Intensive Alligator Harvest on Salvador Wildlife Management Area, Louisiana, 1986–1990

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Abstract: During 1986–1990 an intensive harvest of alligators was conducted on Salvador Wildlife Management Area (SWMA). A total of 4,173 alligators averaging 1.84 m total length (TL) were harvested. Hunters successfully filled all tags and completed the harvest in only 12 to 16 days. Sex ratios, size class frequency distribution (SCFD), average length, and nest production all remained consistent throughout the study. Harvest parameters (average length, sex ratios, and SCFD) differed significantly from Louisiana's statewide harvest and suggested proportional harvesting; however, none of the data examined indicated that the intensive harvest had any significant impact on the alligator population on the study area.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 46:88–97

Alligators (*Alligator mississippiensis*) historically have been harvested from Louisiana's vast coastal wetlands (McIlhenny 1935, Chabreck 1966). The apparent decline in alligator populations in the mid 1900s resulted in the closure of the alligator harvest season in 1963 (Chabreck 1967). The Louisiana Department of Wildlife and Fisheries (LDWF) began an active alligator research program in 1958, designed to evaluate the life history, ecology, abundance, and distribution of the species in Louisiana (Joanen and McNease 1973).

By 1972 alligator populations in Cameron Parish were determined to be sufficient to begin an experimental harvest (Palmisano et al. 1973). Subsequently, the season was expanded to include 1 additional parish each in 1973 and 1975, 9 additional parishes in 1979, and statewide in 1981. From 1972 to 1991, >279,096 wild alligators have been harvested in Louisiana (Joanen et al. 1984, Joanen and McNease 1991, LDWF alligator harvest stat., unpubl. data).

Harvest quotas in coastal Louisiana are based on conservative alligator popula-

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tion estimates derived by conducting coastwide annual nest counts and utilizing the methodology described by Chabreck (1966). Analysis of Louisiana harvest statistics, night counts, sex ratios, and reproductive data (Joanen 1969, Joanen and McNease 1973) resulted in development of a size class frequency distribution (SCFD) model, a population estimate, and a conclusion that McNease and Joanen (1978) underestimated alligator populations in coastal Louisiana (Taylor and Neal 1984). Addition of extensive alligator reproductive data to the Taylor and Neal (1984) model resulted in a new SCFD model and a population estimate 4 times as large as previous estimates (Taylor et al. 1991).

Taylor and Neal (1984) and Taylor et al. (1991) suggest that alligator populations are far larger than previously thought and that the harvest in Louisiana could be greatly expanded if alligators were harvested proportional to their existence in the population. To evaluate the effect of increased harvest quotas on alligator populations, the LDWF conducted an experimental harvest of alligators in September each year from 1986 to 1990 on Salvador Wildlife Management Area. Our objectives were to determine the impact of high harvest rates on 1) sex and age ratios of harvested alligators, 2) SCFD of harvested alligators, and 3) annual nest production, and to determine if this harvest could be completed within Louisiana's annual 30-day September alligator season.

This research was funded by the LDWF. We thank Mike Windham, Irvin Dares and Leroy Schouest for their assistance. We also thank Lisa Gorman for manuscript preparation and Rebecca Frederick (La. State Univ. Dep. Exp. Stat.) for statistical analysis.

Methods

Study Area

Salvador Wildlife Management Area is owned by the LDWF and is located in St. Charles Parish approximately 30 km southwest of New Orleans. The study area is comprised of 12,426 ha of freshwater marsh including natural levees, spoil banks, wax myrtle (*Myrica cerifera*) ridges, and bald cypress (*Taxodium distichum*)-tupelo gum (*Nyssa aquatic*) swamp. Common emergent plant species include maidencane (*Panicum hemitomon*), bulltongue (*Sagittaria falcata*), spikerush (*Eleocharis* spp.) and smooth beggartick (*Bidens laevis*). Approximately 19.6% (2,435 ha) of the area is water habitat comprised of deepwater canals (62.8 km, 200 ha), interior mudboat ditches, large ponds (0.3–1.2 m deep), and interior marsh ponds (<.3 m deep). Common aquatic plants include *Myriophyllum* spp., coontail (*Ceratophyllum demersum*), pondweeds (*Potamogeton* spp.), water hyacinth (*Eichhornia crassipes*), American lotus (*Nelumbo lutea*), and white waterlily (*Nymphae odorata*).

Hunter Selection

Fur trappers who had hunted alligators on SWMA since 1979 were permitted to harvest alligators from 1986 to 1990 from their current fur trapping lease. Due to

lease size and available water habitat, some hunters were assigned additional harvest areas (within SWMA) to facilitate completion of their harvest quotas. Harvest was restricted in some years by marsh water levels which prevented access and by instructions to hunters to avoid selected areas of interior marsh alligator habitat in order to limit the harvest of adult female alligators. Tags were allocated equally among 9 hunters. All harvested alligators were taken to the SWMA headquarters, measured, sexed, and then transported to a processing plant.

Harvest Quota

An average of 265 alligators (1 alligator/47 ha) was harvested on SWMA during 1979–1985. An annual harvest quota of 945 alligators (1 alligator/13 ha) was established based on 1985 Marsh Island Wildlife Refuge reproductive data (N. Kinler, D. Taylor, and G. Linscombe, unpubl. rep. 1987), a 50M:50F sex ratio, a SCFD from previous harvests, and a harvest rate derived from Taylor and Neal (1984) (Table 1). This quota was utilized each year except in 1989 when a quota of only 393 alligators was set because LDWF personnel selectively removed 552, 1.22-m–1.52-m TL alligators during March and April 1989 as part of another project.

Nest Counts

Aerial transects to estimate alligator nest production was described by Chabreck 1966. Beginning in 1986 transects were placed at 1.6-km intervals beginning 0.8 km inside the western boundary of SWMA. A Bell 206 Jet Ranger helicopter flown at a speed of 80 km/hour and an altitude of 60 m was utilized for this survey. A 107 m transect was estimated and surveyed by a single observer throughout the study period to facilitate consistency. A 6.7% sample (832 ha) was conducted annually.

Table 1. Data and calculations utilized to develop intensive harvest quotas for Salvador Wildlife Management Area, Louisiana.

Data utilized	Source of data
18.7% reproductive rate of adult females[a]	Kinler et al. unpubl. rep. 1987
533 nests (1982–1985)	SWMA nest surveys
1M:1F Sex ratio	Assumed sex ratio in population
20% harvest rate	Taylor and Neal 1984
Size class frequency distribution	Statewide harvest statistics

Calculations:

1. If 18.7% of adult females produced 533 nests; then 533 ÷ .187 = 2,850 adult females on study area.
2. If sex ratio is 1M:1F then 2,850 ÷ 0.5 = 5,700 total adults on study area.
3. 5,700 × 20% harvest rate = 1,140 tags for adults.
4. If adults comprise 80% of statewide harvest; then 1,140 ÷ 0.80 = 1,425 total tags.
5. Total tags reduced by approximately 33% due to limited data and assumptions therefore actual harvest quota = 945.

[a]≥1.83 m TL.

Data Analysis

Intensive harvest parameters were compared to Louisiana's statewide harvest and to the 1979–85 harvest on SWMA (LDWF alligator harvest stat., unpubl. data). Chi-square test of homogeneity was used to evaluate age and sex ratio data (Johnson 1984). Alligator length from within the study period were compared with a *t*-test, while ANOVA was used to compare mean hide lengths (Steel and Torrie 1960). Variations in SCFD were analyzed with Chi-square analysis, Komogorov-Smirnov 2-sample test, and Kruskal-Wallis 1-way analysis of variance by ranks (Siegel and Castallan 1988). Regression analysis was used to evaluate trends in estimated nest production on the study area (Steel and Torrie 1960).

Results and Discussion

Hunter Success

From 1986–90, 4,173 alligators were harvested from SWMA. Hunters were able to complete each harvest in a 12–16 day period and utilized all allocated tags. Hunter success in the statewide harvest averaged 96.7% during this period (Joanen and McNease 1991).

Age and Sex Ratios

Sex ratios of all harvested alligators on SWMA during 1986–90 was 64M:36F as compared to 74M:26F in the statewide harvest reported by Joanen et al. (1984) (Table 2). Adult (≥1.83 m TL) sex ratios was 72M:28F and did not vary among years (X^2 = 1.197, 4 df. P = 0.879). Immature sex ratio averaged 58M:42F, and varied among years (X^2 = 23.510, 4 df, $P < 0.01$) but did not demonstrate an increasing trend toward a particular sex class. Joanen et al. (1984) reported an adult and immature sex ratio of 77M:23F and 66M:34F, respectively, in the statewide harvest. With the increased harvest rates on SWMA during 1986–90, sex ratios of harvested alligators were less skewed toward males than in the statewide harvest (X^2 = 85.194, 1 df, $P < 0.01$).

Of the 4,173 alligators harvested on SWMA, immatures (<1.83 m TL) comprised 56% (Table 2). Age ratio varied among years (X^2 = 25.799, 4 df, $P < 0.01$) and approached 50A:50I during 1989 when only 393 alligators were harvested. In the statewide harvest immatures comprised only 24% of the 1986–90 harvests (Joanen et al. 1984). Taylor and Neal (1984) and Taylor et al. (1991) indicated that the vast majority of the alligators in the wild are in the immature sizes. More specifically the 1.22 m and 1.52 m TL classes are more abundant than the entire adult segment of the population. As harvest rates are increased, the immature segment of population must contribute heavily to the harvest so that the adult segment of the population is not adversely impacted.

Average Length

Total length of alligators harvested during 1986–90 on SWMA averaged 1.84 m ± 0.01 m (mean ± SE) (N = 3,585). Mean TL in 1989 was significantly greater (P

Table 2. Percent of harvested alligators by sex and age from Salvador Wildlife Management Area, Louisiana, 1986–90.

	Year of Harvest					
Age/Sex class	1986	1987	1988	1989	1990	1986–90
Adults[a]	39	47	44	51	40	44
Immature	61	53	56	49	60	56
Females	34	32	38	32	40	36
Males	66	68	62	68	60	64
Adult females	25	27	29	29	28	28
Adult males	75	73	71	71	72	72
Immature females	40	37	45	34	48	42
Immature males	60	63	55	66	52	58
Total harvest[b]	945	945	945	393	945	4,173

[a]≥1.83 m TL
[b]In 1986, sex and age was determined for only 370 alligators.

≤ 0.05) than in 1990 and can be attributed to the reduced harvest imposed that year (Fig. 1). No difference in average TL occurred during the years when 945 alligators were harvested.

Mean hide lengths from alligators harvested from SWMA during 1979–85, SWMA during 1986–90, and statewide during 1986–90 were compared using analysis of variance. Mean hide length for alligators harvested on SWMA during 1979–85 (2.19 m TL, N = 1,601) and for those harvested statewide during 1986–90 (2.19 m TL, N = 114,497) were greater ($P \leq 0.05$) than those harvested on SWMA during 1986–90 (1.92 m TL, N = 4,018). Harvest rates for SWMA from 1979–85 were developed in the same manner as those for the standard statewide

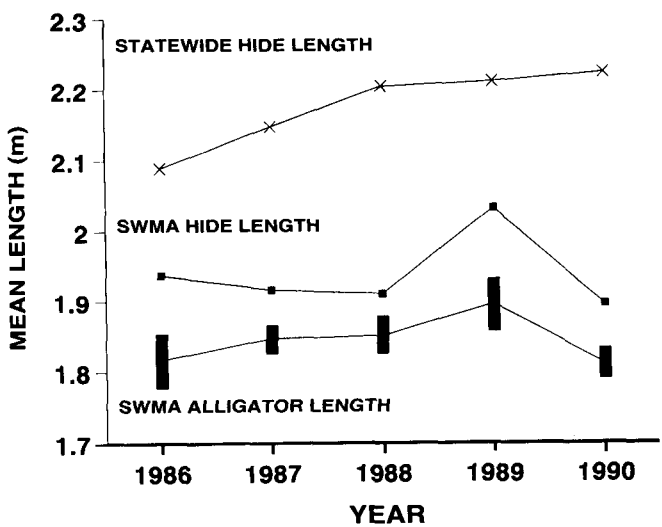

Figure 1. Mean total length (± 95% CI) of alligators harvested from Salvador Wildlife Management Area and mean length for alligator hides from Salvador Wildlife Management Area and statewide harvest, Louisiana, 1986–90.

harvest. The 0.27 m decrease in average length during SWMA intensive harvest is due to the increased harvest of alligators in the 1.22 m–1.83 m TL size classes.

Size Class Frequency Distribution

During the intensive harvest, the proportion of alligators in each size class changed from year to year (X^2 = 53.6, 4 df, $P < .01$) (Table 3). Variation in the 0.91–1.83-m TL class contributed the most to the overall Chi-square value. These classes also comprised 84.5% of the total alligators harvested. Additional analyses were conducted to determine the significance of variation in SCFD. A Kruskal-Wallis 1-way analysis of variance by ranks indicated that there was no significant difference in SCFD between years (X^2–1.83, 4 df, P = 0.7669). Additionally we partitioned the SCFD into 4 groups (1986, 1987, 0.91–1.83 m TL; 1986, 1987, 2.44–3.35 m TL; 1989, 1990, 0.91–1.83 m TL; 1989, 1990, 2.44–3.35 m TL) and conducted a Chi-square analysis on these groups. No difference was found (X^2 = 0.142, 1 df, P = 0.706), indicating that there was no change during the intensive harvest in the ratio of adults to immatures in 1986–87 versus 1989–90; therefore, indicating no population change (Taylor and Neal 1984, Taylor et al. 1991).

The SCFD of the alligator hides harvested on SWMA 1986–90 was compared to the SCFD of hides harvested on SWMA 1979–85 and statewide during 1986–90. A Kolmogorov-Smirnov 2-sample test used the cumulative frequency distribution of the number of alligator hides in each size class to evaluate the independence of the SCFD from each harvest. As expected, the intensive harvest on SWMA 1986–90 resulted in a SCFD different from either the harvest on SWMA 1979–85 or the statewide harvest 1986–90 ($P \leq 0.01$). The differences result from the harvesting of alligators on SWMA during 1986–90 more in proportion to their presence in the population as compared to the 1979–85 SWMA or 1986–90 statewide harvests (Fig. 2). These SCFD's were converted to reflect SCFD's of harvested alligators per 100 adults by summing the number of alligator hides ≥1.83 m TL and then calculating

Table 3. Size class frequency distribution(%) of alligators harvested from Salvador Wildlife Management Area, Louisiana, 1986–90.

	Year of Harvest					
Size class (m)	1986	1987	1988	1989	1990	1986–90
0.91	1.4	0.4	0.5	0.8	0.4	0.6
1.22	16.5	10.9	15.7	9.9	13.9	13.4
1.52	42.7	41.4	39.7	37.9	45.6	41.8
1.83	24.9	32.2	26.1	32.6	27.6	28.7
2.13	5.9	9.3	8.9	10.9	6.9	8.4
2.44	4.1	3.2	4.3	3.8	2.9	3.6
2.74	4.1	2.0	3.1	1.3	1.6	2.3
3.05	0.5	0.5	1.3	2.3	1.0	1.0
3.35	0.0	0.1	0.4	0.5	0.2	0.3
N	370	945	945	393	945	3,598

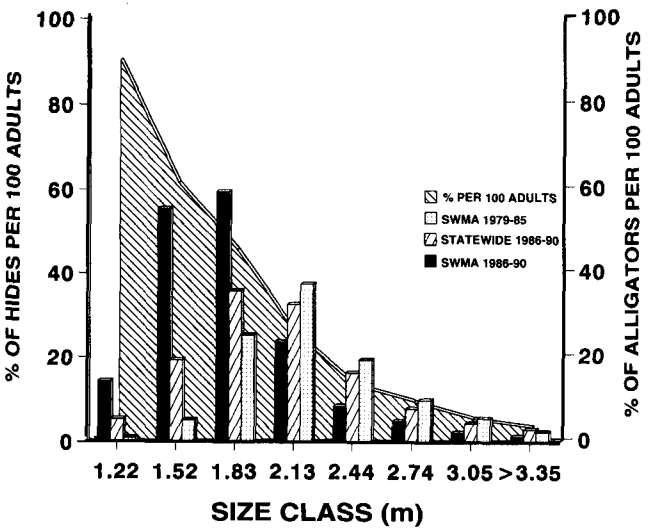

Figure 2. Size class frequency distribution of alligator hides per 100 adults harvested from Salvador Wildlife Management Area 1979–85 and 1986–90 and statewide 1986–90, compared to Taylor et al. (1991) population model. Note distinction of percent of hides for harvest data and percent of alligators for population model.

a percentage for each size class. These new SCFD's were plotted with a SCFD of alligators per 100 adults from a population model developed by Taylor et al. (1991) (Fig. 2). Although we are contrasting percent of hides per 100 adults (≥1.83 m TL) versus percent of alligators per 100 adults, Figure 2 demonstrates the availability versus utilization of alligators in various size classes and the increased harvest from the 1.22–1.83 m TL size classes during the intensive harvest. Even with the increased harvest, the 1.22 m class is still underrepresented in the harvest.

Due to variation in alligator hide prices in recent years (higher prices paid for hides ≥2.13 m TL), there was concern that increased harvest rates would reduce the number of ≥2.13 m TL alligator hides in the harvest, thereby reducing overall value of the harvest. SCFD analysis indicated that the SWMA 1979–85 harvest produced 187 alligator hides ≥2.13 m TL (70.6% of 265) annually, while the SWMA 1986–90 produced 197 alligator hides ≥2.13 m TL (23.6% of 835) annually. The intensive harvest strategy produced similar numbers of alligator hides ≥2.13 m TL while simultaneously producing 638 additional alligators as compared to 78 for the SWMA 1979–85 harvest, thereby significantly increasing the economic return of this renewable resource.

Nest Counts

Estimates of nest density on SWMA during 1986–90 varied from 1 nest per 23.8–39.6 ha ($\bar{x}$ = 29.9) (Table 4). An average of 414 nests were produced annually. A regression analysis indicated that the annual estimate of nests present did not change during the study period (r^2 = 0.0016, F = 0.006, P = 0.9405).

Table 4. Estimates of nest production on Salvador Wildlife Management Area, Louisiana, 1986–90.

Year	Nests counted	Ha per nest	Total nests
1986	28	29.7	417
1987	32	26.0	476
1988	21	39.6	312
1989	23	36.2	343
1990	32	23.8	521
1986–90 Average	27.8	29.9	414

Management Implications

The intensive harvest of 4,173 alligators from SWMA during 1986–90 produced harvest parameters that differed dramatically from the annual statewide alligator harvest in Louisiana. Since Louisiana renewed its alligator harvest program in 1972, these harvest parameters have remained relatively constant. During this study harvest sex ratios were less skewed, average length decreased, proportion of immature alligators in the harvest increased and the SCFD indicated an increase in the harvest of alligators in the 1.22–1.83-m TL classes as compared to the statewide harvest. Estimates of nest production on the study area did not vary statistically during 1986–90. It is obvious that a significant variation in harvest strategy (increasing harvest rate threefold) would result in changes in harvest statistics, but the more accurate measure of impact on the population should be determined by review of results from within 1986–90. Within the study period, these harvest parameters generated by this intensive harvest remained consistent therefore reflecting no impact on the alligator population within the study area.

Taylor and Neal (1984) and Taylor et al. (1991) demonstrated that the majority of the alligator population in Louisiana is within the immature size classes and that the majority of the harvestable size ($\geq$1.22 m TL) alligators are in the 1.22–1.83-m TL classes. As harvest rates are increased, these segments of the population must be targeted to avoid impacting the $\geq$2.13 m TL males which currently are the most common size and sex group harvested during the statewide harvest. This intensive harvest demonstrates that alligator harvest rates can be increased without impacting populations using current tagging methods. However, in order to achieve a more optimum harvest, a size specific harvest strategy should be developed in order to harvest alligators in proportion to their occurrence in the wild. Estimates of mortality rates by sex and size class would allow for development of harvest strategies that would maximize resource utilization and protect any particular segment of the alligator population from overharvest. Implementation of such a harvest strategy would require allocation of tags for specific segments of the population. Variations in current harvest techniques including altering fishing methods and night-time live capturing or shooting would need to be evaluated and implemented to accomplish a size specific harvest. The ramification of changes in harvest techniques on hunters and landowners would require investigation and be subject to public review. Pro-

mulgation of new regulations would involve approval of state and federal regulatory agencies. Proportionally harvesting all segments of the alligator population would increase the economic value of this renewable natural resource thereby providing landowners economic incentive to maintain wetland habitat with alligators and other fish and wildlife species.

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