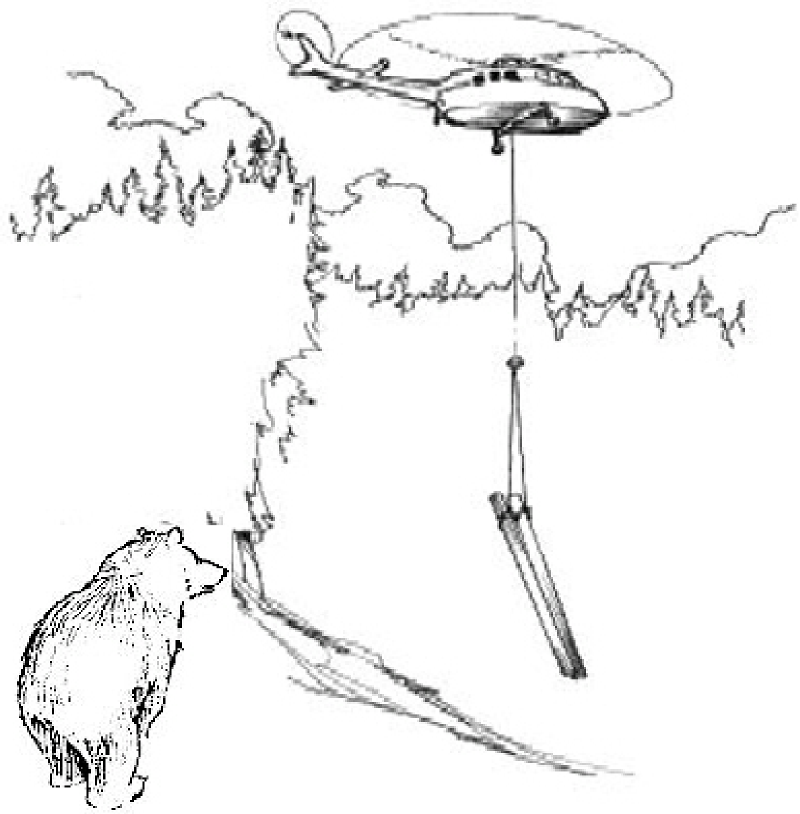
Guide to Effects Analysis of Helicopter Use in Grizzly Bear Habitat



Montana/Northern Idaho Level I Terrestrial Biologists Team
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Guide to Effects Analysis of Helicopter Use in Grizzly Bear Habitat

This Guide has been adopted by the Montana/Northern Idaho Level 1 Terrestrial Biologists Team for use throughout this geographic area. The Guide was prepared by the work group listed below, with support and input from the entire Level 1 Team.

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Background

The potential effects of motorized activities on grizzly bears have been the subject of much discussion and research, mostly in the context of roads and trails. Motorized use of roads and trails is recognized as one of the most influential factors affecting habitat security for grizzly bears because of a route's fixed, long-term presence on the landscape (IGBC 1998). Roads and other more permanent development can contribute to increased grizzly bear mortality, habituation to people, or long-term displacement from key habitat. Consequently, the management of human access to grizzly bear habitat through route restrictions is one of the most effective strategies to minimize human interactions with grizzly bears and potential bear mortality.

The potential effects of aircraft on grizzly bears have been less studied, with judgments based mostly on anecdotal observations. Aircraft typically exert temporary, audible effects in grizzly bear habitat without residual effects of roads or other physical features. Therefore, aircraft use does not generally result in the same level of effects to grizzly bears as those associated with roads or permanent developments. However, the lack of information and vague and inconsistent management direction relative to aircraft-supported activities in grizzly bear habitat has lead to inconsistent approaches to effects analysis for aircraft use.

The primary purpose of this Guide is to help biologists conduct defensible, consistent effects analysis of proposed helicopter use in grizzly bear habitat. Most of the principles contained herein could apply to fixed-wing aircraft use as well**.** This Guide is only a reference for analyzing potential effects and how these effects can be consistently disclosed in a biological assessment (BA). **This Guide does not establish standards, policy, or other direction regarding how managers may, or may not, use helicopters in grizzly bear habitat.**

Key Literature Findings Regarding Effects of Aircraft of Bears

Following are some key findings of the few studies that addressed aircraft effects on bears. The appendix expands on this information to include a selection of references with summaries, for aircraft effects on other species, as well as other industrial and human-caused disturbances on bears.

IGBC (1987) summarizes numerous studies that have documented a wide variety of reactions by grizzly bears to aircraft disturbance due to factors such as the degree of habituation to aircraft, availability of cover, altitude, noise level and behavior of the aircraft. Individual bears may demonstrate different tolerances to helicopter disturbance. Overall, grizzly bears may be more sensitive to helicopter disturbance than to fixed-wing aircraft.

Bear responses may range from: (1) slight loss of habitat due to avoidance or displacement; (2) disturbance of bears during denning, causing abandonment of dens; and (3) physiological or behavioral stress (Harding and Nagy 1980; Reynolds, et al. 1986).

Many of the studies occurred in more open country than normally found in northwest Montana and Northern Idaho which could elicit different responses from bears or actually prevent a response from being noticed due to forested cover. Harding and Nagy (1980) mention there is no evidence to suggest that the current numbers and distribution of grizzly bears are being affected by hydrocarbon exploration or associated activities, but neither can they show that the population has not been affected. McLellan and Shackleton (1989a) observed bears responded more strongly to fixed-wing aircraft when it was less than 150 meters away. In timbered habitats, McLellan and Shackleton (1989b) found that an overt avoidance or displacement response required high intensity helicopter activity, such as carrying equipment within 200 meters of a grizzly bear. Reynolds et al. (1986) detected increased heart rates in grizzly bears when fixed-wing aircraft were within 100 meters above ground level (AGL) after den emergence.

So in summary, the available evidence suggests that aircraft flying at relatively low altitudes in occupied habitat can elicit a response by grizzly bears. Effects may range from a simple awareness of the aircraft (i.e., raising the head but otherwise continuing uninhibited) to short-term disturbance or flight response (resulting in physiological changes such as increased stress and energetic demands) to temporary displacement from an area.

A Consistent Approach to Effects Analysis

The effects of helicopter operations on grizzly bears will depend on a number of variables, plus consideration of any extenuating circumstances. It is inappropriate to believe there is a "cook book" or "one size fits all" answer, such as *"administrative flights will not affect grizzly bears."* Each biologist preparing a BA is responsible to consider all relevant site-specific circumstances in arriving at and documenting the determination.

The biologist must consider (in part):

- Occupied or unoccupied grizzly bear habitat
- Sensitive habitat (e.g., spring range, post-denning area, important seasonal food sources)
- Time of year (denning or non-denning seasons)
- Core habitat or roaded habitat
- One flight, several flights, or extended operations
- Indirect effects of the overall operation (i.e., those that are caused by or will result from the proposed action and are later in time, but are still reasonably certain to occur)
- Actions interrelated to and interdependent upon the helicopter activity (i.e., what else is related to, or dependent upon, the flight?)…consider ground operations to support the helicopter as well as the intended purpose such as logging or communications tower maintenance

Furthermore, individual and population response by grizzly bears to human activity also includes the nature and extent of historical interactions with humans and the distribution of native habitats and foods (Mace and Waller 1996). In areas with relatively dense grizzly bear populations, the physiological cost to a bear caused by moving from preferred habitat (i.e., displacement) may be high because of the social intolerance of other bears. Conversely, if the grizzly bear population is low, moving from a disturbance would incur less cost because available habitats would be relatively abundant (McLellan and Shackleton 1989b).

Biologists should consider the following important factors in determining the effects of an action on fish and wildlife resources (USFWS and NMFS 1998, page 4-23):

Proximity of the action: To the species, management units, or designated critical habitat units.

Distribution: Geographic areas where the disturbance occurs (e.g., may be several small or one large area).

Timing: Relationship to sensitive periods of a species' lifecycle.

Nature of the effect: Effects of the action on elements of a species' lifecycle, population size or variability, or distribution; or on the primary constituent elements of the critical habitat, including direct and indirect effects.

<u>Duration</u>: The effects of a proposed action on listed species or critical habitat depend largely on the duration of its effects. Three potential categories of effects are: (1) a short-term event whose effects are relaxed almost immediately (pulse effect); (2) a sustained, long-term, or chronic event whose effects are not relaxed (press effect); or (3) a permanent event that sets a new threshold for some feature of a species' environment (threshold effect). For many species, a proposed action producing a single, short-term effect is less likely to jeopardize the continued existence of a species than a long-term chronic event or the permanent alteration of a species' habitat.

<u>Disturbance frequency</u>: The mean number of events per unit of time affects a species differently depending on its recovery rate. If the disturbance frequency is less than the species' recovery rate, the species might persist in the face of the disturbance. If the disturbance frequency equals the species' recovery rate, the species becomes more sensitive to the effects of other disturbances. If the disturbance frequency is greater than a species' recovery rate, the species will be unable to recover between disturbances. Disturbance frequency is an important consideration when evaluating the accumulating effects of proposed actions on listed species and/or designated critical habitat, particularly when it is combined with information on a species' recovery rate.

<u>Disturbance intensity</u>: The effect of the disturbance on a population or species as a function of the population or species' state after the disturbance. For example, a disturbance reducing the size of a population or critical habitat unit by 40 percent is more intense than a disturbance reducing population or unit size by 10 percent.

<u>Disturbance severity</u>: The effect of a disturbance on a population or species as a function of recovery rate; the longer the recovery rate, the more severe the disturbance. For example, a disturbance from which a species or habitat takes 10 years to recover is more severe than a disturbance requiring 2 years for recovery. A severe disturbance makes a population or species more susceptible to the effects of multiple actions.

<u>Removing or minimizing potential effects of an action</u>

By "deconstructing" a proposed action into its components, the biologist, working with the project proponents, can identify which components of the project may cause unacceptable effects or "stressors" to the species, and may recommend best management practices to avoid, minimize, or mitigate the stressor. For example, some helicopter operations might result in "no effect" if conducted during winter (denning period) and away from denning habitat. Likewise, effects might be lessened if conducted during the least important season of use such as lower elevations during late summer or fall while berries are out at higher elevations.

<u>Arriving at an Appropriate Effects Determination</u>

The final determination is made on the final project design, including measures to avoid or minimize potential adverse effects. If *potential* adverse effects were identified but avoided, then the BA should disclose this fact. The final determination should be based on the final likely effects, not the original potential effects.

The Endangered Species Consultation Handbook (USFWS & NMFS 1998) glossary includes the following definitions:

No Effect – the appropriate conclusion when the action agency determines its proposed action will not affect listed species or critical habitat.

Not Likely to Adversely Affect – the appropriate conclusion when effects on listed species are expected to be discountable, or insignificant, or completely beneficial.

> *Discountable effects* are those extremely unlikely to occur; they are possible but unlikely. Based on best judgment, a person would not expect discountable effects to occur.
>
> *Insignificant effect*s relate to the size of the impact and should never reach the scale where take occurs. Based on best judgment, a person would not be able to meaningfully measure, detect, or evaluate insignificant effects.
>
> *Beneficial effects* are contemporaneous positive effects without any adverse effects to the species.

Likely to Adversely Affect – the appropriate conclusion if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable, insignificant or beneficial. In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action is "*likely to adversely affect*" the listed species. If incidental ***take*** is anticipated to occur as a result of the proposed action, a "*likely to adversely affect*" determination should be made. A "*likely to adversely affect*" determination requires the initiation of formal section 7 consultation.

Take - to **harass**, **harm**, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. [ESA §3(19)]

- **Harm** is further defined by FWS to include *significant* habitat modification or degradation that results in death or injury to listed species by *significantly* impairing behavioral patterns such as breeding, feeding, or sheltering.
- **Harass** is defined by FWS as actions that create the *likelihood* of injury to listed species to such an extent as to *significantly disrupt* normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. [50 CFR §17.3]

General Agreement about Helicopter Effects on Grizzly Bears.

The Level 1 Team reached some general agreement after considering the common uses of helicopter operations, the results of the literature review, and the principles of the Consultation Handbook. Nevertheless, each biologist preparing a BA for proposed activities in grizzly bear habitat is responsible to consider all relevant circumstances in arriving at and documenting the determination.

A. Helicopter operations at altitudes greater than 500 meters AGL and with no landings generally should have "no effect" on grizzly bears.

Aircraft use > 500 meters AGL do not appear to elicit a behavioral response by bears. While these flights may take place over recovery zones or areas occupied by grizzly bears (proximity), the action's effects do not extend to the ground (distribution). Therefore, helicopter use at high altitudes (> 500 meters AGL), which may or may not involve multiple passes or multiple days, and which do not involve landing in grizzly bear habitat, are not expected to have any affect on grizzly bears. Consequently, a "*no effect*" determination is reasonable for similar actions.

Each specific helicopter activity should be reviewed by a qualified biologist to determine if there are extenuating circumstances that would warrant a determination other than "*no effect*."

Examples of helicopter operations > 500 meters AGL and with no landings:
➢ Administrative reconnaissance flights ➢ Cross-country travel

B. Helicopter operations at altitudes of less than 500 meters AGL, with or without landings generally "may affect" grizzly bears.

Low elevation flights (<500 meters AGL) typically elicit a response by bears. At issue is whether or not the response results in an adverse effect.

1. If the duration of helicopter use is short and the effects are relaxed almost immediately (see qualifiers below), then low altitude helicopter operations are generally "not likely to adversely affect" (NLAA) grizzly bears.

When aircraft are used at low altitudes (<500 meters AGL), bears become aware of the aircraft, may flee to cover, or may move away from an area. Helicopter use involving a short duration (e.g., one day) and low frequency (e.g., several trips) may affect grizzly bears, but because the disturbance is relatively minor in intensity and does not persist for long periods (or through a season), the consequences should be *insignificant.* In other words, the potential or actual effect on a grizzly bear could not be meaningfully measured, detected, or evaluated. The effect(s) should not cause injury, decrease productivity, or significantly interfere with normal behavior patterns such as breeding, feeding, or sheltering. A *"not likely to adversely affect"* determination is reasonable for similar actions.

Helicopter operations that *may affect but are not likely to adversely affect* grizzly bears include all of the following features:

- Low altitude (<500 m AGL)
- With or without landings
- In proximity to grizzly bears or their habitat
- The effects are relaxed almost immediately once activity is complete, with no lingering effects (low frequency, e.g., "in and out" drop off and pick up)
- The duration is short (activity usually concludes within a 48-hour period)

Each helicopter activity must be reviewed by a qualified biologist to determine if there are extenuating circumstances that would warrant a determination other than "*not likely to adversely affect.*"

Examples of helicopter operations < 500 meters AGL, with or without landings:
➢ Maintenance or supply of sites, such as fire lookouts, electronic sites, drill rig or other mineral operations ➢ Transport of tools or materials for trail improvements ➢ Wildlife surveys, captures, releases ➢ Personnel drop off or pick up ➢ Limited aerial herbicide/pesticide spraying (qualifiers above are met) ➢ Limited prescribed burning (qualifiers above are met) with limited ground activity

2. If the duration of the low altitude helicopter use is extended (occurs over a 48-hour period), and the effects are not relaxed (multiple trips, passes, or sweeps each day), then the operation is <u>generally</u> "likely to adversely affect" (LAA) grizzly bears (see qualifiers below).

The threshold for a "*likely to adversely affect"* determination is when the potential or actual effect on a grizzly bear can be meaningfully measured, detected, or evaluated. An adverse effect is present if:

- the impact significantly interferes with normal behavior patterns such as breeding, feeding, or sheltering
- the bear is likely to experience injury or decreased productivity
- the bear is likely to experience disturbance with high energetic costs and no period for recovery

Examples of extended helicopter operations < 500 meters AGL, with or without landings:
➢ Helicopter logging in Core habitat or undisturbed habitat ➢ Prolonged maintenance or servicing drill rigs and other mining or seismic operations ➢ Heli-skiing within denning habitat and extended post-denning season ➢ Heli-touring along established flight paths if at high frequency and < 500 meters AGL ➢ Extended aerial herbicide/pesticide spraying ➢ Extended prescribed burning ➢ Extended fire suppression activities *(follow emergency consultation procedures)*

Discussion of Extenuating Circumstances and "Gray Areas"

Helicopter Effects in and to Core Habitat

Security is an important consideration in managing grizzly bear habitat. Secure habitat that is relatively free of human disturbances is necessary for grizzly bears to meet their life requisites for survival and reproduction. The IGBC (1998) defined security "core" habitat in the terms of specific proximity to motorized roads and trails and recommended prescriptions for a certain percentage of "core" grizzly bear in each Bear Management Unit or Subunit. Core habitat is intended to provide a secure area that bears are familiar with and can rely on to be relatively free from the chronic disturbances of roads.

Research has consistently shown that female grizzly bears select home ranges with large areas of "core." This suggests the importance of areas relatively free of intense human disturbance within female grizzly bears home ranges. Thus, actions which compromise the purpose of core habitat are not easily characterized as "insignificant" or "discountable."

When discussing helicopter effects and core habitat, it is important to distinguish between the effect to the bear, and the management implication (accounting) to the habitat.

Helicopter use in core habitat likely results in more pronounced disturbance reaction in grizzly bears since bears are not conditioned to expect disturbances from motorized equipment or vehicles in core habitat. The effect of the disturbance would vary depending on the helicopter operation and duration. Intense events of short-term duration, such as dropping supplies in a remote location, would have less severe impacts than an intense, long-term event such as conducting a large, green tree timber sale within core using helicopters.

However, when considering long-term habitat effects, aircraft activities which do not use or require roads may not pose the same chronic displacement effects or mortality risks that roads-based operation do. Helicopter use is a transitory event, whereas roads are typically chronic features on the landscape that facilitate access for people into bear habitat long after a project is complete. Consequently, while short-term helicopter activities may impact grizzly bears in core habitat, they do not impart the same chronic habitat effects as roading core habitat. Thus, a "reduction in" or "loss of" in core habitat should not result from most helicopter projects except those that are recurrent (repeated over and over the same area). If repeated, low altitude flights continue into multiple seasons, the effects upon grizzly bear behavior (i.e., avoidance and more than just temporary displacement) may become more long lasting.

Helicopter Effects along Roads and in Roaded Habitat

The effects to grizzly bears of repeated, low altitude flight paths that follow open roads may be partially offset by the existing under-use of habitat in the immediate vicinity of the roads (i.e., due to the "avoidance" by grizzly bears of habitat in close proximity to open roads). This would be best quantified in a cumulative effects model that considers the chronic road effects as well as the disturbance effects of a helicopter.

Likewise, most Forests have management prescriptions for habitat that is roaded (open and total road densities) and security core habitat. These prescriptions presume that roaded habitat is used less by grizzly bears than its availability. "Major" activities like timber sales are routinely conducted in roaded habitats. If the effects of the proposed project would not impart any effects to grizzly bears in addition to those analyzed in a previous programmatic consultation (road densities and security core habitat standards or parameters are maintained) these proposed projects have justified a NLAA determination. In most cases, helicopter logging that occurs in roaded habitat may also warrant a NLAA determination so long as all roaded and core habitat effectiveness parameters indicate enough secure habitat is provided for grizzly bears.

Extenuating Circumstances

Even if the guidance provided above leads to a particular effects determination, extenuating circumstances may be present that justify a higher or lower effect determination.

Literature Cited

Harding, L. and J.A. Nagy. 1980. Responses of grizzly bears to hydrocarbon exploration of Richards Island, Northwest Territories, Canada. In Bears- Their Biology and Management; a selection of papers from the Fourth International Conference on Bear Research and Management (1977), Kalispell, MT. Pages 277-280. *(pdf)*

Interagency Grizzly Bear Committee (IGBC). 1987. Grizzly Bear Compendium. USDI US Fish and Wildlife Service. 540pp. *(partial pdf)*

Interagency Grizzly Bear Committee. 1998. Taskforce Report: Grizzly bear/motorized access management. Unpublished Report. 6pp. *(pdf)*

Mace R.D. and J.S. Waller. 1996. Grizzly bear distribution and human conflicts in Jewel Basin hiking area, Swan Mountains, MT. Wildlife Society Bulletin. 24(3):461-467. *(pdf)*

McLellan, B.N. and D.M. Shackleton. 1989a. Immediate reactions of grizzly bears to human activities. Wildlife Society Bulletin. 17:269-274. *(pdf)*

McLellan, B.N. and D.M. Shackleton. 1989b. Grizzly bears and resource-extraction industries: habitat displacement in a response to seismic exploration, timber harvesting and road maintenance. Journal of Applied Ecology 26:371-380. *(pdf)*

Reynolds, Patricia, H.V. Reynolds, and E.H. Follmann. 1986. Responses of grizzly bears to seismic survey in northern Alaska. Int. Conf. Bear Res. and Manage. 6:179-175. *(pdf)*

U. S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook: Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. 315 pp. online @ http://www.fws.gov/endangered/consultations/s7hndbk/s7hndbk.htm

APPENDIX

(Examples of scientific literature on the effects of aircraft on grizzly bears and other wildlife)

Bleich, Vernon 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(4): 197-204.

Abstract. 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 kilometers super(2)] following sampling from a helicopter, whereas only 11% did so on the day prior to the survey. Likewise, some animals left the study area following surveys. Sampling intensity [0.8 min/km super(2) vs. 2.0 min/km super(2)] 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.

Côté, Steeve D. 1996. **Mountain Goat Responses to Helicopter Disturbance. Wildlife Society Bulletin, 24(4): 681-685.** *(pdf)*

Abstract. Mountain goat (*Oreamnos americanus*) responses to helicopter traffic were investigated at Caw Ridge (Alberta) from June 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 meters. Eighty-five percent of flights within 500 meters caused the goats to move >100 meters; 9% of the flights >1,500 meters 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 >=5 occasions and resulted in 1 case of severe injury to an adult female. Based on these observations, restriction of helicopter flights within 2 kilometers of alpine areas and cliffs that support mountain goat populations is recommended.

Efroymson, Rebecca A. and G.W. Suter II. 2001. Ecological Risk Assessment Framework for Low-Altitude Aircraft Overflights: II. Estimating Effects on Wildlife Risk Analysis, 21(2): 263–274. *(pdf)*

Abstract. An ecological risk assessment framework for aircraft overflights has been developed, with special emphasis on military applications. This article presents the analysis of effects and risk characterization phases; the problem formulation and exposure analysis phases are presented in a companion article. The framework addresses the effects of sound, visual stressors, and collision on the abundance and production of wildlife populations. Profiles of effects, including thresholds, are highlighted for two groups of endpoint species: ungulates (hoofed mammals) and pinnipeds (seals, sea lions, walruses). Several factors complicate the analysis of effects for aircraft overflights. Studies of the effects of aircraft overflights previously have not been associated with a quantitative assessment framework; therefore no consistent relations between exposure and population-level response have been developed. Information on behavioral effects of overflights by military aircraft (or component stressors) on most wildlife species is sparse. Moreover, models that relate behavioral changes to abundance or reproduction, and those that relate behavioral or hearing effects thresholds from one population to another are generally not available. The aggregation of sound frequencies, durations, and the view of the aircraft into the single exposure metric of slant distance is not always the best predictor of effects, but effects associated with more specific exposure metrics (e.g., narrow sound spectra) may not be easily determined or added. The weight of evidence and uncertainty analyses of the risk characterization for overflights are also discussed in this article.

Efroymson, Rebecca A., W.H. Rose, S. Nemeth, G.W. Suter II. 2000. Ecological risk assessment framework for low-altitude over flights by fixed-wing and rotary-wing military aircraft. U.S. Department of Defense Strategic Environmental Research and Development Program. Environmental Sciences Division. Publication No. 5010. 115 pp. *(pdf)*

- Defines low-level as below 1500 feet above ground level (p.21).
- Identifies stressors from aircraft over flights as sound of aircraft, sight of aircraft, air movement from aircraft take off and landings.
- Caribou calf survival negatively correlated with over-flights less than 1 kilometers (0.6 miles) from animal location (p. 48).
- Mountain goats show at least moderate reaction to helicopter flights even at horizontal distances from flight path greater than 1500 meters (0.9 miles) (p.63).
- Slant distance is probably a better measure of exposure than sound (p.78).
- Mountain sheep changed use of vegetation types following exposure to helicopter over flights, suggesting potential impacts on growth (p.78).
- Caribou nursed less frequently when exposed to over flights (p.78).
- Behavioral effects of over flights related to animal movement, which may be related to abundance and production. Energy loss is an important predictor of production. If movement associated with over flights is combined with other high energy activities, growth may be impaired. Movements to new habitats alter abundance of local population, as well as potentially lowering foraging success (p.79).
- Response to over flights is dependent on the activity that the animal is engaged in at the time (p.79).
- Slant distance thresholds for ungulate behavioral effects from aircraft (p. 95).

Foster, Bryan R. and E.Y. Rahs. 1983. Mountain goat response to hydroelectric exploration in northwestern British Columbia. Environmental Management, Vol. 7, No. 2, pp 189-197. *(pdf)*

Abstract. The behavioral responses of more than 800 mountain goats, comprised of 195 social groups, were recorded during hydroelectric exploration activities (primarily aircraft) in northwestern British Columbia. Four categories of overt response were recorded during case tests, ranging from maintenance activity to severe flight. More than 80 percent (n = 667) of the observed goats elicited some form of behavioral stress response, with 33 percent (n = 265) displaying a severe flight response to local rock or plant cover. Multiple regression analysis inferred goat responses to be statistically independent of the time of year, type, and vertical orientation of disturbance and group size. As expected, significant correlations ($p \leq$ 0.05) existed between distance of disturbance, geographic area, cover availability, and degree of awareness. Responses were stimulated primarily by auditory and secondarily by visual cues. Repeated aerial and ground follow-up surveys documented temporary range abandonment and changing observability indices (habitat use and activity patterns) associated with areas of intense exploration activity. The assessed data offer mitigation possibilities and enable formulation of management guidelines to lessen project impacts during future exploration, construction, and operation phases.

Goldstein, Michael I., A.J. Poe, E. Cooper, D. Youkey, B.A. Brown, T.L. McDonald. 2005. Mountain Goat Response to Helicopter Overflights in Alaska. Wildlife Society Bulletin. 33(2): 688-699. *(pdf)*
Côté (1996) recommended a 2,000-meter buffer between mountain goats and helicopter activities to minimize adverse impacts. Foster and Rahs (1983) analyzed mountain goat response to hydro-electric exploration in British Columbia and recommended a 2,000-meter buffer to prevent an overt disturbance response to human activity. Aircraft on the TNF and CNF are expected to maintain a minimum landing distance of 805 meters from all observed mountain goats (USDA FS1997, 2002). While flying, aircraft are required to maintain a 500-meter minimum vertical distance from all observed goats. The probability of any mountain goat in a group becoming disturbed at 500 meters was 62% in EPWS, 52% on the KP, 38% in the CKT, and 25% in the ICE. At 1,000 meters, the probabilities decrease to 45% in EPWS, 25% on the KP, 18%, in the CKT, and 10% in the ICE. Taken another way, if managers wish to consider a measure of risk of disturbance at <25% (an arbitrary delineation) when permitting helicopter traffic, then the helicopter approach distance could be 1,234 meters in EPWS, 1,000 meters on the KP, 771 meters in the CKT, and 500 meters in the ICE. Managers would need to consider whether pilots could effectively judge these distances or if a distance such as 805 meters better facilitates judgment.

Hamilton, Dennis and Steve Wilson. 2001. Access management in British Columbia: a provincial overview. Ministry of Environment, Lands and Parks Habitat Protection Branch, Victoria, B.C. and Nanuq Consulting Ltd. Nelson, B.C. 29 pp. *(pdf)*

- Aircraft impacts involve two categories: over flights, and flights involving landings. Potential for impacts is greater when aircraft land, because aircraft make closer approaches to animals (p. 16).
- Most studies of the effects of aircraft have measured short-term behavioral reactions (p.17).
- Impacts from aircraft activity could include habitat impacts from fuel deposits and spills and wildlife impacts in the form of harassment and poaching.

Harding, L. and J.A. Nagy. 1980. Responses of grizzly bears to hydrocarbon exploration of Richards Island, Northwest Territories, Canada. In Bears- Their Biology and Management; a selection of papers from the Fourth International Conference on Bear Research and Management (1977), Kalispell, MT. Pages 277-280.

Abstract. Observations on numbers, distribution, locations of dens, and responses of grizzly bears (*Ursus arctos*) to industrial disturbances were noted on Richards Island, Northwest Territories, Canada, during 1972-75. During this period, 13-23 bears occupied the 2,460-km2 study area. Bear responses to hydrocarbon exploration and related activities were observed 23 times, and 35 dens were located. Bears were distributed evenly over the study area during summer but avoided camps by 1 kilometer or more. Density was comparable to that of other arctic mountain and coastal bear populations, and no decline was apparent. Effects of industrial activities included slight loss of habitat, disturbance of denning areas resulting in abandonment of dens, and relocation of problem bears. It is predicted that proposed natural gas production facilities will not be compatible with continued survival of grizzly bears in Richards Island.

- No evidence to suggest that the current numbers and distribution of grizzly bears are being affected by hydrocarbon exploration or associated activities, but neither can we show that the population has not been affected.
- Individual bears are, however, being affected through: (1) slight loss of habitat due to avoidance of drilling and staging camps; (2) disturbance of bears during dormancy causing abandonment of dens; and (3) relocation of problem bears frequenting camps.

Harper, W.L., D.S. Eastman. 2000. Wildlife and commercial backcountry recreation in British Columbia: assessment of impacts and interim guidelines for mitigation. Wildlife Branch Ministry of Environment, Lands and Parks, Victoria, British Columbia. 80 pp. *(pdf)*

- Risk of impact to grizzly bear from helicopters is very high (p. 13).
- Aircraft disturbance of wildlife becomes a serious issue when frequency of aircraft disturbance is high (p. 15).
- Limit helicopter and fixed-wing flight altitudes to a minimum of 300 meters over grizzly bear habitat (p. 36).

IGBC. 1987. Grizzly Bear Compendium. National Wildlife Federation, Washington D.C. 540 pp. *(partial pdf)*

- Grizzly bears react strongly to both fixed-wing aircraft and helicopters (p. 71).
- Bears already fleeing aircraft when first spotted, including 1.0 miles distance and several at ½ mile (p.71).
- Grizzly bears may be more sensitive to helicopter disturbance than fixed-wing aircraft (p.71).
- Suggestions for minimizing disturbance: (1) minimize traffic during the denning period and emergence; (2) schedule helicoptor flights between 1 hour after sunrise to 1 hour before sunset from 15 Apr to 15 Oct; (3) maintain a minimum of helicoptor altitude of 600 feet; (4) establish helicoptor flight patterns of less than ½ mile width; and (5) designate landing zones with adequate visual and topographic barriers (pg. 152).

Larkin, Ronald P. undated. Effects of military noise on wildlife: a literature review. http://nhsbig.inhs.uiuc.edu/bioacoustics/noise_and_wildlife. 87pp. *(pdf)*

- Helicopters usually elicit more vigorous behavioral responses and/or responses at greater distances than fixed-wing aircraft (Watson 1993) (p.37).
- Grizzly bears react very strongly to aircraft, often starting to run while the aircraft was some distance away. As aircraft over takes running bears they veer sharply away from the aircraft flight path (p. 18).

McLellan, Bruce N. and D.M. Shackleton. 1989. Immediate Reactions of Grizzly Bears to Human Activities. Wildlife Society Bulletin. 17(3): 269-274. *(pdf)*

With all stimuli pooled, bears showed stronger responses in open areas than in cover, independent of the bear-stimulus distance (<150 meters: U = 1,095, n = 50 and 27, P < 0.001; >150 meters: U = 630, n = 45 and 43, P = 0.002). Responses to people on foot and to moving vehicles were greater when bears were in the open than in cover. Although sample size was small, the trend was the same for machinery and helicopters. Reactions of bears to fixed-wing aircraft were not different whether they were in the open or in cover, although in 9 of 10 cases when a bear fled (responses 1 and 2) from a fixed-wing aircraft, it was in the open.

Reynolds, P.E., H.V. Reynolds, and E.H. Follman. 1986. Responses of grizzly bears to seismic surveys in northern Alaska. International Conference on Bear Research and Management 6:169-175. *(pdf)*

- Heart rates measured the same during mid-winter small fixed-wing aircraft over flights (500-700 meters above ground) as during undisturbed conditions.
- Just prior (3 days) to den emergence heart rate increased with small fixed-wing aircraft over flight (150 meters above ground).
- After den emergence responses included increased heart rate, running into den, sitting and looking up, lie down, walk away with small fixed-wing aircraft over flights (100 meters above ground).

Schoen, J.W., L.R. Beier, J.W. Lentfer, L.J. Johnson. 1987. Denning ecology of brown bears on Admiralty and Chichagof Islands. International Conference on Bear Research and Management. 7:293-304. *(pdf)*

Frequently, bears instrumented with motion sensor transmitters became active as we flew over their dens at an altitude of about 150 meters. These flights were in small, fixed-wing aircraft, which are much quieter than helicopters. Thus, in an area that receives intensive aircraft traffic, especially helicopter traffic, bears could be negatively affected by disturbance. These findings suggest that intensive development, including aircraft traffic, may reduce an area's suitability as brown bear denning habitat.

USDI Glacier National Park. 2003. Biological assessment to conduct additional administrative helicopter and fixed-wind flights in 2003. USDI National Park Service, GNP, West Glacier, MT. *(pdf)*

Low level flights have the potential to displace and/or disrupt normal behavior patterns of grizzly bears present along flight paths. Several studies have documented

the behavioral responses of grizzly bears to various types of aircraft disturbance. A summary of the literature by the Interagency Grizzly Bear Committee (IGBC 1987) concluded that there is wide variability in the reaction of grizzly bears to aircraft disturbances. Factors which may affect the way in which bears respond to aircraft include the degree of habituation to the activity, availability of escape cover, and the type, noise level, altitude, and movements of the aircraft involved. Impacts of aircraft on bears can include possible displacement, or physiological arousal without overt response. Bears may be less likely to flee from aircraft while they are feeding.

Much of the published research on responses of wildlife to helicopter overflights was conducted in Canada and Alaska to determine the impacts of oil and gas exploration on arctic mammals. The plant community, and therefore vegetative cover, is quite different in the open arctic tundra than in Glacier National Park, with the exception of the park's alpine areas. However, some inferences can be made about animal responses to the noise and sight of an approaching helicopter.

Some studies have indicated that grizzlies may be more sensitive to helicopters than to fixed-wing aircraft **(Harding and Nagy 1980)**. During hydrocarbon exploration in the Northwest Territories, 61% of grizzly bear responses to fixed-wing aircraft were "overt" (running or hiding), as opposed to 88% for helicopters (Harding and Nagy 1980).

McCourt et al. (1974) noted that grizzly bears in the open tundra of Yukon and Alaska demonstrated greater response to small fixed wing aircraft and helicopters than either moose or caribou, and unlike the ungulates, the grizzly bears did not exhibit an increase in response with decreasing distance from the aircraft. The authors recommend avoiding low level flights over areas with known grizzly bear concentrations, and avoiding circling or hovering over bears with helicopters. They also recommend a 1,000-foot AGL minimum altitude for aircraft flying over open habitats.

Of 17 grizzly bear responses to helicopters used during hydrocarbon exploration activities in the Northwest Territories, 15 were "overt" (running or hiding), suggesting aversion and energy expenditure (Harding and Nagy 1980). These bears were accustomed to aircraft in the area, and some had been tranquilized and captured from the air; these bears appeared to have learned to avoid approaching aircraft by hiding or running away.

Kendall (1986) documented that 81% of grizzlies observed during low-level helicopter flights in the Apgar Mountains of GNP displayed a strong reaction. A "strong" reaction was defined as a bear moving faster than a slow walk, while a "mild" reaction was indicated when a bear did not move at all or slowly walked as the helicopter approached.

Aune and Kasworm (1989) monitored radio-collared grizzly bear movements in response to oil and gas exploration and seismic activities from 1980 to 1984, in an area along Montana's Rocky Mountain East Front where bears have not likely habituated to aircraft and human activity. The seismic surveys were helicopter supported programs using a surface charge (blast) to measure seismic response of the subsurface. Aircraft flying within 1 km of a collared bear caused the bear to react, and seismic activities caused temporary displacement of bears, but the seismic activities did not cause the bears to be displaced from home ranges.

Researchers in Yellowstone **(Graham 1978)** and Glacier **(Peacock 1978)** National Parks observed that grizzlies often fled into timber when approached by fixed-wing aircraft.

Schleyer (1980) noted that grizzlies on day beds were not disturbed by fixed-wing aircraft monitoring flights.

During radio-tracking of bears in SE Alaska from a small fixed-wing aircraft, **Schoen et al. (1987)** noted that some bears became active when the aircraft flew over their dens at an altitude of about 150 m. Some bears in the arctic tundra of NE Alaska abandoned den construction due to helicopter disturbance, although most bears in this study apparently returned to the den or entered a new den **(Quimby 1974)**. The denning season in GNP begins in October/November. Because of the tendency of grizzly bears in GNP to be more active during daylight hours in the fall than in spring or summer, fall flights could have a greater impact on bears.

Klein (1974) reviewed the potential energy losses of animals due to reactions to aircraft overflights. He found that at altitudes above 500 feet, no panic response was observed. He suggested that under extreme weather or stress conditions, the net result of several overflights could be deterioration in the condition of the animals. While his studies focused on caribou on the tundra, repeated stresses on any species can accumulate to cause a negative effect on the animals. Since the proposed flights will not be frequent and will only be at low levels for short periods, they are not expected to add extreme amounts of stress to grizzly bears in the park.

Although the total number of flights over the park in 2003 is large, the flights will be spread out over the park and will occur at various times, leaving plenty of space for relocation of disturbed animals. Areas for displacement are not always available to a bear, due to occupation by another bear, but this is relatively unlikely. In frequently disturbed locations, animals may be habituated to aircraft activities. The helicopter flights are to developed locations that may already experience some level of human activity. Fixed-wing flights can occur over any area of the park, but the effects of fixed-wing aircraft are believed to be less severe than helicopters.

USDI Glacier National Park. 2003. Environmental assessment to conduct additional administrative helicopter and fixed-wind flights in 2003. USDI National Park Service, GNP, West Glacier, MT. 49 pp. *(pdf)*

- Specifies mitigation measures (p.10):
    - Helicopters fly at a minimum of 500 feet above ground level

  - Fixed wing aircraft fly at a minimum of 500 feet above ground level
- Identified minor to moderate short-term, site-specific and local adverse effects to grizzly bears IF individual animals flee from aircraft or are displaced from favorable foraging sites (p.15).
- Provides impact threshold definitions: negligible, minor, moderate, major and defines duration as short and long term (p.28).
- Provides detailed grizzly bear effects analysis (p.31-33).
- Aircraft over flights at altitudes above 500 feet did not elicit a panic response (p.32).