Comparison of harvested and nonharvested painted turtle populations

Tony Gamble and Andrew M. Simons

Abstract Painted turtles (*Chrysemys picta*) are commercially harvested in large numbers in Minnesota for sale to biological supply companies and the pet trade. We investigated the possible effects of this harvest by comparing size, demography, and catch rates of painted turtles in 12 harvested and 10 nonharvested painted turtle populations in 2001 and 2002. We correlated turtle catch rates to harvest status, and harvested lakes had a lower catch-per-unit-effort than nonharvested lakes. Harvest had minimal effect on the size of turtles captured, and we found no significant differences in the count of male:female:juvenile turtles among lakes of different harvest status. We suggest that painted turtle populations likely have been impacted by harvester activities, but it was unclear whether the current harvest is sustainable. Further work is needed to determine whether there are any long-term effects on painted turtle populations.

Key words catch-per-unit-effort, *Chrysemys picta*, harvest, Minnesota, painted turtle

Human use of turtles has been implicated in the population decline and local extirpation of several turtle species (Thorbjarnarson et al. 2000). Turtle life-history characteristics, such as low and stochastic hatching success, delayed sexual maturity, and high juvenile and adult survival, limit the harvest potential of turtles and make them vulnerable to exploitation (Congdon et al. 1993). Population models based on long-term studies of Blanding's turtles (*Emydoidea blandingii*), snapping turtles (*Chelydra serpentina*), and loggerhead sea turtles (*Caretta caretta*) have shown that a small increase in subadult and adult mortality can negatively impact long-term population viability (Congdon et al. 1993, 1994; Crouse et al. 1997). Painted turtle (*Chrysemys picta*) life histories are comparable to the previously mentioned species in many respects, although painted turtles mature at 6–8 years old (Wilbur 1975, Mitchell 1988) versus 14–20 years for Blanding's turtles (Congdon et al. 1993), 11–16 years for snapping turtles (Congdon et al. 1994), and 22 years for loggerhead sea turtles (Crouse et al. 1997). Maturing at a relatively young age suggests that painted turtles may be less susceptible to increased adult mortality than other studied turtle species, but such generalities should be made cautiously as life-history parameters can differ, even among painted turtle populations (Heppell 1998). An awareness of the expanding domestic and international trade in turtles for food and pets has caused many state and federal wildlife agencies to limit or prohibit commercial turtle harvesting (Thorbjarnarson et al. 2000, Anonymous 2002). Often, restrictive regulations are made with little knowledge of the impact of harvest on the populations in question and rarely contain supporting quantitative data, which may limit their utility. An understanding of population size and structure and the effects of harvest can enhance management programs and protection of harvested populations.

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Life-history data are difficult to collect in long-lived species like turtles, but short-term studies, especially well-designed comparative studies, provide valuable information on possible impacts of harvest on relative abundance and population size.

Painted turtles are captured in large numbers in Minnesota for the pet trade and biological supply trade. There was minimal regulation of the commercial turtle harvest prior to 2002 in Minnesota, and painted turtles could be taken in unlimited numbers. The number of turtles captured has varied from year to year, but harvest levels increased dramatically during the decade of the 1980s. In 1978, for example, 6,965 painted turtles were harvested (Lang 1986) while a mean of 29,050 painted turtles were taken each year from 1991 to 2001 based on commercial permit returns, collected by the Minnesota Department of Natural Resources (Minnesota DNR) (Table 1). Minnesota DNR conservation officers have indicated that numerous turtles often are removed from a single lake. One harvester, using 60 basking traps in 1999, removed over 300 turtles from Pelican Lake in Stearns County (B. Mies and D. Rodahl, Minnesota DNR, personal communication). Harvesters use 2 methods to catch turtles: floating basking traps, which take advantage of the basking behavior of turtles, and submerged traps made of wire or net, which attract turtles in the water with bait. Basking traps are the preferred method to take painted turtles (B. Mies and D. Rodahl, Minnesota DNR, personal communication). Painted turtles usually are bycatch in submerged traps, which are used to trap common snapping turtles and spiny softshell turtles (*Apalone spinifera*). Harvesters typically will trap a lake on a rotating basis every 4–5 years (R. Campbell, commercial turtle harvester, personal communication; B. Mies and D. Rodahl Minnesota DNR, personal communication). The impact of commercial harvest on painted turtle populations is unknown, but there are concerns that it may not be sustainable (Lang and Karns 1988).

Table 1. Eleven-year summary (1991–2001) of the turtle harvest in Minnesota from commercial license returns. Columns represent total number of licensed harvesters, number of licensed harvesters that reported catching painted turtles, and number of painted turtles retained for each year.

Year	Harvesters total	Harvesters painted turtles	Painted turtles
1991	62	14	12,469
1992	83	22	23,084
1993	93	22	14,280
1994	70	26	55,017
1995	69	23	22,886
1996	45	14	10,562
1997	67	21	22,010
1998	74	29	68,852
1999	82	21	44,096
2000	60	14	25,499
2001	67	21	20,799

We present the results of a preliminary study to examine impact of harvest on painted turtle populations in Minnesota. Our goals were to compare the relative abundance, size distributions, and sex ratios of painted turtles between several harvested and nonharvested lakes.

Methods

We sampled painted turtles in 12 harvested and 10 nonharvested lakes in central Minnesota from late June through late August 2001 and mid-May through late August 2002. We determined harvest status from conversations with Minnesota DNR conservation officers and land managers. All nonharvested lakes were on protected land such as state and county parks or wildlife refuges, and most had no public boat access. All of the harvested lakes had been commercially trapped in the 2–3 years prior to the start of this study (B. Mies and D. Rodahl, Minnesota DNR, personal communication.). Lakes ranged in size from 6–136 ha.

We captured turtles using basking traps, baited hoop traps, and by hand. Basking traps consisted of a floating wood platform for the turtles to bask on, with a net basket attached underneath (Plummer 1979). Turtles entered the trap through openings on top of the floating platform. The sides of the basking platform were sloped to facilitate entry and prevent escape of turtles captured in the net after leaving the platform. The net basket attached beneath the wood frame was approximately 90 cm deep and 122 cm in circumference, and had 3.8-cm-square mesh. Basking traps were similar in design to those used by commercial harvesters. Hoop traps, made by Memphis Net and Twine (Memphis, Tenn.), consisted of a 72-cm cylindrical frame covered in 3.8-cm-square mesh; turtles, attracted by bait, entered the trap through a single inverted funnel-shaped opening (Plummer 1979). We used canned sardines packed in soybean oil as bait. We set basking and hoop traps in areas likely to catch turtles, using the same criteria that commercial harvesters use to set their traps. We placed traps near the shoreline, adjacent to cattails and other emergent vegetation, in spring and early summer and moved traps out from shore near floating mats of vegetation in mid to late summer. We also set traps near sites where painted turtles had been observed basking. We made no consistent effort to capture turtles by hand, and we did not analyze catch estimates for this method. We included hand-captured turtles in analyses for carapace length and sex ratios. We set basking traps and hoop traps at the same time on each lake for 1–5 days at a time and checked and emptied the traps every day. We sampled each lake at least 6 times during the study.

We recorded the kind of trap in which each turtle was caught and measured the straight-line carapace (shell) length (CL) to the nearest 0.1 cm. We used front-claw length and position of the cloaca relative to the rear edge of the carapace to classify each captured turtle as male or female (Gibbons and Lovich 1990). Males possess long front claws and a cloaca that extends to the rear edge of the carapace. Females have short front claws, and their cloaca is anterior to the rear edge of the carapace. We considered turtles with no discernible secondary sex characteristics and a carapace length less than 9–10 cm as juveniles (Ernst et al. 1994). Turtles received a permanent, individual identification code, drilled into the marginal carapace scutes, so they could be identified if recaptured.

We performed 2 statistical analyses to determine whether differences in number of turtles captured in harvested and nonharvested lakes were significant. The first analysis compared differences in mean catch-per-unit-effort (CPUE) between harvested and nonharvested lakes using a nonparametric 2-sample Wilcoxon rank sum test for independent groups. A nonparametric test was chosen because mean CPUE for each lake was tested for normality using Shapiro-Wilk goodness-of-fit test (Sall et al. 2001) and was not normally distributed (basking traps: $W=0.816$, $P=0.0006$; hoop traps: $W=0.6628$, $P=0.0001$). While the first analysis was designed to approximate the relationship between the number of turtles captured and harvest status, it did not take into account the numerous environmental and seasonal factors known to influence the catchability of painted turtles. The second statistical analysis, therefore, incorporated multiple independent variables using multiple linear regression. Multiple linear regression tests relationships between a single dependent variable and multiple quantitative and qualitative independent variables (Fox 1984; Sall et al. 2001). We analyzed effort as an independent variable in the regression rather than incorporating it in the response variable because CPUE data were not normally distributed, even after transformation. Independently examining variables that make up a ratio is one way to overcome nonnormal distribution problems (Sokal and Rohlf 1995). Catch data, the number of turtles captured, were tested for normality using Shapiro-Wilk goodness-of-fit test and were not normally distributed (basking trap: $W=0.567$, $P=0.0000$; hoop traps: $W=0.667$, $P=0.0000$). Catch data were transformed ($\ln[y+1]$) to better fit a normal distribution (Sokal and Rohlf 1995). We inspected normal quantile plots a posteriori to verify whether residuals were approximately normally distributed (Sokal and Rohlf 1995). We analyzed catch data using the following linear regression model: catch = harvest status + lake size + month + effort + residual. Harvest status was a categorical variable, with each lake classified as harvested or nonharvested; lake size was the surface area of the lake measured in hectares (ha); month was a categorical variable that accounted for seasonal differences in trappability; and effort was measured as trap-hours or number of traps multiplied by the number of hours set. The data were unbalanced in that not all lakes were sampled every month, and F ratios were calculated from type III sums of squares (SAS Institute 1988). We analyzed basking-trap and hoop-trap data separately because they have significantly different catch rates; hoop traps catch almost half as many painted turtles per unit effort as basking traps (Gamble 2003). These differences in catch rates may be related to the ability of painted turtles to escape from hoop traps (Frazer et al. 1990). Hoop traps also were adult-biased, catching far fewer juvenile painted turtles than basking traps (Gamble 2003).

We compared mean carapace length (CL) for each lake between harvested and nonharvested populations using a *t*-test. We considered the carapace measurements of males and females separately because painted turtles are sexually dimorphic, with adult females typically larger than males (Oldfield and Moriarty 1994). We included only sexable, adult turtles with CL greater than 9 cm (Ernst et al. 1994) in size analyses. We compared the count of males:females:juveniles between harvested and nonharvested lakes using contingency table analysis. We included individual turtles captured multiple times only once.

We analyzed commercial permit return data, collected by the Minnesota DNR, to determine whether there was significant interannual variation in the reported harvest of turtles by licensed harvesters from 1991–2001. We tested annual number of turtles captured per harvester for normality using Shapiro-Wilk goodness-of-fit test and found they were not normally distributed (W = 0.378, P = 0.0000). Transformed annual catch per harvester (ln[y]) was tested using ANOVA. We conducted all statistical analyses using JMP IN Version 4.0.4 (Sall et al. 2001).

Table 2. Painted turtle catch data from 12 harvested (Status = H) and 10 nonharvested (Status = N) lakes in central Minnesota from 2001-2002. Turtles column represents total number of turtles captured including recaptures. CPUE = catch-per-unit-effort.

				Mean CPUE (S.D.)	
Lake	Status	Area (ha)	Turtles	Basking trap	Hoop trap
Bjorkland	N	15	91	0.083 (0.061)	0.008 (0.013)
Gemini East	N	12	59	0.044 (0.043)	0.008 (0.015)
Gemini West	N	6	67	0.039 (0.068)	0.034 (0.042)
Half Moon	N	11	78	0.032 (0.040)	0.044 (0.057)
Henschein	N	26	121	0.053 (0.024)	0.026 (0.048)
Lake 21	N	8	237	0.112 (0.085)	0.009 (0.006)
Maria	N	44	1,124	0.157 (0.094)	0.054 (0.063)
Sagatagan	N	64	98	0.028 (0.027)	0.023 (0.025)
Spurzum	N	28	162	0.030 (0.023)	0.033 (0.040)
Stumpf	N	31	91	0.038 (0.029)	0.013 (0.022)
Beaver	H	62	80	0.047 (0.047)	0.019 (0.026)
Black Oak	H	48	138	0.099 (0.041)	0.115 (0.093)
Cedar South	H	36	27	0.012 (0.012)	0.030 (0.051)
Cedar North	H	64	29	0.015 (0.012)	0.018 (0.024)
Guernsey	H	51	61	0.019 (0.015)	0.013 (0.015)
Goodners	H	61	54	0.065 (0.098)	0.019 (0.025)
Little Sauk	H	108	51	0.026 (0.039)	0.008 (0.015)
Long South	H	28	135	0.045 (0.034)	0.022 (0.028)
Long North	H	87	31	0.010 (0.014)	0.014 (0.021)
Mary	H	42	122	0.027 (0.022)	0.019 (0.031)
Pelican	H	136	54	0.024 (0.022)	0.013 (0.022)
Sylvia	H	33	41	0.021 (0.013)	0.019 (0.027)

Results

Over 2 field seasons we marked 2,474 painted turtles and captured 2,951 turtles, including recaptures. We captured more painted turtles overall in nonharvested lakes than in harvested lakes. The mean CPUE for basking traps was 0.068 turtles/trap-hour in nonharvested lakes and 0.033 turtles/trap-hour in harvested lakes. The mean CPUE for hoop traps was 0.029 turtles/trap-hour in nonharvested lakes and 0.022 turtles/trap-hour in harvested lakes (Table 2). The CPUE was significantly correlated to harvest status for basking traps but not for hoop traps using the nonparametric Wilcoxon rank sum test (basking trap: Z=2.143, P=0.0321; hoop trap: Z=0.497, P=0.6191). Number of turtles captured per trap session also was significantly correlated to harvest status for basking traps but not for hoop traps using multiple linear regression (Table 3). The effect of effort was significant for both basking traps and hoop traps. The month effect was not significant for basking trap catch data but was significant for hoop traps. Lake size was not correlated with catch for either trap type. Normal quantile plots indicated that both hoop- and basking-trap residuals were close to normally distributed (Figure 1).

Painted turtles were slightly smaller overall in nonharvested lakes than harvested lakes (Figure 2). Mean CL for females was 14.6 cm (SD=2.6) in harvested lakes and 13.8 cm (SD=2.4) in nonharvested lakes, and mean CL for males was 12.8 cm (SD=2.0) in harvested lakes and 12.0 cm (SD=1.6) in nonharvested lakes (Table 4). There were significant correlations between the mean CL of female turtles and harvest status (t=2.348, df=20, P=0.0293) but not male turtles (t=1.945, df=20, P=0.0660). Males were captured more frequently than females, and more adults were captured than juveniles in all lakes. There was no correlation between the count of males:females:juveniles captured in each lake and harvest status (χ^2=3.592, df=2, P=0.166). Harvesters captured and retained a mean of 1,408 painted turtles per harvester from 1990 to 2001. The number of turtles captured per harvester did not significantly differ from year to year (F=0.661, df=10, SS=13.772, P=0.7603).

Discussion

A correlation between number of turtles cap-

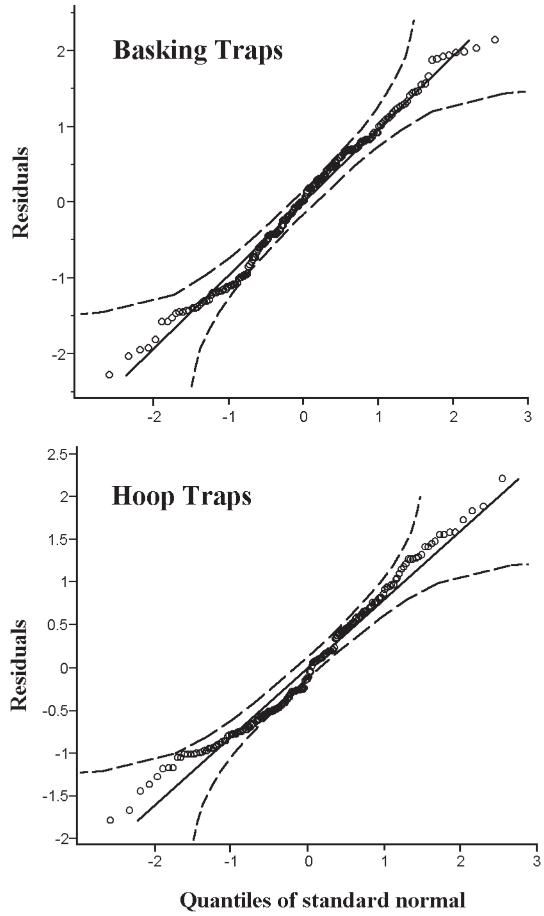

Figure 1. Normal quantile plots of residuals from multiple linear regression analyses of painted turtle catch data from 22 harvested and nonharvested lakes in central Minnesota from 2001-2002. Basking traps and hoop traps are considered separately. Residuals for both trap types are approximately normally distributed. Dashed lines indicate 95% confidence intervals.

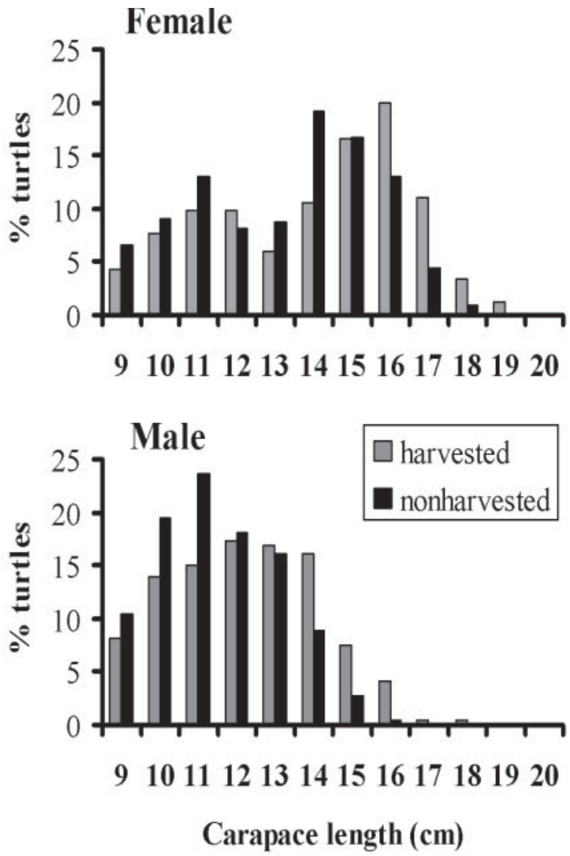

Figure 2. Pooled size distributions of male and female painted turtles captured in 12 harvested and 10 nonharvested lakes in central Minnesota from 2001–2002.

tured and harvest status indicated that commercial harvest likely has had an impact on turtle populations. However, factors other than harvest can influence number of turtles captured, and we included these in the regression model. Painted turtle populations exhibit large differences in relative abundance related to habitat quality, food productivity, pond size, and other factors, and population densities can vary by a factor of 10–20 among different populations (Zweifel 1989). We included lake size in the regression model for 2 reasons. First, larger lakes could contain more turtles as a function of their increased size. Second, trap density will be lower in larger lakes, which could potentially lower CPUE for larger lakes. We included the month effect to take seasonal catch differences into account. Basking trap efficiency, for example, should increase as turtles bask more frequently. The primary purpose of basking is thermoregulation (Boyer 1965), and turtles bask based on seasonal and reproductive energy requirements (Ream and Ream 1966, Lefevre and Brooks 1995, Krawchuk and Brooks 1998, Thomas et al. 1999). Egg development and nesting in females and mate-searching and spermatogenesis in males are energetically demanding and correlated with increased basking (Krawchuk and Brooks 1998, Thomas et al. 1999). Male turtles also are attracted to traps containing females, and both basking- and hoop-trap efficiency will increase for male turtles during periods of mate-searching activity (Cagle and Cheney 1950; Vogt 1979, Frazer et al. 1990, Thomas et al. 1999). We included effort so that differences in number of trap-hours spent on each lake would be incorporated into the regression.

Size differences in female turtles between harvested and nonharvested lakes may be related to

Table 3. Significance tests from multiple linear regression model of painted turtle catch data from 2001-2002 for 22 central Minnesota lakes. Basking traps and hoop traps were analyzed separately.

	Basking traps					Hoop traps				
Source	df	SS	MS	F	*P*	df	SS	MS	F	*P*
Harvest Status	1	12.0459	12.0459	12.5815	0.0005	1	0.0024	0.0024	0.0036	0.9522
Lake Area (ha)	1	0.1029	0.1029	0.1075	0.7434	1	0.0440	0.0440	0.0664	0.7969
Month	3	7.4280	2.4760	2.5861	0.0545	3	8.8516	2.9505	4.4568	0.0047
Trap-hours	1	32.6416	32.6416	34.0928	0.0000	1	13.8577	13.8577	20.9319	0.0000

harvester behavior. Two of the largest harvesters in Minnesota have claimed to prefer medium-sized turtles with CL of 10–16 cm (R. Campbell and B. Hedstrom, personal communication). While we could not confirm whether turtles captured outside of this initial size range were regularly released, harvester selection of mid-sized turtles could produce CL distributions consistent with our results. Harvester selection has been implicated in skewed size distributions of harvested red-eared slider populations in Louisiana, where large turtles were conspicuously absent from harvested lakes (Close and Seigel 1997). Larger red-eared sliders are more valuable in Louisiana because they are sold for food or to turtle farms as breeding stock while smaller turtles generally go into the pet trade (Close and Seigel 1997).

Size differences in female turtles between harvested and nonharvested lakes could also be related to habitat area and population density. Rowe (1997) and Iverson (1985) both found positive relationships between mean population body size and habitat area in painted turtles and mud turtles (*Kinosternon hirtipes*), respectively. Both studies found that larger turtles associated with larger habitats (e.g. larger lakes or larger river drainage systems). Iverson (1985) attributed this relationship to reduced food availability in smaller habitats limiting individual growth rates. While harvested lakes were over twice as large, on average, as nonharvested lakes, in this study we found no correlation between mean CL and lake area for either male or female turtles. A density-dependent response to harvest could also result in increased body size in harvested lakes. Reduced population density due to harvest would mean more food and space for remaining turtles resulting in increased growth. Though this possibility is plausible, we were not able to fully explore it with our data. Finally, although size differences

Table 4. Mean and maximum carapace length (CL) measurements (cm) for male and female adult painted turtles captured in 22 central Minnesota lakes (Status N = nonharvested; H = harvested) in 2001-2002.

		Female			Male		
Lake	Status	Turtles	Mean CL (SD)	Max. CL	Turtles	Mean CL(SD)	Max.CL
Bjorkland	N	19	14.4 (2.6)	17.8	43	12.9 (1.8)	15.5
Gemini East	N	15	13.7 (3.5)	18.3	16	11.2 (1.2)	13.2
Gemini West	N	22	13.8 (1.8)	18.0	34	12.5 (1.8)	16.0
Half Moon	N	15	14.7 (2.9)	18.8	46	12.2 (1.5)	15.7
Henschein	N	18	14.8 (2.4)	17.5	72	12.3 (1.6)	16.1
Lake 21	N	44	13.2 (2.7)	19.3	100	11.8 (1.8)	16.0
Maria	N	237	13.7 (2.2)	18.3	472	11.8 (1.5)	17.5
Sagatagan	N	28	13.7 (2.0)	16.0	68	12.6 (1.5)	15.4
Spurzum	N	25	13.8 (3.2)	18.5	87	12.6 (1.7)	17.5
Stumpf	N	23	15.0 (2.1)	18.0	52	11.6 (1.5)	15.9
Beaver	H	28	13.6 (1.9)	16.3	44	12.0 (1.6)	15.5
Black Oak	H	36	14.5 (3.2)	19.8	84	13.4 (1.9)	17.5
Cedar North	H	9	16.0 (1.8)	17.8	14	13.1 (1.9)	15.5
Cedar South	H	4	16.2 (1.0)	17.3	16	12.1 (2.0)	14.6
Goodners	H	16	13.7 (2.3)	17.5	25	12.6 (1.4)	15.0
Guernsey	H	17	15.0 (3.3)	18.8	36	14.4 (2.3)	18.5
Little Sauk	H	14	14.4 (3.0)	19.1	32	12.6 (2.3)	18.3
Long North	H	11	15.6 (1.4)	17.3	18	12.7 (1.6)	15.1
Long South	H	32	15.0 (2.5)	18.0	62	12.2 (1.9)	16.3
Mary	H	37	14.8 (2.5)	18.5	71	12.8 (1.5)	16.0
Pelican	H	20	13.8 (2.6)	18.5	23	11.8 (1.9)	15.2
Sylvia	H	12	15.2 (1.1)	17.3	17	12.6 (2.5)	16.0

between female turtles in harvested and nonharvested lakes were statistically significant, the differences were small (approximately 1 cm) and may not be biologically important.

Most long-term studies of painted turtle populations exhibit a 1:1 sex ratio (Ernst et al. 1994). When painted turtle sex ratios were not equal, they tended to be skewed in favor of males. The primary reason for this disparity is that males mature faster than females and therefore enter the adult cohort sooner (Gibbons 1990). Gibbons (1990) lists several other factors that can influence the perceived or actual sex ratios in turtle populations, the most relevant to this study being the sample bias associated with trapping methods. Both basking traps and hoop traps tend to catch more males because male turtles are attracted to traps already containing females (Cagle and Cheney 1950, Vogt 1979, Frazer et al. 1990). It is conceivable that male-biased commercial trapping could result in populations with seriously skewed sex ratios. We found no correlations between the count of male:female:juvenile turtles and harvest status, suggesting that harvesters, using male-biased trapping methods, have no noticeable effect on sex ratio. Another possible explanation is that revealing differences in sex ratio among lakes of different harvest status is difficult to do using male-biased methods. Multiple capture methods, including non-male-biased methods such as hand-capture (Ream and Ream 1966), should be used in future assessments of harvested turtle populations to determine whether sex ratio is indeed biased.

Juvenile painted turtle captured in central Minnesota in 2002. Small size and attractive coloration make painted turtles desireable pets.

Basking adult painted turtle about to be captured in one of our basking traps on Stump Lake, Stearns County, Minnesota.

While the total number of harvested turtles reported each year to the Minnesota DNR varied substantially, the mean number of turtles captured per harvester did not. The reasons for this apparent discrepancy were yearly fluctuations in number of harvesters filing permit returns and dramatic catch increases in 1994 and 1998. Catch increases in these 2 years primarily were due to the activities of 2 harvesters catching 17,883 and 28,000 turtles, respectively, in 1998 and 1 harvester who captured 35,000 turtles in 1994. Seventy-five percent of all harvesters reported catching <1,200 turtles per year, indicating that most of the harvest was done at a relatively small scale. Any inferences taken from these numbers should be viewed cautiously; there was evidence that some harvesters underreported their catch and not all harvesters filed yearly returns (J. Moriarty, Ramsey County Parks, personal communication).

While commercial harvest does affect relative abundance in painted turtle populations, the bigger question regarding the sustainability of Minnesota's turtle harvest is unknown. Does our data indicate the start of a trend toward declining turtle populations or just short-term fluctuations in an otherwise sustainable harvest? This is a difficult question to answer with a long-lived species in a 2-year study. In the short term, population models incorporating harvester behavior could prove useful. Long-term monitoring of harvested and nonharvested turtle populations will be required to determine, ultimately, whether harvest is sustainable. Furthermore, commercial harvest is not the only threat faced by these animals. Turtles are vulnerable to lakeshore development, subsidized predators, wetland loss, road mortality, and global climate change (Janzen 1994, Boarman 1997, Mitchell and Klemens 2000, Gibbs and Shriver 2002). More information is needed to evaluate the impact of these threats as well. For now, cautious management actions such as those taken by the Minnesota Department of Natural Resources in 2002 are warranted. The primary change made to the harvest regulations was to exclude new harvesters from obtaining commercial permits. Persons currently holding permits can continue to trap turtles, but no new commercial permits will be issued. Additional management action also may be needed. While 2 harvesters claim to adhere to self-imposed size limits, it is not clear that other harvesters follow this practice. Regulations setting a maximum size limit of 14–16 cm would be useful in maintaining adult female breeding stock. These actions, while not eliminating harvest, would limit its growth, facilitate monitoring and enforcement, and help ensure that the painted turtle remains Minnesota's most abundant turtle.

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