

2003

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J. A. Pitt

Iowa State University

W. R. Clark

Iowa State University

R. D. Andrews

Iowa Department of Natural Resources

K. P. Schlarbaum

Iowa Department of Natural Resources

D. D. Hoffman

Iowa Department of Natural Resources

See next page for additional authors

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Recommended Citation

Pitt, J. A.; Clark, W. R.; Andrews, R. D.; Schlarbaum, K. P.; Hoffman, D. D.; and Pitt, S. W. (2003) "Restoration and Monitoring of the River Otter Population in Iowa," *Journal of the Iowa Academy of Science: JIAS*, 110(1-2), 7-12.

Available at: <https://scholarworks.uni.edu/jias/vol110/iss1/4>

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Authors

J. A. Pitt, W. R. Clark, R. D. Andrews, K. P. Schlarbaum, D. D. Hoffman, and S. W. Pitt

Restoration and Monitoring of the River Otter Population in Iowa

J. A. PITT¹, W. R. CLARK¹, R. D. ANDREWS², K. P. SCHLARBAUM³,
D. D. HOFFMAN² and S. W. PITT⁴

¹Department of Animal Ecology, Iowa State University, Ames, Iowa 50011

²Iowa Department of Natural Resources, Fish & Wildlife Station, Clear Lake, Iowa 50428

³Iowa Department of Natural Resources, Boone Research Station, Boone, Iowa 50036

⁴Palo Alto County Conservation Board, Lost Island Nature Center, Ruthven, Iowa 51358

Northern river otters (*Lontra canadensis*) were widespread in North America at the time of European settlement. However, river otters were extirpated from most of Iowa in the early 1900s due to habitat degradation and unregulated harvest. In 1985, the Iowa Department of Natural Resources began an effort to restore the river otter population throughout the state, including a pilot study of survival to determine if establishment was feasible. Annual survival was estimated to be 86% during the pilot study. River otters dispersed an average of about 11 km from the point of release and exhibited habitat use typical for the species. Based on the successful pilot study, 261 river otters were released in the state of Iowa from 1986–2001. More recently we examined the age structure and reproductive effort of 81 river otters (43 females and 38 males) collected in Iowa from 1999–2001 to document the characteristics of the reestablished population. We found that 41% of the otters sampled were juveniles, 38% were yearlings and 21% were adults. Fifty-five percent of all female otters were pregnant, and 80% of adult females were pregnant. We observed a mean of 2.9 corpora lutea/female and calculated that females ≥ 1 year old could potentially produce an average 5.7 female offspring during an average life span. Based on the widespread distribution, healthy reproductive characteristics, and high survival rates it is feasible that a limited harvest of river otter could be implemented in Iowa.

INDEX DESCRIPTORS: age structure, corpora lutea, Iowa, *Lontra canadensis*, reproduction, river otter, survival.

Historical records indicate that river otters once inhabited most of the major river drainages in the continental United States and Canada prior to European settlement (Hall 1981). Following European settlement the river otter was extirpated in 10 states and severely declined in 9 states from the Appalachians, throughout the Great Plains, and the southern Rocky Mountains (Nilsson 1980, Berg 1982). The majority of river otter extirpations were in interior riverine habitat (Raesly 2001), and declines continued well into the 20th century. Conservationists recognized sufficient habitat still existed in many regions, and, in 1976, Colorado began river otter restoration. By 1990, seventeen states had begun to reintroduce river otters, and they are now established in portions of their historic range in every state except New Mexico (Raesly 2001).

Prior to settlement, the river otter was common along major rivers and streams throughout the state of Iowa. Unregulated hunting and trapping, stream pollution, and agriculture activities contributed to the demise of the river otter (Nilsson 1980, Toweill and Tabor 1982, Melquist and Dronkert 1987). Especially in the Midwest, stream channelization and riparian timber removal degraded the aquatic food sources and removed essential denning and loafing sites. The combination of stream channelization, timber removal, and increased agricultural activity also led to siltation and poor water quality that likely influenced prey populations. River otters hunt by a combination of sight and touch, and good water quality facilitates their foraging activities for fish and invertebrates. Runoff of agricultural pesticides could also have played a role in population declines. Although it has been shown that river otters accumulate toxins in their tissues (Halbrook et al. 1996), accumulation of agricultural pesticides has not been directly linked to lower reproductive rates. Declines in reproductive output have been documented in mink (*Mus-*

telon), another mustelid species (Jensen et al. 1977, Kihlstrom et al. 1992).

By the early 1900s there were few river otter sightings on Iowa's interior streams (Dinsmore 1994). The species was extirpated from most of the state, except for a remnant river otter population along and adjacent to the Mississippi River in northeastern and eastern Iowa. This residual population apparently did not disperse into the major tributaries of the Mississippi River throughout Iowa. Consequently, the river otter had negligible presence in most of the state of Iowa from the early 1900s to 1985. In 1985, the Iowa Department of Natural Resources (IDNR) began restoration of river otters to the interior river systems of the state.

About the same time as the initial effort to restore river otters, there was an increasing awareness about erosion and decline in water quality throughout the Midwest. In 1985, the U. S. Department of Agriculture implemented the Conservation Reserve Program that converted almost 1 million ha of Iowa row cropland into perennial grassland within 2 to 3 years (Mayer 1994). This effort, along with better farming practices resulted in a decline of annual sheet and rill erosion from 18,821 kg/ha/yr on cultivated cropland in 1982 to 11,795 kg/ha/yr in 1997 (Natural Resource Conservation Services and Iowa State University Statistical Laboratory 1999). Annual wind erosion also declined on cropland from 7,278 kg/ha/yr in 1982 to 3,262 kg/ha/yr in 1997 (Natural Resource Conservation Services and Iowa State University Statistical Laboratory 1999). These efforts improved water quality and probably improved the potential success of reintroduction of river otter.

Wildlife biologists continue to monitor the distribution of the Iowa river otter population. Currently, efforts are focused on assessing reproductive effort and the age structure of the river otter population.

In this paper we document the pertinent history of the releases of river otters in Iowa and update the information on distribution of the species in Iowa. We examine pregnancy rates, litter size, and population age structure of the river otters recently collected in Iowa.

METHODS

Historical Information

The IDNR provided historical information pertaining to the initial release of the river otters, including information on how and where the river otters were obtained, the number and years that the river otters were released, and the specific locations of the releases. Additional resources such as statistics on Iowa wildlife populations (Fritzell 2001) and archives of magazines and newspapers were also reviewed for relevant information.

Recent sightings and accidental deaths of river otters were obtained from the IDNR. This information was collected either by 1) IDNR officers and citizens that reported these sightings and river otters that were incidentally trapped or 2) through road-killed river otters that were reported and verified by IDNR officials. These locations were recorded at a county level and provided a minimum estimate of river otter presence across the state.

Survival and dispersal was estimated based on the initial release of sixteen river otters of equal sex ratio made at Red Rock Lake in Marion County in March 1985 (Clark 1987). A radio transmitter with a mortality switch (Advanced Telemetry Systems, Isanti, Minnesota) weighing about 15 g was surgically implanted in each animal that was released. Animals were located every other day, and animals that had dispersed from the general vicinity of Red Rock were located using aircraft. We assessed habitat use from locations that were within a 1-ha triangulation error polygon or from visual sightings. We assessed food habits by examining remains of prey found at feeding and toilet sites near dens and resting locations.

Monthly survival was estimated from location data collected for a period of 390 days post release, using the modified Mayfield method (Heisey and Fuller 1985). We censored (used only days lived) those observations where an animal disappeared from the area before we observed mortality. Daily survival was estimated by the Mayfield formula $s_d = (x - y)/x$, where x was the sum of all days lived by all radio-collared river otters, and y is the sum of all deaths of river otters during the study period. Monthly survival was estimated by $S_{month} = s_d^{30}$.

Age and Reproduction

We used carcasses that were taken beginning in the fall of 1999 through the early spring of 2001 to determine age composition and reproductive condition of the reestablished otter population. Most were taken via incidental trapping or as a result of road kill between the months of November and February. Eighty-one river otters were collected throughout the state of Iowa and stored in freezers by IDNR personnel. Once the river otters were collected at a central location, the river otters were thawed and weighed to the nearest 0.28 kg (1/16-lb).

Reproductive tracts (including ovaries, uterine horn, and the uterus) were taken from female river otters and stored in a 10% formalin solution for approximately four months. Each reproductive tract was taken from solution and dissected. Incisions were made at the bottom of the reproductive tract and the uterus and uterine horns were searched for the presence of embryos. Ovaries were dissected from the surrounding mesentery tissue and then carefully cross-sectioned into ≤ 1 mm slices. Corpora lutea were differentiated from corpora albicantia by size and color following Hamilton and Eadie (1964) and Kirkpatrick (1980). Corpora lutea ranged from yellow to gray

and were sometimes partially hollow. Corpora albicantia were solid and lighter in color, ranging from light gray to a creamy white. Corpora lutea were > 2 mm in diameter from November to December and > 3 mm in February collections. Corpora albicantia were < 2 mm in diameter (Hamilton and Eadie 1964).

To determine age of the collected river otters, the lower jaw was taken from each animal and frozen for later analyses. Jaws were thawed, placed in a warm water bath at 70°C for approximately four hours, and then dental lifters were used to loosen the roots of the lower canines from the jawbone (Dimmick and Pelton 1994).

Teeth were sent to Matson's Laboratory (Milltown, Montana) for aging based on a standardized cementum-aging model specific to river otter canines. Teeth were given a rating of A, B, or C; with "A" indicating that the cementum characteristics of the tooth section very nearly matched those of the standardized cementum-aging model. We used these ratings, along with eight duplicate teeth from our sample sent to Matson's Laboratory, to test the accuracy of the age analysis.

RESULTS

Historical Data

Restoration of the river otter to the interior regions of Iowa began in 1985 when 16 river otters (eight males and eight females) from Louisiana were released near Swan, Iowa at the upper end of Red Rock Reservoir in Marion County. These river otters were obtained through a three-way trade in which the IDNR provided wild turkeys (*Meleagris gallopavo*) to Kentucky who, in turn, bought river otters from Louisiana for \$400 each. Ultimately, two turkeys from Iowa were traded for each river otter released in Iowa.

Only two of these initial 16 river otters were confirmed mortalities within the first year after release. A trapper snared one river otter, a female, after 241 days. The other dead otter, also a female, died as a result of transmitter torsion after 259 days. We lost the transmitter signals from two additional river otters, a male and a female, on days 208 and 316 respectively. After 390 days of investigation, the daily survival (s_d) was estimated to be 0.99959 (SE = 0.00029), including the days survived by the two animals that we censored after the date that they were last known alive. On a monthly basis survival rate was estimated at 0.9878 (SE = 0.0001). This is equivalent to an annual survival of $0.9878^{12} = S_{Annual} = 0.863$. If we assume that the two river otters that we censored lived through the entire period, the monthly survival rate would be 0.9884 (SE = 0.00007), or 0.869 annual survival. Mean life span (MLS = $1/(-\ln[S_{Annual}])$) was calculated to be 6.8 years/individual.

Of the 14 river otters that survived the year after the initial release, all but two remained within or near the 24,000 ha Red Rock wildlife area and reservoir throughout the 390-day study period. The average distance moved from the release site was 9.7 km for females, and 12.1 km for males. One male was last located on 13 October 1985 (208 days post release) downstream along the Des Moines River at Tracy Iowa, a straight line distance of about 60 km from the point of release. A female was last located on 29 January 1986 (316 days post release) in a gravel pit near the Skunk River at Colfax Iowa, a straight line distance of about 21 km from the point of release. Other river otters remained in close proximity to each other throughout the period suggesting social interaction typical for the species and sufficient to establish normal reproduction. For example, one female remained in close contact with three males until she died of transmitter complications. The monitored river otters used beaver lodges, logjams, and brush piles as their preferred daytime resting-sites. Observations of feeding and toilet sites indicated that river otters were feeding primarily on abundant rough fish such as common carp (*Cy-*

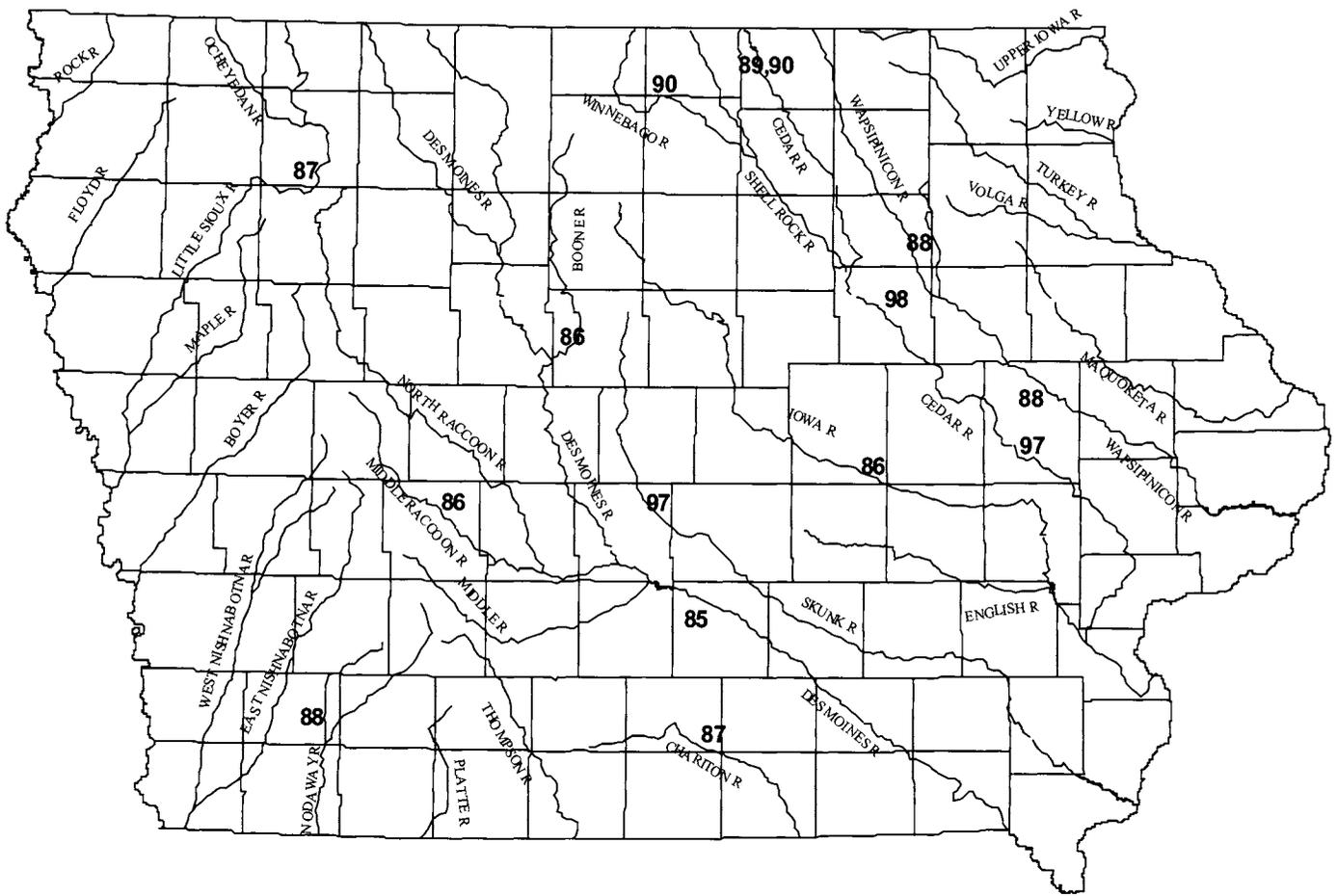


Fig. 1. Sites where river otters were released in Iowa, indicated by the year of release from 1985–1998.

pinus carpio), black bullheads (*Ameiurus melas*), and gizzard shad (*Dorosoma cepedianum*).

Not only did the initial release demonstrate that river otters could successfully be restored to Iowa, but the program generated much public interest in IDNR conservation programs. Between 1985 and 1990, 222 more river otters were released at 11 sites (Fig. 1). After a hiatus, releases resumed again in 1997 and continue through the present. A total of 261 Louisiana river otters have been released into Iowa's rivers and lakes (Table 1). River otters have been sighted in 94 of Iowa's 99 counties and reproduction has been documented 67 counties (Fig. 2).

Age and Sex Structure

Matson's Laboratory reported that the histological condition of teeth was excellent. The periodontal membrane was intact which confirmed that no cementum was missing from the periphery of the root. Differential staining between dark cementum annuli was excellent. Of the 73 teeth analyzed, 62 were reported to be in "A" condition (84.9%) and the remaining 11 were in "B" condition (15.1%). No teeth were given a "C" rating. We found only one distinct error of misclassification of the eight duplicate tooth samples that were sent to the lab.

The age structure was derived from 73 of the 81 river otters that were collected. Forty-two were females and thirty-one were males. Seventy-nine percent of the sample of the population was < 2 years old (Table 2). Only 15 river otters were adults, which comprised

21% of the sample. One river otter was 11-years old. There were no river otters in our sample that were between the ages of 8 and 10. Eight river otters (one female and seven males) were excluded from our age analysis due to problems with tooth collection and preparation.

Reproduction

Seventeen (55%) of the thirty-one adult and yearling females were pregnant (Table 3). Eight of ten adults (80%) and seven of seventeen yearlings (41%) were pregnant. The average number of corpora lutea was 2.9 (SE = 0.2904) among females of all ages. Adults averaged 3.3 (SE = 0.378) corpora lutea per female and yearlings averaged 2.3 (SE = 0.3595). The number of corpora lutea ranged from 1–5 per female. Three of the forty-three females were excluded from age-specific analyses because their age was undetermined. One female was excluded from the reproductive analysis due to a storage problem with the ovary tract. Average number female young produced per adult female per year (number of corpora lutea/2), weighted by the sample size in the reproductive age classes, was 0.833/female \geq 1 year old. The average potential number of female offspring that a female river otter would produce was calculated by multiplying female young produced per year by mean life span. We estimated that a female river otter in Iowa could produce 5.7 female offspring over the entire life span (0.833×6.8).

Table 1. Sites where river otters were released in Iowa, 1985–1999.

Year	Males	Females	County	Nearest Town	River/Area
1985	8	8	Marion	Runnells	Red Rock Reservoir
1986	10	10	Tama	Chelsea	Otter Creek WMA
1986	10	10	Hamilton	Stratford	Boone River
1986	10	10	Guthrie	Guthrie Center	Springbrook Park
1987	10	10	Clay	Peterson	Little Sioux River
1987	10	10	Lucas	Russell	Rathbun Reservoir
1988	10	10	Bremer	Tripoli	Sweet Marsh WMA
1988	10	10	Linn	Waubeek	Wapsipincon River
1988	10	10	Montgomery	Morton Mills	Nodaway
1989	5	3	Mitchell	Otranto	Cedar River
1990	7	8	Mitchell	Otranto	Cedar River
1990	13	10	Cerro Gordo	Mason City	Winnebago River
1997	9	8	Linn	Cedar Rapids	Indian Creek
1997	6	6	Polk	Chichaqua	Skunk River
1998	7	5	Black Hawk	Cedar Falls	Cedar River
1999	5 sex unknown		Story	Ames	Skunk River
1999	3 sex unknown		Sac	Reiff Park	Boyer River
2000	5 sex unknown		Sac	Reiff Park	Boyer River
2000	5 sex unknown		Audubon	Audubon	Nishnabotna River
2000	3 sex unknown		Monroe	Miami Lake	Miami Lake
2000	2 sex unknown		Wapello	Cedar Creek	Cedar Creek
2001	5 sex unknown		Audubon	Audubon	Nishnabotna River
2001	11 sex unknown		Hardin	Steamboat Rock	Iowa River

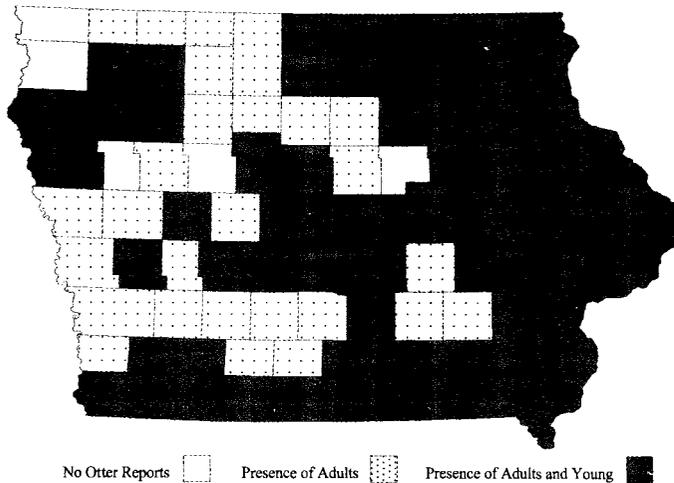


Fig. 2. Presence of adult or adult and young river otters in Iowa through the year 2001, based on sightings, incidental trapping, and confirmed evidence.

DISCUSSION

Historical Information

Otters have dispersed widely since the series of releases, and their documented distribution now encompasses all but five counties in Iowa. The initial release demonstrated that river otters could successfully be restored and also generated public interest in IDNR conservation programs. High survival and successful reproduction of river otters in Iowa has been documented. Based on the documented distribution and population characteristics, on 13 February 2002 river otters were removed from Iowa’s list of threatened and endangered species. The IDNR plans to continue to capture and move Iowa river

Table 2. Age distribution and fraction of a sample of 73 river otters collected in Iowa, 2000–2001.

Age	n	Fraction of Sample
0–1	30	0.4109
1–2	28	0.3835
2–3	3	0.0411
3–4	3	0.0411
4–5	2	0.0274
5–6	2	0.0274
6–7	3	0.0411
7–8	1	0.0137
>8	1	0.0137

otters from watersheds where they are abundant to areas where they are less abundant or absent.

Age Structure

Although the age composition that we estimated is based on a small sample that was collected through incidental trappings, the age structure of the Iowa population is similar to that of surrounding states in the Midwest. A sample of 760 river otters in Missouri was comprised of 39% juveniles, 23% yearlings, and 38% adults (D. Hamilton, pers. comm.). J. Erb (pers. comm.) reported an average of 48% juveniles (range 42–55%), 23% yearlings (range 15–31%) and 29% adults (range 23–34%) from river otters harvested between 1980–87 in Minnesota.

We would expect a relatively young age distribution given that the Iowa population currently is expanding into uncolonized habitat. However, young river otters could be over represented in our sample because they are more vulnerable to trapping. But our sample also

Table 3. Number of females (n), number of pregnant females, average number of corpora lutea, and average number of young produced per female per age class of river otters in Iowa, 2000–2001.

Age	n	Number of Pregnant Females	Average Number of Corpora Lutea	Average Number of Young Produced per Female per Age Class
1–2	17	7	2.3	1.0
2–3	2	2	3.5	3.5
3–4	1	1	3.0	3.0
4–5	2	1	5.0	2.5
>5	5	4	3.3	2.6
Sample Total	31 ^a	17	2.9	1.6

^aIncludes 4 individuals of unknown age

included several older individuals, including an 11-year-old, indicating that longevity is possible in Iowa habitat, despite potential for accidental deaths and incidental trapping. Long-lived adult river otters are reliable annual producers of young that are important to expansion of Iowa's river otter population.

Reproduction

The pregnancy rate and average litter size observed in Iowa are average or above average compared to river otter populations elsewhere. In a population in Oregon it appeared adult females bred every year following maturity (Tabor and Wight 1977). In Maryland, however, only 25% of females with regressing corpora lutea were found to also exhibit active corpora lutea (Mowbray et al. 1979). Lauhachinda (1978) reported that alternate year breeding occurred and suggested in Alabama and Georgia a 50% pregnancy rate of adult females. Part of variation in reported river otter pregnancy rates is likely due to the timing of collections relative to the delayed implantation life history characteristic of river otters. In a study conducted in Maine, Docktor et al. (1987) indicated that pregnancy rate increased significantly with age, from 33% for age 1 females to > 90% for females > 4 years old. Litter size, based on corpora lutea, also increased with age. Based on data in Docktor et al. (1987), we calculated that annual average production of female offspring, weighted by the sample size in the reproductive age classes, was 0.746/female \geq 1 year old, a value that is very similar to our estimate of 0.833/female.

Reproductive data from Minnesota and Missouri might be most comparable to that of Iowa, considering similar habitat and climate patterns in those neighboring states. J. Erb (pers. comm.) recently reported a mean pregnancy rate of 34% of yearling river otters (range 23–57%) over a 4-year period in the early 1980's. Pregnancy rate of river otters 2 years or older was 83% (range 77–89%). Berg (1984) previously reported 20% of two-year-olds and 61% of 3-year and older were pregnant, but these data may have been based on preliminary samples. Erb also reported that the average litter size of yearlings was 1.9 young (based on corpora lutea) (range 1.7–2.4) and 2.3 young per adult female (range 2.2–2.3). Data from Missouri, indicated that 70% of adult females were pregnant, and 35% of yearlings were pregnant, and litter size averaged 3.5 (D. Hamilton, pers. comm.).

The essence of a species restoration program is to reestablish a self-sustaining population in native habitat, a goal that has been accomplished for river otters in Iowa. In the case of a species that

was formally harvested, the ultimate indication of success may be a harvestable population. Data in this paper could form the basis for a report to the Scientific Authority of the United States Fish and Wildlife Service before the IDNR would establish regulations. Based on the current population growth and expansion, the river otter population in Iowa should be able to sustain limited harvest. Harvest data provides a mechanism for monitoring the river otter population in relation to changes in the Iowa landscape.

ACKNOWLEDGMENTS

Numerous Iowa Department of Natural Resources personnel have been involved in reporting observations of river otters and in conducting public programs that stimulated interest in river otter conservation. D. Reeves and L. Jackson of the IDNR also were involved in early phases of the project to reintroduce river otter to Iowa. We thank R. Hutton for the use of his facilities to skin the river otters and P. Fritzell, IDNR, for his assistance in preparing the figures. The IDNR provided financial assistance covering tooth sectioning and the Iowa State University Agricultural Experiment Station provided support for J.A. Pitt. J. Erb, Minnesota Department of Natural Resources, Madelia, and D. Hamilton, Missouri Department of Conservation, Columbia, freely provided access to unpublished data. We thank J. Erb and L. Pitt for editorial comments on the manuscript.

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