7.711kg.

N. A. River Otter Pup Daily Weights - Table (From AAZK Zoo Infant Development Notebook 1994) Little Rock Zoo, Grassmere Wildlife Park, John Ball Zoo							
Males (N = 9)				**Females** (N = 8)			
Age/days	**Weight**	**Age/days**	**Weight**	**Age/days**	**Weight**	**Age/days**	**Weight**
1	110 - 170gr.	32	992g–1.03kg.	1	170gr.	32	971gr.
2	177 – 184gr.	33	998g-1.09kg.	2	177gr.	33	
3	193 - 220gr.	34	1.08-1.11kg.	3	198gr.	34	1.01kg.
4	204 - 241gr.	35	1.11-1.14kg.	4	213gr.	35	1.05-1.15kg.
5	241 – 276gr.	36	1.13-1.19kg.	5	248gr.	36	1.06kg.
6	249 –298gr.	37	1.16-1.18kg.	6	262gr.	37	1.09-1.23kg.
7	266 – 333gr.	38	1.20-1.25kg.	7	298gr.	38	1.13kg.
8	28 - 354gr.	39	1.23-1.28kg.	8	333gr.	39	1.15-1.30kg.
9	325 - 376gr.	40	1.28-1.34kg.	9	347gr.	40	1.23kg.
10	353 - 404gr.	41	1.35-1.36kg.	10	383gr.	41	1.28kg.
11	364 – 425gr.	42	1.32-1.41kg.	11	397gr.	42	1.25-1.35kg.
12	398 – 453gr.	43	1.35-1.39kg.	12	411gr.	43	1.28kg.
13	414 – 475gr.	44	1.40-1.43kg.	13	439gr.	44	1.35kg.
14	496gr.	45	1.45-1.57kg.	14	454gr.	45	1.39kg.
15	531 – 539gr.	46	1.52-1.62kg.	15	489gr.	46	1.43kg.
16	499 – 574gr.	47	1.43-1.62kg.	16	517gr.	47	1.34-1.48kg.
17	595gr.	48	1.59-1.69kg.	17	546gr.	48	1.46-1.60kg.
18	617 – 624gr.	49	1.59-1.67kg.	18	560gr.	49	1.58kg.
19	624 – 645gr.	50	1.69-1.79kg.	19	609 - 685gr.	50	1.62kg.
20	666 – 680gr.	51	1.62-1.74kg.	20	637gr.	51	1.56kg.
21	687gr.	52	1.67-1.87kg.	21	652gr.	52	1.53kg.
22	765 – 780gr.	53	1.74-1.88kg.	22	660 - 730gr.	53	1.62kg.
23	780 – 808gr.	54	1.74-1.92kg.	23	723gr.	54	1.64kg.
24	810 – 843gr.	55	1.71-1.96kg.	24	758 - 850gr.	55	1.66-1.81kg.
25	822 – 858gr.	56	1.54-1.68kg.	25	720 - 795gr.	56	
26	829 – 872gr.	57	1.71-2.03kg.	26	772gr.	57	1.93kg.
27	850 – 872gr.	58	1.87-2.10kg	27	794gr.	58	1.76kg.
28	865 – 910gr.	59	1.90-2.06kg.	28	815 - 900gr.	59	1.80kg.
29	907 – 921gr.	60	1.52-2.12kg.	29	872gr.	60	1.86-1.70kg.
30	935 – 978gr.	61	1.97-2.15kg.	30	907gr.	61	1.84-2.33kg.
31	971g-1.00kg.	62	1.96-2.24kg.	31	928gr-1.06kg	62	1.88kg.

Management for Breeding or Non-breeding

ENVIRONMENTAL CUES

It is assumed that photoperiod plays a part in signaling the onset of estrus and the implantation of the embryo; Bateman et al. (2009) speculate it may be tied to lengthening days after the winter solstice. Photoperiods in indoor exhibits should mimic a natural day/night cycle regardless of breeding or non-breeding goals. M. Ben-David (personal communication) has theorized that temperature change could play a role in prompting the onset of estrus.

BREEDING IN CAPTIVITY

Emil Liers appears to have been the first one to breed N. A. river otters, consistently, in captivity; at least the first from whom we have extensive records. The majority of his work took place in the 1930's, 1940's, and 1950's; his landmark paper was published in 1951. Arthur Hoffman was the next significant breeder of captive otters. Mr. Hoffman supplied a number of zoos with offspring from his otters during the 1960's (Davis, 1985). The Mole Hall Wildlife Park in Essex, England bred otters in the late 1960's and early 1970's achieving at least a complete third generation birth (Duplaix-Hall, 1975). Since the mid-1990's zoological institutions have improved their breeding of this species with a goal towards a self-sustained captive bred population with room for non-releasable orphans.

Housing Multiple Otters to Allow for Choice

It is believed Liers and Hoffman used similar management strategies to get their otters to breed. Information on Mr. Hoffman's management techniques comes from a conversation with him Joe Davis reported on during a River Otter Breeding Symposium held at the Turtle Back Zoo in 1985. Davis states that Hoffman kept 6.6 animals and found that the same pair did not always breed each year. Hoffman would introduce different pair combinations until he hit on a pairing that worked, i.e. breeding occurred. Generally, breeding took place within the first hour if it was going to occur at all. With this method, Hoffman's otters produced four litters from six pairs annually. Joe Davis, formerly of the Brookfield Zoo, and the staff at the Minnesota Zoo, where seven litters were born between 1986 and 1990, agree that the best way to manage river otter for breeding is to maintain enough animals to allow for multiple pairing combinations. It is undoubtedly the preferred method, one which would insure the production of litters every year but, not many facilities are equipped to house several animals.

The Minnesota Zoo took the concept of multiple mate selection and added a variation to it, the stranger factor. Separating animals during the months prior to breeding season, then reintroducing them seemed to stimulate interest. It was using this technique and the option of different pairings by maintaining multiple animals that led to Minnesota's success in the 1980's. Another facility annually brought in a male for the breeding season leading to a litter a year from one or the other of their two resident females.

PAIR MANAGEMENT

Some single pairs have been successful at producing litters. Breeding in most of these pairs has essentially been fortuitous; nothing was really done to encourage breeding. Some of the animals are kept together all of the time, some are separated at night, some have been together for years before they breed successfully, some have just recently been introduced. Many, although not all, of these pairs are found in large, semi-naturalistic exhibits – particularly the pairs that reproduce more than once. A few of these pairs reproduce again after the first litter; others have produced only one litter. Typically, pairs prove to be more successful breeders if they are not introduced when very young, i.e. 2 years or less. Following are six examples of pair management practices from facilities that have had successful otter breeding at their institutions:

Example One – Single pair left together for rearing

At least two institutions have used this approach successfully. In both cases the enclosures were designed in a way that allowed for this management technique and/or were large enough to accommodate this approach. . The animals were kept together all of the time, the pairs reproduced annually. The male was not removed when the female gave birth but he 'knew enough' to stay clear of her nest box and out of sight if the female was outside of the pupping den. Essentially, the female decided when it was all right for the male to approach the pups, generally when they were swimming fairly proficiently.

> *"The female has access to two portable wooden den boxes throughout the year. She also uses a burrow that she dug in the soil near her pool. All three of these dens are used by the female when she is raising pups. She becomes more vocal to keepers and spends more time in the den boxes or in different spots in the yard that she normally does not occupy. Also, her feeding habits change prior to birth and after giving birth. Instead of coming to both feedings daily, she comes to only one feeding or refuses to come out to feed."* (Steve Bircher, Assistant Curator of Mammals – St. Louis Zoo)

Example Two – Single pair housed together year-around

In one case the pair was maintained together for 11 years before they bred successfully in 1998. The institution was unaware that the female was pregnant until the day before she gave birth. The morning of parturition the female snapped at the male, ate very little then gave birth one hour later. 0.1 pup was born on 20 February 1999; the male was reintroduced to 0.2 on 06 May 1999. Typically, this approach works less well if the animals are housed together from a young age.

Example Three – Single pair or male w/multiple females separated then reintroduced prior to breeding season

In this example 1.2 otters were held; females were rotated on exhibit with the male because they did not get along. The pair (the second female showed no interest in the male and never produced a litter) was kept together during the day and all animals were separated at night. The protocol was to stop putting a female with the male during the day in December and begin reintroducing them in March (for Michigan). The introductions occurred every second to third day and lasted only ½ to 1 hour unless breeding was seen, at which time the pair was left together all day. Pups were produced every-other year. After the 1st litter the separation period prior to estrous season was no longer employed.

Based on behavioral records and Helen Bateman's reproductive physiology studies the following guidelines are suggested if you utilize this separation method to promote interest in breeding.

- Otters should be separated two to three months prior to typical breeding season.
- Breeding season typically lasts 19 to 24 days (Bateman et al. 2009).
- In the chart below the peak month for breeding is in **bold type**; but introductions should begin prior to and extend after this period for several weeks.
- The male and female(s) can be rotated on exhibit or, the male can be removed to another location.
- Introductions should occur every 2nd or 3rd day for ½ to 1 hour. If breeding is not observed the otters should be separated and reintroduced again in 2 or 3 days. This should continue until breeding is observed. If there is any serious physical aggression the animals should be separated immediately.
- The breeding column indicates when breeding should be observed by; however, they could occur several weeks earlier or later.
- Successful breeding bouts should be of ~15 minutes or more duration and occur several times over the course of a day. Once definite breeding has been observed the otters should be left together for their normal period (e.g. 24 hours, during the day only, etc.). Breeding typically occurs over several days
- If breeding is not observed by the end of latitude appropriate breeding season the otters can be left together or normal routine resumed.

Location	Begin Introductions	Breeding
Florida (roughly 25 to 30' parallel)	November	December, **January**
Southern & Southwestern U.S. (roughly 31 to 36' parallel)	December	January, **February**
Northern U.S. & Southern Ontario	February	March, **April**, May
Canada (North 49' parallel)	Late February, early March	April, May

Example Four – Multiple pairs (2.2) or otters (1.2)

In at least one case 2.2 otters were routinely housed together. These animals are kept together 24 hours year around except during feeding, estrus, and when a female has pups. During a female's estrus she is separated from the males at night to give her a break from breeding. She is first introduced to the subordinate male, for about one week. The next step is the introduction of the dominant male. There is some fighting between the males for the right to breed the female but, there were no serious injuries. In this case the females produced a litter in alternate years so they were never in estrus simultaneously. It should be noted that the two females in this group were raised together from a very young age which may contribute to their continuing compatibility even after separations of several months. (Mother and pups were not reintroduced to the group; but likely could be if the introduction process is based on the temperament of the otters involved, done slowly, and staff is responsive to signals from the otters.)

Valerie M. Burke, Assistant Curator, Florida Mammals provided the following over view of their pair management (personal communication, 2000):

"River otter breeding seems to occur in January and February, although there is noted aggression between the males starting in December. We feel that two males are healthy competition for breeding the females.

We also feel that separating the female from the males helps stimulate breeding behavior. We do not feel that the female needs to be separated for those three weeks that we separated Okie from Oscar and Elvis. We feel that a week will be sufficient. During that separation time there probably will be continued aggression between the males. The intense breeding season will vary depending on the location of the facility or the environment of the enclosure. We are seeing that the breeding and births of our captive otters directly corresponds to otters in the wild. Our otters are outside on exhibit during the day and inside in a night house throughout the night (most of the time).

"After the female is separated from the males she is reintroduced to the subordinate male first, on exhibit. She will then remain with him for a few days to a week, after which time the dominant male will be reintroduced to the female and subordinate male. This will be done in the outside exhibit. We do not reintroduce otters in the night house any longer. We will separate the female from the males if they have been relentlessly breeding her all day or we will keep them outside in the exhibit together. The female will not be locked in with the males in the night house. The night house is so much smaller and does not allow the female enough room to get away from the males. There is quite a bit of aggression when breeding. Once the intense breeding aggression decreases the female can then have access to the males in the night house all night long.

"We used to lock a suspected pregnant female in the night house at the beginning of December until she either gave birth or we were confident she was not going to give birth. That protocol has changed. We will set up 2 dens for the pregnant female, one water den with a tub of dirt and one den with a den box (crate with the door removed), nesting material, floor mats and a heat lamp. The female will be allowed to go out into the exhibit if she would like to go, she probably will stay in the night house most of the time though. The pregnant female will be separated and locked in her 2 dens throughout the night. She will not be denied access to a pool any more. The males are given access to the pregnant female in the AM after feeding when shifted on exhibit; we noted extreme aggression towards the males from both females when they entered the pregnant female's dens.

"After the pups are born they are not allowed out in the exhibit until they can swim well. They seem to be able to swim well at about 8 – 10 weeks. We no longer retrofit the bottom of the night house pool to make it shallow. The pups can have access to a full pool. The pups are extremely buoyant. The depth of the water does not seem to be a problem. Pups will stay with their mother until they are at least 5 months old. After all the pups are separated from their mother, the female will be reintroduced to the group. The females will be reintroduced first, then the subordinate male and finally the dominant male. The reintroduction is done in the exhibit."

A variation on this would be holding 2.2 or more otters and mixing pairings for exhibiting and for breeding. Compatible females should not be separated for extended periods as they may not get along after lengthy separations. However, mixing enclosure groupings and introducing females to different males may stimulate more breeding interest as well as more activity.

Example 5 – All females

In one case, the institution housed only females but brought in a male each spring for several months. The male bred successfully with both females but never in the same year.

Example 6 – Males and females separated all year

This example, from the Minnesota Zoo was the basis for Example 3. Once breeding was confirmed the male and female were separated again. When signs of "post-partum" estrus were observed the pair was again introduced.

"Breeding pairs are always separated, usually all year except for breeding. At times, some pairs have been together until January. On at least one occasion a female was left with a male until shortly before parturition, but this was her male offspring from a previous litter to whom she was not introduced for breeding, i.e. our separation is for at least 2 – 3 months for animals which are going to be introduced for breeding.

"Open females are introduced to a male every 2 – 3 days beginning in mid-March, unless signs of estrus are noted earlier. Pairs are mixed only briefly until there are positive indications, and then intros are extended. When definite breeding occurs, the pair is left together all day unless we have reason to do otherwise (e.g. injury).

"The last few weeks before birth females become intolerant of other animals. They tend to spend more time swimming, probably for comfort. Some animals spend more time in the nest box and are reluctant to go on exhibit, especially the last few days. Typically, the female will not eat the afternoon prior to birth.

"Post-partum estrus has been obvious in our experience. A dramatic behavior change occurs. The female, who has spent 10 – 14 days secluded with her litter in the nest boxes, suddenly is active; moving around the cage frequently and often scratches at the shift doors to the exhibit or the males' cage. Her reaction to a male provides conclusive evidence."

CONTRACEPTION

In addition to reversible contraception, reproduction can be prevented by separating the sexes or by permanent sterilization. In general, reversible contraception is preferable because it allows natural social groups to be maintained while managing the genetic health of the population. Permanent sterilization may be considered for individuals that are genetically well-represented or for whom reproduction would pose health risks. The contraceptive methods most suitable for otters are outlined below. More details on products, application, and ordering information can be found on the AZA Wildlife Contraception Center (WCC) webpage: www.stlzoo.org/contraception or email: Contraception@stlzoo.org (Sally Boutelle). See also Section 2, Chapter 10.

ENCLOSURE DESIGN AND PUPPING BOXES/DENS

See also Section 2 Chapter 7.

Institution 1 Den Arrangement

"*The off-exhibit area for the otters consists of six connected dens, side by side. The dens are cement block construction on three sides, the fourth wall consists entirely of the keeper access door to the den. The den floors are poured cement with a gutter in front of the dens. The dens are built three feet off the floor with storage underneath, and are 4 ½ ft.* (1.37 m) *tall. Each of the end dens has an outside access door for the otters. These dens are 2 ½ ft. x 4 ft.* (.762m x 1.22 m) *with metal clad plywood access doors for the otters' privacy. The four center dens are 3 ft. 8 inches x 4 ft.* (.91 m x 1.22m). *These dens have 1" x 4"* (2.54 mm x 10.16 cm) *aluminum industrial floor grate keeper access doors for easy observation of the otters. There are heat pads in the cement floors of the four center dens.*

"The dens are connected by sliding, metal-clad plywood doors, 8" x 8" (20.32 cm x 20.32 cm). *These sliding doors are operated by the keepers from the outside and can be locked shut from the outside.*

"This den arrangement makes it possible to separate the animals in the exhibit and still allow each animal access to the outside. It is also easy to move the animals from den to den for cleaning." (Note: The floor heating units are not used and the floor grate doors proved to be hard to see through and are due to be replaced.)

Institution 2 Den Arrangement

The holding consists of four stalls (10 x 10 ft.) provided with fire-hose hammocks and at least one Vari Kennel; one of these is a sound-proof whelping den with an attached den box (this stall has always been selected by the female for giving birth). Each stall has a 50 gallon, above ground pool. See Section 2 Chapter 7.

Denning Boxes

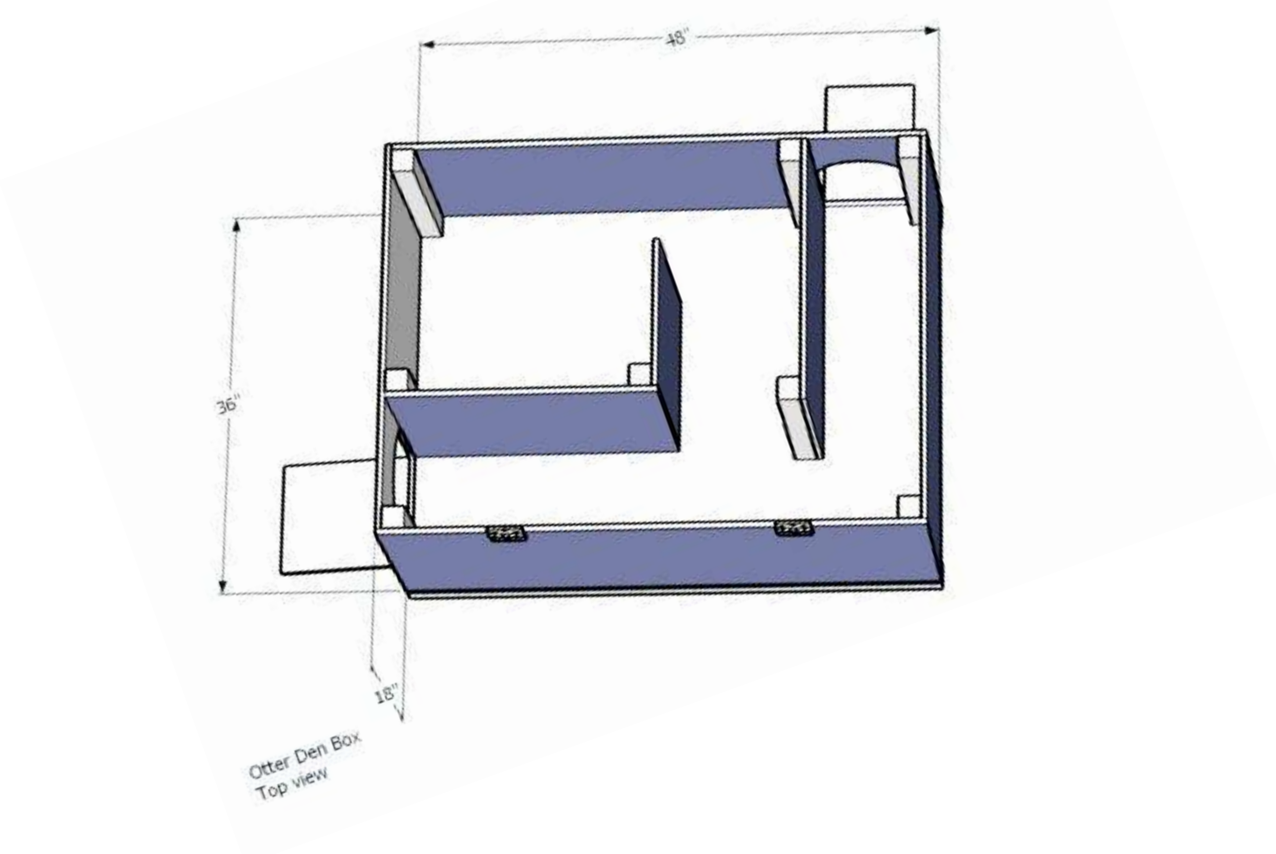
Also see Section 2, Chapter 7, Sample Denning Boxes for additional photos and examples.

Institution 1 - A 36"W x 48"L x 19"H (91.44 cm x 121.92 cm x 48.26 cm) nest box, split by a solid divider, is provided. Access to both sides of the box is through 6" diameter PVC pipe.

Institution 2 – A self-dug on-exhibit den and two nest boxes (24"W x 36"L (60.96cm 91.44 cm) with an 8" (20.32 cm) entrance made of ¾" (1.9 cm) plywood painted with brown latex paint) are provided.

Institution 3 – Photos: Jennifer Galbraith, Tampa's Lowry Park Zoo

Top View: 48" long x 36" wide x 18" high



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APPENDIX A - COLUMBUS ZOO IMPENDING BIRTH TEMPLATE

1. Overview
    - A. Description of present social and housing situation
    - B. Species Gestational Information
        - 1. Predicted due date
        - 2. History of past gestations
        - 3. Statement about what's known about species gestation (in general)
    - C. Goals statement
        - 1. Goals of birth management plan
        - 2. Goals of maternal training plan (if applicable)

2. Staff Assignments
    - A. Keepers/trainers
    - B, Hand Rearing staff
    - C. Animal managers
    - D. Veterinary staff
    - E. Nutrition staff
    - F. Other support staff
        - 1. Night keepers
        - 2. Volunteers
        - 3. Night keepers
        - 4. Medical specialists

3. Pre-partum preparations
    - A. Physical facility review
        - 1. Needed modifications to manage birth
        - 2. Areas of concern for an impending birth
        - 3. Lighting/audiovisual review if videotaping birth
    - B. Hand-rearing equipment review/needs
    - C. Notifications of impending birth
        - 1. Animal managers
        - 2. Veterinary staff
        - 3. Hand-rearing staff
        - 4. Night keepers
        - 5. Nutritionists
    - D. Animal management plan for onset of labor
        - 1. Notification tree of who to call when labor is confirmed
        - 2. Specifics for birth watch (who, how long, documentation)
    - E. Assessing the condition of the infant
        - 1. Physical condition of the animal
        - 2. Species norms (if known)
        - 3. Management plan for problem infants
    - F. Additional considerations
        - 1. Plan for medically compromised infant
        - 2. Scenarios for potential reintroduction
    - G. Plan B – if all scenarios fail
        - 1. Immediate reintroduction plan
        - 2. Removal of infant and plans for a future introduction to dam
        - 3. Surrogate mothers

Birth Plan Tracking Summary

1. Day of birth
    A. When labor is confirmed
    B. When the infant is born
2. After-hours birth
    A. If the night keeper discovers the parturient female is in labor
    B. If the night keepers discovers that birth has occurred
3. Post-partum
    A. If the infant is medically compromised
    B. If the dam is aggressive to the infant
    C. If other group members (if present) are aggressive to the infant
    D. If the dam is ignoring the infant or interested in the infant but not carrying/moving it
    E. If the infant nurses within 24 hours
    F. If no nursing is observed within 24 hours
    G. If the infant's condition deteriorates
    H. If the infant is healthy and a reintroduction could take place
    I. If the dam shows no interest in the infant
    J. If all efforts fail to get the dam to care for the infant

NORTH AMERICAN RIVER OTTER

Husbandry Notebook, 4^{th} Edition; Chapters 7 - 10

(Photo: Dave Mellenbruch)

NORTH AMERICAN (Nearctic)
RIVER OTTER *(Lontra canadensis)*
Husbandry Notebook, Section 2 Chapters 7 - 10©

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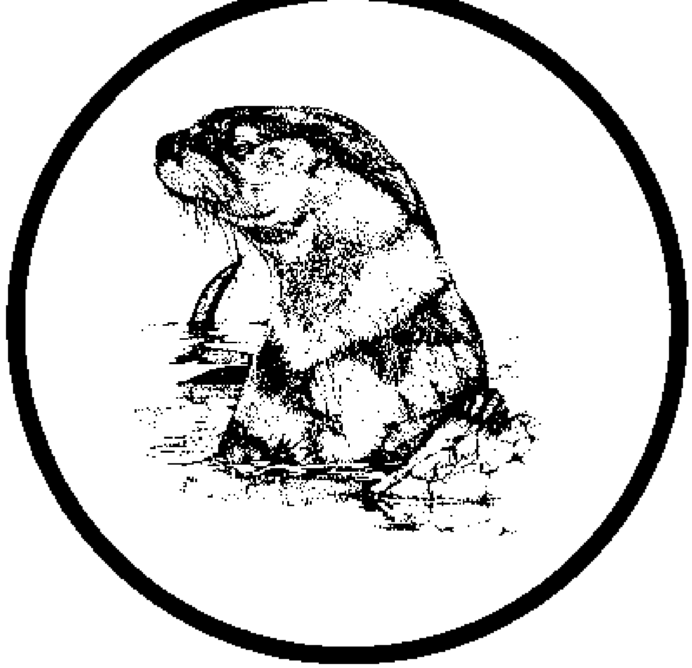

"Alacris ad ludos est."

"It is quick to play"

(Albertus Magnus, 13th Century teacher and naturalist)

North American River Otter Husbandry Notebook

4th Edition; Section 2, Chapters 7 - 10

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Photo: Julie Katts

In the days when the earth was new and there were no men but only animals the sun was far away in the sky. It was so far away that there was no summer. It was so far away that the trees and the grasses did not grow as they should.

He-Who-Made-the-Animals saw how it was that there was not enough sun to heat the earth, and so he fashioned a snare. The Sun did not see the snare in his path, walked into the snare and the snare held him fast.

The sun was close to the earth. In fact, the snare held the sun so close to the earth that there was no night. Day after day the sun shone and the earth dried and the grasses withered. There was not enough food or water for the animals and they desperately called a council. "Sun," the animals said, "You give too much heat to the earth."

"Set me free from this snare" the Sun said, "and I will go away."

"But if you go away, then there will not be enough heat." "Set me free," the Sun said, "and I will come to the edge of the earth in the morning and in the evening; then at noon-time I will stand straight above the earth and warm it then."

The animals sat around the council fire and they said, "Who is going to set the sun free?"

"I shall not do it," Wildcat said. "Whoever sets the sun free must go so close to the sun that he will be burned to death." Lynx said, "Whoever sets the sun free must chew the leather thong that holds him; the sun will burn him to death before he can do it." "I shall not do it," said the deer, the wolf and the raccoon.

"I shall do it," Otter said. "How can you do it?" said the animals. "You are too small, your teeth are for fish, and your fur has already burned away." None of the other animals liked the otter because he played too much. They did not think he was brave.

"Let him try," Bear said. "He will burn to death, but we will not miss him. He is of no use to us. He looks silly now that his fur is gone." The animals laughed.

Ignoring the taunts, the otter set off to the place in the sky above the earth where the sun was held by the snare. Otter took many days to get to the sun. The sun burned him. The sun was so bright, Otter had to close his eyes. When he reached the sun, Otter began to chew on the leather thong that held the sun. His skin was burning and blistering, his eyes were hot stones. But, Otter did not stop chewing.

Suddenly he chewed through the leather. The animals saw the sun rise into the sky. The animals felt the cool winds begin to blow on the earth. Otter had freed the sun from the snare.

Time passed. Otter lay in the center of the council ring. There was no fur at all left on his body. His skin was burned and scorched and his flesh was falling off his bones. His teeth were only blackened stumps.

He-Who-Made-the-Animals also stood in the center of the council ring. "Otter," he said, "the animals will not forget what you have done for them. I will see that they do not forget," and he gave Otter new strong teeth, tireless muscles, keen eyesight, and a powerful tail to help him in his hunting and in his play. He did not have to give him bravery. But he gave him new fine fur that was like down on his skin, and a second coat of fur to guard the first so that he would not get cold in water or in winter. Then he gave him joy so that he would always be happy in his otter's life, and Otter has so remained until this day.

An Otter Legend derived from the Cree Indians
Contributed by John Mulvihill
The River Otter Journal Vol. VIII, No. 2, Autumn 1999

Contributors

4th Edition

Thank you to all who contributed to the 1st and 2nd editions as well as the 1997 Husbandry Survey (the 3rd edition was never published). Some of this information is still part of this edition. However, the 2nd edition is available on the IUCN Otter Specialist Group website and the original Otter Lore and other deleted sections can be found there.

Contributors to this new edition include: Helen Bateman, Gwen Myers, DVM, Melanie Haire, Tanya Thibodeaux, David Hamilton, Brian Helton, Lynn Hougle, Jennifer Mattive, Kristina Smith, Mike Maslanka, M.S., Barbara Henry, M.S., Monica Anderson, Nicole Barker, Rachael Chappell, Julie Christie, Kristin Clark, Erin Dauenhauer-Dacota, Erin Erbren, Bethany Gates, Katie Jeffrey, Maggie Jensen, Brett Kipley, Marcy Krause, Tara Lieberg, Hilary Maag, Christine Montgomery, Melissa Newkoop, Melanie Pococke, Josh Prince, Nancy Ramsey, Tami Richard, Karen Rifenbury, Jan Sansone, Ashley Snow, Alicia Striggow, Maicie Sykes, Janée Thill, Marla Tullio, Jen Wilson, Andrea Dougall, Victor Alm, Courtney Lewis, Bill Hughes, Jennifer Galbraith, and the Otter Keeper Workshop Attendees (2004, 2006, 2008, 2010, 2012). Thank you to the zoo and aquarium people who contributed photos and to the professionals who gave permission for use of their photographs: Dave Mellenbruch, Haley Anderson, Graham Jones, Gary Woodburn, Debbie Stika, and Herb Reed.

USER GUIDE

INTRODUCTION

Lontra canadensis **is most commonly known as the North American river otter but also will be referred to here as the N.A. river otter, NARO, and Nearctic otter.**

As soon as the first edition of the North American River Otter Husbandry Notebook was completed additional information became available – that is the way projects of this nature all work. I have no doubt it also will be true for this edition. Each edition should be used as a beginning point when looking for an answer to a particular otter problem or question. Our approach to captive husbandry should be as dynamic as the animals in our care. **This 4th edition includes updated information. Since publication of the last edition significant work has been done on otter reproductive physiology, contraceptive recommendations have changed, and there have been some changes made to recommended routine veterinary care. These changes as well as additional enclosure, training and enrichment information have been included in this digital update of the NARO husbandry notebook. All deleted information and sections (e.g. North American River Otters in European Institutions) are still available in the 2nd edition. The 2nd and 4th editions are available at otterspecialistgroup.org, Otters in Zoos, etc. link (OZ Task Force – Otters in Zoos, Aquariums, Rehabilitation, and Wildlife Sanctuaries).**

Where possible, all measurements and weights have been put into the English and metric systems. This is not true for the weights tables, however. There is some duplication from one chapter to another; some information on a given topic may only appear in one location. This is inconsistent but an attempt was made to at least provide some basic information on pertinent topics where appropriate so a reader would not have to go to all of the sections. For example: there is pup development information in the Reproduction section and Hand Rearing.

Many thanks go out to all of the people who have shared ideas with me over the years, too many of you to name here however, your contributions have all been helpful and have been incorporated in some way in this manual. The notebook has been split into three sections allowing the inclusion of more photos while trying to keep the file sizes manageable. They are as follows:

SECTION 1

Chapter 1 Taxonomy
Chapter 2 Distribution
Chapter 3 Status (*In-situ* and *Ex-situ* studbook information)
Chapter 4 Identification and Description
Chapter 5 Behavior, Social Organization, and Natural History
Chapter 6 Reproduction

SECTION 2

Chapter 7 Captive Management
Chapter 8 Hand-rearing
Chapter 9 Nutrition and Feeding Strategies
Chapter 10 Health Care

SECTION 3

Chapter 11 Behavioral and Environmental Enrichment
Chapter 12 Training
Chapter 13 Rehabilitation of Orphaned Otters
Chapter 14 Useful Contacts and Websites
Chapter 15 North American River Otter Bibliography

Table of Contents

CHAPTER 7 Captive Management

> *"Otters in general are most attractive exhibits in the zoological garden, their antics in the water being especially engaging. The races of **L. canadensis** and **L. lutra** are best suited for northern institutions, since their hardiness permits them to be shown in permanent outdoor installations. The first essential is a pool of fresh, clean water, deep and long enough for swimming, diving, and play. Moderately running water is certainly preferable, if not actually essential. There should also be sufficient land area to allow reasonable space for the explorations in which the otter seems to delight. For, while we tend to think of the otter in terms of water, the animal really spends much more time out of that element than in it. A dry, clean shelter, well packed with clean straw, will complete the requirements, at least as far as the welfare of the otters is concerned."*
>
> (Crandall 1964)

Introduction

The basic requirements for a river otter exhibit have been understood for a long time, at least since Crandall was writing in 1964. However, zoological institutions were not always familiar with what Crandall had to say. As a result, many old river otter exhibits were poorly designed and did not address the species behavioral or physiological needs. Additionally, in the past the zoological community had a tendency to think: small mammal – small exhibit. Wallach & Boever (1983) gave minimum dimensions for otter (species not specified, figures taken from the AZA Animal Health Committee) as 10.98 m^2 floor space for one animal and 12.80 square meters floor space for two animals; minimum height is given as 1.22 meters. More recently the AZA publication, Minimum Exhibit Requirements (1997) gives 231 $ft.^2$ as a minimum enclosure requirement for two animals, with additional space 'probably needed' for breeding pairs.

After looking at 25 zoos and observing more than 100 otters, Duplaix-Hall (1975) concluded that the lack of breeding success could be linked to three factors: "*…the enclosure, the diet, and the otters themselves."* Duplaix-Hall believed that most often, the lack of success was due to one of the first two, inadequate enclosures and/or poor diet.

As of the writing of the 1st edition of this manual there had been improvements in our captive management of river otters however, U.S. and Canadian zoos were only beginning to experience anything more than hit and miss breeding. The reasons for this appear to have been one or more of the following:

- Inadequate enclosure and den design
- Insufficient enclosure space,
- Insufficient numbers of animals to allow for mate selection;
- A lack of the resources needed to implement an appropriate breeding arrangement protocol,
- Paired animals that were introduced at too young an age which may have caused them to become too familiar with one another,
- A lack of interest in breeding this species

Over the last decade significant improvements have been made in our ability to breed Nearctic otters in zoos, aquariums, and wildlife sanctuaries. This improvement is due to greater cooperation between facilities, good population management led by the AZA Studbook Keeper, improved enclosures and pair management, as well as better understanding of river otter reproductive physiology and otter behavioral needs.

Understandably, it is not possible, or desirable, for every institution housing river otters to breed them.
However, it is advisable that the otters are housed and cared for in a manner that does not preclude breeding if it becomes a desired goal. Proper diet, adequate enclosure facilities, and good management

practices are important to the health and well-being of otters. The recommendations contained in this section are based on a literature search, historical records, 20 years of personal experience and visiting over 60 otter facilities, as well as input from over 100 professionals who work with Nearctic otter in *ex-situ* situations. Many variables should be considered when designing or modifying otter enclosures; there is no definitive size or design, but there is a body of experience; as well as creative ideas and options not yet attempted.

Housing and Enclosure Requirements

MINIMUM SIZE

Duplaix-Hall (1975) recommended a minimum enclosure size of 15 x 10 meters, or 150 m^2 (1614 $ft.^2$). Reuther (1991) requires a minimum exhibit size of 100 m^2 (1076 $ft.^2$) for *L. lutra* (Eurasian otter) that are sent on "loan contract" from the Otter Zentrum in Hankensbüttel, Germany. After visiting over 60 otter exhibits worldwide I agree with Duplaix-Hall's recommendation of a minimum of 150 m^2. Having said this, I will add that I have seen exhibits smaller than this that offer the otters a highly varied and enriched environment. These include Columbus Zoo and Central Park Wildlife Conservation Center; both of these facilities offer good quality land space, bushes and trees for shade, soil and natural vegetation for digging and rooting around in, as well as streams that run through the land area. However, it is suggested that all new exhibits be designed with a <u>minimum</u> of 150 m^2 of useable land/water surface; if larger groups are planned for space should be increased.

Although there is no definitive way to establish a species' minimum spatial requirements, the river otter is an active animal, adapted to traveling long distances [daily movements from 2.4 to 42km (1.5 – 26 miles) up to 42km for a dispersing males in one day (Melquist & Hornocker 1983)], and curious by nature. For these reasons, otters are best kept in environmentally complex exhibits where they can be offered a variety of behavioral choices to include: a long, complex water/land interface for exploration and object manipulation; a variety of substrates and vegetation; resting sites; holts or denning sites; pools; logs or other high spots for grooming and as sprainting spots; digging pits; leaf litter piles; trees, shrubs, grasses; deadfall piles, rafts, floating logs, or islands, etc. It is possible to provide these options, to a limited extent, in exhibits smaller than 150m^2 but these exhibits will prove difficult to maintain and enrich over time. Inquisitive animals will quickly become overly familiar with small, un-enriched environments; the result of this familiarity is generally, excessive sleeping, or, abnormal repetitive behaviors such as rotational swimming, pacing, and self-directed aberrant behaviors. Although a larger exhibit does not guarantee these behaviors will not occur, it does provide the animal with more behavioral options, room for exhibit-mates to interact or not-interact, and offers the management team greater enrichment and education choices.

LAND/WATER RATIO AND INTERFACE

In 1975 Duplaix-Hall set down guidelines that are frequently cited as the desired standard. These guidelines were based on an assessment of the river otter exhibits she had seen, a historical literature review, field experience with some otter species, and gut instinct (pers. com.). Her recommendations were an exhibit size as listed above, a land to water ratio of 4:1, a turf to shrub ratio of 2:3, and a containment barrier at least 1.80 meters (6 ft.) high with an 80cm (2.6 ft.) smooth overhang. These guidelines are still considered valid today. A land to water ratio of 3:1 also is acceptable if the exhibit is large. The land to water ratio is critical because the river otter actually spends more time out of the water than in the water.

- Dry land area is important because this is where the animals groom, sleep, rest, play, and eat their food.
- Pools are important because this is where otters play, hunt for food, most frequently breed, sometimes defecate, and, where our visitors expect to see them.
- The length and complexity (e.g. convoluted, interrupted with deadfall, shrubs, rock piles, trees, digging pits, etc.) land/water interface is of primary importance because this is where otters are known to spend the majority of their time.

The importance of the complexity of the land/water interface cannot be stressed enough; in the wild otters spend very little time along smooth, barren shorelines. The complex shoreline interface is where otters spend the majority of their time (~ 60%, Reuther 1991). This should consist of convoluted shorelines broken up with rock piles, deadfall, downed trees attached to pool sides, docks, etc. Well placed shrubs and trees also should be incorporated to the land/water interface with hollows designed for denning and visitor viewing. Many exhibits, large and small, can be enhanced by the placement of logs, branches, rock outcroppings, mud banks, etc. sticking out into pools.

> "*Looking at the space using behaviour of the Eurasian Otter in captivity it has to be realized that the length of the banks seems to be more important than the water-land-ratio. More than 60% of the total activity happens in an area of 1.5 – 2.0 meters* (5 ft. – 6 ½ ft.) *left and right of the water-line."* (Reuther 1991)

CONTAINMENT BARRIERS

Otters are diggers and are known to climb, therefore sinking perimeter fences/walls at least 2.6 feet (80 cm) into the ground is advisable and containment walls should be unclimbable and at least six feet (180 cm) high (temperate facilities need to take into account snow levels). If the containment barrier is chain-link fencing, it should be topped with an unclimbable overhang (Duplaix-Hall 1975, Foster-Turley 1990, Reuther 1991). Hot-wire can be used effectively but caution should be taken to ensure that animals cannot reach the hot-wire from the water.

Studies conducted on *L. lutra* at Otter Zentrum (Reuther 1991) showed that the Eurasian otter can "*...jump well leaping a distance of 130cm* (4.27 ft.) *in height when jumping from the ground to a platform, 160 cm* (5.25 ft.) *in width when jumping from one platform to another and 90 cm* (3 ft.) *in height when jumping out of the water on to a platform if there is a possibility to push off from the bottom."*

There are numerous reports of climbing otters; personally, I know of several. We should not be trying to completely prevent them from climbing, just controlling what and where. Placement of trees and the design of solid surface containment walls (gunite, rock, etc.) should be considered carefully.

DENS/HOLTS

There should be at least a one to one ratio of dens to animals. Dens should be large enough for an adult animal to turn around and curl up in comfortably. Denning areas and/or nest boxes are important and can be made from PVC tubes, plywood, cement blocks or more natural materials such as hollow logs and 'constructed' log jams (make sure the logs are secure and will not collapse onto the animals). Photo: Pueblo Zoo on-exhibit den.

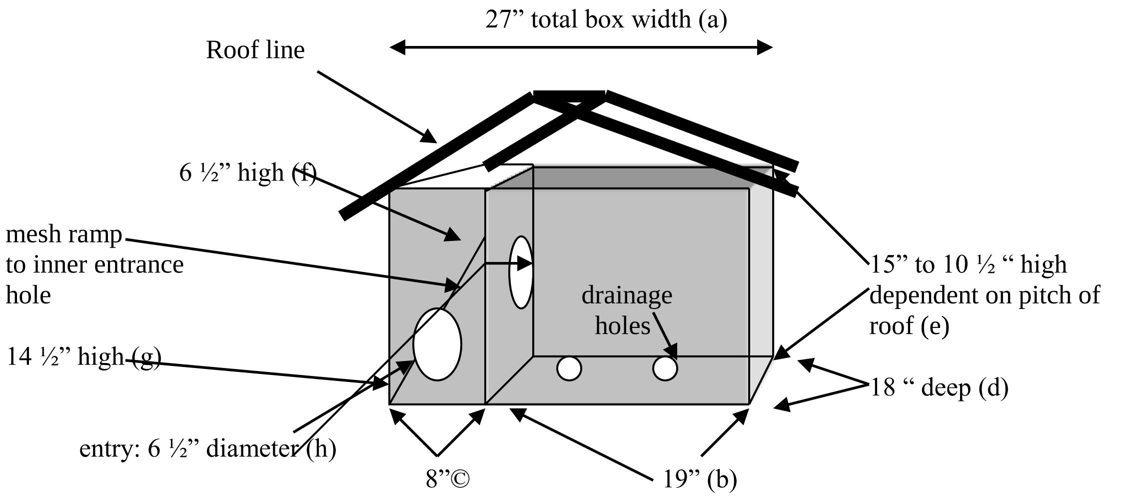
Suggested den box dimensions include: 30" x 30" x 17" (.76 m x .76 m x .43m) (Wallach & Boever 1983 citing AAZPA [AZA] Animal health Committee), and, 75 cm x 75 cm x 50 cm with a 22 cm entrance (2.46 ft. x 2.46 ft. x 1.64 ft., entrance is 8.66 in.) (Duplaix-Hall 1975)

Sample Denning Boxes

See also Section 1, Chapter 6, Pupping Boxes for additional examples and photo.

John Ball Zoo

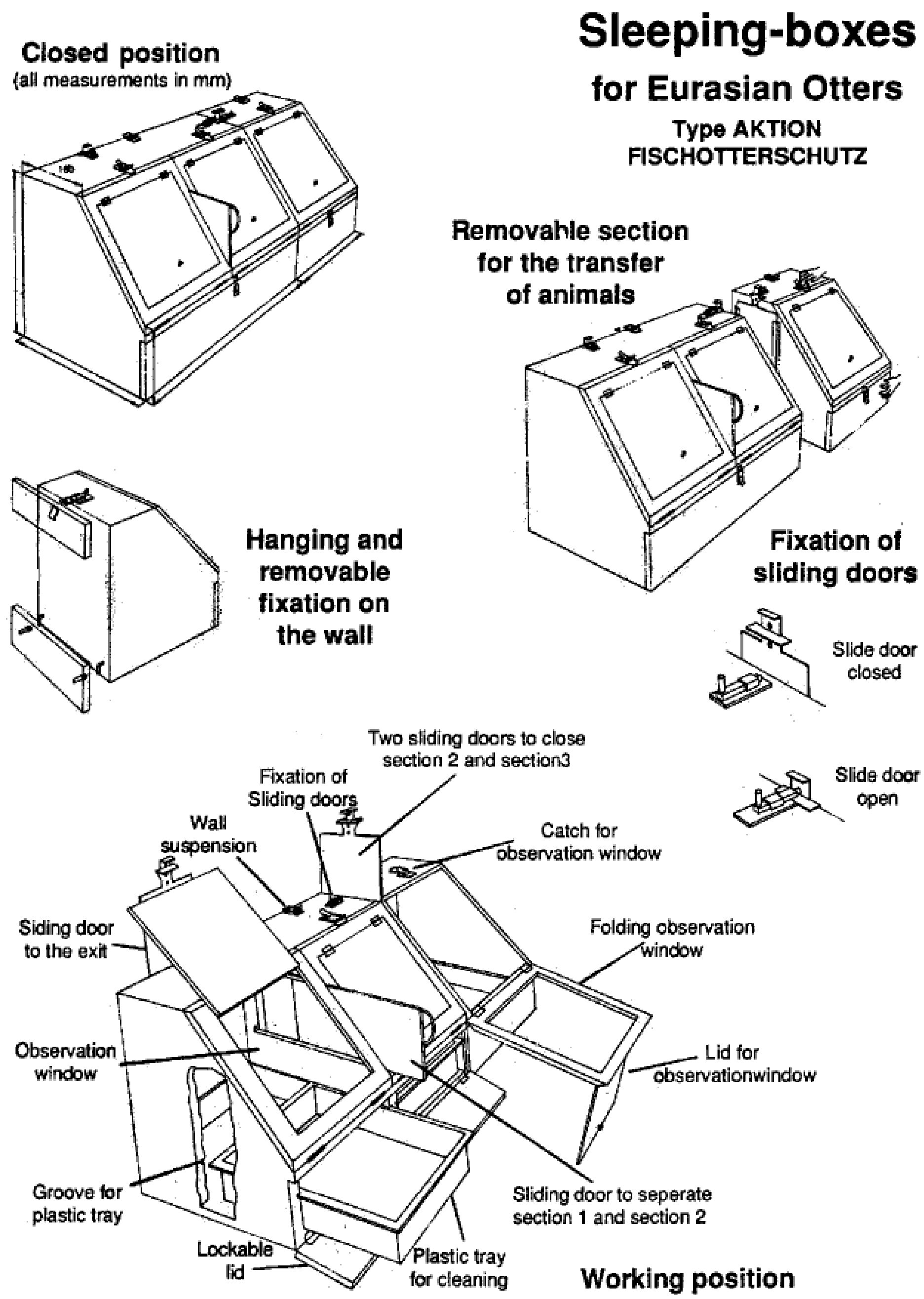
This nest box is used off exhibit in the night quarters, especially for the female when she was due to give birth. The rest of the year this box is alternated with an air kennel and a 30” (76.2 cm) diameter heavy-rubber tub with, or without, a lid constructed out of the end portion of a soft drink barrel.



(a) 68.58 cm	(b) 48.26 cm	(c) 20.32 cm	(d) 45.72 cm	(e) 38 cm to 26.67 cm
(f) 16.5 cm	(g) 36.83 cm	(h) 16.5 cm		

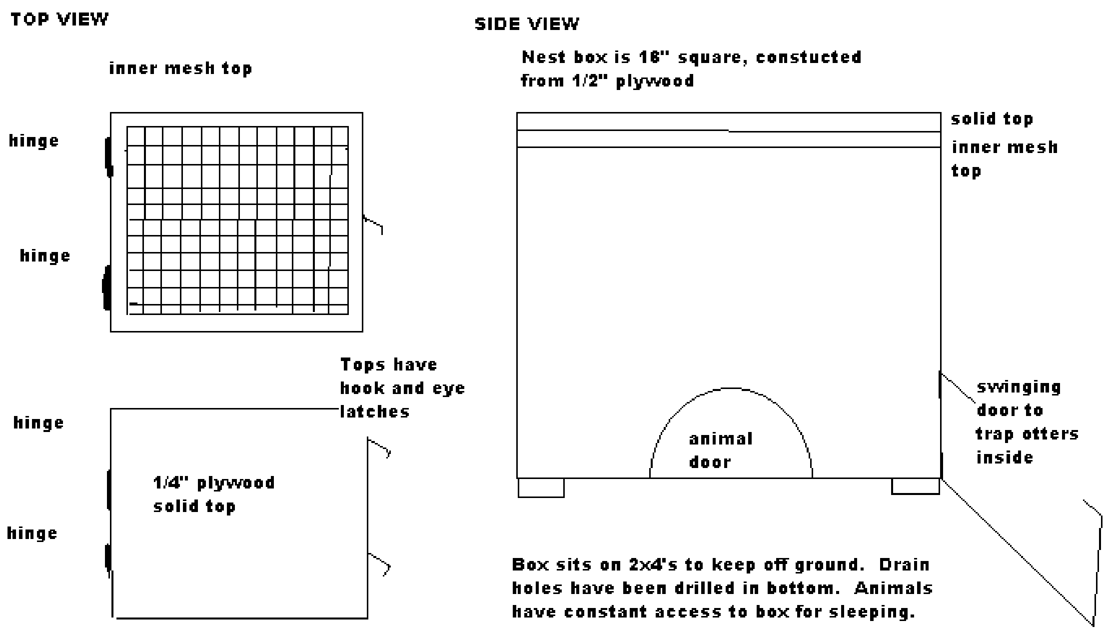
(Nest box pictured below with the top up; the top is hinged on one side and held with a hasp on the other side.)

Otter Zentrum den box, Hankensbüttel, Germany

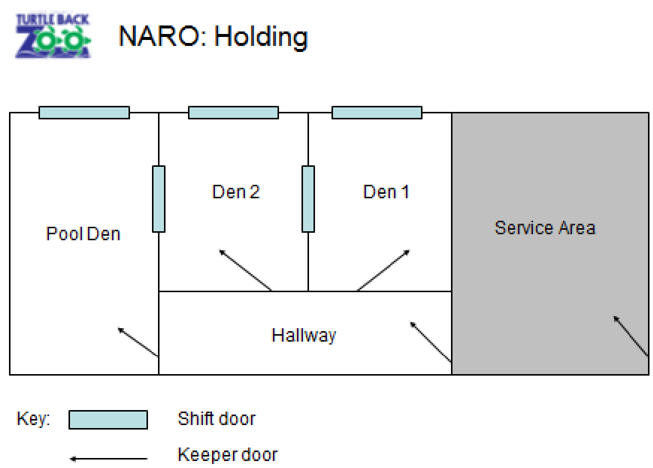


Sleeping-boxes for Eurasian Otters, Type AKTION FISCHOTTERSCHUTZ.

Stone Mountain Zoo
Contributed by: Sandy Elliot, Lead Keeper. Nest box design, allows animals to be locked in and moved.



OFF-EXHIBIT HOLDING



Night holding facilities may be used as an alternative to on-exhibit dens, if, the exhibit has sufficient hiding places to provide the animals with a sense of security and shelter. The Turtleback Zoo's diagram of their otter holding is provided as an example of good holding design. Designs should offer egress to the exhibit from all dens as well as shifting between dens. Separating walls should be solid but provide for visual introductions when necessary. Ideally, the number of individual dens should equal the number of otters you anticipate holding, plus a pupping den. Off-exhibit holding varies greatly in size based on its intended use. Whenever possible design off-exhibit holding that is satisfactory for at least short term maintenance of sick or new individuals, or animals separated for other management reasons.

If at all possible, it is preferable that animals be given access to holding at night but not locked in. Some facilities require that all animals be secured in holding at night. In these cases it is advisable that the animals be given access to: a nest box or sleeping area per individual (otters most frequently choose to sleep together but provisions must be made for social dynamics); pool; fresh drinking water separate from the swimming pool; dry bedding, and rotating furnishings and institution approved enrichment items.

Some institutions offer expanded off-exhibit outdoor areas that include pools and yards; one of these is the Pueblo Zoo, photos shown here:

Photo 1: Off-exhibit outdoor yard (70' x 90') with an 800 gallon semi-buried stock tank as a pool and chain link containment (buried and with flashing to prevent digging/climbing). This is an excellent idea offering multiple management options and room for managing new animals, family groups, and discordant individuals. **Photo 2**: Off-exhibit den site made from plastic culverts embedded in the hillside.

BEDDING MATERIAL

It is advisable to provide some kind of bedding material on, and off, exhibit year around, particularly when the exhibit substrate is gunite, concrete or something similar. The roughness of these surfaces can be tough on foot pads in the absence of material for the otters to dry off on. Straw, wood-wool, hay, grass, sedges, pine needles, and leaves have all been used. Bret Sellers of Oregon Zoo has a caution regarding the use of conifer shavings such as pine or fir; he says that these stripped their otters' coats of their water repellency due to the natural turpentine found in these products. His advice is to use Beta chips made from autoclaved maple and alder chips if wood shavings are the bedding material you choose (per. com.).

HIDING PLACES

Areas where the otters can feel protected are important as resting places. These can be depressions near logs, hollow stumps, bushes, solid walls away from viewing areas, etc. When designing exhibits keep this in mind; a well-designed space should offer a sleeping area that will attract the otters, yet leave them at least in view of the public. As previously mentioned, this can be achieved by creating a depression with some sort of shade covering and providing bedding. A word of caution, otters like to build beds, they will haul material from one spot to another which may drop into the pools. The best way to counteract this is to design a bedding location back far enough from the water so that it is not an issue, or keep a good long-handled skimmer on hand!

WEATHER PROTECTION

It is important to provide shaded area for animals exhibited outside.

DRAINAGE

Proper drainage is very important. There should be enough dry area in the exhibit to allow all animals room for rubbing and drying their coats. Inside holding facilities should be provided with dry areas as well as built in pools or water tubs for swimming. Nest boxes should be provided with adequate drainage to allow bedding to stay dry.

SUBSTRATE/TOPOGRAPHY

Land to water ratio should be around 4:1 to 3:1. This ratio unfortunately is seldom the case. The majority of facilities have a land to water ratio of 3:2 or 1:1; older facilities may even be weighted the other way. This is because historically river otters were regarded as aquatic mammals instead of semi-aquatic. It is preferable to provide a variety of substrates in the exhibit area. If an exhibit is all concrete the animals will not have a suitable surface for adequate coat maintenance. Otters are diggers – while this should be kept in mind, and exhibits designed so animals cannot dig out, offering a variety of natural substrates in which the animals can dig aids in coat care and provides natural behavioral opportunities. The Pueblo Zoo has had excellent results using digging pits of soil or sand. The substrate is turned regularly prompting renewed interest by the otters due to the fresh scent and looseness of the soil. Duplaix-Hall (1975) cautioned against the use of sand substrates, unless they are of a non-abrasive quality. In particular, builder's sharp sand is dangerous because it can wear away the otter's guard hairs. It is recommended that as far as possible different substrates should be made available, to include: soil, non-abrasive sand, gravel, rocks, mulch, leaves, pine needles, grass, river rock, etc. As previously mentioned, simply turning over the soil will attract attention and provide scent, tactile, and behavioral enrichment.

SPECIAL FURNISHINGS

In addition to a pool, preferably of varying depths, logs, rocks, grass, bushes, bedding choices and a variety of substrates are all important to the maintenance of healthy otters. These items not only provide stimulation by provoking investigatory behavior, but they are important to the maintenance of a healthy coat. Water falls, sprinklers, shallow streambeds, periodic flooding of shore lines, underwater entrances to holts, log jams, stumps, complex root systems and structures, as well as islands all add variety and environmental enrichment.

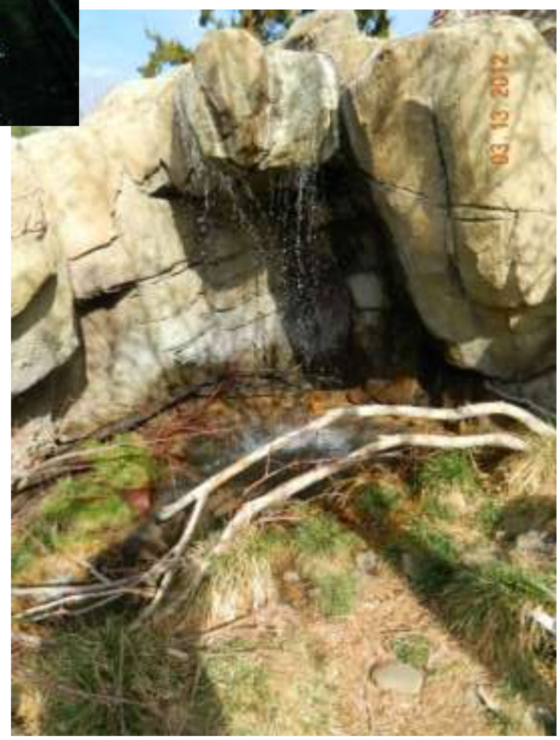
Feature Photos

Audubon Park Zoo – bridges and Jacuzzi jets (otter playing in jets)

Coyote Point Zoo - hammock

Sedgewick County Zoo – hollow logs and deadfall

Pueblo Zoo – waterfall and stream which runs into lower pool; rockwork, grasses, and deadfall



Denver Aquarium – underwater swim-through features

WATER SOURCE/TREATMENT

Fresh drinking water should always be available. Drinking containers should be cleaned daily and disinfected at least every other day.

Pool, or swimming, water should at least be monitored for chlorine level. Many facilities also monitor pH level and some monitor Coliform levels. Water may be changed daily or re-circulated through some sort of filtration system. What is important is the maintenance of potential disease causing vectors at concentrations below health hazard levels. Vacuuming of outdoor, re-circulating pools can be very effective at keeping algae growth and debris under control. The important thing to remember with otter enclosure water features is that most facilities are concerned with water clarity versus water quality. Water quality is taken care of with most water treatment systems (ozone, biological filters, sand filters, etc.) however, to provide clear water for underwater viewing can be complicated in outdoor environments. The key is the design of the filtration system in addition to placement of the pool which should be done in conjunction with experts experienced in otter aquatic exhibit systems.

What sort of water treatment system is the most effective, and safe for the animals is still subject to some debate. In general, it is this author's opinion that every method available carries with it some risk: natural flowing streams may carry pathogens or pollutants; ozone systems may be set, or designed improperly; chlorinated systems are now fairly widely accepted as detrimental to the animals' health and the water repellency of their coats; dump and fill systems are potentially expensive and may be utilizing chlorinated municipal water; filtration systems using chlorine free water may not do as good a job at keeping the water clear for underwater viewing. Whatever the solution chosen by your facility, please keep all of the information provided in this chapter in mind. At this time, the safest, and most effective systems appear to be properly designed ozone systems, de-chlorinated dump and fill, or de-chlorinated filter systems using a secondary filter medium for algae control.

Algae Control and Underwater Viewing

Underwater viewing offers a unique look at this semi-aquatic animal. Problems presented include keeping the water clear enough for viewing and algae growth. The 1st edition of the husbandry manual suggested the use of chlorine, maintained at .05ppm or less, as a means of controlling algae. Further research has uncovered concerns about the use of chlorine as an algaecide due to its potential impact on the otters' coat quality and its role as a possible carcinogen (see Chlorine). Unfortunately, some of us are still restricted to the use of chlorine. If this is the case, these precautions should be taken: 1) Chlorine should be added only when the animals are not in the pool. 2) Animals should not be allowed back into the exhibit until the chlorine level is lower than .05ppm – this level is ARBITRARY, future research may reveal this to be too high, or it may be safe at slightly higher levels. The best policy is to monitor your otters' coats water repellency quality closely. 3) Research alternate methods of algae control that will work in your institution. 4) The addition of sodium thiosulfate will neutralize the chlorine. (Photo: Graham Jones, Columbus Zoo)

Note: Boness (1996) raises questions regarding the effectiveness of using chlorine as a disinfectant (particularly for true aquatic species which the otter is not) if the breakpoint chlorination approach is not used. To use this approach effectively in a pool where ammonia may be continuously added via animal urines it is necessary to continuously monitor chlorine levels.

"Breakpoint chlorination is generally believed to be the most effective technique of chlorine disinfection. When chlorine is first added to a system, it reacts with ammonia and nitrogenous waste to form combined chlorines. With time and increased chlorination, the ammonia levels decline, so that the addition of more chlorine results in the formation of a free chlorine residual. The point at which the combined chlorine residual is at a low is called the breakpoint. Breakpoint curves are unique to each water system because they are dependent on the initial concentrations of nitrogenous material and other oxidizable substances in the water.

Breakpoint chlorination is possible in an aquatic mammal facility, but, because ammonia is added continuously via the animals' waste products and because the animals are in the water all the time, careful monitoring of chlorine levels is required to stay beyond the breakpoint once it is achieved. The relatively high chlorine residuals that might be required to stay at breakpoint should not be a problem because free chlorine appears not to be toxic, but if breakpoint is lost and these high residuals become mainly combined chlorine, one has a serious problem. Depending on the concentration of nitrogenous material added to the pool on a daily basis (a direct function of the number of animals in the pool), whether or not there are precursors of trihalomethanes present, and the bacterial load of the system, it may be more feasible in an aquatic mammal exhibit just to use a low level of combined chlorines to keep bacteria levels down.

Chlorine should always be administered to the pool through a high-quality injection system. Manually adding any type of chlorine is unsafe and does not properly distribute the chemical in the pool….Because of the known and probably negative effects of chlorine on animal health, alternatives should be considered."

Chlorine

"Chlorine is a very active oxidizing agent, and it readily reacts with ammonia and other nitrogenous materials to form chloramines, or combined chlorines.

"Free chlorines are much more effective disinfectants than combined chlorines….Combined chlorines are more toxic than free chlorines, but free chlorines used in the presence of humic and fulvic acid or some algae can produce carcinogenic trihalomethanes. And, even though chlorine is a good bactericide, many protozoans, yeasts, cysts, and viruses are resistant to it." (Boness 1996)

There is a great deal of debate over the use of chlorine as an algaecide. However, after completing my own, simple water tests and observations, questioning over 50 institutions worldwide and speaking with several water quality experts, I have come to the conclusion that chlorine levels of .5ppm are potentially harmful and levels above this have a definite impact on the water repellency of otters' coats. I have left a recommendation of .05ppm if chlorine is used or present in the water supply however, all facilities are strongly urged to explore other methods of algae control and water treatment.

Additionally, LaBonne (per. com.), Boness (1996), Oliver (1980), Briley et al. (1980) raise questions about the presence of Trihalomethane, a chlorinated organic compound and *"…a volatile substance…"* (LaBonne per. com.) that is a known carcinogen in aquatic mammal pools. *"The concentration will depend upon how much dissolved organic material is available, the concentration of chlorine (how much is free and how much is combined), the water temperature, and the filtration equipment (copper, ozone, biofilter, sand filter, etc.)."* (LaBonne per. com.)

Barley Straw

Some institutions have had success controlling algae growth using barley straw. It is available commercially packaged specifically for use in streams and ponds (example: Aquatic Ecosystems, Inc.; http://www.aquaticeco.com/subcategories/2786/Barley-Straw). Aquatic Ecosystems claims a ½ lb. bag per 1,000 gallons of water works up to 6 months when placed where the water can flow over it in a pond or in the sump or filter. Research on how, and if, barley straw effectively controls algae is inconclusive with results perhaps being dependent on the size of the water body. The activity of barley straw is typically regarded as being algistatic (prevents new growth of algae) versus algicidal (kills existing algae) (Lembi 2002).

HUMIDITY

Due to the semi-aquatic nature of these animals, humidity should not be a problem in properly designed exhibits. Lack of sufficient land area for drying-off on is more often the problem. A relative humidity of 30 – 70% is recommended for mustelids in general.

LIGHTING REQUIREMENTS

Animals not housed out of doors year around, or a full 24 hours a day, should be provided with a varying photoperiod which can be easily set up with timers. Indoor facilities should provide full spectrum lighting, if possible, in addition to the varying photoperiod.

TEMPERATURE

Indoor facilities should be kept at an ambient temperature below 70 - 75ºF (15.5 - 18º C) (Wallach & Boever 1983). Animals housed indoors should be provided with a thermal gradient within the exhibit. This will allow for the selection of a comfortable temperature by each individual animal (Moore, unpubl.). Obviously, the temperature of outdoor facilities cannot be controlled however, shade in the warm months and shelter from inclement weather in the cold months is very important. Dry bedding material should always be provided in, or near, the otters' denning facilities.

VENTILATION

"*Indoor exhibits should have negative air pressure of 5 – 10 air changes per hour of non-recirculated air. Separate ventilation systems should be provided between exhibit and visitor areas to reduce air (and odor) transmission, and potential disease transmission, between humans and animals"* (Moore, unpubl.).

CAPTURE AND HANDLING

Many facilities are training their animals for routine husbandry procedures; target training can be very useful in reducing stress on the animal and the keeper staff. See Training Section for information on training for hand injections which is the preferred method of administering vaccines/anesthetics. These squeeze/transfer cages are best used if the otters are trained to enter them calmly and willingly.

McCullough et. al. (1986) describes a squeeze box they used on otters. Serfass (1994) gives the design of a transport tube used by the Pennsylvania State Wildlife Agency. Reuther (1991) includes the design of a squeeze cage used at Otter Zentrum in Hankensbüttel, Germany. Air Kennels (or similar), squeezes designed in-house, and smaller sized squeeze cages are probably were the most frequently used methods of capturing and containing otters in zoos; currently most facilities train their otters to willingly enter a containment box or squeeze. Other capture methods include nets or catch-poles. Due to their loose skin, it is not advisable to hand catch these animals; it could lead to keeper injury and undue stress on the animal. If it is necessary to hand hold an otter, gloves should be worn. For anesthetizing information see the Health Care section.

SAMPLE CAPTURE BOXES, TRAINING CHUTES, AND SQUEEZE CAGES

Oregon Zoo Squeeze cage (LGL Animal Care Products, In., College Station, TX; http://www.lglacp.com/transfer_restraint_cages.htm) used for weighing as well as transport

Dickerson Park Zoo – injection/physical inspection chute

National Zoo (made in-house)
Dimensions: 34” long, 18” high, 18” deep. The length of the bars that lift up are 21” across.

Cleaning and Waste Removal

Food bowls and feeding stations should be disinfected daily; water bowls should be cleaned daily and disinfected at least every other day. Enclosures and holding facilities should be cleaned daily and disinfected as necessary. Do not disinfect every den, or the entire exhibit, at the same time, (it is preferable to leave the animals' scent on something); disinfecting of dens and sprainting sites should be done as necessary. Because scent is important to this species, nest boxes and exhibit furniture should not be cleaned as frequently as other surfaces. When these items are cleaned do not do all of them on the same day. In the AZA's Minimum Exhibit Guidelines (1997), Moore suggests not more than 25% be cleaned at any given time. Soiled or wet bedding should be removed and replaced daily. Pools should be kept free of accumulated feces or discarded food. Waste and trash should be removed in a timely fashion to minimize odor, disease hazards and pest infestation. The enclosure design should facilitate the drainage of excess and/or cleaning water.

Enclosures Examples

Otter enclosures range in size and cost. To illustrate this I have selected two outstanding examples that represent different positions on the cost spectrum however, both provide more than the minimum suggested enclosure space and make excellent use of space, complexity, natural substrates, and holding options.

Pueblo Zoo

Exhibit

Square footage: 2,250 cubic feet; 60% land to 40% water; 8600 cubic feet of water
Enclosed in "Rock wall" that leans inward for containment

Pueblo Zoo built this exhibit approximately 9 years ago. It was designed to allow for breeding and management of two groups if required. To maintain the vegetation staff periodically replants plugs and reseeds grasses. The otters have created trails through the grasses and make good use of two digging pits (sand and soil) that are frequently dug out or turned over (serving to attract the otters' attention with new smells and fresh soil). Daily enrichment is supplemented by novel feeders and scatter feeds for portions of the diet, as well as training (see enrichment and training chapters). Otters are given access to the exhibit, off-exhibit enclosure, and holding dens overnight (as one group or two during pre-breeding separation). (Photos: Jan Reed-Smith)

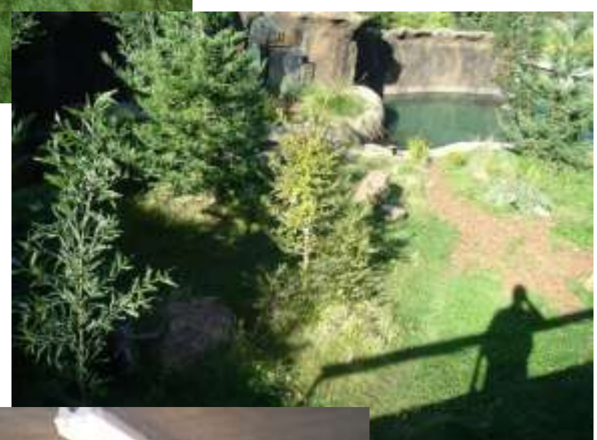
Off Exhibit Enclosure
Space- 70’x 90’
Water source is an 800 gallon semi-buried stock tank. The perimeter is chain link fencing with the bottom few feet buried at an inward angle. There is a sheet metal flashing approximately two feet off the ground to prevent climbing. Enclosure dens created from partially buried plastic culverts

Holding

The holding space was intentionally built smallish to be used for maternal denning and temporary holding only. Holding dens are each provided with tough rubber bins (holes drilled in the bottoms for drainage) and/or rubber tubs. Bedding used includes straw, shredded paper, cardboard chips, and materials brought in by the otters. The room is 15’X 15’; Smallest den: 3’x 5’; Largest den: 5’x 5’; 4 Dens total. Two shift doors to exhibit; 2 shift doors to patio leading to off-exhibit enclosure. Access to both sides (exhibit and off-exhibit yards) is through squeeze cage. Otters are not locked inside the holding building overnight but given access to both, or at least one outdoor enclosure. Photos: M. Pocock, one side of holding dens and back patio/yard.

OAKLAND ZOO

Exhibit: Approximately 3000 ft.^{2} of natural substrate (grass and soil) with trees, bushes, rocks, branches, and two 30,000 gallon pools. The holding consists of four stalls (10 x 10 ft.) provided with fire-hose hammocks and at least one Vari Kennel; igloos also are used as an option. One of these stalls is a sound-proof whelping den with an attached den box (this stall has always been selected by the female for giving birth; den box is similar to Otter Zentrum example). Each stall has a 50 gallon, above ground pool. The otters are allowed access to the enclosure and holding dens at night. (Photos: Andrea Dougall)



Holding dens

Animal Management

IDENTIFICATION OF INDIVIDUAL ANIMALS

Generally each animal has a slightly different shaped rhinarium (nose pad); this can be used to identify some individuals visually from the outside of the exhibit. Many otters also have some sort of spot pattern on the upper lip area. Scott Shannon (personal communication) used these “moustachial maculations” to identify individuals in the otter population he studied for many years in Northern California. Behavioral cues and coat color variations also may prove to be useful identifiers. However, all of these methods require patience, experience, and familiarity with the animals. Temporary pup identification can be achieved by the clipping of a small patch of hair in a different location for each pup.

Permanent identification should be done in a manner consistent with the holding institution’s policy. Options include: transponders, tattooing on the inside of a hind leg, or tattooing on the interdigital membrane of two hind toes a method used by Melquist & Hornocker (1983). See Health Care for transponder placement information.

PHYSIOLOGICAL AND BEHAVIORAL INDICATORS OF SOCIAL STRESS, HARASSMENT, ILLNESS, ETC.

If an animal is being harassed by exhibit mates it may show some of the following symptoms: wounds, stereotyped or abnormal repetitive behaviors, hiding, self-mutilation, loss of appetite, poor coat condition, hair loss, screaming. Because these also can be indicators of illness it is sometimes difficult to determine the true cause. If an animal shows any of these symptoms an environmental/exhibit-mate problem should be thoroughly checked out. This may be difficult to do and could necessitate 24 hour observations. Once the problem has been identified immediate steps should be taken; if one animal is harassing another the harasser should be temporarily removed. Re-introduction of this animal should be done slowly and with close supervision. Causes of hair loss also can be very difficult to determine; in addition to considering illness or parasites in cases of hair loss, over-grooming, hair plucking, and limb or body sucking are all factors that need to be considered. See Exhibit-mate Aggression.

FEEDING

Due to their high metabolic rate and rapid digestion (Iversen 1972, Toweill & Tabor 1982, Estes 1989, Davis et. al. 1992, Kruuk 1995, Spelman et al. 1997) otters should be fed at least twice a day, three, or more, is preferable. This prevents consumption of spoiled food, accommodates their rapid digestion of food as well as their high metabolism and can stimulate increased activity. Note: The consumption of spoiled food can lead to enteric problems, something otters are very susceptible to. See Section 3 Enrichment, Abnormal Repetitive Behaviors (ARBs or stereotypies) for information on use of feeding cues and their possible mitigation of pre-feeding related ARBs associated with more frequent feedings and training sessions.

Duplaix-Hall (1975) found that in the wild, river otters rarely ate more than 500 grams of food at a time but that they would eat approximately 20% of their own body weight daily. See Diet/Nutrition.

Weight

The ideal weight for all animals will vary and should be established on an individual basis. Subcutaneous fat is not widely distributed but is located primarily at the base of the tail and caudally on the rear legs. Smaller deposits are located in the axillary regions and around the external genitalia” (Baitchman & Kollias 2000). AZA Otter SSP Nutritional Advisors and individual institutions have been working on a weight matrix. The following photos are provided as a guideline:

Thin (Photo: Gary Woodburn, wild otter)

Good condition (Photo: Dave Mellenbruch, wild otter)

Heavy (Photo: Jan Reed-Smith, captive otter)

NEW ANIMAL INTRODUCTION AND REINTRODUCTIONS

Introduction of new animals can take anywhere from one day to several months; it just depends on the animals. It is advisable to plan on proceeding slowly via sight and smell first, gradually building to a physical introduction. The animals will generally give you behavioral cues as to what their reaction to a physical introduction will be.

It is possible to introduce adults, some of these introductions work, some do not. Two factors appear to be very important; 1) Both animals have a place to get away, 2) Introductions take place in neutral territory. An alternate, but slightly less preferable method is to introduce them in the home turf of the animal likely to be the more submissive (personal observation & K. Butkiewicz pers. com.).

Problem introductions should be done slowly, back up a few steps if need be. Be aware that some animals will just never get along (especially females) and an introduction may have to be abandoned. The reverse of this also is true, some animals hit it off right away and an introduction can be accomplished in just a few days, or in some cases, hours. Several facilities have had problems reintroducing an animal after an extended absence from the exhibit due to illness. Again, this usually occurs with females and these reintroductions may need to be treated as if the animals were meeting for the first time. An introduction plan should be laid out in advance, for example:

- ✓ Where; holding or outdoor enclosure. If at all possible do intros where an animal cannot become cornered.
- ✓ When; preferably before opening, and when there is no external stimuli such as construction or grounds cleaning, etc.
- ✓ Who will be there (staff, supervisor, veterinarian, volunteers).
- ✓ What you will need to separate animals in case of aggression (e.g. baffle boards, hose, net, catch pole, etc.).
- ✓ When early introductions will be ended; preferable to end when animals are getting along or ignoring one another.
- ✓ How and who will handle extended introduction periods. Will they be monitored, for how long, and by whom?

- Phase 1: Introduce new animal to the facility alone (holding and exhibit) and, exchange scents between otters.
- Phase 2: Allow visual access without possibility of physical interaction (i.e. side-by-side dens with small mesh wire). Otters also will be able to smell and hear one another. Monitor for affiliative or agonistic behavioral clues.
- Phase 3: Allow brief physical introductions which should be continuously monitored.

Affiliative grooming (Photo; Montreal Biodome)

- Phase 4: Increase length of physical introductions with continuous monitoring gradually switching to periodic monitoring.
- Phase 5: Once staff is confident the otters are compatible they can be left together unmonitored or overnight.

Introducing Females to Females

Introducing adult females to unfamiliar adult females can be difficult, if not impossible. There also have been reports of previously compatible females becoming aggressive to one another after extended separations. Having said this, in the years since publication of the last Husbandry Notebook edition several institutions have had great success introducing females, particularly younger females to old females. These introductions should be planned in advance with well-defined roles for the staff and emergency procedures identified in case of aggression (females have been known to try and drown newly introduced otters, both sexually immature males and other females). This introduction approach can be used for all otters, regardless of sex; it is just that male/male and male/female introductions may go more quickly. It always should be remembered that some introductions may never be successful and the most important key is a staff who knows the animals involved.

M. Rabon and C. Zewe, Houston Zoo's John P. McGovern Children's Zoo (2010) reported on their introduction process which was based on experience gathered from other successful institutions. An adapted version of their plan outline for their introduction approach is provided on the following page.

Female/Female River Otter Introductions –Approach Outline

Phase One – In Quarantine (30 Days):

- Have staff develop a relationship with the new otter while in quarantine by visiting at end of the day. Start training the new otter husbandry behaviors.
- Introduce new otter to resident female's scent by bringing bedding or used enrichment items to quarantine (with quarantine supervisor's approval).
- Begin, or continue, training sessions with resident otter; particularly recall and station. In this situation training sessions were to occur on exhibit.
- Add smaller mesh covering to exhibit holding dens, if required, to prevent injury to paws, etc. during introduction howdy sessions. Install video cameras for future monitoring when otters are left alone.
- Ensure otters can be separated in holding during introductions if required. Modify dens if required.

Phase Two – Howdy Time (2 – 4 weeks):

- Move new otter to holding. Leave resident female on exhibit for a few days to allow the new otter time to adjust to holding.
- Start howdy process by alternating otters on exhibit during the day. Leave one otter outside at night and one in holding.
- Start short, supervised howdy sessions in side-by-side dens.
- Continue training begun in quarantine. Begin on-exhibit training with new otter.

Phase Three – Introduction (one week to months):

- Introductions should first take place in holding if possible; this requires a set-up where an otter cannot be trapped by an aggressing animal. If this is not possible in holding then animals should be given access to exhibit and holding. Introduction area should be provided with visual barriers, escape routes, non-food enrichment.
- First introduction should take place when zoo is not open to the public and area disturbances are minimized (i.e. no grounds cleaning, construction, etc.). Observers should be limited to staff involved in introductions, with trainers ready to enter the exhibit if required.
- Have all necessary intervention equipment ready and available, such as hose, net, baffle board, CO^2 fire extinguisher, air horn, crate, etc. Have a plan identified as to which intervention should be used first, by whom, and under what circumstances.
- Begin with short introduction sessions; stop before aggression occurs if possible. Gradually increase session length based on otters' behavior. These sessions should be continuously observed by trained staff. Once otters are showing signs of getting along or non-aggressive avoidance volunteers can be used with qualified staff nearby.
- Continue to separate at night until the otters' behavior indicates they are past aggressive interaction.
- If otters are left together overnight video camera tapes should be reviewed for aggression, submissive, stress-related, or avoidance behaviors.

Phase Four – Success

- All successful introductions should be monitored by well-trained staff for any changes in individual otter behaviors, stress, and/or dominance.

Introducing Male to Family Group

In the wild males do not participate in pup rearing. However, in captive settings they are routinely reintroduced to the female and pups. The concern for when this should occur is primarily based on the female's acceptance of the male. No incidences of the male attacking the pups have been reported. The suggested process is as follows:

- Pups should be swimming well before the male is introduced to the family group (intros typically at 3 – 6 months of age).
- If the male has been moved to another exhibit he should be returned to the otter enclosure and rotated onto the exhibit separately from the family group for several days to allow the female to become accustomed to his presence and scent in the enclosure and holding.
- If the female appears comfortable and unconcerned about his presence they should be allowed visual, but not physical access in holding. Staff familiar with both animals should assess the female's reaction; if she appears comfortable or exhibits affiliative behavior towards the male introduction can be attempted.
- Introduction of the male to the female, without the pups present, should be attempted first. This can occur in holding or by giving the male access to the exhibit and opening the female's den door. This will allow her to enter the enclosure and interact with the male yet return to the den and pups if she wants.
- If she behaves aggressively the introduction should be stopped and tried again ~ a week.
- Once the pair demonstrates no aggression between them the male can be introduced to the pups. Typically, if the female is comfortable with the male's presence the male/pup introduction goes smoothly.

Exhibit-mate Aggression

Aggression between otters can occur. Often it is brief and results in a loud squabble with little actual fighting. Behavior such as this should be noted but typically is not of great concern unless it occurs with increasing frequency or intensity. Aggression which leads to physical fighting, and at times attempted drowning generally only occurs during initial introductions, if an otter has been removed for an extended period, or during breeding season if multiple males are in the exhibit or the female is not interested.

It appears that more actual fighting has occurred between female/female cage-mates than male/male or male/female pairings. Mixed-sex groups (2.2 or more) are exhibited, but, they may require a long introduction period particularly if the animals are adults. In mixed-sex groups with multiple males aggression may increase during breeding season and should be monitored for. Males are frequently reintroduced to family groups, the time frame ranges from 3 to 6 months. Males left in an exhibit with a lactating female should be provided with enough room to stay out of her line of sight until she decides he may approach the pups. See Behavioral Indicators of Social Stress.

WHAT SORT OF GROUP TO EXHIBIT

Otters in the Wild

Most frequently zoos exhibit a pair, this is fine, and will probably continue to be the norm, but is not believed to be the typical social grouping found in the wild.

Typically, female otters are found alone (Blundell et. al. 2000), or, with: 1) pup(s); 2) offspring from the previous year (probably female, but it is not known for sure); 3) pup(s) and a "helper otter" which is generally believed to be a female (Rock et. al. 1994, Blundell 1999 & Blundell et. al. 2000), or 4) with a male (Blundell et. al. 2000) during the breeding season.

Blundell (2000 and pers. com.) has found females joining groups of males in marine environments for some part of the year. Most males are found, by themselves or in a group of males; less frequently, but observed, they are found with a female or with a female and pups (Blundell et. al. 2000). It is difficult to observe otters in the wild so it has been hard to determine the otters' social history. However, recent, and on-going studies, are showing the river otter, particularly males, to be more adaptable socially than previously thought.

All Male Groupings

All male groups do very well. The Virginia Marine Museum exhibited a group of five males and researchers at the University of Alaska, Fairbanks housed 15 males together without any problems. (Harshaw per. com., Ben David per. com.) There are frequent reports from the wild of all male groups (for example: Blundell 1999 pers. com., Shannon 1999 pers. com., Melquist & Hornocker 1983, Blundell et. al. 2000), in fact, all male groups containing up to 20 individuals have been seen.

Male/Female Pair

As stated earlier, this is the most frequently seen captive grouping. Although pair living is not the normal social structure for otters in the wild they seem to adapt to living in pairs in *ex-situ* situations. An option to explore, even if a facility is not interested in breeding their river otters, is rotating the pair through the exhibit. The male can go out for a while, then the pair, then just the female or any variation. This mimics their natural social state a little more closely, will help stimulate activity in the exhibit, and provide an enriched behavioral environment for them. (Photo: Haley Anderson)

Multiple Pairs

Facilities have kept multiple pairs in three ways: all together (Lowry Park Zoo & Nashville Zoo @ Grassmere), males and females separately (Minnesota Zoo, St. Louis Zoo), or, separate pairs (Little Rock Zoo, St. Louis Zoo). See Section 1, Chapter 3, page 21 for groupings currently held in AZA institutions.

All Female Groupings

In a zoo, it is generally wiser to not exhibit multiple females together unless they are related or introduced at a very young age. Several facilities that have been successful with multi-female groups have had problems arise when one animal has been reintroduced after a brief absence. However, as with everything, there are exceptions. Some multi-female groups get along for years (the individual relationship history of many of these groups is unknown, this is not true for all), and have no trouble adjusting after brief separations. Related females kept together tend to do well over the long term.

Multiple Female-Single Male

Knoxville has been successful with 1.2 (females came from the same source, same age, same acquisition date but it is not known if they are related). These animals are together 24 hours a day. There are a few other facilities that have housed multiple females with a single male. If this group structure is selected you should watch for signs of stress because, the females may fight with each other or team up against the male.

It is possible to house 1.2 but exhibit the females separately from the male by rotating them through the exhibit. If this method is chosen adequate off-exhibit holding should be provided. The male can then be introduced to the females during the breeding season if desired. If space allows and this rotational method is chosen it may be advisable to house 2.2 to allow for mate choice. See female introduction protocol.

Multiple Male-Single Female

There is not a good reason to exhibit multiple males and one female unless something happens to one of your animals. If this is the case, the group should be monitored closely to ensure the female is not being traumatized by too much attention from the males. If possible, rotating animals through the exhibit is recommended. This could include different pairings such as 2.0, 1.1, 0.1, and the other 1.1 pairing.

Family Groups

Males are often reintroduced to a female and pups with great success. If the male is reintroduced the pups should be swimming well and the pair should be introduced on their own to determine if the female will accept the male. When pups sexually mature they should be sent to another facility.

GERIATRIC/IMPAIRED OTTERS

Modifications to the exhibit and holding may make it easier for older otters to manage their environment. These could include ramps, steps, softer substrates, "beds", hammocks, etc. Chondroprotective agents can be tried and pain should be managed. It is particularly important that the weight of older otters be appropriately managed and that annual physical exams are performed to monitor bloodwork, dental condition, radiographs, etc. (G. Myers per. com.)

MIXED-SPECIES EXHIBITS

North American river otters are not routinely kept with other species. I have heard rumors of a Canadian facility housing them with raccoons and/or fox but have not been able to confirm this. They also have been kept with sea lions and in one case with beavers; how long these mixed-groupings endured is unknown. There have probably been other mixed species groupings, both successful and unsuccessful but I have not been able to find any further information.

RECORD KEEPING

In general, most facilities have record keeping procedures in place. Information on an animal's behavior, training, enrichment, food intake, weight, health, reproductive status, vaccinations, etc. should be maintained to facilitate its proper care. All facilities should participate with the AZA North American River Otter Studbook Program (D. Hamilton, DHamilton@monroecounty.gov). The AZA Otter Care Manual has more detail on record keeping practices for member institutions.

SHIPPING

The IATA regulations are subject to constant review, so the current Live Animals Regulations Volume at the time of any animal shipment should be consulted. This information is provided as a guideline only. The sample crate below and all information contained in this section come from the International Air Transportation Association (IATA) Live Animals Regulations (LAR), 29th Edition, 2002, page 299-302.

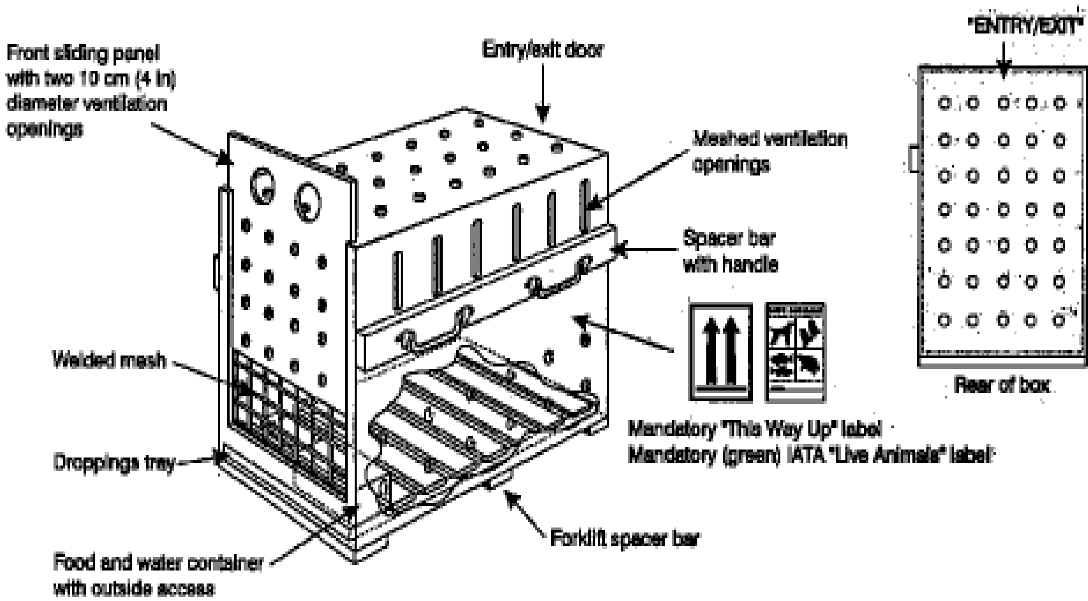
> *"The height of the container must allow the animal to stand in a natural position with its head extended and the width must permit it to turn around and lie down comfortably. The actual measurements will vary with the species involved.*
>
> *"The frame must be made from solid wood or metal parts bolted or screwed together. It must be constructed so that it cannot be damaged from continual biting or scratching at the corners. If the total weight of the container plus the animal exceeds 60kg (132 lb.) metal bracing must be added to the frame.*
>
> *"The sides and door must be made of metal or solid wood. The front of the container must be constructed of weld mesh. The mesh must have a diameter that will prevent the animal protruding its nose or paws to the outside. The whole front must be covered by a sliding shutter which can be raised and lowered to permit feeding and watering. It must have two observation holes of at least 10 cm (4 in.) in the upper part and ventilation holes, with a minimum diameter of 2.5 cm (1 in.), spread over the remainder of the surface in order to give good ventilation but at the same time leave the animal in semi-darkness.*

"The floor must be slatted, over a leak-proof droppings tray.

"The roof must be solid wood or metal with ventilation openings over its surface.

"A sliding door must be provided, it can be made from the weld meshed ventilation front if required. It must have a secure means of fastening so that it cannot be opened accidentally.

EXAMPLE:



Container Requirements 82 apply to otters.

"The main ventilation front must be supplemented by meshed openings along the upper part of the container walls and/or holes with a minimum diameter of 2.5 cm (1 in.) spread over the top third of the sides and the whole of the back and top. These holes must be spaced both horizontally and vertically at intervals of approximately 10 cm (4 in.) center to center. It is essential that there is some ventilation provided in the lower third of the sides for the removal of harmful waste gases.

"The total ventilated area must be at least 20% of the total area of the surface of all four sides. More ventilation and the use of larger meshed openings is permitted but the animal must not be able to protrude its nose or paws to the outside from any opening.

"If the mesh is fixed to the interior of the container all sharp edges must be protected.

"Spacer Bars/Handles must be made to a depth of 2.5 cm (1 in.), must be present on the sides of the container as shown in the illustration. (See illustration)

"Food and water containers must be provided with a means of access from the outside.

"Forklift spacers must be provided if the total weight of the container plus the animal exceeds 60 kg (132 lb.) (IATA Live Animals Regulations 26th Edition, p296)

Regulations have obviously become fairly rigid. Hard plastic pet containers can be used with the following modifications:

- *"The grill door must be covered with securely fixed weld mesh and all ventilation openings covered with wire mesh;*
- *"The door of the larger containers must have secure fastenings at the top and the bottom;*
- *"A curtain, that can be raised and lowered and does not impede ventilation, must be fixed over the door to reduce light inside the container;*
- *"A dropping tray must be fixed to the floor and filled with absorbent material;*
- *"There must be ventilation openings on the rear of the container, extra ventilation openings may have to be made in order that the total ventilation area is at least 20% of the four sides;*
- *" Food and water containers must be fixed inside with access from the outside;*
- *"The container must be correctly labeled."*

When shipping an animal, especially across international borders, check to see what types of special requirements/restrictions may be in place. For example, some countries will not accept crates in which straw has been used as a bedding material.

All animals should be shipped one to a crate. Lactating mothers should not be shipped.

Sample Shipping Crate

Photos: Boonshoft Museum

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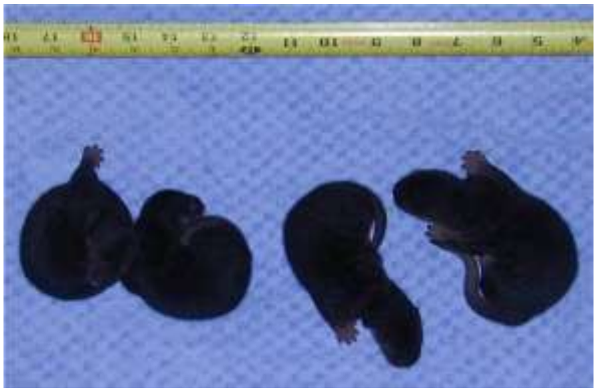
CHAPTER 8 Hand-rearing

General Information



See Health Care Section for vaccination information and Section 3 Rehabilitation of Otters for additional details on hand-rearing pups. Although mothers may successfully give birth, there are times when they are not able to properly care for their offspring, both in the wild and in *ex-situ* populations. Fortunately, animal care staff should be able to assist with the rearing of these offspring if necessary.

(Photo: Florida Aquarium pups, day 1, P. Blum)

Hand-rearing may be necessary for a variety of reasons: rejection by the parents, ill health of the mother, or weakness of the offspring. Careful consideration should be given as hand-rearing requires a great deal of time and commitment (Muir 2003). Before the decision to hand-rear is made, the potential for undesirable behavioral problems in a hand-reared adult should be carefully weighed (e.g., excessive aggression towards humans (rare in most otters), inappropriate species-specific behavior, etc.) and plans made to minimize deleterious effects on the development of natural behaviors as far as possible. This will require an extensive time commitment on the part of staff. Things that should be considered include: fostering or relocation of the young to another facility that has pups of a similar age, exposure to species-specific sounds, teaching the pups to swim, companionship for singletons, etc. At this time, the AZA Otter SSP is recommending hand-rearing of all otter species, if necessary.

Pups that have been abandoned by their mother should be removed as soon as possible to prevent infanticide. There is a 'Neonatal Examination and Monitoring Protocol' provided later in this section. Offspring that are not receiving milk will be restless, possibly calling continuously, may be hypothermic, and scattered around the enclosure. Another indicator of trouble would be the female moving around the exhibit continuously while carrying the young; this could mean she is not comfortable with the denning provided, or there is a problem with her or the pups (Muir 2003). If it is necessary to remove offspring because of an exceptionally large litter, it is best to remove two of the largest pups. The temptation is often to take the smallest, but they stand the best chance if raised by their mother. Hand-rearing of singletons is more likely to lead to severe imprinting on humans than if they have a conspecific to play with (Muir 2003). The AZA Otter SSP recommends that singleton pups being hand-reared be placed together, if at all possible. To date, fostering has been attempted once

with otter pups and was successful. A pup was taken from a female with no milk and sent to another facility where their female was already nursing pups (Columbus Zoo and Beardsley Zoo). In these cases, the AZA Otter SSP management team should be consulted first. Columbus Zoo also has been successful at stimulating milk production in a female and placing pups on teats for first nursing (Photo previous page: Columbus Zoo). Young otters removed for hand-rearing should not routinely be reintroduced to the parents with an expectation of acceptance. Introductions of hand-reared animals should follow procedures specified in the standard introduction protocol.

PUP DEVELOPMENT

The following information provides a summary of pup development. Consult Section 1, Chapter 6 Reproduction and Section 3, Chapter 13 Rehabilitation for additional information.

- Birth weight: 120-135g
- Born blind with dark brown fur
- External ears are flat against the head, and claws and toe webbing are well formed.
- Deciduous upper and lower canines begin erupting at about 12 days
- Eyes fully open at 28-35 days
- Eyes focus ~50 days
- Walking at about 35-42 days, first swimming lesson generally at 28-56 days
- Beginning to play ~25-42 days
- Leaving nest box on their own ~49 days, range 38 to 70 days
- Pelt change 28-56 days, born with all dark fur
- First solid food taken at 42-56 days
- Localized latrine use ~49 days
- Pups should be weaned by 3-4 months of age, may start as early as 75 days

SWIMMING, TERRESTRIAL ACTIVITIES, AND BEHAVIORAL STIMULATION

Otter pups are not born knowing how to swim and may even be scared of the water. They will usually start to take interest in the water at 4-8 weeks of age. The pups should be started off in shallow pools and watched carefully; once comfortable, they can gradually be introduced to deeper water. Pups should be dried off completely and warmed after their swim.

Enrichment is crucial to the development of the pups; toddler safe toys, grooming materials, dens, climbing structures, live food, etc. have all been used successfully. The more items that are introduced to otters at an early age, the more they will interact with as they age. All toys need to be safe and approved by the veterinary staff. The suitability of toys should be regularly re-evaluated, as some may no longer be safe as the otter grows. Due to the tendency of all otters to take things into the water, the use of cardboard or other paper-type items, especially for young animals, is not recommended. Cases of these items becoming water logged and congealing in an animal's mouth or over their nose have been reported.

Physical Care Protocol

Incubators provide the best source of warmth. Heat lamps are too intense and can be dehydrating. In an emergency, hot water bottles wrapped in a towel may be placed in a box with the pups nestled next to it, or they can be warmed slowly by placing them next to your body (Muir 2003). Pups may feel more secure if wrapped in layers of towels; this also aids in keeping them warm (Muir 2003). Pups should be dried after feeding/bathing to prevent hypothermia until they are proficient at self-grooming. The normal body temperature for pups is unknown (for adults: 38.1 – 38.7°C (100.6 to 101.7°F); baseline = 38.4°C (101.1°F) (Spelman 1999), but the animal should feel warm to the touch.

Altricial young are unable to self-regulate their body temperature during the early postnatal period and require an external source of warmth. If an incubator is not used, it may be necessary to place a heating pad, set on low, under the housing container until the pups are able to thermo regulate. Meier (1986) and

Wallach & Boever (1983) recommend 29.4-32.2°C (85-90°F) and 50-60% humidity as the desired incubator setting for neonate mustelids. The temperature should be gradually reduced to room temperature, 21.2-23.9°C (70-75°F), over the course of about three weeks (unless the neonate becomes ill). Litters of pups are less likely to need additional ambient heat since huddling together may provide an adequate amount of warmth. External temperatures should be closely monitored to prevent hyperthermia. Rapid and/or open-mouth breathing, restlessness, and hair loss are indication of an external environment that is too warm.

Pups should be stimulated to urinate and defecate, at least 4-5 times each day for several weeks, generally before feeding. However, some animals may respond better to post-feeding stimulation. The genitals and anal area are rubbed gently with a finger, towel, or damp cotton to stimulate the pup to urinate and have a bowel movement. If pups do not urinate and/or defecate after two successive feedings, the formula should be reviewed and their health status evaluated immediately.

NEONATAL EXAMINATION & MONITORING GUIDELINES

(from Read & Meier 1996)

Categories should be recorded daily while pup(s) are in incubators and monitored regularly after that. The optional laboratory values should be recorded if analyzed.

Vital signs	Temperature, include activity level Pulse, rate and character Respiration, rate and character
Organ systems	**---**
Weight	Record daily at same time (Reed-Smith)
Hydration	Skin tone and turgor
Mucous membranes	Color and capillary refill
Vitality	Response to stimulation, activity levels: type, frequency, duration
Physical condition	Coat, coordination, feet, tail (Reed-Smith)
Laboratory values (optional)	Complete blood count White blood cell count Serum chemistries, including blood glucose & blood urea nitrogen Urinalysis and urine specific gravity (recommended)
Urination	Frequency, amount, and character
Defecation	Frequency, amount, and character
Condition of umbilicus	Present, dried, gone (Reed-Smith)
Total fluid intake	Amount in 24 hours Parenteral fluids, amount, frequency, and type Oral fluids, amount, frequency, type, nipple
Housing temperature	Record daily while in incubator (Reed-Smith)

FEEDING AMOUNT AND FREQUENCY

Initially, the animal should receive only an electrolyte solution for the first 2-3 feedings, depending on how compromised it is. This is to rehydrate the animal and clear the stomach of the maternal milk. The artificial formula should be started at a diluted concentration, generally at a 1:4 ratio (mixed formula: water) for another 2-3 feedings. It generally takes about 72 hours to get the animal on full-strength formula by gradually offering higher concentrations. Typically, 4-5 feedings of each concentration level (1:2, 1:1, 2:1, full-strength) are required to allow for adaptation and to minimize the onset of digestive problems, particularly diarrhea. During the initial phase (24-36 hours), weight loss is to be expected, but the animal should quickly begin to maintain weight and then start gaining as the formula concentration increases. It is important that the pups are not given full strength formula too soon (in less than 48 hours after pulling for hand-rearing) because the likelihood of diarrhea is extremely high. Diarrhea is of particular concern with neonates less than one week of age, because they have very little or no immunity to infections.

Pups should have a normal body temperature and be properly hydrated before starting them on formula. Young mammals require a specific amount of calories per day for optimum development and growth. A nutritionally dense milk formula will allow for fewer feedings than more dilute formulas that are low in fat or protein. A method for calculating the volume of food to be offered per meal as well as total daily amount is presented below.

The Basal Metabolic Rate (BMR) or Basal Energy Requirement (BER) is the amount of energy (kcal) an animal needs for basic metabolic function at rest in a thermo-neutral zone. This represents the amount of calories it needs to stay alive, without having to use energy to maintain normal body temperatures (Grant 2004). Mustelids have a higher metabolic rate per body weight than many other placental mammals. For that reason, Iversen's equation of 84.6 x body weight (in kg) $^{0.78}$ (1972) is used rather than Kleiber's equation of 70 x body weight (in kg) $^{0.75}$ (1947) typically used for other species. Therefore, for a 200g river otter, the BER would be: 84.6 x 0.2 $^{0.78}$ = ~24 kcal/day.

Once the BER is established, the Maintenance Energy Requirement (MER) can be calculated. This measurement determines the amount of calories the animal needs to function in a normal capacity at its life stage. For adults in a maintenance life stage, the BER is multiplied by 2. For pups that have a higher metabolism and are developing and growing, the BER is multiplied by 3 or 4 (Evans 1985), depending on the species and other factors.

The stomach capacity for most placental mammals is 5-7% of the total body weight (Meehan 1994). Convert the body weight into grams to find the stomach volume in ml (cc). To calculate the stomach capacity in ounces, convert body weight into grams (30g ~ 1 oz). It is important that units are the same for body weight and stomach volume. The stomach capacity is the amount of formula an infant can comfortably consume at one feeding. Offering much more than this value may lead to overfilling, stomach distension, and bloat. It also prevents complete emptying of the stomach before the next feeding, and promotes the overgrowth of potentially pathogenic bacteria, diarrhea, and enteritis (Evans 1985).

The following calculations will determine the total volume and kcal to feed/day, as well as the amount of formula for each feeding and the total number of feedings daily.

- Calculate Maintenance Energy Requirement: 84.6 x body wt (kg) $^{0.78}$ x 3.
- Determine stomach capacity (amount that can be fed at each meal): Body weight (in grams) x 0.05.
- Divide Maintenance Energy Requirement (number of calories required per day) by the number of kcal/ml in the formula to determine the volume to be consumed per day (this can be converted into ounces by dividing it by 30).
- Divide ml of formula per day by volume to be consumed at each meal (stomach capacity). This gives the number of meals to offer per day.
- Divide 24 hours by the number of feedings/day to find the time interval between feedings.
- See following table.

Calculations for formula volume and feeding frequency for neonate with an approximate birth weight of 135g (MER = Maintenance Energy Requirement)

Step 1: calculate MER	84.6 x 0.135kg $^{0.78}$ x 3	~53 kcal/day
Step 2: determine stomach capacity	135g x 0.05 (stomach capacity of 5% body weight)	~7g (ml) per feeding
Step 3: calculate daily volume fed	53 kcal/day (MER) / 1.78 kcal/ml (formula contents)	~30ml/day
Step 4: number of feedings	30ml/day (total volume fed) / 7ml/feeding (stomach capacity)	4.2 feedings/day (=5)
Step 5: feeding schedule	24 hrs/5 feedings	Every 5 hours

New calculations should be performed every few days so formula volume can be adjusted to accommodate growth. The general target average daily gain for infants is 5-8% increase of body wt./day while on formula feeding and 8-10% body wt. increase/day on weaning diet (Grant 2005). **Since neonates being hand-reared (less than one week of age) are typically severely compromised, they should be given smaller, more frequent feedings than calculated until roughly 2-4 weeks of age.**

As a general rule, animals should have an overnight break between feedings that are no longer than twice the time period between daytime feedings (equivalent to missing one feeding). For example, if they are being fed every three hours during the day, they can go six hours at night without food. When they are eating every four hours, they can go eight hours at night. **It is not advisable to go more than eight hours between feedings with species that typically nurse throughout the day when mother-raised.** Intervals between feeding also will depend on how healthy or strong the infants are. Very weak neonates will probably need feedings every few hours even through the night; typically this is necessary for only a few days to a week. **The AZA Otter SSP recommends that neonates be fed every two hours around the clock initially. Depending on how the animal is doing, these feedings may be stretched to every three hours after the first few weeks.**

Otter pups should only be fed if the pup is hungry and suckling vigorously. Weak infants may be hypothermic, dehydrated and/or hypoglycemic. Do not offer anything by mouth until the body temperature is within the normal range for its age (i.e., warm, not hot, to the touch; adult normal body temperature range is given as 38.1 – 38.7°C (100.6 to 101.7°F); baseline = 38.4°C (101.1°F) (Spelman 1999). Electrolytes can be offered orally if the pup is suckling, or subcutaneously if it is too weak; 2.5-5% dextrose can also be given to raise the pup's glucose level. More research is required to determine body temperature norms for young of all the otter species. Young animals will be hungry at some feedings, less at others, but this is quite normal (Muir 2003). However, refusal of two feedings is a sign of trouble in young otters. Pups will not die from being slightly underfed, but overfeeding may result in gastrointestinal disease, which is potentially fatal. (Photo: Florida Aquarium nursing orphan, P. Blum)

If any animal's formula is changed abruptly, it is likely to cause diarrhea, which can dehydrate the pup quickly. Any formula changes should be made slowly, by combining the formulas and gradually changing the ratio from more of the first to more of the second. If an animal develops diarrhea or becomes constipated with no change having been made in the formula, consult the veterinarian. In general, adjusting the formula ratios should be attempted before medicating the animal. For diarrhea, increase the ratio of water to all the other ingredients. Be sure the water has been boiled or sterilized well, and the bottle is clean. Subcutaneous fluids (e.g., lactated ringers) may be needed if the infant dehydrates significantly.

Feeding Techniques

To bottle feed, hold the pup in the correct nursing position; sternally recumbent (abdomen down, not on its back), with the head up. Place the hand holding the bottle in such a way that it provides a surface for the pup to push against with its front feet. If milk comes through their nose, the nipple hole may be too large or the pup may be trying to eat too quickly. Make sure there is consistency with who is feeding the pups. Note any changes in feeding immediately. Decreased appetite, chewing on the nipple instead of sucking, or gulping food down too quickly can be signs of a problem (Blum 2004). (Photo: P. Blum)

It is important to keep in mind that neonates are obligate nose breathers and incapable of breathing through their mouths and nursing at the same time. For this reason, respiratory infections can be life threatening because they may interfere with breathing and make nursing difficult or impossible (Meier 1985). Aspirated formula is frequently a contributing factor to neonatal respiratory infections; to avoid this, be sure to select the appropriate nipple. The nipple's hole needs to suit the neonate's sucking reflex. Also, if a nipple is too stiff, the pup may tire and refuse to nurse.

If an animal aspirates fluids the recommended protocol is to hold the infant with head and chest lower than the hind end. A rubber bulb syringe should be used to suck out as much fluid from the nostrils and the back of the throat as possible. If aspiration is suspected, or if fluid is heard in the lungs, contact the veterinarian immediately; do not administer drugs without the veterinarian's involvement. Monitor body temperature closely for the occurrence of a fever and a decline in the animal's appetite and general attitude. Depending on the condition and age of the animal, diagnostic procedures may include radiographs, CBC, and chemistry. It is possible to start a course of antibiotics while results from the blood work are pending, and the attending veterinarian can prescribe an appropriate antibiotic course.

Pups will need to be stimulated to urinate and defecate for the first six weeks of life, either immediately before or after feeding.

Otter Milk, Milk Replacer and Selecting a Formula

"It should be noted that artificial milk replacer cannot be expected to perform as well as mother's milk. Rather, the goal is to produce a positive growth rate to enable the neonate to wean itself to a solid diet.

"In order to provide a neonate with proper nutrition and, hence, facilitate its growth while it is being fed an artificial milk replacer, one should remember the following concepts: (1) Protein, fat, carbohydrates, energy, vitamins, and minerals must be supplied in amounts and proportions that support a positive growth rate. (2) The amount fed at each feeding should not exceed the maximum comfortable stomach capacity. (3) The number of feedings per day should be adequate to supply daily energy requirements considering the finite amount that can be delivered at each feeding. (4) Every effort should be made to promote weaning to a complete and balanced solid diet when physiologically possible." (Evans 1985)

There have been a number of formulas used over the years to hand-raise otters. Keep in mind that the dams milk composition is presumed to change over the course of lactation and that, as of this writing, we do not know when these changes occur. For this reason, when hand-rearing otters it is important to closely monitor the pups' progress and re-evaluate the number of feedings and formula offered on a case by case basis. It is important that the artificial milk formula matches the maternal milk in protein, fat, and carbohydrate composition as closely as possible.

OTTER MILK COMPOSITION

Water: 62% Fat: 24.0% Protein: 11% Carbohydrates: 0.1% Ash: 0.75%
(Ben Shaul 1962)

Solids: 38% Fat: 23.9% Protein: 11% Carbohydrates: 0.1% Ash: 0.75%
Energy(KCAL/ML): 2.83 (Evans 1985)

Solids: 38% Fat: 63% Protein: 28.9% Lactose: 0.3%
(Pet Ag, Inc. 1993 Zoological Nutritional Components Milk Matrix Formulation & Mixing Guide. From: Jenness R. & R. E. Sloan 1970)

Otter (*Lutra* spp.) Milk Nutrition Composition on As Fed (AFB) and Dry Matter Basis (DMB)
(Ben Shaul 1962; Jenness & Sloan 1970)

Species	**Solids %**	**Kcal (ml)**	**Fat %**	**Protein %**	**Carb. %**
Otter	38.0	2.6 (AFB)	24.0 (AFB) 63.2(DMB)	11.0 (AFB) 28.9(DMB)	0.1 (AFB) 0.3 (DMB)

It should be noted that no data is available as to when during the process of lactation milk samples were collected. Further, it has been pointed out that sample size and how the data was collected is not specified resulting, possibly, in a high margin of error. However, Evans (1985) comments: *"Despite the sources of error, practical experience has shown that these data generally are adequate for formulation of artificial milk replacers."*

MILK REPLACER & FORMULA OPTIONS (HISTORICAL RECORDS)

General Formulas

Esbilac and Milk Matrix 30/55 (also known as Multi-Milk available from *Zoologic® a division of PetAg®, 261 Keyes, Hampshire, IL 60140, 800-323-0877*), combinations of these, and combinations of these formulas with other additives have all been used. (Foster-Turley 1985, Lowry Park Zoo pers. com., Cain-Stage 1992, and many others). In Great Britain, a product called Lactol has been used successfully. (Johnstone 1978)

Davis (1983, unpublished): This information comes from a conversation between Joe Davis, IUCN/SSC Otter Specialist Group Advisor, and Joan Ryskamp, John Ball Zoo (6/22/83).

> *"He recommended Esbilac at a mixture of 1 part Esbilac powder to 3 parts water. Of the reconstituted Esbilac he suggested 2 tbsp. of liquid per 4 oz. of body weight, or, 1 fluid once of liquid per 4 oz* (113 g) *of body weight. For every pound of weight gain increase daily amount offered by 4 oz. He apparently did not recommend offering more than 6 oz*. (170 g) *per feeding.*

"Mr. Davis suggested using a rubber ear syringe for feeding because it is stronger than a regular nipple, it won't collapse, and it can be forced into the mouth if necessary.

"As solids are offered, he suggested adding rendered chicken fat and powdered Esbilac to Nebraska Feline diet. The additives are required because the feline diet does not have enough calories. For 1 lb (453 g) *of feline add, 2 tbsp. of rendered chicken fat and 3 to 4 tbsp. of powdered Esbilac. If meat mix will not be consumed quickly he strongly suggested adding 2 tbsp. of active cultured yogurt to prevent rancidity.*

"Pups should be pot-bellied, if they appear lean, increase milk.

"Wean at four months. If a weight loss is seen for two days there could be a severe problem."

Cain-Stage (1992): This formula was first published in the Wildlife Health News, 1992. M. Cain-Stage works with the rehabilitation center H.A.W.K.E., Inc. in St. Augustine, Fl.

"Multi-milk (one part powder:2 parts water)
½ oz. (15 ml) *liquid whole milk whipping cream*
½ tsp. white Karo syrup
One egg yolk
½ eye dropper of liquid HiVite multi-vitamins

"Formula is made fresh daily and heated portions should not be reheated. The formula is mixed in a blender and stored in the refrigerator until used.

"A composition more like the natural milk can be achieved using Multi-milk, Esbilac, and heavy whipping cream. The ration is as follows:
one part powdered Esbilac
two parts water
one part Multi-milk
one part heavy whipping cream

"…river otters have also been successfully raised using Esbilac mixed as shown on the carton."

Diana Sevin from the Bayou Otter Farm provided this formula that she uses for raising young otters:

½ c. Fowl starter/grower crumbles
½ c. Rice cereal
Mix with 1 c. Esbilac & 1 tsp. cod liver oil

MILK REPLACER & FORMULA OPTIONS (CURRENT)

The following two tables provide information on the nutritional content of otter milk, and on the nutritional composition of selected substitute milk formulas/replacers.

Nutritional Analysis of Commercial Animal Milk Replacers

Product	Solids %	Fat %	Protein %	Carbohydrates %	Ash %	Energy (KCAL/ML)
Esbilac						
Undiluted powder	95.00	40.00	33.00	15.80	6.00	6.20
Diluted 1:3*	15.00	6.00	4.95	2.38	0.90	0.93
Diluted 1:1.5*	30.00	12.00	9.90	4.76	1.80	1.86
Liquid product	15.00	6.00	4.95	2.38	0.90	0.93
KMR						
Undiluted powder	95.00	25.00	42.00	26.00	7.00	5.77
Diluted 1:3*	18.00	4.50	7.56	4.68	1.26	1.04
Diluted 1:1.5*	36.00	9.00	15.12	9.36	2.52	2.07
Liquid product	18.00	4.50	7.56	4.68	1.26	1.04
Multi-Milk						
Undiluted powder	97.50	53.00	34.50	0	6.63	6.85
Diluted 1:1*	22.70	12.00	7.83	0	1.51	1.55
Diluted1.5:1*	36.00	19.59	12.75	0	2.54	2.47
Evaporated Milk						
Undiluted product	22.00	7.00	7.90	9.70	0.70	1.49
Multi-Milk:KMR+						
1:1*	22.81	8.93	8.71	3.20	1.55	1.45
3:1*	22.90	10.97	8.63	1.54	1.59	1.57
4:1*	22.90	10.90	8.27	1.17	1.50	1.51
1:3*	22.70	7.28	9.10	4.39	2.30	1.37
1:4*	22.60	6.95	9.16	4.68	1.57	1.36
Multi-Milk:KMR++						
1:1*	34.22	13.40	13.07	4.80	2.33	2.18
3:1*	34.55	16.46	13.03	2.31	2.39	2.36
4:1*	34.55	16.35	12.41	1.76	2.25	2.28
1:3*	34.05	10.92	13.65	6.59	3.45	2.06
1:4*	33.90	10.43	13.74	7.02	2.36	2.04
Multi-Milk:Esbilac+						
1:1*	22.81	10.63	7.70	1.78	1.44	1.49

Product	Solids %	Fat %	Protein %	Carbohydrates %	Ash %	Energy (KCAL/ML)
3:1*	22.93	11.63	8.00	0.89	1.52	1.56
4:1*	22.90	11.60	7.86	0.71	1.49	1.55
1:3*	22.70	9.81	8.75	2.67	2.13	1.51
1:4*	22.60	9.65	7.54	2.84	1.39	1.43
Multi-Milk:Esbilac++						
1:1*	34.22	15.95	11.55	2.67	2.16	2.24
3:1*	34.40	17.45	12.00	1.34	2.28	2.33
4:1*	34.35	17.40	11.79	1.07	2.24	2.33
1:3*	34.05	14.72	13.13	4.01	3.20	2.28
1:4*	33.90	14.48	11.31	4.26	2.09	2.15

* Ratio of powder to water; + Ratio of powder-to-powder, diluted 1 part powder to 1 part water; ++ Ratio of powder-to-powder, diluted 1.5 parts powder to 1 part water (Evans 1985)

The addition of an anti-gas build-up product to the formula should be considered (milk sugars can cause the build-up of gas). Lact-aid® is an enzyme that has been used successfully with many species. Add two drops of Lact-aid® to 100ml of mixed formula. The formula then should be refrigerated for 24 hours prior to feeding for the enzyme to perform correctly (Grant 2005). *Lactobacillus* spp., in Bene-bac® or Probios®, is a group of beneficial gut bacteria that also break down milk sugars in the digestive tract. Follow label instructions for these products.

Substitute milk formulas for otters. Values taken from product composition documents available from PetAg™
(K.Grant, personal communication)

Formula	% Solids	% Fat	% Protein	% Carb	Kcal/ml
Formula #1 1 part Esbilac® or Milk Matrix® 33/40 1 part Multi-Milk® or Milk Matrix® 30/55 2 parts water	30.9	15.6	10.5	2.7	1.78
Formula #2 1 part Multi-Milk® or Milk Matrix 30/55® 1 part water	31.3	17.8	10.4	1.1	1.91

Preferred formulas

Esbilac® (or Milk-Matrix® 33/40) is preferred as the base for milk formulas offered to otters and provides good pup growth. The addition of Multi-Milk® (or Milk-Matrix® 30/55) increases the total fat and protein content without adding substantially to the carbohydrate content of the formula. The maternal milk composition of otter milk only has a trace amount of milk sugars, so this component of the substitute formula must be kept as low as possible to prevent gastric upset and diarrhea.

The addition of an anti-gas build-up product to the formula should be considered (milk sugars can cause the build-up of gas). Lact-aid® is an enzyme that has been used successfully with many species. Add two drops of Lact-aid® to 100ml of mixed formula. The formula then must be refrigerated for 24 hours prior to feeding for the enzyme to perform correctly (Grant 2005). *Lactobacillus* spp., in Bene-bac® or Probios®, is a group of beneficial gut bacteria that also break down milk sugars in the digestive tract. Follow label instructions for these products.

Haire (2011 and Section 3 Rehabilitation) states:

> ***Formula Note**
> *Recent change (2009) in the manufacturing process of Esbilac powder has been causing some growth and digestibility problems in squirrels, opossums and raccoons for some wildlife rehabilitators using this milk replacer. Problems regarding this product with other wildlife species have not yet been reported or published to author's knowledge.*
>
> *Pet Ag®, manufacturer of Esbilac and the Zoologic Milk Matrix line of milk replacers, reminds wildlife rehabilitators that using Esbilac on wildlife is "off label" usage and they recommend that instead rehabilitators use the Zoologic Milk Matrix products such as Zoologic 33/40 since it is manufactured and labeled for use in wild orphan mammals.*
>
> *Wildlife rehabilitators are advised to know about these issues in order to make informed decisions on the formulas we choose to feed. Current updates on milk replacers, feeding practices, and information on gastrointestinal conditions in wildlife are available at www.ewildagain.org.*

The following formulas used successfully by rehabilitators working with orphaned otter pups are provided in Haire (2011 and Section 3 Rehabilitation):

- *1 part powdered Esbilac® + 2 parts water + Lactobacillus (Avian Benebac™) powder (1t/cup of formula) (provided by M. Haire)*
- *1 part powdered Esbilac® + 2 parts water + 1 part heavy whipping cream + 1 part Multi-Milk® (provided by M. Caine-Stage)*

- *2 part liquid Esbilac® + 1 part whipping cream*
- *Multi-Milk ®30/55 until eyes open, than;*
  2 parts liquid Esbilac + 1 part Multi-Milk® (Provided by S. Beckwith)
- *Canned Esbilac® (as is)*
- *1 part powdered Esbilac® or Milk Matrix® 33/40 + 1 part powdered Multi-Milk® or Milk Matrix® 30/55 + 2 parts water*
- *Multi-Milk® 30/55 until eyes open then transition to Esbilac® (Zoologic milk substitute 30/55 has low level of lactose)*
- *Esbilac® 2 T/4 oz BW divided into 5 - 7 feedings every 2 - 3 hours until 10:00pm*
  4 weeks old consume 1 oz/feeding 4 - 6 x/day
  6 weeks old consume 2.5 oz/feeding 4 x/day (provided by Blasidell)

Feeding Young Pups and Weaning

FEEDING YOUNG PUPS (NEONATES TO SIX OR TEN WEEKS)

Very young pups are more difficult to raise, this information can be used as a guideline if pups are pulled when slightly older. It is preferable that neonates, in particular, are raised by experienced personnel. Care must be taken to closely monitor the animal's growth, development, and coat condition. **Do not** over feed, feed too quickly, bottle feed holding the pup on its back, forget to stimulate to urinate and defecate, allow severe diarrhea to continue, or change more than one formula/diet item at a time when trying to resolve a problem. **Do** keep the pup warm, clean, feed the age/weight appropriate amounts (frequent, small feedings for very young animals), wean to solids as soon as possible, keep detailed records, groom and maintain the pups coat, and teach the pup to swim.

Lowry Park Zoo
In 1994/95 Lowry Park hand raised a number of pups. Their guideline was to offer no more than 30% of the pup's body weight (in formula) in a 24 hour period. Weight data can be found later in this section.

Week 1:	Pups fed 8 – 10 times per day (every 2 –3 hours). 3 – 5ml. were offered at each feeding. Started with Pedialyte then offered Milk Matrix 30/55. The specific gravity (SG) of their urine was tested to monitor the pup's hydration. A SG value of 1.020 is considered normal for adults and 1.012 for juveniles; if it is higher the animal was considered to be dehydrated.
Week 2:	On day 10 switched to 1:1 Esbilac: Pedialyte; on day 11 full strength Esbilac was offered. Consumption at each feeding ranged from 5 – 9ml.
Week 3:	Pups were taking about 7 – 15ml. at each feeding.
Week 4:	Mid-week one feeding dropped so they are now fed seven times in 24 hours. 11 – 20ml. offered at each feeding.
Week 5:	20 – 30ml. offered per feeding
Week 6:	Up to 55ml. offered per feeding.
Week 7:	Same.
Week 8:	Chicken baby food was added on day 54. Pups still being fed seven times per 24 hours. ½ to 1 teaspoon of baby food offered each feeding.
Week 9:	Fed six times per day. 60ml. of Esbilac and 1 Tablespoon to 1/3 jar of chicken baby food was offered at each feeding.
Week 10:	Feedings were gradually reduced to four times per day. They continued to offer 60ml. of Esbilac at each feeding supplemented with chicken baby food which was then switched to a mix of liver baby food and feline diet.

Feeding Older Pups (six to ten weeks and older)

Occasionally zoos and aquariums may receive orphaned pups or have cause to take over feeding of weaning or weaned pups. In the case of wild orphans, they are frequently young animals found in the wild when the dam was killed by cars or dogs. Usually these animals are old enough to be following mom so should require minimal formula feeding. With animals in this age range (six to ten weeks) it is important to wean them onto solid foods as soon as possible. Watch the animals coat condition, fecal output and consistency. See Do's and Don'ts under Feeding Young Pups.

> *"Some of litter removed at six weeks (when mature there is no difference in size, weight, or condition when compared with naturally reared companions). To each 8 oz.* (237 ml) *of Carnation or homogenized milk, add 1 drop of Tri-vi-sol, yolk of one egg, 1 teaspoon lime water. Feed every 4 hours at blood heat from 6 weeks of age, then on demand. Shavings of lean horse-meat offered from start."* (Jeremy Harris, Oxnead Hall, Norwich, Great Britain)

The specific zoo/aquarium information listed below was taken from the responses to the 1994 John Ball Zoo North American River Otter Breeding Survey unless otherwise noted.

Audubon Park Zoo

The pups came in at about 2 ½ to 3 months old. At first they were given thinned Esbilac using a standard baby bottle and nipple. They were quickly switched to Esbilac mixed with baby cereal. The next progression was mixing meat baby food with the Esbilac.

Baton Rouge Zoo

The pups came in at about 6 weeks old. They were fed 2oz (59 ml) Esbilac and three to four whole smelt twice a day for about one week. a standard baby bottle and nipple were used. No problem getting the pups to nurse and the pups ate the smelt well. After about the first week, the adult diet (finely ground) was offered and their milk intake was gradually reduced over the next week. No additional supplements were added.

Metro Toronto Zoo

One animal was hand reared from about six weeks of age. Initially, he was fed five times a day (7am, 11am, 3pm, 7pm, 11pm). The formula was an Esbilac/2% milk combination; 1 ½ Tbsp. Esbilac to 3 ½ Tbsp. 2% milk. He also was fed finely ground carnivore mix in meatballs and smelt filets. *"As he got older, the number of feeds per day was reduced. At two months of age he was fed twice a day."*

WEANING

The weaning process should be started when the pup shows interest in solid food, generally at about 6.5 to 8 weeks of age. If the pup is not gaining enough weight on formula alone, solid food can be added at six weeks of age (this may need to be pureed or chopped). To begin, formula can be mixed with AD diet (canned cat food or similar), baby food, mashed up fish, rice cereal, or ground meat. New food can be added to the bottle; feed this mixture with a syringe, baby bottle, or offer it in a bowl. Only add one new food component to their diet every couple of days until they are eating solids well. It is best to be creative, flexible, and not to rush the weaning process. In the case of problems, try different approaches, try them multiple times, and try foods in new ways like bottles, syringes, suction bulbs, bowls, etc. Do not cut back on bottle-feeding to make the pup "hungry". Offer new food at the beginning of the feeding and finish with the bottle (Blum 2004). Situations to watch for during the weaning process include (Blum 2004): weight loss, diarrhea and sucking behavior. If sucking on tails, feet, genitals, etc. is observed between feedings, an additional bottle-feeding should be offered for a few days. R. Green of the Vincent Wildlife Trust recommends putting orange oil on the genitals to discourage sucking; this worked well with *Lutra lutra* and is not harmful to the otter (G. Yoxon, personal communication). Additional information on weaning pups is available in Section 3, Rehabilitation.

Young Animal Health Concerns

Otter pups can develop health issues suddenly, and they must be carefully watched for any change in behavior. Some problems that have developed in young hand-reared pups are listed below with suggested first-step solutions or treatments. The following recommendations and cautions come from P. Blum (unpublished Florida Aquarium data).

Dehydration/emaciation: Give subcutaneous or oral (only if sucking well) electrolytes. Lactated Ringers Solution (LRS) with 2.5% dextrose or sodium chloride (0.8% NaCl) are recommended. Oral fluids are given at the dose of 5% body weight per feeding. The dose for subcutaneous fluids is determined by the level of dehydration, and should be determined by a veterinarian.

Diarrhea/constipation: Digestive upset is a common issue with hand-reared neonates, and may be associated with several factors (Meier 1985): a) inappropriate milk formula; b) feeding frequency; c) overfilling the stomach which can cause bloating; and d) rapid changes in the diet. When digestive upset occurs, characterized by diarrhea, bloating, inappetance, and/or extreme disorientation, it is recommended that one factor is analyzed and/or changed at a time. The veterinarian should be consulted immediately in the case of diarrhea, as the condition of very young animals can deteriorate rapidly.

- **Diarrhea** related to diet changes may be treated with Kaopectate® with veterinary approval. It should be noted that Kaopectate® now contains salicyclic acid (aspirin), as does Pepto-Bismol®, and gastrointestinal bleeding may result from frequent doses. Persistent diarrhea, or loose stool accompanied with inappetance requires continuous veterinary care. Bacterial infections or parasites, such as Coccidia may be the cause of the problem and require specific medication. Osmann (personal communication) recommends the administration of *Lactobacillus spp*. into the formula for *P. brasiliensis* pups with diarrhea, or after antibiotic treatment. Veterinarians should consider this for all otter species.

- **Constipation** may be treated by diluting the formula to half-strength for 24 hours, and gradually increasing back to full-strength over a period of 48 hours. The pup also can be given oral electrolyte fluids at the rate of 5% body weight in between feedings, and 1-2 times over a 24-hour period. The pup's back end can be soaked for a few minutes in warm water (make sure to dry off completely) accompanied by gentle stimulation, but care should be exercised that the anal area is not irritated.

Upper respiratory infections: Pups that have been eating normally and suddenly start chewing on the bottle or seem uninterested in the bottle may have an upper respiratory infection. They cannot nurse properly when congested. Upper respiratory infections need to be treated immediately. Newborn pups can die within 24 hours of the first symptom. Antibiotics should be started at the first sign of infection.

- **Antibiotics** can be given orally or injected. Care should be taken with the location of injections to avoid the sciatic nerve in their rear limbs (in two cases where limb mobility was affected due to injection site, the lameness/paralysis was resolved over time). Pups on antibiotics may also develop GI problems and/or get dehydrated, and this should be treated accordingly. Antibiotics that have been used successfully for upper respiratory infections are listed below. Antibiotics should not be given without consulting a veterinarian first.

> Enrofloxacin: injectable at 5mg/kg BID IM
> Amoxicillin: 20mg/kg BID PO
> Penicillin G Procaine: 40,000-44,000 IU/kg q24 hr IM

Bloat: Some otter pups have developed bloat. Care must be taken to ensure that there is no air in the formula or any leaks in the bottles. The amount of formula fed at each feeding should be re-evaluated as the pup may be receiving too much. Reducing the amount fed per feeding and adding another feeding should be considered. Watch for respiratory distress as respiration may become labored with severe abdominal distention. Treatment options for bloat include passing tubing to decompress, or the use of over-the-counter medication. Infant gas drops have been tried with no effect. Care should be taken with the use of certain gastric coating agents, such as bismuth subsalicylate (Pepto-Bismol®), as some ingredients may create more problems.

Fungal infections: Caretakers should look for hair loss and discoloration of skin, and should pull hair samples and culture for fungus using commercially available fungal culture media. At first appearance, fungal infections can be treated with shampoos and creams, and shaving the affected areas can also help. Severe infections may need to be treated with oral/injectable medication.

Parasites: Fecal samples should be taken regularly from otter pups (specifically hand-reared pups), even if they are negative. Pups should be dewormed as needed, and treatment started immediately to avoid any weight loss.

Bite/puncture wounds: Any bite or puncture wounds should first be cleaned and flushed with fluids, and then treated with topical antibiotic and systemic antibiotics if necessary.

L. CANADENSIS : HAND-REARED VERSUS MOTHER-REARED PUP WEIGHTS - TABLE

The following table provides a comparison of hand-reared versus mother reared pup weights taken from several institutions to be used as a guideline.

L. canadensis : Hand-reared versus Mother-reared Pup Weights - Table

Age in Days	LO* 100645	LO* 100646	LO* 100647	LO** 100651	LO** 100652	LR 3762	LR 3763	LR 3764	LR 4177	LR 4178	JBZ 301165	JBZ 301169	JBZ 301561	JBZ 301560	JBZ*** females
1	110.0g	118.0g	110.0g		170.0g	170.0g	170.0g	168.0g	168.0g	168.0g					
2	106.0g	120.0g	109.0g	177.0g	184.0g	177.0g	190.0g	179.0g	182.0g						
3	103.7g	119.7g	114.3g	220.0g	220.0g	198.0g	204.0g	193.0g	193.0g						
4	107.6g	123.7g	115.3g	241.0g	241.0g	213.0g	221.0g	204.0g	213.0g						
5	111.4g	127.0g	116.5g	276.0g	255.0g	248.0g	263.0g	241.0g	249.0g						
6	113.5g	135.5g	123.5g	298.0g	291.0g	262.0g	291.0g	249.0g	272.0g						
7	113.7g	138.0g	115.0g	333.0g	326.0g	298.0g	322.0g	266.0g	286.0g						
8	113.2g	137.4g	124.4g	354.0g	354.0g	333.0g	344.0g	288.0g	308.0g						
9	110.5g	135.8g	122.5g	376.0g	376.0g	347.0g	372.0g	325.0g	347.0g						
10	111.6g	142.4g	135.6g	404.0g	404.0g	383.0g	397.0g	353.0g	364.0g						
11	115.3g	145.7g	137.0g	425.0g	418.0g	397.0g	412.0g	364.0g	378.0g						
12	123.0g	165.5g	152.5g	453.0g	446.0g	411.0g	445.0g	398.0g	414.0g						
13	122.0g	173.2g	159.4g	475.0g	467.0g	439.0g	473.0g	414.0g	431.0g						
14	136.0g	195.0g	176.2g	496.0g	496.0g	454.0g	459.0g	428.0g	448.0g						
15	147.0g	223.0g	200.5g	539.0g	531.0g	489.0g	498.0g	437.0g	462.0g						
16	152.5g	240.0g	220.0g	574.0g	560.0g	517.0g	554.0g	454.0g	468.0g	499.0g			533.0g	672.0g	
17	171.5g	256.0g	240.5g	595.0g	595.0g	546.0g	560.0g	473.0g	512.0g	532.0g					
18	183.6g	296.5g	271.5g	624.0g	617.0g	560.0g	599.0g	496.0g	526.0g						
19	199.5g	321.0g	290.0g	645.0g	624.0g	609.0g	633.0g	515.0g	535.0g						
20	218.5g	346.0g	305.5g	680.0g	666.0g	637.0g	636.0g	549.0g	568.0g						
21	233.0g	367.0g	330.0g	440.0g	450.0g	687.0g	687.0g	652.0g	672.0g	566.0g					
22	252.0g	397.0g	352.0g	483.8g	478.5g	780.0g	765.0g	723.0g	694.0g	619.0g			721.0g	912.0g	
23	280.0g	429.0g	388.0g	484.0g	492.0g	808.0g	780.0g	723.0g	734.0g	622.0g					
24	309.0g	467.0g	388.0g	520.0g	515.5g	843.0g	822.0g	758.0g	756.0g	644.0g					
25	343.0g	500.0g	453.0g	575.0g	543.0g	858.0g	822.0g	772.0g	806.0g	669.0g					
26	346.0g	490.6g	473.4g	570.5g	545.5g	872.0g	829.0g	772.0g	829.0g	711.0g					
27	367.0g	530.0g	483.5g	594.0g	565.1g	872.0g	850.0g	794.0g	871.0g	736.0g					
28	372.0g	535.0g	484.5g	621.6g	592.1g	886.0g	865.0g	815.0g	890.0g	756.0g	862.0g	907.0g			
29	412.0g	595.0g	560.0g	658.0g	610.0g	921.0g	907.0g	872.0g	913.0g	840.0g			952.0g	1.18kg	
30	448.0g	643.0g	553.0g	665.0g	637.0g	978.0g	935.0g	907.0g	969.0g	879.0g					
31	473.2g	660.6g	607.0g	725.0g	680.0g	999.0g	971.0g	928.0g	1.00kg	935.0g					
32	491.0g	652.8g	622.3g	733.6g	690.5g	1.04kg	992.0g	971.0g	1.04kg	969.0g					
33	510.0g	676.0g	632.1g	753.0g	725.0g	1.09kg	1.00kg	921.0g	998.0g	1.09kg	953.0g	1.09kg			
34	543.0g	735.0g	658.5g	801.2g	796.0g	1.11kg	1.08kg	1.01kg	1.13kg	1.04kg					

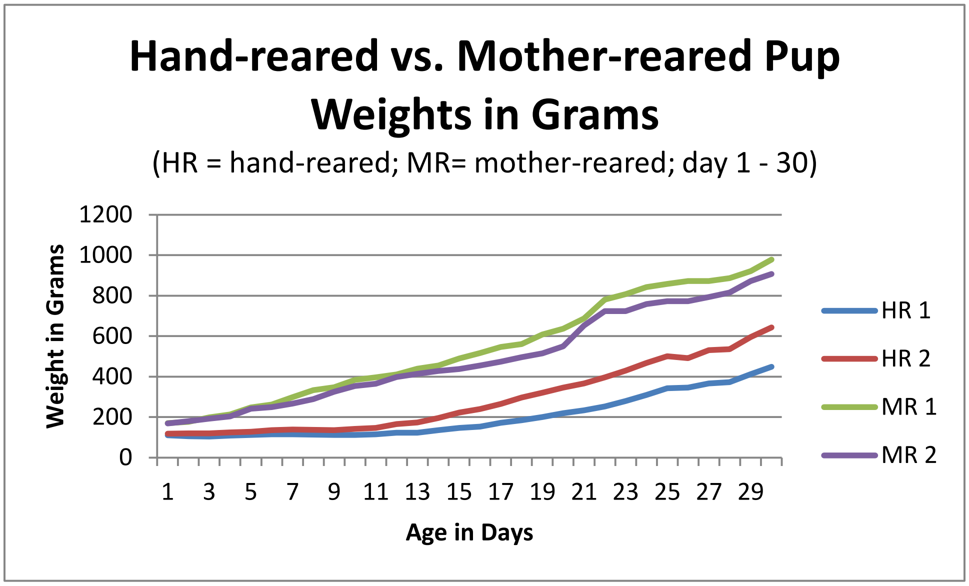
* Hand raised ** Wild born then hand raised, estimate as to age. *** Weights for four female pups born at JBZ, lightest weight recorded for that particular day, may be from different pups. All four pups survived to adulthood. There is no indication why the LO** pups show such a drastic weight change on day 21

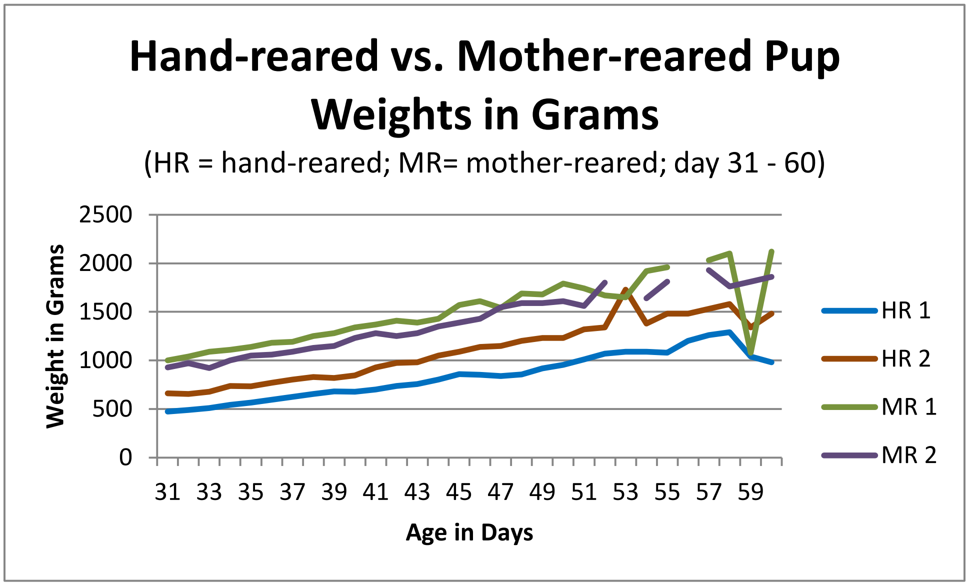
L. canadensis : Hand-reared versus Mother-reared Pup Weights – Table (cont.)

Age in Days	LO* 100645	LO* 100646	LO* 100647	LO** 100651	LO** 100652	LR 3762	LR 3763	LR 3764	LR 4177	LR 4178	JBZ 301165	JBZ 301169	JBZ 301561	JBZ 301560	JBZ*** females
35	564.0g	733.0g	688.0g	808.0g	783.0g	1.14kg	1.11kg	1.05kg	1.15kg	1.06kg	998.0g	998.0g			
36	595.0g	771.0g	725.5g	878.0g	838.0g	1.18kg	1.13kg	1.06kg	1.20kg	1.09kg			1.23kg	1.53kg	
37	625.0g	802.0g	760.0g	913.5g	903.5g	1.19kg	1.16kg	1.09kg	1.22kg	1.14kg					
38	654.2g	828.7g	814.0g	957.0g	898.0g	1.25kg	1.21kg	1.13kg	1.28kg	1.18kg					
39	678.6g	820.0g	827.7g	998.0g	916.0g	1.28kg	1.23kg	1.15kg	1.33kg	1.20kg					
40	677.2g	844.8g	813.5g	1.01kg	951.0g	1.34kg	1.28kg	1.23kg	1.37kg	1.26kg					
41	700.0g	926.8g	865.9g	1.08kg	977.7g	1.37kg	1.35kg	1.28kg	1.39kg	1.25kg	1.20kg	1.30kg			
42	736.9g	972.6g	918.7g	1.11kg	1.02kg	1.41kg	1.32kg	1.25kg	1.43kg	1.29kg					
43	754.8g	980.0g	900.8g	1.12kg	1.07kg	1.39kg	1.35kg	1.28kg	1.46kg	1.31kg					
44	802.0g	1.05kg	981.0g	1.18kg	1.09kg	1.43kg	1.40kg	1.35kg	1.49kg	1.33kg					
45	856.5g	1.09kg	997.0g	1.21kg	1.12kg	1.57kg	1.45kg	1.39kg	1.55kg	1.39kg	1.32kg	1.45kg			
46	852.4g	1.14kg	1.04kg	1.20kg	1.25kg	1.61kg	1.51kg	1.43kg	1.42kg	1.42kg					
47	837.6g	1.15kg	1.08kg	1.29kg	1.61kg	1.54kg	1.47kg	1.62kg	1.45kg	1.39kg					
48	853.7g	1.20kg	1.15kg	1.38kg	1.30kg	1.69kg	1.59kg	1.51kg	1.62kg	1.46kg					
49	917.5g	1.23kg	1.19kg	1.40kg	1.30kg	1.68kg	1.59kg	1.59kg	1.65kg	1.50kg					
50	952.5g	1.23kg	1.19kg	1.41kg	1.32kg	1.79kg	1.69kg	1.61kg	1.69kg	1.53kg					
51	1.01kg	1.32kg	1.26kg	1.47kg	1.39kg	1.74kg	1.62kg	1.56kg	1.77kg	1.59kg			1.76kg	2.07kg	
52	1.07kg	1.34kg	1.27kg	1.12kg	1.87kg	1.67kg	1.53kg	1.80kg	1.62kg	1.60kg					
53	1.09kg	1.73kg	1.61kg	1.84kg	1.63kg	1.65kg									
54	1.09kg	1.38kg	1.28kg	1.50kg	1.40kg	1.92kg	1.74kg	1.64kg	1.85kg	1.68kg					
55	1.08kg	1.48kg	1.38kg	1.46kg	1.46kg	1.96kg	1.71kg	1.81kg	1.90kg	1.72kg	1.63kg	1.72kg			
56	1.20kg	1.48kg	1.39kg	1.80kg	1.51kg				1.90kg	1.74kg	1.54kg	1.68kg			
57	126kg	1.53kg	1.44kg	1.48kg	1.48kg	2.03kg	1.72kg	1.93kg	1.93kg	1.78kg	1.59kg	1.72kg	2.04kg	2.27kg	
58	1.29kg	1.58kg	1.48kg			2.10kg	1.87kg	1.76kg							
59	1.04kg	1.34kg	1.34kg	2.09kg	1.90kg	1.80kg	1.63kg	1.81kg			1.633kg	1.81kg			
60	980.0g	1.48kg	1.46kg	1.80kg	1.70kg	2.12kg	1.93kg	1.86kg							
61	1.10kg	1.54kg	1.48kg	1.90kg	1.80kg	2.15kg	2.00kg	1.84kg							
62	1.34kg	1.51kg	1.40kg	1.90kg	1.85kg	2.24kg	1.95kg	1.88kg							
63	1.50kg	1.90kg	1.12kg	1.90kg	1.90kg	2.25kg	1.20kg	1.91kg	1.59kg	1.81kg	1.59kg	1.81kg			
64	1.60kg	1.80kg	2.0kg	1.90kg	2.26kg	2.00kg	1.93kg						2.04kg	2.27kg	
65	1.60kg	1.90kg	1.80kg	2.0kg	1.90kg	2.23kg	2.01kg	1.96kg	1.66kg	1.81kg	1.66kg	1.81kg			

* Hand raised ** Wild born then hand raised, estimate as to age. *** Weights for four female pups born at JBZ, lightest weight recorded for that particular day, may be from different pups. All four pups survived to adulthood. There is no indication why the LO** pups show such a drastic weight change on day 21

Hand-reared versus Mother-reared Pup Weights in Grams – Graphs
There is no explanation for the dramatic weight shifts in Mother-reared (MR 2) pup, possibly due to scale error. The data is taken from the previous chart. Weights of hand-reared pups should be catching up to those of mother-reared by 60+ days or once they are weaned.





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CHAPTER 9 Feeding and Nutrition

"Wild animals require the same basic nutrients as their domestic counterparts. For many exotic species that have closely related domestic counterparts (e.g. …mustelids…), nutrient requirements established by the National Research Council (NRC) for domestic and laboratory animals can be a guide to minimum nutrient concentrations in the diet. Although less directly applicable to other species, NRC requirements can still serve as a useful general reference for evaluating the nutritional adequacy of diets for any bird or mammal." (Merck 1991)

General Guidelines

The target nutritional values for otters are based on several sources. The cat is typically used to establish nutrient guidelines for carnivorous animals. The National Research Council (NRC) (1986, 2006), Association of American Feed Control Officials (AAFCO) (1994), and Waltham Center for Pet Nutrition (Earle & Smith 1993) have provided recommendations for cats. A limited amount of information is provided by the NRC publication for mink and foxes (1982), which represents the requirements of another mustelid species. The target nutrient values presented (Maslanka & Crissey 1998) are a range of values reported from various references. As new information becomes available, these ranges will change to reflect knowledge gained. Table 1 lists dietary nutrient ranges for otters. Table 2 contains updated information on feline nutritional requirements based on NRC recommendations published in 2006. The original target values have been retained for comparison. See Dierenfeld et al. (2002) for information on nutrient composition of whole vertebrate prey.

It is essential that good quality foods be offered. Long storage times of frozen foods (over 6 – 12 months depending on the food item) should be avoided. Bagged feeds should be stored less than one year (Merck 1991). Specific guidelines for the inspection and handling of fish and/or meat products can be found in the UDSA publications: Crissey and Spencer, 1998.

Primarily piscivorous, otters have high metabolic rates, rapid digestion, and have been found to spend 41-60% of their time involved in feeding or foraging activities (Hoover & Tyler 1986; Davis et. al 1992; Kruuk 1995; J. Reed-Smith, unpublished data). Duplaix-Hall (1975) found that otters (unidentified species) in the wild rarely ate more than about 500g of food at a time and that they consumed approximately 20% of their own body weight daily. Kruuk (1995) reviewed his and other study results indicating that *ex-situ* populations of *Lutra lutra* consuming between 11.9-15% of their body weight maintained a healthy weight. A study conducted by Ben-David et al. (2000, 2001a and b) reported success using 10% of a *L. canadensis'* (*ex-situ* population) body weight as a guide for the basis of their maintenance diet. In general, otters are very active animals and as such require nutrient dense diets. Fats are an important source of energy for these animals (Wallach & Boever 1983). Given the rapid transit time of food through their intestinal tract (see below), and the generally high activity level of otters, frequent, smaller feedings will help encourage activity, and eliminate concerns over food spoiling before it is consumed.

Clean, fresh drinking water should be available at all times. If an otter refuses two or more meals consecutively, they should be monitored for potential health problems.

Wild Feeding Habits

As previously stated, free-ranging North American river otters are reported to spend 41-62% of their time engaged in foraging and feeding activities (Hoover and Tyler 1986) in a primarily aquatic habitat. As a general rule, otters will first prey on those species easiest to catch and stay in shallow waters or near the shore. (Sheldon & Toll 1964, Knudsen & Hale 1968, Toweill & Tabor 1982)

N. A. otters are predominantly piscivorous. Researchers have found that the bulk of their diet consists of fish and crustaceans (crayfish); a minor portion of their diet consists of: amphibians (frogs, salamanders, newts and mud-puppies), reptiles, birds (most frequently ducks and divers), aquatic insects, mollusks, and occasionally small mammals (Chanin 1985, Berg 1999). The percentage of crayfish varies seasonally and with geographic location (Grenfell 1974, Chanin 1985, Toweill & Tabor 1982,) becoming the primary prey choice during most of the year. Also see: Feeding Behavior under Natural History.

H. Hansen provided an excellent overview of wild N. A. river otter diet studies in her 2003 dissertation (University of Wyoming); an excerpt is below:

River otters consume a wide variety of fish species ranging in size from 0.8 to 19.5in (2 to 50cm) that provide adequate calorie intake from a small amount of energy expenditure (Melquist and Dronkert 1987). Ryder (1955) stated that river otters feed predominantly on prey in proportion to their abundance but in inverse proportion to their swimming ability. Therefore, slow swimming fishes are preyed upon more often than game fishes when both are equally abundant (Serfass et al. 1990; Toweill and Tabor 1982). Slow-moving fishes include suckers (Catostomidae); sunfishes and bass (Centrarchids); and daces, carp and shiners (Cyprnidae) (Route and Peterson 1988). For example, Berg (1999) found Catostomidae to dominate the diet in the Upper Colorado River Basin in Colorado. Likewise, in other regions of Colorado, Beck (pers. comm.) found common carp (Cyprinus carpio) to be a preferred fish species for the otter.

Some specific examples of fish species that have been found frequently in the otters' diet include: Catostomidae - suckers (Catostomus spp) and redhorses (Moxostoma spp); Cyprinidae - carp (Cyprinus spp), chubs (Semotilus spp), daces (Rhinichthys spp), shiners (Notropis spp and Richardsonius spp) and squawfishes (Ptychocheilus spp); Ictaluridae - bullheads and catfishes (Ictalurus spp). Other fishes that are important in the otters' diet include: fishes that are often abundant and found in large schools such as sunfishes (Lepomis spp), darters (Etheostoma spp) and perches (Perca spp); and bottom dwelling species that are susceptible because of their habit of remaining immobile until a potential predator is close such as mudminnows (Umbra limi) and sculpins (Cottus spp.) (Melquist and Hornocker 1983; Toweill 1974; Toweill and Tabor 1982).

Game fishes, such as trout (Salmonidae) and pike (Esocidae), are not an important part of the river otters' diet (Melquist and Dronkert 1987; Toweill and Tabor 1982). Game fishes are fast-swimming and can find good escape cover, making them less available as prey for the otters (Melquist and Dronkert 1987). However, river otters will
eat trout (Salmo spp), pike (Esox spp), walleye (Stizostedion vitreum), salmon (Oncorhynchus spp), and other game fishes during spawning (Melquist and Hornocker 1983; Reid et al. 1994; Toweill 1974).

Adult river otters can consume 1 – 1.5 kg (2 – 3 lb) of fish per day (Serfass et al. 1990)

Crustaceans
Across North America where crustaceans, especially crayfish (Cambarus spp, Pacifasticus spp, and others), are locally and seasonally abundant, otters may prefer to feed on them more than fish (Route and Peterson 1988). In Georgia, crayfish constituted 2/3 of the prey items in the summer diet and were present in 98% of the summer spraint. In the winter, crayfish constituted 1/3 of the otters' diet (Noordhuis 2002). Tumlison and Karnes (1987) documented a shift in the river otters' diet from fish to crayfish with a shift in water levels in a swamp in Arkansas. During the winter and spring when the water levels were higher, otters preferred to feed on crayfish (73% of scats had crayfish remains) more than fish (Tumlison and Karnes 1987). However, during low water events, crayfish will seek out shelter while fish become more concentrated and highly vulnerable. Therefore, fish are more susceptible to being preyed upon by otters because the easier-to-catch crayfish are more difficult to obtain (Route and Peterson 1988).

Conclusion
River otters' food habits are determined by prey availability (Ryder 1955). This availability may be determined by the following factors: (1) detectability and mobility of the prey; (2) habitat availability for various prey species; (3) environmental factors such as water depth and temperature; and (4) seasonal changes in prey abundance and distribution in relation to otter foraging habitat (Melquist and Dronkert

1987; Route and Peterson 1988). Otters do not seriously reduce prey populations. When an abundant food source diminishes or other prey become available, otters either move to a new location or shift their diet to the most available prey (Melquist and Hornocker 1983). Although other prey species are important to the river otter temporally, the potential limiting factor to the river otter being established as a permanent resident is the availability of fish year-round (Melquist and Hornocker 1983).

GI-TRACT MORPHOLOGY

Otters are semi-aquatic carnivores. As in other mustelids, they possess a simple stomach. They may have a somewhat elongated small intestine like the mink. They do not have a cecum. (Steven and Hume, 1996)

Digestion

Davis et. al. (1992) and Spelman et al. (1997) report that gastrointestinal transit time for a fish meal took anywhere from 2 to 4 hours with a mean of 202 minutes. In 1951, Liers tested otters previously fed a bland diet and found that the exoskeletal remains of crayfish were passed about one hour after consumption.

Target Nutrient Ranges and Nutrient Content of Dietary Component Samples

TARGET DIETARY NUTRIENT VALUES FOR A FISH-EATING SPECIES.

Much of this information is similar to that reported for Asian small-clawed otters (Maslanka and Crissey, 1998). Target values for otters are based on several sources. The cat is typically used to establish nutrient guidelines for carnivorous animals. The NRC (1986), AAFCO (1994), and Waltham Center for Pet Nutrition (Earle and Smith, 1993) have provided recommendations for cats. A limited amount of information is provided by the NRC publication for mink and foxes (1982), which represents the requirements of another mustelid species. The target nutrient values presented here (Table 1 & Table 2; Maslanka and Crissey, 1998; Henry and Maslanka, 2010) are a range of values reported from various references. As new information becomes available, these ranges will change to reflect knowledge gained.

Energy requirements for otters have not been determined specifically, however dietary energy target values can be based on diets successfully used to maintain captive otters (Table 1). According to survey information (Reed-Smith 1997, Foti 2010), most institutions offer food two or more times per day. Where seasonal dietary alterations occur (in approximately one half of the responding institutions), most involve diet increases during the winter months.

(Photo: P. B.um, Florida Aquarium, First fish.)

Table 1: Target dietary nutrient ranges for North American River Otters.

Item	Target Nutrient Range*
Energy, kcal/g	3.6-4.0
Crude Protein, %	24-32.5
Fat, %	15-30**
Vitamin A, IU/g	3.3-10***
Vitamin D, IU/g	0.5-1.0
Vitamin E, mg/kg	30-120 (α)
Thiamin, mg/kg	1-5 (α)
Riboflavin, mg/kg	3.7-4.0
Pantothenic Acid, mg/kg	5-7.4
Niacin, mg/kg	9.6-40
Pyridoxine, mg/kg	1.8-4.0
Folic Acid, mg/kg	0.2-1.3
Biotin, mg/kg	0.07-0.08
Vitamin B12, mg/kg	0.02-0.025
Choline, mg/kg	1000-3000
Calcium, %	0.6-0.8 (β)
Phosphorus, %	0.6 (β)
Potassium, %	0.2-0.4
Sodium, %	0.04-0.06
Magnesium, %	0.04-0.07
Zinc, mg/kg	50-94
Copper, mg/kg	5.0-6.25
Manganese, mg/kg	5-9
Iron, mg/kg	80-114
Iodine, mg/kg	1.4-4.0

* Target nutrient ranges expressed on a dry matter basis derived from requirements for domestic cats (NRC 1986), AAFCO recommendations (1994), Waltham Center for Pet Nutrition recommendations (Earle and Smith 1993), and requirements for mink and foxes (NRC 1982).
** The fat content of fish commercially available in North America typically ranges from 5-40% (Maslanka and Crissey 1998), and North American river otters have been maintained on diets containing 24-30% fat (Reed-Smith 1994), thus an appropriate range for fat appears to fall between 15-30%.
*** The vitamin A requirement for cats is 10 IU/g (dry matter basis; NRC 1985), which represents the upper bound of the range. However, free-ranging North American river otters may consume a higher proportion of fish and may have a higher tolerance for vitamin A due to the high levels which may occur in their natural diet.
(α) When mostly fish diets are offered, the presence of unsaturated fatty acids and thiaminases causes the breakdown of these vitamins. Thus, dietary levels of 400 IU vitamin E / kg of dry diet and 100-120 mg thiamin / kg of dry diet are recommended (Engelhardt and Geraci 1978; Bernard and Allen, 1997). (β) The recommended Ca:P ratio is between 1:1 and 2:1.

Table 2: Target nutrient ranges for carnivorous species (dry matter basis) (Henry and Maslanka, 2010)

Nutrient	NRC 1986 Cat[1]	NRC 2006 Cat[2]			Arctic fox[3]	Mink[4]	Carniv[5]
	Maintenance	Growth	Maintenance	Gestation Lactation	Maintenance	Maintenance	All
Protein (%)	24-30	22.5	20	21.3-30	19.7-29.6	21.8-26	19.7-30
Fat (%)	9.0-10.5	9.0	9.0	15.0	--	--	9-15
Linoleic Acid (mg/kg)	0.5	0.55	0.55	0.55	--	--	0.5-0.55
Vitamin A (IU/g)	3.3-9.0	3.55	3.55	7.5	2.44	5.9	2.44-9
Vitamin D (IU/g)	0.5-0.75	0.25	0.25	0.25	--	--	0.25-0.75
Vitamin E (mg/kg)	27-30	38.0	38.0	38.0	--	27.0	27-38
Vitamin K (mg/kg)	0.1	1.0	1.0	1.0	--	--	0.1-1
Thiamin (mg/kg)	5.0	5.5	5.6	5.5	1.0	1.3	1-5.6
Riboflavin (mg/kg)	3.9-4.0	4.25	4.25	4.25	3.7	1.6	1.6-4.25
Niacin (mg/kg)	40-60	42.5	42.5	42.5	9.6	20.0	9.6-60
Pyridoxine (mg/kg)	4.0	2.5	2.5	2.5	1.8	1.6	1.6-4
Folacin (mg/kg)	0.79-0.8	0.75	0.75	0.75	0.2	0.5	0.2-0.8
Biotin (mg/kg)	0.07-0.08	0.075	0.075	0.075	--	0.12	0.07-0.12
Vitamin B_{12} (mg/kg)	0.02	0.022	0.022	0.022	--	0.032	0.02-0.032
Pantothenic acid (mg/kg)	5.0	6.25	6.25	6.25	7.4	8.0	5-8
Choline (mg/kg)	2400	2550	2550	2550	--	--	2400-2550
Calcium (%)	0.8-1.0	0.8	0.29	1.08	0.6	0.3-0.4	0.29-1.08
Phosphorus (%)	0.6-0.8	0.72	0.26	0.76	0.6	0.3-0.4	0.26-0.8
Magnesium (%)	0.03-0.08	0.04	0.04	0.06	--	--	0.03-0.08
Potassium (%)	0.4-0.6	0.4	0.52	0.52	--	--	0.4-0.6
Sodium (%)	0.05-0.2	0.14	0.068	0.132	--	--	0.05-0.2
Iron (mg/kg)	80.0	80.0	80.0	80.0	--	--	80
Zinc (mg/kg)	50-75	75.0	75.0	60.0	--	--	50-75
Copper (mg/kg)	5.0	8.4	5.0	8.8	--	--	5-8.8
Manganese (mg/kg)	5.0	4.8	4.8	7.2	--	--	4.8-7.2
Iodine (mg/kg)	0.35-0.42	2.2	2.2	2.2	--	--	0.35-2.2
Selenium (mg/kg)	0.1	0.4	0.4	0.4	--	--	0.1-0.4

[1] NRC (1986), Legrand-Defretin and Munday (1993), AAFCO (1994). All numbers are based on requirement set for maintenance.
[2] Dog and Cat NRC (2006).
[3] NRC (1982). Protein is range of growth and maintenance; vitamins are for growth, and minerals for growth and maintenance.
[4] NRC (1982). Protein is for maintenance, vitamins are for weaning to 13 weeks and minerals are a range of growing and maintenance.
[5] Combination of cat, mink, and fox

NUTRIENT CONTENT OF TYPICAL DIET INGREDIENTS.

As mentioned previously, several basic diet items (including fish and commercially available dry, canned, and frozen diets) have been used to maintain otters in captivity. Meat-based diets have been used in most institutions for growth, maintenance, and breeding. There is a variety of products upon which the diet may be based. Following are tables that describe nutrient concentrations in some commonly used manufactured products that are intended to be nutritionally complete (Maslanka and Crissey, 1998).

Nutrient content of several commonly used meat/nutritionally complete food items (dry matter basis).[a]

Nutrient	Ground horsemeat	Nebraska Feline ®
Crude protein, %	51.7	50.0
Fat, %	19.7	31.6
Vitamin A, IU/g	-	97.1
Vitamin D, IU/g	-	1.2
Vitamin E, mg/kg	-	42.4
Ca, %	-	1.6
P, %	-	1.3
Mg, %	-	0.05

[a] Values from manufacturers' guaranteed analysis and analyses performed at or for Brookfield Zoo.

Nutrient	Toronto Zoo Feline Diet*	Toronto Carnivore Diet	Dallas Crown Diet
Protein % (min.)	50	50	30, 56 expected(exp)
Fat % (min.)	20	25	10, 20% exp.,40 max.
Crude Fibre % (max.)	6	4	3
Calcium % (min.)	0.8	0.7	1.3
Phosphorus % (min.)	0.7	0.6	1.2
Magnesium %	0.09	0.07	0.09
Iron ppm.	160	190	80, exp. 183
Zinc ppm.	120	170	110
Taurine %	0.2		0.3
Vit. A IU/kg	11,000	18,000	14,000
Vit. E IU/kg	200	170	470
Vit. D IU/kg	2,160	3,540	2400

***** Manufactured by: Milliken Meat Products, Ltd. of Ontario, Canada. ^ Manufactured by Dallas Crown, Inc., Kaufman, Texas.

Nutrient content of several commercially available fish species and marine products (dry matter basis).[a] (Values vary with each shipment and provider.)

Nutrient	Capelin	Herring	Oyster shell	Shrimp[17,19]	Smelt	Trout
Dry matter, %	18.8	27.7	100	24.1	22.7	23.7
GE, kcal/g	5.5	6.3	-	2.3	7.0	6.5
Crude protein, %	59.8	45.3	0	20.5-44.2	70.4	55.8
Fat, %	14.8	34.0	0	1.8-4.3	16.6	34.5
Vitamin A, IU/g	44	56	0	-	-	58
Vitamin E, IU/g	0.024	0.034	0	-	-	0.32
Ca, %	1.7	1.7	38.0	10.8	1.4	2.1
P, %	1.7(1.2-1.4)[b]	1.3	0.07	2.1	1.6	1.5

[a]Analyses from Bernard and Ullrey[3], Minnesota Zoo, and Brookfield Zoo, unless otherwise noted.
[b]Unpublished data from the Brookfield Zoo and Minnesota Zoo.

Sample Diets

The one best diet for any of the otters of *ex-situ* populations has not been found and requires further research. However, current recommendations are that a variety of fish species should be offered 3-4 times a week, preferably daily (AZA 2010). Only good quality, mostly fresh water fish, low in thiaminase and fat should be offered (Wünnemann 1995a). The fish source(s) and/or vendor(s) should be examined closely to assess their handling practices, ensure that HACCP (Hazard Analysis and Critical Control Point) guidelines are being met, and, that the fish is considered human grade. Historical use of a type of fish by zoos and aquariums does not ensure it is an adequate diet ingredient, and only careful inspection of handling practices and the fish itself ensures consistent safety and quality. Most diets currently include horsemeat products, or alternative beef-based products which are available in addition to nutritionally complete dry and wet cat foods.

The diets of several institutions are listed below. This is just a sampling of diets being fed *L. canadensis*. Where available, comments on palatability to the otters, any associated dietary problems and observed physical condition of the animals are noted.

DIETS FROM THE LITERATURE

Liers' Diet (1951)
His mixture was: "*74% ground horse meat, ½% ground raw liver, 2% bone meal, 8% bran, ½% grated carrots, tomatoes, or lemon or orange juice, 10% raw rolled oats, and 5% commercial mink meal. To this I add one teaspoonful of cod liver oil per day per otter, one ounce of brewer's yeast per day per ten otters, one egg a day for each two otters. The entire concoction is mixed thoroughly with enough whole liquid milk to make a soft mash.*" When fresh food was available, such as frogs, crayfish or fish, they were fed as well.

Duplaix-Hall (1975)
Due to their high metabolic rate and rapid digestion, otters *"…eat up to 20 per cent of their own weight daily."* Because an adult will normally eat no more than 500 g (17.5 oz.) of food at a time, otters should be fed at least twice, preferably three times a day. She suggests feeding day-old chicks, and some fish to supply the necessary roughage. The following amounts are given by her as the food requirements per otter per day:

Chopped raw beef or horse meat	1500g.	Dog meal	200g.
Osteo-calcium	1 tablet	Halibut liver oil	4 drops
Soluble multi-vitamins	3 drops	Bone meal	50g.
Bran	50g.	Raw carrot	50g.
Vegetable oil or margarine	50g.	Day-old chicks	4
Fish (6 – 10") or eels	4		

ZOO AND AQUARIUM DIETS (1990'S AND 2000'S)

Example 1(Reed-Smith 1997)
Fed at least three times a day, sometimes four or five times per day. These additional feedings are fish, rib bones, hard-boiled eggs, mice, or live fish as enrichment items offered on a limited basis above and beyond their normal diet. The amount of feline diet is increased only when the female is lactating (for her, fish also is increased), or rarely, as an enrichment treat hidden around the exhibit or frozen in small meat balls. Anecdotally, it has been found

that the addition of extra fish (the diet was fish 2x/week) has improved their coats' water repellency but not caused them to add weight.

142 g (5 oz.) Nebraska Feline Diet – 2x/day, 7x/week.
½ medium carrot – 1x/day scattered on exhibit.
2 rib bones – 1 to 2x/week.
1 medium sized trout – 4x/week.

Example 2 (Reed-Smith 1997)

Daily: 3 – 3 ½ lbs. capelin or smelt, Vitamins B, E, and Pet Tabs added.
The respondent stated after switching to this diet, from a diet of meat and pellets, their animals no longer had any dental problems.

Example 3 (Reed-Smith 1997)
Their otters are fed a diet of fish (approximately 75%), and Nebraska Brand Feline Diet (approximately 25%). No supplements are added. The coats of both animals show good water repellency, the otter that generally refuses most of the feline has consistently had better dental hygiene.

Example 4 (Reed-Smith 1997)
Amounts vary with the animals' weight.
Toronto Diet: 200 to 300g (7 – 10.5 oz.) per feeding (400 - 600g (14 – 21 oz.) per day; mostly in the bottom half of that range (400 - 500g (14 – 17.5 oz.) per day.
Mackeral: One, every-other-day.
Derm-Caps

Example 5 (Reed-Smith 1997)
60% Toronto Feline Diet
40% fish (butterfish, capelin, herring or spot)
Daily they receive one or more of the following: mice, chicks, live fish, carrot, sweet potato, apple, hard-boiled egg.

Amounts vary with the condition and weight of the animal. Generally an adult diet is: *"... about 1 1/4 cup meat daily along with 4 capelin and 2 butterfish or herring. The otters are weighed weekly and amounts adjusted if needed. Usually one chick, one mouse, one egg each for the additional items. We give them 100iu Vitamin E and 25 mg Vit B-1 every third day."*

Example 6 (Reed-Smith 1997)
"I consider fish to be critical. I have seen many facilities offer otters only feline meat product with some vitamin supplements. We feed our otters whole smelt as their primary food source. They each also get two chicken breasts a day, and two whole mice. This provides a variety of items that mimics their natural diet. On top of that we add vitamins (Mazuri Marine Mammal vitamins). This combination has provided our river otters with excellent coats. During random times of the day, other food items are occasionally given to the otters to promote behavioral enrichment. This could be in the form of live minnows, fiddler crabs from our salt marsh, some fruits or veggies frozen in ice, etc...."

Example 7 (Reed-Smith 1997)
Amount fed differs for each animal, based on weight and age. Amounts given are the total for a 24 hour period, animals are fed four times a day. Two to three feedings per day are training sessions, at least one is a "free feed".

1.0 adult, weight: approximately 22 lb.
7 oz. (198.5 g) Hill's Science Diet-Feline Light
½ lb. (227 g) Capelin
¾ lb. (340 g) Lake smelt
4 baby carrots & ½ medium carrot
1 *Nature Made* Antioxidant capsule*
(this is given once daily)

0.1 7 ½ months, weight: approximately 14 lbs.
4 oz. (113 g) Hill's Science Diet – Feline Light
¾ lb. (340 g) Capelin
¾ lb. (340 g) Lake smelt
4 baby carrots
1 *Derm Cap* every other day^

* *Nature Made* Antioxidant formula capsules: Information available @ 1-800-276-2878 or www.naturemade.com

^ *Derm Cap*: DVM Pharmaceuticals, Inc., Miami, Florida

645mg. per capsule:	crude protein	not less than 7%
	crude fat	not less than 90%
	crude fiber	not less than 1%
	moisture	not less than 2%
	Vit. E	75 IU
	Linoleic Acid	71%
	Gamma Linolenic Acid	2%
	Eicosapentaenoic Acid (EPA)	4%
	Docosahexaenoic Acid (DHE)	3%

Example 8 (Reed-Smith 1997)
Amounts vary with the weight of the animal which varied from 8.7 to 9.7kg for the diets listed below. Listed here are the total amounts which are divided each day into three to six feedings and/or training sessions. Enrichment items are not given here.

Smelt	.7kg.	.8kg.	.7kg.
Clam	.3kg.	.4kg.	.3kg.
Shrimp	.3kg.	.3kg.	.2kg.

2 Mazuri Bird vitamin tablets per day.

Example 9 (AZA 2010)
The amounts of food items in the sample diet below are based on achieving a target weight for otters. The diet should be fed at least three times a day and 4-5 times if possible. These additional feedings can consist of the fish, rib bones, and enrichment/training feeds.

- 155g commercially prepared feline diet, 2 x day, 7 days a week
- 112g capelin, 1 x day
- 120g smelt, 1 x day
- 135g trout, 1 x day
- ½ medium carrot, 1 x day scattered
- 2 rib bones, ox tail, or similar 3 x week
- 25-35mg thiamin per kg of fish offered
- 100 IU vitamin E per kg of fish

Example 10 (AZA 2010)

- 13.5% capelin
- 14.5% smelt
- 16.3% herring
- 18.2% carrots
- 37.5% nutritionally complete cat food or beef-based product (IAMS® cat food used for analysis)
- 2 bones, 3 per week (rib, ox/horse tail, or similar)
- 25-35mg thiamin and 100 IU vitamin E per kg of fish fed

Example 11 (Montgomery 2012 personal communication)

- 825g smelt ± 25 – 50g (dependent on target weight for each otter, can go as high as 950g right before breeding season due to increase in activity; even though this is an all-male group)
- 75 – 200g peeled shrimp (dependent on individual; shrimp peeled due to a problem with possible choking on exoskeleton)
- 4 – 6 whole capelin
- 5g carnivore diet (just switched to horsemeat-based, will increase up to 10g only due to high fat and caloric content of the horse-based product. Fed up to 25g daily of beef-based carnivore diet)
- Live crayfish and fish several times per week, as enrichment

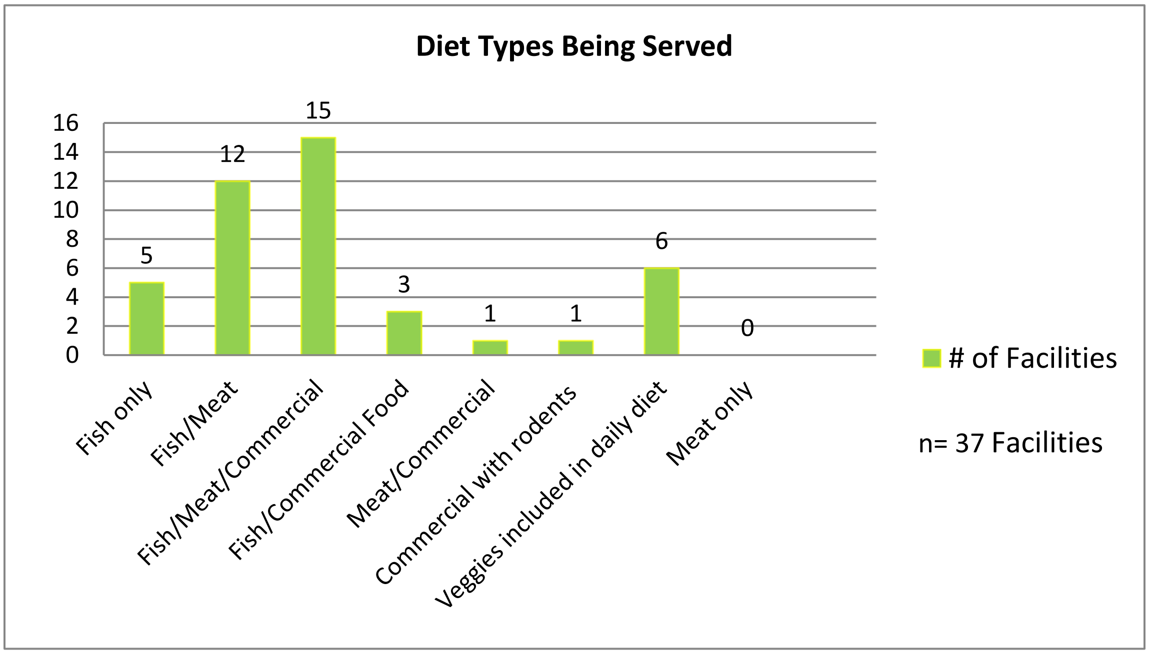
- Five days per week fed a "avian fish-eating vitamin tab" which will soon be switched to a marine mammal tab due to more appropriate Vitamin E levels.

Diet is offered spread out over 4 meals, roughly 2 to 2 ½ hours apart. If the otters refuse one meal this amount is not added to the total (they used to add it but once they allowed them to self-regulate by refusing a meal they found the animals' weights remained more consistent). (Editor Note: The otters fed this diet are 2 years, 14 years, and 14 years old. Their coats are in excellent condition, weights are good, and their teeth are in very good shape.)

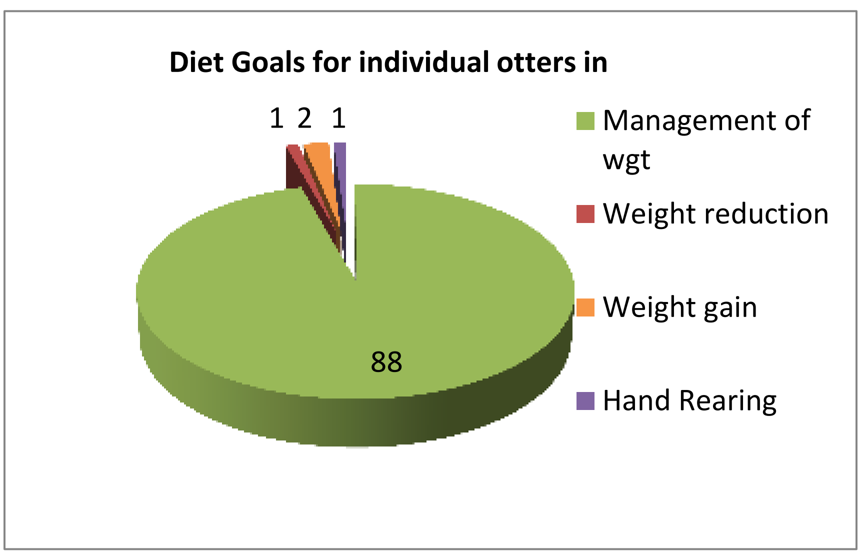
FOTI DIET SURVEY (2010)

Thirty-seven facilities participated in a diet survey, conducted by J. Foti and presented at 2010 AZA Otter Keeper Workshop, by contributing diet information for 93 N. A. river otters (age range 1 – 20 years; weight range 4 – 15 kg). A summary of the survey is presented here in chart form.

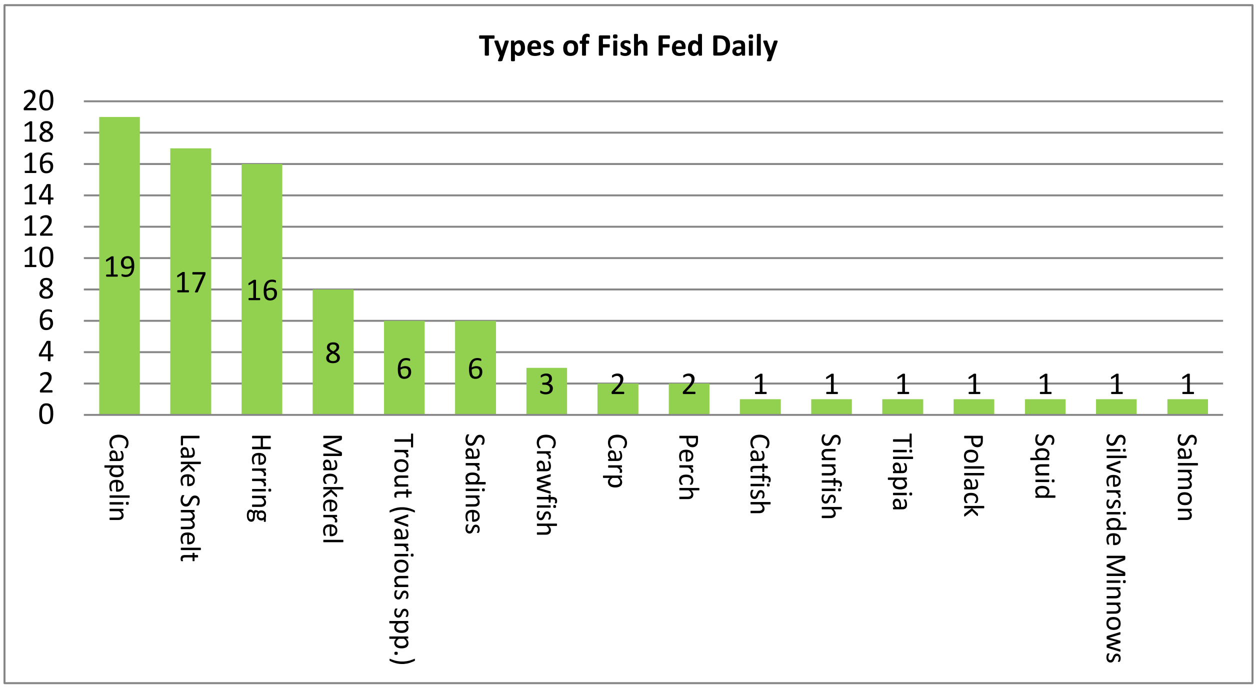
Diet Components (Fish: live and frozen; Meat: Nebraska and chicken; Commercially prepared food ranged from dog food to zoo prepared diets).



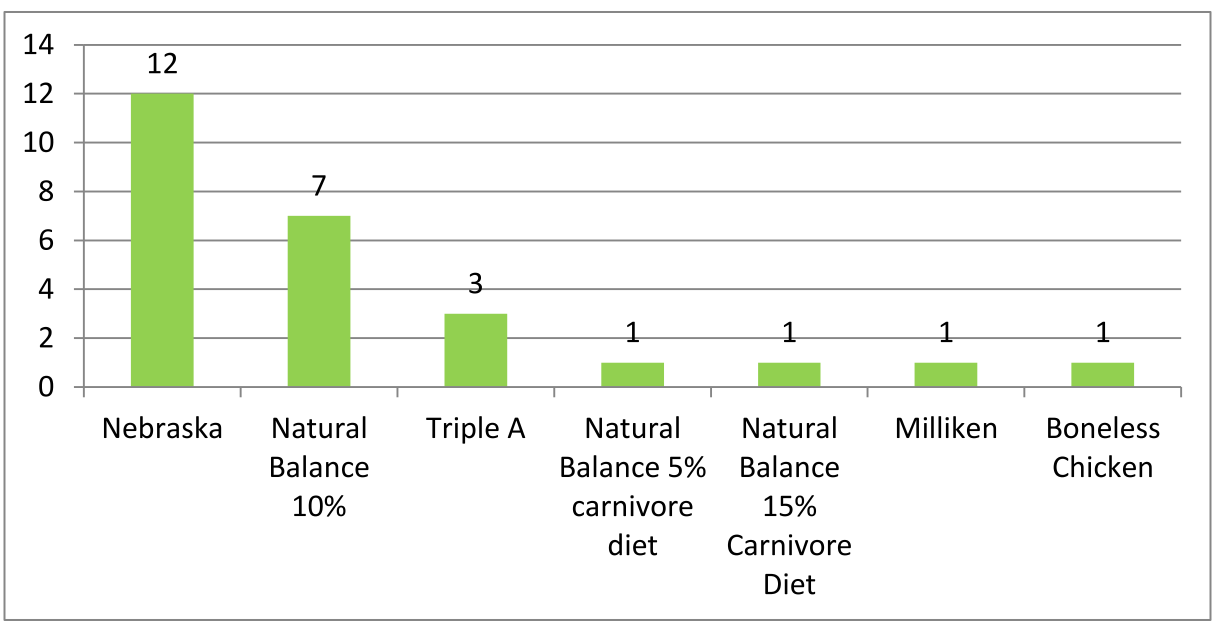
Diet Goals



Types of Fish Fed Regularly (n = 35 feed fish multiple times per week as part of diet)



Meat Products Offered (n = 25 that feed meat products as part of daily diet)



Commercially Prepared Diet Products (n = 20)

Cat Food:
Iams Feline Dry Food (2)
Blue Bonnet
Pro Plan Chicken and Rice Dry Food
Science Diet Hairball Diet
Iams Original Ocean Fish and Rice
Mazuri Exotic Feline Diet
Hills K/D canned cat food

Ferret Chow:
Mazuri Ferret Pellets (2)
National Mink Fur Pellets

Dog Food:
Purina Dog Chow (2)
Sport Mix
Science Diet Canine Maintenance Dry Food
Science Diet Canine Biscuits
EVO Dog Food
Mazuri Large Carnivore Diet

Other Prepared Diets:
Liers' Diet
Brave Meat Eater
Primate Biscuit

CHANGING NUTRIENT REQUIREMENTS

Age: An animal's diet should be developed to maintain optimal weight or weight gain and normal physical development for a young animal. Diets for young or senescent adults should take into account their activity level, dental development and/or body condition.

Pregnant/Lactating Female: A pregnant female's diet should be monitored closely and increased as necessary to maintain the dam's condition. The pregnant female requires more energy than the non-pregnant female. These requirements may increase up to 17 to 32% (Robbins 1993).

There is an increased need for energy during lactation. Tumanov & Sorina (1997) supported the use of high-energy diets for lactating female mustelids. Fat is the most concentrated source of energy in the diet. For lactating females, fat levels in the diet may be increased to support lactation and also to provide increased energy to minimize mobilization of body stores and metabolic stress associated with milk production. Diet increases for lactating otters should be based on past experiences with individual otters and/or observed body weight loss (mobilization of tissue to support lactation). To date, institutions have typically increased the amount of fish offered a lactating female versus simply increasing the fat content by switching the type of food offered. An increase of 10-30% is the accepted rule.

In practice, during the last trimester of gestation and through lactation, diet increases of 30% to three times maintenance may be necessary to maintain adequate growth of the pups and body weight of the dam (Reed-Smith 1994). Energy requirements will differ based on numerous variables (exhibit size, environmental temperature, individual activity patterns, stage of gestation/lactation, etc.), thus it is recommended that goal weights be established, animals weighed on a regular basis, if possible, and diet adjustments made based on observed body weight changes.

Seasonal Changes in Nutritional Needs: An animal's weight should be monitored regularly and diets adjusted accordingly. Some institutions report seasonal changes in appetite of some otters, but not in the majority of animals. Further research in this area is required. An animal's weight should be regularly monitored and diets adjusted accordingly. At this time, further research into seasonal nutritional requirements is required.

Weight Loss: While otters should carry some body fat and not be kept artificially thin, they are prone to gaining excessive weight in captivity. Tarasoff (1974) reported subcutaneous fat deposits primarily at the base of the tail and caudally on the rear legs, with smaller deposits around the genitalia and in the axillary regions (this is the normal placement of fat stores with some deposits in these areas considered desirable). There are several ways to approach formulating a weight loss diet for otters. Depending on the food items available, the feeding situation (fed alone or in a group), and the amount of weight loss desired, one or more of the following approaches may be appropriate.

Feed less total food: By reducing the amount of total food offered, weight loss may occur. This practice is confounded by the aggression observed in most otter groups around feeding time and the potential for this to increase when less food is offered.

Add more water to the diet: By providing a diet that contains more moisture, the total calories in the diet are diluted and this may allow for weight loss. The otter can consume the same amount of total diet, but will actually be consuming fewer calories.

Increase the "bulk" of the diet: By adding indigestible or lower calorie items to the diet, the total "bulk" of the diet can be increased, effectively diluting the calories in the diet. The otter can consume the same amount of total diet, but will actually be consuming fewer calories.

Offer lower calorie items: Lower calorie items can be substituted in the diet. For example, fish varies in energy content from species to species. If weight loss is desired, a leaner fish, such as Pollock, could be substituted for a fattier fish, such as herring or capelin, to reduce total calories in the diet. This would be the preferred method for all otter species fed fish.

Food Variability

Otters should routinely be offered a variety of fish either as part of their diet or as enrichment. Reliance on multiple fish species, versus one or two, will prevent animals from developing strong preferences and help in switching them over to new sources if one fish type becomes unavailable. Hard dietary items should be routinely incorporated for dental health. These can include: hard kibble, crayfish, crabs, chicken necks, ox/horse tails, partially frozen fish, bony fish, day-old chicks, mice, rib bones, canine dental bones, or other similar items.

Otters will sample a variety of food groups, especially if introduced to them at an early age; cat kibble, worms, crickets, vegetables, berries, mice, chicks, etc., can all be added to the diet as enrichment. Due to the possible formation of uroliths, foods high in calcium oxalates should be avoided (e.g., beans, celery, leafy greens, sweet potato, berries, peanuts, among others) or used only on an occasional basis. The overall nutrient and caloric intake, body weight of the animal(s), and condition of the animal(s) should be taken into consideration. All otters will benefit from receiving live fish/crayfish (from approved sources), at least as enrichment on a weekly basis. Whole fish should comprise a portion of the daily diet of all other species.

SPECIES-APPROPRIATE FORAGING AND FEEDING:

Live fish and crustaceans can and should be provided, if possible, on a regular basis. However, due to the risks of live fish or crayfish transmitting disease or parasites, policies regarding the feeding of live prey should be established by each facility. If these items are used, they should be obtained only from known, institutionally approved sources. Where live prey are used, provisions in the exhibit should be made to allow these prey species a place to hide from the otters, thus forcing the otters to use their hunting skills and extending the time of activity.

There also are a variety of puzzles and other feeding devices described in the literature that can be adapted for use in river otters. Alternatively, feeding tubes can be built into exhibits that randomly release live prey or food items into the exhibit. See Section 3, Chapter 11 for other enrichment items used, including non-food items.

Feeding Schedule

Due to their naturally nutrient dense diet, reliance on fat as a source of energy, rapid transit time of food through the intestinal tract, feeding style of frequent, small amounts, and generally high activity level – it is recommended that otters be fed at least twice a day and preferably three or more times daily (including enrichment or training feeds). Frequent feeding prevents consumption of spoiled food, accommodates their rapid digestion (Ormseth & Ben-David 2000), and can stimulate increased activity in these generally active and curious species.

In addition to feeding smaller amounts frequently, it is recommended that a portion of the daily diet be fed as part of enrichment or husbandry training activities. At least one of the daily feedings, or part of a feeding, should be scattered to encourage foraging. Timing of foraging opportunities and items offered should be varied to prevent habituation. All uneaten food should be removed before it spoils; this may be daily or more frequent in warm climates or seasons. (See below for a discussion of abnormal repetitive behaviors (ARBs) associated with feedings and training. At this time it is still recommended that more frequent feedings are preferable but, staff should make an attempt to 1) record ABRs in all otters and document if feedings are increased or reduced as a result of these, and 2) test the use of a "feeding cue" to distinguish feeding times from other staff visits to the enclosure.

ABNORMAL REPETITIVE BEHAVIORS (ARBS) ASSOCIATED WITH FREQUENT FEEDINGS

Morabito (Morabito & Bashaw 2012) conducted a two-part survey of 106 AZA institutions housing North American river otters; part one consisted of management and exhibit characteristic questions applicable to all otters resident in the enclosure, part two dealt with ARBs in individual otters. Their response rate was 52% representing 61 exhibits in 55 institutions and 129 individual otters (59.70.0). Their results are thought provoking and worthy of further research as they potentially represent a change in how we approach training as well as delivery of food and enrichment to this species. In summary, their findings indicate:

- 46% of the otters at respondent institutions were reported as exhibiting ARBs.
- Neither age nor sex were significant predictors of ARBs in the otters reported on.
- 21 otters were reported to exhibit more ARBs in winter versus 9 exhibiting more in summer (of these it appeared to be associated with increased public attendance).
- 30 otters were reported as exhibiting pre-feeding ARBs; 6 exhibited post-feeding ARBs.
- NARO are prone to developing ARBs, particularly before feeding.
- Most frequently these ARBs take the form of repetitive swimming or pacing.
- Frequent feeding and training were both reliable predictors of ARBs. (this could be because individuals who already exhibit ARBs are targeted for more feedings and/or training sessions.)
- Institutions that utilized feeding cues which served to notify the otters that food/enrichment would be coming reported slightly fewer ARBs in their otters, but this was not statistically significant.
- Their recommendations are:
  - ✓ Further study based on observational data versus self-reporting by individual institutions.
  - ✓ Looking at what types of exhibit designs reduce the effect of visitor attendance on ARBs.
  - ✓ Experimentally manipulating feeding and training frequency to determine if these changes cause, or are a result of changes in ARBs.
  - ✓ DO NOT recommend reducing number of feedings or training sessions at this time.
  - ✓ ADDING reliable cues before feeding/enrichment and training allowing the otters to distinguish between types of keeper visits to the enclosure should be explored further.
  - ✓ ADD or use feeding techniques that require active foraging.
  - ✓ MINIMIZE the amount of time otters are confined in a less preferred environment (e.g. holding), or, provide hiding places to reduce escape-motivated ARBs.

Other Nutritional Issues

USE OF SUPPLEMENTS

For Coat Maintenance

Over one half of the 1997 N. A. River Otter Husbandry Survey respondents indicated use of some type of supplement for maintenance of coat condition in North American river otters (Reed-Smith, 1997). Poor coat condition (i.e. dry, dull appearance, hair loss, etc.) can be a manifestation of multiple disorders (Muller, et al. 1983).

Parasitic or bacterial infections can cause poor coat condition in captive mustelids (Wallach and Boever 1983). Nutritionally, fatty acid deficiency, protein deficiency, vitamin A deficiency or toxicity, vitamin E deficiency, vitamin B complex deficiencies, vitamin C deficiency, or several mineral deficiencies can all be manifested in poor coat condition (Muller, et al. 1983). For this reason, the clinical signs of poor coat quality are crucial in determining the cause and treatment of poor coat quality. The diet should be analyzed. If deficiencies or toxicities are noted, and appear to be the cause of the observed coat condition, adjustments should be made. Acute treatment may be necessary if the insult has occurred for an extended period of time, however, if diet appears the principle cause, adjustment should be paired with that treatment.

For Thiaminase and Vitamin E Loss

Fish types containing high thiaminase and/or high polyunsaturated fat levels should be avoided as they can cause malnutrition, sickness, and even death (Merck 1986). Diets containing fish high in thiaminase can lead to thiamin (vitamin B_1) deficiency in the otters fed this diet (Merck 1986). The process of fish storage (freezing), thawing, and preparation, can lead to fish nutrient loss, particularly vitamins B_1 and E, and especially in fish with high fat and/or high thiaminase content (Crissey 1998; Merck 1986). Vitamin supplements, especially vitamin B_1 (thiamin), vitamin E, and a multivitamin, should be added when fish is the main diet. The recommended vitamin supplementation regime for fish eating animals is as follows:

- Thiamin: 25-30mg/kg fish fed, fresh weight as fed basis (Bernard & Allen 1997)
- Vitamin E: 400 IU/kg dry weight basis (Engelhardt & Geraci 1978)

The 1997 N.A. River Otter Husbandry Survey conducted by Central Park Zoo is still one of the most complete. As a matter of institutional memory, retained in this edition is the table listing supplements used at that time. Also provided is diet information collected between 2004 and 2009 and compiled by Jessica Foti (2010).

Dietary Supplements Offered (N = 34) (Foti 2010)

No vitamins offered (8)
Vit.B^1/Vit.E/glucosamine/Chondroitin/Manganese (5)
Thiamine paste/Vitamin E (4)
Pet Tab/Vit. B^1 & E (2)
Mazuri Vita Zu Marine Mammal Tab (3)
Mink Pellets (1)
Clovite (1)
Linatone Plus (1)
Mazuri Vita Zu Bird Tab/ Cod Liver Oil (1)
Sea Tab/Vit. C/Linatone (1)
Linatone Plus/Clovite (1)
Zu Vite (1)
Salmon Oil (1)
Derm Caps (1)
Pet Tab/Cod Liver Oil (1)
Cod Liver Oil (1)
Wheat Bran (1)

Dietary Supplements Offered (N=50) (1997 N.A. River Otter Husbandry Survey)

Supplements are listed as given by the submitting institutions. M = multi-vitamins/minerals, including Mazuri Vit. Blend, Vita Sol, & Chaparral Zoological Vit.; ST = Sea Tabs; P = Pet Tabs; Ca = Calcium; Vi = Vionate; Di = Diaglo S. A.; Cl = Clovite; De = Derm Cap; Os = Osteoform; Li = Lixotonic; Nu = Nutriderm; Lin = Linatone; Ve = Vegetable Oil; Cod = Cod Liver Oil; Br = Bran; Y = Yeast; Wh = Wheat Germ Oil; Ao = Anti-oxidants; D-Ca-Fos split in to D, Ca, Pho; No = None. * Indicates supplements given only sporadically.

Dietary Supplements Table
1997 N. A. River Otter Husbandry Survey

Inst.	B_1	E	B	M	ST	P	Ca	D	Pho	Di	Vi	Os	Li	Nu	Ve	Wh	Br	Cod	Lin	Cl	De	Ao	No
AK																			X*				
AR	X																						
AS					X																		
BA																							X
BG				X																			
BR		X		X																			
BU														X									
BV																							X
BW																							X
CA																				X			
CF	X	X																					
CG																							X
CM																					X	X	
CP	X	X																					
DA																							X
DE																							X
DI																		X					
EL																		X					
HO													X										
HR						X*					X												
JB																							X
KX																							X
LI																							X
LO				X														X					
LP	X																						
LR																							X
MI																							X
MP	X	X	X																				
MT	X	X																					
NC				X																			
NT				X																			
NZ	X															X		X					
OA										X							X						
OH																							X
PB											X	X											
RI																							X
SE																							X
SF																							X
SN	X																						
SP																			X				
ST																							X
SU																X	X						
SZ																							X
TS	X												X										
TT^		X					X	X	X						X					X		X	
TZ	X						X				X												
WO														X									
WP				X																			
ZA																							X
ZO	X																						

DENTAL PROBLEMS

Dental problems are of concern in otters. Merck's Veterinary Manual (1991) and Petrini (1992) suggest offering rib bones one to two times per week for maintenance of dental hygiene. Other options are crunchy dry foods and some whole prey items including fish. Whatever is selected, it is very important that these animals be given something hard to maintain good dental hygiene

ROUGHAGE

As the natural diet of otters may contain some roughage, Duplaix-Hall (1975) and others have stressed the need for roughage in the diet fed to otters. Fish and other whole prey items, and crunchy vegetables are some of the items added to supply this roughage.

NUTRITIONAL RELATED DISEASE

Few reports of calculi are documented, thus this does not appear to be a problem in this species.

Nutrient Overview

This section is not intended to explain in depth the science of nutrition but, to introduce the essential dietary elements. Without these essential nutrients in the required quantities, the animal will become ill, cease to reproduce, and depending on the severity of the deficiency, may die because of the deficiency. Though it is *very important to obtain essential nutrients from the diet, more is not better. There are also maximum* tolerances and safe levels for each nutrient. Some nutrients can be very toxic to certain animals while others may be harmful to a lesser extent (NRC, 1980). Nothing can be considered completely safe and all nutrients must be considered in relationship to interactions with other nutrients. (Robbins, 1993).

ENERGY

Protein, carbohydrate and fat all provide energy to the animal. When any of these is fed in excess to energy needs, the animal will become fat. It is difficult to determine in a practical manner, the energy requirement of any one animal. Energy utilization is a combination of basal metabolic rate (BMR), the energy it takes to digest food, and the energy needed for activity and reproduction (gestation and lactation), and the energy needed for growth (maximum cell division). There are some basic measurements which allow calculations for energy demand (Miller and Koes, 1988). BMR for many mammals equals 70 x Body mass in kg to 0.75 power however, Iversen determined that the BMR of otters can be expressed by the equation: $M = 84.6W^{0.78}(+0.15)$. M = basal metabolic rate in kcal/day and W = body weight in kg. *"This is about 20% higher than expected from the mammalian standard curve described by $M = 70\ W^{0.75}$."* (Iversen 1972; Toweill & Tabor 1982; Kruuk 1995; Estes 1989)

In controlled feeding experiments on captive *L. lutra*, Erlinge (1968) reported that the animals were satiated after consuming about 900 to 1000 grams of live food; Toweill (1982) cites unpublished data of his that, *"...recorded similar volumes of food in moderately distended northern river otter stomachs containing food."* Harris (1968) reports that otters in captivity required about 700 to 900 grams of food.

Klieber outlined energy requirements for a number of species. This is a simplistic approach to a complex issue (Thompson, 1996). Additionally, it is very difficult to determine energy needed for activity, since in many cases, every animal differs in its activity level. So far, the most non-invasive method to measure whether the diet is providing the appropriate amount of energy (measured in kcals) is to weigh the animal periodically and look for changes (Gettys et al., 1988). Additionally, if the diet consumed is accurately measured, one can calculate energy consumed.

PROTEIN AND AMINO ACIDS

Protein is comprised of amino acids (Robbins, 1993). The actual requirement for animals is for amino acids not protein as such. However all amino acids must be present in adequate amounts. Not all of the 20 common amino acids are required in the diet of all animals. Some animals can produce some amino acids to a greater or lesser extent from essential dietary amino acids. These are non-essential amino acids. Simple stomach species generally require ten essential amino acids: arginine, histidine, isoleucine, leucine, threonine, lysine, methionine, phenylalanine, tryptophan, and valine (Robbins, 1993). Cats, being obligate carnivores with simplistic GI-intestinal tracts, require an array of pre-formed amino acids from the diet with additional needs such as taurine (Morris, et al., 1991). The amino acid requirements of otters remains unknown.

Utilization of protein from the diet begins with digestion which depends on sequential cleavage of amino acids from the protein molecule. The cleavage is performed by digestive enzymes. There are many mechanisms for transport of these amino acids through the intestinal cells into the body. Once in the body, some amino acids are metabolized and converted as needed into other amino acids. As needed, proteins are made by the body and comprise muscle, hair, enzymes, hormones, etc. The requirement for protein in the diet is somewhat based on the animal's ability to digest whole protein and utilize protein from sources such as muscle meat, cereals and microorganisms. The animal must receive an adequate compliment of essential amino acids, regardless of the source (Nutrition Reviews, 1985).

Young, growing animals require more protein than adult animals. In general, adult carnivores require a dietary protein level of 18 to 30% whereas a weaned kitten needs approximately 35% and young mink or foxes require 25 to 38%. (Robbins 1993)

Often requirements are expressed as crude protein. This is actually a calculation based on an average nitrogen content of various proteins of (16% nitrogen). To determine crude protein content of a food item the nitrogen content is multiplied by 6.25 (or100/16). There is error in this estimate since not all plant or animal nitrogen is in the form of protein, for example chitin in insects (Robbins, 1993; Bernard and Allen, 1997b). Animal protein requirement estimates are difficult to make because the quality of dietary protein depends on its amino acid composition, the ratio of protein to energy, and the total amount of food consumed. Additionally, amino acids if not needed as body protein, can be broken down and used as an energy source. Thus, protein needs and energy should be considered together (Robbins, 1993).

WATER

Water is sometimes the "forgotten" nutrient but the most important. Water is needed by all animals. Some animals need continuous supplies of drinking water. For safety sake, fresh water should be available at all times. Many otter exhibits have potable water provided via running water and/or pools. Some institutions offer water in separate tubs for drinking (Maslanka and Crissey, 1998). Neonatal mammals have a water concentration of between 71 and 88% of their body weight. Adult animals of normal weight have a concentration of between 50 and 65% (Robbins 1993).

MINERALS

Minerals have been classified into two groups: major (or macro) minerals and trace (micro) minerals. Many minerals, approximately 26, are known to be essential for life. It is not known why certain elements are essential for life while others may not be. It is quite possible that future study will find links and requirements for other minerals. All elements are toxic if ingested or inhaled at sufficiently high levels for long enough periods (NRC, 1980). Sometimes there is a relatively fine line between the biological level of need for a mineral and a toxic level. It should be remembered that the level of a mineral found in any source is, in part, directly related to soil. Plants for example can provide deficient or excess levels of minerals such as selenium depending on the soil in which the plant is grown. Various geographic regions are known for their deficiencies or excesses of minerals (Maynard, et al., 1979).

The major elements are: Carbon, hydrogen, oxygen, nitrogen, sulfur, calcium, phosphorous, potassium, sodium, chlorine, and magnesium. Since carbon, hydrogen, oxygen, nitrogen, and sulfur are major constituents of many molecules, these are not considered with respect to essential nutrient intake. However, calcium, phosphorous, potassium, sodium, chlorine, and magnesium are considered essential dietary nutrients. This category contains minerals present in large quantities in the body (Maynard, et al., 1979; Robbins, 1993).

The trace elements considered in nutrition are: iron, zinc, copper, manganese, nickel, cobalt, molybdenum, selenium, chromium, iodine, fluorine, tin, silicon, vanadium, and arsenic. Each of these is needed in very small amounts. The role of some of these in metabolism is not fully determined. Interactions among minerals are many and each should be considered in light of the other (Miller, et al., 1991).

The form of the mineral in the diet affects its absorption. Some forms are absorbed to a much greater extent than others. For example, it is thought that iron is not absorbed well from the GI-tract, in general. Inorganic sources may be absorbed at only about 5-15%. Heme sources however (associated with animal tissues) are better absorbed. Additionally, many factors may affect absorption of minerals. The example with iron shows that dietary vitamin C and sugars can increase inorganic iron absorption (Smith, 1997). Additionally some animals may have evolved ways to obtain nutrients when evolving either in nutrient toxic or deficient habitats and may not fall in line with the general statements (Kincaid and Stoskopf, 1987).

VITAMINS

Vitamins have been defined as a group of organic substances present in minute quantities in foods which are essential to normal metabolism and lack of which in the diet causes deficiency diseases (Robbins, 1993). Scientists have categorized vitamins as fat soluble and water soluble. Fat soluble vitamins can be stored in the body whereas water soluble vitamins have very limited storage and when fed in excess are primarily excreted (Machlin, 1984). As we learn more about vitamins, we find that animals utilize different forms of the vitamins differently. This can have a profound effect on nutritional status (Papas, et al., 1991).

The fat soluble vitamins are A, D, E, and K. Since these vitamins are stored by the body, toxicities may occur when fed in excess. Vitamin E is considered relatively non-toxic while vitamins A and D are known to cause toxicity symptoms in animals studied (Rucker and Morris, 1997). The toxicity of vitamin K depends on the source of vitamin K utilized.

The water soluble vitamins are vitamin C and "B" vitamins, including Thiamin, Riboflavin, Niacin, Biotin, Pantothenic Acid, Pyridoxin, Folic acid, Vitamin B12, Choline and Carnitine. These vitamins are utilized by the body for many metabolic processes. Each acts in a different way to provide for normal function of metabolism. Since these vitamins are not usually stored in the body for long periods, it is felt that daily intakes are preferred. Excess of these substances are usually excreted in the normal healthy animal and thus are considered somewhat non-toxic (Machlin, 1984; Rucker and Morris, 1997).

Fat-soluble Vitamins – General Functions & Reported Deficiency Symptoms

Vitamin	Major Functions	Deficiency Signs
A (Retinol, retinal, and retinoic acid)	In eye pigment For maintenance, differentiation & proliferation of epithelial tissue..	Reduced fertility or sterility, birth defects, reduced growth or loss of weight, oral & nasal pustules, weakness, night blindness, impaired eyesight because eye problems, bone and teeth deformities, unsteady gait and incoordination, ruffled-droopy appearance.
D (D_2-ergocalciferol; D_3-cholecalciferol	Needed for calcium absorption and metabolism.	Rickets in young, osteomalacia in adults.
E (Tocopherol)	Antioxidant functions	Yellow fat disease (steatitis) sudden death with stress, lumpiness of subcutaneous fat, severe edema, nutritional muscular dystrophy, severe hemolytic anemia, reproductive failure
K (Phylloquinone & menaquinone)	Necessary for blood clotting	hemorrhaging.

(Adapted from: Robbins 1993)

Two vitamins are especially important when animals are fed a large proportion of fish in the diet. This is because these vitamins degrade relatively quickly in killed fish. Diets that contain high levels of marine products may not only predispose individuals to thiamin deficiency, but also to vitamin E deficiency if not adequately supplemented (Engberg, et al 1993).

Thiamin –fish eating animals including dolphins, polar bears, mink, foxes, sea lions, grebes, and gulls have been reported to have had thiamin deficiencies (Robbins, 1993). Many species of fish and shellfish contain the enzyme group called thiaminases that breaks down thiamin in the killed fish (Robbins 1993; Bernard and Allen, 1997a) Robbins (1993) also reports that thiaminase occurs in newly hatched chicks.

Supplementing otters consuming a large proportion of fish in their diet should be performed to ensure adequate thiamin status. The recommended supplementation regime for fish eating animals is 25-30 mg of thiamin per kg of fish fed (fresh weight basis; Bernard and Allen, 1997a)

Vitamin E –Vitamin E deficiencies are most frequently seen in species fed fish-based diets. Marine products contain high levels of poly- and mono-unsaturated fatty acids. Because vitamin E functions as an antioxidant, the breakdown of these oils during storage causes vitamin E destruction. For this reason, it is recommended that a vitamin E supplement be fed to otters on a fish only diet or a diet comprised of a large proportion of fish. (Crissey & Maslanka contribution IUCN Otter Specialist Group Otter Action Plan, in press) The recommended supplementation regime for fish eating animals is 100 IU of vitamin E per kg of fish fed (fresh weight basis; Bernard and Allen, 1997a). Similarly, the recommended supplementation level is 400 IU vitamin E / kg of *dry* diet (Engelhardt and Geraci 1978).

If a fish-based only diet is offered, supplementation with a multivitamin is recommended. Nutritional deficiencies have been reported in commercially farmed mustelids (hypovitaminoses A and E, thiamin deficiency, calcium deficiency; Wallach and Boever 1983, NRC 1982). Fish composition can change based on species, season of harvest, duration of storage, etc., and addition of multivitamin may provide some consistency in the nutrients contained in the diet. However, the diet should be analyzed to determine nutrient levels prior to supplementation in order to minimize the chance of over-supplementation and toxicity (especially of fat-soluble vitamins).

Water-soluble vitamins – General Functions & Reported Deficiency Signs Table

Vitamins	Major Functions	Deficiency Signs
Thiamin (vitamin B_1)	Needed in carbohydrate metabolism.	Anorexia, weight loss, weakness, lethargy, unsteady gait, diarrhea, seizures, and other neurological disorders, “star-gazing”.
Riboflavin (vitamin B_2)	Needed in carbohydrate metabolism	Anorexia, weight loss, poor hair coat, atrophy of hair follicles, diarrhea, leg paralysis, reduced fertility.
Niacin (nicotinic acid & nicotinamide)	Functions in metabolism (in NAD and NADP)	Retarded growth, , anorexia, diarrhea, dermatitis, drooling & tongue discoloration,
Vitamin B_6 (pyridoxine, pyridoxamine, & pyridoxal)	Needed in protein metabolism	Testicular atrophy, sterility, anorexia, retarded growth, poor hair coat, muscular incoordination, neurological disorders.
Pantothenic acid	Needed for fat, carbohydrate, & amino acid metabolism	Skin lesions, crusty scabs about the eyes, emaciation, degeneration of the liver, kidney problems, reproductive failure, death.

Water-soluble vitamins – General Functions & Reported Deficiency Signs Table		
Vitamins	**Major Functions**	**Deficiency Signs**
Biotin	Needed in metabolism	Fur discoloration, hair loss, degenerative changes in the hair follicles, thickened & scaly skin, conjunctivitis,
Folicin (folic acid)	Needed in metabolism	Anorexia, retarded growth, diarrhea, profuse salivation, convulsions, adrenal hemorrhages, , anemia
Vitamin B_{12} (cyanocobalamin)	Needed in carbon & carbohydrate metabolism	Anorexia, weight loss, pernicious anemia neurological & locomotion disorders.
Choline	Nerve functioning	Liver damage, reduced growth of the leg bones, awkward gait, growth retardation, weakness, lowered hematocrit.
Vitamin C (ascorbic acid)	Not required by many species. Needed for bone & collagen formation	Scurvy, severe necrotic stomatitis, anorexia, weight loss, gingivitis, glossitis, pharyngitis, hemorrhages

(Adapted from: Robbins 1993)

FAT AND ESSENTIAL FATTY ACIDS (EFAS)

Fats and oils (lipids) are utilized by animals as energy. Lipids are comprised mainly of glycerol and fatty acids. The energy value of fat is considered to be at least double that of protein or carbohydrates. Dietary fat is also the source of essential fatty acids which are required by animals. Thus the dietary requirement for fat in the diet is actually an energy requirement and the requirement for essential fatty acids. In general, the essential fatty acids include linoleic, linolenic and arachidonic acids or their metabolic derivatives. Some animals may have specific needs different from others (Rouvinen and Niemela, 1992; Stanton, et al., 1989). Essential fatty acids can be converted in the body to other important fatty acids. Some animals can convert these essential dietary fatty acids better than other animals. Obligate carnivores such as cats require not only linoleic acid but also, pre-formed arachidonic acid as they cannot convert the other essential fatty acids to this nutrient.(Burger, 1993). This may apply to otters too.

Much research is being conducted with respect to fatty acids. Of special interest is the work being done with omega-3 fatty acids in both humans and domestic animals. This work could prove very important to fish eating animals in particular (March, 1993).

Deficiencies of essential fatty acids include poor reproduction, kidney problems, poor wound healing, poor coat condition, and possibly dehydration, liver degeneration, and immune system failure.

Arachidonic acid is present in animal matter but not in plants. Good sources of arachidonic acid are meat, liver, and some seafoods. Linolenic acid is found in linseed, soybean, rapeseed oils, and marine fish oils. Omega-3 fatty acids are found in marine fish as well as trout. Oily fish, such as sardines, anchovies, and herring, are much better sources of EFAs than non-oily fish (Robbins, 1993)

CARBOHYDRATES

Sugars, starches and fiber are carbohydrates. Carbohydrate is broken down to simple sugars before it is absorbed from the GI-tract in to the body. It is utilized by animals for energy. Some animals possess the ability to utilize different sources of carbohydrate to a greater or lesser extent (Yokota, et al., 1992; Kienzle, 1993). Carbohydrates play a minor role in the nutrition of otters (Wallach & Boever 1983). Animals that harbor large quantities of microorganisms in their GI-tract, like ruminants, can digest fiber to a greater extent than those with a more simple tract like most carnivores (Bonhomme-Florentin, 1990; Graham and Aman, 1991).

There is, in general, no definitive requirement for carbohydrate, including fiber, in the diets of animals. However, it is well know that fiber allows proper functioning of the GI-tract for many animals and should be included in the diet based on the species and its GI-tract morphology (Shaver, et al., 1988; Milton and Demment, 1988).

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CHAPTER 10 Health Care

Introduction

This section is intended as an overview of health care, not as a guide to diagnosis or treatment. The intent is to help the keeper, curator or veterinarian with no otter experience understand the basic health needs of captive river otters and some of the diseases these animals are susceptible to. (For the reader's convenience, there is a limited glossary of medical terms used at the end of this chapter.)

As is true for many small mammals, otters may be hit with serious disease with little or no warning. The only way to mitigate a potentially life threatening illness is through keeper awareness and familiarity with the animals in their charge. Always take the time to observe, and record, how the animals are behaving; eating; performing bodily functions; using their exhibit; interacting with exhibit mates, and their general physical appearance. A good daily record keeping system can be vital if an animal becomes ill; or, the attention to detail can alert you to a problem before it becomes too severe. If an animal is exhibiting signs of illness call the veterinarian, do not treat it without professional assistance.

Some of this material is generalized to all mustelids and its application to river otters is assumed. For additional information the bibliography contains a number of excellent references.

Weight Ranges

4.5kg – 11.3kg. (10 lbs. – 25 lbs.) Harris 1968
5kg. – 15kg. (11 lbs. – 33 lbs.) Hall 1981

Melquist & Hornocker (1983) found that adult males, on average, were 17% heavier than adult females. They cite an average weight of 7.9 kg. (17.4 lbs.) for females. Every animal will have its own "good weight". Diets should be adjusted as needed to maintain a healthy weight and normal activity pattern. (Not every female should weigh the average and not all males are larger than females.) See Chapter 7, Animal Management, Weight; for weight range photos.

Weights of Captive N. A. river otters (*Lontra canadensis*) (ISIS, 1999)

Weight	Units	Mean	St. Dev.	Minimum Value	Maximum Value	Sample Size[a]	Animals[b]
Weight: 0-1 days age	Kg	.1242	.0147	.0950	.1450	12	10
Weight: 0.9-1.1 months age	Kg	.8669	.1488	.6890	1.160	8	8
Weight: 5.4-6.6 months age	Kg	6.038	1.315	3.900	8.020	10	10
Weight: 1.8-2.2 years age	Kg	8.701	1.629	4.540	10.75	21	11
Weight: 2.7-3.3 years age	Kg	9.033	2.115	5.780	12.50	32	15
Weight: 4.5-5.5 years age	Kg	10.68	1.61	6.818	13.18	21	8

[a] Number of samples used to calculate the reference range.
[b] Number of different individuals contributing to the reference values.

Life Span

In the wild otters live a maximum of about 10 to 13 years. Mortality rates for wild otters increase at three to five years, the reasons for this are unknown (Polechla 1989). Historically, longevity in captivity is given as 25 years (Melquist & Dronkert 1987), and 23 years (Park 1971, Nowak 1991). While these figures are supported by an entry of a 25 year old animal in the N. A. river otter studbook, the median age is 12.3 years with lifespans of 16 to 20 years fairly common (D. Hamilton personal communication).

Physiological Norms

Heart Rate

137 – 170 beats/minute (Grassmere Wildlife Park now Nashville Zoo @ Grassmere)
130 – 178 beats/minute; baseline = 152 beats/minute (Spelman 1999)
160 – 180 beats/minute; baseline = 174 ± 9 beats/minute (Hoover 1986)

EKG

From: Hoover 1986

Rhythm: Normal sinus rhythm
Mean Electrical Axis (frontal): 54 ± 13°

Lead II	Mean ± SD	Range
P (sec)	0.051 ± 0.006	0.040 – 0.060
PR (sec)	0.086 ± 0.008	0.075 – 0.095
P (millivolt)	0.24 ± 0.6	0.15 – 0.30
QRS (sec)	1.82 ± 0.48	1.30 – 2.60
QT (sec)	0.184 ± 0.011	0.170 – 0.200
T (millivolt)	0.45 ± 0.11	0.30 – 0.60

Respiration Rate

When under anesthesia, the important factor is that the mucous membranes and mouth stay a pink color.
Grassmere (Nashville Zoo) records show a respiratory rate range of 30 – 60 while under anesthesia.

Range: 10 – 60 breaths/minute; baseline = 31 breaths/minute (Spelman 1999)
Range: 20 - ~34 breaths/minute (Hoover & Jones 1986) These figures were obtained from otters during chemical immobilization and inhalation anesthesia.

Body Temperature

Body temperature range of 37.5° to 40°C (99.5° to 104°F) for otters involved in a translocation project (Serfass (1994). (The upper end of this spectrum should be considered pathologic if it continues very long. An animal's normal temperature may reach this height after the exertion and stress associated with being caught.)

Body temperature range: 38.1 – 38.7°C (100.6 to 101.7°F); baseline = 38.4°C (101.1°F) (Spelman 1999)

Body Temperature of captive N. A. river otters (*Lontra canadensis*) during immobilization (ISIS, 1999)

Test	Units	Mean	St. Dev.	Minimum Value	Maximum Value	Sample Size[a]	Animals[b]
Body Temperature:	°F	102.0	1.8	96.8	105.8	161	96

[a] Number of samples used to calculate the reference range.
[b] Number of different individuals contributing to the reference values.

ARTERIAL BLOOD PRESSURE

Mean arterial blood pressure range: 31 – 77 mm Hg; baseline = 63 mm Hg (Spelman 1999)

BLOOD VALUES

Captive Animals

Hematology Values for Captive North American River Otters (*Lontra canadensis*) (ISIS, 1999)

Test	Units	Mean	St. Dev.	Minimum Value	Maximum Value	Sample Size[a]	Animals[b]
WHITE BLOOD CELL COUNT	*10^3/µl	7.935	4.138	1.980	32.30	236	130
RED BLOOD CELL COUNT	*10^6/µl	9.96	1.38	6.62	14.30	175	95
HEMOGLOBIN	g/dl	14.2	1.7	9.2	19.2	208	121
HEMATOCRIT	%	44.8	5.8	30.5	64.2	240	132
MEAN CORPUSCULAR VOLUME	fL	46.6	5.2	30.8	67.6	173	95
MEAN CORPUSCULAR HEMOGLOBIN	pg/cell	14.7	1.5	10.1	23.1	171	95
MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION	g/dl	31.8	2.3	23.5	41.3	206	121
PLATELET COUNT	*10^3/µl	489	137	190	810	74	45
NUCLEATED RED BLOOD CELLS	/100 WBC	0	0	0	1	25	19
RETICULOCYTES	%	0.3	0.2	0.0	0.9	19	16
SEGMENTED NEUTROPHILS	*10^3/µl	5.563	3.206	0.191	19.10	215	121
LYMPHOCYTES	*10^3/µl	1.606	0.935	0.035	5.630	224	126
MONOCYTES	*10^3/µl	0.214	0.227	0.000	1.292	185	111
EOSINOPHILS	*10^3/µl	0.536	0.699	0.000	4.608	194	117
BASOPHILS	*10^3/µl	0.021	0.044	0.000	0.182	36	28
NEUTROPHILIC BANDS	*10^3/µl	0.384	0.743	0.000	3.060	57	44
ERYTHROCYTE SEDIMENTATION RATE	mm/Hr	0	0	0	0	1	1

[a] Number of samples used to calculate the reference range.
[b] Number of different individuals contributing to the reference values.

Physiological reference ranges are calculated from samples submitted by 34 member institutions and are both sexes and all ages combined.

Biochemistry Values for Captive North American River Otters (*Lontra canadensis*) (ISIS, 1999)

Test	Units	Mean	St. Dev.	Minimum	Maximum	Sample Size[a]	Animals[b]
CALCIUM	mg/dl	8.8	0.7	7.4	11.2	212	122
PHOSPHORUS	mg/dl	5.6	1.6	2.2	12.3	202	118
SODIUM	mEq/L	150	4	139	164	204	116
POTASSIUM	mEq/L	4.3	0.5	3.0	5.9	207	117
CHLORIDE	mEq/L	114	4	97	128	200	116
BICARBONATE	mEq/L	23.5	2.4	19.0	28.0	28	25
CARBON DIOXIDE	mEq/L	23.7	3.5	15.0	30.0	75	42
OSMOLARITY	mOsmol/L	303	14	287	328	14	11
IRON	µg/dl	175	62	77	359	48	32
MAGNESIUM	mg/dl	1.59	0.55	0.65	2.50	23	16
BLOOD UREA NITROGEN	mg/dl	28	8	13	56	220	126
CREATININE	mg/dl	0.6	0.2	0.3	1.8	205	115
URIC ACID	mg/dl	1.9	0.7	0.0	4.3	123	81
TOTAL BILIRUBIN	mg/dl	0.3	0.2	0.0	1.0	198	116
DIRECT BILIRUBIN	mg/dl	0.1	0.1	0.0	0.3	52	32
INDIRECT BILIRUBIN	mg/dl	0.2	0.1	0.0	0.4	51	32
GLUCOSE	mg/dl	96	33	35	247	218	123
CHOLESTEROL	mg/dl	233	67	99	421	213	123
TRIGLYCERIDE	mg/dl	47	37	4	201	136	81
CREATINE PHOSPHOKINASE	IU/L	509	446	99	2613	81	55
LACTATE DEHYDROGENASE	IU/L	524	1051	24	6200	129	83
ALKALINE PHOSPHATASE	IU/L	83	43	17	279	215	122
ALANINE AMINOTRANSFERASE	IU/L	106	67	32	449	196	112
ASPARTATE AMINOTRANSFERASE	IU/L	93	49	20	334	202	117
GAMMA GLUTAMYLTRANSFERASE	IU/L	12	11	3	83	102	65
AMYLASE	U/L	14	22	0	105	66	44
LIPASE	U/L	27	25	0	98	29	21
TOTAL PROTEIN (COLORIMETRY)	g/dl	6.6	0.6	5.2	8.3	205	119
GLOBULIN (COLORIMETRY)	g/dl	3.6	0.6	2.2	6.0	171	105
ALBUMIN (COLORIMETRY)	g/dl	2.9	0.3	2.0	3.8	171	105
ALBUMIN (ELECTROPHORESIS)	g/dl	2.8	0.1	2.7	2.8	2	2
TOTAL THYROXINE	µg/dl	2.1	0.1	2.0	2.2	3	3

[a] Number of samples used to calculate the reference range.
[b] Number of different individuals contributing to the reference values.

Physiological reference ranges are calculated from samples submitted by 34 member institutions and are both sexes and all ages combined.

Wild animals

Hematology values for adult live-trapped river otters (*Lutra canadensis*) (Tocidlowski, 1997)					
Test	Units	Median	Minimum Value	Maximum Value	Sample Size
WHITE BLOOD CELL COUNT	*10^3/µl	11.3	4.7	33.2	132
RED BLOOD CELL COUNT	*10^6/µl	10.99	6.10	14.50	132
HEMOGLOBIN	g/dl	15.1	10.4	19.0	132
HEMATOCRIT	%	47.6	32.2	60.8	132
MEAN CORPUSCULAR VOLUME	fL	43.3	38.3	49.0	132
MEAN CORPUSCULAR HEMOGLOBIN	pg/cell	13.7	11.3	15.8	132
MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION	g/dl	31.4	27.8	39.2	132
PLATELET COUNT	*10^3/µl	565	298	931	132
SEGMENTED NEUTROPHILS	*10^3/µl	8878.5	3003.0	28220.0	132
LYMPHOCYTES	*10^3/µl	1254.0	123.0	4950.0	132
MONOCYTES	*10^3/µl	452.3	52.0	2380.0	132
EOSINOPHILS	*10^3/µl	312.0	0.0	1833.0	132
BASOPHILS	*10^3/µl	88.0	0.0	219.0	132
NEUTROPHILIC BANDS	*10^3/µl	94.0	0.0	486.0	132

Biochemistry values for adult live-trapped river otters (*Lutra canadensis*) (Tocidlowski, 1997)					
Test	Units	Median	Minimum Value	Maximum Value	Sample Size
CALCIUM	mg/dl	8.4	6.8	10.0	50
PHOSPHORUS	mg/dl	5.8	3.2	8.3	50
SODIUM	mEq/L	152	136	158	50
POTASSIUM	mEq/L	4.4	3.5	5.3	50
CHLORIDE	mEq/L	113	94	121	50
CARBON DIOXIDE	mEq/L	24	19	28	21
BLOOD UREA NITROGEN	mg/dl	31	17	56	50
CREATININE	mg/dl	0.5	0.4	0.8	50
TOTAL BILIRUBIN	mg/dl	0.2	0.1	0.5	50
GLUCOSE	mg/dl	130	56	225	50
CHOLESTEROL	mg/dl	152	63	279	29
TRIGLYCERIDE	mg/dl	31	9	72	29
CREATINE PHOSPHOKINASE	IU/L	219	67	1300	50
LACTATE DEHYDROGENASE	IU/L	149	36	10820	21
ALKALINE PHOSPHATASE	IU/L	85	29	282	50
ALANINE AMINOTRANSFERASE	IU/L	194	46	990	50
ASPARTATE AMINOTRANSFERASE	IU/L	85	34	1260	50
GAMMA GLUTAMYLTRANSFERASE	IU/L	19	8	38	29
AMYLASE	U/L	12	2	22	21
TOTAL PROTEIN (COLORIMETRY)	g/dl	7.3	5.7	9.0	50
GLOBULIN (COLORIMETRY)	g/dl	4.0	2.9	5.8	50
ALBUMIN (COLORIMETRY)	g/dl	3.3	2.4	4.1	50

Hematology/Blood Chemistry – Serfass, 1994 – Pennsylvania River Otter Reintroduction

Range	
Hematocrit gm/dl	34 – 59%
Red Blood Cell Count	9.4 – 11.9/mm
Segmented Neutrophils	61 – 87%
Basophils	0
Mean Corpuscular Hemoglobin (MCH)	14.2 – 16.9pg
Blood Urea Nitrogen (BUN)	26. 45 mg./dl
BUN/Creatinine mg/dl ratio	41 – 130
Triglyceride meg/l	20 – 128 mg/dl
Total Protein gm/dl	6.3 – 7.2 gm/dl
Globulin	3.4 – 4.3 gm/dl

Range	
Hemoglobin	13.0 – 18.5
WBC	7.0 – 16.1/mm
Band Neutrophils	0 – 5%
Lymphocytes	5 – 20%
Glucose	74 – 148 mg/dl
Creatinine	0.3 – 0.6 mg/dl
Cholesterol	108 – 242
Sodium	148 – 153
Albumin	2.7 – 3.0
Alkaline Phosphatase	81 – 193 I.U./L

Range	
Alanine Aminotransferase (ALT)	77 – 321 I.U./L
Aspartate Aminotransferase (SGOT)	0 – 1053 I.U./L
Monocytes	0 – 8%
Mean Corpuscular Volume (MCV)	38.6 – 52.3 u3
Potassium	3.9 – 4.9 meg/L
Bicarbonate	21 – 25 meg/L
Total Bilirubin	0.1 – 0.2 mg/dl
Ionized Calcium	3.9 – 4.1 mg/dl

Range	
Lactate Dehydrogenase (LDH)	73 – 390 I. U./L
Uric Acid	1.3 – 3.7 ug/ml
Eosinophils	0 – 14%
Mean Corpuscular Hemoglobin (MCHC)	29.3 – 40.2%
Chloride	108 – 114 meg/L
Iron	71 – 192 meg/L
Calcium	8.1 – 9.1 mg/dl
Phosphorus	4.5 – 7.5 mg/dl

Physical Norms

TEETH

3/3 Incisors; 1/1 Canines; 4/3 Premolars; 1/2 Molars x 2 = 36 Total

VERTEBRAE

14 rib bearing; 7 cervical; 14 thoracic; 6 lumbar; 3 sacral; 22 caudal. The normal total is 52. (Toweill & Tabor 1982)

MAMMAE

Four, inguinal.

FEET

Webbing between all digits but, slightly more extensive on the hind feet. The claws are sharp and probably aid in gripping. The hind feet are generally larger than the fore and the hind legs are longer leading to the typical hump-backed gait when traveling across land. The soles of the feet have tufts of hair under the toes (in some subspecies). Plantar pads are found on the soles of the hind feet. Pentadactyl and plantigrade. Also see skeletal adaptations under Descriptions.

Captive Care

MEDICAL RECORDS

Thorough and accurate medical records are essential to learn and understand more about the medical problems of any of our captive species. Medical records should be systematic and entries should identify the history, physical findings, procedures performed, treatments administered, differential diagnosis, assessment, and future plans for treatment. A computerized medical record system, which can help track problems and can be easily transmitted from one institution to the next is extremely beneficial. The otter SSP encourages the use of Med ARKS (International Species Information System, 12101 Johnny Cake Ridge Road, Apple Valley, MN 55124, U.S.A.) as a universal medical record program. Many institutions already use this program making it easy to transfer information between them.

IDENTIFICATION

Transponder Chips:

The AZA Otter SSP recommends that all otters be identified as soon as possible after birth with a transponder chip. Chips have been placed subcutaneously over the bridge of the nose/forehead area (Photo: G. Myers), SQ/IM in the intrascapular area at the base of the ears, and many institutions have placed them between the scapulae. Placement in all of these areas has been met with success and failure (migration, loss, unable to read them as planned). At this time, the AZA Otter SSP recommends the forehead area as the preferred area of placement; this location should make the chip easy to read when the animal comes to the front of the cage. The intrascapular area should be used as an alternative (this is the most frequently used location reported by member institutions). However, transponders placed in the intrascapular area can migrate and may be broken or lost during fighting and breeding attempts. Placement location of the transponder chip should be recorded in the animal's medical record.

Tattoos:

River otters should have their studbook number tattooed on the medial thigh as soon as they reach adult size. This should be applied to the left medial thigh for females and to the right medial thigh for males.

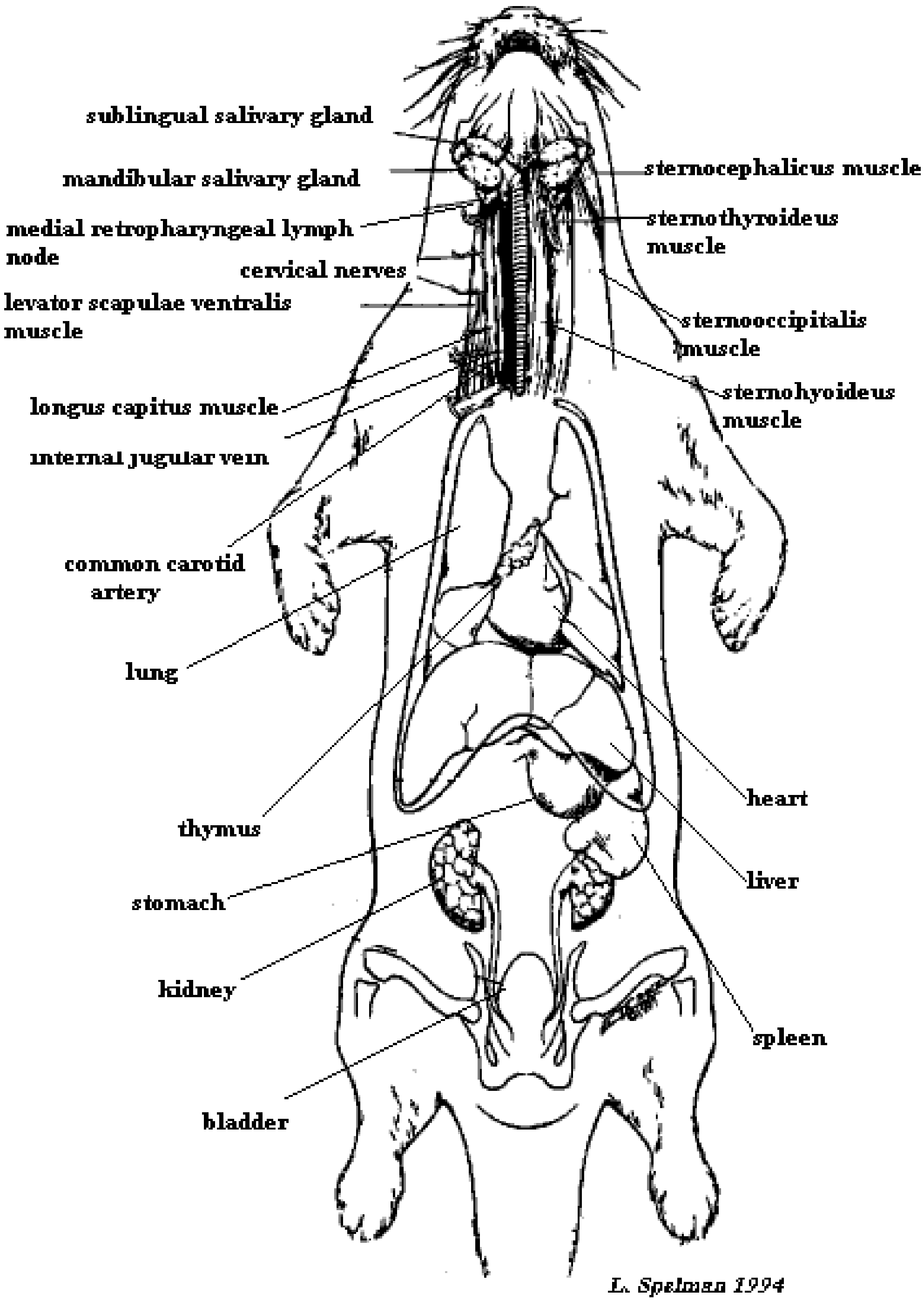
PREVENTATIVE HEALTH CARE

Annual physical examinations

It is recommended that all animals have at least a biannual examination and, if possible, an annual examination during which the following procedures are performed:

- Transponders and/or tattoos should be checked and reapplied if they are not readable.
- Baseline physiological parameters (e.g., heart rate, weight, body temperature, respiratory rate) should be obtained & recorded.
- The oral cavity and all dentition should be examined. Teeth should be cleaned and polished if necessary. Any tooth that is fractured or in need of repair should be noted in the medical record and the condition corrected as soon as possible.
- The reproductive tract should be evaluated. Care should be taken to record any changes in the external genitalia, such as vulvar swelling or discharge, testicular enlargement, and mammary gland changes. Contraceptive hormone implants also should be checked to make sure they are in place, and not causing any local irritation.
- Radiographs taken to check for any abnormalities. If renal or cystic calculi are seen, then numbers, location, and approximate sizes should be noted in the records.
- Blood collection done, and complete blood count and chemistry profile performed. Blood serum frozen and banked when possible.
- Animals housed outside in heartworm endemic areas should be checked for heartworm disease by performing a heartworm ELISA antigen test and the animal routinely given heartworm preventative treatment (see 'parasite control' section).
- Urine collected whenever possible by cystocentesis for a complete urinalysis.
- An annual fecal examination should be performed to check for internal parasites, and anthelmintics administered if necessary (see 'parasite control' section).
- Vaccines updated if necessary (see 'vaccination' section).

General Otter Anatomy



IMMUNIZATIONS

The following vaccination schedule is recommended by the AZA Otter SSP Veterinary Advisor. Vaccination product recommendations are based on clinical experience (as of 2006) in most cases, and not necessarily on controlled scientific study.

Distemper

Merial's new PureVax™ Ferret Distemper Vaccine currently on the market is a univalent, lyophilized product of a recombinant canary pox vector expressing canine distemper virus antigens. The vaccine cannot cause canine distemper under any circumstances, and its safety and immunogenicity have been demonstrated by vaccination and challenge tests. Otters should initially be given 1ml of reconstituted vaccine for a total of 2-3 injections at three-week intervals, followed by a yearly booster. This vaccine should be given IM instead of SQ in exotic carnivores for increased effectiveness. More information on PureVax™ Ferret Distemper Vaccine can be found at www.us.merial.com (Merial Ltd., 3239 Satellite Blvd., Duluth, GA 30096). An alternative vaccine that is available is Galaxy D (Schering-Plough Animal Health Corporation, P.O. Box 3113, Omaha, NE 68103), a modified-live canine distemper vaccine of primate kidney tissue cell origin, Onderstepoort type.

Safety and efficacy of canine distemper vaccinations in exotic species of carnivores have been problematic. Vaccine-induced distemper has occurred in a variety of mustelids using modified-live vaccine, and killed vaccines have not provided long-lived protection and are not commercially available. However, to date there have been no cases of vaccine induced distemper in otters given the Galaxy product, and excellent seroconversion following vaccination using this product has been documented in young N.A. river otters (K.Petrini, unpublished data, Petrini et al. 2001). The use of any modified-live canine distemper vaccine in exotic species should be done with care, especially with *P. brasiliensis*, young animals, and those that have not been vaccinated previously. The use of PureVax™ Ferret Distemper Vaccine is recommended where possible.

Parvovirus

The efficacy of feline and canine parvovirus vaccines has not been proven in otters. Otters should initially be given 1ml of vaccine IM for a total of 2-3 injections at three-week intervals followed by a yearly booster. Parvocine™ (Biocor Animal Health Inc., 2720 North 84th Street, Omaha, NE 68134) is a killed univalent parvovirus vaccine that has been used in otters. Using a univalent product such as Parvocine™ reduces the risk of vaccine allergic reactions.

Rabies

The efficacy of rabies vaccines has not been proven in *Lontra canadensis* or other exotic mustelids. Vaccinated otters that bite humans should not be considered protected from rabies. **Only killed** rabies products should be used in otters. One commonly used product is Imrab® 3 (Merial Ltd., 3239 Satellite Blvd., Duluth, GA 30096), which is a killed rabies vaccine that has been used extensively in small carnivores without apparent adverse effects. Otters should be given 1ml of vaccine IM once at 16 weeks of age followed by a yearly booster. Although new rabies glycoprotein, canarypox vector vaccinations have recently been introduced to the market, these vaccines have not been used widely in exotic carnivores and their safety has not been determined at this time.

Leptospirosis

The susceptibility of river otters to leptospirosis is debated in the literature, and the benefit of vaccination is unknown. Killed Leptospira bacterins are available and can be administered in areas where leptospirosis has been problematic. Initially two doses should be given at 3-4 week intervals. Vaccine efficacy and duration of immunity has not been studied in the otter and is an area where further study should be conducted.

Vaccination schedule

AGE	Canine Distemper	Feline Panleukopenia	Rabies	Leptospirosis
8 weeks	X	X		
12 weeks	X	X	X	(X)
16 weeks	X	X		(X)
Adult	X	X	X	(X)

- Sub adults should be vaccinated with killed parvovirus at 8, 12, and 16 weeks. Vaccination should begin earlier in pups from unvaccinated dams**.** (Photo: G. Myers)
- Veterinarians should **consider** vaccinating sub adults at 8, 12, and 16 weeks for distemper. **See discussion of distemper vaccines above.**
- Rabies vaccine should be given once at 8 or 16 weeks (product dependent) for animals at risk of contracting rabies.
- Adults should be vaccinated annually for all of the above.

PARASITE CONTROL

Otters should have fecal examinations performed regularly. The frequency of these examinations depends on the incidence of parasitism in the geographic region and the animals' likelihood of exposure. Animals should also be screened for parasites before shipment and during quarantine. Fecal testing should include both a direct smear examination as well as fecal flotation and sedimentation techniques. Baermann fecal examination techniques help identify certain parasites such as lungworms that are otherwise difficult to detect. Heartworm ELISA antigen tests should be conducted annually in animals exposed to mosquitoes in heartworm endemic areas. External parasites such as ear mites, fleas, ticks, etc. can be detected during a physical examination. A list of some of the parasites that have been identified in river otters and other mustelids is included in the disease section of this chapter for reference. See also Appendix A for parasites (endo- and ecto-) found in otters.

Recommendations for Parasite Testing

Otter parasite testing protocols

Parasite	Testing protocol
External parasites	Regular inspections during any physical examinations
Internal parasites	<u>Annual fecal examinations</u>: direct smear, fecal flotation, & sedimentation or Baermann techniques. <u>Pre-shipment fecal examinations</u>*:* direct smear and flotation <u>Quarantine fecal examination</u>: 3 negative direct smear results & 3 negative fecal flotation results before release from quarantine. <u>Heartworm ELISA antigen tests:</u> conducted annually in animals exposed to mosquitoes in heartworm endemic areas (test will not detect all male infections or infections with < 3 female nematodes). If infection is suspected, positively identify the microfilaria as pathogenic before instituting treatment.

Parasite Treatment

Recommended anthelmintic treatments for otters (G. Myers, DVM; Otter SSP Veterinary Advisor)

Treatment	Dose
Fenbendazole	50 mg/kg PO sid X 3-5 days
Pyrantel pamoate	10 mg/kg PO sid; repeat in 2 weeks
Ivermectin	For heartworm prevention 0.024 mg/kg PO q 30 days For GI nematodes 0.2-0.4 mg/kg PO or SQ
Praziquantel	5mg/kg SQ or orally

Upon completion of treatment, fecal exams should be repeated to assure that the therapy was successful; two to three weeks after cessation of treatment, and repeated in two weeks.

Heartworm

Heartworm ELISA antigen tests should be conducted annually in animals exposed to mosquitoes in heartworm endemic areas and animals maintained on a heartworm preventative. External parasites (e.g., mites, fleas, ticks) can be detected during physical examinations.

Dr. George Kollias, Cornell University School of Veterinary Medicine, states: *"Dirofilaria immitis, the cause of heartworm disease in dogs, cats and some other carnivores, has been found in the hearts of otters in and from Louisiana. This filarial worm has to be differentiated from Dirofilaria lutrae, the microfilaria of which can be found in the blood and adults in the subcutaneous tissues and coelomic cavity of river otters. D. lutrae generally does not cause disease. Newly acquired otters should be screened for microfilaria (via the Knott's test on blood) and for adults, via the ELISA antigen test on serum. D. immitis can be differentiated from D. lutrae by the morphological appearance of the microfilaria and by the antigen test. Thoracic radiographs should also be taken as part of routine health screening and definitely if an otter is Knott's test positive and/or antigen positive"*. See also Snyder et al. (1989), Neiffer et al. (2002), and Kiku et al. (2003) for reports of heartworm in otters.

In heartworm endemic areas, otters can be given ivermectin (0.1mg/kg orally once/month year around) as a preventative. Although it is still uncertain whether or not *D. immitis* causes progressive heartworm disease, as in the dog and cat, prevention is safest approach. If used at the proper dose, ivermectin has proven safe in otters. **Mortality has been associated with Melarsomine dihydrochloride administration to North American river otters and a red panda for heartworm disease (Neiffer et al. 2002).** In another report of otter deaths after treatment with Melarsomine, adult heartworms were found in the hearts of three out of the four animals during necropsy (G. Kollias, personal communication).

Heartworm Positive Test

According to the AZA Otter SSP Veterinary Advisor, Dr. Gwen Myers, several institutions now have had one or more positive heartworm tests in 3 otter species (NARO, ASCO, Spot-necked). None of these animals were symptomatic and all were on annual preventative (monthly ivermectin). The positives showed up during routine screening using heartworm ELISA antigen tests. She recommends that while positive tests warrant further work-ups these animals should NOT be treated for heartworm until it is confirmed 100% that they have heartworm.

PRE-SHIPMENT EXAMINATION RECOMMENDATIONS

All otters should receive a thorough pre-shipment physical examination as outlined above in the preventative health care section. Ideally, a copy of the pre-shipment physical exam findings and laboratory work should be sent to the veterinarian at the receiving institution before the animal is transferred. If an otter has a current medical condition requiring ongoing treatment, the case should be discussed between the shipping and receiving institutions' veterinarians **before** the animal is moved. All animal shipments should be accompanied by a hard copy of the medical record, as well as a health certificate and the USDA acquisition, disposition, or transport form (APHIS form #7020). Institutions using MedARKS should provide the receiving institution with the medical records on a floppy disc or send them via E-mail.

QUARANTINE

> *"…every animal is capable of carrying infectious diseases in a quiescent state (cub-clinical infection), which can readily be reactivated by the stress of moving and change in regime. Such an animal may not necessarily become ill itself, but may begin shedding infectious agents which pose a risk to other animals in the collection. Freedom from disease or latent disease must never be assumed."* (Lewis 1995)

Basic guidelines for quarantine have been established by the Veterinary Standards Committee of the AAZV which are designed to prevent the introduction of infectious disease into an animal collection. While the individual zoo has ultimate control over in-house quarantines it is recommended that all animals should undergo a 30-day quarantine stay at the receiving institution before being added to the rest of the collection. This allows time for the development of clinical signs of disease that may have been incubating before the animal was shipped. During the quarantine period the animal should be observed for signs that may be associated with disease, such as sneezing, coughing, vomiting, diarrhea, ocular or nasal discharge, etc. Three fecal examinations for parasites should be performed. The diet should be slowly adjusted over several weeks if there is to be a diet change.

Ideally, quarantine facilities should be isolated from the risk of cross-contaminating other carnivores already in the collection. If this is not possible, different keepers should be used, or strict rules of personal hygiene should be adopted and resident animals should be cared for first, then quarantine animals.

Balance between the necessity of keeping the quarantine pen clean and the needs of the animal can be tricky. There is some indication that many mustelids do *"…better isolated in enclosures as opposed to hospital-type quarantine pens"* (Lewis 1995). If this is not practical, or possible, a privacy box, climbing furniture, substrate suitable for rubbing/drying-off on, and a pool or water tub suitable for swimming should be provided. Whatever type holding facility is used, be sure it is otter-proof, they will climb, dig and chew.

There is much to be learned from a close physical examination (see below). In the case of otters, this requires putting the animal under a general anesthetic. The facility's policy on non-vital anesthesia should be followed, however, because otters are particularly adept at masking signs of illness, it is advised that a thorough physical exam be conducted before releasing the animal into the resident population.

Quarantine examinations

Two quarantine exams are recommended for otters; one performed at the beginning of the quarantine period (even if one has been conducted at the shipping institution) and one performed at the end.

Initial exam:
Veterinarians should visually inspect otters as soon as possible after they have arrived in quarantine. If a pre-shipment physical examination has not been done before the animal was transferred it would be prudent to perform a complete examination during the first week of quarantine.

Required:
1. Direct and flotation fecals
2. Vaccinate as appropriate

Strongly Recommended:
1. CBC/sera profile
2. Urinalysis
3. Appropriate serology (FIP, FeLV, FIV)
4. Heartworm testing in appropriate species

Final exam:
During the last week of quarantine, a thorough physical examination should be conducted as outlined in the preventative health care section. **It is extremely important to take radiographs of the animal during this time even if they were done at the previous institution.** This gives the new institution its own baseline film from which to compare future radiographs. This is especially important since radiographic techniques vary from facility to facility.

CONTROL OF REPRODUCTION

Note: This information has been updated as of 2012 AZA Wildlife Contraception Center recommendations for contraception in otter species. Their website should always be checked for more current information.

In addition to reversible contraception, reproduction can be prevented by separating the sexes or by permanent sterilization. In general, reversible contraception is preferable because it allows natural social groups to be maintained while managing the genetic health of the population. Permanent sterilization may be considered for individuals that are genetically well-represented or for whom reproduction would pose health risks. The contraceptive methods most suitable for otters are outlined below. More details on products, application, and ordering information can be found on the AZA Wildlife Contraception Center (WCC) webpage: www.stlzoo.org/contraception or email Contraception@stlzoo.org (Sally Boutelle).

The progestin-based melengestrol acetate (MGA) implant, previously the most widely used contraceptive in zoos, has been associated with uterine and mammary pathology in felids and suspected in other carnivore species (Munson 2006). Other progestins (e.g., Depo-Provera®, Ovaban®) are likely to have the same deleterious effects. For carnivores, the AZA Wildlife Contraception Center now recommends GnRH agonists, e.g., Suprelorin® (deslorelin) implants or Lupron Depot® (leuprolide acetate) as safer alternatives. Although it appears safe and effective, dosages and duration of efficacy have not been systematically evaluated for all species. GnRH agonists can be used in either females or males, and side effects are generally those associated with gonadectomy, especially weight gain, which should be managed through diet. Suprelorin® was developed for domestic dogs and has been used successfully in African clawless otters, North American river otters, Asian small clawed otters and sea otters.

Gonadotropin releasing hormone (GnRH) agonists [Suprelorin® implants, or Lupron Depot®]: GnRH agonists achieve contraception by reversibly suppressing the reproductive endocrine system, preventing production of pituitary (FSH and LH) and gonadal hormones (estradiol and progesterone in females and testosterone in males). The observed effects are similar to those following either ovariectomy in females or castration in males, but should be reversible. GnRH agonists first stimulate the reproductive system, which can result in estrus and ovulation in females or temporary enhancement of testosterone and semen production in males. Then, down-regulation follows the initial stimulation. The stimulatory phase can be prevented in females by daily Ovaban administration for one week before and one week after implant placement (Wright et al. 2001).

GnRH agonists should not be used during pregnancy, since they may cause spontaneous abortion or prevent mammary development necessary for lactation. They may prevent initiation of lactation by inhibiting progesterone secretion, but effects on established lactation are less likely. New data from domestic cats have shown no effect on subsequent reproduction when treatment began before puberty; no research in prepubertal otters has been conducted.

A drawback of these products is that time of reversal cannot be controlled. The depot vehicle (Lupron®) cannot be removed to shorten the duration of efficacy to time reversals. The implant, Suprelorin®, may be placed strategically to allow for removal though this technique has not been fully tested. Contact the WCC for more information and tips on placement to facilitate removal which may hasten reversal. The most widely used implant formulations are designed to be effective either 6 or 12 months, but those are to be considered minimum durations, which can be longer in some individuals.

Although GnRH agonists can also be an effective contraceptive in males, they are more commonly used in females, because monitoring efficacy by suppression of estrous behavior or cyclic gonadal steroids in feces is usually easier than ensuring continued absence of sperm in males, since most institutions cannot perform regular semen collections. Suprelorin® has been tested primarily in domestic dogs, whereas Lupron Depot® has been used primarily in humans, but should be as effective as Suprelorin®, since the GnRH molecule is identical in all mammalian species.

If used in males, disappearance of sperm from the ejaculate following down-regulation of testosterone may take an additional 6 weeks, as with vasectomy. It should be easier to suppress the onset of spermatogenesis in seasonally breeding species, but that process begins at least 2 months before the first typical appearance of sperm. Thus, treatment should be initiated at least 2 months before the anticipated onset of breeding. Suprelorin may also be used to mitigate aggression, however the suppression of testosterone does not always stop aggression if they are learned behaviors.

Progestins [Melengestrol acetate (MGA) implants, Depo-Provera® injections, Ovaban® pills] If progestins must be used, they should be administered for no more than 2 years and then discontinued to allow for a pregnancy. Discontinuing progestin contraception and allowing non-pregnant cycles does not substitute for a pregnancy. Use of progestins for more than a total of 4 years is not recommended. MGA implants last at least 2 years, and clearance of the hormone from the system occurs rapidly after implant removal. Progestins are considered safe to use during lactation.

Vaccines: The porcine zona pellucida (PZP) vaccine has not been tested in otters but may cause permanent sterility in many carnivore species after only one or two treatments. This approach is not recommended.

Ovariectomy or Ovariohysterectomy: Removal of ovaries is a safe and effective method to prevent reproduction for animals that are eligible for permanent sterilization. In general, ovariectomy is sufficient in young females, whereas, removal of the uterus as well as ovaries is preferable in older females, due to the increased likelihood of uterine pathology with age.

Vasectomy: Vasectomy of males will not prevent potential adverse effects to females that can result from prolonged, cyclic exposure to the endogenous progesterone associated with the pseudo-pregnancy that follows ovulation. This approach is not recommended for otters.

References:
Bertschinger, H. J., C. S. Asa, P. P. Calle, J. A. Long, K. Bauman, K. DeMatteo, W. Jochle, T. E. Trigg and A. Human (2001) Control of reproduction and sex related behaviour in exotic wild carnivores with the GnRH analogue deslorelin: preliminary observations. Journal of Reproduction and Fertility, Supplement **57**: 275-283.
Calle, P.P., M.D. Stetter, B.L. Raphael, R.A. Cook, C. McClave, J.A. Basinger, H. Walters, and K. Walsh, 1997. Use of depot leuprolide acetate to control undesirable male associated behaviors in the California sea lion (*Zalophus californianus*) and California sea otter (*Enhydra lutris*). In Gregory A. Lewbart (Ed.), Proceedings of the International Association of Aquatic Animal Medicine, 28: 6-7.
Calle, P.P., C. McClave, J.A. Basinger, H. Walters, B.L. Raphael, and R.A. Cook, 1998. Use of depot leuprolide and cyproterone to control aggression in an all male California sea otter (*Enhydra lutris nereis*) colony. In C.K. Baer (Ed.), Proceedings AAZV and AAWV Joint Conference. pp. 375-377.

Anesthesia

ANESTHESIA ADMINISTRATION, MONITORING AND RECOVERY

It is recommended that anesthesia be given intramuscularly (IM) in the cranial thigh (quadriceps), caudal thigh (semimembranosus-tendinosus), or paralumbar muscles. (Spelman 1999) Animals should be kept as quiet as possible. Generally restraint is accomplished using a net, squeeze cage, or capture box. The AZA Otter SSP recommends training animals to receive injections to minimize stress prior to all anesthesia events. A variety of agents have successfully been used in otter species for immobilization. These include Ketamine alone (not recommended), Ketamine with midazolam (preferred), Ketamine with diazepam, and Telazol®.

Otters have a large respiratory reserve, and so using gas induction chambers is often very time consuming (this can take up to 10 minutes in *A. cinereus*), but has been done successfully. However, due to the stress experienced by the animal as a result of the amount of time required using this method it is considered less desirable. Training otters to receive voluntary hand injections of anesthesia agents is the preferred method. Despite the method of induction, anesthesia can be maintained by intubating the animal and maintaining it on Isofluorane (Ohmeda Pharmaceutical Products Division Inc., P.O. Box 804, 110 Allen Rd., Liberty Corner, NJ 07938) or Halothane (Fort Dodge, 9401 Indian Creek Parkway, Ste. 1500, Overland Park, KS 66210) anesthesia. Otters are relatively easy to intubate, and this method is preferred when it is necessary for an animal to be immobilized for procedures longer than 15 minutes.

Careful monitoring of anesthetic depth and vital signs is important in any immobilization. Body temperature, respiratory rate and depth, heart rate and rhythm, and mucous membrane color and refill time should be assessed frequently. Pulse oximetry sites include the tongue, the lip at the commissure of the mouth, or in the rectum; however, it can be difficult to find a suitable probe site for pulse oximetry. Spelman found the following methods successful: a Nellcor D-25 probe (Nellcor, Inc.) *"..folded over the tongue or digits and secured with a paperclip, or a Nellcor RS-10 reflectance probe modified as an esophageal or rectal probe (or any comparable probe), indirect blood pressure can be readily measured with a small or neonatal cuff on the base of the tail"* (Spelman 1999). Oxygen supplementation should be available and administered when indicated.

The AZA Otter SSP veterinary advisor (G. Myers) suggests the following to improve anesthetic events:

- Accurate weights to establish appropriate drug doses,
- Reduction of stress leading up to anesthetic event, (training, conditioning),
- Intubation of all otters on procedures lasting longer than 15 minutes,
- Oxygen supplementation, intermittent positive pressure ventilation,
- Monitoring equipment, (SpO2, EKG, TPR),
- Well trained support staff (keepers, technicians)

Intubating an Otter

Photos: G. Myers

River Otter Short-term Anesthesia (Max 25-30 mins.) - Table

Anesthetic combination (mg/kg)*	Comments
Ketamine (10), midazolam (0.25)	Highly recommended
Ketamine (2.5), medetomidine (0.025) (atipamezole 0.125)	May need higher dosages (Ket 3.5, Med 0.035) but respiratory depression more likely
Tiletamine-zolazepam (4) ** (flumazenil 0.08)	Recovery may be prolonged without flumazenil
Ketamine (10)	Expect muscle rigidity and variable duration
Ketamine (10), diazepam (0.5 – 1)	Prolonged recovery compared to ketamine, midazolam
Ketamine (5-10), xylazine (1-2) (yohimbine 0.125)	Variable effects from heavy sedation only to respiratory depression. Alternative dosages Ket (3-4), xyl (3-4)
Azaperone (0.1), fentanyl (0.1-0.2) (naloxone 0.04)	Not recommended

***Dosages given are based upon intramuscular administration.**
From: Spelman, Lucy DVM: Table 2 from EAZWV Proceedings May 1998, Recommended anesthetic dosages (including reversal agents, in brackets, where appropriate) for short term anesthesia (25-30 min) in North American river otters (*Lutra canadensis)*.

** Petrini uses 8mg/kg Tiletamine-zolazepam (Telazol®) in *L. canadensis*

Physiologic Measures and the Effect of Anesthetic-Related Complications - Table

Physiologic Measure	Baseline (Range)	Increased	Decreased
Heart rate(beats/minute)	152 (130 – 178)	>180 (tachycardia)	<100 (bradycardia)
Respiratory rate (breaths/minute)	31 (10 – 60)	>40 (tachypnea)	<8 (bradypnea)
Relative oxyhemoglobin saturation (%)	97 (92 – 100)	NA	<80% (hypoxemia)
Mean arterial blood pressure (mm Hg)	63 (31 – 77)	<50 (hypotension)	>100 (hypertension)
Rectal temperature (°C)	38.4° (38.1 – 38.7°)	>40.1° (hyperthermia)	<36.7° (hypothermia)

From: L. Spelman 1999

Representative Arterial Blood Gas Results from 6 River Otters Anesthetized with Different Protocols - Table

Anesthesia Combination	PO_2 (mm Hg)	PCO_2 (mm Hg)	pH	HCO_3- (mEq/L)	SPO_2 (%)	SaO_2 (%)
Ketamine-midazolam	81.6	56.6	7.29	27.4	93	94.2
Tiletamine-zolazepam	69.3	51.9	7.32	27.2	93	91.8
Medetomidine-ketamine	68.8	54.2	7.29	26.4	93	90.9
Ketamine-diazepam	60.3	54.1	7.38	30.0	93	88.7
Fentanyl-midazolam	34.4	90.7	7.11	29.2	<50	44.6
Fentanyl-midazolam-azaperone	29.4	76.2	7.24	32.7	<50	42.0

From: L. Spelman 1999

Supplemental oxygen should always be available for administration, if necessary. For procedures lasting 30 minutes or longer, animals should be maintained on Isofluorane.

Signs of Illness

◄ It has been frequently repeated that an otter that skips one meal is worthy of concern; an otter that skips two meals is definitely ill. (An exception to this rule is a female that has just given birth; she may skip meals just prior to, and just after parturition. If this persists a veterinarian should be consulted.)

◄ Another excellent indicator of the state of an otter's health is the condition of its coat. It should be smooth, soft and shiny looking when dry. When wet, the coat should form spikes which allow the moisture to bead and run off upon emerging from the water. If it stays matted down, the coat is becoming saturated which is an indication there is something wrong. (This could be a sign of illness, poor nutrition or, an environmental problem such as caustic substances in the water, i.e. chlorine or an ozone system set too high.)

◄ If an animal is spending an excessive amount of time rubbing and rolling in an attempt to dry its coat.

◄ A reluctance to go in the water can mean an animal's coat is becoming drenched. Not only does this cause the animal to feel the cold but, also is an indication of a potential health problem.

◄ Loose or excessively soft stool; a healthy otter, receiving an appropriate diet, should have formed, soft stools.

◄ All of the non-species specific signals also should be watched for, i.e. swelling, lethargy, unusual behaviors, abnormal fluid drainage, etc.

Common Injuries or Ailments

VAGINAL DISCHARGE AND UROGENITAL DISORDERS

Captive otters are often noted to have a slightly bloody or even a reddish-brown vaginal discharge. The significance of this is as yet unknown. One author describes a slightly blood-tinged vaginal fluid as being normal during estrus in the river otter (Seager 1978); blood spotting had been reported by some institutions. Other researchers suggest that bloody mucopurulent vaginal discharge is indicative of genitourinary disease (Hoover 1984, Hoover 1985) which appeared to be common in wild-caught captive females (4 of 10 females; *Proteus mirabilis* was the most important pathogen found in all four). There have been reports of females with intermittent red to reddish-brown vaginal discharge that have appeared healthy, but other animals have had serious, even life-threatening urinary or uterine disease. Some otter caretakers believe that bloody vaginal discharge is seasonal and related to the estrous cycle. However, one captive otter with a persistent history of bloody vaginal discharge had an ovariohysterectomy performed, and although histopathology of the uterus supported mild endometrial disease, the bloody vaginal discharge returned after the surgery. This case suggests that the etiology of bloody vaginal discharge in this species is not simple and is probably multifactorial. Numerous organisms have been isolated from the vagina of otters with bloody discharge, including *Pseudomonas aeruginosa* and *Proteus mirabilis*. Since pyometras and other significant urinary and uterine infections do occur in otters, it is important to investigate any symptom that may indicate genitourinary disease. These symptoms may include a distended abdomen, increased water consumption, frequent urination, and genital rubbing, as well as vaginal discharge.

POOR COAT CONDITION

Hair coat problems are frequently reported in captive North American river otters. A healthy otter coat has guard hairs which form spikes when wet rather than becoming clumped or smooth. Water on the surface of a well waterproofed otter will form small droplets that do not penetrate the undercoat and are quickly removed with one good body shake. Indeed, the lighter colored undercoat should not be visible (Duplaix-Hall, 1975). If the coat is in poor condition the otter may refuse to go in the water because it is becoming waterlogged. One of the causes of a poor coat is poor water quality either due to excessive organic debris or to chemicals used in pool filtration systems. High levels of chlorine pose a threat to the water repellent ability of an otter's coat. Chlorine levels should be monitored closely and not be allowed to go above 0.5 ppm for long periods of time. (See Captive Management section for chlorine discussion.) Another potential cause of poor coat quality is lack of appropriate dry surfaces for grooming. Sufficient land area, bedding material, exhibit furniture, and a variety of substrates are very important for the otter to maintain a healthy coat. Over-grooming is another common cause of coat problems. Over-grooming is often associated with stress or overcrowding. It can either be self-induced, or caused from an overzealous exhibit-mate. Dietary imbalances and dermatological disease from fungi, bacteria, parasites, or allergies can also cause hair/coat problems. A methodical approach to investigating the cause of poor coat condition is necessary to identify and correct the problem.

Coat Photos

Poor coat quality (Photo, right: Gary Woodburn; Photo below: OKWS 2010)

Good coat quality (Photo: Wikipedia)

ALOPECIA

Seasonal coat changes and even a partial alopecia may occasionally occur in both males and females during the breeding season. The alopecia most commonly involves the tail and ventral abdomen and usually is bilaterally symmetrical. It resolves spontaneously at the end of the breeding season and is a normal hormonal phenomenon. In addition, pregnant females may occasionally pull hair from their abdominal region when parturition draws near. Because Alopecia is a commonly reported problem in river otters the AZA Otter SSP Veterinary Advisor (G. Myers) has evaluated records submitted to her regarding this issue.

Her findings to date are as follows:

- Most report a focal area of hair loss
- Reported in both sexes, but more often in females
- Most often involves the tail and/or the abdomen
- Most cases resolve with, or without intervention or treatment, if the resolve
- Agrees, it is possibly associated with breeding season and hormonal influences

Her diagnostic recommendations are:

- Skin scrapes; superficial and deep to detect parasites
- Fungal and bacterial cultures
- Biopsy if it does not resolve in a timely fashion, but these are often unrewarding
- Multiple treatments have been tried with varying success:
    - Antibiotics
    - Antihistamines
    - Environmental changes
    - Eliminating pain or neuropathy as causal agents

BITE WOUNDS

Bite wounds caused by exhibit mates can become infected and form abscesses. These should be surgically drained and the wound flushed with antibacterial agents such as dilute Nolvasan® or Betadine®. Systemic antibiotic therapy is often indicated. Bacteria commonly found infecting bite wounds include *Pasturella sp., Streptococcus sp*., and *Staphylococcus sp.*

FOOT PAD ABRASIONS

Abrasions, erosions, and ulcers of the feet are generally caused by the lack of a suitable substrate for the otter to adequately dry itself on, or continued pacing. If an exhibit consists primarily of concrete, or gunite, bedding of some type should be provided. When feet are chronically wet, the pads become soft and can be easily rubbed raw by rough surfaces.

LOOSE STOOL/DIARRHEA

Otter feces are normally softly formed. Loose stools or diarrhea can result from a variety of diseases, but often is simply the result of poor diet, overfeeding, abrupt dietary change, or consuming food that is spoiled or has become rancid. Many experienced otter rehabilitators report that diarrhea can be a problem when hand raising pups. Frequently this is the result of overfeeding or feeding an inappropriate diet. (See Hand Rearing and Nutrition sections for more information on these topics.) Clostridial enteritis is one of the most commonly reported diseases in both wild and captive North American river otters and can result in diarrhea, often with blood and mucous. See Bacterial Diseases for more details on *Clostridium*. Many other bacteria, viruses, and parasites can also cause loose stools or diarrhea.

PNEUMONIA

Pneumonia is relatively common in both captive and free-living otters (Madsen 1999, Chanin 1985, Duplaix-Hall 1975, Hoover 1984, Hoover 1985). Pneumonia and other respiratory disease can result from parasitic, bacterial, fungal, or viral disease. Often it is secondary to underlying problems such as stress, poor coat condition, extreme environmental conditions, or concurrent illnesses that have reduced the animal's immune capability. Treatment usually includes appropriate antimicrobial or antiparasitic agents, supportive care, and eliminating any underlying environmental or health problems. Symptoms of pneumonia include coughing, dyspnea, and rapid breathing. Otter pups are particularly susceptible to pneumonia and respiratory disease.

STRESS

Foster (1986) defines stress as, "*...a cumulative response, the result of an animal's interaction with its environment through receptors. This is an adaptive phenomenon. All responses are primarily directed at coping with environmental change, and behavioral repertoires may be dependent upon the stressful interaction of an animal with its environment."*

Stressors can be somatic, psychological, behavioral or miscellaneous; all of which can lead to poor health. Signs of stress may include poor coat condition, lack of appetite, unusual behavior, and/or frequent screaming. Examples of stressors given by Foster (1986) are listed below:

- Somatic stressors include: strange sounds, sights, and odors; unexpected touches; changes in position, heat, cold, or pressure; abnormal stretching of muscles and tendons; or effects of chemicals or drugs.
- Behavioral stressors include: unfamiliar surroundings, overcrowding, territorial or hierarchical upsets; changes in biological rhythms; lack of social contact; lack of isolation; the lack of habitual or imprinted foods.

Many other sources of stress are also possible. The vigilant otter keeper should always be on the alert for potential sources of stress to animals in their care.

DENTAL DISEASE

Periodontal disease**,** fractured teeth, and apical abscesses are common problems in captive otters. Facial swelling is a common symptom of an abscessed tooth, but it is not uncommon for animals to have severe dental disease and show no clinical signs. Regular examinations can help identify problems before they become too severe. Prompt treatment of fractures and abscesses is extremely important. Endodontic procedures such as root canals and pulpotomies can be performed on diseased teeth following appropriate antibiotic therapy. Alternatively, diseased teeth can be extracted. Animals with periodontal disease should have their teeth regularly cleaned and polished. Antibiotic therapy initiated several days before a dental cleaning and extended for 1-2 weeks following a procedure can help minimize bacterial embolism. Providing bones, such as knucklebones or neck bones from sheep or other large animals **twice** weekly, along with regular cleaning and polishing will help reduce periodontal problems.

Common Causes of Death

Dr. Gwen Myers, AZA Otter SSP Veterinary Advisor conducted a review of all submitted necropsy reports for this species. Her findings (table below) indicate that the most frequent causes of *L. canadensis* deaths (excluding neonatal deaths) are:

Common Causes of Death in L. Canadensis
(Unpublished research, G. Myers, DVM – Otter SSP Veterinary Advisor)
2007

Cause of death	Causal factor
Heart disease	- Heartworm/death from heartworm treatment - Acute myocarditis - Myofiber degeneration
Renal failure	- Etiology unknown - Amyloidosis - Pyelonephritis
Hepatic lipidosis	-

Adenocarcinoma	-
Transitional cell carcinoma (bladder)	-
Peritonitis	- Secondary to intestinal perforation from foreign body - Secondary to GI perforation from ulcers
Diarrhea	- Unknown etiology - Clostridial endotoxin - *Helicobacter* (also causing vomiting, weight loss) - *Salmonella*
Gastric dilatation with volvulus	-
Pneumonia	- Often without identifying underlying cause*
Anesthetic death	-

*Poor coat quality and other factors can lead to pneumonia. Poor coat quality is of concern when its water repellency is affected. If water does not form droplets, and cannot be easily shaken off the guard hairs, (i.e., brown fur), the otters' guard hairs clump together resulting in a coat that looks slick and saturated. This leads to water penetrating the guard hairs and exposure of the under-fur (gray/white under coat), which can then become waterlogged. An otter in this condition may not swim in an effort to remain as dry as possible. If the otter does swim, and it cannot keep dry, its body temperature will drop rapidly leading to observable shivering, even during sleep. Enteritis can develop in cases of extreme chilling. If measures are not taken, death can follow in a matter of days through pneumonia and/or gastro-intestinal complications (Duplaix-Hall 1972). Insufficient land vs. water area, and/or inappropriate enclosure substrates causing overly damp/wet conditions, were historically most often the reason for poor coat condition and the resulting health problems in river otters (Duplaix-Hall 1972, 1975).

General Mustelid Disease

VIRAL DISEASE

See also Appendix A.

Canine Distemper

Canine distemper has been confirmed in multiple species of mustelids, including the Eurasian otter, *Lutra lutra* (Madsen 1999, Geisel 1979, Loupal In Press). Antibody titers have been noted in *L. canadensis* (Kimber 2000), and recently a suspected case of distemper occurred in *L. canadensis* in Canada. Distemper could not be confirmed but clinical signs and distemper serology were supportive of the diagnosis. The animal survived without treatment (Sandra Black 2000, personal communication). In general, however, otters may be relatively resistant to canine distemper virus, compared to other mustelid species such as weasels and ferrets. In North America there have been many well-described epizootics of canine distemper in wild foxes and raccoons in areas where otters are common and there has been no corresponding mortality in otters. The clinical presentation of distemper in mustelids is similar to that in dogs. In addition to mucopurulent oculonasal discharge, respiratory disease, diarrhea, hyperkeratosis of the footpads, and C.N.S. signs; ferrets and mink also frequently get a rash under the chin and in the inguinal area. In the black-footed ferret intense pruritis and cutaneous hyperemia is common. Vaccine-induced distemper may have a slightly different clinical presentation, but has never been reported in the otter despite the use of a variety of modified-live products in this species.

Mink Enteritis Virus, Feline Panleukopenia, Canine Parvovirus

These closely related viruses have been shown to affect mink and the skunk. The domestic ferret is not susceptible to these viruses under natural circumstances. The disease in mustelids is similar to that in felids and includes diarrhea, vomiting, fever, and leukopenia. Several studies have reported positive antibody titers in wild river otters (Hoover 1985, Kimber 2000) and there has been at least one suspected case of parvovirus in a small-clawed otter housed in a United States zoo. However, viral particles were not found on histopathology and viral cultures and serology were not performed. “Feline enteritis/panleukopenia” was diagnosed in 18 out of 88 post mortems from a variety of zoos that were reviewed by one author (Duplaix-Hall), although the method of diagnosis was not described in these cases.

Aleutian disease (plasmacytosis)

Typically a disease of farm-raised mink, but has been found in feral mink, the domestic ferret, and the striped skunk. Aleutian disease viral antibody has been found in skunks, fishers, and the American marten (*Martes americana*). In one study, a river otter was challenged with Aleutian virus, but did not become clinically ill nor did it develop an antibody titer (Kenyon 1978). However, a disease resembling Aleutian disease was recently described in a wild European Otter *(L. lutra)*, although no virus was actually isolated (Wells 1989). Aleutian Disease is an immune-mediated disease caused by a parvovirus of which there are several strains of varying pathogenicity. In mink, infection can range from unapparent to fatal. Generally, the course of the disease is slowly progressive over months to years. It is characterized by weight loss, hypergammaglobulinemia (greater than 20% of total serum protein), reproductive failure, and an immune-mediated glomerulonephritis. Some animals have hemorrhagic enteritis. Neonates may develop a fatal interstitial pneumonia. Increased numbers of plasmacytes are found in the liver, kidney and other organs, hence the name plasmacytosis. Several methods of detecting the disease ante mortem are used including the rapid iodine agglutination test (IAT) and the counter immuno-electrophoresis (CIEP) test.

Rabies

The Center for Disease Control has records of at least 24 cases of rabid otters in North American. (Serfass 1995). Affected animals may remain calm and asymptomatic .

Coronavirus

Coronavirus has been implicated as the cause of epizootic catarrhal enteritis in both mink and ferrets (Williams 2000). There have been no confirmed cases of coronavirus enteritis in otters. In 1995-1996 thirty-eight river otters were tested for feline and canine coronavirus antibody. All were negative. In 1975, feline infectious peritonitis (FIP), a disease caused by a feline coronavirus, was suspected to have caused the death of 2 small-clawed otters, but the case was never confirmed with serology or viral isolation. (Van de Grift 1976).

Influenza

The domestic ferret is susceptible to certain strains of human influenza and is used as a research animal to study the disease. Symptoms in ferrets include sneezing, conjunctivitis, unilateral otitis, fever, and sometimes photophobia. The disease usually lasts 7-14 days. Avian influenza A virus was responsible for an outbreak of contagious interstitial pneumonia in mink in Sweden in 1984. Although it is not known whether other species of mustelids are susceptible to influenza, it would seem prudent for animal caretakers exhibiting signs of influenza to wear masks and disposable gloves when caring for mustelids. Infected ferrets can also transmit influenza to humans.

Rotavirus

A disease described in domestic ferrets as "ferret kit disease" is caused by a rotavirus. The disease usually affects kits from two to six weeks old causing diarrhea and resulting in high mortality. Histopathologic lesions include villous atrophy and vacuolation of villar epithelial cells in the small intestine. Direct electron microscopy is used to identify the virus in the feces. Serological tests are unreliable. Since secondary bacterial invaders may increase mortality, it has been recommended that affected individuals be treated with oral gentomycin and parenteral ampicillin. A syndrome in farmed mink known as "**3-day disease**", "**Utah disease**", or "**Epizootic Catarrhal Gastroenteritis**" may also be caused by a rotavirus. The disease is characterized by a short course of diarrhea, anorexia, and lethargy. It is rarely fatal.

Transmissible Mink Encephalopathy (TME)

TME is caused by a scrapie-like virus that occasionally causes disease in adult mink. Experimentally, striped skunks are also susceptible. It has a long incubation period lasting five to 12 months. Both morbidity and mortality are high. The main clinical signs can be attributed to lesions in the cerebrum and include behavioral changes, weakness, ataxia, and sometimes paralysis. Reproductive failure including stillbirths (often with anasarca) and congenital defects is also a feature of the disease. Diagnosis is based on histopathologic findings in the cerebrum.

Feline Leukemia Virus

Healthy domestic ferrets have tested positive to FeLV by ELISA, but the significance of this is unknown. It is possible that the test is cross-reacting with another retrovirus or that false positive results are occurring. To date, no immunodeficiency virus has been identified in otters.

Adenovirus (Infectious Canine Hepatitis)

This disease has been reported in the striped skunk, and there has been one river otter that died of symptoms suggestive of canine adenovirus, but the diagnosis was not confirmed by viral isolation (Kimber 2000). Antibody testing of wild, unvaccinated river otters has been negative for canine adenovirus in several studies (Hoover 1985, Kimber 2000).

Feline Rhinotracheitis (Feline Herpesvirus-1) and Feline Calicivirus

Upper respiratory disease suggestive of feline rhinotracheitis or calicivirus has not been reported in North American river otters. Sixty-four wild river otters from New York were serologically tested for antibody to feline herpesvirus-1 and feline calicivirus during a translocation study conducted in 1995-1996. All 64 animals were negative for antibody to both viruses. (Kimber 2000).

Herpesvirus

Herpesvirus-like intranuclear inclusion bodies were found in the oral, esophageal and corneal epithelial cells of a dead adult male sea otter (*Enhydra lutris*) found in Alaska (Harris 1990). Herpesvirus infections have been reported in both wild and captive sea otters. (Reimer 1998). Antibody titers to canine herpesvirus-1 have been reported in wild-caught otters. (Kimber 2000).

Herpes Necrotizing Encephalitis

Herpes necrotizing encephalitis is caused by a herpes simplex virus and has been reported in skunks. The virus causes necrotizing meningoencephalitis with necrosis and hemorrhage in the liver and adrenal gland. Clinical signs include salivation, tremors, and head bobbing. Diagnosis can be made from serology. (Wallach 1983).

Pseudorabies (Mad Itch)

This has been reported in several species of mustelids. Signs are similar to those of other carnivores and may include intense pruritis, ataxia, vomiting, salivation, dyspnea and death. (Wallach 1983).

BACTERIAL DISEASE

See also Appendix A.

Bacterial Pneumonia

Pneumonia has been frequently reported in otters (Duplaix-Hall 1975, Madsen 1999, Hoover 1984, Hoover 1985). No one agent appears to be responsible, although bacterial cultures are not available for most of the cases reported. Signs of pneumonia may include nasal discharge, dyspnea, coughing, anorexia, and lethargy. Treatment involves appropriate antibiotic therapy. Viral infections, poor coat quality, and/or stress can predispose animals to bacterial pneumonia.

Pseudomonas pneumonia

Several serotypes of *Pseudomonas aeruginosa* cause hemorrhagic pneumonia in mink. The disease usually occurs in the autumn and can quickly spread through a ranch. Mortality rates vary from 0.1% to 50%. Animals die quickly, often without showing clinical signs. Occasionally dyspnea, a bloody nasal discharge, or convulsions are seen. The main post mortem lesion is hemorrhagic pneumonia with or without hemorrhagic pleural exudate. There is evidence that bacterial toxins may play a role in the pathogenesis of the disease. Concurrent infection with calicivirus or picornavirus, as well as poor air quality with high ammonia levels has been implicated as predisposing factors in the pathogenesis of the disease. This particular syndrome has not been reported in river otters.

Clostridial Infections

Botulism--Most species of mustelids are susceptible to type C toxin (and to a lesser extent types A, B, and E) produced by *Clostridium botulinum*. Usually animals are found dead but some may exhibit paralysis and dyspnea before dying. There are no postmortem lesions. Eating cooked or uncooked meat contaminated by *Clostridium botulinum* spores found in the soil causes the disease. The prevalence of Clostridial organisms in the soil varies greatly from one geographic area to another. Animals not on a commercially prepared diet may benefit from annual vaccination, however eliminating soil contamination of food can also prevent the disease.

Clostridium perfringens enteritis—River otters appear to be particularly susceptible to overgrowth of *Clostridium perfringens* during periods of stress or dietary conversion. In a recent translocation study, a number of wild river otters became ill shortly after capture (Kollias 1998). These otters died anytime from 6 to 72 hours after capture. Clinical symptoms ranged from sudden death in some animals to mucoid watery diarrhea with or without blood to lethargy, anorexia, and hypothermia. Diagnosis is based on histopathological findings, anaerobic culture and the detection of Type A *Clostridium perfringens* exotoxin. Animals treated early in the course of the disease may respond to oral metronidazole (Kollias 1998) or parenteral trimethoprim-sulfa and *Clostridium perfringens* antitoxin (Kollias 1999), along with supportive care.

Tuberculosis

Many mustelids are susceptible to bovine, avian and human strains of tuberculosis. The disease has been reported in the domestic ferret, mink, otters, and the European badger. It is usually acquired by eating contaminated food, however in the European badger, transmission can occur from mother to cub, by aerosol, or through bite wounds. Clinical signs may include weight loss, enlarged lymph nodes, chronic respiratory disease, and mastitis. Tuberculin skin testing is unreliable. Serological tests used to identify European badgers with *Mycobacterium bovis* have also been unreliable.

Anthrax

Anthrax has been reported in the European badger, the honey badger (*Mellivora capensis*), and mink. Clinical signs include sudden death with blood draining from body cavities. Postmortem findings include subcutaneous and subserosal edema, hepatomegaly, and splenomegaly.

Campylobacteriosis

Diarrhea caused by *Campylobacter jejuni* and *Campylobacter coli* has been reported in domestic ferrets and mink (Petrini 1992). Fever and leucocytosis often accompany infections. Abortion and other reproductive problems occur in both mink and ferrets when they are inoculated with *C. jejuni* during pregnancy. Clinical disease is most common in animals less than six months of age, and asymptomatic carriers are not uncommon especially with adults. Special techniques are required to culture the organism from the feces. Humans are also susceptible to infections with *C. jejuni*. Erythromycin, the drug of choice in humans, does not eliminate the carrier state in ferrets. Raw meat diets appear to predispose mink to *C. jejuni* infection.

Helicobacter mustelae

Helicobacter mustelae is a bacterium that often colonizes the stomach of ferrets and causes a chronic, persistent gastritis, and sometimes leads to gastric or duodenal ulceration, and/or gastric cancer (Fox 1998). The organism is quite common in ferrets but infected animals are often asymptomatic, especially when they are young. Symptoms of disease such as vomiting, dark tarry stools, chronic weight loss, and anemia may occur if gastric ulceration or cancer develops. The diagnosis is made by special culture techniques of gastric biopsy or necropsy samples. Recently a serological assay has been developed (Fox1998).

Proliferative Bowel Disease

This is a syndrome described in young, 4-6 month old domestic ferrets characterized by mucohemorrhagic diarrhea , weight loss, and partial prolapse of the rectum. The disease causes a profound thickening of the mucosa and muscular wall of the colon, which can be palpated per rectum. Pathological lesions are similar to those found in hamsters with "wet tail" and swine with proliferative ileitis, except lesions in the ferret are in the colon not the ileum. A Campylobacter-like organism closely related to *Desulfovibrio spp* causes the disease in ferrets. In swine and hamsters it is named *Lawsonia intracellularis* (Fox 1998). Diagnosis is based on the detection of the organism in histological sections of the colon stained with silver. Recently a PCR test has been developed as a diagnostic test.

E. coli mastitis

Mastitis caused by *E. coli* is a rapidly progressive disease that has been reported in the domestic ferret. Toxemia occurs, and mortality can be quite high. Early, aggressive therapy involving amoxicillin with clavulanate, chloramphenicol, or gentamicin, along with surgical excision of the affected mammae has been successful (Fox 1998). The disease has also been seen in mink (Fox 1998). Other bacteria may also be associated with mastitis in mustelids.

Purulent Pleuritis

Pleuritis is an inflammation of the pleura, often accompanied by an accumulation of pus in the pleural space around the lungs. Purulent pleuritis involving several different bacteria has been commonly reported in mustelids including the European badger, mink, and a North American otter. *Bacteroides melanigenicus* was isolated from the pleural fluid in one case (Griffith 1983). In mink, it is often seen in conjunction with dental disease and severe gingivitis.

Purulent Peritonitis

Peritonitis is an inflammation of the lining of the abdomen (peritoneum). It can be caused by a variety of different bacteria, and is often accompanied by purulent liquid in the abdominal space. Invasion of the peritoneal cavity with bacteria is most often the result of a penetrating foreign object, either through the abdominal wall or through the intestine. However, blood-born septicemias can also result in peritonitis. In one river otter, the peritonitis was due to a pure growth of *Klebsiella pneumonia* with no evidence of underlying disease (Petrini, unpublished).

Brucellosis

Brucellosis is an infectious disease caused by one of several species of *Brucella*. Clinical signs usually included abortion and, sometimes, orchitis and infection of the accessory sex glands in males. An unidentified *Brucella sp*. was recently isolated from the lymph node of a European otter (*Lutra lutra*) which had been killed in a road traffic accident in Scotland (Foster 1996). The significance of this finding is unknown.

Leptospirosis

Wayre considered leptospirosis an important disease in otters (Chanin 1985), and it was suspected to be the cause of death in several otters in a review of postmortem reports from a variety of zoos (Duplaix-Hall 1975). However, Fairley in 1972 found no histologic evidence of leptospirosis in the kidneys of 15 otters (Chanin 1985), and it is rarely mentioned in the literature. Leptospirosis is a contagious disease that causes anorexia, fever, vomiting, lethargy, anemia, hemoglobinuria, icterus, abortion, or death. There are many serotypes of the virus and humans are also susceptible to infection. Transmission occurs via contact with water, moist soil, or vegetation contaminated with infected urine, or by direct contact with the infected animal. Rats are common carriers.

Listeriosis (Circling disease)

Listeriosis is a disease caused by infection with the bacteria *Listeria monocytogenes*. In most species it causes neurological symptoms such as ataxia and circling, and thus must be distinguished from rabies. The disease can also result in abortion, perinatal mortality, and septicemia. The disease has been reported in the ferret, sable and striped skunk. Some animals are asymptomatic carriers of the disease and shed the bacteria in their feces.

Pasteurellosis

Pasteurellosis can be caused by either *Pasteurella multocida* or *Pasteurella pseudotuberculosis*. Although this disease is most commonly seen in rodents and lagomorphs, it has been reported in several mustelid species including mink, marten, badger, otters, and ferrets (Wallach 1983). Clinical signs can vary and may include depression, septicemia, ataxia, anorexia, diarrhea, dyspnea, or acute death.

Salmonellosis

Salmonellosis is caused by one or many species of Salmonella and characterized clinically by one or more of three major syndromes – septicemia, acute enteritis, chronic enteritis. Although it can be treated with antibiotics, it is often difficult to rid the animal of the organism. *Salmonella* spp. have been isolated from the feces of clinically normal otters and does not always cause disease.

Tularemia

Tularemia is a bacterial disease caused by *Francisella tularensis* that results in small granulomas or abscesses throughout the lungs, liver, mesenteric lymph nodes, and spleen. It can infect a variety of species including free-ranging mustelids and ranch mink, as well as humans. Sudden death or acute onset of anorexia is the most common clinical sign in mustelids. Animals are infected when they ingest carcasses of infected animals, particularly fish, rabbits or rodents.

Actinomycosis

Actinomycosis has been reported in the ferret and other mustelids. The infective agent, *Actinomyces sp*., causes a disease known as "lumpy jaw". The organism has a predilection for the cervical area and often results in the abscessation of the submandibular lymph nodes, although lymph nodes throughout the body can also be affected.

MYCOTIC DISEASES

Fungal diseases have not been frequently reported in mustelids. See also Appendix A.

Dermatomycosis

Dermatomycosis is more commonly referred to as "ringworm". The most common causative agents are members of the genera *Microsporum* and *Trichophyton.* Dermatomycosis has been reported in mink, domestic ferrets, and otters. Ringworm is contagious and potentially zoonotic. Although some cases are self-limiting, others require treatment with topical and/or oral anti-fungal agents.

Histoplasmosis

Histoplasmosis is a systemic fungal disease that results in variety of clinical signs including, lymphadenopathy, pneumonia, anorexia, weight loss, splenomegaly, and hepatomegaly. It is caused by the intracellular organism, *Histoplasma capsulatum*. Histoplasmosis has been reported in both domestic ferrets and striped skunks, and is most common in the central part of the United States where the organism can be found in the soil.

Cryptococcosis

Cryptococcosis is an infection caused by *Cryptococcus neoformans* and usually causes neurological signs as a result of meningoencephalitis. There have been several cases in the domestic ferret (Fox 1998).

Blastomycosis

Blastomycosis is a systemic fungal infection caused by the fungus *Blastomyces dermatidis*. It has been reported in the domestic ferret. Blastomycosis can affect both the lungs and skin causing pneumonia and/or cutaneous lesions. The disease occurs most commonly in the central and southeastern United States.

Coccidioidomycosis

Coccidioidomycosis is a fungal disease caused by *Coccidioides immitis* and is most common in the southwestern United States. The disease can cause respiratory disease as well as lymphadenopathy and occasionally osteomyelitis. Several cases of this disease have been reported in captive small-clawed otters from Arizona (Petrini 1992)

Mucormycosis
Mucormycosis is a fungal infection usually caused by *Absidia corymbifera (ramosa).* It generally occurs in conjunction with the ear mite, *Otodectes cyanotes* and causes otitis media and meningoencephalitis. This disease has been reported in farmed ferrets.

Adiaspiromycosis
Adiaspiromycosis is a disease that causes granulomatous lesions in the lungs, and sometimes involves regional lymph nodes. Mustelids appear to be particularly susceptible, and there are several reports of the disease in European otters (Simpson 2000). The disease is caused by the fungus *Emmonsia* crescens (formerly *Chrysosporium crescens).*

PARASITES
Numerous external and internal parasites have been identified in both wild and captive otters. Only a few will be covered here. (See Appendix A).

Microfilaria
Microfilaria are found frequently in the blood of wild North American river otters (Hoover 1984, Hoover 1985, Davis 1992, and Tocidlowski 1997). There are at least 2 species of microfilaria that have been identified in otters. *Dirofilaria lutrae* adults have been found in both the subcutaneous tissues (Hoover 1984 and Hoover 1985) and in the pulmonary arteries (Hoover 1985) of wild otters. A second *Dirofilaria* species has been identified from the pulmonary arteries as well (Hoover 1984.) In addition, there is one report of a North American river otter from Louisiana that had one male *Dirofilaria immitus* in its heart (Snyder 1989). *D. immitus* is the agent that causes heartworm disease in dogs, but in this case no pathology was attributed to the parasite. It is unclear whether *D. lutrae* or any of the other *Dirofilaria* sp. can cause clinical heartworm disease in otters, but since they can occupy the pulmonary arteries, it is possible. Many institutions housing otters outside in heartworm endemic areas keep their animals on heartworm preventative.

Respiratory Parasites
Lungworms are fairly common in wild otters. Several species affect mustelids including *Crenosoma spp.*, *Perostrongylus spp*., and *Filaroides spp*. Clinical signs vary from cachexia and anemia to coughing, dyspnea, depression, and nasal discharge. Diagnosis is made by finding the first stage larvae in the feces. New York has reported ivermectin-resistant strains of *Crenosoma sp*. in *L. canadensis* and recommends treatment with fenbendazole (Kollias 1999). Baermann and direct fecal smear examination techniques are helpful in diagnosing these parasites.

Capillaria aerophilia is another common nematode that causes respiratory disease in mustelids. The adult worms live in the trachea, bronchi, and bronchioles. Animals with mild infections may be asymptomatic but heavy infestations can result in coughing, respiratory difficulty, bronchopneumonia, nasal discharge and anorexia. *Capillaria* has been identified in the North American river otters (Hoover 1984, Hoover 1985, Kollias 1999). The ova, resembling a whipworm egg, are found in the feces or sputum.

Adult nematodes of the genus *Skrjabingylus* are located in the frontal sinus and cause progressive damage to the skull and nasal turbinates. Clinically, nasal discharge and neurological signs may be seen. *Skrjabingylus spp.* have been reported in mink, ermine, fishers, North American otters, striped skunks, and spotted-necked otters (*Lutra maculicollis*), as well as other mustelids. One study reported that as many as 13 % of wild North American river otters from Ontario were affected by the parasite (Addison 1988).

Lung flukes (*Paragonimus kellicotti*) have been reported in mustelids including mink, marten, badger, weasel, and skunk (Wallach 1983, Davis 1971). Infection results in a moist cough, sometimes with blood, elevated temperature, anemia, and difficulty breathing.

Kidney worm

Dioctophyma renale has been reported in a variety of mustelids including the North American otter. Mink appear to be the primary host in North America. The parasite causes weight loss, abdominal pain, and hematuria. Infection almost always involves the right kidney where a plate of bone often forms which is visible on radiographs. Diagnosis can be made from finding the ova in the urine. Another species of kidney worm, *Gnathostoma miyazakii*, is commonly found in *L. canadensis* in Virginia.

Acanthocephala (Thorny-headed worms)

Acanthocephalus spp. have been found in wild North American river otters (Kollars 1997, Hoberg 1997, Hoover 1984). One species has been identified as *Corynosoma strumosum* (Hoberg 1997). These relatively large worms can cause anemia and enteritis.

"Guinea worm"

Dracunculus insignis is a nematode that has been found in the subcutaneous tissues of several mustelid species including fishers, skunks, and mink. A separate species has been identified in the North American river otter. *Dracunculus* causes a varying degree of pruritis and local erythema. It is most commonly located on the legs. Removal of the adult parasite is curative (Petrini 1992).

Trichinosis

Trichinosis is a disease caused by the nematode *Trichinella spiralis*. The disease has been reported in the European otter and other mustelid species. Mustelids fed raw meat harboring viable trichina larvae are susceptible to the infection. Typical clinical signs include muscular pain, anorexia, and dyspnea. Heavy infestations are fatal.

Cestodes (Tapeworms)

Multiple species of cestodes have been identified in mustelids. Species that have been identified in North American river otters include *Ligula intestinalis* and *Diphyllobothrium* (questionable identification) (Chanin 1985), as well as *Schistocephalus solidus* (Hoberg 1997).

Miscellaneous nematodes

Several species of intestinal nematodes have been identified in North American river otters. One of the most commonly reported is *Strongyloides lutrae* (Kollias 1999, Hoover 1984, Hoover 1985, Hoberg 1997, Kollars 1997). Other species identified include *Ancylostoma sp* (Hoover 1985), and *Eustrongylides sp*. (Hoberg 1997). Some nematodes have been reported but not speciated. Many of the oocytes found in the feces of wild *L. canadensis* are considered incidental, and are actually fish or amphibian parasites whose eggs are being passed in the feces of the otter after consumption of the host.

MISCELLANEOUS TREMATODES (FLUKES)

Several kinds of intestinal flukes have been reported in mustelids. Species that have been reported in North American river otters include: *Euparyphium inerme* (Hoberg 1997), *Baschkirovitrema incrassatum* (Kollars 1997), *Enhydridiplostomum fosteri* (Hoover 1984), *Euparyphium melis* (Chanin 1985), and *Nanophyetus salmincola* (Schlegel 1968).

PROTOZOAN

See also Appendix A.

Coccidia

Heavy infestations of coccidia can cause mortality in young ferret and mink kits. Several species of *Isospora* have been reported in North American river otters (Hoover 1985), but clinical disease due to the parasite was not noted.

Toxoplasmosis

Toxoplasmosis can cause neonatal deaths and stunting in both ferrets and mink. A survey of North American river otters conducted in North Carolina showed that 45 % of the animals had positive titers to toxoplasma (Tocidlowski 1997).

Cryptosporidia

Asymptomatic ferrets can shed C*ryptosporidia* and pose a zoonotic hazard. To date there are no reports of this parasite in the North American river otter.

Giardia

Giardia spp. has been seen in the feces of various mustelids.

Sarcocystis

Sarcocystis spp. have been found in fishers, mink, wolverines, badgers, and recently in a European otter (*Lutra lutra*). In this case, the sarcocysts were found in large numbers in the skeletal muscle, but there was no apparent pathology associated with their presence (Wahlstrom 1999). Ferrets can be infected experimentally but remain asymptomatic (Fox 1998). Sarcocystis eggs can be passed in the feces and are easily mistaken for coccidia.

EXTERNAL PARASITES

External parasites are relatively uncommon in North American river otters (Serfass 1992) compared to other carnivores. However there are occasional reports of ticks, lice, and fleas. See Appendix A.

MISCELLANEOUS DISEASES

Urolithiasis

Urolithiasis has been reported in a variety of otter species. Calcium oxalate stones are common in captive *Aonyx cinerea* (Petrini, 1996). And in one study, 10 out of 14 *Lutra lutra* carcasses submitted for pathological examination were affected with urolithiasis. These uroliths contained calcium phosphate, calcium urate, or ammonium urate (Keymer, 1981). Other pathological reports of *Lutra lutra* have also detected kidney stones (Madsen 1999, Chanin 1985, Simpson 1997). One of these reports identified the calculi in three otters as being composed of ammonium urate (Madsen 1999). Small uroliths are often seen on radiographic examination of *L. canadensis* at the Minnesota Zoological Garden, however clinical disease is rarely noted. Of 21 animals radiographed over the past 20 years, 10 have had uroliths. Both calcium oxalate and magnesium phosphate calculi have been detected at this institution (Petrini, unpublished).

Neonatal mortality

Neonatal mortality in otters is most commonly due to septicemia, but starvation and hypothermia are also common in the first four weeks of life. Trauma and cannibalism can also occur. Neonatal losses can be minimized by providing secluded nest boxes (at least two, offering the dam a choice), sufficient dry bedding, and insuring adequate nutrition for the dam.

Hypocalcemia, Milk Fever, Pregnancy Toxemia

Low serum calcium levels in lactating or late gestation females can cause weakness, rear leg paralysis, convulsions, and death. The disease can affect ferrets approximately 3-4 weeks postpartum but sometimes occurs in the late pregnancy (Petrini 1992). Poor nutrition has been implicated as a cause, but this is not proven. Post mortem findings usually include hepatic lipidosis. Prompt treatment with intravenous calcium can quickly reverse the condition.

Agalactia, “Nursing Sickness”

Both mink and ferrets are afflicted with a syndrome known as agalactia or "nursing sickness". This generally occurs 5-6 weeks postpartum before the kits are completely weaned, but it can occur even after weaning. Clinical signs include lethargy, weight loss, ataxia, weakness, and coma. Occasionally hemolytic anemia can occur. The cause of the disease is unknown, but diets high in polyunsaturated fats may predispose animals to the condition. Some authors believe the condition is due to a sodium chloride deficiency. Hepatic lipidosis is often seen on post mortem examination. Offering food and water to kits beginning at 2-3 weeks of age will help prevent the disease (Petrini 1992).

Gastric ulcers

Gastric ulcers can cause vomiting, halitosis, melena, anemia, and acute death in mink and domestic ferrets. It has also been seen in weaning age otter pups (Joe Davis 1985, unpublished). Although stress has usually been implicated as the etiology, *Helicobacter mustelae* has been shown to cause gastritis and ulcers in domestic ferrets (see Bacterial Diseases for more information). Cimetidine, amoxicillin, metronidazole, and bismuth subsalicylate are suggested treatments (Fox 1998). Gastric ulcers can also occur secondary to renal failure.

Gastric dilatation (Bloat)

Acute gastric dilatation has also been reported in ferrets. It is often associated with dietary changes or overeating, especially after a prolonged fast. *Clostridium welchii* has sometimes been isolated from bloated ferrets. *Clostridium perfringens* enterotoxemia (see Bacterial Diseases for more details) may lead to gastric distention in North American river otters.

Diabetes mellitus

Diabetes mellitus has been described in the ferret and there has been at least one case in an Asian small-clawed otter and one case in a North American river otter (Petrini, unpublished).

Exertional Myopathy (Capture Myopathy)

Capture myopathy has been reported in translocated North American river otters (Hartup 1999). This disease is the result of excessive muscle exertion and stress and involves complex metabolic changes occurring 1-3 days after a stressful event. Animals typically show depression, anorexia, muscle weakness, ataxia, and pain.

Intervertebral disc disease

This is another common entity reported in ferrets, otters, and other mustelids. Exhibit space, housing, handling procedures and activity can predispose animals to vertebral problems and should be carefully evaluated.

Cancers

Numerous **neoplasias** have been reported in mustelids. Lymphosarcoma is the most commonly reported tumor type in the domestic ferret, followed by tumors of the reproductive tract and skin. In the mink, lymphoreticular tumors and anal sac carcinomas are commonly reported. Tumors resembling Hodgkin's Disease in humans have been reported from striped skunks.

Pulmonary Silicosis

Three North American river otters from one zoo died during or shortly after anesthetic procedures and were found to have pulmonary silicosis. Aluminum silicate was found in the lung tissue and also in the insulation material used in the nest box. It is likely that chronic inhalation of silica particles resulted in serious lung pathology and predisposed them to anesthetic complications (Suedmeyer 1999).

Dietary Issues

North American river otters have a high metabolic rate compared to other mammals and will eat approximately 9 % of their body weight per day (wet weight basis) (Davis 1992). One study reported that river otters consume about 177 kcal of gross energy per kg body weight per day (Davis 1992). They also have a very short digestive tract compared to other mammals. It takes only about 3 hours for food to pass through the entire tract once it is consumed (Davis 1992). A diet high in protein and fat and low in carbohydrates fed two or preferably, three times daily is best suited for this type of animal. Frequent feeding of small meals also helps stimulate physical activity and reduces the likelihood that food will spoil and later be consumed.

General Nutrition

► **Protein** – Otters are for the most part dependent on animal protein sources.

► **Carbohydrates** – *"Carbohydrates are not as important as an energy source to the mustelids as are fats, and therefore low carbohydrate cat or mink diets are preferable to the high carbohydrate dog foods."* (Wallach 1983)

► **Fats** – *"Fats are an important energy source for the mustelids. Rancid fats cause severe digestive problems and interfere with utilization of several nutrients, including vitamin A, vitamin E-selenium, calcium, and zinc."* (Wallach 1983)

► **Vitamins and Minerals** – The omission of these important elements can lead to serious deficiencies. Although, most commercially prepared diets contain adequate amounts of these essential elements, **all dietary products should be researched and monitored for quality on a regular basis.)**

■ **Thiamine (B_1) –** Thiamine deficiency is also known as Chastek's paralysis. Clinical signs include, anorexia, salivation, ataxia, incoordination, papillary dilatation, sluggish reflexes, and paralysis . Feeding certain types of raw fish that are particularly high in the enzyme thiaminase is the usual cause. Thiaminase destroys the thiamine present in the food and therefore results in a deficiency of this nutrient. Herring, smelt, and carp are only a few of the fish that contain high levels of thiaminase. Otters that are being fed fish should be supplemented with thiamine at the rate of 25-30 mg thiamine per kg of fish fed. (See the Diet/Nutrition Section for more details.)

■ **Vitamin E** – a deficiency of Vitamin E can cause yellow-fat disease, also known as steatitis. Clinical signs may include lethargy, lumpy subcutaneous fat, rear leg weakness, and death. Vitamin E deficiency can also cause fatty degeneration of the liver, hemolytic anemia, and anorexia. Young growing animals are particularly sensitive. Diets that are high in long-chain polyunsaturated fatty acids (common in fish oils), or rancid fats can cause vitamin E deficiency Otters that are being fed fish should be supplemented with vitamin E at the rate of 100 I.U. of vitamin E per kg of fish fed.

■ **Vitamin A deficiency** – clinical signs include, poor growth, dry and dull hair coat, infertility and birth defects in young.

"...Mustelids do not convert b-carotene to vitamin A efficiently, (so), it should not be used as the sole source of vitamin A" (Petrini 1992).

■ **Biotin** – Biotin deficiency can be caused by feeding raw eggs; this is due to the biotinase content of albumin. Biotin deficiency results in pale fur and skin problems.

■ **Vitamin D** – a deficiency of Vitamin D will produce Rickets. Conversely, over supplementation of Vitamin D causes abnormal calcification of soft tissues.

Lactating Females

"Energy demands during lactation are quite high in mustelids" (Petrini 1992). Although it is not known specifically for *L. canadensis*, *"...in the American badger (Taxidea taxus), lactation demands 16 times more energy than gestation. This is approximately four times more than required by most mammals"* (Petrini 1992). A gradual increase in diet during lactation to a level 30 to 40% over maintenance level is usually required for successful growth of the pups and maternal health.

Post Mortem Examinations

The value of a thorough postmortem examination for disease surveillance of both wild and captive populations cannot be overemphasized. Animals should be necropsied as soon as possible after death. Bacterial overgrowth begins shortly after death making it difficult to isolate pathogens that may have been involved in the animal's demise. Carcasses should be refrigerated until the examination can be completed. This will retard bacterial growth and help slow down the autolysis of tissues. If it is not possible to complete the necropsy within about 5 days, the carcass should be frozen. This however, greatly changes the microscopic architecture of the tissues, rendering them useless for histological examination. Therefore, a great deal of valuable information will be lost if the carcass is frozen.

The ideal necropsy will include a complete gross examination of the carcass and internal organs, a parasitological exam, and histological examination of the individual tissues. In addition, cultures for pathogens such as bacteria, fungus, and viruses are often indicated.

Below is an example of a standardized necropsy protocol for otters as well as a necropsy report form.

NECROPSY PROTOCOL

Blood Collection
Antemortem blood collection for serum banking is recommended on any animal that is to be euthanized. Collect enough to obtain a minimum of 5 ml of serum. Post mortem blood collection may be possible on specimens that have recently died.

Radiographs
Ventral-dorsal and lateral abdominal radiograph should be taken on all otters that die. Urolithiasis (kidney and bladder stones) is relatively common in several species of otter. Radiographs can help document the degree (or lack thereof) of urolithiasis at the time of death. Although this is not believed to be as prevalent in *Lontra canadensis* radiographs should still be done.

Gross Port Mortem Examination
A veterinarian should perform a thorough post mortem examination as soon as possible after death. The standardized necropsy report included at the end of this section can be used for recording the results.

Handling Pathological Lesions
- Cultures: Cultures (aerobic, anaerobic, and fungal) should be taken of any lesions before they are contaminated.
- Freeze tissues: Samples of lesions should be frozen at -20^{o} or -70^{o} C.
- Histopathology: Make sure all lesions are saved for histopathology.

Formalin Fixed Tissues
Tissues should be collected and placed in 10% buffered formalin. All tissues may be placed together in a single container as long as the volume of formalin is at least 10 times the total volume of the tissues collected. Tissues should be no thicker than 0.5 cm. A checklist of tissues that should be preserved in formalin is attached. In addition, include sections of all lesions in formalin.

Histopathology
Fixed tissues should be sent to a pathologist, preferably one that is familiar with exotic species.

Frozen Tissues

3-5 cm sections of the following tissues should be frozen in plastic bags at –20 to –70 ^{o}C.

- Liver
- Brain
- Kidney
- Serum, (antemortem or postmortem) if possible.
- Sections of any lesions.

Neonates, Stillbirths, Abortions

In addition to the standard adult necropsy protocol, include the following:

- Weight, crown-rump length, and sex.
- Estimate degree of maturity (1st, 2nd, or 3rd trimester).
- Fix umbilical stump and surrounding tissues. Obtain bacterial cultures before fixing if there is evidence of infection.
- Check carefully for evidence of congenital deformities (cleft palate, deformed limbs, heart defects, anal atresia, etc).
- Assess hydration (tissue moistness) and evidence of nursing (milk in stomach).
- Determine if breathing occurred (do lungs float in formalin).
- Note whether there is meconium in the colon/rectum.
- Fix placenta if available. Culture first if indicated.

Tissues to be placed in 10 % formalin.

□ Skin: full thickness of abdominal skin.

□ Skeletal muscle: medial thigh, with sciatic nerve.

□ Tongue: Cross section near tip including both mucosal surfaces.

□ Trachea

□ Thyroid/parathyroid

□ Thymus: representative section.

□ Lungs: section from several lobes including a major bronchus.

□ Heart: Longitudinal section including atrium, ventricle and valves form both right and left heart. Include large vessels.

□ Aorta

□ Salivary gland

□ Gastrointestinal tract: 2-3 cm long section of esophagus, stomach (cardia, antrum, pylorus), duodenum, jejunum, ileum, colon, omentum. Open carefully along the long axis.

□ Lymph nodes: Cervical, bronchial, and mesenteric with a transverse cut.

□ Liver: Sections from several lobes with capsule and gall bladder.

□ Adrenal: Incise transversely.

□ Reproductive tract: Entire uterus and ovaries with longitudinal cut into lumen. Entire testis with transverse cut, entire prostate with transverse cut.

□ Pancreas: Representative sections from 2 areas.

□ Spleen: Cross sections including capsule.

□ Kidneys: Section from both kidneys (cortex, medulla, and pelvis).

□ Urinary bladder/ureter/urethra: Cross section of bladder, 2-cm sections of ureters, cross section of urethra.

□ Eyes: leave intact.

□ Brain, include cerebrum and cerebellum: Sliced longitudinally along the midline.

- □ Pituitary gland: Submit entire gland including dura.
- □ Long bone: Submit ½ of femur.
- □ Mammary gland
- □ Diaphragm
- □ Spinal cord: 1-cm section from cervical cord.

OTTER NECROPSY REPORT

Institution where otter was housed or location where found: ______________________________________

Common name:________________________ Genus / Species:___________________________________

Identification or Accession #: _____________ Necropsy #: ___________ Studbook #:__________

Date of Birth: _____________ Age: _______ Weight:_______ Kg Sex:___________

Length, tip of nose to base of tail:_____________ Length, tip of nose to tip of tail: ___________

Date of Death: _______________ Date of Necropsy: _____________________________

Gross exam performed by: ____

Histopathology performed by: ____

Pathology Accession # ____________ Disposition of carcass: _______________________

Tissue saved: Yes 9 No 9

Formalin 9

Frozen 9

Other 9

____

HISTORY (Include clinical signs, treatments, antemortem test results, diet, circumstances of death and quarantine status.

Laboratory Studies: (List bacterial and viral cultures submitted. Attach results of any of the following:)

Hematology	□	Chemistry	□	Photography	□
Cytology	□	Fluid analysis	□	Bacteriology	□
Mycology	□	Virology	□	Urinalysis	□
Parasitology	□	Toxicology	□	Urolith analysis	□
Other	□				

Radiology:

Urinary calculi Yes 9 No 9

Left kidney: Number _____ Size _____
Right kidney: Number _____ Size _____
Urinary bladder: Number _____ Size _____

Gross Diagnosis: (List each lesion separately. Include organ, lesion type, distribution, severity, etc.)

Histological Diagnosis: See attached report 9 Not done 9

Final Diagnosis:

Summary / Comments:

GROSS EXAMINATION
General Condition: (External appearance, condition of carcass, physical and nutritional condition, pelage, subcutaneous fat stores, body orifices, superficial lymph nodes.)
Musculoskeletal System: (Bone, joints, muscles)
Body Cavities: (Fat stores, abnormal fluids)
Hemolymphatic: (Spleen, lymph nodes, thymus,)
Respiratory System: (Nasal cavity, larynx, trachea, bronchi, lungs, regional lymph nodes)
Cardiovascular System: (Heart, pericardium, great vessels)

Digestive System: (Mouth, teeth, esophagus, stomach, intestines, liver and gall bladder, pancreas, mesenteric lymph nodes)
Urinary System: (Kidneys, ureters, urinary bladder, urethra)
Reproductive System: (Testis, ovary, uterus, oviduct, vagina, penis, prepuce, accessory sex glands, mammary glands, placenta)
Endocrine System: (Adrenals, thyroid, parathyroids, pituitary)
Nervous and Sensory Systems: (Brain, spinal cord, peripheral nerves, eyes, ears)

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Appendix A Ectoparasites, Endoparasites, Viruses, Bacteria, Fungi, and Protozoans known to inhabit river otter (Melquist et al. 2003)

Ectoparasites found in river otter (Melquist et al. 2003)				
Order	**Family**	**Species**	**Geographic location**	**Source**
Acarina	Ixodidae	*Ixodes cookie*	Alabama, Arkansas, Florida, Pennsylvania	Cooney & Hays 1972; Forrester 1992; Polechla 1996
		Ixodes uriae	California	Eley 1977
		Ixodes banksi	Florida, Michigan, Pennsylvania	Forrester 1992
		Amblyoma americanum	Arkansas, Florida	Polechla 1996; Eley 1977
		Dermacentor variabilis	Florida	Eley 1977
	Listrophoridaea	*Lutracarus canadensis*	Alaska	Fain & Yunker 1980
		Lynxacarus mustelae	Alaska	Fain & Yunker 1980
Anoplura	Echinophthiriidae	*Latagopthirus rauschi*	Oregon	Kim & Emerson 1974
Siphonaptera	Certophyllidae	*Oropsylla arctomys*	Pennsylvania	Serfass et al. 1992
Coleoptera	Leptinidae	*Leptinillus validus*	Minnesota	Route & Peterson 1988
		Platypsyllus castoris	Minnesota	Route & Peterson 1988

Helminth Endoparasites Reported in River Otter
(Melquist et al. 2003 citing Kimber & Kollias 2000)

Phylum	Species	Geographic Location	Body Location Parasitized
Pentastomida	*Sebekia mississippiensis*	Florida	GI (intestine)
Platyhelminthe			
Cestoidea	*Spirometra mansonoides*	Florida, Georgia	GI (intestine), subcutaneous
	Diphyllobothrium latum	North Carolina	Subcutaneous
	Ligula intestinalis	Montana	GI (feces)
	Protoecephalus perplexus	Alabama	GI (stomach)
	Schistoecephalus solidus	Oregon, Newfoundland	GI (intestine)
	Braunia sp.	New York	GI (feces)
Trematoda	*Euparyphium melis*	Massachusetts, Michigan, Minnesota	GI (stomach, small intestine)
	Euparyphium inerme	Oregon, Washington	GI (stomach, small intestine)
	Enhydrodiplostomum alaroides	Alabama, Florida, Georgia, Massachusetts, North Carolina	GI (stomach, small intestine)
	Enhydrodiplostomum fosteri	Alabama, Louisiana	GI (small intestine)
	Enhydrodiplostomum sp.	North Carolina	GI (intestine)
	Bashkirovitrema incrassatum	Alabama, Florida, Georgia, Louisiana, Massachusetts, North Carolina, New York, Tennessee, Ontario	GI (stomach, small intestine)
	Nanophyetus salmincola	Pacific Northwest	Unknown
	Paragonius kellicoti	Michigan	Unknown
	Alaria canis	Ontario	Subcutaneous mesenteric fat
	Crepidostomum cooperi	Alabama	Unknown
	Telorchis gracilis	Alabama	GI (small intestine)
	Telorchis spp.	Alabama	Unknown
	Diplostomium alarioides	Ontario	GI (small intestine)
Acanthocephala	*Pilum sp.*	Unknown	Unknown
	Oncicola spp.	Florida	GI (intestine)
	Acanthocephalus spp.	Alabama, Tennessee	GI (large intestine)
	Pomporhynchus spp.	Alabama	GI (large intestine)
	Corynosoma strumosum	Oregon	GI (stomach, intestine)
	Leptorhynchoides spp.	Alabama	Unknown
	Neoechinorhynchus spp.	Alabama	Unknown
	Paracanthocephalus rauschi	Alaska	GI (intestine)
Nematoda	*Physaloptera spp.*	Alabama, Massachusetts	GI (stomach, intestine)
	Skrjabingylus lutrae	Ontario	Frontal sinuses
	Dracunculus lutrae	Arkansas, Nebraska, New York,	Subcutaneous tissues, leg

Helminth Endoparasites Reported in River Otter
(Melquist et al. 2003 citing Kimber & Kollias 2000)

Phylum	Species	Geographic Location	Body Location Parasitized
	Dracunculus lutrae	Ontario	Subcutaneous tissues, leg
Nematoda	*Dracunculus insignis*	Alabama, Florida, Michigan, New York	Facial layers of leg
	Strongyloides lutrae	Alabama, Florida, Louisiana, Oregon, Tennessee, Washington	GI (small intestine), lung
	Crenosoma goblei	Florida, North Carolina	GI (intestine), lung
	Dirofilaria lutrae	Florida, Louisiana, Southeastern USA	Blood, subcutaneous tissue
	Dirofilaria immitis	Louisiana	Heart
	Capillaria plica	Florida, North Carolina	Urinary bladder
	Capillaria aerophilus	Unknown	Lungs
	Capillaria hepatica	Florida	Liver
	Capillaria sp.	Louisiana	Unknown
	Gnathostoma miyazakii	Alabama, Florida, North Carolina, Virginia, Ontario	GI (intestine), kidney
	Dioctophyme renale	Unknown	Kidney
	Filaroides canadensis	Ontario	Lungs
	Contracaecum spp.	Oregon	GI (stomach, large intestine)
	Spinitectus gracilis	Alabama, Oregon	GI (small intestine)
	Spinitectus sp.	Oregon	GI (intestine)
	Eustrongylides spp.	Maryland, Oregon	GI (small and large intestine)
	Anisakis simplex	Oregon, Washington	GI (small and large intestine, stomach)
	Anisakis spp.	Oregon	GI (intestine)
	Metabronema sp.	Oregon	GI (intestine)
	Hedruris siredonis	Oregon	GI (small and large intestine)
	Hedruris spp.	Oregon	GI (intestine)
	Cystidicoloides	Washington	GI (intestine)
	Ancylostoma spp.	Louisiana	GI (intestine)
	Uncinaria stenocephala	Unknown	GI (intestine)
	Strongyle sp.	Minnesota	GI (feces)
	Cruzia sp.	Oregon	GI (small and large intestine)

Viruses, Bacteria, Fungi, and Protozoans Reported From River Otters

(Melquist et al. 2003 citing original sources)

Disease	Causative Agent	Note	Source
VIRAL			
Canine Distemper	Canine distemper virus	Antibody titers, clinical signs, and distemper serology	Kimber et al. 2000
Mink enteritis virus, feline panleukopenia, canine parvovirus		Positive antibody titers	Hoover et al. 1985; Kimber et al. 2000
Aleutian disease (plasmacytosis)	Aleutian virus	Challenged, but not clinically ill, no antibody titer	Kenyon et al. 1978
Rabies	Rabies virus	24 cases reported	Serfass, 1995
Infectious canine hepatitis	Adenovirus	Symptoms but no viral isolation confirmation	Kimber et al. 2000
Feline rhinotracheitis	Feline herpesvirus-1, feline calicivirus	64 animals tested negative for antibody	Kimber et al. 2000
Herpesvirus	Herpesvirus-1	Antibody titers reported	Kimber et al. 2000
BACTERIUM			
Bacterial pneumonia	Unknown	Frequently reported	Hoover 1984; Hoover et al. 1985
Clostridial infection	*Clostridium botulinum*	Susceptible to type C toxin	Reed-Smith 2001
Enteritis	*Clostridium perfringens*	Susceptible during periods of stress or dietary conversion	Kollias 1999
Tuberculosis	*Mycobacterium bovis*	Reported	Reed-Smith 2001
Purulent pleuritis	*Bacteroides melanigenicus* and others	*B. melanigenicus* isolated in one case	Griffith et al. 1983
Purulent peritonitis	*Klebsiella* pneumonia	Presence of bacteria but no underlying disease	Reed-Smith 2001
Brucellosis	*Brucella spp.*	Presence in lymph node of a road-killed *Lutra lutra*	Foster-Turley 1996
Leptospirosis	? bacteria	Believed to be an important disease but no histopathology	Chanin 1985; Reed-Smith 2001
Pasteurellosis	*Pastueurella multocida* or *P. pseudotuberculosis*	Clinical signs vary	Wallach & Boever 1983; Reed-Smith 2001
Salmonellosis	*Salmonella spp.*	Isolated from feces of clinically normal otters, no symptoms	Reed-Smith 2001
FUNGAL			
Dermatomycosis	*Microsporum spp.* and *Trichophyton spp.*	Contagious and potentially zoonotic	Reed-Smith 2001
Coccidiodomycosis	*Coccidioides immitis*	Reported from small-clawed otters	Reed-Smith 2001
Adiaspiromycosis	*Emmonsia crescens*	Reported from Eurasian otters	Simpson & Gavier-Widen 2000

Viruses, Bacteria, Fungi, and Protozoans Reported From River Otters

(Melquist et al. 2003 citing original sources)

Disease	Causative Agent	Note	Source
PROTOZOAN			
Giardiasis	*Isospora spp.*	Light infestation	Hoover et al. 1985
Coccidiosis	*Giardia spp.*	Reported from other mustelids	Reed-Smith 2001

Health Care Glossary

Anasarca: Severe generalized edema. (Taber's Cyclopedic Medical Dictionary)

Anemia: A quantitative deficiency of the hemoglobin, often accompanied by a reduced number of red blood cells causing pallor, weakness, and breathlessness. A lack of vigor, creativity, forcefulness, or the like. (Webster's Unabridged Dictionary)

Apnea: Cessation of breathing.

Ataxia: Defective muscular coordination often manifested when voluntary muscular movements are attempted.

Autolysis: The self-dissolution or self-digestion that occurs in tissues or cells by enzymes in the cells themselves, such as occurs after death and in some pathological conditions. 2) Hemolysis of blood cells occurring as a result of the action of an animal's own serum or plasma. (Taber's Cyclopedic Medical Dictionary)

Bacteria: Any of numerous microscopic, spherical, rod-shaped, or spiral organisms of the class Schizomycetes, various species of which are concerned in fermentation and putrefaction, the production of disease, the fixing of atmospheric nitrogen, etc. (Webster's Unabridged Dictionary)

Bacterin: A vaccine that contains specific bacteria and is injected to increase immunity. (Webster's Unabridged Dictionary)

Cachexia: General ill health, with emaciation, due to a chronic disease, as cancer. (Webster's Unabridged Dictionary)

Catarrh: Term formerly applied to inflammation of mucous membranes, especially of head and throat. (Taber's Cyclopedic Medical Dictionary)

Catarrhal: Of the nature of or pertaining to catarrh.

Conjunctivitis: Inflammation of the mucous membrane that lines the inner surface of the eyelids. (Webster's Unabridged Dictionary)

Cutaneous: Pertaining to the skin. (Taber's Cyclopedic Medical Dictionary)

DHLPP: Canine vaccine. Sometimes called DA_2PL (A=adenovirus)

D = Canine Distemper
H = Hepatitis
L = Leptospira Bacteria
P = Parainfluenza-Adenovirus Type 2
P = Parvovirus vaccine

Dyspnea: Air hunger resulting in labored or difficult breathing, sometimes accompanied by pain. (Taber's Cyclopedic Medical Dictionary).

Enteritis: Inflammation of the intestines, especially the small intestines. (Webster's Unabridged Dictionary)

Erythema: Abnormal redness of the skin due to local congestion, as in inflammation. (Webster's Unabridged Dictionary)

FVRCP: Feline vaccine.

F = Feline distemper
V = Viral
R = Rhinotracheitis
C = Calici Virus
P = Panleukopenia

Hematuria: The presence of blood in the urine. (Webster's Unabridged Dictionary)

Hemorrhagic: Pertaining to or marked by hemorrhage.

Hyperemia: Congestion. An unusual amount of blood in a part. (Taber's Cyclopedic Medical Dictionary)

Hypergammaglobulinemia: Excess amount of gamma globulin in the blood. (Taber's Cyclopedic Medical Dictionary)

Hyperkeratosis: Overgrowth of the cornea. 2) Overgrowth of the horny layer of the epidermis. (Taber's Cyclopedic Medical Dictionary)

Hypostasis: Diminished blood flow or circulation. 2) Deposit of sediment due to decreased flow of body fluid such as blood or urine. (Taber's Cyclopedic Medical Dictionary)

Lacrimation: Tearing.

Leucocytes: Any of the small, colorless cells in the blood, lymph, and tissues, which move like amoebae and destroy organisms that cause disease; white blood corpuscle. (Webster's Unabridged Dictionary)

"Leukocytes, or white blood cells (WBC), in mammalian blood include segmented neutrophils, band (nonsegmented) neutrophils, lymphocytes, monocytes, eosinophils, and basophils. These cells vary in their site of production, duration of peripheral circulation, recirculation, and in the stimuli that affect their release into and migration out of the vascular bed. These factors also vary among species.

***"Leukocytosis** is an increase in the total number of circulating WBC: leukopenia is a decrease."* (Merck 1991)

Leukopenia: A decrease in the number of leucocytes in the blood. (Webster's Unabridged Dictionary)

Mucopurulent: Consisting of mucous and pus. (Taber's Cyclopedic Medical Dictionary)

Mycosis: The growth of parasitic fungi in any part of the body. A disease caused by such fungi.

Mycotic: Pertaining to or caused by mycosis. (Webster's Unabridged Dictionary)

Nematode: Any unsegmented worm of the phylum or class nematoda, having an elongated, cylindrical body; roundworm. (Webster's Unabridged Dictionary)

Orchiditis: Inflammation of the testicles.

Otitis: Inflamed condition of the ear. (Taber's Cyclopedic Medical Dictionary)

Parasite: An animal or plant that lives on or in an organism of another species from whose body it obtains nutriment. (Webster's Unabridged Dictionary)

Plasmacyte: A plasma cell, one of those found in connective tissue, with an eccentrically placed round nucleus and filled with a chromatin mass that stains deeply. (Taber's Cyclopedic Medical Dictionary)

Pruritis: A severe itching. May be a symptom of a disease process such as allergic response, or be due to emotional factors. (Taber's Cyclopedic Medical Dictionary)

Purulent: Full of, containing, forming, or discharging pus; of the nature of or like pus. (Webster's Unabridged Dictionary)

Rhinitis: Inflammation of the nose or its mucous membrane. (Webster's Unabridged Dictionary)

Septicemia: The invasion and persistence of pathogenic bacteria in the blood stream. (Webster's Unabridged Dictionary)

Serology: The scientific study of serum. (Taber's Cyclopedic Medical Dictionary)

Seroconversion: Development of evidence of antibody response to a disease or vaccine.

Silicosis: A form of pneumoconiosis resulting from inhalation of silica (quartz) dust, characterized by formation of small discrete nodules. In advanced cases, a dense fibrosis and emphysema with impairment of respiratory function may develop.

Tachypnea: Rapid breathing.

Titer: Standard of strength per volume of a volumetric test solution. (Taber's Cyclopedic Medical Dictionary)

Vaccine: Any preparation of dead bacteria introduced in the body to produce immunity to a specific disease by causing the formation of antibodies. (Webster's Unabridged Dictionary)

Virus: An infectious agent, especially any of a group of ultramicroscopic, infectious agents that reproduce only in living cells. (Webster's Unabridged Dictionary)

NORTH AMERICAN RIVER OTTER

Husbandry Notebook, 4th Edition; Chapters 11 - 15

(Photo: Dave Mellenbruch)

NORTH AMERICAN (Nearctic) RIVER OTTER *(Lontra canadensis)* Husbandry Notebook, Section 3 Chapters 11 - 15©

Edited & Written by:

Janice Reed-Smith
2012

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"Alacris ad ludos est."

"It is quick to play"

(Albertus Magnus, 13th Century teacher and naturalist)

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K. Talcott Photo

In the days when the earth was new and there were no men but only animals the sun was far away in the sky. It was so far away that there was no summer. It was so far away that the trees and the grasses did not grow as they should.

He-Who-Made-the-Animals saw how it was that there was not enough sun to heat the earth, and so he fashioned a snare. The Sun did not see the snare in his path, walked into the snare and the snare held him fast.

The sun was close to the earth. In fact, the snare held the sun so close to the earth that there was no night. Day after day the sun shown and the earth dried and the grasses withered. There was not enough food or water for the animals and they desperately called a council. "Sun," the animals said, "You give too much heat to the earth."

"Set me free from this snare" the Sun said, "and I will go away."

"But if you go away, then there will not be enough heat." "Set me free," the Sun said, "and I will come to the edge of the earth in the morning and in the evening; then at noon-time I will stand straight above the earth and warm it then."

The animals sat around the council fire and they said, "Who is going to set the sun free?"

"I shall not do it," Wildcat said. "Whoever sets the sun free must go so close to the sun that he will be burned to death." Lynx said, "Whoever sets the sun free must chew the leather thong that holds him; the sun will burn him to death before he can do it." "I shall not do it," said the deer, the wolf and the raccoon.

"I shall do it," Otter said. "How can you do it?" said the animals. "You are too small, your teeth are for fish, and your fur has already burned away." None of the other animals liked the otter because he played too much. They did not think he was brave.

"Let him try," Bear said. "He will burn to death, but we will not miss him. He is of no use to us. He looks silly now that his fur is gone." The animals laughed.

Ignoring the taunts, the otter set off to the place in the sky above the earth where the sun was held by the snare. Otter took many days to get to the sun. The sun burned him. The sun was so bright, Otter had to close his eyes. When he reached the sun, Otter began to chew on the leather thong that held the sun. His skin was burning and blistering, his eyes were hot stones. But, Otter did not stop chewing.

Suddenly he chewed through the leather. The animals saw the sun rise into the sky. The animals felt the cool winds begin to blow on the earth. Otter had freed the sun from the snare.

Time passed. Otter lay in the center of the council ring. There was no fur at all left on his body. His skin was burned and scorched and his flesh was falling off his bones. His teeth were only blackened stumps.

He-Who-Made-the-Animals also stood in the center of the council ring. "Otter," he said, "the animals will not forget what you have done for them. I will see that they do not forget," and he gave Otter new strong teeth, tireless muscles, keen eyesight, and a powerful tail to help him in his hunting and in his play. He did not have to give him bravery. But he gave him new fine fur that was like down on his skin, and a second coat of fur to guard the first so that he would not get cold in water or in winter. Then he gave him joy so that he would always be happy in his otter's life, and Otter has so remained until this day.

An Otter Legend derived from the Cree Indians
Contributed by John Mulvihill
The River Otter Journal Vol. VIII, No. 2, Autumn 1999

Contributors

4th Edition

Thank you to all who contributed to the 1st and 2nd editions as well as the 1997 Husbandry Survey (the 3rd edition was never published). Some of this information is still part of this edition. However, the 2nd edition is available on the IUCN Otter Specialist Group website and the original Otter Lore and other deleted sections can be found there.

Contributors to this new edition include: Helen Bateman, Gwen Myers, DVM, Melanie Haire, Tanya Thibodeaux, David Hamilton, Brian Helton, Lynn Hougle, Jennifer Mattive, Kristina Smith, Mike Maslanka, M.S., Barbara Henry, M.S., Monica Anderson, Nicole Barker, Rachael Chappell, Julie Christie, Kristin Clark, Erin Dauenhauer-Dacota, Erin Erbren, Bethany Gates, Katie Jeffrey, Maggie Jensen, Brett Kipley, Marcy Krause, Tara Lieberg, Hilary Maag, Christine Montgomery, Melissa Newkoop, Melanie Pococke, Josh Prince, Nancy Ramsey, Tami Richard, Karen Rifenbury, Jan Sansone, Ashley Snow, Alicia Striggow, Maicie Sykes, Janée Thill, Marla Tullio, Jen Wilson, Andrea Dougall, Victor Alm, Courtney Lewis, Bill Hughes, Jennifer Galbraith, and the Otter Keeper Workshop Attendees (2004, 2006, 2008, 2010, 2012). Thank you to the zoo and aquarium people who contributed photos and to the professionals who gave permission for use of their photographs: Dave Mellenbruch, Haley Anderson, Graham Jones, Gary Woodburn, Debbie Stika, and Herb Reed.

USER GUIDE

INTRODUCTION

***Lontra canadensis* is most commonly known as the North American river otter but also will be referred to here as the N.A. river otter, NARO, and Nearctic otter.**

As soon as the first edition of the North American River Otter Husbandry Notebook was completed additional information became available – that is the way projects of this nature all work. I have no doubt it also will be true for this edition. Each edition should be used as a beginning point when looking for an answer to a particular otter problem or question. Our approach to captive husbandry should be as dynamic as the animals in our care. **This 4th edition includes updated information. Since publication of the last edition significant work has been done on otter reproductive physiology, contraceptive recommendations have changed, and there have been some changes made to recommended routine veterinary care. These changes as well as additional enclosure, training and enrichment information have been included in this digital update of the NARO husbandry notebook. All deleted information and sections (e.g. North American River Otters in European Institutions) are still available in the 2nd edition. The 2nd and 4th editions are available at otterspecialistgroup.org, Otters in Zoos, etc. link (OZ Task Force – Otters in Zoos, Aquariums, Rehabilitation, and Wildlife Sanctuaries).**

Where possible, all measurements and weights have been put into the English and metric systems. This is not true for the weights tables, however. There is some duplication from one chapter to another; some information on a given topic may only appear in one location. This is inconsistent but an attempt was made to at least provide some basic information on pertinent topics where appropriate so a reader would not have to go to all of the sections. For example: there is pup development information in the Reproduction section and Hand Rearing.

Many thanks go out to all of the people who have shared ideas with me over the years, too many of you to name here however, your contributions have all been helpful and have been incorporated in some way in this manual. The notebook has been split into three sections allowing the inclusion of more photos while trying to keep the file sizes manageable. They are as follows:

SECTION 1

Chapter 1 Taxonomy
Chapter 2 Distribution
Chapter 3 Status (*In-situ* and *Ex-situ* studbook information)
Chapter 4 Identification and Description
Chapter 5 Behavior, Social Organization, and Natural History
Chapter 6 Reproduction

SECTION 2

Chapter 7 Captive Management
Chapter 8 Hand-rearing
Chapter 9 Nutrition and Feeding Strategies
Chapter 10 Health Care

SECTION 3

Chapter 11 Behavioral and Environmental Enrichment
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CHAPTER 11 Behavioral and Environmental Enrichment

Introduction

> *"What is an enriched environment? It is one that allows animals to perform natural behaviors, gives animals control over their lives, eliminates frustration, makes captive environments more interesting, gives animals more choice, and allows animals to be more active. Enrichment of the enclosure involves the physical environment including shape, size and complexity. Complexity consists of an animal environment such as visual barriers, climbing or traveling structures, substrates, rest/sleep areas and temporal complexity. Manipulable objects such as toys and vegetation, the opportunity to use five senses, and the social environment are all beneficial to the animal. The types of food offered, the frequency and presentation play a large role in enriching the lives of our captive charges.*
>
> (Grams, K. 2000. *Exhibitry and Enrichment of North American River Otters (Lontra canadensis) at The Arizona-Sonora Desert Museum.* Animal Keepers' Forum, Vol. 27, No. 4. Quotation is referencing a presentation given by D. Shepherdson & J. Mellen at the First Environmental Enrichment Conference in Portland, Oregon, 1992.)

The Webster's New Universal Unabridged Dictionary lists these definitions: Behavior – *manner of behaving; conduct….it expresses external appearance or action.* Enrich – *to make rich or richer; to give greater value or importance to.*

In his book, Behavioral Enrichment in the Zoo (1981), H. Markowitz refers to zoos evolving into the "best possible facilities", defining best as follows: "*1) The best possible home for animals that have been removed from their natural habitat. 2) The best educational recreational experiences for zoo visitors. 3) The best provision for research of all kinds beneficial to the resident species."*

These are all definitions and goals easily agreed upon. How we achieve them is another matter, primarily because every animal is unique and will respond to different stimuli, and all zoo professionals are unique and will develop different solutions.

In the case of *Lontra canadensis*, zoos have a wonderful opportunity to teach our visitors about a native animal. Our enrichment goals should aid this education effort and create an environment that promotes good health and the otters natural high activity level, playfulness, and curiosity.

There are some general guidelines that should be kept in mind when designing an enrichment program for any animal: the target species (in this case, otters) natural history should be researched; goals and objectives should be identified in advance; aberrant or unnatural behaviors should not be promoted; any activity should be approved by the appropriate supervisory personnel; questions regarding toxicity/safety of an item should be reviewed with a veterinarian, nutritionist, chemist, curator, and/or botanist; responses should be documented to determine if an enrichment item/activity is successful, or not; treat delivery methods should not promote begging behavior; not all enrichment should be food, don't forget smell, sight, sounds, and touch; and, remember, when it comes to enrichment, variety is truly the spice of life.

This chapter will cover some of the many enrichment items tried by contributing institutions; keep in mind: not all of them were successful, some were not successful at first but when introduced repeatedly over time they eventually elicited a response; if animals are introduced at a young age to novel situations and items, they will be more responsive to new things through adulthood; and, what may have proven safe for one animal could present a problem for another, vigilance is the key. Caution should be exercised when offering paper products to otters as they can become wet and stuck to faces/ noses, or, may be covered with a thin layer of glue or similar substance.

Abnormal Repetitive Behaviors (ARBs) or Stereotypies

Morabito & Bashaw (2012) provide a good definition of these terms which is quoted here:

> *"A stereotypy is a behavior that is "repetitive, invariant, and has no obvious goal or function" (Mason, 1991, p.1015; Shyne, 2006, p. 317). In zoos, stereotypies most commonly begin when an animal is motivated to perform a certain behavior but cannot succeed because of the captive conditions (Ridley & Baker 1982). For example, lack of control or frustrated appetitive behaviors such as foraging for food or looking for a mate can contribute to the development of stereotypies (Clubb & Vickery 2006). The presence of stereotypies is therefore commonly used to indicate poor welfare in nonhuman animals, although stereotypies may reflect past environments rather than current conditions (Mason 1991, 1993; Mason & Latham 2004).Recent work has suggested a variety of behaviors previously described as stereotypic may vary in form (overgrooming, self-injury) or have a documented function (to reduce arousal, increase stimulation, or allot the animal to cope with the environment). Mason, Clubb, Latham, and Vickery (2007) have suggested that the term "stereotypic" should be limited to cases of "repetitive behaviour induced by frustration, repeated attempts to cope and/or [brain] dysfunction" that are "demonstrably caused by deficits in captive housing" (p. 164). They propose a broader term, abnormal repetitive behavior (ARB), be used for behaviors that have not been experimentally shown to meet these criteria, although they acknowledge that with continuing research most ARBs are likely to be reclassified as stereotypic (Mason et al. 2007).*

Morabito (Morabito & Bashaw 2012) conducted a two-part survey of 106 AZA institutions housing North American river otters; part one consisted of management and exhibit characteristic questions applicable to all otters resident in the enclosure, part two dealt with ARBs in individual otters. Their response rate was 52% representing 61 exhibits in 55 institutions and 129 individual otters (59.70.0). Their results are thought provoking and worthy of further research as they potentially represent a change in how we approach training as well as delivery of food and enrichment to this species. In summary, their findings indicate:

- 46% (~59) of the otters at respondent institutions were reported as exhibiting ARBs.
- Neither age nor sex were significant predictors of ARBs in the otters reported on.
- 21 otters were reported to exhibit more ARBs in winter versus 9 exhibiting more in summer (of these it appeared most were associated with increased public attendance).
- 30 otters were reported as exhibiting pre-feeding ARBs; 6 exhibited post-feeding ARBs.
- NARO are prone to developing ARBs, particularly before feeding.
- Most frequently these ARBs take the form of repetitive swimming or pacing.
- Frequent feeding (>twice per day) and training (>multiple times per week) were both reliable predictors of ARBs. (This could be because individuals who already exhibit ARBs are targeted for more feedings and/or training sessions.)
- Institutions that utilized feeding cues which served to notify the otters that food/enrichment would be coming reported slightly fewer ARBs in their otters, but this was not statistically significant.
- Their recommendations are:
  - ✓ Further study based on observational data versus self-reporting by individual institutions to double check these results.
  - ✓ Looking at what types of exhibit designs reduce the effect of visitor attendance on ARBs.
  - ✓ Experimentally manipulating feeding and training frequency to determine if these changes cause, or are a result of changes in ARBs.
  - ✓ DO NOT recommend reducing number of feedings or training sessions at this time.
  - ✓ ADDING reliable cues before feeding/enrichment and training allowing the otters to distinguish between types of keeper visits to the enclosure should be explored further.
  - ✓ ADD or use feeding techniques that require active foraging.
  - ✓ MINIMIZE the amount of time otters are confined in a less preferred environment (e.g. holding), or, provide hiding places to reduce escape-motivated ARBs.

"How Can a Zoo Enclosure be Enriched?"

From: *Compendium of Enrichment Ideas*, Proceedings of 1st Conference on Environmental Enrichment 1993, Oregon Zoo, 4001 S. W. Canyon Rd., Portland, Oregon 97221.

Physical Environment

Size & Shape
Complexity
- Visual Barriers
- Climbing/Travel Structures
- Substrates
- Rest/Sleep Areas

Temporal Complexity
Manipulable Objects
- Toys
- Vegetation

Social Environment

Conspecific
- Group size and composition (wild as a model)

Contraspecific
- Mixed Species

Occupational Enrichment

Learning
- Training
- Puzzles

Food

Type
- Novelty
- Variety
- Treats

Delivery
- Frequency

Presentation
- Hidden
- Whole Food
- Dispersed
- Live Food
- Processing Time, etc.

Sensory

Auditory
- Taped Vocalizations, sounds

Olfactory
- Scents, spices, herbs, etc.
- Faeces, urines
- Spices

Tactile
- Texture
- Manipulable Objects
- Novelty

Taste
- Variety
- Novelty
- Seasonal Change

Planning an Enrichment Program (Oregon Zoo 1993)

GOAL SETTING QUESTIONS

1. What is this species' wild habitat (e.g., desert, tropical rainforest, cover, moisture, concealment/camouflage options, temperature ranges, barriers from conspecifics)?
2. How does the animal in the wild behave in response to changes in temperature and weather? What temperature/humidity range does it experience in the wild?
3. What are some self-maintenance/comfort behaviors (e.g., preening, grooming, bathing, dust-bathing, wallowing, sunning, panting)? Is there a seasonal molt/shed?
4. When is it most active (diurnal, nocturnal, crepuscular)? Why (e.g., predator avoidance)? Does the activity pattern change seasonally?
5. Does the species in the wild inhabit primarily arboreal, terrestrial or aquatic environments or does it switch between them at times?
6. What are the main threats to the animal in the wild? What is it likely to be afraid of (e.g., conspecifics, humans)? What different types of predators does it have to look out for in the wild? Are there any anti-

predator behaviors (e.g., broken-wing display)? Where and how does the animal seek refuge in the wild from fearful situations (e.g., loud noises like thunder)? What does fearful behaviors look like?
7. What are its primary sensory modalities (e.g., sight, smell, sound) for communicating with conspecifics, detecting predators and for finding food, mates, or other social partners?
8. What is the social structure of this species (e.g., solitary, dyads, "harem," colonial, leks, polyandry)? What is the average/typical group size?
9. What is the average distance between social group members and from neighboring conspecifics?
10. Describe the primary social behaviors of this species (e.g., aggression, courtship, affiliative, play).
11. Does the social structure change seasonally or throughout the animal's life (e.g., juvenile versus adult, bachelor groups)?
12. Does this species defend territories? Does it maintain a home range? What is the size of the home range/territory? Does this species migrate seasonally?
13. How does the animal advertise its home range or territory (e.g., scent marking, song)? How does the animal attract a mate (e.g., displays, scent marks)? Who displays?
14. Where does the animal raise young (nest location/type, den)? What materials does it use to build nests/prepare dens? Are both sexes involved in rearing young? Are the young precocial or altricial? How are the young fed?
15. How does the animal locomote through its habitat?
16. What is the animal's diet type (e.g., omnivore, carnivore, herbivore, nectivore) in the wild? Does diet change seasonally? By age?
17. What does the animal feed on in the wild? What variety of food does it need to eat? What behaviors does it use to locate and procure the different types of food it needs? Does it use tools to obtain food? Store/cache food?
18. Where does the animal sleep or rest? Does that change seasonally?
19. Any other considerations?

Individual History: Review information in ARKS and related studbooks.
1. Does this animal have any medical problems (e.g., arthritic, obese, diabetic, missing digits, wing damage, pinioned)?
2. Does this animal have any behavioral problems (e.g., fearful/aggressive to humans, stereotypy, hand-reared)?
3. Any other considerations (e.g., exhibit at previous institution, hand-raised)?

Current Exhibit: Review information in related husbandry manuals.
1. What is the size of the animal's enclosure (exhibit and holding area)? What are the containment barriers (e.g., chain link, moat)?
2. Can the animal use all components of its exhibit? Can it hide? For example, how many places could this animal be out of view of its cagemate?
3. How functional is the current exhibit? Does the exhibit facilitate/allow the animal to exhibit natural behaviors? How does the animal interact with exhibit elements?
4. Where and how is the animal's food (normal diet, enrichment, browse) provided? Does the animal have a preference for one feeding site over another?
5. Does the physical environment contain elements of novelty (e.g., weather changes, can furniture be changed easily)?
6. What are the animal's opportunities to feed/forage, breed, and socialize in species-appropriate ways? Do/can/should animal interact with other species in exhibit?
7. Can the animal exhibit normal patterns of behavior? Are components of the physical environment available for this to occur?
8. Can the animal make choices about where and how it spends its time? Does the animal have control over acquisition of food? Access to hiding places? Protection from the elements?
9. Are there any hazards in this enclosure?
10. Any other considerations?

Randomize & Evaluate
Otters should be enriched several times a day. This can consist of auditory, olfactory, sensory, environmental, social, temporal, foraging, or feeding opportunities as well as novel situations (such as

behind the scenes tours) or interaction with keepers. On the following pages are some examples of enrichment calendars and assessment formats for keeping track of what the otters respond to and how they respond (positively or negatively). Many institutions utilize a ratings scale based on one used by Disney's Animal Kingdom.

Enrichment Rating Scales
1 = no observed interaction with enrichment
2 = animal orients towards enrichment, but does not physically contact enrichment
3 = 1- 5 visits/minutes of interaction
4 = 5 - 10 visits/minutes of interaction
5 = greater than 10 visits/minutes of interaction

Please note: signify ratings made other than immediately following enrichment introduction with + sign. All other ratings will be presumed to be made immediately following enrichment placement.
This 1-5 scale is useful for assessing the degree to which an animal interacts with an enrichment initiative (either novel or familiar) for a specific period of time. This scale can be used to assess how an animal's interest in a particular enrichment changes over time. Important points to note will be that the animals' response to the enrichment may vary depending on the time of day that the animals are observed and the scale used, as well as how long the observation period is. Both of these factors should be made as consistent as possible. For example, all keepers assessing a otter's use of a feeder should come to an agreement as to when and for how long their observations should take place (e.g., 10 minutes when the otters are first let out on exhibit).

ENRICHMENT PHOTOS 1

Pillow case feeders: fish placed in the pillow case and the otters must untie it (Pueblo Zoo).

Plastic fish feeder – otters must get fish through the hole (Pueblo Zoo)

Paper toweling hung from outside – the otters pull in to use as bedding (Pueblo Zoo)

RIVER OTTER ENRICHMENT INVENTORY

Toy	Quantity	Animal: Dusty (D) Merlin (M)	Supervised Unsupervised Overnight	Animal: Odie (O) Oliver (Ø)	Supervised Unsupervised Overnight	Comments	Repair
Ball-- Basketball	1	D/M:	Overnight	O/Ø:	Overnight		
Ball-- Basketball, sinker	0	D/M:	Supervised	O/Ø:	Supervised		
Ball-- Black float	1	D/M:	Overnight	O/Ø:	Overnight		
Ball-- Boomer, large with holes	2	D/M:	Overnight	O/Ø:	Overnight		
Ball-- Boomer, medium with holes	4	D/M:	Overnight	O/Ø:	Overnight		
Ball-- Boomer, solid	2	D/M:	Overnight	O/Ø:	Overnight		
Ball-- Bowling, blue	1	D/M:	Overnight	O/Ø:	Overnight		
Ball-- Bungee	1	D/M:	Supervised	O/Ø:	Supervised		
Ball-- Jolly, large	0	D/M:	Unsupervised	O/Ø:	Supervised		
Ball-- Jolly, medium	0	D/M:	Unsupervised	O/Ø:	Supervised		
Ball-- Wiffle, medium	6	D/M:	Unsupervised	O/Ø:	Unsupervised		
Ball-- Wiffle, small	11	D/M:	Unsupervised	O/Ø:	Unsupervised		
BC Toy-- Black	1	D/M:	Unsupervised	O/Ø:	Unsupervised		
Bilibo-- Large	4	D/M:	Overnight	O/Ø:	Overnight		
Bilibo-- Mini	2	D/M:	Overnight	O/Ø:	Overnight		
Bin-- Blue toy box	1	D/M:	Unsupervised	O/Ø:	Unsupervised		
Bin-- Recycle	1	D/M:	Overnight	O/Ø:	Overnight		
Bin-- Rubbermaid with holes	1	D/M:	Supervised	O/Ø:	Supervised		
Bin--Rubbermaid, brown	1	D/M:	Overnight	O/Ø:	Overnight		
Bin--Rubbermaid, gray, large	1	D/M:	Supervised	O/Ø:	Supervised		
Bird-- Dove, clip-on	1	D/M:	Unsupervised	O/Ø:	Unsupervised	Never inside area with animals	
Boat seat	1	D/M:	Overnight	O/Ø:	Overnight		
Bone-- Nylabone	1	D/M:	Overnight	O/Ø:	Unsupervised		
Boogie Board	1	D/M:	Unsupervised	O/Ø:	Unsupervised	At Dolphin Bay	
Bowl-- 4-Liter, plastic	2	D/M:	Overnight	O/Ø:	Overnight		
Bowling Pins	6	D/M:	Unsupervised	O/Ø:	Unsupervised		
Box-- Red with holes, 25"x25"x32"	1	D/M:	Overnight	O/Ø:	Overnight		
Buoy-- 12" white	1	D/M:	Supervised	O/Ø:	Supervised		
Buoy-- 16" blue	2	D/M:	Supervised	O/Ø:	Supervised		
Cutting Board	2	D/M:	Overnight	O/Ø:	Overnight		
Dental Toy-- Blue	1	D/M:	Overnight	O/Ø:	Overnight		
Dental Toy-- Red	1	D/M:	Overnight	O/Ø:	Overnight		
Disc-- 6" Bamboo flying	1	D/M:	Unsupervised	O/Ø:	**DO NOT GIVE**		
Disc-- Firehose Flying, large	2	D/M:	Unsupervised	O/Ø:	Unsupervised		
Disc-- Firehose Flying, small	2	D/M:	Unsupervised	O/Ø:	Unsupervised		
Disc-- Green, 40" diameter "cheese wheel"	1	D/M:	Overnight	O/Ø:	Overnight		
Disc-- White, pancake	1	D/M:	Overnight	O/Ø:	Overnight		
Disc-- White, pancake with holes	1	D/M:	Overnight	O/Ø:	Overnight		

Maryland Zoo Enrichment Calendar

ENRICHMENT CALENDAR

ANIMAL/GROUP: ____________________ **MONTH/YEAR:** ____________________

RATINGS: 1 - NO INTERACTION; 2 - ORIENTS TO ENRICHMENT, NO PHYSICAL CONTACT; 3 - 1-5 MINUTES OF INTERACTION; 4 - 5-10 MINUTES OF INTERACTION; 5 - 10 + MINUTES OF INTERACTION

SUNDAY RATING INITIALS:	MONDAY RATING INITIALS:	TUESDAY RATING INITIALS:	WEDNESDAY RATING INITIALS:	THURSDAY RATING INITIALS:	FRIDAY RATING INITIALS:	SATURDAY RATING INITIALS:
SUNDAY RATING INITIALS:	MONDAY RATING INITIALS:	TUESDAY RATING INITIALS:	WEDNESDAY RATING INITIALS:	THURSDAY RATING INITIALS:	FRIDAY RATING INITIALS:	SATURDAY RATING INITIALS:
SUNDAY RATING INITIALS:	MONDAY RATING INITIALS:	TUESDAY RATING INITIALS:	WEDNESDAY RATING INITIALS:	THURSDAY RATING INITIALS:	FRIDAY RATING INITIALS:	SATURDAY RATING INITIALS:
SUNDAY RATING INITIALS:	MONDAY RATING INITIALS:	TUESDAY RATING INITIALS:	WEDNESDAY RATING INITIALS:	THURSDAY RATING INITIALS:	FRIDAY RATING INITIALS:	SATURDAY RATING INITIALS:
SUNDAY RATING INITIALS:	MONDAY RATING	TUESDAY RATING INITIALS:	WEDNESDAY RATING INITIALS:	THURSDAY RATING INITIALS:	FRIDAY RATING INITIALS:	SATURDAY RATING INITIALS:

Blank Park Zoo Enrichment Calendar

BLANK PARK ZOO **ENRICHMENT CALENDAR**

Species/group: North American River Otter___ **Month/Year:___January 2012_____ ________**

DATE	ENRICHMENT	RATING	ENRICHMENT	RATING	COMMENTS
1	AM-diet in lunch bags buried in straw	4	PM-diet scattered around dens	4	
2	AM- diet scattered and in toys, carrot on exhibit	3	PM- diet in boxes, paper towels	3	
3	AM-diet in pans with frozen paper towels on top	3	PM- newspaper balls with perfume, meat and kibble in box with holes, blue cylinder	4	
4	AM: kibble in TP tubes	3	PM: lots of paper, some with kibble and some wtihout	3	
5	AM: diet in upside down rimmed bowl	3	PM: diet under boxes	3	
6	AM: diet in cricket cardboard/leaf piles on exh.	3	PM: tubs of snow with carrots./meatballs	3	
7	AM; diets under large black tubs	3	PM- meat in swirly ball, kibble in molecule ball	4	
8	AM: diet between metal bowls	3	PM: dog food on wobbly feeders; meatballs hidden around dens	3	
9	AM- scattered diet, hid diet under metal bowl	3	PM- diet in/under boxes	3	
10	AM- diet in rimmed bowl under boxes, wrapped "presents" on exhibit	4, 2	PM- diet in wrapped "presents"	4	
11	AM: playtime	2	PM: diets spread around holding	3	
12	AM: diet in egg crates	3	PM: diet in cricket containers w paper towels	3	Otters separated overnight
13	AM: diets in rimmed bowls	3	PM: diets in cricket cardboard	3	
14	AM: diets scattered around dens. Dog food wrapped in paper towel	4	PM: diets in cardboard boxes mixed in hay	3	
15	AM-diet in 10 dixie cups	3	PM-diets hid underneath numerous leaf piles	3	
16	AM- scattered diet, diet in kongs	4	PM- diet in paper sacks, kongs	3	
17	AM- diet in between two metal bowls, in kongs, fish in wrapped "presents" on exhibit	3	PM- diet in upside down rimmed bowls, chew toys		
18	AM: diet spread around	3	PM: tower of boxes with snow/fish and meat.	3	PM: k in paper towels
19	AM: diet spread around	3	Exh: perfume	2	PM: kibble in tp tubes
20	AM: diet under upside down bowls	3	Exh: leaf piles on top of rock area	3	
21	AM: L-k in 3hole jollyball with papertowels S-diet in cricket container	3	PM-diet in numerous small boxes	4	
22	AM-meat in swirl balls/dog food scattered	4	PM-diet in cricket containers	3	
23	AM- hid meatballs/ scattered diet	3	PM- diet in paper bag piñatas	3	
24	AM- meat in jollyball covered in paper towel	3	PM- kibble smashed in meat between two bowls.	3	

Table 1 List of enrichments items utilized in 25 zoological institutions from the AZA Otter Keeper Workshop, Dallas World Aquarium, 12 – 16 April 2012

Any item used from this list should be cleared with zoo management and carefully monitored when first introduced. Some items should only be used while otters are supervised. **Many people use paper products however caution should be exercised, there have been problems when the paper becomes wet and "glues" itself to an animal's mouth. The same holds true for cardboard.**

Enrichment Items Used for N. A. River Otters by AZA Institutions (2012)	
Enrichment items contributed by 2012 AZA Otter Keeper Workshop Attendees from 25 institutions (Baton Rouge, Blank Park, Cameron Park, Denver, Detroit, Dickerson Park, EcoTarium, Fort Worth, Great Lakes Aquarium, Houston, Hutchinson, Knoxville, Lake Superior, N. C. Aquarium Roanoke Island, Oregon, Potawatomi, Pueblo, Seattle Aquarium, Seneca Park, St. Louis, Texas State Aquarium, Utah's Hogle, and Zoo of Acadiana). Puzzle feeders, etc. listed as "Delivery"; bedding, tubs, etc. listed as "Environmental". NOTE: * Items not placed inside enclosure but outside where cannot be reached. Paper products should be used near water with caution! Some of these items may have been used under keeper supervision only. All items must be approved by institution's management.	
Delivery	**Food or food-type items**
Aussie foraging ball	Anchovy paste
Aussie hanging food ball	Apples
Automatic food dispenser in a tree which randomly dispenses food to several locations	Balls, swirly with meat
Ball, rubber, Molecule ball that treats can be placed inside	Berries and grapes (strawberries, blueberries)
Bobbin feeder	Biscuits, carrot
Box, cedar forage	Biscuits, dog or cat
Bucket, 5 gallon with holes and lid. Submerged in pool and fastened in place; also live fish placed inside.	Biscuits, monkey
Bullet feeder	Blood balls
Diet, scattered	Blood-sickles
Digging bowl	Boiled eggs
Firehose box (woven with holes for food)	Bones
Fish catapult (wish list)	Bread
Fish, crayfish, shrimp, etc. frozen	Broth ice cubes (chicken, beef)
Floating fish feeder	Canned sardines
Forage pans	Carcasses (pieces of deer, goat, sheep)
Forage pile	Carrots (whole and cut up)
Foraging opportunities	Cat food, moist
Frisbees, frozen with flavored ice/food pieces	Cat treats
Frozen fruits/ veggies: baked, whole, kebabs	Catfish chow
Fruit or meat trails	Cereal
Jolly balls with diet wrapped in paper towels inside; sometimes frozen	Chicken necks

Delivery	Food or food-type Items
Kebobs on branches	Chicken, live
Meat balls tossed into enclosure through mesh	Chicks (day old)
Meat packed in small metal bowls turned upside down	Clams, mussels
Meat packed into creases of no-spill bowls turned upside down	Coconuts
Meat/fish juice trails	Cooked rice
Paper bags with diet/treats inside	Corn hanger
Peanut butter, etc. smeared on branches or toys	Corn stalks
Plastic barrels made into puzzle feeders	Corn-on-the-cob
Puzzle feeder, mesh	Crackers
Puzzle feeders	Cranberries
PVC end caps to hide food under	Crayfish
PVC tube with rubber mat wrapped around it	crickets scattered
Snowman stuffed with treats	Cucumbers, broccoli, zucchini, steamed beats, banana, pears,
Stock tank filled with water and live fish or treats	Dog kibble (also cat kibble)
Teepee feeders	Earthworms
Treat ball: hard plastic with holes, anchored to the bottom of the pool with fish inside	Eggs, emu
Tubs -black stock feeder filled w/straw, etc. and dry food scattered throughout	Eggs, hardboiled egg slushy
Environmental	Eggs, raw (with vet approval only)
Access to different shift area	Eggs, scrambled
Air kennel	Elk bones/roast
Alfalfa	Ferret chow, trout pellets
Animal hair	Fish flakes, dried
Animal pinwheels*	Fish goo
Alpaca fur	Fish juice-sickles
Aquatic plants	Fish-sickle
Bamboo teepee	Flowers; edible and also rose hips
Bamboo with smooth edges	Foods, assorted treats: popcorn, crackers, cereal, marshmallows, croutons, graham crackers, tuna, etc.
Barrel (plastic, all sizes) suspended from chain, in water, on ground, with holes; may have food hidden inside	Frogs
Beaver fur and squirrel tail autoclaved	Frozen fish treats

Environmental	Food or Food-type Items
Behind-the-scenes-tours	Fruit hollowed out and stuffed with treats
Branches	Gelatin jigglers
Browse (approved)	Gourds
Brush groomer	Green peppers
Bubble machine*	Grubs
Burlap	Ham, unsalted
Burlap hammock with PVC frame	Honey
Car wash strips/freezer door flaps	Honey comb
Carpet squares	Honey cone
Carpet, indoor-outdoor	Horse knuckles
Climbing structures (durable children's toys)	Hot dogs
Cloth; green cut to resemble kelp	Ice blocks, layered flavors
Clover (fresh)	Ice blocks, layered food pieces
Coco fiber doormat	Insects (mealworms, wax worms, etc.)
Coke barrel beds	Jell-O, with fish chunks or broth
Comforters	Jelly
Construction pipe tunnel	Knuckle bones, rib bones
Crushed ice	Krill
Dirt piles (fresh)	Lettuce head
Feathers	Live fish (creek chubs, shiners, goldfish, minnows, capelin, herring, trout, blue carp)
Fire hose strips hanging	Melons
Firehose	Mice and rats (whole carcass)
Fleece	Milk bone dog biscuits
Fleece balls	Night crawlers
Fleece blankets	Oatmeal
Furniture changes	Oranges
Furniture from another approved enclosure	Pasta, cooked
Grass piles	Pecans
Hammock, circular and swings	Peanuts
Hammocks	Pegetables (vegetables on wooden pegs)
Hand-held or box fan*	Pine nuts
Hay, straw, leaf litter	Popcorn
Horse trough	Pumpkins (all sizes)
Hula hoops weighed down by bricks	Quail
Ice (also artificial iceberg)	Rabbit legs
Ice (blocks or cubes; hanging, barbells, cubes, blocks, balls, rings, piles)	Raisins
	Rats

Environmental	Food or Food-type Items
Keeper interaction	Salmon eggs, fresh
Kiddie pool	Sand eels
Kid's turtle shaped sand box	Scare crows made from edible items
Kuzu vines	Shrimp, not peeled
Laser pointers	Shrimp, raw and peeled
Llama/bison fur	Snails, clams; live
Log ladder	Squid, crab legs, sardines
Logs	Worms (red wrigglers, meal, wax)
Logs, hanging	Yogurt
Logs, stumps, shrubs, trees, grass, hollow logs, sticks, drift wood, natural substrates	Acrylic sheet feeder
Milk crate	Acrylic tube feeder
Mirror mobile*	Antlers
Mirror*	Aussie "Lion ball"
Mister fans*	Aussie Ping Thong ball
Mister hose	Balls (whiffle, tennis, jolly, fortex rubber balls, boomer, bowling)
Mollusk shells	Bamboo flying disk, 6"
Moss	Basketball
Mud pits	Bins, heavy plastic, all sizes
Mulch	Bobbin
Natural fiber mat	Boogie board
Novel visual item	Boomer ball
Palm fronds	Boomer ball, extra-large with hole for entry
Pampas grass fronds	Bowling pins
Pillows	Boxes
Pinecones (also scented or with food hidden within)	Bubbles
Pipe, gutter	Buoy
Plants, aquatic purchased at pet store	Buoy toys
Plush dog beds	**Toys or Manipulable Items**
Raft, bamboo	Cardboard, paper bags (not around water)
Rock piles	Chains (large or small enough they cannot become caught
Rock piles	Chew toy shaped like a tire
Rocks, fake	Coconut shells
Rocks, piles	Coke crates
Root balls (tree roots cleaned and placed upside down on trunk stump for climbing one	Cow hooves

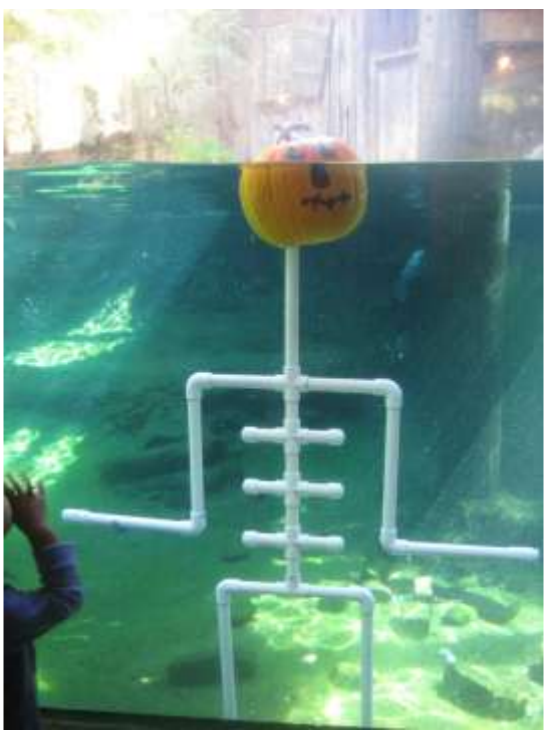
Environmental	Toys or Manipulable Items
Sand box, moveable	Dental chew toy, Pas – A – Fier
Sand piles/boxes/tubs, etc.	Diving toys
Seaweed, culinary grade	Dog crates, kennels, igloos
Sheets, towels, washrags	Duck decoy
Shells	Egg cartons
Shifting changes (time)	Faux feathers
Slides	Fly swatter
Snake sheds	Frisbees
Snow	Grain sacks
Snow in holding	Hexagon kong (hollow bones)
Snowman	Jolly balls
Sod	Jugs
Sprinklers and waterfalls	Kegs
Traffic cones	Klinker ball
Training	Kong chew toys
Trees: Christmas tree, privet, pine, beech, iron wood, willow, cypress	Kracor keg and log
Tube, corrugated large black	Milk crate
Vegetable fiber sacks	Nyla rings
Vegetable vines	Nylabones
Visual barriers: camo netting, bamboo, hula skirt, etc.	Painting
Warm water	Paper Mache figures
Warm water hose	Paper towel jungle
Willow branches	Pigs ears and snouts
Woodchips	Plant pots, non-breakable
Wooden raft (heavy duty) on PVC frame	Plastic bottle, 2 liter (no lid) #3 food degree
Wooden scratch post wrapped in Astroturf	Plastic container filled with rocks and put in pool
Wooden swings	Plastic egg (extra-large)
Wood wool	Plastic keg coupled with mop head
Wool	Plastic logs
Wreaths, grapevine	Plexiglas shield
Scents	Plush toys
Allspice	Pool rings that float
Animal feces (non-carnivore)	Pool rings that sink
Animal scents, synthetic	Pool, kiddie
Animal urine (commercially purchased)	PVC Alka-Seltzer tube
Broth	PVC toy (various shapes; incl. tubes, rings, standing figures, trees, etc.

Scents	Toys or Manipulable Items
Butter extract	PVC/fire hose "seaweed" toy
Cheery extract	Rattles
Cinnamon powder	Rawhides
Condiments (ketchup, mustard, vinegar, peanut butter, maple syrup, salad dressing, relish, molasses, applesauce, etc.)	Rocks, small river rocks for carrying or playing with
Cumin	Rope bone
Elephant foot shavings	Rubber duck
Garlic	Rubber feed tubs
Herbs, fresh	Sand box toys
Lavender oil	Scrub brush heads
Lemon extract	Sled
Mint extract (powdered and liquid)	Slip n' Slide
Nutmeg	Spools, plastic
Oils; fragrant/essentials	Tire; floating plastic
Orange marmalade	Tires
Perfumes	Toboggan
Pumpkin paste	Toy barbells
Root beer, strawberry and vanilla extract	Training dummy
Scents, assorted: coffee, cooking spray, catnip, Asian essence, dill weed, bacon bits, black pepper, grill seasoning, crushed red pepper flakes, tarragon, sesame seeds, ground clove, rosemary, onion salt, Mrs. Dash, BBQ seasoning, root beer concentrate, Obsession cologne, eucalyptus spray, coconut-lime spray, parsley, bay leaves, celery salt, paprika, thyme, pickling spice, Ben Gay, breath spray,	Trash can lid, 25 gallon
Vaporub	Trash can; empty, filled with water, filled with bedding
Sounds	Tub - 55 gallon
Echoes of Nature: thunder, forest sounds, frog chorus, morning songbirds, jungle talk, forest wild lands, wolves, night of the owl, echoes of glaciers, etc. Also Sun Catcher CD’s and assorted Animal sounds CD*; radio; wind chimes, and noise makers/rattles.	Vinyl tube, clear
Game caller, Bird caller, electronic	Virginia creeper balls
Noise maker/ rattle	Water cooler bottles
Radio	Weeble
Wind chimes*	Wheelbarrow & stroller seat buckets

ENRICHMENT PHOTOS 2

Dickerson Park submerged "sea weed".

Fort Worth PVC pumpkin man and bamboo raft.



John Ball Zoo root-ball-island, fastened to bottom of pool. Fun with just a few feet of water too.

Seneca Park
Hanging hammock

Training as enrichment and good husbandry Seattle Aquarium (Photo: C. Hempstead)

Enrichment Ideas Explained and Quotes

This list is not exhaustive and not all of these ideas have been tried with otters. Before using any of the fabricated toys, i.e. puzzle feeders, etc.; make sure no animals can accidentally become caught inside while under water.

Brush Pile Feeder (Law et. al 1990) – Place meat or other food items under a brush pile; can also use a rock pile or logs.

Dog Chews – Try different things with them, i.e. hang them, soak them in water, fish juice, blood, etc.

Artificial Tree Food Dispenser (Carlstead et. al. 1991) – Mechanism in tree dispenses food items to one of 6 locations around the tree's base at random intervals.

Fish Catapult (Washington Park Zoo; Markowitz 1982; Hawke, L., P. Lauer, D. Bartholomeusz & Z. Steen. 2000) – Catapult fed by conveyor belt ejects fish into the enclosure at varying intervals.

Hard Plastic Balls (Shepherdson 1993) – Variations, e.g. "Boomer Balls" can be covered with a variety of scents or holes drilled in them and filled with food, stones, etc.; or used as day beds.

Meat Trail (Glasgow Zoo, Law et. al. 1990) – Drag meat around the exhibit leaving a trail; the meat may, or may not, be at the end. (Fish juices also could be used.)

Visual Barriers (Mckenzie et. al. 1986; Adams & Babladelis 1987) – Vegetation, rocks, waterfalls, etc. increase the environmental complexity and increase the animals' psychological space.

Rubbing Post (C.E.E. 1993) – "*Begin with a concrete parking bumper or other appropriate substance. Bolt a natural bristle broom head (bristles up) onto the concrete and put into pool. The animals can utilize the bristles for tactile stimulation. Different texture bristles could be used…"* (H. Hellmuth personal communication)

Milk Crate Feeder Puzzle (C. E. E. 1993) – *"Take a metal milk crate, weight it down and place it upside down on the bottom of the pool with fish underneath. If you cannot enter the pool to place fish under, or for a different type of enrichment, put frozen fish blocks under the crate.* Also suggests: *"Take two plastic milk crates and secure them together (or one crate with a makeshift cover). Put fish inside the crates and place them in the pools."* (H. Hellmuth personal communication)

PVC Feeder (C. E. E. 1993) – Idea submitted by the Oregon Coast Aquarium for sea otter.
"4" cellular PVC tube with four holes drilled along its length …with slide-able rings covering them. In addition to the floating cellular PVC, a small float is installed under the fixed cap to avoid sinking. "The four slide-able rings (with retaining tracks) cover the four access holes drilled along the length of the tube. The ring has a hole that matches those on the tube. Once the ring slides to match both holes, items can be reached."

This idea may be better suited to Asian small clawed otters but could be used for N. A. if something like fish pieces were put in (because otters will tend to take the toy out of the water) and the rings made moveable and easily pushed with noses.

Boomer Ball Feeder (C. E. E. 1993) – Adapted from an idea for sea otters submitted by Oregon Coast Aquarium. Drill holes in any size Boomer Ball. Hole size should be large enough to allow the insertion of ice cubes (these help hold the fish in) and fish pieces.

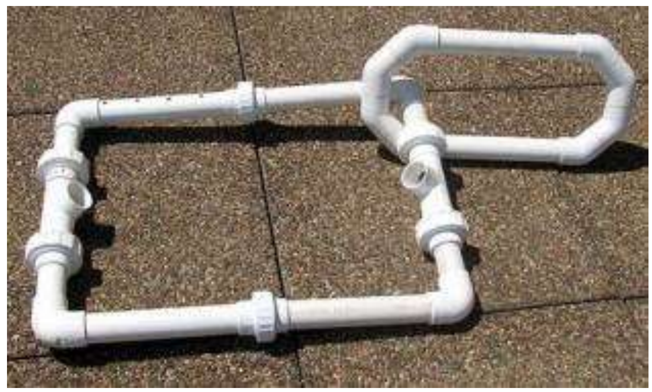
Ice Cube Mountain (C. E. E. 1993) – Oregon Coast Aquarium. *"Large buckets of ice cubes are dumped in piles at various locations on the deck of the exhibit. Frozen butter clams are hidden under the piles of ice."* This idea was used for sea otter but could easily be adapted to river otter.

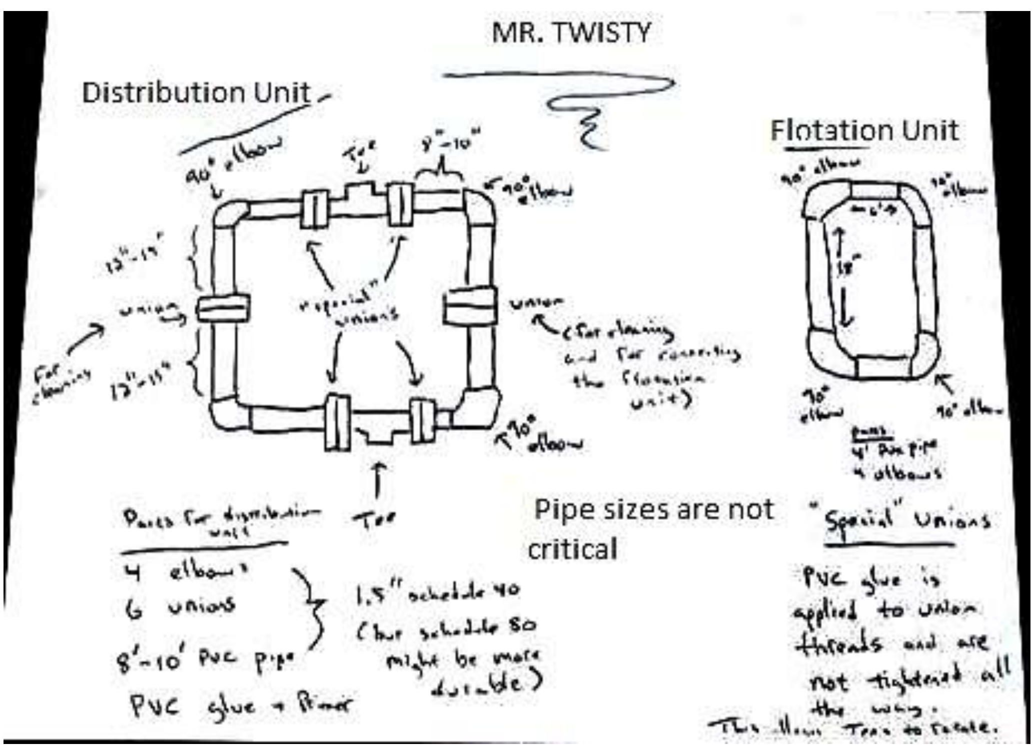
Animal Shower (C. E. E. 1993) – Brookfield Zoo *"Animal can walk or swim to an area in the pool or enclosure and self-activate the operation of a shower head located in the area"* (E. Krajniak). He suggests using a motion sensor like the ones used to turn lights on. Mount a shower head to a water source using a hose. *"Go back to the water valve you are going to hook the hose up to for water. At this point install an electric solenoid valve (you want a solenoid valve that is normally closed when the power is off and opens when you turn the power on.) Next run an electric power line to the motion sensor. Run two wires from the electric wire that would normally turn on lights, when the sensor senses motion, it will turn on the water instead of the lights.*" (E. Krajniak)

Mirrors – Place outside the exhibit, preferably on under water viewing window.

Floating Bag (G. Ziegler personal communication) – *"... food items inside a loosely tied mealworm bag (small muslin cloth bag) and tossed in the pool. Our otter played with it longer than anything I've observed. She had a hard time opening the bag, but finally got it.*" A variation on this is using a pillow case – place fish or fish pieces inside and tie the end (Pueblo Zoo, M. Pococke)

Mr. Twisty – Design by Bill Hughes, submitted by Courtney Lewis;





Car wash strip toy – Kristine Smith, Oregon Zoo (OKWS 2010)

There are an unlimited number of variations and combinations for the enrichment ideas and items listed here. As stated earlier, any one idea may work for some animals and not others; it may take a while for an animal to respond to any given item so try it more than once; be watchful for adverse reactions, even with previously used items; be creative, and, share. If you find a novel approach share it on the AZA river otter or enrichment list serves or one of the other enrichments resources currently available.

Remember!

When developing your otter enrichment program do not forget the importance of your exhibit design. A complex, well thought out exhibit will provide a multitude of enrichment options. Exhibit furniture can be moved (both onshore and "offshore") and should be changed periodically to introduce novelty to the animals' environment. It is preferable to offer a variety of substrates. This affords the animals a choice of where to do their grooming and allows for a range of exploratory behaviors which can be encouraged by planting toys, food items, etc. Pools, streams, waterfalls, etc. need to be varied in depth; if possible, water bodies in the same exhibit should also offer different features such as degree of turbulence, shore composition, and submerged fixtures like logs, rocks, etc. Stones, rocks, pebbles, and sand placed along the shoreline, or as part of shallow water bodies, offer a rich medium for manipulation by the otters and hiding of treats and toys. Temporal enrichment can be a valuable option for those exhibits designed with adequate off-exhibit holding facilities. Animals can be rotated on and off exhibit providing them with the opportunity to explore different spaces, get away from the public or conspecifics for a while, pursue a more natural behavior cycle like following the scent of an estrous female, and finally, periodic rotation of animals stimulates activity in the exhibit and creates an opportunity for keepers to introduce other enrichment items to the exhibit. Indoor exhibits should offer temperature gradients to allow animals the choice of where they want to be and outdoor exhibits should provide varying degrees of shade. Sleeping/hiding place choices should be available in any exhibit type.

And finally, when looking for new enrichment items keep these criteria in mind: *"First, the object must be large enough so that it cannot be ingested. Second, it must be strong enough to stand up to their teeth. Third, it cannot have any sharp edges that could cut the otters. Fourth, it cannot have any small parts that could break off…"* (Gabbert 1999).

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CHAPTER 12 Training or Behavioral Modification

Introduction

Training is a complex and dynamic subject with a vast array of resources available. This section is designed to; a) provide an introduction to training otters for those are new to working with them or just beginning a training program at their facility and, b) to provide examples of behaviors trained by institutions to encourage otters to willingly participate in common husbandry activities. See Chapter 11 Abnormal Repetitive Behaviors for information on the use of training session cues to reduce pre-training/feeding session ABRs.

Basics of Otter Training

Written by: K. McKay. Published by: IUCN/SSC Otter Specialist Group, Otters in Zoos, Aquariums, Rehabilitation, and Wildlife Sanctuaries Task Force (OZ); Edited by: Jan Reed-Smith, OZ Chair Contributors: A. Dougall, M. MacPhee, J. Mellen, S. Tippet (Abridged Version 2012); *http://www.otterspecialistgroup.org/Library/TaskForces/OCT.html*.

The Otters in Captivity Task Force extends special thanks to Disney's Animal Kingdom® staff for their review of this document and contribution of extensive training expertise.

Why we train

A common goal shared by keepers is to provide the best possible care for our otters. The physical well-being of the animals is, perhaps, the most immediate concern of animal caretakers. Training can have an impact on every facet of an animal's health, and can be used in a variety of ways to aid in husbandry and medical care. For example, through training an undernourished otter can be encouraged to eat; an injured otter can be trained to take medication or allow injection; disabled otters can be trained to use their remaining faculties. Healthy otters can benefit from training also. Training otters to stand on a scale allows the keepers to obtain weights reliably without the stress of physical restraint (e.g. netting, grabbing by hand). Otters can be trained to present body parts to the trainer for close inspection. All of these are examples in which the otter participates in its own health care.

Otters are complex animals. Those of you who have worked with otters are probably aware that they are intelligent, curious creatures. They can solve puzzles, use tools, and manipulate their environment. In the wild, otters will use these skills to acquire food and engage in social activities. In captivity, food is provided for them, eliminating the need to work for their meals. How the food is presented to the otters can have an impact on their well-being. A training session during feeding times is one way to allow otters to use those parts of the brain they might use for hunting. Training can be considered activity time, giving otters an opportunity to solve a puzzle and use their memory to achieve training goals. Some otters may respond enthusiastically to training sessions, much like children at playtime. In the absence of pressure to find food or avoid predators, otters may find themselves getting into trouble; in these cases, training can be used to reduce or eliminate undesirable behavior. A consistent training program contributes to the otters' mental health.

Otters have sharp teeth, powerful jaws, and can have aggressive tendencies. Otter and keeper safety, especially with larger species, should always be a priority. Training an otter to voluntarily enter a crate/kennel can eliminate the need to physically restrain or catch with a net, reducing risk of injury for both parties. In some circumstances an otter may be considered too aggressive or dangerous to work with in close contact. Training methods exist that can be used to achieve goals while keepers remain a safe distance from the otter.

Even the daily management of the otters can benefit from training methods. Otters can be shifted from one area to another without force. If two or more otters show aggression toward each other during feedings, they can be trained to separate into different areas. In some cases aggressive otters can be trained to eat cooperatively without separating. In situations where there is not enough space to separate the group, keepers can place visual barriers between animals during feedings. Otters can also be trained to station, that is to go to a specific location such as a log or rock and stay there for feeding.

An added or unexpected bonus of training is its effect on the quality of care given. Training engages keepers in the care of their otters. Keepers who train daily have an investment in their otters that can translate into better care. Success in training creates positive feedback, or sense of accomplishment, which can motivate keepers to invest more time and energy into the otters in their care.

How we train

Motivation

The foundation of any training program is motivation. Before you begin to train you must understand what motivates your otters. While the most common motivator for training is food, it can take other forms as well. Access to an outdoor exhibit, nest box, or group member can all be motivators, so can a favorite toy or substrate. Training is a two-way process. The trainee offers the behavior and the trainer offers the reinforcement (reward). Keep in mind that each species has a unique set of motivators. Learning the natural history of your species is a good first step toward discovering what will motivate. For example, access to saltwater will likely be less reinforcing to a river otter than to a marine or sea otter. Some species will have preferences for crustaceans or mollusks, while others prefer fish. In addition to natural history, it is equally important to look into your otters' individual history. Two otters within the same family can prefer two different types of fish.

A key element of natural history shared by all species of otter is their high metabolism relative to other mammals (Kruuk et al., 2002). The need to consume a substantial quantity of food relative to their body size makes the diet an excellent motivator. Using their diet to provide reinforcement for a correct behavior provides an opportunity for many behaviors per session versus a single reinforcer such as a toy or access to a favored area. Most fish species can be cut into smaller pieces, allowing for even more rewards per session. Using daily diet items rather than special "treat" foods also makes it easier to maintain healthy weights.

While determining what best motivates your otters, special consideration should be given to the social dynamics of your species as well as to the individuals within the group. At times the desire to be with a family or group member (or to avoid them) can override the desire for food. This fact can make the training of group separations difficult. You may need to work with small approximations, or series of steps, to slowly move individuals farther apart over time.

Creativity

There are a number of books, journal articles, and web sites covering the subject of animal training and for each reference there might be a different way of training. There are many methods that can be successful. Being flexible and creative is important as a trainer. Do not be afraid to try something new or different, even if it does not follow what you have read (including this manual). Knowing your otters will go a long way toward shaping your training plans. In the following example, a keeper overcame a training challenge by looking beyond the designated training time: this particular group of otters was so motivated by food that the beginning of any session was very chaotic. They were so focused on the food they could not focus on the training. The solution was to feed the group a small part of their diet twenty minutes before a session. This had a calming effect on the group and allowed them to focus on the trainers during training time.

Positive Reinforcement and Trust

The concept of positive reinforcement is important in animal training. The basic principle is that a reward is given to the otter for a correct response to a training cue. Over time this can establish a relationship of trust between the trainer and the animal. This trust can be incredibly useful when training behaviors that may normally cause distress. One individual Asian small-clawed otter came to a facility after eleven years in a zoo that did little husbandry training. Her only experience with a crate came from being caught by net and placed in the crate, usually for veterinary procedures. At this new facility, it took several months of training to get this otter to enter a crate willingly. When the time came for her first examination, there was concern that she would, once again, be afraid of the crate. After her exam she was returned to the exhibit and allowed to spend the rest of the day with her mate. During her first training session the following day, when asked to enter the crate, she did so willingly and without hesitation. Her recent and consistent positive reinforcement history was enough to overcome the negative experience of the examination.

Timing

Creating a bond of trust between otter and trainer requires careful timing. This can be one of the more challenging aspects of any kind of training. Otters are known in training circles to be difficult to work with for two reasons: 1) they can move quickly, making it difficult to reinforce at exactly the right moment, and 2) they are very intelligent, which can work against you when training new behaviors. When asked to stand up, your otter may stand, open its mouth, step to the left, hold up its tail, make noise, and put its paw on a rock all in the space of a few seconds! Reinforcement will need to be given at precisely the right time to let the otter know exactly which behavior you want. Accidentally reinforcing inappropriate behavior; such as screaming while feeding or biting at a target, can be very easy to do. Once learned, eliminating the undesirable behavior can be difficult and/or time consuming, especially for a novice trainer. One way to avoid reinforcing these behaviors is to begin with steps that are very short in duration and can be achieved quickly. Doing this gives the otter less time to offer any of the undesired behaviors.

Training Plans and Consistency

Timing of reinforcement goes hand in hand with consistency. This means rewarding at the right time, every time. The right time will be determined by your training plan in a series of steps called ‘approximations.’ These approximations will provide a map from beginning to end of a new behavior. Having a plan is important, but remember, be flexible. Your otter may not know the plan and will go in a direction that you did not anticipate. A good training plan is one that is adaptable to many situations. Examples of training plans are provided later in this document.

Another recommended technique to maintain consistency is to use one trainer for any new behavior. While going through the steps to produce a new behavior, having the same person with the same timing leading the way can be beneficial. Two or more people with different timing can cause confusion for the otter and tend to slow the process. Ideally sessions occur one or two times a day every day. For some institutions this schedule may not be possible since they have employees or volunteers who work with the otters for only one or two days a week. In these situations, having two trainers who are able to work more sessions per week is preferable over one trainer working fewer sessions. With multiple trainers, having a clear training plan and good communication between trainers is essential for success.

The Bridge

In addition to a good training plan and a single trainer for each new behavior, another tool commonly used to help with consistency and timing is known as a “bridge.” In some cases delivering the fish reward at the right moment is easy to do. At other times the otter may be several feet away or behind a fence. In these situations a whistle, clicker, or a verbal “good” can be used to tell the otter that it has just done the right thing and a reward is coming. This is called a “bridging stimulus” or “bridge” because it bridges the gap in time between correct behavior and reward. With practice a bridge can become very precise so the otter knows the exact behavior you are looking for the moment it occurs. There are many different types of bridge. The selection of the bridge will depend on trainer preference, what makes sense to the animal you are working with, and the animal’s current situation. A favorite among trainers is the dog whistle, a three to four inch (seven to ten centimeter) metal tube that can emit a range of high frequency tones. It can be held in the mouth keeping hands free for feeding. The whistle can be used to respond quickly and the tone makes for a very clear bridge. A clicker is a small, rectangular box with a metal plate inside. Sound is produced by pressing down on the metal plate and releasing, creating a double click.

Dog whistle

Clicker

What we train

When starting a training program with an otter that has never been trained before, begin with behaviors that lay a good foundation for future training. Most foundation behaviors are simple but immensely useful for building more complex behaviors later. What follows are examples of common otter foundation behaviors. With each there is a description of the foundation behavior, how it is used, and how it is trained. A sample training plan is provided for a few of the more complex behaviors that can be used as a starting point. Training plans act as the roadmap for a given behavior, where each approximation is mapped out from beginning to end. In those instances where the otter moves two steps ahead, the trainer will already know what the next step will be. Training plans also work in reverse. If an otter becomes stuck on a certain step, the trainer can go back to a previous step, reinforce that, and continue forward, or go in an entirely new direction. The training plans may need to be revised for each institution based upon animal management policies. In some cases plans may need to be altered to better suit individuals within the same group. Once again, be flexible.

Bridging
The first behavior that you train should be to recognize the bridge. Otters do not instinctively know that a whistle or a click means food is coming. This is a good behavior for a new trainer to start with as it is a good way to practice timing. Bridging can be done during every feeding and most otters will learn this quickly.

The training plan is quite simple. Blow your whistle (or use your clicker, or say “good” etc.) followed by giving the otter its food. The bridge can be used once per feeding if the entire meal is given at once, but you can progress faster by dividing each meal into smaller portions and bridging before each one. The goal here is to have the otter associate the bridge with a food reward.

Focus
An often overlooked foundation behavior is having the animal focused on the trainer. The otter attention span is notoriously short, which leads to frustration as you wait for your otter to focus on you. What the behavior looks like is the otter sits or stands calmly in front of the trainer with its eyes focused on what the trainer is doing. Having this behavior trained can do wonders for any other training you plan to do.

Like every other facet of training, knowing your otters will be the first step. Giving undivided attention can be difficult for some otters. Begin by learning their behavior patterns and plan accordingly. Trying to train at the same time that they take a nap every day is not the best way to earn their attention. In some cases otters are shifted from one area to another for training (e.g. from an outside exhibit to indoor holding). This new area may require some scent marking, especially if this area has been cleaned recently. In this situation it can be beneficial to allow the otters a few minutes to sniff around before asking them for attention. Choosing the right time for training will provide your otters with the best opportunity for success.

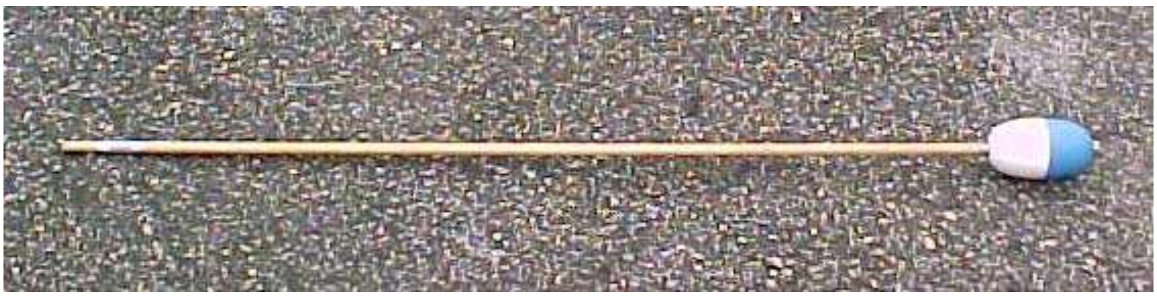
Training this behavior will look different for each otter that is trained. There are a few behaviors to watch for with all otters. Unless you want your otter to scream throughout your training sessions, be sure to bridge and reward only when it is quiet. This is a good opportunity to get a particularly noisy otter to quiet down a little. If the otter moves around a lot, be sure to bridge and reward only when it is near you. Once the otter is nearby and quiet, watch for it to look in your direction; then bridge and reward. Doing so will establish you as the focus of each feeding/training session. When you are confident the otter understands what you are looking for you can increase the length of time required for calm, focused behavior before giving the reward.

In some cases it can be useful to have a hand cue to help focus the otters' attention. Any cue can be used, such as holding your arm out in front of you with the palm of your hand facing the otter. A cue is not necessary if you have an attentive otter, but is helpful when working with an otter that needs something specific to hold its attention.

Target

One of the single most useful behaviors an animal can learn is to recognize a target. This is our way of asking them to go to a certain place or touch a certain object without having to learn otter language. A target can be used as the foundation for almost any other behavior.

The first step will be to decide what to use as a target. A common target is a thin pole with a ball or pool buoy attached to the end.


Sample target

The length will vary depending on your circumstances but a common starting point is four feet (1.23 m). The materials used should be safe. Otters may try to bite the target in the beginning so it should not break off in their mouths.

The next step will be to show the target to the otter and reward for calm behavior. When you are confident the otter understands that the target is not bad, bring it close enough to be sniffed. The sense of smell is so important to otters it is likely that the first response to the target will be to sniff it. If that happens, reward the otter as its nose comes close to or in contact with the target. Use your bridge to ensure that you are rewarding at the right moment; your otter may only sniff the target for a second. Some species, notably sea otters, may immediately attempt to grab the target with their paws.

While it is unlikely, there is a chance that the otter will show no interest at all in the target. In this case you can take small steps to bring the target close to the otter's paw. Show the target, then bridge and reward. Bring the target a little closer and, as long as the otter doesn't move away, bridge and reward. Continue until you can touch the otter's paw with the target.

From this point it will be up to the trainer how to proceed. Touching the target with the nose or grabbing the target with both paws are common and acceptable forms of targeting. Touching the target with the top of the head or the tail are also useful at times. Train the behavior in the direction you want it to go according to the plan you have put together.

Now that the otter is touching the target with the body part you have chosen, move the target a few inches (cm) away and allow the otter to go to the target. When the otter understands the concept of "go to the target," you can move to different places and have it follow. At this stage you can also train the otter to hold the target in one place for longer periods of time.

Sample Training Plan: Target

Goal of behavior: To have otters go to a target object and hold its position at the target until bridged

1. Introduce the target at the side of the mesh door while you feed the otters through the mesh.

2. Approximate the target closer to the otters. Once they are comfortable with the target, place target in front of them and cue "target".

3. Reward the otters for touching the target.

4. Approximate that one paw touches the target.

5. Approximate that both paws touch the target.

6. Work on shaping step 5 so that the otters hold their paws to the target for short periods of time.

7. Lengthen the holding time and then vary it. When bridged, they should release the target.

8. Move target a short distance away and bridge when otter goes to the target.

9. Move target a greater distance away. Have otter go to target and hold until bridged.

Crate

When transporting otters from one location to another, a common practice is to place them in a small kennel or crate. Getting untrained otters into a crate can involve baiting (throwing food into the crate and waiting for the otter to go in on its own), leaving the crate in the enclosure to encourage the otter to nest in the crate, or capturing the otter with a net and placing it in by hand. Any of these methods can be effective; however, the first two are unreliable, and the third can be unsafe for both the keepers and the otters. Grabbing an otter by hand is notoriously difficult. Their loose skin and flexible bodies allow them to practically turn in their own skin and bite the grabber. Training the otters to enter the crate can reduce the possibility for injury and stress.

The training plan for crate training will vary depending upon each institution's policies and setup. Some kennels will have side swinging doors while others have guillotine (up and down moving doors) doors. The general training plan provided here should be adaptable for any situation. The first step will be to choose/build your crate. Ideally your crate will be at least as long as the otters. A shorter crate will require an extra training step since the otters will need to turn around in order to get their whole bodies, tail and all, inside.

One benefit to working with otters is they are not often easily frightened by new things. Placing the crate in the otters' enclosure will often result in curious exploration inside and out. If the otters have had negative experiences with the crate in the past, it may be best to introduce it slowly. Have the crate visible but outside the enclosure at first. Once the otters are accustomed to the crate, move it closer until you are confident that it can be placed in the enclosure without causing unnecessary stress. The amount of time this takes will vary depending on the otter and will be up to the trainer to judge. In some cases it can take one session, in others several weeks.

When the otters are comfortable with the crate, the trainer can begin using the target to bring them closer. Having the door to the crate open or removed completely in the beginning can give the otters room to move. The trainer will need to be flexible and be aware of the otter's behavior at all times, and that behavior can certainly be unexpected. For instance, during one otter's crate training there came a point where she would not put more than her head into the crate. In an effort to make some progress the trainer closed the door and asked the otter to enter. Having the door closed gave the otter a task which was enough of a distraction to make her seemingly forget that she did not want to enter. Seeing the door closed, she

opened it herself and entered immediately. The trainer blew the whistle and gave her a reward. By trying something new an obstacle was overcome and the training progressed quickly from that point.
When you are working with otters in free contact (i.e., working inside the enclosure with the animal) having a long target pole can be helpful. Begin by placing the target outside the front of the crate. As the otter becomes comfortable going to the target it can be moved into the crate in a series of small steps until you have reached the back of the crate. Each small step should be rewarded at this point, preferably giving each reward inside the crate. In some cases a target used in this way can become difficult to work with as you try to get the otter and the target to fit in the back of the crate. If your crate has holes in the sides, one trick that can help is to hold the target against the holes on the outside and have the otter touch the target from inside the crate. Another solution can be to create a small target that can fit through the holes. This will allow you to place the target in the back of the crate without going through the front. One advantage of this method is it can be safer since you are not reaching over the otter while targeting.

A complete behavior will often fade the use of a target and introduce a cue. This is accomplished by giving the verbal cue such as "crate" or any hand cue you choose right before you show the target. Once the target and cue are associated together you can remove the target by giving only the cue and waiting for the otter to respond. If the otter responds immediately, you are ready to move on. If the otter hesitates, you can show the target after giving the cue and slowly fade its use until only the cue is needed. If you choose to eliminate the target this is a good place within the plan to do so.

The last step in the process can also be the most challenging. Closing the door can cause some otters to panic and should be done very carefully. Begin by touching the door with your hand while the otter is sitting calmly in the crate. If you work in protected contact (i.e., keepers do not enter the animal's enclosure) the door may have a string or lever that is pulled to close it. If that is the case you can hold the string/lever and apply slight pressure as the otter sits calmly in the crate. Close the door a little at a time and be sure to reward the otter only while it is in the crate. Some otters may try to force open the door as you start to close it. If this happens open the door and start over. This is the stage in the training where you want the otter to trust you. Trying to trick the otter into letting the door close, or shutting it too fast and leaving it closed can cause setbacks for the training process. For the first few times that you close the crate completely, open it again immediately, before the otter has a chance to react. Doing this can show your otter that you can be trusted to open the door at all times. At this point you should be able to increase the amount of time the door is closed with a calm otter sitting in your crate.

Since most crating will involve moving the otter, it can be beneficial to include that in your training plan. As the otter sits calmly in its crate stand next to it and put your hand on the handle. Proceed in small steps to raise the crate off the ground and carry it a short distance, rewarding the otter in the crate during each step.

Sample Training Plan: Crate

Goal of Behavior: To have otter sit calmly in crate with door closed and allow transport to other areas

1. Allow the crate to sit in the holding stall until otters appear comfortable with it there.

2. Use the target behavior to approximate the otters towards the holding crate. Reward as the otter comes closer to the crate.

3. Cue with verbal "crate" or hand cue, place target inside crate and reward otter for going into crate.

4. Fade use of target and use only "crate" cue.

5. Work on closing the door behind the otter.

6. Once the otter is calm, keep door closed for longer periods of time.

7. Pick up crate and carry for increasingly long periods of time

Using these training plans will get you started, but you may find you quickly outgrow the limited offerings herein. You are encouraged to create your own training plans for the behaviors that best suit your otters' needs and environment.

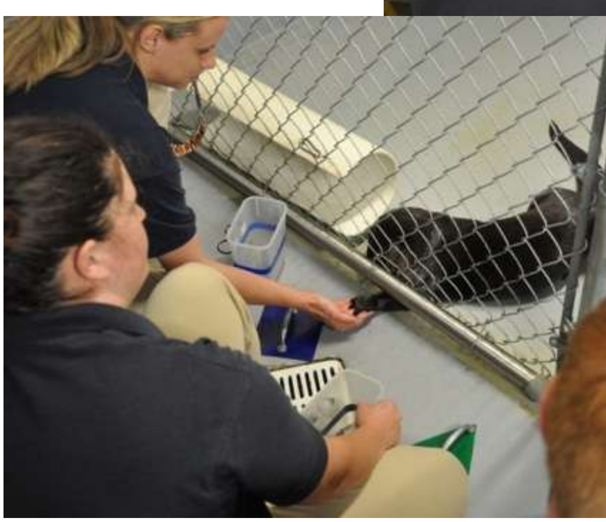
TRAINING PHOTOS

(Photos by K. Talcott, and thank you to the staff of the Downtown Denver Aquarium)

Target

Target to shape (not color)

Paw or foot



An Introduction to Training and the Basic Steps Used to Successfully Introduce Five Males: Behavioral Training of North American River Otters at the Virginia Marine Science Museum.

By: Chip Harshaw, Curator of Marsh and Marine Mammals Virginia Marine Science Museum Virginia Beach, Virginia

While the title of this article and its contents describe some of the Virginia Marine Science Museum's training strategies and methods for *Lontra canadensis*, much of what you will read can be applied to most other types of otters and/or animal species. The physiological makeup and mannerisms in other taxa vary and thus require different approaches; however the concepts and strategies are basically the same. Before moving forward, it is important to have a basic understanding of behavioral training and how it can serve animal management programs. This information is condensed and intended to provide a general overview of behavioral management. There are several books and journals available which can assist interested persons or facilities in furthering their understanding on this subject.

To begin, "What is Training"?

There are different definitions for training. Some of these descriptions can be found in books and journals which can be complex and confusing. To keep this simple we should define training in its most basic form. *Training is teaching. (Ramirez - Animal Training p.8)* For our purposes training is not for teaching tricks but instead to enable animal care staff to teach animals such as otters to live successfully within their zoological environment. Animals under our care look to us to serve many of their physiological, environmental, and behavioral needs. An effective behavioral training program can help to accomplish all of these things and at the same time enhance the lives of the animals under our care.

Why Have A Training Program?

In order to have a successful training program, one should have a clear understanding of why they wish to train. In other words, what do you hope to accomplish by training your animals? Do you desire to have this type of program to enhance the lives of the animals under your care, improve medical husbandry, better facilitate maintenance routines, or all of the above. You should first have clear objectives. The specific training goals will evolve as your program develops.

Training Objectives

Typically, training programs serve a few basic yet critical objectives. These objectives can be broken down into *Primary* and *Secondary* reasons to train.

Primary reasons: Perhaps the most important purpose or *Primary* reason to have a behavioral training program is to teach animals to cooperate in husbandry or veterinary procedures. In the case of our five male N. A. river otters at the Virginia Marine Science Museum, we have taught them a variety of behaviors to assist both the animals and staff caring for them. These behaviors range from very simple shifting on and off exhibit to expedite maintenance, to more complicated behaviors. An example of one of our most complex trained behaviors is allowing our veterinarians and /or myself the ability to sedate each of our otters under protected contact, without physical restraint. We typically conduct this procedure once a year during annual physical examinations. Ultimately, this behavior has allowed us to conduct complete physical examinations with all five otters in about one hour. This process has essentially eliminated any stress associated with restraint. It also eliminates any risk to the otters or keepers if a net and/or a squeeze cage where to be typically used. Other *Primary* reasons to train include mental stimulation (behavioral enrichment) and physical exercise, both of which help to promote the overall well-being of an animal collection. Primary behaviors can be considered behaviors which directly benefit and serve the animal first.

Secondary reasons to train could include public educational programs and presentations, or research projects within a zoological or aquarium facility. Additional *Secondary* reasons with domestic animals could involve police work, rescue work, and assisting the disabled. These behaviors, although beneficial to the animals, more directly benefit and serve the public first. Now that you have a better understanding of why training is beneficial, the next subject to discuss is where to begin?

How to get started?
If one wishes to begin a behavioral training program with a specific animal group, it is imperative to know as much about the natural history of this animal as possible. In other words, where does the animal normally live? What are its food requirements and typical food preferences? What is its social structure? In a nut shell, how does this animal live and interact within its natural environment. Basic understandings, such as these, help to lay the groundwork to start this type of program. One also should have a clear understanding of the exhibit and holding area's potential as a source of training for the animals. In other words, how can I train the animals within areas I have to work with, and what limitations are there? Finally, a familiarity of behavioral training should be acquired. You may already have a behavioral coordinator within your facility, or someone with experience on site that can be of assistance. Other sources of help can be found in a few selected books and organizations.

- *"Don't Shoot the Dog"* by Karen Pryor and published by Bantam books is an excellent introduction to behavioral modification and in fact is required reading at several facilities involved with this type of work.
- *"Animal Training - Successful Animal Management Through Positive reinforcement"* by Ken Ramirez is another very good source if information.
- Additional sources of information are organizations such as IMATA (International Marine Animal Trainers Association), AZA (American Zoo and Aquarium Association). Of course the Internet can open up many resources in a very short period of time.

The Virginia Marine Science Museum River Otter Training Program
The Virginia Marine Science Museum river otter collection consists of 5 males acquired in two separate groups. The first group consisted of two rehabilitated otters which were born in April or May of 1993. When these two otters were first acquired in 1995 they were placed in an off-site holding location 7 months prior to the opening of their new exhibit. This temporary kennel system was a 20' x 10' chain link enclosure with a small 3' x 5' shifting kennel attached to one end of the structure. The second group of three otters, born in April of 1994, arrived at the museum approximately 2 months prior to the new exhibit's opening. By the time this second group had arrived, the first two otters had been relocated to their permanent holding location attached to the new exhibit. The second group of otters was placed in the original 20' x 10' enclosure that had been relocated to the museum site from its off-site location. This was done to allow for the completion of their quarantine process and to begin their training program.

Prior to the arrival of the second group of otters, and while still working at the off-site location, I began teaching our first two otters basic behaviors. This was even more challenging because our new staff had no training experience and had to learn training fundamentals as well. Our objectives at the time were fairly simple. We understood that we were going to have 5 male otters arriving in two groups at different times and they were going to have to be introduced at some point prior to going onto exhibit and living permanently together. The process of training began with our first group of animals.

Establishing a Wholesome and Effective Diet
We began this process by determining what we felt would be not only a nutritional diet for our collection, but also one that we could feed to each otter by hand in individual pieces through their chain link enclosures. The bulk of our otters' diet (75%) consists of whole smelt cut into 1' to 2' pieces. Each otter also gets two uncooked, skin-on chicken breasts cut up into bite size cubes. This chicken is evenly distributed into the two or three feeding/training sessions that occur each day. Additionally, each otter gets one or two whole mice (frozen then thawed). A vitamin supplement is given to each otter on a daily basis. We use Mazuri Vita-Zu Mammal tablets. These tablets must be cut to the appropriate size for the animals based on their average daily food intake. The vitamin pieces are hidden in the food. In most cases the otters eat the vitamins without hesitation. There is on occasion the need to replace vitamins if an otter spits a piece out. During the rest of the day, at random times, our otters are given various items for both behavioral enrichment and for food diversity. These items include, but are not limited to, live fiddler crabs from our

salt marsh, an occasional blue crab, minnows (Shiners), fruits and/or vegetables frozen in ice, dog bones, eggs, and whatever else we might think up. (*Note: We have been asked on occasion if we have any concerns in regards to giving our otters uncooked chicken breasts. Salmonella is of little concern to our veterinary staff in regards to feeding this food item. Otters will normally eat a variety of food items that might carry salmonella out in the wild such as small amphibians and reptiles. The items we feed are of restaurant quality and are slow thawed in a cooler overnight just prior to their use. We have never encountered any problems with our animals when feeding this diet.)*

It is very important to note that we feed each of our otters by hand. Each animal receives a specific diet based on its individual food requirements. This method of feeding eliminates competition for food which can occur if a facility where to feed animals in a shared food dish. Hand feeding also enables us to visually check on each individual very closely several times a day. It also enables us to medicate the otters in pill form with relative ease. By feeding in this manner we can help to ensure that our otters are eating and acting normally.

The purpose for cutting the otters' diet up into bite size pieces is so that we may use the food as a reinforcement item during training. Bite size items allow staff the ability to control the quantity of food given for each reinforcement. In other words, a successful behavior might earn a "jack pot" of several pieces of food. Accomplished lesser behaviors might earn one or two pieces of food.

How We Started the Training Process

After determining the appropriate diet we began the training process. In our case we work with our otters under protected contact as they have shown unpredictable tendencies. With this in mind, we first started by simply getting the otters to eat from our hands through the chain link enclosure. At the same time we introduced a common but critical training tool called a ***"Bridge***". A Bridge is an audible or visual signal that tells an animal <u>"Good"</u> or "<u>Job Well Done</u>". In other words, this signal "bridges" the gap between the desired response and the reinforcement the animal receives for accomplishing this task. Before an animal can understand that a Bridge means <u>Good,</u> it must be taught this. In our case we chose to use Acme Dog Training whistles as the bridging mechanisms. Our whistles are attached to lanyards that hang from the trainers necks. This type of bridging device leaves our hands free. To teach the otters that the sound of the whistle means <u>good</u>, we began pairing this sound with the process of feeding. At the beginning of each session, we blow the whistle twice as a form of notification that the feeding is about to begin, in other words, "come and get it". After this, the trainer would Bridge (blow the whistle) as a food item was placed in the otters mouth. After a relatively brief period of time, the otters began to associate the whistle with something that was good, food! This repetitious process is called conditioning.

Stationing

Our first objective during this initial phase of training was to get the otters to sit still next to each other at their feeding locations or "stations". The idea is for the animal to eat quietly next to the other otter without being concerned with what he was eating or doing. To clarify, a station, or the act of stationing is when an animal learns to sit at a consistent location during a feeding or training session. This location can be determined in a number of ways, but often is initially determined during the beginning stages of training by the animal itself. It will often sit to the right or left of another animal based on what is most natural and comfortable for it. You could compare this seating arrangement to that of an elementary student who sits at the same desk each day of school. It is a place of familiarity which provides some elements of comfort. Stationing can eventually evolve to the animal sitting not only at a particular location, but sitting where ever the keeper or trainer moves. The trainer at this point essentially becomes the station location. Where the trainer goes, the animal goes.

During this initial process we simply fed and bridged the otters as the food was given. We also began to use the bridge if the otters sat very still at their station and focused on the trainer. For example, if an otter typically fidgeted during a feed or would leave its feeding station to see what another otter was doing we would obviously not bridge and then reinforce, otherwise you would be reinforcing the otter for leaving. Remember the Bridge means "Good". To help correct a problem like this, we wait for approximately 3 seconds after the otter returns to its station and focuses himself on the session before we resume the session. This process is called ***LRS*** or ***Least Reinforcing Stimulus***. LRS is an effective way to extinguish an undesired behavior by simply not reacting. For example, if an animal like an otter leaves, and then returns to eat at its leisure, the keeper should give no response at all for 3 to 5 seconds. This means that the keeper should not talk, move or do anything, <u>no response</u>. The reason for this is that we do not always understand what is and is not reinforcing, thus LRS is probably the least possible reinforcing action of a trainer. A simple analogy to help understand this could be, if a comedian where to tell an audience several bad jokes, and they did not laugh or respond in any way, chances are, this person would either stop telling jokes, or find new material to use. In the case of our otters, when they remain at station and show focus, we bridge at the peak of this quiet and stable positioning, and then deliver the food as quickly as possible. If by chance the otter is exceptionally good, we offer a jackpot of several pieces of food. By bridging at the peak of a desired behavior such as sitting quietly, this alerts the otters to the fact that what they have done is very good and that positive reinforcement was on the way. This phase of bridging indicated to us that the otters had graduated to a basic understanding of positive reinforcement. They had learned that the whistle meant <u>Good.</u>

Target Training

Target training is an important behavior which can allow a trainer to teach an animal to accomplish many tasks. A target can be described as an extension of a trainer’s hand. It can also be described as “A prop which pinpoints a critical location for an animal in training”. *(Ramirez - Animal Training p. 552)* In our case, we taught each of our otters to “target” by touching their nose to a small blue and white pool buoy attached to the end of a 3' foot PVC pole. We accomplished this process by first showing the otters the “buoy target” through the chain link. Our otters where curious and immediately approached the buoy to get a closer look. As soon as they placed their nose on the target to smell it, we bridged (blew the whistle) and immediately reinforced. After the bridge, the buoy target was removed and the food reinforcement was given. This process was repeated throughout several sessions until the otters got the hang of it. It did not take long! “Touch the buoy with my nose, and get a few pieces of chicken or fish, not a bad deal.”

The next step was to get the otters to not only touch the target, but to maintain contact with it for as long as the trainer desired. This behavior is called extended targeting which can last up to 10 or 15 seconds, and even longer before the bridge and reinforcement. This is accomplished by not bridging right away when the otter touches the target, but instead holding the target in position. When working on this behavior, the otters had a tendency to anticipate the bridge occurring quickly and thus would sometimes touch the target, then immediately break contact from it looking for the reinforcement. When they reacted in this way and did not hear the bridge, but the target was still in place, they would typically place their nose back on it. The task was then to get them to stay locked on to the target for increased increments of time. The trainers would literally count in their heads, one thousand and one...Bridge, reinforce. Present the target again and count, one thousand and one, one thousand and two.....Bridge, reinforce. And so on. After a few days of training the otters got the idea and learned to stay on target for increasing periods of time.

The next behavior to train was to get the otters to follow the target. Remember, our training occurs through chain link. We began by calling the animals to their stations, then bridge and reinforce once they are calmly in place. We then present the target to their right or left sides at random intervals during the sessions. By having them move directionally to each side and make contact with the target, they began to learn to go to, or follow the target. Of course during the same session we would ask them to occasionally extend their targeting at random schedules to ensure that they would lock onto to it for more than just a second. We also would present the target in front of them and then <u>slowly</u> move the target to the left or right sides in a smooth motion. This enables the otters to follow the target directionally. Over a brief period of time (2 or 3 days), one or two feet of side to side targeting increased to greater distances. Eventually, the trainer could walk with the target while the otter followed it. When the trainer stopped, the otter would have to stop and lock on to the target with its nose through the fence. At this stage we could lead the otters around to different points within the holding area. These accomplishments opened up new opportunities for both the otters and animal care staff.

The Introduction of Our Otters

Some of the important benefits achieved by teaching our otters these first basic behaviors were evident during the introduction process. Having five male otters living harmoniously together was the objective, and predictions from other facilities working with otters ranged from “Good luck”, to “No way”, to “Wow, that will be a dynamic situation”. This was a period of time when careful planning, consistent training, and a little luck would play an important role in the success of this living situation. The introduction began by first establishing an “Introduction Process Plan” while at the same time physically preparing the permanent holding area prior to the arrival of the three newest otters. To fully grasp the plan, it is important to understand the design of our holding area and what we did to make this situation work.

The permanent river otter holding area is made up of two 4'x3' and four 3'x3' kennels constructed of chain link. Each of these kennels can be interconnected, or isolated, from each other and a 1500 gallon pool with clear, Lexan guillotine doors. Initially, we used Plexiglas as doors, but quickly learned that the otters could shatter those doors with little effort. When completed, this design gave us what we felt to be the most options in moving animals around and providing separate enclosures as necessary. The design in fact played a major role in the success of the introduction. It allowed both groups of otters to live, eat, and share both the kennel enclosures and the pool on a rotational basis without ever having physical contact with each other up until the day the two groups were mixed.

The first two otters “Tango” and “Cash” had already been living within the permanent holding area for several weeks. They had essentially gotten used to this new surrounding and continued with training sessions during each of their feeds, approximately 3 x daily. While this was taking place, the three newest otters where completing their quarantine process, learning to eat the same diet as the two other otters, and getting a crash course in basic stationing and target training several times a day. As the animals progressed in their preparation, the animal care staff began lining their interior chain link enclosures with Plexiglas. This glass would allow visual access to each other as well as hearing and smelling each other, but it would reduce the possibility of an animal being bitten through the chain link. The overall design enabled the otters to eat together without the fear of competition for food.

The idea was fairly basic in that one group would typically have access to ½ the kennels and the pool, while the other group had access to the other half of the kennels. We had no means of dividing the pool in ½ so that both groups could use it simultaneously, thus they went through frequent rotations within this area on a daily basis. Frequently, one group was closed in the pool area, while the other group was given access to the entire kennel system so as to have direct contact with the other group’s kennels. This was often comical to observe as the group exploring this area would make a point of marking the entire kennel system with feces and urine. During a rotation when one group had no pool access, they were given water to drink and a spray hose to play with to keep them cool as needed. Rotating the animals allowed for the sharing of this entire area without contact. It also allowed one group to investigate the area recently occupied by the other group. This enabled them to get used to the different smells and kennel areas. Of course, the otters always had visual access to each other.

As explained earlier, we feed our otters by hand while they sit side by side. The otters are expected to sit quietly next to each other so that feeding and training can take place with few distractions. During the introductory period, the clear separation doors played a crucial role in the two groups getting comfortable with each other during feeds. Although there was initial aggressiveness during feeds such as growls and screaming, once the otters realized that they could not get to each other and there was no competition for food, they quickly settled down and learned to eat quietly. At each of these feeds, we conditioned the otters to eat at the same spot each time so that they would become used to this location. It would be considered “their feeding station”. This location became a comfortable place for them to eat with little concern about the intrusion of the others.

As their comfort level and training progressed over the next couple of weeks, we began to approximate the otters to the actual mixing process. They had become fairly used to living with each other in the same enclosure yet they had not had physical contact. We began to devise our introduction plan with the hope of minimizing stress and potential injury. For this reason, we decided to introduce one otter from each group to each other. This process would allow us to intervene if necessary, but with only two otters and not all five.

We set a date for the mixing to begin. We did this based on a number of factors. We also began seeing both otter groups sleeping next to each other with only chain link separating them. Typically, they would sleep on opposite ends of the kennels. The otters were seen on numerous occasions standing face to face through the chain link sniffing each other without signs of stress or aggression. Finally, we noticed that the otters had begun to rip off the Plexiglas barriers attached to the interior of the chain link kennels that served to protect them from biting each other through the chain link. In seeing this, we felt the time had come. We chose the least dominant animals from each group as the two to begin with. The plan was to call all of the animals into their kennel areas and close off access to the pool during a feeding session. After the feed, we would then open the guillotine door to the two selected animals' kennels allowing them access to the pool and their kennel enclosure. This would provide them with the most room to run around as needed. Although the plan was well thought out, our newest otters apparently lost patience with us and our slow methodical process of planning. One morning prior to the mix we came in and discovered that Willoughby, an otter from the second group of animals was fast asleep in the kennels with Tango and Cash. We discovered that a pool access door in the newest groups' area had been partially pushed out of its tracts. Although this essentially gave the entire group access to each other Willoughby was the only one we knew for sure had mixed. We thus decided to continue with what Willoughby had started by opening the doors to the other kennels one at a time. We chose Rudee as the next animal to introduce due to his calm nature and less dominant presence. This went fairly well with almost no aggression present. Because of this, we finally opened Pungo's door. He was the last of the newest group to be introduced. After doing this we opened all doors and removed all separation barriers to allow the otters the maximum amount of room to run.

What happened next was interesting in that all of the otters began to chase and play with each other, or at least that is what it initially looked like. They began running around and diving in and out of the water with a fairly high level of energy and enthusiasm. This carried on for approximately 30 to 45 minutes. The interaction after this period of time began to elevate to include some aggression and dominance role playing. The otters began screaming at each other and would also mock bite each other. This carried on at random intervals for several hours. During this time we never left them unattended and kept detailed records of the mix. At about mid-day, the otters where seemingly so worn out that the two groups went to opposite ends of the kennel system and slept. That afternoon, we fed them in their kennel enclosures with the separation doors closed so that they could eat their entire diets without the concern of the intrusion of the other group. During the next few days, we began mixing them at random intervals for longer and longer periods of time until they were spending most of their days as one group. We also began feeding them with the separation doors partially opened for brief periods of time. As this work continued, aggression decreased and a more cohesive group of otters began to develop. A large hurdle had been overcome. The two groups where now one. The next and perhaps most important step was to have all five otters shift out onto exhibit.

Shifting

Several years ago I observed keepers at a large and well known zoo attempting to shift two otters off of exhibit in to their holding area so that the final days cleaning of the exhibit could take place. What should have only taken a few seconds to accomplish, was never successfully completed on this particular day. In fact, the keepers finally gave up frustrated that they could not complete the day's routines. I found it both interesting, and somewhat amusing to see the otters run around chaotically while the keepers attempted to bribe, chase, threaten, and even use a hose to get them to shift. I suspect the keepers' exploits on this and probably other occasions where somewhat reinforcing to the otters. At least, I feel that staying out on exhibit was in this instance more reinforcing than shifting into their holding dens; otherwise they would have done so.

Shifting zoological collections on and off exhibit as needed, and in a controlled and expedient manner has historically been problematic for keepers with little or no behavioral experience. An inability to accomplish this basic behavior can delay or even eliminate some daily husbandry responsibilities. However, if trained properly, this behavior can allow for flexibility with husbandry routines and even the mixing or rotation of different animals. I believe this behavior can, and should, become as routine as diet preparation and cleaning. We accomplished this aspect of training at the museum soon after we relocated our otters from their temporary holding location to their permanent holding area for the opening of their new exhibit in 1996.

We accomplished this behavior with our otters by applying a couple of strategies. First, as the countdown to the exhibit's opening drew near, we began leaving the connection doors from the holding area to the exhibit open. We felt that the natural curiosity of the otters would get the best of them and they would venture out to explore. This process was of course not as easy as it might seem. Our holding area is connected to the exhibit by an 8" diameter clear acrylic pipe that is approximately 10' long. At each end of the pipe is a guillotine door. When shifting animals on and off exhibit, both doors must be manually opened to allow the otters to pass through these locations. In the initial design, the idea was that when the otters moved on and off exhibit through the pipe, the public could watch. At first, the otters were very hesitant to even stick their heads into the pipe. Every so often, one of them might go ½ way through the pipe, then back up until he was back in holding. This was particularly amusing when one or two other otters followed this individual into the pipe and then had to go into reverse as well. Finally, after a few hours, our first otter ventured out on to exhibit. Of course he sat at the entrance to the exhibit for quite a while before becoming brave enough to explore. By the end of this first day the two otters from the original group where out on exhibit exploring and swimming in their 35,000 gallon pool.

The new group of otters proved to be more of a challenge in getting out on to exhibit. They acted as if they would be more than happy to simply stay in the holding area. Periodically, Tango and Cash from the first group would run into the holding building, instigate play behavior with the others, and then run out to exhibit. It was as if they were trying to get the others to come out. This type of behavior did create curiosity with the otters from the new group, but they continued to resist venturing on to the exhibit. At feeding times, we would begin each of our sessions on exhibit in an effort to coax out the remaining three otters. The keeper area where we feed the otters on exhibit has two access doors on each side of it that allow for exhibit maintenance without the public clearly seeing the doors. These doors have ½ inch Plexiglas panels instead of chain link. The panels help to further hide the door locations from the public. In order to feed the otters at these door locations we had to cut several 2" circular holes at each door in order to slip food items through the holes. When we first began calling the otters to station on exhibit, Tango and Cash quickly learned to go to the door nearest the holding connection access door. This enabled us to establish their feeding / training station immediately. While working with them on exhibit, at the same time we continued to try to coax the others out on to exhibit.

After one week with the second group of otters still refusing to go onto exhibit I decided to cut a series of 2" holes along the top of the acrylic connection pipe to enable the otters to follow a target out to the exhibit. The holes where spaced approximately 1' apart so that successive approximation “baby steps” could take place. The goal was to slowly get the otters to move further through the pipe by going to the target presented at the drilled hole locations. If they moved successfully to a hole and touched the target they would get reinforced with food. After a few days, each of the otters where going as far as the last hole that was approximately 6" before the entrance to the exhibit. At this point, they could see the other two otters playing and thus they quickly went in to the exhibit. It took a total of two weeks to get the second group of otters to enter the exhibit. They missed the public opening of the exhibit by one week. Fortunately the first two otters were on exhibit at this time and were actively exploring their new surroundings. Once the second group went in, they quickly learned that the keeper access door opposite the door closest to the connection pipe was to be their station for feeding and training on exhibit. The first two otters had already established their feeding / training station, thus the second group had only one other option which made this transition easy.

In order to get the otters to shift on and off exhibit as needed we simply started randomly calling the otters to station in holding, then calling them back out to exhibit to their station using food as the primary reinforcer. We also began varying the amount of time the otters would be closed into the holding and/or exhibit area. When they would successfully shift from one area to the next, we not only reinforced with food, but we also had behavioral enrichment ideas in place that made the shifting a fun process. A variety of otter toys, PVC pipes to crawl through, live fish in the holding pool all offered interesting opportunities to the otters. Offering this type of variety is an important factor in maintaining behavioral consistency. To this day, our otters will generally come off of exhibit at a moment’s notice. I say generally because, on occasion some behavioral factor such as breeding season can affect their attention span. They shift with a 95% consistency on a year round basis.

The above information only scratches the surface of potential for training animals such as river otters. By understanding and then applying some of the information within this chapter the doors open up to a more successful animal care program for both your animal collection and keepers. Additional behaviors that can be taught include:

- ✓ kennel separation,
- ✓ crate training,
- ✓ standing on a scale to be weighed,
- ✓ tactile through chain link,
- ✓ application of topical ointments,
- ✓ oral examinations,
- ✓ retrieval of objects,
- ✓ controlled sedation without restraint.

Sample behaviors & training cues for otters (provided by: *Indianapolis Zoo; **Bronx Zoo; ***Toledo Zoo; ^Santa Barbara Zoo; ^^Point Defiance Zoo; & +Oklahoma City Zoo). Behaviors not identified are trained at all reporting institutions. (Table created by J. Reed-Smith for AZA Otter Care Manual)

Behavior	Verbal cue	Visual cue	Criteria for reinforcement
Down *	"down"	Hand flat in front of abdomen-moved in a downward motion	Animal lays down quietly
Up *	"up"	Index finger moved in upward motion to place you want them to target to	Animal moves to position of index finger
Up ^	"up"	Left index points into the air	Animal stands up
Stand **	"up"	Use left hand and give the thumbs-up sign	Otter keeps both back feet on the ground while standing up against the cage. Front feet should be hanging onto target pole place against the bars.
Kennel *	"in"	Index finger used to point into the kennel	Animal goes in kennel and allows door to be closed
Entering a crate **	"box"	Hand begins in fist in front of chest. As command is said, swing arm out and up in direction of the box and open hand into a high five.	Animal will enter crate and lie down at the far right end. Animal will wait in position until bridged.
Squeeze/Crate ***/^^	"crate"	Target into squeeze cage or point to crate	Animal enters and allows the door to be closed
Crate +		Hand placed on chain link near back of crate	Animal enters and stands in the crate, tail completely in
Scale *	"scale"	Index finger used to point to scale	Animal gets on scale & waits
Target *	"here"	Closed fist presented to front of mesh	Nose placed at position of fist
Target **	"target"	Hold up target pole	Animal grabs with both hands without biting – ASC otters
Target ***/ ^	"target"	Show target pole	Nose placed on target and holds until bridged

Behavior	Verbal cue	Visual cue	Criteria for reinforcement
Target +		Show 15’ broom handle on fence	Put nose to target
Stay **	“stay”	Right hand palm down and out. While in this position, push slightly toward animal while saying verbal cue.	Animal stands/sits still while trainer moves away and returns
Stay/remote stay ^	“stay”	Hold hand up, palm towards the animal Hold fist up	Animal stays calmly
Hold ^^	“hold”	Hand cue	Animal stays in place
Lying parallel to cage front	‘lie”	Palm flat out and facing down. Sweep arm in direction animal should face.	Animal lays down parallel to and touching cage front. Remains calm and quiet until bridged.
Shift	“over”	Arm begins up and parallel to chest, index finger pointed up. (Use arm that is in the direction you want the animal to shift. Move arm and corresponding foot in a sweeping motion indicating the direction you want the animal to go).	The animal goes to the are indicated, comes to front of cage, stands quietly with eyes on trainer
Come in *	3 whistles-flat tone	None	Animal moves in to location of person whistling
Recall +	Clicker		Animal moves off exhibit to catch area
Station **/^^	None	Trainer stands in specified location with hands at their sides, beginning of training set	Animal comes to the front of the cage, stands quietly with their eyes on the trainer
Station ^	------	Point using two fingers of either hand to station desired	Animal moves to the spot and stays calmly
Follow	“come”	Say come and walk in direction you want the animal to go	The animal follows and stops directly in front of the trainer
Foot present	“toes”	Begin with right arm up parallel to body, index and middle fingers pointed up. Extend arm straight down (palm side down) continuing to point both fingers.	Animal should place both feet under the bottom of cage while lying down in front of trainer. It should be lying still and focused on the trainer.
Paw	“paw” “right” “left”	Visual signal for stand; point or target foot wanted.	Cue each foot to right or left, can use target or catch less dominant foot when opportunity rises; most have dominant foot they learn easily.
Ultrasound **	“up”	Cue as for up, trainer body can be low	Same as stand, animal should wait while being touched on abdomen

Behavior	Verbal cue	Visual cue	Criteria for reinforcement
			with pole or wand.
Ultrasound ***	“touch”	Show wand	Otter stands on back legs and touches target with nose while abdomen/kidneys ultrasounded through cage mesh.
Paint ***	“paint”	Show painting apparatus	Animal grabs paint brush and puts paint on canvas.
Nipple presentation ***	“nipple”	Target up while standing on hind legs. Slowly reach with fingers extended, toward otter	Animal presents chest or abdomen against cage mesh for manipulation
Ventral present +		Target placed high on fence	Animal climbs fence until all feet off the ground and ventrum placed on fence
Jumping into the pool **	“water”	Use right hand with food in it. Start with hand in a fist in front of chest. With a sweeping motion, move fist up to cage. Arm should be parallel. Open hand palm up and out. Tap cage with palm to push the food into the pool	The animal should jump into the water to retrieve food.
Water ^	“water”	Right hand motions towards the water	Animal goes in the water
Circle ^	“circle”	Make a circle with right hand	Animal turns in a circle
Steady ^	“steady”	Verbal cue only	Used to keep the animal calm during tactile body examination

Training for hand-injections

The processes used by two institutions successfully doing hand-injections of their otters are provided here. Both facilities had the objective of training their otters to allow injections while standing calmly in a chute fastened to the front of their holding dens; their chutes differ slightly.

TRAINING NORTH AMERICAN RIVER OTTERS FOR INJECTION IN CHUTE

By: Bethany Gates, Dickerson Park Zoo

This chute, designed by the facilities welder, included heavy brackets and a sturdy door because one of the males was so powerful. It should be noted that the door has never been used to restrain an otter; instead all injections have been done with the otter staying in the chute voluntarily. Their objective was to safely restrain the otter for a hand injection.

Training the otters to use the restraint:
Our otters will do anything for their diet. The word “good” is our bridge along with an immediate food reward. We typically train first thing in the morning when they are the hungriest and are willing to work. But feeding is done twice a day in the chute for comfort.

- Our daily routine is to feed one otter at a time in the chute at both feedings.
- After about two weeks or when the otter seems comfortable we introduce movement.

- We move our hand close to the hip area of the otter as the first thing.
- Once the otter is in the chute we start to move our hand, bringing it up close to the fencing.
- Slowly upon getting used to this (usually two weeks) we introduce a syringe with a blunted needle. This begins just in our hand or in sight of the otter.
- Touch is introduced as a word" touch" and a quick touch of the blunted needle to the hip.
- As the animal learns to accept touch, this touch time is extended.
- We try to use two week intervals so as not to rush things.

Chute is placed against the wall

Door can be slid shut if required but has never been used.

TRAINING FOR HAND-INJECTIONS: THE PROCESS

By: Christine Montgomery & Jessica Ehrgott, Downtown Denver Aquarium

Introduction

Captive animals that require injections either for vaccinations or immobilizations are typically handled using restraint devices such as a squeeze cage. AZA otter SSP recommends cooperative training of these animals to receive injections. At the Downtown Aquarium in Denver, trainers chose to move away from using restraint devices and instead to train a voluntary injection on 2.0 13-year-old river otters. Previously, trainers would move the otters to a crate, then to a squeeze cage and either hand- or pole-inject the sedative. The decision to train the otters to accept hand injections cooperatively was taken as a result of concerns about animal health, animal safety, and trainer safety.

Manufacture of chute

We opted to use a PVC chute for the cooperative injection. The PVC chute was made from an 8” diameter PVC pipe. Pipe was cut to 24” in length. We removed 7” lengthwise and rounded the rough edges (Fig. 1). Four holes were drilled in each corner so that the open side would face the trainers and the pipe could be held to the mesh using zip ties. We chose to place the PVC 8” from the wall, leaving it open on both ends (Fig. 2). We chose to leave it open at both ends to allow the otters to leave at any time. Upon completion of immobilizations, the chute was modified with thin cable wire and carabineers to allow easy removal and placement of the chute for weekly refresher sessions.

Figure 1

Figure 2

Training Plan

We began by habituating the otters to the chute one month before we did our first immobilization. We placed it in the reserve unit, permanently, until physicals were complete. We spent a few days allowing the otters to engage in normal training sessions while alongside the chute before asking them to work the behavior (Fig. 3). Before we started formal training, we observed them going into the chute and observed them more readily entering from trainer's left to right, so we proceeded with the training plan:

Figure 3

1. Work targets on trainer's left side of the chute, pushing the target pole as far into the enclosure as possible.
2. Approximate the target pole closer to the opening of the PVC chute.
3. Using a second target pole, target the animal into the chute. Move the second target pole from left to right to approximate the animal into the chute. Their head will be to the right of the chute (Fig. 4).

Figure 4

4. Reinforcements were then given in the chute to associate the chute with food and to extend the time the animal spends in the chute.
5. Ask for an extended target once animal has all feet in the chute.
6. Once the right target pole is removed, this is the animal's cue that they can exit the chute.
7. Approximate a blunt tool to the hip, eventually putting pressure on hip and rewarding for remaining in chute and calm. (Fig. 5).
8. Approximate the use of a paper clip on a syringe, applying slight pressure on the hip, rewarding for remaining in the chute and calm. (Fig. 6)
9. Begin incorporating second person to work with paper clip syringe.
10. Begin incorporating veterinarian to work with paper clip syringe.

Figure 5

Figure 6

Training for actual immobilization

During the week prior to immobilization, we trained the chute behavior using the same scenario as the morning of immobilization. This was important for several reasons. The otter would only be receiving a small amount of food, practicing allowed trainers to test the strength of the behavior and ability to work through issues with little to no reinforcement. The otters would have normally been fed one to two hours prior to scheduled immobilization, so we practiced with the otter on an altered feed time. Also, the otter would be separated from his exhibit mates during immobilization, which can be stressful. Practice sessions seemed to decrease stress levels among the participating otters. This involved the following training plan:

1. Otter will only be fed 3 smelt, cut into small pieces for immobilization practice session.
2. Otter will be separated from exhibit mates for practice session. Exhibit mates will be on exhibit.
3. Session will be performed around 9 a.m., when actual immobilization is scheduled.
4. Trainer performing immobilization training will be the only trainer who works the practice session.
5. Secondary trainer will act as the "veterinarian," using the paper clip syringe. If possible, second trainer will be the same trainer present for actual immobilization.
6. No other personnel will be in reserve or back up area.
7. Animal is asked to perform the behavior once, receiving as little of the smelt as possible. Once the initial behavior is completed, animal will be asked to perform behavior again. However, this time trainer will jackpot animal for performing the correct behavior to highly reinforce the behavior and end on a positive.

Immobilization

During our first immobilization we asked the veterinarians to use the paper clip syringe first. Then, after re-asking the otter to enter the chute, the anesthetic was injected. The first otter moved out of the chute, upon receiving half the injection. The trainer was able to ask the otter to re-enter the chute and receive the remainder of the injection.

During our second immobilization, the otter moved away from the needle so quickly that the needle broke at the junction between the needle and syringe. The animal was unwilling to re-enter the chute and the immobilization was not completed. We then acquired Luer Lock syringes, (Fig. 7) in which the needle screws into the syringe rather than a non-threaded needle-syringe attachment. The animal was partially sedated with the new syringe, as he moved out of the chute before all sedative could be received. Due to the sedation level of the animal, we were unable to move him back into the chute. We were able to ask him to come close to the mesh, where he was pole injected with the remaining sedative.

Figure 7

Conclusion

Doing cooperative injection training was a success. With little stress and no injuries to the animals, we were able to perform immobilization quickly. The animals also were able to receive a few pieces of fish for preforming the behavior during immobilization. The animals had little to no association of the injection with the PVC chute. One animal voluntarily re-entered the chute while recovering. The behavior took one to two months to shape, and we currently work the behavior once a week until our next immobilization.

OTHER RESOURCES

Morabito, P. M., & Dunn, M. (2007). *Injection Training 1.1 North American River Otters (Lontra canadensis) Using a PVC Chute*. ABMA Wellspring, 8(4), 12-13.

Morabito, P. M., & Dunn, M. (2008). *Injection Training 1.1 North American River Otters Using a PVC Chute.* Animal Keepers' Forum, 35, 106-108.

CHAPTER 13 Rehabilitation of Otters

Introduction

This section contains two papers written by wildlife rehabilitators with extensive otter experience. The goal is to reintroduce these orphans or injured otters back to the habitat from which they came. However, it is not easily done. An assessment must first be made as to whether or not the rehabilitator is set up to allow for reintroduction or if the otters will be better placed in an *ex-situ* situation such as a zoo or aquarium. For resources on keeping otters out of fish ponds and suggestions on removing females and cubs from under buildings see Appendix A and B. The two companion documents to the Haire (2011) When to rehabilitate, young pup care, formula feeding and weaning, titled: Section 2: Otter housing, vocalizations, and health care, and Section 3: Otter release, resources, and suggested reading are available from the IUCN Otter Specialist Group website (otterspecialistgroup.org), Otters in Zoos, etc. link.

POST-RELEASE ASSESSMENT

An important element of successful release is planning for the release method. Haire (2009) evaluated post-release data collected on 17 hand-reared orphaned river otters returned to the wild over a 14 year period. The method used was "*soft release*" versus "*hard release*". Hard release is defined as a method "*of returning an animal to the wild without any further contact or follow-up care, which is usually best suited for adult animals returned to familiar territory".* Soft release is described as: "*the method of returning an animal to the wild and providing some level of supportive care such as a feeding station and a nest box*. Haire (2009) and T. Thibodeaux (Arc for Wildlife, personal experience) both recommend using the soft method for hand-reared river otter orphans. For an example of successful hard release see the Cochrane Ecological Institute article following; however, their technique is to release when the cubs are approaching 2 years of age and their facility offers ample room and opportunities for the otters to practice foraging techniques.

Haire's study showed that 100% of the released otters returned to the feeding station (hack site) between 3 weeks and 8 months post-release; of these, 28% returned as a result of an injury. Her return visit data was based on monitoring post-release food intake and spraint content as well as documented otter behavior, home range size, and dispersal times. Thibodeaux monitored 6 yearlings released into two different pond systems on a large private ranch by using digital camera traps, staff sighting reports, and personal observation. In Thibodeaux's case the otters are currently just 4 months post-release and are no longer being offered supplemental feedings; food provisioning stopped at about 3 months post-release because the otters were no longer visiting the hack site. The released otters are doing well and beginning to disperse out based on reports from personal observations by the land owners. Both rehabilitators suggest that a key element to successful release is finding a suitable site that meets optimal criteria; "*The foremost criterion is that the site must be an environment that is appropriate for the target species, providing proper habitat, food, water, shelter, and a viable population of conspecifics. Ideal site criteria for otters include good water quality without serious pollution, isolation from humans, a safe distance from roadways, and a current suboptimal otter population."* (Haire 2009, Thibodeaux personal communication).

Photo: T. Thibodeaux: Yearlings returning to hack site 5 ½ weeks after release. Amount of food left was gradually reduced and visit frequency decreased until provisioning stopped at 3 months.

OTTER MANAGEMENT AT THE COCHRANE ECOLOGICAL INSTITUTE

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Description of Facility:
The Cochrane Ecological Institute (CEI), founded in 1971, is a registered charity, a non-profit, non-government organization established as a center for the captive-breeding for re-introduction of extirpated or endangered indigenous species into their historic range, and the rescue, rehabilitation and release of injured and orphaned wildlife. In addition, the CEI provides Field Station facilities for individuals interested in undertaking behavioural research on the species maintained and managed at the Institute. Although the CEI operates under a zoo permit (2986GP,Alberta Environment) all species held there are intended for re-introduction and release, not for exhibit, trade or sale. As none of the animals held at the CEI are on exhibit, some of the management constraints that influence the way animals are kept within the zoo community are not applicable at the Institute. For example, enclosure size varies from a minimum of 60 meters by 90 meters, 2 1/2 acres, 20 acres, up to a maximum of 130 acres, and no enclosure is designed to facilitate public observation of the animals housed within it.

The CEI is set at 4,700 ft above sea level in the foothills of the Rocky Mountains, and consists of 160 acres of natural prairie/montane habitat, enclosed by an 8ft game fence with 4ft. ground-wire mesh along its base and surmounted by a 4ft. wire-mesh overhang. Within the enclosed 160 acres are three spring-fed bodies of water, a large bog, aspen bluffs and spruce groves.

Situated at the center of the CEI is a fenced-off 30 acre enclosure containing the three CEI buildings (main building containing office facilities, staff housing, and library, Animal Health center, Interpretive center), the swift fox, V*ulpes velox-V.v.hebes*, captive-breeding facility, Mews and raptor flight pens, as well as enclosures designed to house other orphaned species destined for rehabilitation and release.

The CEI has been working with the North American river otter, *Lutra (Lontra) canadensis*, since 1983 and over that period has both successfully raised orphaned otter cubs for release into the wild, and undertaken the capture, translocation, and release into suitable habitat of adult and juvenile "nuisance" individuals.

Captive otter management at the CEI.

CEI facility designed to house orphaned otters:

The otters housed at the CEI have all been orphaned animals and, in general, arrive at the Institute severely dehydrated and often close to death. It is vital that otter cubs, of any age, should be kept in a quiet, dim area that is warm, dry, free of droughts and where the animals are easily, non-intrusively, observable over 24 hours.

The area set aside, at the CEI, for newly arrived otter cubs is 10 ft. by 12 ft. in size, within the CEI main building and referred to as the "otter room". The otter room is heavily insulated to reduce any noise disturbance, and to keep it at a warm, even temperature. The floor is linoleum, while the walls have stainless steel sheeting up to a height of 18 in., above which they are painted wood. A thermostatically controlled infra-red lamp, set 5 ft. above the floor, ensures that the animals are never chilled. Both hot and cold water is provided within the otter room. Two sets of 3 ft. deep wood shelves are set on two sides of the room up to a height of five feet. If the room is occupied, these shelves are covered with toweling. Set along one wall there is an 8 in. deep, 8 ft. by 4 ft. fiberglass bath, with a steel grid covered drain. Adjacent to that is a 2 ft. by 4 ft. by 8 inches deep "drying" area containing sawdust or fine sand. The bathing and drying area is divided from the main body of the room by a four foot high wall and door. It is essential that the bathing area can be closed to very young cubs, and also, when the area is made available to the animals, that there is a large space where the otters can dry off.

Within the otter room, a 6 inch deep, 4 ft. by 6 ft. box of dry powdered peat covered by a layer of hay is set against one wall, under the shelving. We have found well-cured fine hay to be more suitable than the coarser oat or wheat straw more commonly used as bedding, as hay is equally absorbent and holds together better than straw when the cubs burrow into it. The peat and hay "nest" gives the otter cubs shelter and privacy while still making it possible for the keeper to keep them under observation. Also, while the room is in use by otter cubs, the linoleum floor is thickly covered with newspaper. The otter room is entered, from the CEI library, through a horizontally divided "stable" or "Dutch" door.

The whole area can be observed, through plexi-glass windows, from the CEI main library and also from outside through double paned insulated glass windows. The CEI library has an alternative access giving directly onto the CEI's, fenced, 130 acres. When the animals become old enough to leave the otter room and go outside they then have free access to 130 acres of land through a specially constructed, insulated, "otter exit" in the CEI library wall built next to the library's outside door.

The "otter exit" consists of a 2 ft. by 2 ft. by 8 ft. insulated, lidded wooden box containing 3 baffles set at 2 ft. intervals along the inside of the box. The baffles are designed to reduce the amount of winter draught and cold that would otherwise whistle into the library. Entry, exit, and passage past the 3 interior baffles is through holes that are 7 inches in diameter.

Immediately outside the CEI library are three specially constructed ponds linked by a shallow creek. Initially, the young otters will make use of these ponds only when in the company of their keeper and spend the rest of their time, voluntarily, in the "otter room". When the animals are 6 months of age, the keeper will spend a great deal of time taking them for walks all over the CEI's 130 acres and introducing them to the CEI's three large water bodies. These ponds contain, as well as amphibians native to the area, introduced rainbow trout (*Oncorhynchus mykiss*). The natural prairie habitat of the CEI's 130 acres also houses wildlife indigenous to the area, large mammals such as moose, elk, white-tail and mule deer, small predators such as coyotes, red foxes, and bobcats as well as a wide range of prey species.

The largest, seven-acre, pond has an artificially built otter holt, a six foot by three foot insulated box with direct access to the pond. This "holt" is set within a section of the machine room at the base of a windmill. The pump operated by the windmill keeps the water open and ice-free all winter, enabling the adolescent animals to use the water throughout that period. By midwinter of their first year, most young otters will be living in the windmill holt, and will spend little time in the otter room. By the time of release, September, they will spend no time at all in the otter room

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Handling and hand-rearing North American otter cubs:

Otters are an active, lively, vocal, and intensely social species. Work undertaken at the CEI has demonstrated that it is essential both for the well-being of the orphaned animals and for success in re-introduction and release, that the orphaned animals have significant interaction with their keepers, that they be taken, from the age of five months on walks with the keeper and introduced to natural water bodies. This exercise cannot, and must not, be hurried. As the animals get older, it is important that they are introduced to fishing and to the other indigenous species that occupy their native habitat. Although otter cubs are as dependent upon their Keeper for reassurance as any dog is to its master, at the age of 18 months, most hand raised otter cubs will exhibit a large measure of independence and will cease to be reliant upon their Keeper.

<u>On Arrival</u>:

Otter cubs have been brought to the CEI from within 24 hours of their birth to four months of age, one thing is in common for all new arrivals; they are dehydrated and severely stressed. The skin of the new arrival should be pinched between forefinger and thumb to check for "tenting". Ideally, the pinched skin should slide smoothly back into position and not stay peaked. The animal's gums should be examined for colour (rose pink, not white), while doing this, the body temperature can be estimated by sticking your little finger into the animal's mouth (it should not feel cold to the touch). If possible, little other veterinary action should be taken until the animals are accustomed to their new accommodation and feeding well.

The newly arrived otter cubs should be kept isolated from other animals for 2 weeks, or until it is certain that they are disease-free.

All handling of otter cubs should be done without gloves*, and should be undertaken quickly, firmly, but gently. North American otter cubs do not open their eyes until the 34^{th} to 36^{th} day after birth (Liers 1958 &1960, Harris 1968) and handling them without gloves at that age is of no risk to the keeper. Older otter cubs also offer no threat if properly and confidently handled. The handler, no matter how idiotic it seems, should speak continuously and reassuringly to the animal. Otters are a vocal species and respond well to vocalization, even of a human sort.

The first essential, after its arrival, is to re-hydrate the animal. Using electrolytes, we have found that injection, rather than the use of an I.V. drip, is more efficient and less stressful to the cubs.

If the animal is caked and filthy with dried faeces, (this is more likely if it is single, because a group of cubs will suckle each other clean) it is essential to clean the animal up, using a moist, blood heat, cloth and a slow rhythmic motion to remove detritus. This gentle rhythmic cleaning action is generally reassuring to the young animal being treated.

Formula and Diet:

At the CEI we give otter cubs, that come in toothless and with their eyes still shut, a formula consisting of Esbilac (PetAg, Hampshire, Il. USA, www.petag.com) mixed as recommended by the company, plus 4ml of cod liver or halibut oil per 240ml of formula. This formula is fed, at blood heat, every hour during the day, every 2 hours during the night. At approximately 2 ½ weeks after arrival, or when the milk teeth erupt, one tablespoon of infant's Rice or Oatmeal Cereal is added (Heinz, H. J. Heinz Company of Canada

Ltd.5700 Yonge St, North York, Toronto Ontario M2M 4K6, Canada), included is 40ml of liquidized raw meat (beef or chicken heart) per 240 ml of formula, plus one raw egg per day. Any un-used formula should be disposed of and not kept, even under refrigeration.

We use very soft nipples (Gerber; 0 to 3 months), with the nipple hole enlarged, for feeding young cubs. As the animals increase their formula intake, the number of feedings can be reduced, but there must never be a gap of more than 3 hours between feedings until the animals are eating solid food. Usually, by six weeks of age young otters will be eating solid food, and taking milk formula on demand. At the CEI we wean otter cubs at five months old, unless an animal has been ill or is noticeably undersized, in which case we will continue to provide formula in order to enhance weight gain.

When the animals are eating solid food, they should be provided with an ample supply of food at regular intervals, in individual bowls, at a minimum of four times a day in the summer months. We have found that an adult North American river otter will easily eat an average of 3 to 5lbs of meat per day, although rarely more than 1lb per meal.

Because the animals maintained at the CEI are intended for release, once on solid food, they are fed raw trout, herring, smelt, anchovies, chicken necks, whole chicken hearts, chopped beef heart or liver, day-old chicks, and mice. The daily composition of the feed must vary, as otters get easily bored. The otters also are given access to limited amounts of fresh berries and fruit. As five-month old otters kept at the CEI also have free access to 130 acres, they are supplementing their feed (with varying levels of success) by hunting.

Any animal that is looking slightly "off-colour" is given mice. In Europe, where eels are readily available, they are fed eels as a pick-me-up in preference to mice (Harris 1968).

Prior to release, captive-raised rainbow trout (*Oncorhynchus mykiss*) are released into the CEI ponds, so that the juvenile otters can hunt them. The young otters also take the indigenous species naturally occurring on CEI land: amphibians, Richardson's ground squirrels *Spermophilus richardsonii*, pocket gophers *Thomomys talpoides* and other small mammals.

Estimating age:

It is the experience of the CEI personnel that it is practically impossible to estimate the age of orphaned North American otter cubs, once their eyes are open. Size varies in direct ratio to the amount of feed available to the lactating female and the number of cubs in a litter. If the animal has been abandoned for some time, it will be smaller than a normal cub of similar age.

We have noted the size and weight of four blind and toothless cubs at 24 hours old (the otter bitch was observed whelping) to be 4 in. to 6 in. in length, and weighing between 5 and 6 oz. At 16 days of age their size and weight had increased substantially to between 7 and 9 inches in length and 12 to 16 oz. in weight. Their eyes opened at 35 to 36 days, by which time they each weighed in at 2 ½ to 3 ½ lbs. In contrast, we have had otter cubs brought in whose eyes have been open and whose milk teeth are all in place, (meaning that they must have been older than 39 days) , that have weighed less than 20 oz. and measured 12in. in total length.

Scat:

After each feeding, the otter cub's stomach, abdomen and anus should be massaged with a damp finger (the finger will inevitably become damper) to ensure a bowel movement. This action takes the place of the licking a mother would naturally give her cub and contributes significantly to the animal's well-being. The procedure should be following each feed until the cub's eyes are open and they are able to leave their "nest" by themselves. Otters, even little cubs, are naturally clean, and, as soon as their eyes are open will leave their "bed" to defecate on the paper provided. Once they have decided upon a suitable site within the inner enclosure, it will become a "latrine" and will be used by all the otter cubs contained in the enclosure. If the otter's bed gets damp or dirty from faeces it is a warning sign of potential ill health.

A milk-fed otter's scat should look like a row of small amber beads in a translucent jelly. As they begin to eat solid food the colour and size of the "beads" will change to reflect the changes in the animal's feed, for example, chicken hearts can result in dark red “beads”, and some insect chiton will pass unchanged right through the otter.

Otters are very formal in the use of latrines, and once they are using a larger enclosure, or in the case of the CEI, 130 acres, they will continue to use the same areas as latrines. These are generally distinctive sites; prominent rocks or fallen logs, a site where two trails cross, the end of a rocky promontory in a lake, or sometimes a site, which to the human eye, has nothing distinctive to recommend it. The regular use of latrine sites by otters is a useful trait, and makes it easier to monitor the animals over a large area.

Singles versus Groups:
North American river otter cubs are seldom alone in the wild and they are intensely dependent upon their family group. If the cubs brought in are in a group, the level of stress is greatly lessened. Single cubs are sometimes reduced to a coma-like behaviour by prolonged anxiety. This coma-like condition will be alleviated by the keeper putting the cub inside his/her shirt until the animal has warmed-up and revived. Once the single cub has revived and is feeding well, it is possible to put it in the hay bed in the otter room, if the keeper takes off his/her worn T-shirt, wraps it around a ticking clock and provides a stuffed animal for company. If the intention is to produce a healthy well- balanced individual, it is essential to spend at least an hour with the single cub at each feeding, handling it, massaging it, and talking to it.

Introduction to other otters:
At the CEI we have had success introducing otter cubs, of any age up to and including 8 month old animals, to each other. If their milk teeth have not yet erupted, cubs can easily be put together, and will accept each other, without any obvious stress or aggression. In the case of older animals (6 to 8 months of age), as otter cubs will follow their keepers anywhere, our policy has always been to take the litter-mates for long (4 km) walks and to introduce newcomers during these walks. We have experienced no aggression between newly introduced animals.

We have, once, introduced a single cub to an adult female (as our aim is to introduce singles to groups as soon as possible,) because at that time we did not have a group of cubs of a similar age to introduce it to. Initially the female rejected the cub, but after one month she accepted the animal. We have not introduced adult animals to each other as we have not had the occasion to do so.

Introduction to other species:
Juvenile otters, hand-reared at the CEI come in contact with most of the species native to the eastern slopes of the Rocky Mountains. Moose *Alces alces*, elk *Cervus elaphus*, mule deer O*docoileus hemionus,* and white-tailed deer *Odocoileus virginianus*, occur on the 130 acres in use by the otters, as do coyotes *Canis latrans*, red fox *Vulpes vulpes*, swift fox *Vulpes velox,* bobcat *Felis rufus*, skunk *Mephitis mephitis*, porcupine *Erethizon dorsatum* , and black bear *Ursus americanus.* Although the otters have been observed near to these animals there has been no observed adverse reaction between the species.

Health:
North American river otters are capable of survival on an insufficient diet in improper housing, but they will not do well. If maintained as a zoological exhibit they will prove unsatisfactory and unappealing to the public. They will be in poor condition, solitary, lethargic, depressed, a wasteful exhibit in a Zoo, and unlikely to survive if released. Their coats will be patchy when wet and dull when dry.. A healthy otter is active, curious, and extremely lively. It’s coat is slick when wet, and, as soon as it comes out of the water and shakes will form into paintbrush tips, before drying to a shiny evenness.

Otters are susceptible to both canine and feline distemper, parvo virus and its mutations, feline panleukopenia, human jaundice and hepatitis. Pneumonia, abscesses, and perforated ulcers can be caused by improper management and housing. Death from over-heating and stress can occur very rapidly if the animal is improperly confined, or transported in an unsuitable travel crate. At the CEI we have lost one animal to intestinal torsion, “twisted gut”. We have had five adult otters (four of them dead) brought in to us with mercury poisoning, and one cub.

Release methodology:
The CEI works with the Canadian Provincial government, the Environmental Agencies of British Columbia and Alberta, in order to identify potential release sites for otters. It is also necessary to obtain import, export, and transport permits from the relevant government jurisdictions prior to the animals' release into the wild. After review of the information provided by provincial government agencies, CEI personnel will examine potential release sites for prey availability, existence of other otters, and possibility of adverse human/otter interface. The policy is to release animals into areas on coastal rivers where there is no human occupancy of the land.

CEI hand-reared otters are prepared for release in their second year and are released onto suitable, previously identified, coastal rivers when the salmon (*Oncorhynchus nerka*, *Oncorhynchus keta*, *Oncorhynchus tshawytscha*, *Oncorhynchus kisutch*), are running in September. We have noted groups of two-year old otters wintering together along the seacoast of British Columbia, and also, if there is sufficient feed available, there is a marked increase of otter use in estuarine habitat. The choice of the Fall of the year for the release of juvenile otters at the time of their natural dispersal, and when there is an ample supply of readily obtainable fish, appears to enhance survival.

Transport:
Crates are best constructed of heavy gauge, fine mesh, welded wire with a solid metal or wood roof and floor. The crate should be large enough to comfortably contain the animal when divided in half, one half being dark and draught-proof, and the other half open to the air on three sides, with an 8 inch diameter entrance hole giving the animal access to both halves. A heavy metal water-bowl should be bolted to the floor. The crate and all its fastenings should be made extremely stoutly, and the enormous strength of adult otters constantly considered while the crate is under construction. Crated animals should never be exposed to heat, direct sun, wind and rain. Otters have little heat tolerance and will die rapidly from being over-heated (Best, A. 1962, The Canadian otter, *Lutra canadensis,* in captivity. *Int. Zoo. Yb.* 4: 42- 44)

Capture of adults for translocation:
The CEI has most frequently been requested to remove adult animals from the crawl-space under the main building of sea-side cottages in early Fall or over the Winter. In general, these animals are either single, or very small groups of juveniles. After checking that the otter is in occupation and discovering which entrance to the cottage's crawl-space is most used by the animals, an un-baited drop-trap (Pied Piper, Model 301, 15" x 15" x 46"), covered with plywood, is set in the otter's entryway. All other entrances to the crawl-space are stopped up (again, the enormous strength and power of the otter must be taken into consideration). Like many mustelids, otters seem to be attracted to tunnels, and, if the drop trap is properly covered by a fitted wooden box, will willingly explore it. The trap should be unobtrusively checked, using binoculars, every hour. Once the animal has been removed, the entryway should be firmly and permanently blocked. Any adult animals intended for translocation are not maintained at the CEI facility but translocated to a suitable site, not less than 15 miles away, as soon as possible after being trapped.

Design of permanent otter facility.
For the successful management of otters in captivity it is essential to provide them with sufficient food, clean running water, and a ratio of 2/3rd dry land to 1/3rd water. Water is essential for otters, both for their health and also to provide the public with the entrancing and educational sight of healthy happy otters behaving in a natural fashion. If the pool is an artificial one, the drain outlet should be designed in such a way that the otters cannot stop it up. Sufficient land, not a cement pit, is equally essential for the animal's well-being. Provided with the enrichment of sufficient land, running water, and ample food otters will repay their care, by providing a fascinating exhibit.

*I appreciate that handling without gloves is a difficult requirement within an accredited Zoo, but there are no gloves that can withstand the bite of a determined otter, but the contact or bond formed between keeper and animal, between bare hand and fur, is beyond price.

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Successful Hand-rearing and Rehabilitation of North American River Otters

Successful Hand-rearing and Rehabilitation of North American River Otter (*Lontra canadensis*)

Section 1 – When to rehabilitate, young pup care, formula feeding, and weaning.

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This document, a compilation of advice from multiple individuals with otter rehabilitation experience, is designed to provide guidelines and techniques of river otter care for licensed wildlife rehabilitators or wildlife care centers that may be unfamiliar with this species. Due to its length it has been divided into 3 Sections. The remaining 2 sections are available at Otterspecialistgroup.org; Otters in Zoos, etc.; OZ Task Force documents

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OTTER PUPS – FIRST ARRIVAL

- North American river otter’s give birth once annually, or biennially, usually between the months of January and June with the earlier part of the range being in the southernmost latitudes.
- Otter pups tend to come into rehabilitation facilities most often when they are old enough to begin venturing out of the den on their own (8 - 12 weeks of age) and get separated from mom due to predators, flooding, construction, injury to or death of mom, etc.
- Orphaned or lost pups may approach people or wander into sheds, roadways, golf courses, garages, or other areas of human habitation in search of mom and food. At this point they may appear “tame” or already “imprinted’ on people but usually that is not the case. Once they are taken into proper care and treated appropriately they typically revert to normal behavior.
- Most pups arrive hypothermic and dehydrated. It is vital to attend to these issues before attempting to feed or treat minor injuries. Hypoglycemia often closely follows the previous two conditions. At this stage experienced veterinarians should be consulted.

ATTEMPT TO REUNITE WITH MOTHER

- In some situations the pups may get separated from mom when their dens flood with rapidly rising river water, often due to heavy spring rains. In these cases they most often float out and down river not yet being strong enough to swim against the current. This typically prevents them from returning to the den area. Another reason for separation is den relocation. When the mother is moving pups to another den site she sometimes gets interrupted by unknown causes causing her to lose track of pups, **or their discovery before she returns**.
- If the mother is known or believed to be alive and the pup appears healthy, an attempt to reunite a lost pup with its mother should be tried by first attempting to locate the entrance hole to the den.
- Many otter dens are in or on the banks of rivers or ponds. The den may have several connecting tunnels and holes, sometimes with tree roots exposed in and surrounding the opening. The soil is usually worn down smooth around the entrance with paths leading to the water. Often times the entrance is best spotted by searching the bank from the opposite side of the river. Also search for signs of daily activity such as sand/soil diggings, foot tracks, scat, or scent mark mounds mixed with vegetation and soil nearby.
- Place the pup near the entrance and hide nearby, upwind, to observe. Often times the pup will chirp when it gets cold, hungry, or restless. This loud, high pitched distress call should attract the mother if she is able to respond. In some cases the mother may be the one doing the chirping in hopes of persuading the pup to chirp back so she can better locate it.
- Otters can see movement quite a long distance away so be sure to hide carefully and refrain from any quick movements. If the pup is in danger of rolling down the bank or wondering off, it can be placed inside a box or kennel with the top off. This will keep the pup in place but allow the mother access to it by hopping inside or knocking over the container.
- If the mother is thought or known to be dead, the baby is cold, dehydrated, weak, or the den location is unknown the decision to rehabilitate should be made.

WHO SHOULD REHABILITATE OTTERS?

To maximize the chance of successful rearing and potential release of rehabilitated otters these questions should be asked first:

- Does the rehabilitator have adequate facilities and time to raise the animal properly?
- Does the rehabilitator have adequate funds to supply formula and weaning diets to, and perhaps after, release?
- Is there an appropriate release area available? What is the current state of the otter population in the area?
- Are facilities and resources available to support and monitor release?
- Is another rehabilitator more qualified and/or does someone else already have an orphan(s)? If so, it is better for the orphans to be raised together. There is a lower risk of imprinting and they learn from one another.
- Does the rehabilitator have access daily to large amounts of whole fresh fish?
- Does the rehabilitator have access to live fish and a pool with a fresh water source for the animal to fish and swim in?
- Does the rehabilitator have an established relationship with an experienced otter veterinarian?
- Does the rehabilitator already have an otter diet, husbandry, medical, and release plan established?

- Does the rehabilitator have a suitably isolated, natural pen (no dogs and limited human presence) where the orphans can be placed as they become more independent?
- Does the rehabilitator have facilities to hold the otter for at least 9 months?
- If release is not an option, rehabilitators should begin researching good placement options early.

ONCE THE DECISION TO REHABILITATE IS MADE

If the pup is indeed an orphan and the decision to hand rear is made, the following rules apply.

- Know the animal's natural history and development time line.
- Have as few care takers as possible (ideally just one). **Keep human contact to a minimum.** The animal will not be releasable if it becomes imprinted, tame, or too accustomed to humans. This becomes even more critical in the case of single pups.
- Few otter pups are suitable for release. Before this is attempted experienced professionals should be consulted and a plan put in place.
- **Do not** house these animals near human or pet trafficked areas.
- There **must not** be any positive exposure to dogs.
- Be prepared ahead of time for the next stage of the animal's growth so he/she need not face undue delays when reaching the next point in development.
- If you receive a single pup, network with regional rehabilitators in an attempt to locate another orphan(s) so pups can be raised together. Otters are very social, active and playful and do much better in groups than when raised alone. The development of normal social behavior skills, natural companionship, healthy competition, added body heat, and physiological comforts are just a few of the benefits of rearing otter pups together.
- Introducing unfamiliar otter pups to one another is easier the younger they are. Expect a rough and tumble introduction (lots of vocalizations and perhaps some play biting and wrestling) if the pups are over 3 months old when they first meet. Introduce new animals slowly and with a barrier initially.

- Pups 6 - 12 months of age may take longer to introduce, however, typically introductions before sexual maturity are successful unless either animal is excessively imprinted.
- Always use caution and careful observation when introducing otter pups of different ages/sizes. Injuries may occur to the smaller of the two. Offer pups multiple hiding places to provide 'safe zones".
- Raising a single otter pup to successful release can be challenging but is possible. **This is not the preferred method.**

HANDLING

- Young pups tend to settle down and accept captivity quickly. Typically, all that may be needed to handle them is a pair of leather gloves and/or a towel for wrapping them in.
- After the age of about 10 - 12 weeks of age, otters can become quite difficult to handle and nearly impossible to restrain by hand. Otters can roll around in their hide while being held by the nape of the neck and are quite capable of biting your "scruffing" hand in mid restraint.
- Older juveniles and adults become quite desperate to escape and can harm themselves in their attempts. They will chew, dig, and/or climb which may result in injuries or death if the caging is not appropriate. Handling these otters should only be done if absolutely necessary and requires wearing heavy leather gloves, long pants, and heavy boots.
- If utilizing a rabies or snare pole to restrain an otter be sure the loop goes behind one front leg as well as the neck otherwise the loop will slip right off the head since their neck is the same circumference.
- Nets are useful for quickly moving an animal from one secured spot to another as long as the net is heavy duty. It also must be long enough to properly contain the body and have room to "flip" the net on itself to temporarily keep the otter closed inside while being lifted. Nets also have been used for securing an animal to the ground long enough to allow administration of an IM or SQ injection through the netting. Padding the net rim is advisable to help prevent injury to the otter's teeth or mouth in the event he bites it.

- Squeeze cages (available from many sources) are generally a safe method (for both animal and handler) of restraint for injections as they allow the handler access to many body parts of the otter. They also offer quick and reliable immobility of the animal. However, the safest and best method is to train the otters to receive hand-injections. This method also tends to be the least stressful as it reduces the potential of otters harming themselves when they are habituated to the hand injection procedure. (See training section for hand-injections procedures.)

OTTER DIET AND FEEDING – NURSING ORPHANS

- **Formula:** Stomach capacity is 50 - 60 ml/kg; begin with 50 ml/kg to reduce chances of diarrhea. Use the formula 0.05 X B.W. (in grams) =________ml. to calculate the amount to be fed. There are 30 ml. / fluid ounce.
- 20 - 40% (30% is a good starting point) B.W. (body weight) per day should be fed. This should be divided by the number of feedings and given over a 24 hour period.
- When evening feedings are no longer necessary, stagger the remaining meals so that the otter never goes more than 8 hours without eating (ideally no more than 6 hours for the pre-weaned). Do not overfeed in volume in order to eliminate a feeding or make up for a missed session.
- Prepare and date each day's formula and discard any unused refrigerated formula after 24 hours.
- Warm measured formula to body temperature prior to feeding and discard any uneaten portions.
- Do not refrigerate formula after it has been heated.
- If milk has recently been mixed in a blender or rigorously shaken, allow time for the bubbles to settle out before offering bottle to the animal. Too many bubbles may cause gas and G.I. upset.

See the hand-rearing section for formula information retained from earlier editions. Updated information on formulas used for hand-rearing orphaned otters is listed below.

Formula Note

Recent change (2009) in the manufacturing process of Esbilac powder has been causing some growth and digestibility problems in squirrels, opossums and raccoons for some wildlife rehabilitators using this milk replacer. Problems regarding this product with other wildlife species have not yet been reported or published to author's knowledge.

Pet Ag®, manufacturer of Esbilac and the Zoologic Milk Matrix line of milk replacers, reminds wildlife rehabilitators that using Esbilac on wildlife is "off label" usage and they recommend that instead rehabilitators use the Zoologic Milk Matrix products such as Zoologic 33/40 since it is manufactured and labeled for use in wild orphan mammals.

The addition of an anti-gas build-up product to the formula should be considered (milk sugars can cause the build-up of gas). Lact-aid® is an enzyme that has been used successfully with many species. Add two drops of Lact-aid® to 100ml of mixed formula. The formula then must be refrigerated for 24 hours prior to feeding for the enzyme to perform correctly (Grant 2005). *Lactobacillus* spp., in Bene-bac® or Probios®, is a group of beneficial gut bacteria that also break down milk sugars in the digestive tract. Follow label instructions for these products.

Wildlife rehabilitators are advised to know about these issues in order to make informed decisions on the formulas we choose to feed. Current updates on milk replacers, feeding practices, and information on gastrointestinal conditions in wildlife are available at www.ewildagain.org.

Substitute milk formulas for otters. Values taken from product composition documents available from PetAg™ (K.Grant, personal communication)

Formula	% Solids	% Fat	% Protein	% Carb	Kcal/ml
Formula #1 1 part Esbilac® or Milk Matrix® 33/40 1 part Multi-Milk® or Milk Matrix® 30/55 2 parts water	30.9	15.6	10.5	2.7	1.78
Formula #2 1 part Multi-Milk® or Milk Matrix 30/55® 1 part water	31.3	17.8	10.4	1.1	1.91

At this time (2004), the preferred formula is canned Esbilac® due to palatability and good pup growth. Milk Matrix® based formulas also are nutritionally suitable but some facilities have had pups refuse this formula (Blum 2004) while others have had good success.

Formulas:
The following are examples of formulas successfully used to raise N. A. river otter (2011).

- 1 part powdered Esbilac® + 2 parts water + Lactobacillus (Avian Benebac™) powder (1t/cup of formula) (provided by M. Haire)

- 1 part powdered Esbilac® + 2 parts water + 1 part heavy whipping cream + 1 part Multi-Milk® (provided by M. Caine-Stage)

- 2 part liquid Esbilac® + 1 part whipping cream

- Multi-Milk ®30/55 until eyes open, than;
  2 parts liquid Esbilac + 1 part Multi-Milk® (Provided by S. Beckwith)

- Canned Esbilac® (as is)

- 1 part powdered Esbilac® or Milk Matrix® 33/40 + 1 part powdered Multi-Milk® or Milk Matrix® 30/55 + 2 parts water

- Multi-Milk® 30/55 until eyes open then transition to Esbilac® (Zoologic milk substitute 30/55 has low level of lactose)

- Esbilac® 2 T/4 oz BW divided into 5 - 7 feedings every 2 - 3 hours until 10:00pm
  4 weeks old consume 1 oz/feeding 4 - 6 x/day
  6 weeks old consume 2.5 oz/feeding 4 x/day (provided by Blasidell)

Care Timeline

North American River Otter (Lutra Canadensis) Care Sheet					
Age (Weeks)	**Weights (g)**	**Age Determinates**	**Diet**	**Amount**	**Frequency**
birth	110 - 170	Dark brown-grayish black fur, eyes closed, 25 - 30 cm long, toothless, needs stimulation, auditory canals open and able to chirp at birth.	Formula plus Probiotic	Volume by B.W. (body weight)	Every 2 - 3 hours 24/7
1	266 - 333				Every 2 - 3 hours 24/7
2	428 - 671				Every 3 hrs. Min. 5 - 6 feedings. No PM feedings.
3	566 - 912	Can growl; developed olfactory senses. Tooth eruption begins.			Every 3 hrs. Min. 5 - 6 feedings. No PM feedings.
4	721 - 1180	Able to toddle & thermoregulate; housing 75°F w/ lamp. Muzzle hairs begin to lighten; whiskers still undeveloped, body 11 - 13 inches			Every 3 hrs. Min. 5 - 6 feedings. No PM feedings.
5	997 - 1562	Crawling on belly. Eyes open-bluish in color (day35 -40).			Every 3 hrs. Min. 5 feedings. No PM feedings.
6	1200 - 1428	Eyes focused and tracking, localized latrine use. Able to walk holding head up.			Every 3 - 4 hrs. Min. 5 feedings. No PM feedings.
7	1161 - 2072	Urogenital stimulation can be discontinued should be defecating on own.			Every 3 - 4 hrs. 4 - 5 feedings. No PM feedings.
8	1656 - 1907	Introduce to water dish.	Add Canned Food	Solids- Ad Lib.	Every 4 hrs. 4 feedings. No PM feedings.
9	1914 - 2247				Feed 4 times /day
10	1678 - 2419		Add Fish	Fish- Ad Lib.	Feed 4 times /day

Weights- from North American River Otter Husbandry Manual (Reed Smith 2001)

Feeding Nursing Pups:

- Weigh pups at the same time each day (preferably before first AM feeding) to calculate feeding volume.
- For bottle feeding, place infant in a sternal recumbent (belly down) position with the head straight out and slightly up.
- Due to their competitive and sometimes aggressive nature, multiple pups may need to be offered bottles simultaneously or physically separated to feed one at a time to avoid injury to the other otters or the care giver.

- Newborns have been successfully fed by syringes with a cut off portion of a rubber catheter attached to needle hub for a nipple.
- Another option is a Cat-tac® nipple attached to syringe tip than switching to a Pet AG™ Pet nurser with a nipple (size F or LD) from Wombarroo™ as they get a little older. The nipple size depends on the individual otter's preference. (McBride, personal communication)
- Juveniles (4 - 12 weeks of age) are often fed with human baby bottles and soft preemie nipples.
- Otters may get frustrated if the nipple hole does not suit the suckling reflex or if the nipple is too hard.
- Avoid the temptation to enlarge the nipple's hole size. If the otter is outgrowing the nipple, it is safer to go up one nipple size rather than to widen the hole.
- Playtex brand silicone, preemie nipples (hole size 1) generally work well for very young pups as they are soft and PBA free. These nipples are often available at many large chain drug stores and Walmart. (S. Beckwith personal communication)
- Two other brands of nipples that often work well are Similac™ Special Care Nipple and Enfamil™ Neonatal Nipple. Both offer a tip smaller than most other preemie nipples.
- New intakes may take several days to become accustomed to the new diet and feeding equipment.
- One method used to get infants to adjust to nursing from an artificial nipple is to cover the pup's eyes and hold the mouth firmly closed over the nipple until pup stops chewing and resisting and calms down enough to attempt suckling. Squeeze the bottle gently to allow a small amount of milk to flow into the mouth to encourage them to swallow and get used to the taste of the unfamiliar formula.

Clamping jaws over nipple to encourage nursing.

- Line up the nipple/bottle with the center of the mouth (equal distance between canine teeth) because if the nipple is offset to one side of the mouth the pup tends to want to chew and tug on the nipple instead of suckle.
- Otters are obligate nose breathers so they cannot breathe from their mouth and nurse at the same time. This may create a difficult nursing session if the pup has a respiratory infection and is congested. In this case, hopefully the pup is old enough and will eat enough from a bowl. In severe cases, a nasogastric feeding tube may need to be placed by a veterinarian.

Photo: Nasogastric tube sutured in place for stomach tube feeding a young otter unable to eat normally due to neurological issues.

- Bottle aged pups that will not suckle can be successfully transitioned by feeding formula and blended solids (fish and kitten chow) with a **large tipped (gastric) irrigation syringe** (as shown) until they are able to feed from a bowl.

- Once otter pups get the hang of bottle nursing, the rest of the feeding times are spent trying to slow them down. They tend to drink very fast and you may have to pull the empty bottle away quickly to prevent them from swallowing air or chewing the nipple in half due to excitement.
- Unfortunately, not all bottle-aged pups will learn to suckle from the bottle and some choose to just chew on the nipple and force the milk out instead. Although this "drinking" method works well enough, close attention must be paid to the condition of the nipple throughout the entire feeding because they can (and probably will) suddenly puncture and tear the nipple spilling the formula out in a rush.
- Aggressive bottle drinkers can become quite fractious at the end of the feeding sessions so be prepared for possible scratches/bites. Wear leather gloves and keep fingers and face away from the "bite zone" when pulling the empty bottle away.
- Baby otter's abdomens should be nicely rounded after mealtime but never tight or doughy. A healthy well fed otter pup should never show shoulder, hip, or rib bones.

Photo: Healthy well fed baby river otter

- After a bottle feeding, attempt to burp the pup by patting firmly between the shoulder blades and down the infant's back as otter pups tend to accumulate air in their stomachs while nursing. This may cause them to stop feeding before they have ingested the entire meal.

FEEDING VERY YOUNG PUPS THAT WILL NOT NURSE

If very young pups will not nurse they can be tube fed. Prior to attempting for the first time, the tube feeding procedure should be demonstrated by a veterinarian or experienced person. This should only be tried on pups without teeth. The procedure below has been used successfully on N. A. river otter pups.

- Typically, a size 5 Fr. feeding tube (such as a red rubber catheter) is sufficient for feeding most young pups but size is dependent on the individual. The next size down (3.5 Fr.) and next size up (8 Fr.) should be available in case they are needed.

- Pre-load the catheter with formula before passing it into the stomach to avoid injecting a large bubble of air ahead of the meal. This is accomplished by filling the syringe with formula, attaching to catheter, depressing plunger slowly until formula is coming out the end of the catheter. Using this method, you will have an accurate amount of fluid entering the pup, without air bubbles being pumped through first.
- Measure to the last rib and mark the spot on the catheter with a sharpie. Passing the tube is similar to tube-feeding almost any other neonatal carnivore.
- Generally start the first feeding with just Pedialyte® to make sure they are hydrated before putting any actual formula in them.
- Second feeding +/- third feeding is 50% Pedialyte®/50% formula, then 25%/75%, then full strength formula. This is a dynamic process, though, and changes are made based on the neonate – constipation/diarrhea will require adjusting the strength and amount.
- Typically aim to feed 20 - 40% of the pup's body weight daily, divided evenly over a 24 hour period. It is important for the caretaker/keeper to be in touch with their veterinarian during this process so that concerns can be discussed and addressed right away (diarrhea, constipation, aspiration of formula, dehydration, weakness, etc).
- It helps to soak the catheter in warm water before using it. This softens the rubber a little and is gentler on the pup.

STIMULATION TO URINATE/DEFECATE

- Stimulate for urination and defecation with a damp cloth before feeding. This should be done until eyes open and self-elimination is evident (~ 7 weeks).
- Otters on formula have a variety of stool types and consistencies but their feces generally should be soft, but formed, and yellow in color (See photo).
- When the pups begin to eat solid food their feces tend to take on the look and texture of what they ate last (See photo). Anywhere from light tan to almost black feces are typically normal.

- Otters have a mucous lined intestinal tract to protect themselves from fish bones, crayfish shells, and other ingested sharp food items. It is normal for them to occasionally pass mucous in/on their stool.
- Due to their high metabolism otters may urinate/defecate every 2 - 3 hours and they usually do both functions at the same time.
- Generally they defecate in a place away from the food and sleeping quarters but often in a water bowl or pool.
- Occasionally otter pups will use a litter box, with shredded paper or pelleted paper litter, if a shallow pan is provided in their favorite latrine corner or spot.
- Some rehabilitators offer a separate kennel for the pup to use as a latrine.

Photo: Providing a litter box may help with cage cleaning.

Bowl Feeding:

- Juveniles (6 weeks and older) may prefer to take formula out of a bowl and should be encouraged to do so as early as possible.
- Early lappers tend to be easier to wean, form less of a bond with the care giver, and have less chance of aspirating milk than those individuals that are being bottle fed.

- One challenge of bowl feeding the formula is the mess. Be prepared to rinse and dry off the baby (and enclosure) after each feeding.
- **Note**: Offering formula in a bowl makes it more difficult to measure actual formula consumption vs. wasted "milk splatter."
- It is usually best to feed multiple pups separately so they are less likely to fight and to help ensure that each animal is getting the measured volume that he needs.
- **Feeding Tip**: A stainless steel puppy bowl with a cone in the middle helps to reduce face to face contact with other pups and reduces the likelihood of the pups submerging their entire heads into the food bowl.

- When a new pup is introduced to one already familiar with the feeding routine the food competitiveness that often develops may be helpful in stimulating the new animal into defending (and therefore to begin eating) his new and unfamiliar diet.
- Bowl feeding mess clean-up may be easier if pups are first moved to a cleanable "feeding station," such as a stock tank, plastic baby pool, deep sink, or bath tub, away from bedding and sleeping quarters during the meal time.
- Clean and dry the pups immediately following the feeding sessions so as not to allow the pups to chill or the food to dry onto the skin and fur.
- Regardless of the feeding technique used, the true measure of how the individuals are doing is by careful observation of body condition, fur quality, and daily weight gain.

Introduce a scale to the pups when they are young in order to improve your chances of getting routine weights up to release age.

Weaning

- At weeks 6 - 8, gradually begin introducing solid foods such as blended fish or small soft-boned fish (e.g. minnow, smelt), chicken baby food, canned or moistened kitten food into the bottle or formula bowl.
- Only introduce one new weaning food component to the diet every few days until they have adjusted well to solids.
- Gradually decrease the number of formula feedings until weaned (usually by 16 weeks).
- Once they have a taste for the kitten food in the formula, start offering it dry ad lib. Some otters will eat the dry cat food in between meals.
- **Weaning tip**: Remove the nipple and put fish parts, solids, shrimp in the bottle. They will play with the bottle while retrieving the bits. Also stimulates their intellect.
- **Weaning tip:** Weaning off formula can happen overnight or sometimes takes months. Offer small fish/canned kitten food before each formula feeding, while they are still very hungry, to encourage them to begin eating on their own.
- **Weaning tip**: If pups show no interest in kitten chow try tossing it in the pool, they may forage for it naturally.
- Do not skip a bottle feeding in order to make the pups "extra hungry" in an attempt to coax them to eat solid food.
- When weaning an overly excited/anxious pup from bottle to bowl you may try to offer half of the formula from the bottle first, than present a bowl containing the remainder. When the pups are really hungry (and familiar only with a bottle) they may need some food in their bellies first to calm them down enough to allow them to concentrate on the rest of the meal presented in an unfamiliar object (bowl).
- **Weaning tip**: With bottle nursers that are resistant to trying solid food on their own, try slipping small pieces of fish in their mouths along with the nipple to "trick" them into chewing and swallowing the fish.
- If a pup starts to nurse on its', or its sibling's, tail tip or toes, an extra formula feeding may need to be added back in for a few days. This behavior should be dealt with immediately to prevent it from becoming permanent.

Photo: Tail tip after being self- nursed upon.

- Putting orange oil on the genitals to discourage sucking has worked well with *Lutra lutra* and is not harmful to the otter (G. Yoxon, personal communication)
- Some otter pups choose to go from formula straight to fish and are not interested in the baby or kitten food. While feeding a strictly fish diet in captivity may seem to be more natural, be aware that in the wild they would be getting a broad variety of fresh fish species, amphibians, crayfish, invertebrates, birds, small mammals, and other food types that make up a nutritional balance which is often difficult to replicate in captivity. Frozen fish, while easier for the care giver to acquire, is deficient in thiamine and therefore not nutritionally complete so fresh whole fish, vitamin/mineral supplementation, and/or other commercial diets may also be required.
- If weaning pups from formula straight onto adult diet, substitute a single feeding at first with small fish or fish pieces and then gradually replace the number of bottles with fish until they are weaned.
- Begin to offer drinking water in a shallow bowl when otters can walk and begin to eat solid foods but plan to refill the water bowl several times a day because they will climb repeatedly in and out of the bowl.
- Young otters tend to defecate in the water and often soil their water bowls and pools multiple times a day. These should be regularly cleaned and refilled.
- When first introducing live food, start with small harmless prey such as minnows, goldfish, tadpoles, and frogs. Once the otters develop the skill and taste to capture and eat these easy targets then progress to the prey that may fight back such as crayfish, catfish, mice, etc.

Photo: Novel way to introduce live prey.

- Some rehabilitators have reported seeing otters regurgitate bones and scales shortly after a meal. This is probably a natural process and should be ruled out before considering a health condition involving vomiting.
- A variety of whole carcass fish plus a balanced good quality dry and canned kitten food should constitute 90% of the post-weaning diet.
- Every effort should be made to feed live fish and other native prey items daily. Natural diets vary by location and season but mainly consist of fish, crayfish, frogs, water invertebrates, small mammals, and birds.
- Some captive otters eagerly consume mice and chicks as part of their diet.
- Wild adult otters eat 15 - 20 % of their body weight per day.
- Captive weaned pups and adult river otters should be fed at least 3 to 4 times a day due to their high metabolism and caloric needs with 4 daily feedings being ideal.

SOURCES/SUPPLIES:

- **Enfamil™ Neonatal Nipple** Latex-Free by Mead Johnson Nutritionals #4202-02.
- **Esbilac, Multimilk, Benebac, Pet Nurser bottle:** Pet Ag™, 255 keyes Ave., Hampshire, Illinois, 60140, 1-800-323-6878
- **Milk Matrix:** Pet Ag™, 255 keyes Ave., Hampshire, Illinois, 60140, 1-800-323-6878
- **SnuggleSafe™** microwavable heating pad (www.snugglesafe.co.uk).
- **Similac™ Special Care™ Nipple** by Ross Pediatrics- Ross Production Division Abbott Laboratories Item # 00095. Special on line order.
- **Syringes, feeding tubes/catheters, Catac nipples, etc.:** Most of these products are available on-line at Chris's Squirrels and More: www.squirrelsandmore.com
- **Wombaroo™ formula nipples** (Size F or LD)- www.wombarroo.com or www.perfectpets.com
- **Zoologic milk replacer:** Pet Ag™, 255 keyes Ave., Hampshire, Illinois, 60140, 1-800-323-6878

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IUCN/SSC Otter Specialist Group, http://www.otterspecialistgroup.org/

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APPENDIX A – RESOURCES PROVIDED BY INTERNATIONAL OTTER SURVIVAL FUND (WWW.OTTER.ORG)

The following article gives a lot of information on how to keep otters out of fisheries:
http://www.environment-agency.gov.uk/static/documents/Leisure/otters_and_stillwater_fisheriesv4_080501_FINAL_PRINT-CGS3.pdf

A new form of fencing has been developed:
http://www.farminguk.com/news/Otter-Exclusion-With-X-FENCE-Premier-Wire-Netting_18954.html
For more details call tel: 0845 1207755 or look at www.mcveighparker.co.uk Contact -Chris Hambridge 01622 892541, chris@mcveighparker.co.uk

Paper from France - http://www.iucnosg.org/Bulletin/Volume20/Leblanc_2003.html

Use of Lion dung as deterrent - http://www.independent.co.uk/environment/nature/anglers-call-on-new-weapon-to-ward-otters-off-their-fish-ndash-lions-2254765.html

If you have other suggestions of techniques successful at keeping otter out of fish farms or backyard ponds please contact IOSF so they can add them to an important resource database.

APPENDIX B – REMOVING FEMALE OTTERS WITH CUBS FROM UNDER BUILDINGS

If possible, suggest to the site owners that the female's occupancy will cease when the cubs are old enough, typically at about 4 weeks of age after which they can address the issue of preventing future use [Natal Dens - Females frequently use dens dug by other animals as natal holts. These natal holts are generally removed from water; Reid et. al. (1986) reported one female utilized an abandoned fox den 300 meters (984.25 feet) from the shore. The pups were moved closer to water when about three to four weeks old. Liers (1951) reported natal dens located 150 yards (137.16 m) from water and 150 feet (45.72 m) above high-water (female 1) and ½ mile (.085 km) from the water and about 500 feet (152.4 m) above high-water (female 2)].

If the owners are adamant that the female must be moved the method outlined below can be attempted.

Notes on removing a female otter and cubs from under buildings. Clio Smeeton, Cochrane Ecological Institute; CEI, www.ceinst.org.

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- If cubs are very young (eyes shut/no teeth) a female will typically abandon them if disturbed. However, if there is an obvious alternative den site nearby, she may move them.
- Look for alternate sites nearby. Should be removed from possible flooding, with good cover, and a water/foraging source close enough for her to forage and move the cubs when they are old enough (which means good cover along the river/lake shore).
- An artificial holt can be constructed but it must it must be out of any flooding zone. It must be long and dry (she recommends use of an auger for digging the tunnel). Recommends leaving some stucco wire and steel pins at the site of the artificial holt to be used later (as well as some large rocks). If possible a trail camera should be set up focused on the entrance to monitor activity.
    - Females frequently use dens dug by other animals as natal holts. These natal holts are generally removed from water; Reid et. al. (1986) reported one female utilized an abandoned fox den 300 meters (984.25 feet) from the shore. The pups were moved closer to water when about three to four weeks old. Liers (1951) reported natal dens located 150 yards (137.16 m) from water and 150 feet (45.72 m) above high-water (female 1) and ½ mile (.085 km) from the water and about 500 feet (152.4 m) above high-water (female 2).

- An experienced trapper should be asked to live-trap the female and the cubs collected separately.
- The live trap with the otter in it should be completely enclosed using a thick duvet (she does not recommend a tarp as they are stiff and noisy), so that there is no light entering the live trap. Cubs should be placed in a cardboard box, or similar.
- Transport both containers together with the cub box next to, or on top of, the live trap. This allows the female to smell and hear the cubs.
- IMPORTANT; Otters overheat easily and stress is contributory to that. They can be killed by overheating and this should always be considered when handling, transporting capturing otters.
- Take another duvet and fresh fish along during the move to release site.
- Place fresh fish as far down into the artificial/new holt as possible.
- Place the cubs at the entrance to the new holt, no further than arms-length in case the female leaves and the cubs must be retrieved.
- Position the opening of the live trap as close to the opening of the holt as possible. Use the stucco wire, steel pins and rocks to cover all gaps between the holt entrance and the live trap opening. Cover the join with the 2nd duvet.
- Fold back the 2nd duvet only enough so the trap can be opened; if using a guillotine type door completely remove it. Once the trap door is open fold the duvet back over so it joins the duvet already wrapping the live trap. NO LIGHT should be allowed to get in around the join and the door and the entrance to the artificial holt.
- Wait 15 to 20 minutes.

- Begin to slowly fold the duvet back from the end furthest from the artificial holt entrance, moving the folded end up and towards the entrance to the holt. This will let light in and hopefully encourage the otter to move away from it and towards the holt entrance. Keep folding until she is in the holt.
- Stuff the entrance – the stucco wire join – with the duvet and remove the trap.
- LEAVE THE DUVET STUFFED IN THE ENTRANCE TO THE HOLT with one corner sticking out and to the side. When ready to remove the duvet pull the corner very gently and slowly until entrance is open (do not do this yet).
- If possible, and you have time, move about 100m plus away (downwind) and remain watching for at least two hours.
- Leave the duvet for at least a couple of hours; she can push her way out if she is going to do it right away.
- If she immediately pushes aside the duvet and goes to the river wait two hours and then remove the cubs (make sure you are downwind from where the female would most likely return).
- If she does not come out right away, after a minimum of 2 hours (longer is better) cautiously approach the holt FROM THE SIDE and taking hold of the duvet corner slowly and quietly pull it away.
- Go away.
- Return the next day and collect the trail camera, see what the photos show (dating should allow you to know if she left and returned and did not leave again).
- If she is leaving and returning over the 24 - 48 hours since being translocated everything should be ok.
- After a few days of her leaving and returning it should be possible to return and remove the stucco wire, or leave it there if it is not too obvious that it will draw attention.

CHAPTER 14 Websites & Professional Resources

Websites

Otter Specialist Group. Run by the IUCN/SSC Otter Specialist Group this site offers information on all otter species, access to the OSG Bulletin publication, and the OZ Task Force (otters in zoos, aquariums, rehabilitation, and wildlife sanctuaries) publication list. Otterspecialistgroup.org.

International Otter Survival Fund (IOSF). This organization is dedicated to the conservation of all 13 species of otter. They can be reached at **iosf@otter.org** and located at: http://www.otter.org/

The Otter Spotter. Website offering information as well as lesson plans on all otter species. Otterspotter.com

http://bobarnebeck.com/otters/habitat.html

Enchanted Learning.com. This site has an animal print out page for the river otter. http://www.enchantedlearning.com.

Defenders of Wildlife. Their otter information is available at: http://www.defenders.org/north-american-river-otter/basic-facts?gclid=COWGw-ya368CFUOo4AodKFQHWg

The Shape of Enrichment. http://www.enrichment.org/

American Association of Zoo Keepers. Aazk.org

Professional Resources

Studbook Keeper: David Hamilton, dhamilton@monroecounty.gov
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American Association of Zoos and Aquariums (AZA). http://www.aza.org/
American Association of Zoo Keepers (AAZK). http://www.aazk.org/
International Species Information System (ISIS). A network of zoos and aquariums from 54 countries that share information on more than one million specimens (living and dead). Web site can be found at: http://www.worldzoo.org/ 12101 Johnny Cake Ridge Road, Bldg. A, Rm. 6, Apple Valley, MN 55124-8151. 952-997-9500. Fax: 952-432-2757. isis@isis.org
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CHAPTER 15 General Bibliography

This bibliography is not compete but offers an excellent starting point for learning more about otters.

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