Annotated Bibliography
Impacts of Noise and Overflights on Wildlife

Title	Citation	Abstract
Literature Reviews		
The Effects of Aircraft Noise on Wildlife; a Review and Comment.	Kempf, N. & O. Hueppop, 1997,: "The Effects of Aircraft Noise on Wildlife; a Review and Comment". **Vogel und Luftverkehr**, Bd. 1/97: 58-70	The discussion of noise effects involves physical, physiological aspects making an evaluation quite difficult. In humans the effects of noise range from discomfort to severe, irreversible damage. In laboratory animals only strong and long lasting noise causes physiological changes that can affect health. These findings are only partly applicable to wild animals. Field studies have to deal carefully with (1) methodological difficulties in measuring sound pressure levels, (2) interspecific differences of auditory sensitivity, and (3) problems in interpreting behavioural reactions in the field. Non-standardized methods of observations and analysis make a comparison of the results found in the literature almost impossible. Especially the noise of aircraft can scarcely be assessed separately from its optical appearance. Optical or acoustical stimuli taken separately have only minor effects with the optical stimulus evoking the stronger reaction; even soundless paragliders can cause panic flights. In general, noise plays a minor role as a disturbance factor, but in combination with optical stimuli can trigger a reaction. Sonic booms and jet aircraft noise sometimes cause startle responses, which mostly do not result in severe consequences. Apparently, animals can adapt to high noise exposure. When animals react to aircraft noise, it is often due to previous experience associating the noise with an aircraft. Aside from a few accident caused by panic flights, negative consequences of aircraft noise per se on individuals and populations are not proven. In contrast aircraft traffic in general can cause a variety of damages. Concerning the effects of noise on wildlife, many questions remain.
A Review of the Effects of Aircraft Noise on Wildlife and Humans, Current Control Mechanisms, and the Need for Further	Pepper, Christopher B., Nascarella, Marc A.; Kendall, Ronald J. 2003, "A review of the effects of aircraft noise on wildlife and humans, current control mechanisms, and the need for further study". [Article] **Environmental Management**. 32(4).. 418-432.	Military and civilian aircraft overflights are an issue that may impact the quality of life for millions of United States residents. Aircraft noise annoys many people worldwide and is generally thought to adversely affect some wildlife species. In light of increasing demands being placed on airspace, and because of technological improvements in acoustical testing, there is a need to reexamine the effects of aircraft noise exposure on humans and wildlife. This paper reviews past

Study		research, current laws and legislation, and presents an argument for the need to revisit the effects of aircraft noise on humans and wildlife. Some evidence suggests that noise may adversely impact wildlife and humans, however, many of the past studies were inconclusive and based on relatively small sample sizes. Given that aircraft noise abatement legislation has been enacted and because of the recent promulgation of community-based noise awareness programs, future studies should be conducted to resolve public policy problems and debates associated with aircraft noise. The need to further study the effects of aircraft noise on humans and wildlife is critical for creating sustainable land use policies near aircraft installations. Data derived from these studies will be used to create sound public policies that enhance the operational capacity of military and civilian aircraft while reducing the opportunity for human and wildlife exposure to aircraft noise.
The Effect of Noise on Wildlife: A Literature Review	Radle, Lyn Autumn, 1998, " The Effect of Noise on Wildlife: A Literature Review" **World Forum for Acoustic Ecology Online Reader** http://interact.uoregon.edu/MediaLit/wfae/readings/radle.html	Most researchers agree that noise can effect an animal's physiology and behavior, and if it becomes a chronic stress, noise can be injurious to an animal's energy budget, reproductive success and long-term survival. Armed with this understanding it should follow that humans would attempt to minimize the threat to wildlife by reducing the amount of noise that they are exposed to in natural areas; but this has not been the situation. Natural areas continue to be degraded by human-made noise, wildlife continues to suffer from these disturbances, and to date the majority of the debate revolves around the egocentric demands of people to either produce more noise in nature (through motorized recreation, scientific research, military exercises etc.) or experience natural areas in the absence of anthropogenic noise. Neither side has adequately addressed the issue from the biocentric view of wildlife and the known, or as yet undiscovered, damage that our increasingly noisy human-altered environment is inflicting upon them.
Physiological Effects of Noise		
Effects of Environmental Stressors on Deep Body Temperature and Activity Levels in Silver Fox Vixens (Vulpes Vulpes)	Bakken, Morten et.al., 1999, "Effects of environmental stressors on deep body temperature and activity levels in silver fox vixens (Vulpes vulpes)" **Applied Animal Behaviour Science**, Vol. 64, no. 2 pp. 141-151	The present study was performed to investigate the effects of 14 different environmental stimuli on stress-induced hyperthermia (SIH) and levels of locomotor activity in six (three infanticidal, three non-infanticidal) 2.5-year-old silver fox vixens. The effects of contact with humans (six experiments; handling for 5 min, handling of neighbouring animal for 5 min, presence of one person for 20 s, 5 and 90 min, presence of a group of humans for 5 min), exposure to unfamiliar foxes (four experiments; presence of an unfamiliar cagemate [female, male] and an unfamiliar neighbouring animal [female, male] for 90 min), and various recorded noise stimuli (four experiments; aircraft noise [duration 15 s, 100 dB], machine noise [duration 15 s, 90 dB],

		firing a shotgun [duration 1 s, 90 dB], human conversation [duration 15 s, 95 dB]) played back and repeated at 20 s intervals during 5 min were tested. Deep body temperature and activity levels were monitored with surgically implanted radio telemetry devices. All registrations were made during the 90-min period after stimulus presentation. The presence of humans and other silver foxes, but not exposure to loud recorded noise, resulted in a SIH. Comparison of the SIH between the normally reproducing vixens and the previously infanticidal vixens revealed significant differences. The SIH response was most pronounced in the previously infanticidal vixens, whereas the levels of physical activity were lowest in this group. The present study indicated that important means to improve animal welfare in silver foxes should include an improvement of the general human–animal relationship and emphasises the importance of a stable social environment.
Acute and Chronic Blood Pressure Response to Recurrent Acoustic Arousal in Rats	Gang Bao, Naira Metreveli and Eugene C. Fletcher, 1999, "Acute and chronic blood pressure response to recurrent acoustic arousal in rats" **American Journal of Hypertension**, Vol. 12, no. 5, pp. 504-510	Repetitive episodic hypoxia every 30 sec administered chronically to Sprague-Dawley (SD) rats has been shown by previous studies to cause a sustained increase in daytime blood pressure (BP). Acoustic arousal in humans during wake or sleep produces an acute BP rise. The question then arises as to whether chronic episodic acoustic arousal applied with the same frequency and duration as episodic hypoxia induces elevated BP. We exposed 14-week-old (N = 10) SD rats in individual cages to recurrent buzzer noise (500 Hz, 100 db) 6 out of every 30 sec, 7 h/day for 35 days. Ten other rats were placed in similar cages daily but not exposed to noise, to provide a sham condition. An infrared beam with a detector was positioned at the end of each cage. This allowed us to quantify motion by registering the number of times the rat broke the beam per 7 h period. Mean intraarterial BP was measured in unrestrained conscious animals at baseline and at the end of 35 days of their respective conditions. Acute episodic acoustic stimulation caused an immediate response in BP and heart rate. Habituation occurred in that the movement response to 120 noises per hour was 75% in hour one and 20% in hours two through seven on day one. The movement response was further reduced by day 35 but remained significantly higher than in animals not stimulated by noise. The cardiovascular response to noise also showed signs of habituation. Chronic noise stimulation produced no sustained increases in BP after 35 days of exposure.
Behavioural and Physiological Responses of Pigs to Sound	J. C. Talling, N. K. Waran, C. M. Wathes and J. A. Lines, 1996, "Behavioural and physiological responses of pigs to sound" **Applied Animal Behaviour Science**, Vol. 48, no. 3-4, pp 187-201	Sound is a potential stressor to pigs throughout their lives, The following two studies examined the behavioural acid physiological responses of pigs to both artificial and real sound. In the first study, piglets (n = 8) were exposed to artificially generated sounds, nominal intensities of 85 or 97 dB(Lin), and frequencies of 500 Hz and 8000 Hz for 15 min, during an hour experimental session, In the second study the piglets (n = 8) were exposed to 20 min of four sounds: farm

		recording, Leq 80 dB(Lin); transport recording, Leq 83 dB(Lin); abattoir recording, Leq 84 dB(Lin) and white noise, Leq 89 dB(Lin). In both studies piglets were exposed to the sounds in an arena to which they had previously become accustomed and a companion pig was present in the experimental room. The behaviour and heart rate of the piglets were recorded pre-, during and post-exposure to all the sounds in both studies. In addition observations were also made in a control session with no sound stimuli, In both studies an increase in heart rate (maximum 20 beats min(-1)) was observed for the first 15 min of exposure to sound ($P < 0.05$), when compared with controls. An increase in ambulation score (control 4.4 vs 97 dB(Lin) 20.2) due to sound exposure was only observed in Study 1 ($P < 0.05$). Greater increases were found when the pigs were exposed to the higher frequency and higher intensity in Study 1 ($P < 0.05$). In the second study small differences were found between the treatments, with the transporter causing the greatest increase in heart rate ($P < 0.05$) and the greatest reduction in ambulation score ($P < 0.05$). When the specific behaviours of the piglets were compared there was no difference between the different treatments in Study 2 ($P < 0.05$), however sound exposure in general changed the behaviour of the pigs from resting to aroused and attentive ($P < 0.05$), The results from these two studies suggest that sound can activate the pigs' defence mechanisms, though habituation occurs when no immediate danger or threat is identified, and that the manifestation of this response depends on properties of the sound stimuli.
Cardiac Responses to Acoustic Playback Experiments in the Captive Bottlenose Dolphin (Tursiops Truncatus)	Miksis, J L, et.al., 2001, Cardiac responses to acoustic playback experiments in the captive bottlenose dolphin (Tursiops truncatus) **Journal of Comparative Psychology**, 115(3): 227-32	Acoustic recordings were used to investigate the cardiac responses of a captive dolphin (Tursiops truncatus) to sound playback stimuli. A suction-cup hydrophone placed on the ventral midline of the dolphin produced a continuous heartbeat signal while the dolphin was submerged. Heartbeats were timed by applying a matched-filter to the phonocardiogram. Significant heart rate accelerations were observed in response to playback stimuli involving conspecific vocalizations compared with baseline rates or tank noise playbacks. This method documents that objective psychophysiological measures can be obtained for physically unrestrained cetaceans. In addition, the results are the 1st to show cardiac responses to acoustic stimuli from a cetacean at depth. Preliminary evidence suggests that the cardiac response patterns of dolphins are consistent with the physiological defense and startle responses in terrestrial mammals and birds.
Monitoring Stress in Captive Giant Pandas (Ailuropoda Melanoleuca): Behavioral and Hormonal Responses	Owen, et.al., 2004, Monitoring stress in captive giant pandas (Ailuropoda melanoleuca): Behavioral and hormonal responses to ambient **noise Zoo Biology**, 23(2): 147-164; 2004	Anthropogenic noise may impact captive breeding programs for endangered species. We recorded ambient noise and monitored potential behavioral and hormonal indices of stress in two captive giant pandas for 4 years. Statistical analyses were conducted for each individual separately, which allowed us to generalize only to these two animals. These preliminary findings indicate that ambient noise can have long-lasting effects on stress indices. Days characterized by

to Ambient Noise		louder levels of noise were associated with increased locomotion, restless manipulation of the exit door of the enclosure, increased scratching and vocalizations indicative of agitation, and/or increased glucocorticoids excreted in urine. These general effects were modulated by several factors: 1) Brief loud noise evoked behavioral distress, but not pituitary-adrenal activation. More chronic, moderate-amplitude noise was associated with higher levels of glucocorticoids. 2) Some responses were frequency-dependent, with loud low-frequency noise having the greatest impact. 3) Female reproductive condition interacted significantly with noise amplitude for all behavioral measures, with stronger effects for the loudest acute noises. The female appeared especially sensitive to noise during estrus and lactation, and less so during pregnancy/pseudopregnancy and nonreproductive periods. Despite these statistical effects, we found no compelling evidence that these adjustments indicate substantive detrimental effects on well-being or reproduction. Nonetheless, careful monitoring of giant pandas and other captive-held species is advisable, especially during reproductively sensitive periods such as implantation and birth
Effect of Noise Exposure on Rat Cardiac Peripheral Benzodiazepine Receptors	Salvetti, Francesca, et.al., 2000, "Effect of noise exposure on rat cardiac peripheral benzodiazepine receptors" **Life Sciences**, Vol. 66, no. 13, pp. 1165-1175	Noise is an environmental physical agent, which is regarded as a stressful stimulus: impairment and modifications in biological functions are reported, after loud noise exposure, at several levels in human and animal organs and apparatuses, as well as in the endocrine, cardiovascular and nervous system. In the present study equilibrium binding parameters of peripheral benzodiazepine receptors (PBRs) labelled by the specific radioligand [H-3]PK 11195, were evaluated in cardiac tissue of rats submitted to 6 or 12 h noise exposure and of rats treated "in vivo" with PER ligands such as PK 11195, Ro5-4864, diazepam and then noise-exposed. Results revealed a statistically significant decrease in the maximum number of binding sites (B-max) of [H-3]PK 11195 in atrial membranes of 6 or 12 h noise exposed rats, compared with sham-exposed animals, without any change in the dissociation constant (K-d) The "in vivo" PER ligand pretreatment counteracted the noise-induced modifications of PER density. As PBRs are mainly located on mitochondria we also investigated whether noise exposure can affect the [H-3]PK 11195 binding parameters in isolated cardiac mitochondrial fractions. Results indicated a significant B-max value decrease in right atrial mitochondrial fractions of rats 6 or 12 h noise- exposed. Furthermore, as PER has been suggested to be a supramolecular complex that might coincide with the not-yet-established structure of the mitochondrial permeability transition (MPT)-pore, the status of the MPT-pore in isolated heart mitochondria was investigated in noise- and sham-exposed rats. The loss of absorbance associated with the calcium-induced MPT-pore opening was greater in mitochondria isolated from hearts of 6 h noise-than those of sham-exposed rats. In

		conclusion, these findings represent a further instance for PER density decrease in response to a stressful stimulus, like noise; in addition they revealed that "in vivo" administration of PER ligands significantly prevents this decrease. Finally, our data also suggest the involvement of MPT in the response of an organism to noise stress.
Gestational Exposure to Loud Noise Alters the Development and Postnatal Responsiveness of Humoral and Cellular Components of the Immune System in Offspring	Sobrian, S. K. et.al., 1997, "Gestational Exposure to Loud Noise Alters the Development and Postnatal Responsiveness of Humoral and Cellular Components of the Immune System in Offspring" **Environmental Research**, Vol. 73, no. 1-2 pp. 227-241	Gestational exposure of the female to environmental toxins can alter immune function in the offspring. We have recently shown that prenatal maternal stress, that is, stress applied to or induced in the female during pregnancy, can also alter the development of humoral immunocompetence in the offspring and their hormonal. and immunologic responses to postnatal stress. This report presents data from two experiments on the effects of prenatal exposure to loud noise-prenatal sound stress (PSS)-on the development and responsiveness of in vitro and in vivo humoral and cellular immune function in the offspring. Pregnant rats were exposed daily from Day 15 to Day 21 of gestation to an inescapable loud noise (an 85- to 90-decibel fire alarm bell) delivered randomly for 1 hr. In developing offspring, PSS produced age-dependent and mitogen-specific alterations in lymphoproliferative activity and reduced immunoglobulin G levels at Postnatal Day 21. Antibody titers to herpes simplex virus type I were also reduced. Exposure to loud noise before or after infection produced an additional reduction in titers in these offspring. Arthus skin reaction (AR) to old tuberculin was reduced by PSS. Combined prenatal/postnatal sound stress further reduced this response and the AR to bovine serum albumin (BSA). Delayed hypersensitivity reaction to BSA was reduced in PSS offspring; postnatal sound stress enhanced the reaction to both antigens, but only in males. Antibody titers to BSA were increased by PSS; adjuvant-induced inflammation was attenuated by postnatal sound stress. These data suggest that in utero exposure to loud noise, which can occur in the workplace, is toxic to the developing immune system.
Fecal Corticosterone Levels in California Spotted Owls Exposed to Low-Intensity Chainsaw Sound	Tempel, Douglas J.; Gutierrez, R. J., 2003, "Fecal corticosterone levels in California spotted owls exposed to low-intensity chainsaw sound".**Wildlife Society Bulletin**, , Vol. 31 no. 3, pp. 698-703	The California spotted owl (Strix occidentalis occidentalis) is a focal management species in Sierra Nevada national forests. To protect the owl from human activity, the United States Forest Service has proposed guidelines that would prohibit timber harvest and road or trail construction within 400 m of active owl nest sites during the breeding season. To guide these efforts, we tested the physiological stress response of 9 nonbreeding wild male owls to the sound of a chainsaw operated 100 m from their roost site, using change in fecal corticosterone level (ng/g dry feces) as the response variable. We employed a cross-over experimental design to control for differences among individuals. Chainsaw exposure did not result in a detectable increase in fecal corticosterone level (F-1,F-7=0.01, P=0.94). These findings corroborate results of a field study that suggested spotted owls can tolerate low-intensity human sound in their environment without eliciting a physiological stress response. However, activities

		producing chronic and intense noise (e.g., timber harvest, road construction), which might elicit such a response, were not Simulated in our experiment. The effects of these activities on California spotted owls will require further research.
Time-Dependent Differential Changes of Immune Function in Rats Exposed to Chronic Intermittent Noise	Van Raaij, Marcel T. M. et.al, 1996, "Time-Dependent Differential Changes of Immune Function in Rats Exposed to Chronic Intermittent Noise" **Physiology & Behavior**, Vol. 60, no. 6, pp. 1527-1533	Noise is a highly relevant environmental and clinical stressor. Compared to most other experimental stressors, noise is a modest activator of neuroendocrine pathways that mimic the situation in human health where neuroendocrine activation by environmental stressors is often absent or difficult to establish. Little is known about the effects of noise exposure on the immune system. In the present work, the effects of a low-intensity chronic intermittent unpredictable noise regimen on various parameters of immune function was studied. Male wistar rats were exposed to a randomized noise protocol (white noise, 85 dB, 2-20 kHz) for 10 h per day, 15 min per h over a total period of 3 weeks. Control animals were exposed to ambient sound only. Immune function was monitored after 24 h, 7 days, and 21 days of noise exposure. Noise induced several significant changes in immune function in a time-dependent differential pattern involving both immunosuppression and immunoenhancement. After 24 h, serum IgM levels were increased and peripheral phagocytic activity was decreased. Splenic lymphocytic proliferation to mitogens was significantly decreased after 7 days, but slightly elevated after 3 weeks. The activity of splenic NK cells was increased significantly after 24 h and 7 days, but suppressed after 3 weeks. These results show that various parameters of immune function are affected differentially over time in a period of chronic mild noise stress, possibly due to sequential activation of different physiological mechanisms. Copyright (C) 1996 Elsevier Science Inc.
Effects of Non-Aviation Noise Sources		
The Influence of Weapons-Testing Noise on Bald Eagle Behavior.	Brown, Bryan T, et.al, 1999, The influence of weapons-testing **noise** on bald eagle behavior. **Journal of Raptor Research**, 33(3): 227-232	Minor/No Impacts We studied the influence of weapons-testing noise on bald eagle (Haliaeetus leucocephalus) behavior at the Aberdeen Proving Ground (APG); Maryland, in 1995. Our objectives were to document and compare eagle behavior at times with and without weapons-testing noise, determine if the frequency of behavior after noise increased with increasing sound levels and compare nest success and productivity on APG with that of adjacent areas of Maryland. Most roosting (72.7%) and nesting (92.7%) eagles showed no activity (i.e., perched motionless) in the 2-sec interval following weapons-testing noise. The most frequent activity following noise was a head turn, exhibited by 18.2% of roosting and 0.7% of nesting eagles; other eagle activities following noise (e.g., body movement, vocalization and flight) were rare at both roosts (9.1%) and nests (6.6%). Frequency of activity after noise differed between adults and juveniles at nests, but did not differ between adults and immatures at

		roosts. Activity after noise occurred significantly more in roosting than nesting eagles. For roosting eagles, frequency of activity after noise was similar to activity at times without noise. Frequency of no activity versus activity after noise did not vary at sound intensity levels >or= 110 and < 110 dBP for either nesting or roosting eagles.Nest success and productivity on APG did not differ from nest success and productivity in adjacent counties of Maryland from 1990-95, suggesting that weapons-testing noise did not influence eagle reproduction at the population level.
The Impact of Environmental Noise on Song Amplitude in a Territorial Bird.	Brumm, Henrik, 2004, The impact of environmental **noise** on song amplitude in a territorial bird. **Journal of Animal Ecology**, 73(3): 434-440;	1. The impact of environmental background noise on the performance of territorial songs was examined in free-ranging nightingales (Luscinia megarhynchos Brehm). An analysis of sound pressure levels revealed that males at noisier locations sang with higher sound levels than birds in territories less affected by background sounds. 2. This is the first evidence of a noise-dependent vocal amplitude regulation in the natural environment of an animal. 3. The results yielded demonstrate that the birds tried to mitigate the impairments on their communication caused by masking noise. This behaviour may help to maintain a given transmission distance of songs, which are used in territory defence and mate attraction. At the same time, birds forced to sing with higher amplitudes have to bear the increased costs of singing. 4. This suggests that in songbirds the level of environmental noise in a territory will contribute to its quality and thus considerably affect the behavioural ecology of singing males.
Effects of Ecotourists on Bird Behaviour At Loxahatchee National Wildlife Refuge, Florida	Burger, J; Gochfeld, M , 1998, "Effects of ecotourists on bird behaviour at Loxahatchee National Wildlife Refuge, Florida" **Environmental Conservation** Vol. 25, no. 1, pp. 13-21	Increasingly, natural areas are exposed to people who come to view, study or photograph wildlife. In order to develop appropriate management plans for both avian and human use of natural environments it is essential to understand how people affect foraging birds. The foraging behaviour of five species of water-birds at Loxahatchee (Arthur B. Marshall National Wildlife Refuge), part of the Everglades, in Southern Florida was observed, between 1992 and 1994, from a dike that received many visitors. Species examined included common gallinule (Gallinula chloropus), sera rail (Porzana carolina), glossy ibis (Plegadis falcinellus), little blue heron (Egretta caerulea) and Louisiana heron (E. tricolor). These birds were observed before people were near, while people were present, and following the departure of people. Variation in feeding behaviour was largely explained by whether people were present, the number of people present, and the amount of noise made by the people. For all species, time devoted to feeding and number of strikes or pecks decreased while people were present. The percentage of time spent foraging and the number of strikes decreased as the noise made by people increased. Birds that were closer to the path flew away from people more often than birds that were further away. Birds usually swam or flew away from the path while people were present.
Effect of Anthropogenic	Croll, Donald A. et.al., 2001, Effect of anthropogenic low-	Researchers conducted a field experiment to test the effects of loud,

Low-Frequency Noise on the Foraging Ecology of Balaenoptera Whales	frequency **noise** on the foraging ecology of Balaenoptera whales **Animal Conservation**, 4 (1): 13-27	low-frequency noise on foraging fin and blue whales off San Nicolas Island, California. Naive observers used a combination of attached tracking devices, ship-based surveys, aerial surveys, photo-identification, and passive monitoring of vocal behavior to examine the behavior and distribution of whales when a loud low-frequency source was and was not transmitting. During transmission, 12-30 percent of the estimated received levels of LFA of whales in the study area exceeded 140 dB re 1µPa. However, the whales continued to be seen foraging in the region. Overall, whale encounter rates and diving behavior appeared to be more strongly linked to changes in prey abundance associated with oceanographic parameters than to low-frequency sound transmissions
Vigilance Behaviour of Polar Bears (Ursus Maritimus) in the Context of Wildlife-Viewing Activities At Churchill, Manitoba, Canada	Dyck, MG; Baydack, RK, 2004, "Vigilance behaviour of polar bears (Ursus maritimus) in the context of wildlife-viewing activities at Churchill, Manitoba, Canada" **Biological Conservation** Vol. 116, no. 3, pp. 343-350	Viewing of polar bears (Ursus maritimus) from tundra vehicles has been offered at Churchill, Manitoba since the early 1980s. This form of wildlife viewing has provided a unique and safe way for tourists to learn about polar bears. However, these activities have largely been carried out without examining possible effects on polar bear behaviour. We studied vigilance behaviour (a scanning of the immediate vicinity and beyond) of resting polar bears to evaluate impacts from tundra vehicle activity. Focal animal sampling was used to examine whether a difference in vigilance behaviour existed when vehicles were present. We recorded the numbers of head-ups, vigilance bout length, and between-bout intervals for polar bears. In general, the frequency of head-ups increased, and the between-bout intervals decreased for male bears, when vehicles were present. Female bears behaved opposite to males. The vigilance bout lengths did not differ significantly between vehicle presence and absence. Vigilance behaviour of male bears was not magnified with increasing numbers of vehicles; therefore the threshold is one vehicle. We suggest that manipulative studies be conducted to examine how distances between vehicles and bears, tundra vehicle activity in the immediate vicinity of a bear during viewing, and noise of tourists affect increased vigilance
Underwater Noise Of Whale-Watching Boats and Potential Effects On Killer Whales (Orcinus Orca), Based On An Acoustic Impact Model	Erbe, Christine, 2002, Underwater **noise** of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model **Marine Mammal Science**, 18(2): 394-418	Underwater noise of whale-watching boats was recorded in the popular killer whale-watching region of southern British Columbia and northwestern Washington State. A software sound propagation and impact assessment model was applied to estimate zones around whale-watching boats where boat noise was audible to killer whales, where it interfered with their communication, where it caused behavioral avoidance, and where it possibly caused hearing loss. Boat source levels ranged from 145 to 169 dB re 1 [mu]Pa [@] 1 m, increasing with speed. The noise of fast boats was modeled to be audible to killer whales over 16 km, to mask killer whale calls over 14 km, to elicit a behavioral response over 200 m, and to cause a temporary threshold shift (TTS) in hearing of 5 dB after 30-50 min within 450 m. For boats cruising at slow speeds, the predicted ranges were 1 km for audibility and masking, 50 m for behavioral responses,

		and 20 m for TTS. Superposed noise levels of a number of boats circulating around or following the whales were close to the critical level assumed to cause a permanent hearing loss over prolonged exposure. These data should be useful in developing whale-watching regulations. This study also gave lower estimates of killer whale call source levels of 105-124 dB re 1 [mu]Pa.
Logging Truck Noise Near Nesting Northern Goshawks	Grubb, Teryl G., et.al., 1998, Logging truck **noise** near nesting northern goshawks **U.S. Forest Service. Research Note R M**, No. 3: 2pp	Data suggest that nesting northern goshawks are not disturbed by noise from logging trucks passing >400 m away from nesting sites.
The Effect of Vessel Noise on The Vocal Behavior of Belugas in The St. Lawrence River Estuary, Canada	Lesage, Veronique, 1999, The effect of vessel noise on the vocal behavior of belugas in the St. Lawrence River Estuary, Canada **Marine Mammal Science**, 15(1): 65-84	The impact of noise from a small motorboat and a ferry on the vocalizations of belugas was studied during June and July 1991 in the St. Lawrence River, Canada. When the boats were approaching the calling rate decreased, with brief increases in the emission of falling tonal calls. When boats were less than a kilometer away, vocalization rate increased. Frequency bands used by vocalizing belugas shifted from 3.6 kHz to 5.2-8.8 kHz when the boats drew nearer
The Underwater Noise of Vessels in the Hervey Bay (Queensland) Whale Watch Fleet and its Impact on Humpback Whales	McCauley, Robert D.; Cato, 2001, Douglas H. The underwater **noise** of vessels in the Hervey Bay (Queensland) whale watch fleet and its impact on humpback whales **The Journal of the Acoustical Society of America**, 109(5, Pt. 2); p. 2455	1994 the underwater noise of 19 vessels involved in whale watching was measured. Vessels ranged from 1.5-70 tons and included yachts, runabouts and high-speed and displacement mono and multihulls. Except for one water-jet trimaran, all vessels were propeller driven. Unlike the directional patterns reported for merchant shipping, each vessel projected lobes of sound fore and aft with lower levels abeam. In the high speed planing vessels this was exacerbated by the deep propellers exposed for ward, and the vessel squat while on the plane. All vessels displayed a linear relationship with broadband noise level and the logarithm of speed. Although unique for each vessel, as a rule of thumb doubling the speed doubled the detection range. The response of whales to vessel noise was as much a function of the rate of change of noise as its steady level. Rapid increases in noise produced more responses. Vessels which, by their design, required constant maneuvering to maintain station produced greater adverse responses from whales. Some design criteria important in reducing noise impacts from whale watch vessels include shielding of the propellers in the forward direction, windage in relation to draft, slow speed steerage, machinery noise reduction and passenger viewing access.
A GPS-Based Method to Examine Wolf Response to Loud Noise	Merrill, SB; Erickson, CR, 2003, "A GPS-based method to examine wolf response to loud noise" **Wildlife Society Bulletin** Vol. 31, no. 3, pp. 769-773	We used Global Positioning System (GPS) telemetry data to examine responses of a breeding male and 2 yearling wolves (Canis lupus) to military firing at Camp Ripley National Guard Training Site in Little Falls, Minnesota. Two of 3 wolves showed movements toward firing points more often than expected. Movements toward firing points were more f requent when wolves were <5 km from the firing point before firing began. The breeding male moved toward firing points more often than the 2 yearlings. The method developed in this study could be useful for identifying tolerance thresholds in other wildlife species and

		for determining whether thresholds change when animals adjust to human activities.
Anthropogenic Noise and Its Effect on Animal Communication: An Interface Between Comparative Psychology and Conservation Biology	Rabin, Lawrence A.; McCowan, Brenda; Hooper, Stacie L.; Owings, Donald H., 2003, "Anthropogenic Noise and its effect on Animal Communication: An Interface Between Comparative Psychology and Conservation Biology." **International Journal of Comparative Psychology** Vol. 16 no. 2/3, pp172-193	Conservation biology and comparative psychology rarely intersect, in part because conservation biology typically emphasizes populations whereas comparative psychology concentrates on individual organisms. However, both fields could benefit from their integration. Conservation biology can profit from an enhanced understanding of individual-level impacts of habitat alteration and the resulting implications for conservation mitigation strategies. Comparative psychology can gain from increased attention to the mechanisms of adjustment used by organisms to "in vivo experiments" created by anthropogenic change. In this paper, we describe a conceptual framework useful for applying our understanding of animal communication to conservation biology. We then review studies of animal communication with conservation implications, and report our own preliminary work that demonstrates our framework in action.
Buffer-Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft and Outboard-Powered Boats	Rodgers, JA; Schwikert, ST, 2002, "Buffer-Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft and Outboard-Powered Boats" **Conservation Biology** Vol. 16, no. 1, pp. 216-224.	Outdoor recreation and ecotourism can have negative effects on wildlife species, so it is important to determine buffer zones within which activities near critical wildlife areas are limited. We exposed 23 species of waterbirds (Pelecaniformes, Ciconiiformes, Falconiformes, Charadriiformes) to the direct approach of a personal watercraft (PWC) and all outboard-powered boat to determine their flush distances. We used 11 sites with a mixture of low, moderate, and high amounts of human activity along the east and west coasts of Florida during September-November 1998 and April-June 1999. We detected considerable variation In flush distances among individuals within the same species and among species in response to both types of vessels. Average flush distances for the PWC ranged from 19.5 m (Least Tern [Sterna antillarum]) to 49.5 m (Osprey [Pandion haliaetus]), whereas average flush distances for the outboard-powered boat ranged from 23.4 m (Forster's Tern [S. forsteri]) to 57.9 in (Osprey). Larger species generally exhibited greater average flush distances for both types of watercraft. A comparison of the flush distances elicited by each watercraft indicated that only the Great Blue Heron (Ardea herodias) exhibited significantly larger flush distances (t test, $p<0.01$) in response to the approach of the PWC than in response to the outboard, whereas four species (Anhinga [Anhinga anhinga], Little Blue Heron [Egretta caerulea], Willet [Catoptrophorus semipalmatus], and Osprey) exhibited significantly larger flush distances (t test, $p<0.05$) in response to the approach of the outboard-powered boat than In response to the PWC. Eleven species (68.8%) showed no significant difference (t test $p>0.05$) in their flush distances in response to the fast-moving PWC and the outboard-powered boat. Our data suggest that a single buffer-zone distance can be developed for both PWC and outboard-powered vessels. Buffer zones of 180 in

		for wading birds, 140 in for terns and gulls, 100 in for Plovers and sandpipers, and 150 in for ospreys would minimize their disturbance at foraging and loafing sites in Florida.
Reactions of Seals to Underwater Playbacks of Drilling and Icebreaker Noise	Smultea, M. A., et.al. 2000, Reactions of seals to underwater playbacks of drilling and icebreaker **noise Northwestern Naturalist**, 81 (2): 87. 2000.	Few previous data are available on reactions of seals to noise from offshore oil exploration and production activities. In this paper, the authors describe observed reactions of ringed (Phoca hispida) and bearded seals (Erignathus barbatus) to drilling and icebreaker sounds projected underwater along ice edges during spring in the Alaskan Beaufort Sea. Given plans and the potential for development of offshore oil resources in this region and elsewhere, such information is important in assessing potential impacts of these activities on marine mammals. Ice-based observations were conducted during spring 1989-91 and 1994 off Pt. Barrow, Alaska. The authors observed 88 seal groups during a total of 74 h of drilling sound playback, 45 groups during 40 h of icebreaker playback, and 111 during 213 h while the projector was silent. During both playback and quiet periods, most seals surfaced briefly and then dove at distances of 25-500 m from the projector site. During playbacks, more seals were sighted but they departed sooner. Some seals approached the operating projector. Seals apparently avoided the area withn 20-25 m of the operating projector, where broadband received levels below the surface were high. Results suggest that some seals tolerate moderately strong (up to at least 50 dB above ambient) underwater noise from simulated drilling and icebreaking.
Separating the Noise From the Noise: A Finding in Support of the "Niche Hypothesis," That Birds are Influenced by Human-Induced Noise in Natural Habitats.	Stone, Eric, 2000, Separating the **noise** from the **noise**: a finding in support of the "Niche Hypothesis," that birds are influenced by human-induced **noise** in natural habitats. **Anthrozoos**, 13(4): 225-231	Controlling for the confounding influence of physical disturbance, it was possible to test the hypothesis that ambient noise alone would play a role in structuring bird communities in riparian habitats in Boulder, Colorado, USA. Point counts of birds were conducted in open space/minimally disturbed, residential, commercial and industrial neighborhoods. Within the same disturbance parameters and land use, species richness and PIF scores (a weighted value based on species importance) consistently and significantly decreased as ambient noise increased. These results can be viewed as support for the "Niche Hypothesis" (Krause 1987, 1998), that wildlife species' acoustic niches are adversely affected by human-induced noise pollution
Boat Traffic Affects the Acoustic Behaviour of Pacific Humpback Dolphins, *Sousa Chinensis*	Van Parijs, Sofie M.; Corkeron, Peter J, 2001, Boat traffic affects the acoustic behaviour of Pacific humpback dolphins, Sousa chinensis **Marine Biological Association of the United Kingdom. Journal**, 81(3): 533-538	In this study, the indirect (i.e. boats not involved in dolphin viewing activities) impacts of boat traffic on the acoustic behaviour of Pacific humpback dolphins, Sousa chinensis, were assessed in Moreton Bay, Australia. Humpback dolphin acoustic behaviour is affected by transiting boat traffic. Boats' passage did not affect the rates at which dolphins produced click trains and burst pulse vocalizations. However, dolphins significantly increased their rate of whistling immediately after a boat moved through the area. This increase occurred only when boats were less than 1.5 km from the groups. Groups including mother-calf pairs showed an increase in whistles in response to boats'

		passage. Groups with no calves produced significantly fewer whistles. This evidence suggests that the noise from transiting vessels affects dolphins' group cohesion. Mother-calf pairs appear to be most disturbed by transiting vessels and exhibit an increased need to re-establish vocal contact
Overflights and Aircraft Noise		
Response of Nesting Red-Tailed Hawks to Helicopter Overflights	Andersen D E.; Rongstad O J;and Mytton W R., 1986, "Response of Nesting Red-Tailed Hawks to Helicopter Overflights" **Condor**. 91(2).. 296-299.	Low-level helicopter overflights of 35 Red-tailed Hawk (Buteo jamaicensis) nests were conducted at two study areas in southeastern and east-central Colorado in 1984 and 1985. Red-tailed Hawks nesting where low-level air traffic was nonexistent prior to 1983 exhibited stronger avoidance behavior than did hawks nesting where helicopter activity had occurred since the late 1950s. Nine (53%) of 17 birds in the first study area flushed from the nest while only one (8%) of 12 birds in the second study area flushed. Age of nestlings at the time an overflight occurred did not influence avoidance behavior, and overflights did not appear to influence nesting success at either study area. Our results are consistent with the hypothesis that Red-tailed Hawks habituate to low-level air traffic during the nesting period. However, naive birds may respond negatively to low-level helicopter activity prior to habituation and other species of raptors may respond differently than Red-tailed Hawks
Effects of Fixed-Wing Military Aircraft Noise on California Gnatcatcher Reproduction	Aubrey, F. and Hunsaker, D., 1997, Effects of fixed-wing military aircraft **noise** on California gnatcatcher reproduction **The Journal of the Acoustical Society of America**, 102(5pt.2): 3177	To test the assumption that high levels of aircraft noise impede bird reproduction, noise analyzers were placed for 1 week in the nesting territory of each of 39 California gnatcatcher pairs on Naval Air Station Miramar. The 1-week average sound levels (7DL) recorded in those nesting territories were then related to the number of nest attempts; number of eggs laid; number of chicks hatched; number of chicks fledged; and number of eggs, chicks, and fledglings per nest attempt. Nest attempts and eggs laid have weak negative correlations (p=0.14 and 0.28) with 7DL. That is, the birds may tend to build fewer nests and lay fewer eggs in noisier areas, which is consistent with the common observation that bird nesting is more easily disturbed before eggs are laid than after. None of the other indicators is correlated with sound levels. Once a nest is established, with eggs in it, military aircraft noise has no detectable influence on reproductive performance. Gnatcatchers reproduced in places where 1 HL exceeds 80 dB for several hours every day. If fixed-wing aircraft noise impedes California gnatcatcher reproduction, it is overwhelmed by such factors as disturbance, predation, weather, edge effects, and differences in quality of habitat.
Responses of Mountain Sheep to Helicopter Surveys.	Bleich, V. C., R. T. Bowyer, A. M. Pauli, R. L. Vernoy, and R. W. Anthes, 1990, "Responses of mountain sheep to helicopter surveys" **California Fish and Game** 76:197-204.	Effects of helicopter surveys on distribution and movements of desert-dwelling mountain sheep, Ovis canadensis, were studied in San Bernardino County, California during April and June 1988. Adult males and females with radio collars moved about 2.5 times farther

		the day following a helicopter survey than on the previous day. Further, 35-52% of these animals changed polygons (8-83 km2) following sampling from a helicopter, whereas only 11% did so the day prior to the survey. Likewise, some animals left the study area following surveys. Sampling intensity (0.8 min/km2 vs. 2.0 min/km2) had little effect on movement of mountain sheep. Similarly, terrain type (steep vs. rolling) did not influence movement of female mountain sheep following helicopter surveys. Movement by mountain sheep during a helicopter survey may violate fundamental assumptions of several population estimators.
Mountain Sheep *(Ovis Canadensis)* and Helicopter Surveys: Ramifications for the Conservation of Large Mammals.	Bleich,V.C. et.al., 1994, "Mountain Sheep *(Ovis Canadensis)* and Helicopter Surveys: Ramifications for the Conservation of Large Mammals" **Biological Conservation** Vol. 70 pp. 1-7	Mountain sheep Ovis canadensis respond dramatically to helicopter disturbance. Significantly more animals abandoned sampling blocks and moved farther during helicopter surveys than on nonsurvey days throughout the year. Likewise, mountain sheep changed the vegetation type they occurred in more often after than before helicopter surveys: however, this difference was only significant during spring. Mountain sheep did not habituate or become sensitized to repeated helicopter overflights: time since capture was not related to their movements. The negative influence of the helicopter was extreme and may override variables that might otherwise be correlated with movement patterns of mountain sheep: this outcome also may hold for other ungulates. Further, sampling with helicopters may result in the violation of fundamental assumptions of population estimators routinely employed in conservation efforts for large mammals. The consequences of disturbing mountain sheep, such as altering use of habitat, increasing susceptibility to predation, or increasing nutritional stress, need additional study. These factors all have ramifications for the conservation of mountain sheep and other large mammals disturbed by helicopter sampling.
Effects of Simulated Aircraft Noise on Hearing, Food Detection, and Predator Avoidance Behavior of the Kit Fox, Vulpes Macrotis.	Bowles A. E and Jon F., 1993, "Effects of simulated aircraft noise on hearing, food detection, and predator avoidance behavior of the kit fox, Vulpes macrotis." Paper **ASA 125th Meeting** Ottawa"	Four kit foxes were captured south of Gila Bond, Arizona, in an area not overflown by aircraft. Hearing thresholds were measured by startle inhibition with a San Diego Instruments Startle Recording System. Shaped 200-ms tone bursts ranging from 100 Hz to 40 kHz in octave steps were delivered using a step-up, step-down procedure. Startle responses were elicited by a 40-psi air puff 30 ms in duration following 100 ms after the tone burst and startle intensity and latency were measured. Threshold at best frequency lay between -10 and -15 dB re: 20 (mu)Pa at 2--4 kHz and declined rapidly below 1 kHz and above 20 kHz. Foxes were trained to identify simulated prey and predator noise at the minimum level required for detection. Latancies to respond were measured in the absence and presence of simulated aircraft noise, simulated by recordings of F-4 fighter aircraft played for 40 min at 96 dB re: 20 (mu)Pa with onset rate of 25 dB/s. Foxes were also exposed to aircraft noise for 3 h while asleep during the day. Results available to date indicate that foxes can detect test signals

		and respond in the presence of aircraft noise; latencies to response are altered during tests but not after; and no changes in activity are detected during daytime exposures.
Sonic Boom/Animal Stress Project Report on Elk, Antelope, and Rocky Mountain Bighorn Sheep.	Bunch T. D and. Workman, G. W, 1993, "Sonic boom/animal stress project report on elk, antelope, and Rocky Mountain bighorn sheep." Paper **ASA 125th Meeting** Ottawa	The experimental animals included elk, antelope, and Rocky Mountain bighorn sheep. These animals were instrumented with heart rate and body temperature transmitters, which were surgically implanted in the animals. The animals were released in large enclosures, and in some cases were released to the wild for disturbance tests. This was done to determine effects of various disturbances on heart rate and to establish a baseline physiologic database of normal heart rate and body temperature. The animals were subjected to various types of disturbances, including people on foot, motorcycles, four-wheeled vehicles, fixed wing aircraft, helicopters, and F-16 jet aircraft flown subsonic and supersonic, etc. These projects indicated that animals habituated to most disturbance factors in a short period of time. The exceptions included people on foot who entered the research enclosures where the animals were kept; fixed wing aircraft at low levels of flight; and helicopter flights at low elevations near the animal enclosures. The animals habituated to subsonic and supersonic jet overflights after about four passes over the animals. This habituation seemed to be permanent, as these same animals did not respond when tested at a later date.
Effects of Aircraft Noise on Time-Activity Budgets of Wintering Black Ducks.	Collazo, J and Fleming, J., 1993, "Effects of aircraft noise on time-activity budgets of wintering black ducks" Paper **ASA 125th Meeting** Ottawa	The primary goal of this study was to determine if the time-activity budget (TAB) of wintering black ducks (Anas rubripes) was significantly altered by military aircraft noise at the U. S. Marine Corps target range in Piney Island, North Carolina. Sound levels were measured concurrently with behavioral observations. Over a sampling period of 81 days, exceedances >80 dB occurred on 289 occasions, the mean duration of exceedances was 5.09 s, and the mean sound pressure was 85.7 dB. Black ducks spent between 0.2% and 0.5% of their time reacting to aircraft. Correspondingly, the energetic costs of these reactions were low. TABs of black ducks in the high noise environment of Piney Island were within the expected range of those in low noise environments based on published literature. In a follow-up study, captive black ducks were subjected to simulated jet noise at levels approximately those recorded in the field. Measured levels of reactions to noise stimuli indicated that ducks habituated within 1 day. These results suggest that low reaction levels recorded in the field reflect the species' habituation capabilities to some kinds of disturbance. [Work supported by USMC and USAF.]
Dabbling Duck Behavior and Aircraft Activity in Coastal North Carolina	Conomy, John T., et. al., 1998, "Dabbling Duck Behavior and Aircraft Activity in Coastal North Carolina" **Journal of Wildlife Management**. vol. 62, no. 3, pp. 1127-1134	Requests to increase military aircraft activity in some training facilities in the United States have prompted the need to determine if waterfowl and other wildlife are adversely affected by aircraft disturbance. We quantified behavioral responses of wintering American black ducks

		(Anas rubripes), American wigeon (A. americana), gadwall (A. strepera), and American green-winged teal (A. crecca carolinensis) exposed to low-level flying military aircrafts at Piney and Cedar islands, North Carolina, in 1991 and 1992. Waterfowl spent ltoreq1.4% of their time responding to aircraft, which included flying, swimming, and alert behaviors. Mean duration of responses by species ranged from 10 to 40 sec. Costs to each species were deemed low because disruptions represented a low percentage of their time-activity budgets, only a small proportion of birds reacted to disturbance (13/672; 2%), and the likelihood of resuming the activity disrupted by an aircraft disturbance event was high (64%). Recorded levels of aircraft disturbance (i.e.,x = 85.1 dBA) were not adversely affecting the time-activity budgets of selected waterfowl species wintering at Piney and Cedar islands
Do Black Ducks and Wood Ducks Habituate to Aircraft Disturbance	Conomy, JT; Dubovsky, JA; Collazo, JA; Fleming, WJ, 1998, "Do black ducks and wood ducks habituate to aircraft disturbance" **Journal of Wildlife Management** Vol. 62, no. 3, pp. 1135-1142	Requests to increase military aircraft activity in some training facilities in the United States have prompted the need to determine if waterfowl and other wildlife are adversely affected by aircraft disturbance. We quantified behavioral responses of wintering American black ducks (Anas rubripes), American wigeon (A. americana), gadwall (A. strepera), and American green-winged teal (A. crecca carolinensis) exposed to low-level flying military aircrafts at Piney and Cedar islands, North Carolina, in 1991 and 1992. Waterfowl spent ltoreq1.4% of their time responding to aircraft, which included flying, swimming, and alert behaviors. Mean duration of responses by species ranged from 10 to 40 sec. Costs to each species were deemed low because disruptions represented a low percentage of their time-activity budgets, only a small proportion of birds reacted to disturbance (13/672; 2%), and the likelihood of resuming the activity disrupted by an aircraft disturbance event was high (64%). Recorded levels of aircraft disturbance (i.e.,x = 85.1 dBA) were not adversely affecting the time-activity budgets of selected waterfowl species wintering at Piney and Cedar islands.
Mountain Goat Responses to Helicopter Disturbance.	Cote, S.D., 1996, "Mountain Goat Responses to Helicopter Disturbance" **Wildlife Society Bulletin** Vol. 24 pp. 681-685	Mountain goat (Oreamnos americanus) responses to helicopter traffic were investigated at Caw Ridge (Alberta) from lune to August 1995. A population of 109 marked individuals inhabited the ridge during the study. As measured by their overt responses, mountain goats were disturbed by 58% of the flights and were more adversely affected when helicopters flew within 500 m. Eighty-five percent of flights within 500 m caused the goats to move >100 m; 9% of the flights >1,500 m away caused the goats to move similar distances. Helicopter visibility and height above ground, number of goats in the group, group type (bachelor or nursery), and behavior of groups just prior to helicopter flights did not appear to influence reactions of goats to helicopters. Helicopter flights caused the disintegration of social groups on greater than or equal to 5 occasions and resulted in 1 case of severe injury to an adult female. Based on these observations, restriction of helicopter

		flights within 2 km of alpine areas and cliffs that support mountain goat populations is recommended.
Unfriendly Skies : The Threat of Military Overflights to National Wildlife Refuges	Defenders of Wildlife, 1994. **Unfriendly Skies : the threat of military overflights to national wildlife refuges** Washington, D.C	This report shows that military flights distrub wildlife on at least 35 National Wildlife refuges. It discusses the impact these overflights have on the wildlife in these areas.
Effects of Helicopter Noise on Mexican Spotted Owls	Delaney, DK; Grubb, TG; Beier, P; Pater, LL; Reiser, MH, 1999, "Effects of helicopter noise on Mexican spotted owls" **Journal of Wildlife Management** Vol. 63, no. 1, pp. 60-76	Military helicopter training over the Lincoln National Forest (LNF) in southcentral New Mexico has been severely limited to protect nesting Mexican spotted owls (Strix occidentalis lucida). To evaluate nesting and nonnesting spotted owl responses to helicopter noise, we measured flush frequency, flush distance. alert behavior, response duration, prey delivery rates, female trips from the nest, and nest attentiveness during manipulated and nonmanipulated periods, 1995-96. Chain saws were included in our manipulations to increase experimental options and to facilitate comparative results. We analyzed stimulus events by measuring noise levels as unweighted one-third-octave hand levels, applying frequency weighting to the resultant spectra, and calculating the sound exposure level for total sound energy (SEL) and the 0.5-sec equivalent maximum energy level (LEQ max 0.5-sec) for helicopters, and the 10-sec equivalent average energy, level (LEQ avg. 10-sec) for chain saws. An owl-weighting (dBO) curve was estimated to emphasize the middle frequency range where strigiform owls have the highest hearing sensitivity. Manipulated and nonmanipulated nest sites did not differ in reproductive success (P = 0.59) or the number of young fledged (P = 0.12). As stimulus distance decreased, spotted owl flush frequency increased, regardless of stimulus type or season. We recorded no spotted owl flushes when noise stimuli were >105 m away. Spotted owls returned to predisturbance behavior within 10-15 min after a stimulus event. All adult flushes during the nesting season occurred after juveniles had left the nest. Spotted owl flush rates in response to helicopters did not differ between nonnesting (13.3%) and nesting seasons (13.6%; P = 0.34). Spotted owls did not flush when the SEL noise level for helicopters was ltoreq102 dBO (92 dBA) and the LEQ level for chain saws was ltoreq59 dBO (46 dBA). Chain saws were more disturbing to spotted owls than helicopter flights at comparable distances. Our data indicate a 105-m buffer zone for helicopter overflights on the LNF would minimize spotted owl flush response and any potential effects on nesting activity.
Dall's Sheep Responses to Overflights by Helicopter and Fixed-Wing Aircraft	Frid, Alejandro, 2003, "Dall's Sheep Responses to Overflights by Helicopter and Fixed-Wing Aircraft**."** **Biological Conservation** Vol. 110 pp387-399	High rates of behavioural disruption caused by human activities could jeopardize the body condition and reproductive success of wildlife. I exposed Dall's sheep (Ovis dalli dalli) of the Yukon Territory to experimental overflights by a fixed-wing aircraft and a helicopter. Aircraft approaches that were more direct (as determined by the

		aircraft's elevation and horizontal distance from sheep) were more likely to elicit fleeing or to disrupt resting. Latency to resume feeding or resting after fixed-wing overflights was longer during more direct approaches. During indirect approaches by helicopters, sheep far from rocky slopes were much more likely to flee than sheep on rocky slopes. Sheep did not flee while nearby helicopters flew along the opposite side of a ridge, presumably because the obstructive cover buffered disturbing stimuli. Results provide preliminary parameters for predicting energetic and fitness costs incurred as a function of overflight rates, and can help mitigate disturbance by guiding temporal and spatial restrictions to aircraft
Disturbance of Emperor Penguin Aptenodytes Forsteri Chicks by Helicopters	Giese, Melissa and Riddle, Martin, 1999 "Disturbance of emperor penguin Aptenodytes forsteri chicks by helicopters" **Polar Biology**. 22(6) 366-371.	Creching emperor penguin (Aptenodytes forsteri) chicks were exposed to two overflights by a Sikorsky S-76, twin engine helicopter at 1000 m (3300 ft), a current operational guideline of the Australian Antarctic Division for helicopter activity in Antarctica. The flights were conducted on the same day but under different wind conditions: a morning flight with a 10-knot (18 km h-1) katabatic wind blowing perpendicular to the direction of helicopter travel, and an afternoon flight with virtually no wind. Background noise levels recorded in the morning before the helicopter flight were significantly higher than in the afternoon, but these differences were not detectable when the helicopter was overhead. There were also no significant differences in the way chicks responded to helicopters between the morning and afternoon flight. All chicks became more vigilant when the helicopter approached and 69% either walked or ran, generally moving less than 10 m toward other chicks (i.e. not scattering). Most chicks (83%) displayed flipper-flapping, probably indicating nervous apprehension. This behaviour was seldom displayed in the absence of disturbance. Although all effects were relatively transitory, the results support the introduction of a more conservative guideline of 1500 m (5000 ft) minimum overflight altitude for helicopter operations around breeding localities of this species.
A Technique for Dorsal Subcutaneous Implantation of Heart Rate Biotelemetry Transmitters in Black Ducks: Application in an Aircraft Noise Response Study	Harms, Craig A.; Fleming, W. James; .and Stoskopf, Michael K., 1997, "A technique for dorsal subcutaneous implantation of heart rate biotelemetry transmitters in black ducks: Application in an aircraft noise response study" **Condor**. 99(1) 231-237.	A technique for heart rate biotelemetry transmitter implantation was developed to monitor heart rate fluctuations of Black Ducks (Anas rubripes) in response to simulated aircraft noise in a large outdoor enclosure. A dorsal subcutaneous approach, with subcutaneous tunneling of lead wires, was employed for placement of the 32 g transmitters. A base-apex lead configuration, with leads anchored at the dorsal cervico-thoracic junction and the caudal keel, yielded the maximal ECG wave-form deflection for triggering the transmitter. Heart rates of six Black Ducks (three in each of two separate trials) were monitored for 3 days pre-noise to establish a baseline, and then for 4 days of simulated aircraft noise. The noise stimulus replicated an FB-111 military jet, and was played 48 times per day at a peak volume of 110 dB. Daily mean heart rates, used as indicators of metabolic rates, did not increase in response to noise. Recognizable acute heart rate

		increases corresponding with a noise event occurred with increased frequency during the first day of noise presentation, but on subsequent days the responses did not differ significantly from baseline. Acute heart rate responses to aircraft noise diminished rapidly, indicating the ability of Black Ducks to habituate to the auditory component of low altitude aircraft overflights.
Calving Success of Woodland Caribou Exposed to Low-level Jet Fighter Overflights	Harrington, F.H., Veitch, A.M., 1992, "Calving Success of Woodland Caribou Exposed to Low-level Jet Fighter Overflights" **Arctic** Vol. 45 pp. 213-218	Effects on woodland caribou (Rangifer tarandus caribou) of low-level millitary jet training at Canadian Forces Base - Goose Bay (Labrador) were studied during the 1986-88 training seasons. Calf survival was periodically monitored during 1987 and 1988 in a sample of 15 females wearing satellite-tracked radiocollars. During 1987, each female's exposure to low-level overflights was experimentally manipulated on a daily basis. In 1988, daily exposure was determined by analyzing jet flight tracks following the low-level flying season. Calf survival was monitored by survey flights every 3-4 weeks. A calf survival index, the number of survey periods (maximum = 4) that a cow was accompanied by a calf, was negatively correlated with the female's exposure to low-level jet overflights during the calving and immediate post-calving period and again during the period of insect harassment during summer. No significant relationship between calf survival and exposure to low-level flying was seen during the pre-calving period, during the late post-calving period prior to insect harassment, and during fall. In view of the continued depression of population growth in the woodland caribou population within the low-level training area, jets should avoid overflying woodland caribou calving range at least during the last week of May and the first three weeks of June.
Military Jet Activity and Sonoran Pronghorn	Krausman, P. R., Harris, Lisa K., 2002, "Military Jet Activity and Sonoran Pronghorn." **Zeitschrift Fuer Jagdwissenschaft**. 48(Supplement).. 140-147.	Forty percent of the habitat for the endangered Sonoran pronghorn (Antilocapra americana sonoriensis) in the United States is on the Barry M. Goldwater Range (BMGR), a bombing and gunnery range located in southwestern Arizona, USA. Wildlife and land managers have expressed concerns that military aircraft activity may be detrimental to Sonoran pronhorn. We observed the response of Sonoran pronghorn to military jet activity from 4 vantage points, BMGR from February 1998 to June 2000. We obtained behavioral observations on 172 days and obtained 44,773 observation events (i.e., 1 observation / 30 seconds). Pronghorn were exposed to 109 direct military overflights, but only 6 were <305 in above ground level. Overall, behavior of males and females was not significantly different and the presence of military aircraft did not cause changes in behavior.
The Effects of Aircraft Noise on Pronghorn and Other Species	Krausman, Paul R, Lisa K. Harris, and Jennifer S. Ashbeck, 1998, **The Effects of Aircraft Noise on Pronghorn and Other Species** Special report Cooperative National Park Resources Studies Unit (Tucson, Ariz.) School of Renewable	Out of Print - Searching for copy of report

	Natural Resources, University of Arizona,|	
Pronghorn Use of Areas With Varying Sound Pressure Levels	Krausman, Paul, 2003, Pronghorn use of areas with varying sound pressure levels **Southwestern Naturalist**, 48(4): 725-728	The Sonoran pronghorn (Antilocapra americana sonoriensis), a subspecies in danger of extinction, inhabits an area of the Barry M. Goldwater Range (BMGR) in southwestern Arizona. Since 1941, BMGR has been a training site for military pilots. We evaluated whether this subspecies of pronghorn used areas, as defined by noise levels produced by military aircraft, in proportion to their availability. Radiocollar-equipped pronghorn were monitored during September 1994 to August 1998, and their locations were recorded on a map of sound levels. In general, pronghorn used areas with lower levels of noise (<45 decibels (dB)) more than expected and areas with higher levels (gtoreq55 dB) less than expected. More intensive monitoring, habitat influences, and additional measurements of noise in the area, could produce a clearer picture of the factors that determine areas of use within the BMGR by Sonoran pronghorn.
Effects of Jet Aircraft on Mountain Sheep	Krausman, PR; Wallace, MC; Hayes, CL; DeYoung, DW, 1998, "Effects of jet aircraft on mountain sheep" **Journal of Wildlife Management** Vol. 62, no. 4, pp. 1246-1254	Military-designated air spaces have been established above national parks and monuments, wildlife refuges, wilderness areas, and Department of Defense lands. Each of these landscapes is managed differently, which has led to questions of compatibility between military aircraft and wildlife. We determined the influence of F-16 aircraft overflights on mountain sheep (Ovis canadensis nelsoni) from January 1990 to May 1992 in the Desert National Wildlife Refuge, Nevada. We constructed a 320-ha enclosure and calibrated the area for sound pressure levels (i.e., noise) created by F-16 aircraft flying along the ridgeline of the mountains in the enclosure, approximately 125 m above ground level. In May 1990, we placed 12 mountain sheep from the surrounding area in the enclosure and monitored their behavior and use of habitats for 1 year to ensure they were familiar with the area before they were subjected to aircraft overflights. The habitat use and activity of the sheep in the enclosure were similar to free-ranging conspecifics. In May 1991, we instrumented 5 mountain sheep with heart-rate monitors and added them to the enclosure. During May 1991 to May 1992, F-16 aircraft flew over the enclosure 149 times during 3 1-month periods. We recorded heart rate and behavior of sheep 15 min preoverflight, during the overflight, and postoverflight. Heart rate increased above preflight levels in 21 of 149 overflights but returned to preflight levels within 120 sec. When F-16 aircraft flew over the enclosure, the noise levels created did not alter behavior or use of habitat, or increase heart rates to the detriment of the sheep in the enclosure.
Modelling Energy and Reproductive Costs in Caribou Exposed to Low Flying Military Jet	Luick, J. A., J. A. Kitchens, R. G. White, and S. M. Murphy, 1996, "Modelling energy and reproductive costs in caribou exposed to low flying military jet aircraft." **Rangifer** Special Issue 9: 209-211	Requested Article Through Interlibrary Loan

Aircraft		
Responses of Caribou to Overflights by Low-Altitude Jet Aircraft	Maier, JAK; Murphy, SM; White, RG; Smith, MD, 1998, "Responses of caribou to overflights by low-altitude jet aircraft." **Journal of Wildlife Management** . Vol. 62, no. 2, pp. 752-766	Military training exercises have increased in Alaska in recent years, and the possible effects of low-altitude overflights on wildlife such as barren-ground caribou (Rangifer tarandus) have caused concern among northern residents and resource agencies. We evaluated the effects of overflights by low-altitude, subsonic jet aircraft by U.S. Air Force (USAF) A-10, F-15, and F-16 jets on daily activity and movements of free-ranging female caribou. This study was conducted on caribou of the Delta Caribou Herd in interior Alaska during each of 3 seasons in 1991: late winter,, postcalving, and insect harassment. Noise levels experienced by caribou were measured with Animal Noise Monitors (ANMs) attached to radiocollars. Caribou subjected to overflights in late winter interrupted resting bouts and consequently engaged in a greater number of resting bouts than caribou not subjected to overflights (P = 0.05). Caribou subjected to overflights during postcalving were more active (P = 0.03) and moved farther (P = 0.01) than did caribou not subjected to overflights. Caribou subjected to overflights during the insect season responded by becoming more active (P = 0.01). Responses of caribou to aircraft were mild in late winter, intermediate in the insect season, and strongest during postcalving. We conclude that females with young exhibit the most sensitive response to aircraft disturbance. Accordingly, military training exercises should be curtailed in areas where caribou are concentrated during calving and postcalving
Nursing By Muskox Calves Before During and After Helicopter Overflights	Miller F L; Gunn A.; and Barry S J.; 1988, "Nursing By Muskox Calves Before During And After Helicopter Overflights" **Arctic**. 41(3) 231-235.	Nursing bouts by 15 muskox (Ovibos moschatus) calves were measured to evaluate potential use of nursing behaviour as an indicator of muskox responses to helicopters. The muskox calves nursed 225 times during 313 hours of observation: 63% under undisturbed conditions; 12% when helicopter overflights took place; and 25% following those overflights. During exposure to the helicopter, the calf moved to the cow and then sometimes took the opportunity to nurse. Younger calves nursed relatively longer and more often than older calves; they also performed 68% of the nursings that occurred during helicopter overflights. Frequency and duration of nursing bouts are known to be related to the age of calves. This paper demonstrates that these aspects of nursing vary within or among muskox herds and concludes that observations of nursing at this level of effort cannot be employed with any confidence as a monitoring indicator of muskox response to helicopters.
A Simulation Model of Helicopter Disturbance of Molting Pacific Black Brant	Miller, M. W.; Jensen, K. C.; Grant, W. E.; and Weller, M. W., 1994, "A simulation model of helicopter disturbance of molting Pacific black brant" **Ecological Modelling**. 73(3-4) 293-309.	We describe a simulation model designed to study the effects of helicopter disturbance on molting Pacific black brant near Teshekpuk Lake, Alaska. Locations of 18 118 brant were digitized into the model based on 10 years of population survey data. Bell 206 and Bell 412 helicopters were simulated flying across the molting grounds along two routes between two airfields. The model determined the behavioral and energetic response of birds encountered by the aircraft during an

		overflight. Attitude and frequency of overflights were held constant during a simulated 28-day molting period, but were varied among simulations. The model provided the degree of weight loss these birds experienced due to helicopter disturbance. The effects of overflights on brant were classified into five risk categories based on weight. For both routes, the number of flocks and birds in each category was determined for each altitude, aircraft type, and overflight frequency. Simulation results indicated that the model can be used to identify flight-line modifications that result in significantly decreased disturbance to the birds
Effects of Jet Aircraft Overflights on Parental Care of Peregrine Falcons	Palmer, Angela G., Nordmeyer, Dana L., Roby, Daniel D., 2003, "Effects of jet aircraft overflights on parental care of peregrine falcons" **Wildlife Society Bulletin**. 31(2).. 499-509	Concerns voiced by resource managers caused us to examine the hypothesis that low-altitude jet aircraft overflights affect parental care by peregrine falcons. Specifically, we studied effects on nest attendance, time-activity budgets, and provisioning rates of peregrine falcons (Falco peregrinus) breeding along the Tanana River, Alaska in 1995, 1996, and 1997. We detected subtle effects of jet overflights on peregrine falcon parental behavior, but found no evidence that overall attendance patterns differed depending on exposure to overflights. Nest attendance and time-activity budgets of peregrine falcons during periods of overflights differed from those of peregrines at reference nests (nests rarely overflown). Differences depended on stage of the nesting cycle and gender. During the incubation and brooding stages of the nesting cycle, males attended the nest ledge less when overflights occurred than did males from reference nests. Females attended the nest ledge more during overflown periods compared to females from reference nests. Additionally, while females were still brooding nestlings, they were less likely to be absent from the nest area during periods when overflights occurred than females from reference nests. Although we found differences in nest attendance and time-activity budgets between overflown and reference nests, we did not observe differences between periods with overflights and periods without overflights at the same nests. Nor did we detect a relationship between nest attendance and the number of overflights occurring within a given time period, the cumulative number of above-threshold noise events at each nest, or the average sound-exposure level of overflights. Furthermore, we found no evidence that nestling provisioning rates were affected by overflights.
Aircraft Sound and Disturbance to Bowhead and Beluga Whales During Spring Migration in the Alaskan Beaufort Sea.	Richardson, W. John, 2002, Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. **Marine Mammal Science**, 18(2): 309-335	Short-term behavioral responses of bowhead whales (Balaena mysticetus) and beluga whales (Delphinapterus leucas) to a Bell 212 helicopter and Twin Otter fixed-wing aircraft were observed opportunistically during four spring seasons (1989-1991 and 1994). Behaviors classified as reactions consisted of short surfacings, immediate dives or turns, changes in behavior state, vigorous swimming, and breaching. The helicopter elicited fewer detectable responses by bowheads (14% of 63 groups) than by belugas (38% of 40). Most observed reactions by bowheads (63%) and belugas (86%)

		occurred when the helicopter was at altitudes [ltoreq]150 m and lateral distances [ltoreq]250 m. Belugas reacted significantly more frequently during overflights at lateral distances [ltoreq]250 m than at longer lateral distances (P=0.004). When the helicopter was on the ice with engines running, 7 of 14 groups of belugas reacted, up to 320 m away, sometimes with small-scale ([ltoreq]100 m) diversion; only 1 of 8 groups of bowheads reacted. For the fixed-wing aircraft, few bowheads (2.2%) or belugas (3.2%) were observed to react to overflights at altitudes 60-460 m. Most observed reactions by bowheads (73%) and belugas (70%) occurred when the fixed-wing aircraft was at altitudes [ltoreq]182 m and lateral distances [ltoreq]250 m. However, the proportions reacting, especially to low-altitude flights (e.g., [ltoreq]182 m), were underestimated for both species because observation opportunities were brief. Even so, reactions were more common when the aircraft was low ([ltoreq]182 m): P=0.009 for belugas, P=0.06 for bowheads. There was little if any reaction by bowheads when the aircraft circled at altitude 460 m and radius 1 km. Aircraft sounds measured underwater at depths 3 m and 18 m showed that a Bell 212 helicopter was 7-17.5 dB noisier than a Twin Otter (10-500 Hz band). Bell 212 sound consisted mainly of main rotor tones ahead of the helicopter and tail rotor tones behind it. Twin Otter sound contained fewer prominent tones. Peak sound level as received underwater was inversely related to aircraft altitude, and received levels at 3 m depth averaged 2.5 dB higher than at 18 m depth. The dominant low-frequency components of aircraft sound are presumed to be readily audible to bowheads. For belugas, these components may be inaudible, or at most only weakly audible. Mid-frequency sound components, visual cues, or both, are probably important in eliciting beluga reactions to aircraft.
Flushing Responses of Wintering Bald Eagles to Military Activity	Stalmaster, Mark V. and Kaiser, James L., 1997, "Flushing responses of wintering bald eagles to military activity" **Journal of Wildlife Management**. 61(4) 1307-1313.	We studied flushing responses of wintering bald eagles (Haliaeetus leucocephalus) to military firing activity, helicopter overflights, and boating on the Nisqually River and Muck Creek on the Fort Lewis Army Reservation, Washington, during 1991-94. Eight percent of 1,452 eagles monitored near Muck Creek flushed during 373 firing events; 4.5% from ordnance explosions, 9% from automatic weapons fire, 6% from artillery impacts, 4% from mortar impacts, and 3% from small arms fire. Flushing by eagles decreased with increasing distance from firing events (16% flushed at 0.5-1.0 km, 9% at 1-2 km, 4% at 2-4 km, and <1% at 4-6 km). Forty-seven percent of 919 eagles flushed in response to 48 helicopter overflights, 37% on the Nisqually River and 53% on Muck Creek. Sixty-one percent of 1,825 eagles flushed in response to 52 experimental boat disturbances on the Nisqually River. Subadults flushed more often than adults, and eagles feeding or standing on the ground flushed more often than those perching in trees. Our data suggest that ordnance explosions, low-level helicopter overflights, and boating should be restricted near eagle foraging areas.

Conflicts in National Parks: A Case Study of Helicopters and Bighorn Sheep Time Budgets at the Grand Canyon	Stockwell, Craig A. and Gary C. Bateman, 1991, "Conflicts in National Parks: A Case Study of Helicopters and Bighorn Sheep Time Budgets at the Grand Canyon" **Biological Conservation** Vol. 56 pp. 317-328	Wildlife in numerous national parks of the United States experience frequent overflights by aircraft. Such activities may disturb wildlife populations. We analysed time budgets for desert bighorn sheep *Ovis canadensis nelsoni* in the presence and absence of helicopter overflights at Grand Canyon National Park (GCNP) to determine the extent to which food intake may be impaired. Bighorn were sensitive to disturbance during winter (43% reduction in foraging efficiency) but not during spring (no significant effect). This seasonal difference may have arisen because the sheep were farther from helicopters during the spring after they had migrated to lower elevations. Further analyses indicated a disturbance distance threshold of 250–450 m. The conservation implications of these results are discussed.
Effects of Low-Level Jet Aircraft Noise on the Behavior of Nesting Osprey	Trimper, Perry G., et. al., 1998, "Effects of Low-Level Jet Aircraft Noise on the Behavior of Nesting Osprey" **The Journal of Applied Ecology** Vol. 35 no. 1 pp. 122-130.	Nesting osprey Pandion haliaetus L. were exposed to controlled low-level CF-18 jet aircraft overflights along the Naskaupi River, Labrador, Canada, during 1995. Jet aircraft flew near five nests at distances ranging from 2.5 nautical miles (nm) to directly overhead at speeds of 400-440 knots. 2. Maximum noise levels (L1) and other noise metrics were influenced by many factors including topography, distance, altitude, wind speed and direction. 3. Based on 240 h of observations from blinds, we recorded osprey nest attendance and egg exposure during 139 individual overflights. Similar observations were completed at two control nests. Overflights as low as 30 m above ground occurred during incubation, nestling and prefledging only when observers were present. 4. Osprey behaviour did not differ significantly ($P = 0.126$) between pre- and post-overflight periods. Despite L1 values occasionally exceeding 100 decibels, adult osprey did not appear agitated or startled when overflown. 5. Osprey were attentive to and occasionally flushed from nests when float planes, other osprey or raptors entered territories, and when observers were entering or exiting blinds
Response of Fall-Staging Brant and Canada Geese to Aircraft Overflights in Southwestern Alaska	Ward, DH; Stehn, RA; Erickson, WP; Derksen, DV , 1999, "Response of fall-staging brant and Canada geese to aircraft overflights in southwestern Alaska" **Journal of Wildlife Management** Vol. 63, no. 1, pp. 373-381.	Because much of the information concerning disturbance of waterfowl by aircraft is anecdotal, we examined behavioral responses of Pacific brant (Branta bernicla nigricans) and Canada geese (B. canadensis taverneri) to experimental overflights during fall staging at Izembek Lagoon, Alaska. These data were used to develop predictive models of brant and Canada goose response to aircraft altitude, type, noise, and lateral distance from flocks. Overall, 75% of brant flocks and 9% of Canada goose flocks flew in response to overflights. Mean flight and alert responses of both species were greater for rotary-wing than for fixed-wing aircraft and for high-noise than for low-noise aircraft. Increased lateral distance between an aircraft and a flock was the most consistent predictive parameter associated with lower probability of a response by geese. Altitude was a less reliable predictor because of interaction effects with aircraft type and noise. Although mean response of brant and Canada geese generally was inversely

		proportional to aircraft altitude, greatest response occurred at intermediate (305-760 m) altitudes. At Izembek Lagoon and other areas where there are large concentrations of waterfowl, managers should consider lateral distance from the birds as the primary criterion for establishing local flight restrictions, especially for helicopters.
Effects of Simulated Jet Aircraft Noise on Heart Rate and Behavior of Desert Ungulates	Weisenberger, ME; Krausman, PR; Wallace, MC; De Young, DW; Maughan, OE, 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	The effects of simulated low-altitude jet aircraft noise on the behavior and physiology of 6 captive desert mule deer (Odocoileus hemionus crooki) and 5 mountain sheep (Ovis canadensis mexicana) were evaluated. Heart rate and behavior in relation to ambient temperature, number of simulated overflights/day, and noise levels [range =92--112 decibels (dB)] that the animals were exposed to were measured. Heart rates during simulated overflights (n=112/treatments/season) were compared to data collected prior to and following treatment periods. Differences between heart rates for animals, noise levels, and number of overflights between seasons were documented. All animals became habituated to sounds of low-altitude aircraft. Although heart rates increased during overflights they returned to resting rates in (less than or equal to)2 min.
Ecological and Population Impacts from Noise		
Energetic Cost of Man-Induced Disturbance to Staging Snow Geese.	Bélanger, L., and J. Bédard, 1990, "Energetic cost of man-induced disturbance to staging snow geese." **Journal of Wildlife Management** 54:36-41	Energetic cost of man-induced disturbance to fall-staging snow geese in Québec was estimated. Two responses of birds to disturbance were considered: (1) birds fly away but promptly resume feeding following a disturbance (Response A), and (2) birds interrupt feeding altogether (Response B). Daylight foraging time decreased by 4% to 51% depending on disturbance levels. Average rate of disturbance (1.46/hr) in Response A resulted in a 5.3% increase in hourly energy expenditure (HEE) combined with a 1.6% reduction of hourly metabolizable energy intake (HMEI). In Response B, HEE increased by 3.4% and HMEI decreased by 2.9% to 19.4%. A 4% increase in night feeding could compensate for energy losses caused solely by disturbance flights (Response A), but a 32% increase in nighttime feeding was required to restore energy losses incurred in Response B. No increase in daily feeding rate was observed between days with different disturbance levels ($P > 0.05$). Authors concluded that man-induced disturbance had significant energetic consequences for fall-staging greater snow geese
Human-caused Disturbance Stimuli as a Form of Predation Risk	Frid, A., and Dill, L.M., 2002, "Human-caused Disturbance Stimuli as a Form of Predation Risk" **Conservation Ecology** Vol. 6 no.1	A growing number of studies quantify the impact of nonlethal human disturbance on the behavior and reproductive success of animals. Athough many are well designed and analytically sophisticated, most lack a theoretical framework for making predictions and for understanding why particular responses occur. Behavioral ecologists have recently begun to fill this theoretical vacuum by applying economic models of antipredator behavior to disturbance studies. In this emerging paradigm, predation and nonlethal disturbance stimuli

		create similar trade-offs between avoiding perceived risk and other fitness-enhancing activities, such as feeding, parental care, or mating. A vast literature supports the hypothesis that antipredator behavior has a cost to other activities, and that this trade-off is optimized when investment in antipredator behavior tracks short-term changes in predation risk. Prey have evolved antipredator responses to generalized threatening stimuli, such as loud noises and rapidly approaching objects. Thus, when encountering disturbance stimuli ranging from the dramatic, low-flying helicopter to the quiet wildlife photographer, animal responses are likely to follow the same economic principles used by prey encountering predators. Some authors have argued that, similar to predation risk, disturbance stimuli can indirectly affect fitness and population dynamics via the energetic and lost opportunity costs of risk avoidance. We elaborate on this argument by discussing why, from an evolutionary perspective, disturbance stimuli should be analogous to predation risk. We then consider disturbance effects on the behavior of individuals—vigilance, fleeing, habitat selection, mating displays, and parental investment—as well as indirect effects on populations and communities. A wider application of predation risk theory to disturbance studies should increase the generality of predictions and make mitigation more effective without over-regulating human activities.
Why Behavioural Responses May Not Reflect the Population Consequences of Human Disturbance	Gill J. A., K. Norris, and W. J. Sutherland, 2001, "Why behavioural responses may not reflect the population consequences of human disturbance." **Biological Conservation** 97:265-268	The effect of human disturbance on animals is frequently measured in terms of changes in behaviour in response to human presence. The magnitude of these changes in behaviour is then often used as a measure of the relative susceptibility of species to disturbance; for example species which show strong avoidance of human presence are often considered to be in greater need of protection from disturbance than those which do not. In this paper we discuss whether such changes in behaviour are likely to be good measures of the relative susceptibility of species, and suggest that their use may result in confusion when determining conservation priorities.
Predicting the Consequences of Human Disturbance from Behavioral Decisions	Gill, J.A., Sutherland, W.J., 2000, "Predicting the Consequences of Human Disturbance from Behavioral Decisions**"** in Gosling, L.M. and Sutherland, W.J. (eds.) **Behavior and Conservation**. Cambridge: Cambridge University Press	Book Chapter – Requested Book Through Interlibrary Loan
A Method to Quantify the Effects of Human Disturbance on Animal Populations	Gill, J.A., Sutherland, W.J., Watkinson, A.R., 1996, "A Method to Quantify the Effects of Human Disturbance on Animal Populations" **Journal of Applied Ecology** Vol. 33 pp.786-792	1. The extent and consequences of human disturbance on populations of vertebrates are contentious issues in conservation. As recreational and industrial uses of the countryside continue to expand, it is becoming increasingly important that the effects of such disturbance on wildlife are quantified. 2. This study describes a method of quantifying the effect of disturbance, based on measuring the trade-off between resource use

		and risk of disturbance. This approach is based on one used by ethologists to study the effects of predation risk on patch use. 3. Pink-footed geese, Anser brachyrhynchus, feeding on arable fields, are highly responsive to disturbance from surrounding roads. The extent to which these fields are exploited declines linearly with increasing risk of disturbance. The reduction in use of these feeding grounds caused by disturbance can be quantified by translating the biomass of food not exploited into the number of birds that this food could have supported. 4. This approach allows both quantification of the impact of disturbance on a population, and exploration of the potential consequences of changes in disturbance on the size of populations.
Does Risk of Predation Influence Population Dynamics?	Hik, D. S., 1995, "Does risk of predation influence population dynamics?" **Wildlife Research** 22:115-129	Different patterns of survival and changes in body mass were observed in the presence and absence of terrestrial predators. On the CONTROL area, female body mass and fecundity declined, even though sufficient winter forage was apparently available in all years. A similar decrease in body mass was observed on the FOOD treatment, but only during the third year of the population decline. In contrast, female body mass remained high throughout the decline in the absence of terrestrial predators in the FENCE+FOOD and FENCE treatments. Winter survival declined on CONTROL and FENCE areas during the first year of the population decline (1991), but remained higher on FOOD until 1992 and FENCE+FOOD until 1993. These results generally supported the PSF hypothesis where terrestrial predators were present (CONTROL and FOOD grids). Where terrestrial predators were absent (FENCE and FENCE+FOOD), the results supported the alternative condition constraint hypothesis. The evidence suggests that a cascade of sublethal behavioural and physiological effects associated with increased predation risk contribute to the population decline and delayed recovery of cyclic low-phase populations of snowshoe hares.
Mountain Goat Population Changes in Relation to Energy Exploration Along Montana's Rocky Mountain Front	Joslin, G., 1986, **"**Mountain Goat population changes in relation to energy exploration along Montana's Rocky Mountain Front" **Biennial Symposium of the Northern Wild Sheep and Goat Council** 5, 253-271	Where caribou have been hunted or chased (passively or actively) herds are more likely to experience additional stress from associating man with danger, and are especially sensitive during the calving and rut periods. Harassment of unhabituated caribou to human disturbance may have immediate impacts as well as long term effects. Where humans or their machines are perceived as a threat, caribou often experience increased stress levels and subsequently expend more energy attempting to avoid the disturbance. Flight is the most common response for unhabituated animals that perceive humans as predators. This flight response uses up vital body reserves, increases the chance of physical injury or death during stampedes and may cause herd fragmentation. Utilisation of essential body fat and protein, especially during harsh climatic conditions, can lead to increased cow/calf

		mortality, and may effectively reduce productivity of the herd. Long term displacement from home range (especially during calving period) may result in increased mortality, decreased reproductive success, increased predation, altered habitat use and decreased caribou densities. Human activities within caribou range which do not necessarily destroy caribou habitat may still result in a functional loss of usable space by the disturbance and resulting displacement. The relatively isolated areas caribou live in may make them more responsive to human disturbance, eliciting high stress responses. Human activities such as hiking, snowmobiling, low altitude flights and ATV use, which briefly stress caribou are likely to have significant negative effects if animals are displaced out of their preferred habitat.
Stress and Decision Making Under The Risk of Predation: Recent Developments From Behavioral, Reproductive, and Ecological Perspectives	Lima, S. L., 1998, "Stress and decision making under the risk of predation: recent developments from behavioral, reproductive, and ecological perspectives". **Advances in the Study of Behavior** 27:215-290.	Requested Article Through Interlibrary Loan
Ecological and Physiological Aspects of Caribou Activity in Response to Aircraft Overflights	Maier, J., 1996, **Ecological and Physiological Aspects of Caribou Activity in Response to Aircraft Overflights**. Dissertation, University of Alaska, Fairbanks	Resource management agencies are concerned about the potential effects of these overflights on important species of ungulates. I hypothesized that low-altitude overflights would affect activity and movements of caribou, and thereby constitute a disturbance with negative consequences on energetics. I used caribou of the Delta Herd (DCH) and captive animals at the Large Animal Research Station (LARS) to address the hypotheses: caribou (1) exhibit equal activity day and night; (2) do not time activity to light; and (3) activity patterns do not change seasonally in response to daylength. Caribou were nychthemeral and exhibited uniform activity with no apparent timing to light. DCH caribou responded to seasonal changes in the environment by modifying activity (increased activity in response to insect harassment), whereas LARS caribou altered activity in response to fluctuating physiological variables (increased activity during rut). Changes in daylength did not affect activity. Data on activity from LARS and DCH caribou were compared with extant data on caribou of the Denali and Porcupine herds. Poor quality forage in winter was inferred from long resting bouts, and low availability of forage was inferred from long active bouts of post-calving caribou of the DCH. In midsummer, caribou of the DCH exhibited significantly longer active and shorter resting bouts than did LARS caribou, consistent with a moderate level of insect harassment. Responses of caribou to overflights were mild in late winter and, thus, overflights did not constitute a disturbance. Post-calving caribou responded to overflights

		by increasing daily activity, linear movements, incremental energy cost, and average daily metabolic rate. Energetic responses and movements were significantly related to the loudest overflight of the day. In the insect season, activity levels increased significantly in response to overflights but with no corresponding increase in linear movements or energetics. My recommendations are to prohibit aircraft overflights of caribou during calving and post-calving periods and during key feeding times in insect harassment seasons. Research indicates the possibility of more severe effects in nutritionally stressed animals.
Optimally Foraging Mice Match Patch Use with Habitat Differences in Fitness	Morris, D. W., and D. L. Davidson, 2000, "Optimally foraging mice match patch use with habitat differences in fitness." **Ecology** 81:2061-2066	We tested the fundamental assumption of the "optimality paradigm" that the foraging behavior of individual organisms corresponds to what we would expect if it had been honed by natural selection to match habitat differences in reproductive success. First, we used long-term studies of life history and habitat selection in white-footed mice to illustrate that the fitness of females living in the forest is greater than that of females living in forest-edge habitat. Second, we used short-term foraging studies to evaluate whether food patches located in the forest provided more value to foragers than did those in the edge. Third, we used foraging studies and data on the occurrence of predators to demonstrate that animals foraging in areas with little cover face higher risks than when they forage in areas with more cover. We confirmed three a priori predictions: (1) Individual mice abandoned foraging patches at higher harvest rates in edge habitat than they did in forest. (2) Individuals harvested resource patches to lower quitting harvest rates under cover than they did when patches were located in the open. (3) The difference in quitting-harvest rate between "open" and "covered" patches was less in the safe forest habitat than it was in the risky edge habitat. Our results yield an impressive fit with our previous knowledge of habitat differences in reproductive success and substantiate the premise that short-duration strategic decisions by individuals match habitat differences in fitness.
Reproductive Success of Elk Following Disturbance by Humans During Calving Season	Phillips, G. and Alldredge, A., 2002, "Reproductive Success of Elk Following Disturbance by Humans During Calving Season" **Journal of Wildlife Management** 64, 521-530	Restricting human activity in elk (Cervus elaphus) calving areas during calving season can be controversial because of increasing human uses of elk habitat, and little evidence exists to evaluate impacts of these activities on elk populations. We evaluated effects of human-induced disturbance on reproductive success of radiocollared adult female elk using a control-treatment study in central Colorado. Data were collected during 1 pretreatment year and 2 treatment years. Treatment elk were repeatedly approached and displaced by study personnel throughout a 3-4-week period of peak calving during both treatment years, while control elk did not receive treatment. We observed elk on alpine summer ranges in July and August on both areas to estimate the proportion of marked cows maintaining a calf. Calf/cow proportions for the control area remained stable, but those for the treatment area declined each year. Average number of

		disturbances/elk/year effectively modeled variation in calf/cow proportions, supporting treatment as the cause of declining calf/cow proportions. Average decrease in calf/cow proportion in the treatment group was 0.225. Modeling indicated that estimated annual population growth on both study areas was 7% without treatment application given that existing human activities cause some unknown level of calving-season disturbance. With an average of 10 disturbances/cow above ambient levels, our model projected no growth. Our results support maintaining disturbance-free areas for elk during parturitional periods.
Potential Energetic Effects of Mountain Climbers on Foraging Grizzly Bears	White, D., Jr., K. C. Kendall, and H. D. Picton, 1999, "Potential energetic effects of mountain climbers on foraging grizzly bears." **Wildlife Society Bulletin** 27:146-151.	Most studies of the effects of human disturbance on grizzly bears (Ursus arctos horribilis) have not quantified the energetic effects of such interactions. In this study, we characterized activity budgets of adult grizzly bears as they foraged on aggregations of adult army cutworm moths (Euxoa auxiliaris) in the alpine of Glacier National Park, Montana, during 1992, 1994, and 1995. We compared the activity budgets of climber-disturbed bears to those of undisturbed bears to estimate the energetic impact of climber disturbance. When bears detected climbers, they subsequently spent 53% less time foraging on moths, 52% more time moving within the foraging area, and 23% more time behaving aggressively, compared to when they were not disturbed. We estimated that grizzly bears could consume approximately 40,000 moths/day or 1,700 moths/hour. At 0.44 kcal/moth, disruption of moth feeding cost bears approximately 12 kcal/minute in addition to the energy expended in evasive maneuvers and defensive behaviors. To reduce both climber interruption of bear foraging and the potential for aggressive bear-human encounters, we recommend routing climbers around moth sites used by bears or limiting access to these sites during bear-use periods.
Behavior Responses and Reproduction of Mule Deer Does Following Experimental Harassment with an All-Terrain Vehicle	Yarmoloy, C., et. al., 1988, "Behavior Responses and Reproduction of Mule Deer Does Following Experimental Harassment with an All-Terrain Vehicle." **Canadian Field-Naturalist** 102, 425-429	Five mule deer were habituated to an ATV for 12 weeks. Three of the females were then followed by an ATV for 9 minutes per day for 15 days. The harassed females, but not the other females shifted feeding into darkness, used cover more frequently, left home ranges more often, and increased flight distance from the ATV. The harassed females also showed significant decreases in reproduction success.
Habituation		
Pronghorn Foraging Economy and Predator Avoidance in A Desert Ecosystem: Implications	Berger J., D. Daneke, J. Johnson, and S. H. Berwick, 1983, "Pronghorn foraging economy and predator avoidance in a desert ecosystem: implications for the conservation of large mammalian herbivores." **Biological Conservation** 25:193-	Assumptions of optimal foraging theory were applied to the feeding ecology of pronghorn to address issues of immediate relevance to conservation biology in the Great Basin Desert of North America. The relationships between foraging efficiency and (1) group size; (2) habitat; and (3) disturbance history were examined in two study sites. Individual foraging efficiency increased with group size to a point in

for the Conservation of Large Mammalian Herbivores.	208.	both study sites, but animals in the disturbed area remained in larger groups despite foraging less profitably. The hypothesis that individuals in a disturbed environment remain together for enhanced protection from (human?) predators was supported and interpreted in light of proposed habitat alterations in vast portions of this unique desert ecosystem.
Discrimination of the Threat of Direct Versus Tangential Approach to the Nest By Incubating Herring and Great Black-Backed Gulls	Burger, J., and M. Gochfeld, 1981, "Discrimination of the threat of direct versus tangential approach to the nest by incubating herring and great black-backed gulls." **Journal of Comparative and Physiological Psychology** 95:676-684	Requested Article
Risk Discrimination of Direct Versus Tangential Approach By Basking Black Iguanas (Ctenosaura Similis): Variation As A Function of Human Exposure.	Burger, J., and M. Gochfeld, 1990, "Risk discrimination of direct versus tangential approach by basking black iguanas (Ctenosaura similis): variation as a function of human exposure." **Journal of Comparative Psychology** 104:388-394	Requested Article
Responses of Bald Eagles to Human Activity During the Summer in Interior Alaska	Steidl, R. J., and R. G. Anthony, 1996, "Responses of Bald Eagles to human activity during the summer in interior Alaska." **Ecological Applications** 6:482-491	Along narrow rivers, spatial restriction of human use based on wildlife responses can effectively eliminate the entire river corridor from human use. Therefore, if river use by both wildlife and humans is a goal, an alternative management strategy is necessary. We measured flush response rate and flush distance of breeding and nonbreeding Bald Eagles (Haliaeetus leucocephalus) to recreational boating along the Gulkana River in interior Alaska from 1989 to 1992. Eagle responses to our nonmotorized boat were governed by the context within which human-eagle encounters occurred. Flush response rate of nonbreeding eagles decreased as perch height and its distance from the river's edge increased, increased as the season progressed and as eagle group size increased, was lower for juveniles (20%) than other age classes (49-65%), and varied with the existing level of human activity in geographic location ($P < 0.001$ for all parameters). Flush distance of nonbreeding eagles increased as the distance a disturbance was first visible to a perched eagle increased, as perch height and its distance from the river's edge increased, and as the season progressed. In contrast to flush response, flush distance was strongly associated with age and was greatest for adults, least for juveniles, and intermediate for subadults. Breeding adults were much less likely to flush than nonbreeding adults, and flushed at lesser distances. We recommend that along narrow wilderness rivers, the

		impacts of human activity on Bald Eagle populations be regulated with temporal, rather than spatial, restrictions.
Predictors of Vigilance for American Crows Foraging in An Urban Environment	Ward, C., and B. S. Low, 1997, "Predictors of vigilance for American Crows foraging in an urban environment" **Wilson Bulletin** 109:481-489	We examined ways in which American Crows (Corvus brachyrhynchos) foraging in an urban environment balance the conflicting demands of finding food and avoiding predators. As individual vigilance (i.e., scanning) decreased, time devoted to foraging increased. Significant predictors of vigilance varied with location and included time of day, temperature, food availability, distance to nearest source of disturbance, cover distance, and size of foraging group. Group size and, secondarily, distance from cover accounted for most of the variability in vigilance. Crows were more vigilant in areas of high human disturbance than in areas of low human disturbance.