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Original Research

Demographic and Reproductive Characteristics of New Brunswick River Otter Populations Based on 13 Years of Harvest Data

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Abstract

Long-term biometric datasets for North American river otters (*Lontra canadensis*) are sparse and few have been analyzed to assess factors influencing harvest rates. We analyzed demographic data from over 6,000 trapper-harvested otter carcasses between 1997 and 2010 from a mandatory carcass submission program. Variations in annual harvest was most influenced ($R^2 = 0.74$, $P<0.001$) by otter pelt value from the previous year. Average age of harvested otter was 2.36 for males and 2.31 for females over the 13-year period; the sex ratio was 1.13 males:1 female, and based on blastocyst counts, pregnancy rates were estimated to be 41% for females aged yearling and older. Pregnancy rate for ≥2.5-year-old otters was 55%, and litter size was 1.75 based on blastocyst counts. Over 15% of yearling females carried an average of 1.67 blastocysts and contributed 12% to the overall productivity. This is a greater contribution to productivity by yearling females than previously reported in scientific literature, and it should be considered in otter population models and harvest management strategies. We note existing disparities in approaches to otter data collection and suggest that managers and researchers use standardized methods for carcass analysis. In addition, otter harvest managers should consider previous year's otter pelt value when predicting potential harvest of otter populations.

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INTRODUCTION

The North American river otter (*Lontra canadensis*; hereafter river otter or otter) is a top predator in aquatic ecosystems, has relatively low reproductive rates, and because it is a habitat specialist, may be susceptible to overharvest (Toweill and Tabor 1982; Gorman *et al.* 2008). The river otter is listed as an Appendix II species (Greenwalt 1977) under CITES (Convention for the International Trade in Endangered Species) and jurisdictions permitting its harvest must demonstrate "non-detriment" findings of this harvest (see www.CITES.org). River otters are believed to have delayed sexual maturation, with females typically not reproducing until 2 years of age, and males generally not successfully mating until 5 years of age (Liers 1951; Hamilton & Eadie 1964; Docktor *et al.* 1987). As with other mustelids, the number of offspring produced by river otters typically increases with age, and reported moderate reproductive rates suggest otter populations cannot withstand intensive harvest rates (Chilelli *et al.* 1996). In New Brunswick, Canada, management of otter harvest is accomplished through regulated season length. However, otters are susceptible to incidental harvest in traps set for North American beavers (*Castor canadensis*) due to overlapping seasons and similar trap usage. Chilelli *et al.* (1996) provided evidence that otter harvests in 10 northeastern American states was positively related to beaver harvest when overlap exists.

Since 1997, the New Brunswick Department of Natural Resources (NBDNR) has collected data through mandatory otter carcass submissions from trappers across the province. Otter harvest fluctuates annually, and averaged 461 captures per year (range: 205–916) between 1970 and 2010. Here, we report the demographic and reproductive characteristics of river otters based on 13 years of harvest data; we identify implications for otter management, and metrics that best predict annual otter harvest rates. We investigated potential sources of trapping pressure, and whether otter pelt price, either in the previous year or current year, was the cause for increases in otter take; or whether additional pressure from beaver trapping contributes to an increase in otter trapping effort and inadvertently causes concern for overharvest. In addition, if and when pressure on otter increased, we tested if this change in effort altered harvest sex ratio and/or percent juveniles in the harvest. We also assessed reproductive ability by observing blastocysts and used these data to assess reproductive contribution by age to the population. We hypothesized that if otters are equally trap-susceptible by age, there will be an exponential decay in the age-at-harvest (i.e., inverse J-curve).

STUDY AREA

New Brunswick is a maritime province adjacent to marine environments on two-thirds of its borders. The province contains 4 primary river systems (the Miramichi, Restigouche, Saint John and Saint Croix Rivers), with several smaller watersheds flowing directly into marine systems. New Brunswick is similar in size to Maine, USA, and has relatively contiguous vegetation over its 73,500 km^2 as it extends across less than 4 degrees of latitude from 44° 30' to 48° N (Hinds 2000). Eight hundred meters of elevation separates lowlands from mountaintops in the province. Over 85% of the province is forested: the Boreal forest occupies higher elevations, and the Acadian forest, the lowlands (Hinds 2000). The province is divided into 27 Wildlife Management Zones (WMZ) to facilitate more localized and site-specific area management through seasonal harvest dates and quotas for various wildlife species. All 27 WMZ are open to both beaver and river otter trapping, with the current overlapping seasons lasting 13 weeks from the end of October through to the end of January. The otter harvest season and length varied little (between 12 and 14 weeks) over the study period and both beaver and otter were harvested in every WMZ.

MATERIAL AND METHODS

Otter carcasses were obtained through mandatory trapper submissions to local NBDNR district offices. For each trapped otter, trappers were asked to record date, method of capture (i.e. trap type, set type) and WMZ of capture on a carcass tag provided by NBDNR. Carcasses were transferred to the Fish and Wildlife Laboratory in Fredericton, New Brunswick, where they were stored frozen (-18° C) until thawed for processing. Initial processing involved determining gender by examining external genitalia or an internal search for the bicornate uterus if the bacculum was removed by the trapper during skinning. Carcasses were weighed to the nearest pound using a Hanson spring balance. Body mass values were recorded in pounds and converted to kg before reporting herein.

The lower mandible of each carcass was removed and assigned a unique identification (ID) number. Female carcasses were dissected to remove reproductive tracts Gilbert 1987). Thin, opaque uteri were considered immature/barren based on gross characteristics and not removed, whereas swollen or enlarged uteri and ovaries, indicative of sexual maturity, were removed and placed in a 50-ml plastic container with 20 cc of water and frozen for later analysis. When analyzed, uterine horns were separated from ovaries and the vagina. To obtain blastocysts, each horn was independently triple flushed (from both ends) with water injected through an 18-gauge needle attached to a 10-cc syringe (Gilbert 1987). In fall-harvested mustelids, blastocysts appear as opaque bodies roughly 1 mm in diameter and usually with irregular borders (Figure 1). The flushed water for each uterine horn was collected into a separate Petri dish and examined for blastocysts with a variable power dissecting microscope (8 to 64 power). Blastocyst counts were led by the same individual for the duration of the study. Reproductive estimates by age class were calculated based on blastocysts present.

Following methods in Matson (1981), lower mandibles were boiled for 60 min and 4 teeth subsequently removed – both incisors and the fourth premolars. One incisor was mounted on cardboard and labeled with its ID number for radiography. Molars and remaining incisor were placed in labeled envelopes and sealed. Radiography was used to determine presence or absence of hollow pulp cavities. Radiographed teeth with open apical foramens and pulp cavities comprising more than half the tooth width were categorized as juveniles (Kuehn and Berg 1983). Molars from otter with solid pulp cavities were packaged and shipped to Matson's Laboratories (Milltown, Montana, USA) for age determination by cementum annuli analysis (Stephenson 1977; Matson 1981). Matson's Laboratories use cementum annuli to age adult otter and apply a "Certainty Code" to each aged tooth as a reliability index to tooth aging. Code "A" indicates that the cementum characteristics of the tooth section match those of the standardized cementum aging model for the species and tooth type; "B" indicates there is histological evidence to support the result, and the correct age is expected to be within 1 year of the actual age; and "C" is assigned when the match between histological evidence and the standardized model is poor and error is likely. We derived age distributions, sex ratios and longevity based on ages from the entire sample.

We used correlation analysis to determine if harvest effort reflected by pelt value influenced the harvest sex ratio. We used multiple regression analysis to determine if beaver harvests or the previous year's otter and beaver pelt prices influenced the otter harvest. We used a correlation analysis to determine if increased harvest pressure, which typically increases with an increase in pelt value, influenced harvest rates or if it affected the percent juveniles in the harvest or other harvest rates and cohorts. A two-way analysis of

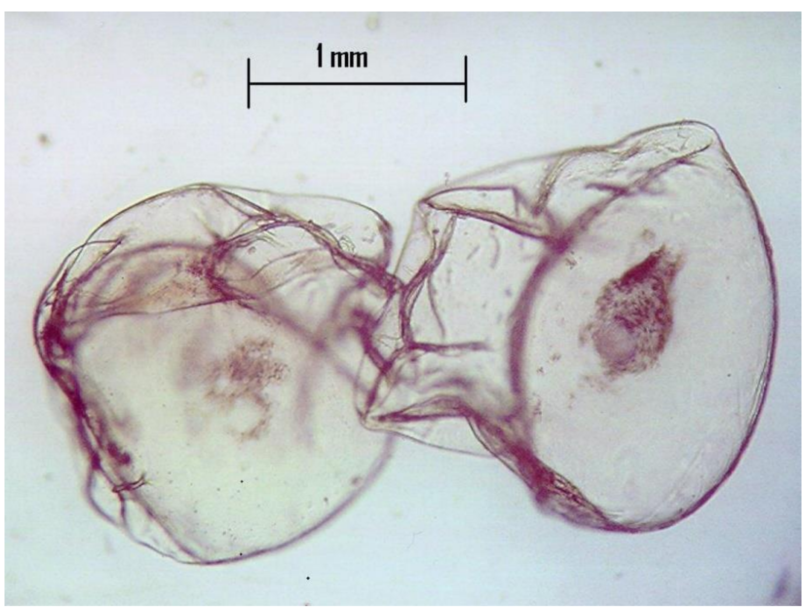

Figure 1. Blastocyst flushed from an otter carcass - Scale approximate. Photo credit NB DNR).

variance (ANOVA) was used to compare carcass weights between sexes by age class. Pelt values in Canadian dollars were not corrected for an inflation index. Statistical analyses were conducted in JMP 5.1 (SAS Institute Inc.).

RESULTS

A total of 6,114 river otters were collected from trappers between 1997 and 2010 using predominantly (>95%) Conibear-style traps. Male (M) and female (F) otters were harvested in all Wildlife Management Zones across the province (range = 32 to 687 by zone) except the islands in the Bay of Fundy. We could not discern gender for 9 otters due to the advanced state of carcass decomposition when these carcasses were received by NBDNR. The remaining 6,105 were categorized as males (n = 3,237) or females (n = 2,843). The annual harvest sex ratio was determined each year and favored males in all but one year, varying from 0.86 to 1.39 M:F for ages ≥1.5 years, with an overall average of 1.13 M:F. The juvenile sex ratio varied from 0.88 to 1.51 M:F, and averaged 1.15 M:F. Harvest sex ratio was negatively correlated with pelt value (sex ratio= -0.0019*pelt value + 0.3197; R = -0.414; P=0.160) even when pelt values for the previous year were considered (sex ratio = -0.021*pelt value + 1.3560; R = -0.383; P=0.197), though both correlations were statistically insignificant (α = 0.05).

Ages were determined for all but 35 otters. Forty percent (2,479) of otters were aged as juveniles by radiography. Of the remaining 3,601 adult otters aged by Matson's, 80% were coded A for certainty, and 19% were coded B. Only 25 otters (<1%) could not be reliably aged using cementum annuli analysis (i.e., code C). The average harvest by age class showed an exponential decay pattern with juveniles comprising approximately one-third of the annual harvest (Figure 2a). Average age of harvested otters was 2.36 years for males and 2.31 years for females. The oldest female otter harvested was 17.5 years and was trapped during the 2007–2008 season; 5 other females over 14.5 years of age were also harvested. The oldest male otter was 18.5 years old and it was taken during the largest harvest which occurred in the 2004–2005 trapping season; 14 other males older than 14.5 years were harvested over the course of the study.

Body mass values for pelted carcasses were not available for 556 otters (514 were not weighed in 2005–2006 due to a shortage of staff). The remaining 2,947 male otters had an average weight of 6.7 kg (±0.02 kg SE), and 2,574 female otters of known ages averaged 5.8 kg (±0.02 kg) (Table 1). The heaviest female otter was a 9.1-kg yearling harvested in 2003–2004, and the heaviest male was a 10.9 kg, 10-year-old otter captured in the 1999–2000 harvest season. Juvenile male and female otters attained, on average, 76% and 79% of the adult body mass, respectively, by the fall harvest season. Within gender, overlap in average weights occurred in all age classes (Table 1). Within age-class, males were significantly (P<0.05) heavier than females in all except for the 11.5-yr age class (Table 1).

Productivity data were obtained for 1,253 female otters from yearling through to 17.5 years of age. Blastocysts were not found in any of the 6 female otters over 14.5 years of age. The majority of female otters had 1 (40%) or 2 (47%) blastocysts. Triplets blastocysts comprised 13% of pregnancies. We detected 4 occurrences of more than 3 blastocysts: 2 7.5-year-olds had quadruplets; 1 7.5-year-old and 1 5.5-year-old each carried quintuplets. Slightly more than 15% of all yearling females carried blastocysts resulting in an estimated average litter size of 1.67, and were the third largest contributor to otter fecundity by age class (Figure 3). Pregnancy rates continued to increase until 5.5 years of age, when nearly 70% of females were pregnant. Pregnancy rate for otters 2.5 years of age and older was 55%, and litter size was 1.75 based on blastocyst counts. Blastocyst counts did not exceed 1 until the 3.5-year age class due to low pregnancy rates, but remained above 1 until otters reached 7.5 years of age.

Linear regression models using previous year's otter pelt value explained most of the variation in otter harvests (harvest = 0.2394*pelt value – 28.19; R^2 = 0.74, n = 13, P< 0.001). Models using previous year's beaver pelt value (P= 0.250) or current year's beaver harvest and pelt value (P= 0.273) did not produce significant relationships.

Average harvest numbers declined as age class increased, with juveniles comprising approximately one-third of the annual harvest (Figure 2a). Harvest proportion by age class was nearly identical for both sexes, but absolute harvest was approximately 14% higher on average for males. Percent juvenile in the harvest was not correlated to pelt value (R=-0.16, P=0.60, n =13). Average age of harvested otters varied from a minimum of 1.9 years in 2007–2008 to a maximum of 2.7 years in 1998–1999. Within sexes, there was no relationship between average age of harvest and either the previous year's pelt price or absolute harvest ($P \geq$ 0.23) (Figure 4). There was also no relationship between annual average age of the harvested females and males (P=0.41).

DISCUSSION

The age structure of the river otter populations harvested between 1997 and 2000 in New Brunswick was similar to that of Oregon (Tabor and Wight 1977; Figure 2b). However,

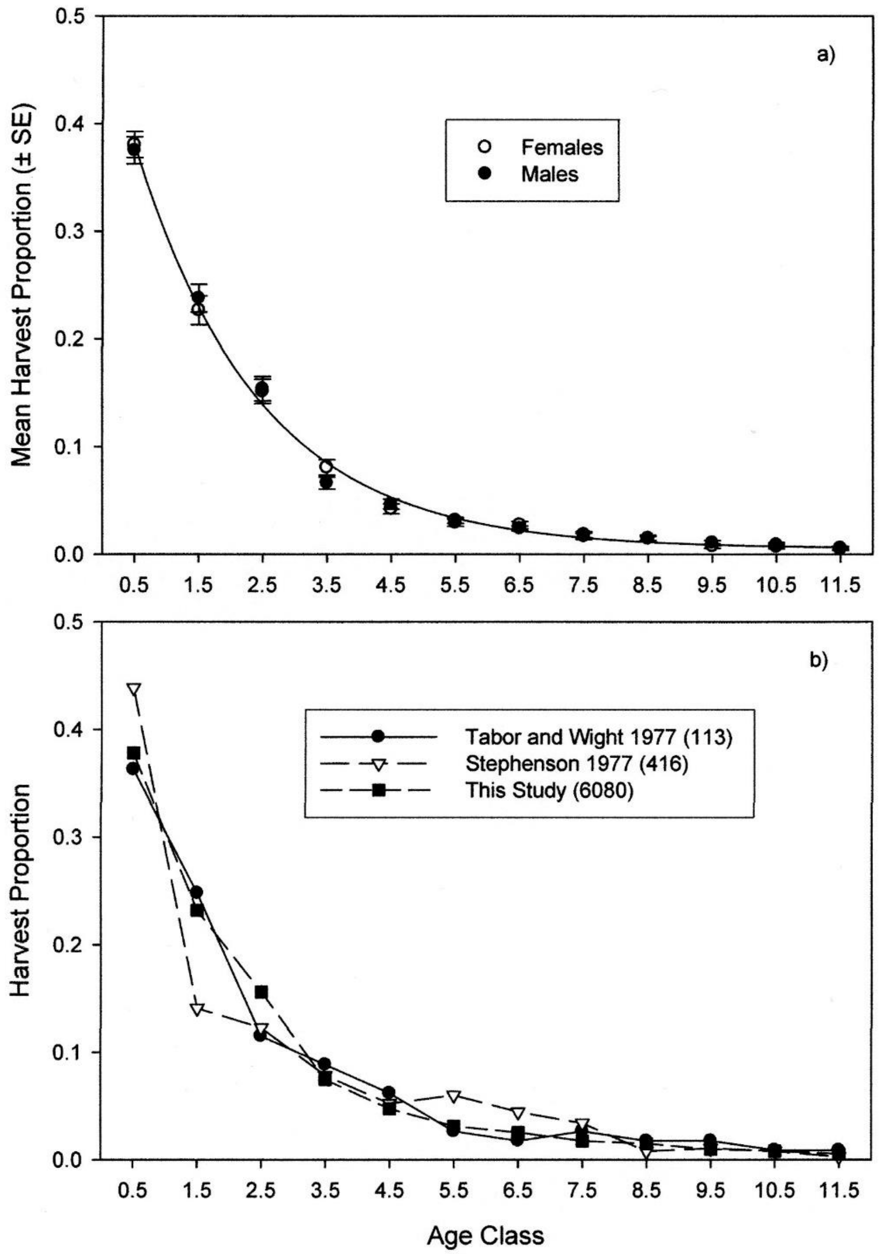

Figure 2. Proportion (±SE) of total New Brunswick river otter harvest by age class and sex 1997–2010 (a). Age classes were limited to <11.5 years of age as harvest of ≥12.5year-old otters was negligible. Regression model is an exponential decay function of annual harvest proportions for males and females combined. Harvest proportion by age class relates to data summed across years for each study (b).

Table 1. Average weights by age class and sex for New Brunswick trapper-harvested river otters from 1997–2010.

	Female					Male				
Age Class	*n*	Mean Weight (kg)	SE	min. (kg)	Max. (kg)	*n*	Mean Weight (kg)	SE	min. (kg)	max. (kg)
0.5	954	4.6	0.03	1.8	7.7	1,118	5.1	0.03	2.7	9.1
1.5	573	5.8	0.04	3.6	9.1	690	6.6	0.04	3.2	10
2.5	406	5.8	0.04	4.1	8.2	452	6.7	0.05	3.6	10.5
3.5	211	5.8	0.06	2.7	8.6	192	6.7	0.07	4.5	9.1
4.5	122	5.8	0.06	3.6	8.6	142	7	0.08	4.5	10.5
5.5	83	5.9	0.09	4.1	7.7	82	7	0.11	4.5	10.5
6.5	67	5.7	0.09	3.6	7.3	74	7	0.11	5.5	10.5
7.5	47	5.8	0.11	4.5	7.7	45	6.9	0.14	4.5	9.5
8.5	36	6	0.17	3.2	7.7	43	7	0.18	5	10.5
9.5	23	5.9	0.18	4.5	7.7	37	7.1	0.16	5	9.1
10.5	20	5.9	0.13	5	7.3	21	7.1	0.27	5.5	10.9
11.5	13	6	0.37	3.2	8.6	16	6.4	0.28	4.5	8.2
12.5	7	5.6	0.32	4.5	6.8	13	6.5	0.26	5	8.6
13.5 +	12	5.5	0.25	3.6	6.8	22	6.5	0.26	5	9.5
Totals	**1,620**	**5.8**	**0.02**	**2.7**	**9.1**	**1,829**	**6.7**	**0.02**	**3.2**	**10.9**

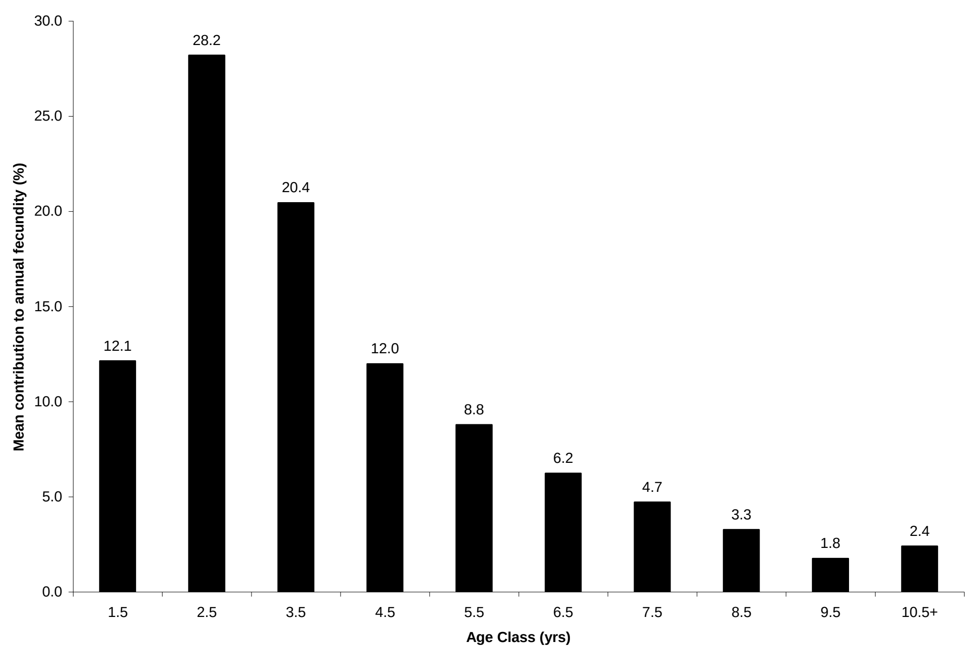

Figure 3. Percent contribution by age class to annual otter fecundity estimates from New Brunswick trapper-harvested otters, 1997–2010.

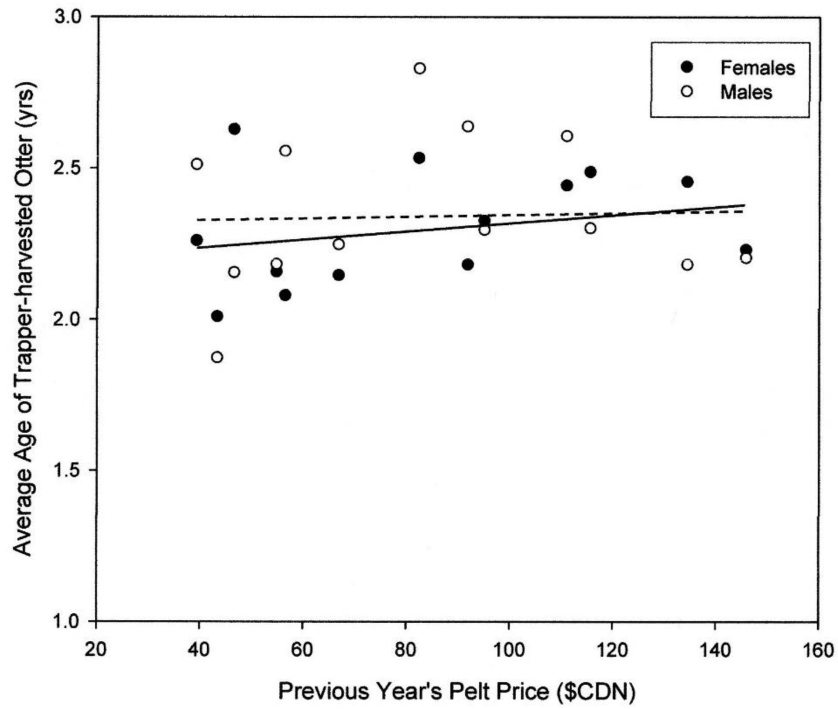

Figure 4. Least-squares mean regression plot of average age of male (open circles) and female (closed circles) New Brunswick river otters with average river otter pelt price in the previous year's auctions.

an Ontario-harvested otter population had a slightly higher proportion of juveniles (Stephenson 1977; Figure 2b), which might indicate higher trapping pressure and potential over-harvest. Juvenile harvest in New Brunswick (nearly 40%) was substantially higher than reintroduced otter populations in Okalhoma (19%; Barrett and Leslie 2012), but lower than a reintroduced population in Kentucky (65%; Barding and Lacki 2014); however, sample size may be a factor in these studies (n = 72 and 170, respectively).

Over the course of this study, more than 20 individual otters were aged reliably at more than 14 years of age. Regular occurrence of older otters in harvest data is indicative of sustainable harvest pressure, as many individuals are surviving to older age classes. Older otters are also indicative of long standing, stable populations as opposed to introduced river otter populations that report maximum ages of otters around 10 years of age (Barrett and Leslie 2012; Barding and Lacki 2014). The harvest proportion by age-class followed an expected exponential decay trend nearly identical for both sexes, and similar to the trend observed in Kentucky (Barding and Lacki 2014). This similarity would indicate that trap susceptibility is not gender-biased, which is reasonable to expect as most river otter trapping is done with blind sets (i.e., traps are not placed in association with bait or scent lures). The average age of otters harvested was unrelated to absolute harvest or previous year's pelt price, which indicates trap susceptibility is not age-biased.

The sex ratio of New Brunswick harvested adult otters was 1.13M:1F, which was consistent among age classes. Given the similar gender ratios, regardless of age class, and an assumed 1:1 sex ratio at birth, this indicates that total harvest of males exceeded females by approximately 14% (3,237 vs. 2,843). The sex ratio in our study is identical to the 28-year weighted average sex ratio (1.13M:1F) of river otters harvested in northern Minnesota (sample size unreported; Gorman *et al.* 2008) and very similar to the 1.2M:1F (n = 5,218) reported by Chilelli *et al.* (1996) from 10 northeastern American states, and as well from Kentucky (1.27M:1.0F; n = 170; Barding and Lacki 2014). Two hypotheses could explain this male-biased sex ratio in these harvested populations. First, non-trapping season survival estimates of river otters suggest that females may have slightly lower monthly survival rates (0.983) compared to males (1.0) (Gorman *et al.* 2008). This reduced survival may be from increased female dispersal distance (Spinola *et al.* 2008), which could lead to higher susceptibility to predation or disease, or increased reproductive costs. A lower survival would shift the population sex ratio in favor of males, similar to that observed in ducks where female survival is lower due to predation while on the nest (Bellrose *et al.* 1961). An alternate hypothesis is that a greater number of males are exposed to trapping because female home range is much smaller than that of males (Gorman *et al.* 2008). More female home ranges may be found in areas inaccessible to trapping, compared to males that range more widely and may encounter trappers more frequently. This would effectively result in a smaller population of females available for trapping, than males. However, the lack of a relationship between harvest or pelt price and sex ratio would suggest that the former explanation is more likely.

Average weights of most age classes of New Brunswick river otters were not significantly different than those in either Ontario (Stephenson 1977) or Michigan (Cooley *et al.* 1983), which share the same subspecies (*L. c. canadensis*; Larivière and Walton 1998). The exception was juvenile male (5.1 ± 0.03SE kg) and female (4.6 ± 0.03SE kg) otters from New Brunswick being significantly ($P<0.05$) heavier than otter of the same age in Ontario (male: 3.7 ± 0.12SE kg; female: 3.4 ± 0.11SE kg; Stephenson 1977) and Michigan (male: 4.8± 0.89SE kg; female: 3.8 ± 0.2SE kg; Cooley *et al.* 1983). Weights of adult male river otters in Michigan (Cooley *et al.*1983) overlapped those of males in New Brunswick. Our data suggest river otters grow rapidly and attain full adult size by the time they are yearlings in New Brunswick, as juvenile male and female otters had reached 76.1% and 79.3% of the average adult weight respectively by the time they were 6 to 8 months of age.

Earlier work suggested river otters generally do not breed until 2 years of age (Liers 1951; Hamilton and Eadie 1964), but these results were based on small sample sizes, visual observations, and estimated ages. Yearling (subadult) females have routinely been excluded from reproductive analysis for various reasons. It has been suggested they were reproductively inactive (Hamilton and Eadie 1964; Tabor and Wight 1977; Lauhachinda 1978), or the data had errors and could not be verified (Chilelli *et al.* 1996). Nevertheless, some mustelids have shown an unusual reproductive feature of precocious maturation where newborns enter oestrus the first few weeks of life, and are able to conceive (Ternovsky and Ternovskaya 1994; King *et al.* 2001; McDonald and Larivière 2002); however, occurrence of this phenomenon has yet to be observed in river otters.

Past work suggested the possibility that some river otters become reproductively active as yearlings (Liers 1951, Mowbray *et al.* 1979, Docktor *et al.* 1987). Chilelli *et al.* (1996) reported 4.7% of 687 juvenile otters and 43.4% of yearling otters in the northeast USA showed signs of reproductive activity. Barding and Lacki (2104) reported 65% of juvenile otters in Kentucky were reproductively active. Von Biela *et al.* (2007) found evidence of reproduction in 2 yearling sea otters (*Enhydra lutris*), but suggested this was biologically implausible.

We found evidence of breeding in only 1 of 528 juvenile otters (a single blastocyst), but found more frequent evidence in yearlings with blastocysts (n = 152) flushed from the reproductive tracts of 90 of 592 (15%) animals. Aging error may have contributed, in part, to this pattern if otters of uncertain age were categorized incorrectly as yearlings. However, according to Matson's certainty code, only 60 of those in the uncertain category were yearlings, and of these, 29 were male, 18 were females without blastocysts, and only 13 were pregnant females that may have been aged erroneously. Therefore, at a minimum, 77 known-aged yearling females were carrying blastocysts. Based on size of yearling otters in New Brunswick, as well as frequent presence of blastocysts, these data suggest that this age class should be considered sexually mature and included in productivity estimates of river otter populations – particularly where juvenile otter growth is robust. Assuming that blastocysts from yearlings survive to produce young at the same rate as older females, this age class would rank as the third largest contributor to productivity by age class at 12.1%, following 2.5-year-olds that contributed 28.2%, and 3.5-year-olds that contributed 20.4% respectively. With more temporal evidence of juvenile productivity, our finding could substantially change river otter demographics, reproductive potential, and potentially the sustainable harvest levels of otters that have previously been dismissed as implausible. Given that juvenile otters in New Brunswick tended to be heavier than those from Ontario and Michigan, we postulate that a more rapid growth rate would allow for more juvenile females to reach a body mass where tradeoff between survival and reproduction favors reproduction in more individuals.

Corpus luteum (CL) counts are most commonly used to report otter productivity (Mowbray *et al.* 1979; Hill and Lauhachinda 1981; Cooley *et al.* 1983, Docktor *et al.*1987). However, corpora lutea are formed in every follicle that releases an ovum if one or more of the ova are fertilized. All corpora lutea persist for the duration of the pregnancy, regardless of the number fertilized (Gilbert 1987), which are likely biased high if not all ova are actually fertilized, or if subsequent blastocysts do not survive through pregnancy. Alternately, blastocyst counts may be biased low due to imperfect detection of blastocysts, or high if the assumption that counts represent future litter size is false. Hill and Lauhachinda (1981) suggested that CL counts were more accurate because blastocysts may not be detected due to freezing or unbuffered preservatives, or they may be lost during flushing. Because of this disparity, reproductive estimates reported in the literature vary widely and may lead to overestimates of population growth rates. Numerous studies have demonstrated that CL counts provide higher litter size estimates than blastocyst counts (Hamilton and Eadie 1964; Chilelli *et al.* 1996; Tabor and Wight 1977), and that blastocyst counts are viewed as a more accurate estimate of litter size (Tabor and Wight 1977; Chilelli *et al.* 1996).

Blastocyst-predicted litter sizes in our sample varied from as low as 1.6 for ≥10-year-old otters, to as high as 2.3 for 9.5-year-old animals. Our average litter size of 1.8 for all >2-years-old females is similar to values obtained for Maine (Docktor *et al.* 1987), Michigan (Cooley *et al.* 1983) and New York (Hamilton & Eadie 1964), but lower than most other values recorded in literature (Tabor and Wight 1977; Mowbray *et al.* 1979; Hill and Lauhachinda 1981; Melquist and Dronkert 1987; Chilelli *et al.* 1996). Much of this discrepancy can be attributable to the technique (CL vs. blastocysts) by which productivity counts were obtained. Our adult pregnancy rate of 55% for all >2-years-old females is at the low end of values reported in other studies, which vary from 51.7% to 98% (Stephenson 1977; Tabor and Wight 1977; Cooley *et al.* 1983; Docktor *et al.* 1987; Gorman *et al.* 2008). The low pregnancy rates suggests that the New Brunswick otters do not breed annually.

Interpretation of harvest results can be problematic when methods and techniques vary. In addition to variation in methods to estimate fecundity, Chilelli *et al.* (1996) found that many American states used different techniques and laboratories to age river otters, which may contribute to disparity in results. We suggest standardizing techniques and methods used to monitor fecundity as well as age and sex structure of harvested river otter populations to improve consistency in support of harvest sustainability assessments required for river otter populations (Raesly 2001).

The lack of a relationship between beaver harvest or pelt price and river otter harvest in New Brunswick does not support the hypothesis that otter harvest is incidental and a function of beaver harvest levels, as was observed in the USA by Melquist and Hornocker (1983) and Chilelli *et al.* (1996). Otter pelt value the previous year appears to best predict upcoming harvest pressure in New Brunswick, suggesting that most river otters are not harvested incidentally while trappers are targeting beavers, but rather are caught in sets targeting otters, and that otter trapping effort is largely a function of otter pelt prices.

MANAGEMENT IMPLICATIONS

We encourage managers to consider the reproductive contribution of yearling otters, which could be as high as 12% of the annual productivity. Although yearlings contribute to annual production in river otter populations, our data also suggest that otter fecundity rates were only moderate, and we postulate that otters in some populations breed in alternate years, as had been suggested previously for other populations (Lauhachinda 1978; Mowbray *et al.* 1979). We believe these data are significant when determining non-detrimental findings for river otters as a CITES listed species. We also recommend that managers use standardized techniques and methods to monitor fecundity as well as age and sex structure of river otter populations. Lastly, trapping effort of river otters in New Brunswick appears to be influenced by the pelt price of the previous year, providing an opportunity to regulate and manage the harvest using pelt price as an indicator of future harvesting levels, especially if harvest rate becomes a concern to population viability. Given the age structure of the New Brunswick otter harvest, it does not appear as though harvest is exceeding population productivity and appears to be sustainable at rates observed from 1997 to 2010.

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