WHAT DOES NOISE AFFECT?

Studies on the effects of overflights and sonic booms on wildlife have been focused mostly on:

- birds
- **ungulates** (hoofed animals) such as caribou and bighorn sheep

Few studies have been conducted on:

- marine mammals
- small **terrestrial** mammals
- reptiles
- amphibians
- carnivorous mammals

Generally, species that live entirely below the surface of the water have also been ignored. This is because they do not experience the same level of sound as terrestrial species (National Park Service 1994). Wild ungulates appear to be much more sensitive to noisedisturbance than domestic livestock (Manci, et al. 1988). This may be due to previous exposure to disturbances. One common factor appears to be that low-altitude flyovers seem to be more disruptive in terrain where there is little cover (Manci, et al. 1988).

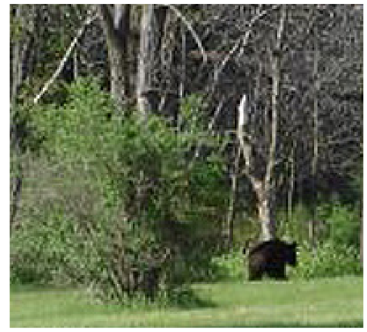
Mammals

Terrestrial Mammals

Studies of terrestrial mammals have shown that noise levels of 120 dBA can damage mammals' ears. Levels at 95 dBA can cause temporary loss of hearing sensitivity. Noise from aircraft has affected other large carnivores by causing changes in:

- home ranges
- foraging patterns
- breeding behavior

One study (Dufour 1980) recommended that aircraft not be allowed to fly at altitudes below 2,000 feet above ground level over important grizzly and polar bear habitat. Wolves have been frightened by low-altitude flights that were 25 to 1,000 feet off the ground. However, wolves have been found to adapt to aircraft overflights and noise (Dufour 1980).



Wild ungulates (American bison, caribou, bighorn sheep) appear to be much more sensitive to noise disturbance than domestic livestock (Weisenberger, et al. 1996). Behavioral reactions may be related to the past history of disturbances by such things as humans and aircraft.

A common reaction of reindeer kept in an enclosure exposed to aircraft noise was a slight startle response. This included raising of the head, pricking ears, and scenting of the air. Panic reactions and extensive changes in behavior of individual animals were not observed.

Caribou in Alaska exposed to fixed-wing aircraft and helicopters showed running and panic reactions when overflights were at an altitude of 200 feet or less. The reactions decreased with increased altitude. In fact, the panic reactions stopped with more than 500 feet in altitude. Also, smaller groups reacted less strongly than larger groups.

One negative effect of the running and avoidance behavior is increased energy use. For a 90-kg animal, the calculated energy usage due to aircraft harassment is 64 calories/minute when running. It is 20 calories/minute when walking. When conditions are favorable, this expenditure can be counteracted with increased feeding. However, during harsh winter conditions, this may not be possible.

Observations of wolves and bears exposed to fixed-wing aircraft and helicopters in the northern regions suggested that:

- wolves are less disturbed than wild ungulates
- grizzly bears showed the greatest response of any animal species observed

It has been proven that low-altitude overflights do induce stress in animals. Increased heart rates have been found in:

- pronghorn antelope
- elk
- bighorn sheep

Such reactions also occur naturally in response to predators. Therefore, infrequent overflights may not be detrimental. However, frequent flights over a long period of time may cause harmful effects. Aircraft disturbance itself may not cause obvious and serious health effects. However, it may have an adverse impact when combined with harsh winters.

Research has shown that stress caused by other types of disturbances produces long-term decreases in metabolism and hormone balances in wild ungulates. Responses can range from mild to severe. Mild responses include:

- head raising
- body shifting
- turning to orient toward the aircraft

Moderate disturbance may be nervous behaviors, such as trotting a short distance. Escape is the typical severe response.

Marine Mammals

Marine mammal ears adapt to their water environment. Their ears are different from those of land animals, particularly in the **auricle** and **middle ear** (Manci, et al. 1988). Some marine mammals use **echolocation** to identify objects and determine the direction and location of sound sources (Simmons 1983 in Manci, et al. 1988).

In 1980, the Acoustical Society of America held a workshop (Acoustical Society of America, 1980). Its purpose was to assess the potential hazard of manmade noise from Alaskan Arctic petroleum operations on marine wildlife. It also was to prepare a research plan that would properly assess noise impacts.

Since 1980, research on responses of aquatic mammals to aircraft noise and sonic booms has been limited. Research was conducted on:

- northern fur seals
- sea lions
- ringed seals

It indicated that there are some differences in how various animal groups receive frequencies of sound. They exhibited varying intensities of a startle response to airborne noise. The mammals adapted to the noise over time. This varied with species, populations, and demographics (age, sex). Time of day of exposure was also a factor (Muyberg 1978 in Manci, et al. 1988).

Studies were also done near the Channel Islands. The location was near the area where the space shuttle launches occur. There were some response differences between species relative to the loudness of sonic booms. Booms that were between 80 and 89 dBA caused a greater intensity of startle reactions than those at 72 to 79 dBA. However, the duration of the startle responses to louder sonic booms was shorter (Jehl and Cooper 1980 in Manci, et al. 1988).

For **pinnipeds** (Jehl and Cooper 1980), the most disturbing things were :

- low-flying helicopters
- loud boat noises
- humans

The space launch and associated noises were not found to have a measurable effect on the pinnipeds. However, the research also suggested that there was a greater "disturbance level" during launch activities. Continued observations for behavioral effects and long-term population monitoring were recommended (Jehl and Cooper 1980).

Continuous single or multiple noise sources could cause marine mammals to leave a preferred habitat. However, it does not appear likely that overflights could cause migration from suitable habitats. This is because aircraft noise over water is mobile. It would not persist over any particular area.

Aircraft noise, including supersonic noise, occurs overwater in Eglin, Tyndall, and Langley Air Force Bases. The source is mainly jet aircraft. Survey results indicate that dolphins are present under all of the Eglin and Tyndall marine airspace. Their presence indicates that aircraft noise does not discourage use of the area. It also does not apparently harm the local population (Davis, et al. 2000).

A National Park Service summary (National Parks Service 1994) determined that:

- **gray whales** and **harbor porpoises** showed no outward behavioral response to aircraft noise or overflights
- **bottlenose dolphins** showed no obvious reaction in a study involving helicopter overflights at 1,200 to 1,800 feet above the water
    - they also showed no reaction to survey aircraft unless the shadow of the aircraft passed over them, at which point there was some observed tendency to dive (Richardson, et al. 1995).

Other noises in the marine environment from ships and pleasure craft may have more of an effect on marine mammals than aircraft noise (U.S. Air Force 2000). The noise effects on **dolphins** appear to be somewhat eased by the air/water boundary. The dolphins along the coast of California have been exposed to sonic booms from military aircraft for many years. They appear to not have experienced any harmful effects (Tetra Tech, Inc. 1997).

Manatees appear relatively unresponsive to human noise. They are often suspected of being deaf to oncoming boats. However, their hearing is actually similar to that of pinnipeds (Bullock, et al. 1980). Little is known about the importance of acoustic communication to manatees. However, they are known to produce at least ten different types of sounds. They are also thought to have sensitive hearing (Richardson, et al. 1995).

Manatees continue to occupy canals near Miami International Airport. This suggests that they have adapted to human disturbance and noise (Metro-Dade County 1995). In addition, manatees spend most of their time below the surface and do not startle readily. So, no effect of aircraft overflights on manatees would be expected (Bowles, et al. 1991).

Birds

Research on birds indicates that their hearing sensitivity falls between that of reptiles and mammals. Within the range of 1 to 5 kHz, their hearing sensitivity is similar to that of the more sensitive mammals (Dooling 1978). In contrast to mammals, bird sensitivity falls off at a greater rate to increasing and decreasing frequencies. Aircraft bird strikes indicate that birds nest and forage near airports. Aircraft noise in the vicinity of commercial airports apparently does not inhibit bird presence.

High-noise events may cause birds to engage in escape or avoidance behaviors. For example, they may flush from perches or nests (Ellis, et al. 1991). These activities cost energy. So, they may affect survival or growth. In addition, the birds may spend less time engaged in necessary activities like:

- feeding
- preening
- caring for their young

This is because they spend time in noise-avoidance activity. However, the long-term impact of noise is less clear.

Songbirds were observed to become silent prior to the onset of a sonic boom event (F-111 jets). This was followed by "raucous discordant cries." There was a return to normal singing within 10 seconds after the boom (Higgins 1974 in Manci, et al., 1988). Ravens responded by:

- calls of protest
- wing flapping
- soaring

Some territorial songbirds (**passerines**) experience reduced reproduction after exposure to low-altitude overflights (Manci, et al. 1988). However, they are not driven any great distance from a favored food source by a nonspecific disturbance (U.S. Forest Service 1992). Further study may be needed.

The DoD and the USFWS recently studied (Pater, et al. 1999) the response of the **red-cockaded woodpecker** to military training noise events, including:

- artillery
- small arms
- helicopter
- maneuver noise

The woodpecker successfully adjusted to these events. Depending on the noise level, the birds responded by flushing from their nest cavities. When the noise source was closer and the level higher, the flushes increased. In all cases, however, the birds returned to their nests within a relatively short period of time. Also, the noise exposure did not cause death or a decline in reproduction (Pater, et al. 1999). The woodpeckers did not flush when artillery simulators were more than 122 meters away. **SEL** noise levels were 70 dBA.

Another study looked at nesting and brooding **eastern wild turkeys** in Alabama (Lynch and Speake 1978). They were exposed to real and simulated sonic booms. Hens at four nest sites were subjected to between 8 and 11 combined real and simulated sonic booms. No apparent nest failure occurred as a result of the sonic booms. All tests elicited similar responses. These included:

- quick lifting of the head
- apparent alertness for between 10 and 20 seconds

Twenty-one brood groups were also subjected to simulated sonic booms. Reactions varied slightly between groups. The largest percentage of groups reacted by standing motionless after the initial blast. Upon the sound of the boom, the hens and poults fled until reaching the edge of the woods. Afterward, the poults resumed feeding activities. The hens remained alert for a short period of time (~15 to 20 seconds). In no instances were poults abandoned. They also did not scatter and become lost. Every observation group returned to normal activities within a maximum of 30 seconds after a blast.

Raptors

Several studies on nesting raptors have indicated that birds adapt to aircraft overflights. A literature review of raptor responses to aircraft noise was conducted (Manci, et al. 1988). It was found that most raptors did not show a negative response to overflights. The few negative responses were mainly linked with rotor-winged aircraft or jet aircraft. In addition, they occurred when these aircraft were often passing within 0.5 mile of a nest.

In addition, studies indicated that long-term reproductive success is not affected (Grubb and King 1991; Ellis, et al. 1991). Threshold noise levels for significant responses range from 62 dB for Pacific black brant (Ward and Stehn 1990) to 85 dB for crested tern (Brown 1990).

One study looked at the effects of low-level military jet aircraft and mid- to high-altitude sonic booms on nesting peregrine falcons Ellis, et al. (1991). They also studied seven other raptors, including:

- common black-hawk
- Harris' hawk
- zone-tailed hawk
- red-tailed hawk
- golden eagle
- prairie falcon
- bald eagle

This study involved:

- observing responses to test stimuli
- determining nest success for the year of the testing
- evaluating site occupancy the following year

Successful fledging of young occurred in 34 of 38 nest sites (all eight species) subjected to low-level flight and/or simulated sonic booms.

Twenty-two of the test sites were revisited in the following year. Observations of pairs or lone birds were made at all but one nest.

- Nesting activity was seen at 19 of 20 sites that were observed for a long enough time to be certain
- The rate of return to nests and productivity rates were within or above expected values for self-sustaining populations
- Overflights at a distance of 150 m or less produced few significant responses and no severe responses
- Typical responses consisted of crouching or, very rarely, flushing from the perch site
- Significant responses were seen most before egg laying and after young were “well grown
- Incubating or brooding adults never burst from the nest

Jet passes and sonic booms often caused noticeable alarm. However, significant negative responses were rare. Also, these responses did not appear to limit productivity or their return to a nest.

Due to the locations of some of the nests, some birds may have adjusted to aircraft noise. There were some test sites located far from zones of frequent military aircraft usage. The test stimuli were often closer, louder, and more frequent than would be likely for a normal training situation.

It was noted that a female **northern harrier** was observed hunting on a bombing range in Mississippi during bombing exercises (Manci, et al. 1988). The harrier was apparently unfazed by the exercises. This was true even when a bomb exploded within 200 feet of her. Similarly, a study on the **Florida snail-kite** stated the greatest reaction to overflights (approximately 98 dBA) was "watching the aircraft fly by." No detrimental impacts to distribution, breeding success, or behavior were noted.

Bald Eagle

A study on the reactions of the **bald eagle** to human disturbances showed that **terrestrial** disturbances caused the greatest response (Grubb and King 1991). This was followed by aquatic and aerial disturbances. The study occurred in an area that was mainly disturbed by aircraft noise. The study found that:

- Pedestrians consistently caused responses that were greater in both frequency and duration
- Helicopters caused the highest level of aircraft-related responses
- Aircraft disturbances (although the most common form of disturbance) resulted in the lowest levels of response

This last finding may have been due to adaptation. However, flights less than 170 meters away caused reactions similar to the other disturbances. Some other studies found that:

- Eagles typically respond to the closeness of a disturbance rather than the noise level (Ellis, et al. 1991).
- Bald eagles were twice as likely to react to commercial jet flights when they passed by at 0.5 mile or less Fleischner and Weisberg (1986). This study also found that helicopters were:
    - 4 times more likely to cause a reaction than a commercial jet
    - 20 times more likely to cause a reaction than a propeller plane

The **USFWS** advised Cannon Air Force Base that flights at or below 2,000 feet **AGL** could have a negative impact on wintering bald eagles (U.S. Fish and Wildlife Serice 1998). However, some researchers suggest that raptors quickly adapt to overflights (Fraser, et al. 1985). They found that the eagles sometimes tolerated aircraft approaches of 65 feet or less (Fraser, et al. 1985).

Osprey

A study done in Goose Bay, Labrador, Canada, focused on the reactions of nesting osprey (Trimper, et al. 1998). The overflights here were made by CF-18 Hornets. Reactions included:

- increased alertness
- focused observation of planes
- adjustment in incubation posture (how they were sitting on their eggs)

No obvious reactions were observed as a result of an overflight. For example, there were no startle responses or quick departures from nests. Young nestlings crouched as a result of any disturbance until they grew to 1 to 2 weeks prior to fledging.

Helicoptes, human presence, float planes, and other ospreys brought out the strongest reactions from nesting ospreys. These responses included flushing, agitation, and aggressive displays. Adult osprey showed high nest occupancy rates during incubation regardless of outside influences.

The osprey observed occasionally stared in the direction of the flight before it the observers could hear the noise. The birds may have adapted to the noise of the flights. However, overflights were strictly controlled during the experimental period. Strong reactions to float planes and helicopters may have been due to the slower flight rather than noise-related stimuli. This may be because the slower flight increased the length of visual stimulation.

Red-tailed Hawk

One study investigated the effects of low-level helicopter overflights on 35 **red-tailed hawk** nests (Anderson, et al. 1989). Some of the nests had not been flown over prior to the study. The hawks that were not previously exposed to helicopter flights showed stronger avoidance behavior than those that were previously exposed. Nine of 17 birds that were not previously exposed flushed from their nests. The overflights did not appear to affect nesting success in either study group. These findings were consistent with the belief that red-tailed hawks adapt to low-level air traffic. This adaptation occurs even during the nesting period.

Migratory Waterfowl

A study of caged American black ducks was conducted in 1996 (Fleming, et al. 1996). It was found that noise had little energetic and **physiologic** effects on adult waterfowl. Measurements included:

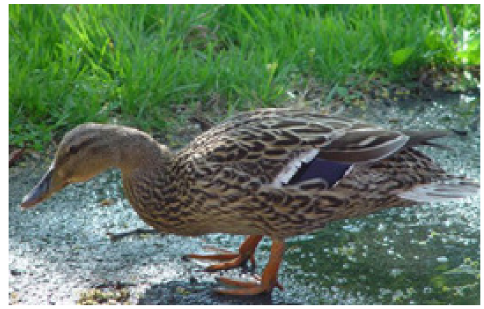
- body weight
- behavior
- heart rate
- enzymatic activity

The experiments also showed that adult ducks exposed to high noise events adjusted quickly and showed no effects.

The reproductive success of captive ducks was also investigated in this study. Duckling growth and survival rates at Piney Island, North Carolina, were lower than those at a background location. In contrast, observations of several other reproductive indicators showed no difference between the two sites. These indicators included:

- pair formation
- nesting
- egg production

- hatching success



Potential effects on wild duck populations may vary. Wild ducks at Piney Island have presumably adjusted to aircraft overflights. It was not demonstrated that noise was the cause of harmful impacts. A variety of other factors could explain the observed effects. These include:

- weather conditions
- drinking water
- food availability and variability
- disease
- natural variability in reproduction

It was noted that drinking water conditions (particularly at Piney Island) deteriorated during the study (Fleming, et al., 1996). This could have affected the growth of young ducks. Further research would be necessary to find the cause of any reproductive effects.

Another study exposed previously unexposed ducks to 71 noise events per day (Conomy, et al. 1998). These noise events equaled or exceeded 80 dBA. It was found that the proportion of time **black ducks** reacted to aircraft activity and noise decreased from 38 percent to 6 percent in 17 days. It remained stable at 5.8 percent after that.

In the same study, the **wood duck** did not appear to adapt to aircraft noise (Conomy, et al. 1998). This supports the notion that animal response to aircraft noise is species-specific. A startle response to aircraft noise can result in flushing from nests. So, migrants and animals living in areas with high concentrations of predators would be the most vulnerable to lowered birth rates and recruitment over time. Species that are subjected to infrequent overflights do not appear to adapt to overflight noise as readily.

Black brant studied (Ward, et al. 1986) in the Alaska Peninsula were exposed to:

- jets and propeller aircraft
- helicopters
- gunshots
- people
- boats
- various raptors

Jets accounted for 65% of all the disturbances. Humans, eagles, and boats caused a greater percentage of brant to take flight. There was markedly greater reaction to Bell-206-B helicopter flights than fixed wing, single-engine aircraft.

The presence of humans and low-flying helicopters in the Mackenzie Valley North Slope area did not appear to affect the population density of **Lapland longspurs**. However, the experimental group had reduced hatching and fledging success and higher nest abandonment. Human presence appeared to have a greater impact on the incubating behavior of the black brant, common eider, and Arctic tern than fixed-wing aircraft (Gunn and Livingston 1974).

Other researchers found that waterfowl and seabirds in the Mackenzie Valley and North Slope of Alaska and Canada adjusted to float plane disturbance in three days (Gunn and Livingston 1974). Additionally, potential predators (bald eagle) caused a number of birds to leave their nests. Non-breeding birds were observed to be more reactive than breeding birds.

Waterfowl were affected by helicopter flights. Snow geese were disturbed by Cessna 185 flights. The geese flushed when the planes were under 1,000 feet. An overall reduction in flock sizes was observed. It was recommended that aircraft flights be reduced in the vicinity of premigratory staging areas.

Others reported that waterfowl were particularly disturbed by aircraft noise (Manci, et al. 1988). The most sensitive appeared to be snow geese. Canada geese and snow geese were thought to be more sensitive than other animals such as turkey vultures, coyotes, and raptors (Edwards, et al. 1979).

Wading and Shore Birds

The effects of low-altitude (less than 500 feet **AGL**) military training flights on wading bird colonies were studied (Black, et al. 1984). Sound levels ranged from 55 to 100 dBA. The species studied included:

- great egret
- snowy egret
- tricolored heron
- little blue heron

The training flights involved three or four aircraft, which occurred once or twice per day. This study concluded that the reproductive activity was independent of F-16 overflights. These activities included:

- nest success
- nestling survival
- nestling chronology

Dependent variables were more strongly related to ecological factors, including location and physical characteristics of the colony and climatology.

Another study looked at the effects of circling fixed-wing aircraft and helicopter overflights on wading bird colonies (Kushlan 1978). At altitudes of 195 to 390 feet, there was no reaction in nearly 75% of the 220 observations.

- 90% displayed no reaction or merely looked toward the direction of the noise source
- 6% percent stood up
- 3% walked from the nest
- 2% flushed (but were without active nests) and returned within 5 minutes

Non-nesting wading birds had a slightly higher frequency of reacting to overflights than nesting birds.

Seagulls observed roosting near a colony of wading birds in another study remained at their roosts when subsonic aircraft flew overhead (Burger 1981). Colony distribution appeared to be most directly linked to available wetland community types. It was found to be distributed randomly with respect to military training routes. These results suggest that wading bird species presence was most closely linked to habitat availability. Also, they suggest that they were not affected by low-level military overflights (U.S. Air Force 2000).

The response of migrating shorebirds to human disturbance was also studied (Burger 1986). It was found that shorebirds did not fly in response to aircraft overflights. However, they did flush in response to more local intrusions (that is, humans and dogs on the beach).

Another study looked at the effects of noise from JFK Airport in New York on **herring gulls** that nested less than 1 kilometer from the airport (Burger 1981). Noise levels over the nesting colony were 85 to 100 dBA on approach. They were 94 to 105 dBA on takeoff. Generally, there did not appear to be any prominent adverse effects of subsonic aircraft on nesting. However, some birds flushed when the Concorde flew overhead. When these birds returned, they engaged in aggressive behavior. Groups of gulls tended to loaf in the area of the nesting colony. These birds remained at the roost when the Concorde flew overhead. Up to 208 of the loafing gulls flew when supersonic aircraft flew overhead. These birds would circle around and immediately land in the loafing flock (U.S. Air Force 2000).

In 1969, sonic booms were potentially linked to a mass hatch failure of **Sooty Terns** on the Dry Tortugas (Austin et al, 1969). The cause of the failure was not certain. However, it was supposed that sonic booms from military aircraft or an overgrowth of vegetation were factors.

In the previous season, Sooties were observed to react to sonic booms by rising in a "panic flight." They circled over the island and then usually settled down on their eggs again. Hatching that year was normal. Following the 1969 hatch failure, excess vegetation was cleared. In addition, measures were taken to reduce supersonic activity. The 1970 hatch appeared to proceed normally. A colony of **Noddies** on the same island hatched successfully in 1969, the year of the Sooty hatch failure.

Subsequent laboratory tests of exposure of eggs to sonic booms and other impulsive noises failed to show harmful effects on egg hatching (Bowles et al 1991; Bowles et al 1994; Cottereau 1972; Cogger and Zegarra 1980). A structural analysis showed that sonic booms would not damage an avian egg, even under extraordinary circumstances (Ting et al, 2002).

No effects of subsonic aircraft on herring gulls in the vicinity of JFK International Airport were observed (Burger 1981). The Concorde aircraft did cause more nesting gulls to leave their nests (especially in areas with higher nest densities). This caused egg breakage and egg scavenging by intruder prey. Clutch sizes were observed to be smaller in areas of higher-density nesting than in areas where there were fewer nests. This is presumably due to the greater tendency for panic flight.

References:

Acoustical Society of America. 1980. *San Diego Workshop on the Interaction Between Manmade Noise and Vibration and Arctic Marine Wildlife.* Acoust. Soc. Am., Am. Inst. Physics, New York. 84 pp.

Anderson, D.E., O.J. Rongstad, and W.R. Mytton. 1989. *Responses of Nesting Red-tailed Hawks to Helicopter Overflights.* The Condor, Vol. 91, pp. 296-299.

Austin, et al. 1969

Black, B., M. Collopy, H. Percivial, A. Tiller, and P. Bohall. 1984. *Effects of Low-Altitude Military Training Flights on Wading Bird Colonies in Florida.* Florida Cooperative Fish and Wildlife Research Unit, Technical Report No. 7.

Bowles, A.E., M. Knobler, M.D. Sneddon, and B.A. Kugler. 1994. *Effects of Simulated Sonic Booms on the Hatchability of White Leghorn Chicken Eggs*, AL/OE-TR-1994-0179.

Bowles, A.E., F.T. Awbrey, and J.R. Jehl. 1991. *The Effects of High-Amplitude Impulsive Noise On Hatching Success: A Reanalysis of the Sooty Tern Incident*, HSD-TP-91-0006.

Bowles, A.E., B. Tabachnick, and S. Fidell. 1991. *Review of the Effects of Aircraft Overflights on Wildlife.* Volume II of III, Technical Report, National Park Service, Denver, Colorado.

Brown, A.L. 1990. *Measuring the Effect of Aircraft Noise on Sea Birds.* Environment International, Vol. 16, pp. 587-592.

Bullock, T.H., D.P. Donning, and C.R. Best. 1980. *Evoked Brain Potentials Demonstrate Hearing in a Manatee (Trichechus inunguis).* Journal of Mammals, Vol. 61, No. 1, pp. 130-133.

Burger, J. 1986. *The Effect of Human Activity on Shorebirds in Two Coastal Bays in Northeastern United States.* Environmental Conservation, Vol. 13, No. 2, pp. 123-130.

Burger, J. 1981. *Behavioral Responses of Herring Gulls (Larus argentatus) to Aircraft Noise.* Environmental Pollution (Series A), Vol. 24, pp. 177-184.

Cogger, E.A., and E.G. Zegarra. 1980. *Sonic Booms and Reproductive Performance of Marine Birds: Studies on Domestic Fowl as Analogues.* In Jehl, J.R., and C.F. Cogger, eds., “Potential Effects of Space Shuttle Sonic Booms on the Biota and Geology of the California Channel Islands: Research Reports,” San Diego State University Center for Marine Studies Technical Report No. 80-1.

Conomy, J.T., J.A. Dubovsky, J.A. Collazo, and W. J. Fleming. 1998. *Do Black Ducks and Wood Ducks Habituate to Aircraft Disturbance?* Journal of Wildlife Management, Vol. 62, No. 3, pp. 1135-1142.

Cottereau, P. 1972. *Les Incidences Du 'Bang' Des Avions Supersoniques Sur Les Productions Et La Vie Animals.* Revue Medicine Veterinaire, Vol. 123, No. 11, pp. 1367-1409

Davis, R.W., W.E. Evans, and B. Wursig, eds. 2000. *Cetaceans, Sea Turtles, and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance, and Habitat Associations.* Volume II of Technical Report, prepared by Texas A&M University at Galveston and the National Marine Fisheries Service. U.S. Department of the Interior, Geological Survey, Biological Resources Division, USGS/BRD/CR-1999-0006 and Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana, OCS Study MMS 2000-003.

Dooling, R.J. 1978. *Behavior and Psychophysics of Hearing in Birds.* J. Acoust. Soc. Am., Supplement 1, Vol. 65, p. S4.

Dufour, P.A. 1980. *Effects of Noise on Wildlife and Other Animals: Review of Research Since 1971.* U.S. Environmental Protection Agency.

Edwards, R.G., A.B. Broderson, R.W. Harbour, D.F. McCoy, and C.W. Johnson. 1979. *Assessment of the Environmental Compatibility of Differing Helicopter Noise Certification Standards.* U.S. Dept. of Transportation, Washington, D.C. 58 pp.

Ellis, D.H., C.H. Ellis, and D.P. Mindell. 1991. *Raptor Responses to Low-Level Jet Aircraft and Sonic Booms.* Environmental Pollution, Vol. 74, pp. 53-83.

Fraser, J.D., L.D. Franzel, and J.G. Mathiesen. 1985. *The Impact of Human Activities on Breeding Bald Eagles in North-Central Minnesota.* Journal of Wildlife Management, Vol. 49, pp. 585-592. Frerichs, R.R., B.L. Beeman, and A.H. Coulson. 1980. *Los Angeles Airport Noise and Mortality: Faulty Analysis and Public Policy.* Am. J. Public Health, Vol. 70, No. 4, pp. 357-362. April.

Fleischner, T.L., and S. Weisberg. 1986. *Effects of Jet Aircraft Activity on Bald Eagles in the Vicinity of Bellingham International Airport.* Unpublished Report, DEVCO Aviation Consultants, Bellingham, WA.

Fleming, W.J., J. Dubovsky, and J. Collazo. 1996. *An Assessment of the Effects of Aircraft Activities on Waterfowl at Piney Island, North Carolina.* Final Report by the North Carolina Cooperative Fish and Wildlife Research Unit, North Carolina State University, prepared for the Marine Corps Air Station, Cherry Point.

Grubb, T.G., and R.M. King. 1991. *Assessing Human Disturbance of Breeding Bald Eagles with Classification Tree Models.* Journal of Wildlife Management, Vol. 55, No. 3, pp. 500-511.

Gunn, W.W.H., and J.A. Livingston. 1974. *Disturbance to Birds by Gas Compressor Noise Simulators, Aircraft, and Human Activity in the MacKenzie Valley and the North Slope.* Chapters VI-VIII, Arctic Gas Biological Report, Series Vol. 14.

Jehl, J.R., and C.F. Cooper, eds. 1980. *Potential Effects of Space Shuttle Sonic Booms on the Biota and Geology of the California Channel Islands.* Research Reports, Center for Marine Studies, San Diego State University, San Diego, CA, Technical Report No. 80-1. 246 pp.

Kushlan, J.A. 1978. *Effects of Helicopter Censuses on Wading Bird Colonies.* Journal of Wildlife Management, Vol. 43, No. 3, pp. 756-760.

Lynch, T.E., and D.W. Speake. 1978. *Eastern Wild Turkey Behavioral Responses Induced by Sonic Boom.* In "Effects of Noise on Wildlife," Academic Press, New York, New York, pp. 47-61.

Manci, K.M., D.N. Gladwin, R. Villella, and M.G Cavendish. 1988. *Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis.* U.S. Fish and Wildlife Service National Ecology Research Center, Ft. Collins, CO, NERC-88/29. 88 pp.

Metro-Dade County. 1995. *Dade County Manatee Protection Plan.* DERM Technical Report 95-5. Department of Environmental Resources Management, Miami, Florida.

National Park Service. 1994. *Report to Congress: Report on Effects of Aircraft Overflights on the National Park System.* Prepared Pursuant to Public Law 100-91, The National Parks Overflights Act of 1987.12 September.

Pater, L.D., D.K. Delaney, T.J. Hayden, B. Lohr, and R. Dooling. 1999. *Assessment of Training Noise Impacts on the Red-cockaded Woodpecker: Preliminary Results – Final Report.* Technical Report. U.S. Army, Corps of Engineers, CERL, Champaign, IL, Report Number 99/51, ADA Number 367234.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine Mammals and Noise.* Academic Press, San Diego, CA.

Tetra Tech, Inc. 1997. *Final Environmental Assessment Issuance of a Letter of Authorization for the Incidental Take of Marine Mammals for Programmatic Operations at Vandenberg Air Force Base, California.* July.

Ting, C., J. Garrelick, and A. Bowles. 2002. *An Analysis of the Response of Sooty Tern eggs to Sonic Boom Overpressures.* J. Acoust. Soc. Am., Vol. 111, No. 1, Pt. 2, pp. 562-568.

Trimper, P.G., N.M. Standen, L.M. Lye, D. Lemon, T.E. Chubbs, and G.W. Humphries. 1998. *Effects of Low level Jet Aircraft Noise On the Behavior of Nesting Osprey.* Journal of Applied Ecology, Vol. 35, pp. 122-130.

U.S. Air Force. 2000. *Preliminary Final Supplemental Environmental Impact Statement for Homestead Air Force Base Closure and Reuse.* Prepared by SAIC. 20 July.

U.S. Fish and Wildlife Service. 1998. *Consultation Letter #2-22-98-I-224 Explaining Restrictions on Endangered Species Required for the Proposed Force Structure and Foreign Military Sales Actions at Cannon AFB, NM.* To Alton Chavis HQ ACC/CEVP at Langley AFB from Jennifer Fowler-Propst, USFWS Field Supervisor, Albuquerque, NM. 14 December.

U.S. Forest Service. 1992. *Report to Congress: Potential Impacts of Aircraft Overflights of National Forest System Wilderness.* U.S. Government Printing Office 1992-0-685-234/61004, Washington, D.C. von Gierke, H.E. 1990. The Noise-Induced Hearing Loss Problem. NIH Consensus Development Conference on Noise and Hearing Loss, Washington, D.C. 22–24 January.

Ward, D.H., and R.A. Stehn. 1990. *Response of Brant and Other Geese to Aircraft Disturbances at Izembek Lagoon, Alaska.* Final Technical Report, Number MMS900046. Performing Org.: Alaska Fish and Wildlife Research Center, Anchorage, AK. Sponsoring Org.: Minerals Management Service, Anchorage, AK, Alaska Outer Continental Shelf Office.

Ward, D.H., E.J. Taylor, M.A. Wotawa, R.A. Stehn, D.V. Derksen, and C.J. Lensink. 1986. *Behavior of Pacific Black Brant and Other Geese in Response to Aircraft Overflights and Other Disturbances at Izembek Lagoon, Alaska.* 1986 Annual Report, p. 68.

Weisenberger, M.E., P.R. Krausman, M.C. Wallace, D.W. De Young, and O.E. Maughan. 1996. *Effects of Simulated Jet Aircraft Noise on Heart Rate and Behavior of Desert Ungulates.* Journal of Wildlife Management, Vol. 60, No. 1, pp. 52-61.

Photo Credits: Bernd. J. Haupt, The Pennsylvania State University

---

For a PDF version of this page, click here.

---

back to top

Home Search Print Team Section