Effects of Seismic Operations on Louisiana's Nesting Bald Eagles

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Abstract: Schlumburger Geco-Prakla (SGP) conducted seismic operations in St. Mary and Terrebonne parishes of Louisiana, between October 1997 and March 1998. This area is located on the marsh-swamp interface and contains approximately 40% of the state's nesting bald eagles *(Haliaeetus leucocephalus).* The Louisiana Department of Wildlife and Fisheries and the U.S. Fish and Wildlife Service used spatial buffer zones with a 460-m radius to protect all eagle nests located on properties of the SGP seismic operations. Bald eagle production during seismic operations (1998) was compared to the previous season (1997) and the following season (1999). Production did not differ (P=0.85) for the interaction between year and area (seismic affected nests/non-seismic affected nests). Experimental airboat disturbances were used in the 1998 and 1999 nesting seasons to evaluate flush response at distances closer than 460 m. Flush response increased as the distance from an airboat to a nest tree decreased. About half of the bald eagles (0.49) flushed when an airboat approached within 230 m of their nest tree. Considerably fewer eagles (0.17) flushed when approached to within 310 m of their nest tree. The authors feel that a reduction in the primary protection zone radius from 460 m to 310 m is an appropriate recommendation for the southern portion of Louisiana. There was no detectable impact of SGP seismic operations on nesting bald eagles.

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Until recently, the population of bald eagles in Louisiana was not quantitatively known. Bald eagles were reported as common residents of the state in the early part of the century (Bailey 1919, Oberholser 1938). Lowrey (1974) indicated lower numbers were present in the middle part of the century. This decrease in population was similar to other regions of the country and coincided with adverse effects of DDT on numerous avian species (Broley 1958). In addition to DDT and subsequent eggshell thinning, many factors such as habitat destruction and human influence contributed to declining populations in the 1960s and 1970s (Dugoni 1980). In 1984, the Louisiana Department of Wildlife and Fisheries (LDWF) initiated formal bald eagle surveys and documented 18 active nesting territories. By winter 1992–93, 80 active nests were documented (Hess et al. 1994), and presently there are 135 active nesting territories in the state (Hess 1998).

Over the past decade the Louisiana coast has been undergoing widespread 3-D seismic survey (oil and gas exploration) efforts. 3-D seismic surveys involve placing thousands of underground charges and receivers (both 70 m apart) in a grid pattern to create a 3-D image of sub-surface geology. Placement of these charges in coastal wetlands requires large-scale operations utilizing as many as 50 airboats per operation. Schlumberger Geco-Prakla (SGP) conducted seismic operations in Terrebonne and St. Mary parishes of Louisiana between October 1997 and April 1998. Approximately 40% of Louisiana's active bald eagle nesting territories are located in this area (Hess 1998). Airboats temporarily displace species such as waterfowl (Mabie 1985) and endangered whooping cranes *(Grus americana)* (Mabie et al. 1989). Concerns that activity associated with seismic operations, primarily high concentrations of airboat traffic, may disturb nesting bald eagles arose. The United States Fish and Wildlife Service (USFWS) and LDWF mandated 460-m protection zones around all active bald eagle nests located on lands covered by the SGP seismic operation (1997–1999).

The use of spatial buffer zones is a common management tool for protecting raptors from human disturbance (Richardson and Miller 1997). The Southeastern Bald Eagle Recovery Plan recommends that primary protection zones (spatial buffer zones) with a 460-m radius be maintained around active nests (USFWS 1989). Recommended spatial buffer zones for bald eagles range from 250 m (Grier et al. 1983) for egg laying and incubation and 800 m (Richardson and Miller 1997) for brood rearing. Many studies have evaluated human disturbance on nesting bald eagles (Mathisen 1968, Stalmaster and Newman 1978, Fraser et al. 1985, Buehler et al. 1991). However, no studies have evaluated the effect of airboat traffic on bald eagle production, nor have any experimentally quantified flush distances to airboats as a tool for setting spatial buffer zones. The effects of human disturbance on nesting bald eagles in Louisiana also have not been examined. The objectives of our study were to: (1) evaluate the impact that the SGP seismic operation had on bald eagle production in the 1998 nesting season by comparing it to productivity in years without seismic operations, and (2) experimentally evaluate flush response of bald eagles to airboats.

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Methods

Nesting Production

LDWF conducted surveys of bald eagle nesting territories between 1997–1999. The 1996–97, 1997–98, and 1998–99 nesting seasons were defined as 1997, 1998, and 1999, respectively, for this research. Surveys using helicopters and fixed wing aircraft were flown at least twice during each nesting season. The first flights in late January were used to locate active nest territories. February flights were used to calculate fledgling (young adults ≥8 weeks) production. Nesting territories were defined as active if 1 or more adult bald eagle was present, and as successful if 1 or more fledglings were produced. Methods were previously described by Hess et al. (1994).

All nests located in the area of the 1997–1998 SGP seismic operation were used to calculate production for the seismic-affected area (SAA) in each of 3 nesting seasons. Although 1998 was the only year in which the SAA was exposed to the SGP seismic operation it was defined as such for all 3 nesting seasons for the purpose of this analysis. All nests located in the 5-parish area surrounding the SGP seismic operation were used to calculate production for the non-affected area (NAA). The NAA area included all nests in Assumption, Lafourche, and lower St. Martin parishes, as well as all nests in St. Mary and Terrebonne parishes not located on SGP seismic operation. Production (mean number of fledglings per active territory) was compared for each of the 3 nesting seasons between areas (Table 1). A 2-way analysis of variance (ANOVA), factors (area and year) was performed to compare mean fledgling production of all nests in the SAA to the NAA for the 1997, 1998, and 1999 nesting seasons. SAS (Proc glm) with type III sum of squares was used for the analysis (SAS Inst. Inc. 1990). An alpha of 0.20 was used for critical level.

Table 1. Comparison of Louisiana bald eagle production between seismic affected (SAA) and non-seismic affected areas (NAA), for the 1997, 1998, and 1999 nesting seasons.

	SAA			NAA		
	1997	1998a	1999	1997	1998	1999
N nest active	6	11	9	76	78	65
N nest successful	6	8	9	65	59	62
N young fledged	11	15	17	103	85	97
Production[b]	1.83	1.36	1.89	1.36	1.09	1.49

a. Geco-Prakla seismic prospect. b. Production = *N* young fledged/*N* active nests.

Flush Response

1998 Experiments.—We conducted experimental airboat disturbances to evaluate eagle flush response to airboats approaching closer than 460 m. Experiments were conducted from early February to late March of the 1998 nesting season on 6 bald eagle nests located on the SGP seismic operation. In early February Global Positioning System (GPS) was used to place a marker pole approximately 230 m from each nest tree. Airboats were driven up to the marker pole on 3 separate runs during a 3-hour period. Passes were spaced approximately 30 minutes apart. Nests were not approached more than 3 times on any given day. A total of 98 approaches were conducted.

Each of 3 different types of approaches, direct approach with stop (DS), tangential approach with stop (TS), and tangential pass without stop (TP), was used during a 3-hour experimental period. During the DS and TS, an airboat was driven to the marker pole and stopped for approximately 30 seconds before it left tangentially. During TP approaches, an airboat was driven by the marker pole without stopping. The sequential order of the 3 different approaches was randomized within each 3-hour period. All 3 runs were attempted regardless of whether an eagle flushed on the first or second runs.

We used chi-square tests to compare flush proportions for all first, second, and third runs, and a separate chi-square test to compare flush proportions for DS, TS, and TP. Chi-square tests were performed in MS Excel. An alpha of 0.20 was used for critical level.

1999 Experiments.—We conducted experimental airboat disturbances again during the 1999 nesting season, but procedures differed from the previous year. We made 1 experimental run on 15 different nest trees in December 1998 (during the incubation period) and 20 different nest trees in January 1999 (during the brood rearing period). In addition to nests located on the area of the 1998 SGP seismic operation, nests in adjacent wetlands were also approached. GPS units with real time differential correction were used to position an airboat >460 m away from each nest. GPS was used to navigate the airboat directly toward each nest in 70-m intervals. Between each 70-m run, the airboat was stopped (engine running) for 30 seconds. Each nest was approached until at least 1 eagle flushed or obstructing terrain prevented closer approach.

Table 2. Number and proportion of flushes observed for 3 different airboat approaches (230 m) in the 1998 nesting season

	Type of approach			
	DS[a]	TS	TP	Total
Caused flush	7	6	0	13
No flush	31	21	33	85
Proportion flushed	0.18	0.22	0	0.13

a. DS = direct approach with stop, TS = tangential approach with stop, TP = tangential approach without stop.

Comparison Between 1998–1999 Experiments.—We compared the proportion of airboat runs that caused a flush at or before an airboat approached within 230 m for the 1998 and 1999 experiments. Only January (brood rearing) runs of the 1999 experiments were used for comparison since all experiments in 1998 were during brood rearing. A Chi-square test of binomial proportion for 1998 and 1999 experiments was performed. An alpha of 0.20 was used for critical level.

Results

Nesting Production

Production on the SAA and NAA was lower in 1998 than in 1997 and 1999 ($P=0.02$) (Table 1). Mean fledgling production was greater on the SAA than the NAA ($P=0.01$) in all years. The interaction between year and area was not significant ($P=0.85$).

Flush Response

1998 Experiments.—Flush proportion did not differ among first, second, and third runs in the 1998 nesting season ($P=0.48$). Flush proportions differed among type of approach (DS, TS, and TP) during the 1998 nesting season ($P=0.02$) with proportion for TP approaches much lower than those for DS or TS (Table 2). On average 13% of eagles flushed as airboats approached within 230 m (Table 3).

1999 Experiments.—Mean flushing distance was 196.4 m and 239.65 m for December and January airboat disturbances, respectively. In 1999, we detected a steady increase in flush proportion as nests were approached (Table 4). This increase in flush proportion occurred during December (incubation) as well as January (brood rearing) experiments.

Comparison Between 1998–1999 Experiments.—Since no difference was detected between first, second, and third runs, we assumed they were independent and pooled data from all 3. However, since runs differed by approach and there were no flushes recorded for TP, only DS and TS were used for the comparison. In addition there were no passing approaches in 1999; therefore, TP from 1998 are not comparable. The proportion of runs (230 m) resulting in flushes was much higher ($P<0.01$) in 1999 (0.55) than in 1998 (0.20).

Table 3. Number and proportion of flushes observed for first, second, and third airboat runs (230 m) in the 1998 season.

	Sequential order of run			
	1st	2nd	3rd	Total
Caused flush	7	4	2	13
No flush	32	29	24	85
Proportion flushed	0.18	0.12	0.08	0.13

Table 4. Cumulative number (and cumulative proportion) of flushes observed for varying distances of airboat approaches during the 1998–1999 nesting season.

	FAB[a] 460 m	FAB 310 m	FAB 230 m	FC[b] 230 m	No Flush[c]
Dec 98	0 (0)	2 (0.13)	6 (0.40)	12 (0.80)	3 (0.20)
Jan 99	2 (0.10)	4 (0.20)	11 (0.55)	20 (1.00)	0

a. FAB = flushed at or before airboat approached within 460 m, 310 m, 230 m of nest tree.

b. FC = flushed when airboat approached closer then 230 m from nest tree.

c. No flush column does not represent cumulative flushes or proportions.

Discussion

Data Analysis

One problem we encountered was the inability to achieve a large sample size of nests on the treated area, which made it difficult to detect important differences at the commonly accepted alpha of 0.05. Accordingly we used an alpha level of 0.20 which increases the probability of a type I error (rejecting a true null hypothesis) with the advantage of decreasing the probability of a type II error (failing to reject a false null hypothesis). Since failure to detect a real decline in productivity would lead to actions detrimental to bald eagle populations, we made an *a priori* decision to err on the conservative side. There were 2 years of experimental flush data and 3 years of production data; however, there was only 1 year of SGP seismic operation. Consequently, the interaction between year and location is the important test. Although an alpha of 0.20 was used for critical levels in all test statistics, exact probabilities are presented.

Nesting Production

We found that overall fledgling production was lower in 1998 than in 1997 and 1999. Although we can only speculate, the reduction in production was not limited to the SAA and is likely related to a year-specific cause such as inclement weather conditions or food availability. The lack of a significant interaction between year and area indicates that the patterns were similar between areas in all 3 years. Consequently, we have no evidence to suggest that the SGP seismic operation affected productivity of nesting bald eagles. Nesting bald eagles in south Louisiana frequently are exposed to high levels of boat and helicopter traffic associated with the oil and gas industry. We believe that bald eagles in this region are highly habituated to traffic and will tolerate disturbance levels not tolerated in other regions.

A major concern before our study was initiated was whether eagles starting new nests would be deterred from doing so on areas of SGP seismic operations, and concomitantly whether we could detect such a response. We made an interesting anecdotal observation very early in the study documenting the presence of a cane marker pole being used in the construction of a new nest. The marker pole with flagging had previously been used to designate the 460-m buffer zone around an adjacent nest located 400 m away. In addition to the nest with the marker pole, 3 nests, which constituted 3 new territories, were constructed during SGP seismic operations. The number of active territories located on the area of the SGP seismic operation increased from 6 in 1997 (prior to seismic) to 11 in 1998 (during seismic operations). These observations indicated that eagles were not deterred from establishing new nests during the SGP seismic operation.

Flush Response

1998 Experiments.—In the 1998 experiments TP approaches caused no flushes; however, 20% of TS and DS approaches combined caused flushes (Table 2). This difference suggests that nesting bald eagles in Louisiana may tolerate passing airboat traffic at a much greater rate than stop-start traffic. Accordingly, we recommend that airboats maintain a constant speed when in close proximity to a bald eagle nest.

1999 Experiments.—Flushing distances were consistent with others such as Buehler et al. (1991) who reported mean flushing distance of 215 m to approaching boats. Stalmaster (1998) reported mean flushing distances of 237 m, 197 m, and 152 m for fishing, research, and viewing boats respectively. Others have reported flushing distances for non-motorized boats ranging from 150 m to 267 m for perched and ground feeding eagles respectively (Knight and Knight 1984).

Comparison Between 1998–1999 Experiments.—When an airboat approached within 310 m, bald eagles flushed at significantly higher rates in 1999 than in 1998 (0.55 and 0.20, respectively). Nesting eagles in 1998 experienced a higher level of airboat traffic (SGP seismic operation) than those nesting in 1999. This high level of disturbance prior to the experimental runs may explain the lower flush rate in 1998. The experimental runs in 1999 probably were the first and only airboat traffic that the majority of nests were exposed to that year. Thus, we believe that bald eagles were more habituated to airboat traffic in 1998 than in 1999.

At 230 m from nests a substantial proportion (0.49) of bald eagles flushed in response to experimental airboat disturbances. At 310 m considerably fewer flushes (0.17) were observed. Previous recommendations for spatial buffer zones have ranged from 250 m to 800 m (Stalmaster and Newman 1978, Knight and Knight 1984, Fraser et al. 1985, Stalmaster and Kaiser 1997, 1998). Effective spatial buffer zones must be administered on a site specific basis as individuals react differently (Richardson and Miller 1997). We recommend a reduction of the primary protection zone from 450 to 310 m for the southern portion of Louisiana. Spatial buffer zones of 310 m would provide protection from disturbance for >80% of all nesting eagles within this region. While we feel this research has valuable management implication for the entire southeastern region of the United States, we must stress that there was no replication of seismic activity and we can only make inferences about the SGP seismic operation (1998).

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