419 OPPDRAGSMELDING

Menneskelig aktivitets innvirkning på klauvvilt og rovvilt; en bibliografi

En utredning foretatt i forbindelse med Forsvarets planer for Regionfelt Østlandet, del 8

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Forord

Denne oppdragsmeldingen er skrevet i forbindelse med Forsvarets planer for opprettelse av et Regionfelt Østlandet. Arbeidet er gjennomført som et samarbeid mellom Norsk institutt for naturforskning (NINA) og Hedmark Høgskole (HH), avd. Evenstad, etter oppdrag fra Forsvarets Bygningstjeneste (FBT). Feltarbeidet ble igangsatt i februar 1995.

NINA og HH har i det omfattende utredningsarbeidet som har vært gjennomført, hatt ansvar for hjortevilt- og rovviltundersøkelsene. I følge de krav til utredningen som er presisert i FBT's rapport «Regionfelt Østlandet - Program for konsekvensutredning», fastsatt av Forsvarsdepartementet 4. mars 1994, skal utredningen gi en oversikt over bestandssituasjonen, hvordan de aktuelle artene benytter planområdet og tilgrensende områder, og for rovvilt spesielt, vurdere potensiale som leveområde for større rovdyrbestander i framtida, og hvordan disse forhold påvirkes av et regionfelt. Under utredningsperioden ble også Gravberget lansert som et aktuelt alternativ. Dette medførte at det også ble gjennomført utredninger om ulv. I tillegg ble det av oppdragsgiver vedtatt å gjennomføre en taksering av lavbeiter for rein i Rendalen.

I denne rapporten presenterer vi en annotert bibliografi på engelsk over de viktigste studier som har fokusert på menneskelig aktivitets innvirkning på klauvvilt and rovvilt. Rapporten kan således tjene som en kilde til referanser for eventuelle andre utredninger hvor dette tema er aktuelt.
I denne serien av rapporter inngår også:

NINA Oppdragsmelding 405: Hovedrapport - Regionfelt Østlandet. Tema Hjortevilt og Rovvilt.
NINA Oppdragsmelding 412: Menneskelig aktivitets innvirkning på klauvvilt og rovvilt.
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NINA Oppdragsmelding 406: Taksering av reinbeiter i Rendalen.

Trondheim, 1. juni 1996

Reidar Andersen
Prosjektleder

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A. Annotated bibliography: Cervids

Altmann, M. (1958) Flight distance in free-ranging big game. *Journal of Wildlife Management.* **2,** 207-209.
The author presents an observational study of moose (large number of observations) flush distances for different individuals approached by human in different situations (simulating; hunting pressure, fishing, equipment etc). Variability of flush distance by type of habitat, social grouping, and reproductive and nutritional states are discussed.

Andersen, R. (1991) Habitat changes in moose ranges: effects on migratory behaviour, site fidelity and size of summer home range. *Alces.* **27,** 85-92.
Andersen found that habitat alteration, due to creation of an artificial lake for hydroelectric power, caused only minor changes in migratory behaviour; the moose crossed the lake where they previously crossed the river. There were no changes in home range size after the development. Distances between activity centers did not change during the study period, but there was a significant increase in summer home range overlap. That home range size did not increase during logging activities may be explained by the fact that all moose had access to escape cover in the area.

Andersen, R., Linnell, J. D. C. & Langvatn, R. (1996) Short term behavioural and physiological response of moose *Alces alces* to military disturbance in Norway. *Conservation Biology.* (In press).
They found that moose had lower flush distances and achieved pre-disturbance levels of heart rate faster when exposed to mechanical disturbance compared to when humans were interpreted as the disturbance source. However, there were no difference in length of flight or maximum heart rate frequency between the two disturbance types. They found a significant inverse relationship between flush distance and flight length, and between flush distance and time to reestablishemnt of pre-disturbance heart rate. There was a general increase in home range size for moose during a large military manoeuvre.

Andersen, R., Wiseth, B., Pedersen, P. H. & Jaren, V. (1991) Moose-train collisions: effects of environmental conditions. *Alces.* **27,** 79-84.
Mean winter snow depth explained 84% of the annual variation in collisions. A high proportion of moose were killed when snow depth exceeded 100 cm, 44% of the moose were killed under these conditions while only 11% of the moose were killed when snow depth varied between 0-35 cm.. High ambient winter temperatures reduced the risk of collisions, while low winter temperatures had the opposite effect. 54% of all moose were killed shortly after a snowfall, however, the mechanisms involved are still unknown.

Bashore, T. L., Tzilkowski, W. M. & Bellis, E. D. (1985) Analysis of deer-vehicle collision sites in Pennsylvania. *Journal of Wildlife Management.* **49,** 769-774.
They tested 19 habitat and highway characteristics thought to influence prbability of collisions. Two variables (inline visibility; distance at which an observer 1 m from highway center could no longer see a 2 m high optical density board placed at highway pavement edge, and non-wooded; proportion of transect lines covered by woody plants <2 m tall, and non-woody herbaceous vegetation including agricultural crops) increased the probability of a section and highway being a high kill site. Seven variables decreased the probability; residences, commercial buildings, other buildings, shortest visibility, speed limit, distance to woodland, and fencing.

Berger, J., Daneke, D., Johnson, J. & Berwick, S. H. (1983) Pronghorn foraging economics and predator avoidance in a desert ecosystem: implications for the conservation of large mammalian herbivoResearch *Biological Conservation.* **25,** 193-208.
Pronghorn foraging and predator avoidance was studied in a desert ecosystem. The study was performed in one area historically disturbad by humans and one undisturbed area. They found that individual foraging efficiency increased with group size to a point in both study sites, but animals in the disturbed area remained in larger groups despite foraging less profitabely. The hypothesis that individuals in a disturbed environment remain together for enhanced protection from predators was supported.

Berntsen, F., Langvatn, R., Liasjø, K. & Olsen, H. (1996) Reinens reaksjon på lavtflygende luftfartøy. NINA Oppdragsmelding 390, 1-43.
Behavioural and heart-rate responses of semi-domestic reindeer to low flying jets and helicopters were monitored. The most common reaction was increased vigilance behaviour. Flight was rare, and only observed when a helicopter hovered at an altitiude of 20-30m.

Bevanger, K. & Henriksen, G. (1996) Faunistiske effekter av gjerder and andre menneskeskapte barrierer. *NINA Oppdragsmelding.* **393**, 1-26.
This report reviews the effects that fences and linear barriers (roads, railways etc) have on wildlife (bird and mammal) mortality and movement. Written in Norwegian with a short english abstract.

Bideau, E., Gerard, J. F., Desneux, L. & Pichon, M. (1992) Roe deer introduction on the mediterranean Peninsula of Sainte Lucie (Aude, France). Relationship with tourism. *Ongulés / ungulates 91* (eds F. Spitz, G. Janeau, G. Gonzalez & S. Aulagnier), pp. 601-604. SFEPM - IRGM.
Radiocollared 13 animals. They found no direct relationship between the displacement of activity of the roe deer and the times of intense activity by tourists although the parts most used by visitors (foothpaths) were less frequented by animals than the rest of the

island, an avoidance which seemed to persist throughout the 24 h cycle. These findings. like the success of the population settling after introduction, indicate that cohabitation between roe deer and the summer tourist population is possible. This can largely be explained by; the density of cover and the relief (presence of craggy areas) gives the environment a good refuge value for the animals; - the channeling of the flood of tourists by clear footpath signposting and maintenance, enhanced by difficult access through the dense scrub offpath.

Bleich, V. C., Bowyer, R. T., Pauli, A. M., Vernoy, R. L. & Anthes, R. W. (1990) Responses of mountain sheep to helicopter surveys. *California Fish and Game.* **76,** 197-204.
Adult male and female bighorn 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 (8-82 km^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^2 vs. 2.0 min/km^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. The authors discuss that helicopter surveys may violate fundamental assumptions of several population estimators in research studies.

Bleich, V. C., Bowyer, R. T., Pauli, A., Nicholson, M. C. & Anthes, R. W. (1994) Mountain sheep *Ovis canadensis* and helicopter surveys: ramifications for the conservation of large mammals. *Biological Conservation.* **70,** 1-7.
They concluded that mountain sheep 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 may also 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 susceptebility to predation, or increasing nutritional stress, needs additional study

Cameron, R. D. & Whitten, K. R. (1980) Influence of the Trans-Alaska pipeline corridor on the local distribution of caribou. *Proceedings of the 2nd International Reindeer/Caribou Symposium* (eds. E. Reimers, E. Gaare & S. Skjenneberg), pp. 475-484.
They found a progressive displacement of cows and calves from the pipeline, and adjacent roads during fours years of study. A decreasing proportion of cows and calves were observed adjacent to the corridor, and the observed crossings also declined during the same period.

Cameron, R. D., Reed, D. J., Dau, J. R. & Smith, W. T. (1992) Redistribution of calving caribou in response to oil field development on the arctic slope of Alaska. *Arctic.* **45,** 338-342.
With construction of an oil field access road through a calving concentration area, mean caribou density decreased significantly (from 1.41/km^2 - 0.31/km^2) within 1 kilometer and increased from 1.41 to 4.53 (also significant) 5-6 kilometer from the road. Concurrently, relative caribou use of the adjacent area declined significantly, apparently in response to increasing surface development. The authors suggest that caribou re-distribution associated with roads reduced the capacity of the nearby area to sustain parturient females and that insufficient spacing of roads may have depressed overall calving activity. Use of traditional calving grounds and of certain areas therein appears to favor calf survival, principally through lower predation risk and improved foraging conditions.

Canon, S. K., Urness, P. J. & DeByle, N. V. (1987) Habitat selection, foraging behavior, and dietary nutrition of elk in burned aspen forest. *Journal of Range Management.* **40,** 433-438.
The foraging effects of habitat change following a burn were monitored. No dietary nutritional differences were found between burned and unburned habitats. Diet composition by forage class varyed due to an abundance of very palatable post-fire forbs on the burn. The burn was significantly more preferred as feeding habitat compared to others probably because preferred forage species were consistently available and greater foraging efficiency was possible than in other habitats.

Carruthers, D. R. & Jakimchuk, R. D. (1987) Migratory movements of the Nelchina caribou herd in relation to the Trans-Alaska Pipeline. *Wildlife Society Bulletin.* **15,** 414-420.
Crossing of the Trans-Alaska Pipeline by the Nelchina caribou herd was studied during spring and fall. Caribou used the traditional migration routes as described prior to construction of the pipeline. The locations of migration routes were associated with topography and terrain features rather than characteristics of the pipeline. Where special crossing structures were absent, caribou continued to cross the pipeline.

Cassirer, E. F., Freddy, D. J. & Ables, E. D. (1992) Elk responses to disturbance by cross-country skiers in Yellowstone National Park. *Wildlife Society Bulletin.* **20,** 375-381.
Disturbance trials were made on radio collared elk (n =15) in three different areas, one in which elk were

accustomed to skiers, and two areas where skiers were rare. In the two latter areas elk started to move at a distance 27 times farther away than in the «habituated» area (median distance; 400 m versus 15 m). Median distances elk moved away from the disturbance also were substantially (42X) greater in the two latter areas. Responses in both areas were skewed by high values in a few trials. No evidence of elk habituation or avoidance was observed during repeated trials. After being disturbed elk in non-habituated areas moved uphill, to steeper slopes, away from the road, and closer to trees. In 78% (31 of 40) of the disturbances elk left the drainage. Distance moved was correlated with the distance to nearest ridge and wind speed, and was not correlated to e.g., distance to tree cover. Elk were displaced from the drainage for at least the duration of human presence; on average they returned within 2 days (se=0.4) in the absence of human activity. Only in a few instances did elk not return to the area (n=5). In other words, displacements were usually temporary. Estimated energy expenditure for movement was 335 kcal/disturbance, which represent 5.5% of estimated daily energy expenditure for elk during winter, and is more than the normal estimated daily energy expenditure for movement. (see disc. for importance of this matter). Number of groups of skiers had no effect on flight distance, distance moved, or overall responses of elk. After initial disturbance, subsequent skiers following the same trial never displaced additional elk or caused elk to move again. Neither response was correlated with the size of the first group or the total number of skiers. Elk responses in the habituated area were nearly always less than in the other areas, however, responses increased threefold when elk were disturbed outside the 100-ha developed area where people were present 24h each day. Flight distances were greater outside the developed area, but distances moved were not. There were large individual differences in elks response to disturbance.

Chabot, D. The use of heart rate telemetry in assessing the metabolic cost of disturbnaces. *Transactions of the North American Wildlife and Natural Resources Conference.* **56**, 256-263.
The paper describes the use of heart rate telemetry to monitor energetic costs resulting from disturbance. Heart rate was correlated with oxygen consumption for six female elk. This is one of the few papers which actually relates increased heart-rate to increased energetic expenditure.

Chubbs, T. E., Keith, L. B., Mahoney, S. P. & McGrath, M. J. (1993) Response of woodland caribou (*Rangifer tarandus caribou*) to clear-cutting in east-central Newfoundland. *Canadian Journal of Zoology.* **71,** 487-493.
Clearcutting was shown to alter movement and habitat use in caribou. This study showed that 42% of the radiomonitored population increased their distance to the area of clearcutting compared to the distance to the same area prior to cutting, with females moving farther away than males (movement determined as altered position of activity center). The same study showed that animals which altered their activity centers also changed their habitat use, and to a larger extend avoided open areas compared to animals that did not change movement pattern after clear cutting. They further suggest that females with calves seemed to be more sensitive to disturbance than other females and bulls (based on sex- and age-ratio classification, and not the radio collared animals).

Curatolo, J. A. & Murphy, S. M. (1986) The effects of pipelines, roads and, traffic on the movements of caribou, *Rangifer tarandus. Canadian Field-Naturalist.* **100,** 218-224.
Caribou crossed an elevated pipeline or a road with a frequency similar to the control. It was only were a pipeline paralleled a road with traffic, that crossing frequencies were significantly less than expected (30% versus 66%), and additionally - there was a negative correlation between magnitude of traffic and crossing of caribou. It is postulated that vehicles act in a synergistic fashion with a pipeline to produce a negative stimulus that results in decreased crossing frequency. Caribou crossing under elevated pipelines did not select for particular pipe heights within the range studied (152-432 cm). Caribou did select buried sections of pipeline as crossing sites more often than expected.

Czech, B. (1991) Elk behavior in response to human disturbance at Mount St. Helens National Volcanic Monument. *Applied Animal Behaviour Science.* **29,** 269-277.
Following the opening of a logging road to public traffic, herds of animals avoided areas near the road (based on observation before and after), and a normal response of alertness and flight when people got out of their cars to view the herds was seen. Larger herds were more likely to contain highly vigilant animals that were more responsive to disturbance. Whatever the disturbance level, smaller herds were less likely to contain an animal that would break for cover. There were indications that elk may become less wary of logging under certain circumstances. If logging activity is performed near hiding cover animals don't avoid the area. However, if no cover was available near the logging operations animals avoided the area. From pre-opening to post-opening they showed that animals retreated from the area by the road, and habitat use was moved several hundreds of meters (250-500m) away from the road relative to pre-opening.

Dau, J. R. & Cameron, R. D. (1986) Effects of a road system on caribou distribution during calving. *Rangifer.* Special Issue **1,** 95-101.
The study was performed 4 years prior to and 4 years after road construction. Significantly fewer caribou were observed in the area surrounding the road after the road development compared to prior the development. After construction, the density of maternal females was

positively correlated with distance to the road, whereas no such relationships was apparent before construction. Density of nonmaternal adults was unrelated to distance during both periods. The results suggest that a local displacment of maternal caribou has occurred in response to roads and associated human activity.

Davis, J. L., Valkenburg, P. & Boertje, R. D. (1985) *Proceedings of the 1st North American Caribou Workshop* (eds A. M. Martell & D. E. Russell). pp 2-6
The Delta caribou herd has been exposed to very heavy disturbance from aircraft (military and civilian) and wildfire. Despite this activity the herd has continued to increase in size and showed no population level effects of disturbance.

Dorrance, M. J., Savage, P. J. & Huff, D. E. (1975) Effects of snowmobiles on white-tailed deer. *Journal of Wildlife Management.* **39,** 563-569.
Home range size, movement, and distance from radio-collared deer to the nearest trail increased with snowmobile activity in the area with normally low snowmobile activity, but remained unchanged in a area were snowmobiles were usual. However, numbers of deer along a 10-km trail decreased as snowmobile traffic increased within the latter area. Additionally, in the latter area, light snowmobile traffic caused the displacement of deer from areas immediately adjacent to trails, thereafter, increased snowmobile traffic caused no additional response. Deer returned to areas along trails within hours after snowmobiling ceased in the latter area. Deer responded to very low intensities of intrusion by man and vehicles. The results from the area were snowmobiles are common suggest that deer become habituated to snowmobile traffic.

Döring, H. (1990) The impact of human disturbance on regional distribution patterns of red deer browsing. *Transactions of the 19th International Union ofGame Biologists Congress*, **Trondheim, Norway,** 411-413.
In a correlational study between browsing intensity and degree of human disturbance, he found a strong negative relationship between these factors. Points of interest were; - browsing was significantly more intense at locations not visible from nearby forest roads/tracks; - browsing was more intense in the vicinity of completely undisturbed areas such as thickets and in dense forests; - the effects of vehicle disturbance were less pronounced on browsing than those caused by pedestrians; - browsing was equally intense at all locations up to 180 m from forest tracks; and at a greater distance browsing suddenly increased.

Eckstein, R. G., O'Brioen, T. F., Rongstad, O. J. & Bollinger, J. G. (1979) Snowmobile effects on movements of white-tailed deer: a case study. *Environmental Conservation.* **6,** 45-51.
They found that there were no significant differences in home range size and habitat use of the deer in areas with and without snowmobiling. However, snowmobiling caused some deer to leave the immediate vicinity of the snowmobile trail. Deer were most affected when they were within 61 m of the snowmobile trail. Daily activity patterns of deer were little affected by snowmobiles except in one period when deer were more active between 1900 and 2000 hrs than when snowmobiles were absent. Darkness reduced the reaction of the deer to disturbance. Deer appeared to react more to a person walking than a person on a snowmobile.

Edge, W. D. & Marcum, C. L. (1985) Movements of elk in relation to logging disturbances. *Journal of Wildlife Management.* **49,** 926-930.
They found that movements away from disturbance were significantly longer than those toward disturbance. Additionally, elk tended to move into areas of logging activity on weekends during non-active periods, i.e.. when there was no human disturbance. The latter movements were interpreted as occupation of preferred areas in the absence of human disturbance, not as habituation to human activity. This interpretation was confirmed when elk moved out of these areas as soon as disturbance was re-initiated during weekdays again.

Edge, W. D., Marcum, C. L. & Olson, S. L. (1985) Effects of logging actvities on home-range fidelity of elk. *Journal of Wildlife Management.* **49,** 741-744.
They found a non-significant decrease in home range size after disturbance had been in progress for 1 year. There were no differences in fidelity coefficients prior to and after onset of disturbance. All elk had large amounts of cover available in their home ranges, and this was used to explain the observed fidelity during the study period.

Espmark, Y. (1972) Behaviour reactions of reindeer exposed to sonic booms. *Deer.* **2,** 800-802.
The animals had experienced occasional exposure to sonic booms. No clear differences in reaction were seen between low and high boom strengths. Moderate reactions were found irrespective of boom level. Common reactions were slight startle responses, raising of head, pricking the ears, and scenting the air. Panic reactions or extensive changes in behaviour of individual animals were not observed.

Fancy, S. G. (1982) Reaction of bison to aerial surveys in interior Alaska. *Canadian Field-Naturalist.* **96,** 91.
Only two of 59 different bison groups encountered showed any visible reaction to aircraft. The height of the aircraft varied between 61 - 150 m. The low reaction showed by this herd may be due to habituation. The herd is potentially habituated to certain human disturbances since the summering and calving grounds are within and adjacent to a military target range.

Fancy, S. G. (1983) Movements and activity budgets of caribou near oil drilling sites in the Sagavanirktok river floodplains, Alaska. *Arctic.* **36,** 193-197.

Activity budgets and movement patterns were similar for caribou exposed to disturbance and those not exposed to disturbance, although some small responses were made with respect to specific stimuli. Crossing success of roads and drill sites was 71 %. There was no clear evidence that cow-calf groups avoided the disturbed areas.

Fancy, S. G. & White, R. G. (1987) Energy expenditures for locomotion by barren-ground caribou. *Canadian Journal of Zoology*. **65**, 122-128.
The energetic costs of different locomotion speeds for caribou were measured. Generally, locomotion in caribou had very low eneregtic costs compared to other terrestrial species. Costs of locomotion in snow increased exponentially with snow depth.

Ferguson, M. A. D. & Keith, L. B. (1982) Influence of nordic skiing on distributions of moose and elk in Elk Island National Park, Alberta. *Canadian Field-Naturalist.* **96**, 69-78.
Aerial observation, and track and pellet-group counts provided indices to distribution that could be related to ski-trail location and/or use. Cross-country skiing influenced the general overwinter distribution of moose but not of elk. Both species, however, tended to move away from areas near heavily-used trails during the ski season compared to low-used trails. Day-to-day movements away from trails occured after the daily onset of skiing, but such displacement did not increase with the passage of additional skiers. The results suggest that an onset of skiing reduces moose numbers within at least 500 m of trails, but thereafter intesified use causes no further displacement. There were also some indications that disturbance was largest where ski trails passed trough open terrain.

Freddy, D. J., Bronaugh, W. M. & Fowler, M. C. (1986) Responses of mule deer to disturbance by persons afoot and snowmobiles. *Wildlife Society Bulletin.* **14**, 63-68.
Responses of mule deer to persons afoot and to snowmobiles were observed during 67 controlled trials (observation of both radiocollared and uncollared animals). Mule deer were disturbed more by persons afoot than by snowmobiles. Responses by deer to people were longer in duration, involved running more frequently, and were greater in estimated energy expenditure. People afoot elicit more intense reactions by ungulates than do vehicles.

Gunn, A. & Miller, F. L. (1980) Responses of Peary caribou cow-calf pairs to helicopter harassment in the Canadian high arctic. *Proceedings of the 2nd International Reindeer/Caribou Symposium* (eds E. Reimers, E. Gaare & S. Skjenneberg), pp. 497-507.
They flew simulations of helicopters carrying cargo slings, and divided responses in four phases; (A) minimum response and (B) maximun response during the approach, and (C) maximum and (D) minimum response during departure. They obtained 368 responses or activities from cow-calf pairs from each of four phases of the 92 passes. Calves responded to 86.7% of the 91 phases during which cows responded, and calves also responded during 28 phases when their cow was foraging or bedded. Of the 123 locomotary responses 19.5% and 20.3% were attributable to regrouping of the cow-calf pair and the pair rejoining their group, respectively. Only 2.2% of the cow-calf pairs were trotting as the helicopter departed, and within 1-min the pair still in sight had stopped trotting and was foraging. Calves tended to alert more and respond sooner than their maternal cows. The calves were also more likely to rejoin their maternal cows than the cows to seek out their calves.

Gunn, A., Miller, F. L., Glaholt, R. & Jingfors, K. (1985) Behavioral responses of barren-ground caribou cows and calves to helicopters on the Beverly herd calving ground, Northwest Territories. *Proceedings of the 1st North American Caribou Workshop* (eds A. M. Martell & D. E. Russell). pp 10-14
Cow-calf aggregations were exposed to a helicopter overflight (300m altitiude) and a landing within 300-2000m. Slight changes in suckling behaviour and adult activity pattern were noticed, and most groups tended to walk slowly away from the landing area.

Gutzwiller, K. J. (1991) Assessing recreational impacts on wildlife: the value and design of experiments. *Transactions of the North American Wildlife and Natural Resources Conference* **56**, 248-255.
The paper discusses some of the problems with the design of experiments to measure the impact of disturbance on wildlife. Recomendations on how to avoid some of these problems are made.

Hamr, J. (1988) Disturbance behaviour of chamois in an alpine tourist area of Austria. *Mountain Research and Development.* **8**, 65-73.
Chamois used mainly vision to detect intruders. Three stages of alarm behaviour were identified. Surprise encounters with humans and airborne objects induced the strongest alarm responses. Chamois were habituated to various recurring, and thus predictable, human activities in their ranges. Both flush distance and escape distance ranged from 10 - 500 m and averaged 71 and 79 m, respectively. Weakest responses to disturbances were shown during winter, strongest responses during spring and early summer. Downslope escapes were more frequent than those directed upwards or horizontally. Steep, forested cliffs were preferred escape terrain. Females were significantly more sensitive to disturbances than males. Intensive disturbances caused by hiking, skiing, livestock grazing, and hunting at times displaced chamois from nutritionally important habitat for prolonged periods and altered the animals' accustomed daily and seasonal pattern of home range use.

Harlow, H. J., Thorne, E. T., Williams, E. S., Belden, E. L. & Gern, W. A. (1987a) Cardiac frequency: a potential

predictor of blood cortisol levels during acute and chronic stress exposure in Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*). *Canadian Journal of Zoology* **65**, 2028-2034.
A close correlation was found between heart rate and blood cortisol levels among captive bighorn sheep exposed to stress. Adrenal responses to stress are also provided.

Harlow, H. J., Thorne, E. T., Williams, E. S., Belden, E. L. & Gern, W. A. (1987b) Adrenal responsivness in domestic sheep (*Ovis aries*) to acute and chronic stressors as predicted by remote monitoring of cardiac frequency. *Canadian Journal of Zoology* **65**, 2021-2027.
A close correlation was found between heart rate and blood cortisol levels among domestic sheep exposed to stress. Adrenal reponses to stress are also reported.

Harrington, F. H. & Veitch, A. M. (1991) Short-term impacts of low-level jet fighter training in caribou in Labrador. *Arctic.* **44,** 218-227.
Visual observations of low-level (30 m altitude) jet overpasses indicated an initial startle response but otherwise brief overt reaction by woodland caribou on late-winter alpine tundra habitat. By the aid of radiotelemetry they studied the activity and movement patterns of disturbed and non-disturbed animals. Level of exposure to low-level flying within the exposed population did not significantly affect daily activity levels or distance travelled, although comparison with the unexposed population did suggest potential effects.

Harrington, F. H. & Veitch, A. M. (1992) Calving success of woodland caribou exposed to low-level jet fighter overflights. *Arctic.* **45,** 213-218.
They found that calf survival 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 the summer. No significant relationships 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.

Herbold, H. (1990) Reactions of roe deer to human disturbance (In German). *Transactions of the 19th International Union of Game Biologists Congress.* **19,** 414-420.
A study of the the effects of disturbance from recreation, forestry and hunting on roe deer. Hunting combined with shooting caused greater flush distances than hunting without shooting or the two other kinds of disturbance.

Hershey, T. J. & Leege, T. A. (1976) Influences of logging on elk on summer range in north-central Idaho. *Proceedings of elk-logging-roads Symposium for Wildlife and Range Exp. Stn.,*University of Idaho, Moscow. 73-80.
They found that elk preferred to use clearcuts less than 10-years old and larger than 81 ha. 80% of of all elk observed in clearcuts were within 46 m of a timbered edge. Elk avoided using areas within 0.4 km of primary and secondary roads and showed a high preference for areas farther than 0.4 km from a road. Elk did not move away from low intensity, short-term logging disturbance.

Hicks, L. L. & Elder, J. M. (1979) Human disturbance of Sierra Nevada bighorn sheep. *Journal of Wildlife Management.* **43,** 909-915.
The study was performed in area with regulated hiker-activity to minimize effects on sheep. The area was visiyed by 2675 overnight users in 43 groups during the study period. Despite heavy use by people, rams used areas within 200 m of a trail in the area. However, people in only 1 of 43 groups (2%) saw sheep. Sheep did not currently use areas where campsites were located. 20 incidents of human-sheep interactions; 10 involved hikers, 9 involved study personel and 1 involved a pack-horse party of 23 persons and 20 horses. Of 58 groups of hikers observed crossing the area (Baxter Pass), 9 crossed while sheep groups were on the pass. Similarly, 17 sheep groups were observed on the pass and 9 of these groups were there while people were on the pass. 6 sheep groups may have left the pass because of disturbance by humans. 4 sheep groups left the pass some time after the people had left. Approach from above by human were more likely to elicit a reaction in a sheep group than were approach from below. Sheep usually run uphill towards rocks when alarmed, or quickly ran to a position where upward flight was possible. Some observations indicated that smaller groups were more suceptible to human disturbance. This may reflect security that sheep derive from being in groups. Foot trails through the area did not adversely affect sheep movements. In fact, trail-edges were fed and bedded on, and trails were used when traversing forest cover. This study indicates that the herd is not declining due to recreational use. Sheep that avoided the area while people used it normally returned to those areas after people had left. Overall distribution of bighorns was related positively to food resources and not negatively to human presence.

Hinman, R. (1974) The impact of oil development on wildlife populations in northern Alaska. *Proceedings of the Annual Conference of the Western Association of State Game and Fish Commissioners.* **54**, 156-164.
The paper provides a general overview over the problems expected to occur during the construction of the Prudhoe Bay oil pipeline, and a discussion of wildlife-construction conflicts in general.

Hood, R. E & Inglis, J. M. (1974) Behavioral responses of white-tailed deer to intensive ranching operations. *Journal of Wildlife Management.* **38**, 488-498.
The effect of cattle round-up on 9 radio-collared white-tailed deer was monitored. Bucks left their home ranges for adjacent areas during the period of disturbance, while does made evasive movements within the limits of their original home range.

Horejsi, B. L. (1981) Behavioral response of barren ground caribou to a moving vehicle. *Arctic.* **34,** 180-185.
In 34 of 36 observations the vehicle approached at 56 km/h. 48% of the individual caribou reacted to the vehicle by running away while 38% trotted away. The mean flight duration for females were longer than for males (73±11 sec. vs 38±8 sec.). Males allowed closer approach than females, but only in forested areas.

Ingold, P., Huber, B., Neuhaus, P., Mainini, B., Marbacher, H., Schnidrig-Petrig, R. & Zeller, R. (1993) Tourism and recreation in the Alps - an increasing problem for wildlife ? *Revue Suisse de Zoologie.* **100,** 529-545.
Ingold et al. evaluated the impact of tourists and sport in the alps on different species, among them chamois and ibex. He found that moderate hiking activity on a path leading across a preferred grazing area of male chamois influenced their use of the area in day time. When hikers were present the chamois avoided the attractive grazing areas. Paragliders provoked strong reactions (flight to the wood at great distances) among chamois where paragliders had not been used in the past.

Jaren, V., Andersen, R., Ulleberg, M., Pedersen, P. H. & Wiseth, B. (1991) Moose-train collisions: the effects of vegetation removal with a cost benefit analysis. *Alces.* **27,** 93-99.
Vegetation removal in a 20-30 m wide sector on each side of the railway line caused a 56 % (±16%) reduction in the number of moose killed by trains. They also calculated that it would be benefical, in an economic perspective, to perform vegetation removal if annual number of collisions were higher than 0.3/ km.

Jeppesen, J. L. (1987) Impact of human disturbance on home range, movement and activity of red deer (*Cervus elaphus*) in a Danish environment. *Danish Review of Game Biology.* **13,** 1-38.
Jeppesen studied the impact of human disturbance (hunting, orienteering, tourism, and military activities) on home range, movements, and activity of red deer. Red deer reacted to disturbances such as hunting and orienteering in various ways. Often they immediately sought dense cover. Here they stayed for some time, either as long as the disturbing event lasted, or for shorter periods until their threshold of tolerance for disturbance was crossed, and they then fled. Radiomonitoring revealed that the deer «followed» attentively the noise around them, while staying in cover. Most of the animals reacted to a major disturbance by taking flight, and ran a distance often more than 5 km (overall mean dist. 3569±396 m). A commonly observed pattern was «delayed flight» where the animal fled to cover when disturbed, and after dark took flight and stayed away for a number of days. Jeppesen also reports that deer in dense sections of forests accept people passing by on foot on the forest roads, sometimes as near as 10-20 m. The deer also accept logging activities occurring close to their dense cover.

Jeppesen, J. L. (1987) The disturbing effects of orienteering and hunting on roe deer (Capreolus capreolus). *Danish Review of Game Biology.* **13,** 1-24.
Jeppesen evaluated the disturbing effects of orienteering and hunting on roe deer. Roe deer fled into cover (a mean escape distance of 432 m) during small orienteering events (below 100 runners), and usually stayed there. Disturbing effects of orienteering activities were greater in March than in June, mainly because the visibility in deciduous forests is greater in March. Orienteering events in June, however, are not advisable because this coincides with parturition in roe deer. Deer were forced from cover and fled a longer distance (mean 847 m) during battues and drive hunts (hunting other game species than roe deer). Roe deer moved from home ranges during both forms of disturbance and stayed from 0-7 hours in the refuge-areas, before returning, typically at nightfall. It is least disturbing to roe deer to arrange large orienteering events in July-August.

King, M. M. & Workman, G. W. (1986) Response of desert bighorn sheep to human harassment: management implications. *Transactions of the 51st North American Wildlife and Natural Resources Conference.* **51,** 74-85.
Bighorn responses were compared between two areas with contrasting disturbance histories. Area 1 had been exposed to greater levels of hunting pressure and vehicular traffic than area 2. Groups of bighorn were deliberately harassed by vehicles and hikers. Immediate response and distance fled by bighorn were recorded during harassment trials. When bighorn remained in the presence of the harassing stimuli, actual time spent by bighorn in various behaviours was recorded to determine group wariness and activity budgets under harassed conditions to compare behaviour under those two circumstances. 83% of harassment trials illicited flight responses in area 1 compared to 46% for area 2. Average distance fled as a result of harassment was approximately 2.75 times greater in area 1 than area 2. Group wariness was exhibited at more intense levels in area 1 than 2 when bighorn remained in the presence of harassing stimuli. Activity budgets of unharassed bighorn were similar between areas. However, activity budgets of harassed animals differed significantly between areas particularly with respect to attention and feeding behaviours. Under harassed conditions, bighorn in area 1 were attentive longer and fed less than did bighorn in area 2. In conclusion, behavioural responses of bighorn to encounters with humans were more severe and thus more costly energetically for animals that had been previously exposed to relatively high levels of human disturbance.

Kitchens, J. A., White, R. G. & Murphy, S. (1993) Predicting energy expenditure of caribou using activity

counts: potential use in disturbance studies. *Rangifer* **13**, 117-119.
This report presents preliminary data on the relationship between recorded activity patterns and energy expenditure for caribou. The main conclusions presented concern the best sampling intervals and sample lengths to monitor activity.

Klein, D. R. (1973) The reaction of some northern mammals to aircraft disturbance. *Transactions of the International Union of Game Biologists Congress.* **11**, 377-383.
This paper provides some of the first observations of caribou flight behaviour from aircraft. Apparent trends were that larger groups of caribou showed a greater probability of showing stronger reactions, and that height of overflight affected flight behaviour.

Klein, D. R. (1980) Reaction of caribou and reindeer to obstructions - a reassessment. *Procdeedings of the 2nd International Reindeer/Caribou Symposium* (eds E. Reimers, E. Gaare & S. Skjenneberg), pp 519-527.
The paper provides a review of the early studies of caribou / reindeer responses to pipelines and other linear featuResearch The main factors such as type of human activity, caribou group size, age, sex and season which affect their responses are also identified.

Knight, R. L. & Cole, D. N. (1991) Effects of recreational activity on wildlife in wildlands. . *Transactions of the North American Wildlife and Natural Resources Conference.* **51**, 238-247.
The paper provides a conceptual overview of the process of disturbance, and the hierarchy of possible impacts on wildlife. A general discussion of the factors that effect the degree of disturbance is also provided.

Krausman, P. R. & Etchberger, R. C. (1995) Response of desert ungulates to a water project in Arizona. *Journal of Wildlife Management.* **59**, 292-300.
Home range size and use of vegetation associations for mule deer and bighorn sheep did not differ between the period of construction of an aqueduct and after completion. Data suggest that the additional water was not important to the deer or sheep populations. The aqueduct reinforced previously established barriers (highways, fences, railroads) that fragmented habitat but did not alter use of habitats or movements of desert mule deer or bighorn sheep.

Krausman, P. R. & Hervert, J. J. (1983) Mountain sheep responses to aerial surveys. *Wildlife Society Bulletin.* **11**, 372-375.
Responses of sheep varied by fixed-wing aircraft altitude; (1) at < 50m all responses were extreme, involving movements > 1km from the areas of observation; (2) at 50-100m responses were mixed, some (13%) extreme, more (27%) mild, and most (60%) sheep showed no overt reaction; and (3) at > 100m ag responses ranged from mild (23%) to no overt reaction (77%).

Krausman, P. R., Leopold, B. D. & Scarbrough, D. L. (1986) Desert mule deer response to aircraft. *Wildlife Society Bulletin.* **14**, 68-70.
There were no effects of the height of the overflights according to whether der changed habitat. The authors concludes that the deer in the study area appears to have habituated to low-flying aircraft. Some possible causes to species difference to mountain sheep are discussed. Mountain sheep less tolerable, but are in larger groups. Or the latter species are not habituated as much as deer, due to low traffic in the specific area.

Krausman, P. R., Wallace, M. C., Zine, M. J., Berner, L. R., Hayes, C. L. & DeYoung, D. W. (1993a) The effects of low-altitude aircraft on mountain sheep heart rate and behavior. *Armstrong Laboratory, Air Force Material Command.* **Report AL/OE-TR-1993-0184,** 1-146.
Habitat use and activity of mountain sheep in an enclosure was similar to habitat use and activity of free-ranging mountain sheep. They recorded heart rate and behaviour prior to, during, and after overflights (125 m altitude.). Heart rate increased above normal level in 21 of 149 (14%) overflights but returned to normal within 2 minutes. Behaviour patterns most often included running <10 m as the jet passed. They concluded that the noise levels created by overflights did not alter behaviour or increase heart rate to the detriment of the population.

Krausman, P. R., Wallace, M., Weisenberger, M. E., DeYoung, D. W. & Maughan, O. E. (1993b) Effects of simulated aircraft noise on heart-rate and behavior of desert ungulates. *Armstrong Laboratory, Air Force Material Command.* **Report AL/OE-TR-1993-0185,** 1-78.
They documented differences between heart rates for animals, noise levels, and number of overflights between seasons. All animals became habituated to sounds of low-altitude aircraft. Although heart rates increased during overflights, they returned to resting states in <2 minutes.

Kremsater, L. L. & Bunnell, F. D. (1992) Testing responses to forest edges: the example of black-tailed deer. *Candaian Journal of Zoology.* **70,** 2426-2435.
This paper show that black-tailed deer respond differentially to forest edges based upon surrounding habitat structure. Little responses of deer to edges was detectable where habitat was a fine-grained mosaic of forage and cover areas. Where forage and cover occurred in clearly distinct habitats, responses to edges were apparent. This study more or less supports the general wisdom that edge habitat is benefical to many species, but that the distribution of other habitats, like food- and cover-habitats, are important in determining deer preference for a particular forest edge area.

Kucera, E. (1976) Deer flushing distance as related to observer's mode of travel. *Wildlife Society Bulletin.* **4,** 128-129.
This paper presents results on flushing distances of white-tailed deer to walking, riding and driving. Driving and riding did not disturb animals as much as walking.

Kuck, L., Hompland, G. L. & Merrill, E. H. (1985) Elk calf response to simulated mine disturbance in southeast Idaho. *Journal of Wildlife Management.* **49,** 751-757.
Compared to undisturbed calves, disturbed calves moved greater distances (both direct and elevational), used larger areas, showed greater use of coniferous forest, and lacked selection for favorable physiographic parameters (i.e. a more random use of their environment). Cow/calf pairs readily abandoned their traditional calf-rearing area during human and simulated mining disturbances, although no calf abandonment was documented. Winter survival between groups and between years was similar. The longer term avoidance of once-disturbed areas was not studied. There were greater effects in response to direct human harassment than to mine-noise simulation. Furthermore, coefficients of association (distance between mother-young pairs) for calves exposed to human disturbance was lower than for calves exposed to mine noises. Elk responded to both levels of disturbance by placing topographic barriers between themselves and the disturbance, which may indicate the importance topography in minimizing disturbance from development activities.

Kufeld, R. C., Bowden, D. C. & Schruff, D. L. (1988) Influence of hunting on movements of female mule deer. *Journal of Range Management.* **41,** 70-72.
Seventeen radiocollared does were used to evaluate the effects of hunting on movement. Hunting pressure did not cause deer movement in terms of distance or cause them to leave their normal home ranges, but did cause deer to move into denser cover. In other words this study, performed in an open area, indicates that deer moved to denser areas with higher hiding oppurtunities due to the disturbance caused by hunting pressure.

LaGory, K. E. (1987) The influence of habitat and group characteristics on the alarm and flight response of white-tailed deer. *Animal Behaviour.* **35,** 20-25.
Observational data. Deer in forest (cover present) and pasture (no cover) were less likely to flee as distance from the observer increased. This decline with distance was more pronounced in the pasture. Larger groups (three or more deer) in the forest were more likely to flee than smaller groups. Most groups flagged when fleeing, though flagging was less common in the pasture than in the forest. Snorting was more common in larger groups, but apparently was not related to group composition. The data support the following hypotheses: (1) Deer in dense vegetation flee even when a predator is at a considerable distance, because of the danger of losing sight of the predator, i.e., in open habitat the deer can preserve energy by delay the flee because it does not lose sight of the predator. (2) Larger groups are more likely to spot a predator than are smaller groups and are thus more likely to flee. (3) Flagging is a low cost alarm signal to other deer which benefits the individual by increasing the number of deer fleeing with it. (4) Snorting has evolved through individual selection as a signal to the predator that it has been detected.

Lamerenx, F., Chadelaud, H., Bard, B. & Pépin, D. (1992) Influence of the proximity of a hiking trail on the behaviour of isards (*Rupicapra pyrenaica*) in a Pyrenean reserve. *Ongulés / ungulates* (eds F. Spitz, G. Janeau, G. Gonzalez & S. Aulagnier), pp. 605-608. SFEPM - IRGM.
Observational study of isards (chamois) with respect to behaviour related to three different situations on a hiking trail; 1. absence of human disturbance, 2. human on trail, 3. human off trail and approaching animals. The results showed that animals staying near the trail (<50 m) had a higher frequeny of movement and vigilance than animals further away. However, the hiking trail was not the only spatial parameter that animals took into account. The animals did not significantly alter their activity budgets as long as a hiker remained on the established trail. But as soon as the person abandoned this trail and approached the animals, some of them (24%) quickly escaped, and the rate of moving of the remainder increased. This experimental study indicates that the isard were habituated to predictable human activities, based on the different behaviour shown when humans stayed on the trail compared to off-trail travel.

Langvatn, R. & Andersen, R. (1991) Støy and forstyrrelser, - metodikk til registrering av hjortedyrs reaksjon på militær aktivitet. *NINA oppdragsmelding.* **98,** 1-48.
They found that in an experimental study vehicles caused less disturbance than people afoot to red deer and moose. Furthermore, disturbance from vehicles was more related to driving pattern and choice of trail than noise level. The same study concluded that aircraft only disturbed animals when flying at extremely low altitudes.

Larsen, D. G. & Gauthier, D. A. (1989) Effects of capturing pregnant moose and calves on calf survivorship. *Journal of Wildlife Management.* **53**, 564-567.
The effects of extreme short-term disturbance (helicopter pursuit, drugging, capture, and handling) of female moose, on pre and post-natal calf survivorship was measured. The only detectable effect was a slight increase in post-natal calf mortality following capture 1-2 months before birth, although the mechanism was unclear. Post-natal capture of calves had no significant effect on their survival.

Leslie, D. M. & Douglas, C. L. (1980) Human disturbance at water sources of desert bighorn sheep. *Wildlife Society Bulletin.* **8,** 284-290.

They found that alterations of behaviour and movement were coincident with constructions activities near the population's primary watering site. The juxtaposition of construction activity and summer water dependence of bighorn sheep caused a significant shift in use of artificial water sources. Nine of 17 marked ewes altered their watering patterns in response to construction activities. Producticity was not reduced. The authors conclude that the observed effects possibly are dampened by a general habituation to human activity in the study area.

Linnell, J. D. C. & Andersen, R. (1995) Site tenacity in roe deer: short-term effects of logging. *Wildlife Society Bulletin.* **23**, 31-35.
Short-term movements of 10 resident radio-collared roe deer were monitored during a period in which logging activity cleared approximately half of an isolated 16 ha woodlot which was the main cover available within their home range. Only one doe and her fawns left the area during the activity, and she returned immediately afterwards. All other animals remained at least partially within the disturbed woodlot. Home ranges were not larger for the 10 disturbed animals than for 12 control animals.

Lott, D. F. & McCoy, M. 1995 Asian rhinos *Rhinoceros unicomis* on the run ? Impact of tourist visits on one population. *Biological Conservation.* **73**, 23-26.
The effects that tourists riding on elephants had on rhinos was studied. The rhinos increased their level of vigilance when in the presence of tourist elephants, however the threshold for flight was as low as 10m.

Luz, G. A. & Smith, J. B. Reactions of pronghorn antelope to helicopter overflight. *Journal of the Acoustic Society of America.* **59,** 1514-1515.
At an altitude of 120m and a slant range of 900 m, no behavioural reactions in pronhorn could be observed. Mild reactions (muscle tensing and interruption of grazing) were observed as the craft moved towards the herd at a descent rate of 80 m/min and a forward air speed of 40-50 knots. Strong reactions (running) began when the aircraft was at 40 m altitude and a slant range of 100 m. Calculated noise levels of no reaction and strong reaction were approximately 60 and 77 dBA, respectively.

MacArthur, R. A., Geist, V. & Johnston, R. H. (1982) Cardiac and behavioral responses of mountain sheep to human disturbance. *Journal of Wildlife Management.* **46,** 351-358.
Telemetered heart rates (HR) and behavioural responses of mountain sheep were measured when reacting to human disturbance (n= 4 ewes and 1 ram). Within the study area sheep were regularly exposed to human activities along a gravel road. During peak recreational use, sheep may encounter 25-30 vehicles passing per hour. Cardiac and behavioural responses of sheep to an approaching human were greatest when the human approached off road accompanied with a dog (III). Thereafter the sheep reacted most to a human approaching over a ridge (II), and lastly, the sheep reacted to an approaching human off road (I). In type II and III trials, HR generally increased from beginning of the advance until the approaching person (with dog in type III) was within 50-25 m of the sheep, after which HR declined as the person withdrew. Moreover, sheep withdrew from the advancing person in only 3.6% of type I, as opposed to 27.6% of types II and III approaches. There was no difference in HR when the person was walking towards the sheep or standing stationary at prescribed stops. There were no differences in basal HR according to time, weather, or social and physical environments of sheep. There were no reduction in HR response with repeated trials. As expected, inclines of slopes on which sheep occurred and mean elevation in HR varied inversely in types I and II approaches. There was a negative correlation between HR response and group size in types II and III approaches. Only minor disturbance from vehicles on sheep was revealed as only 8.8% of vehicle passes (n=215) evoked HR responses. 73.7% of all HR responses occured when vehicles passed within 25 m of the subject. There were no difference in response between different vehicles (cars, trucks, motorbikes, snowmobiles, graders). Only 0.9% of the vehicle passes evoked a withdrawal response by sheep. No HR responses were associated with helicopter or fixed-wing aircraft at distances exceeding 400 m from sheep. However, 5 direct overflights at 90-250 m above ground level increased HR with 2.5-3X, and the sheep ran for 2-15 seconds prior to attainment of max. HR. Generally, individuals were more sensitive to disturbance following an arousal. A total of 142 instances (n=8 sheep) was documentated in which HR response clearly coincided with disturbance (human, vehicle, aircraft, conspecific or predator). 73.9% of all HR responses preceded or occurred in the absence of any motor activity by sheep. However, the duration of HR responses with no motor activity was only 15.6% of HR responses when accompanied by motor reactions.

Maublanc, M. L., Dubois, M., Teillaud, P. & Cugnasse, J. M. (1992) Effects of recreational and hunting activities on the mouflon (Ovis ammon musimon) population of Caroux Espinouse. *Ongulés / ungulates 91* (eds F. Spitz, G. Janeau, G. Gonzalez & S. Aulagnier), pp. 611-615. SFEPM - IRGM.
They studied the effects of recreational and hunting activities on mouflon. They found no correlation between tourist and mouflon distribution; this can be related to the out of phase use of open spaces (temporal seperation between the use of the massif by visitors and the frequentation of open areas (contact areas) by mouflon). Additionally, it appeared that the visitors were not particularly interested in mouflon, and therefore did not disturb them. On the contrary, they found a correlation between the distribution of hunting pressure and animals in autumn. Furthermore, some monitored animals with home ranges close to a wildlife sanctuary, showed an increase in their use of this reserve in autumn. When

tourists where in the area the mouflons had an even distribution. During hunting season the mouflons were heterogeneously distributed. This demonstrates that the mouflon were able to differentiate between two different types of human disturance.

McLaren, M. A. & Green, J. E. (1985) The reactions of muskoxen to snowmobile harassment. *Arctic.* **38,** 188-193.
Maximum reaction level of the muskoxen herd was positively correlated with herd size. Adult female muskoxen reacted first more frequently than expected. The study showed some indications of habituation to harassment.

Merrill, E. H., Hemker, T. P., Woodruff, K. P. & Kuck, L. (1994) Impacts of mining facilities on fall migration of mule deer. *Wildlife Society Bulletin.* **22,** 68-73.
The authors were not able to reject the null hypothesis that mining operations had no effect on migration routes and movements of deer because responses were inconsistent among years.

Miller, F. L. (1985) Some physical characteristics of caribou spring migration crossing sites on the Dempster highway, Yukon Territory. (1985) *Proceedings of the 1st North American Caribou Workshop* (eds A. M. Martell & D. E. Russell). pp 15-21
Habitat characteristics of sites were caribou crossed a highway are reported. While the choice of crossing site appeared to be a function of the channelling effect of the toporgaphy, there was a slight selection for areas with good visibility.

Morrison, J. R., de Vergie, W. J., Alldredge, A. W., Byrne, A. E. & Andree, W. W. (1995) The effects of ski area expansion on elk. *Wildlife Society Bulletin.* **23,** 481-489.
Documentation of responses of 2 populations of elk to disturbances (physical and human disturbances) associated with ski-area expansion in 2 different sites. Responses to physical development (area 1; service roads, timber removal, chair lift installation and revegetation - area 2; use of heavy machinery, chain saws, burning of slash piles) were the following; area 1 - decrease (70%) in number of elk observed pre-development compared to post-development. Three years after development had finished there was an increase in number of elk observed relative to post-development counts; number elk observed at this time was 76% of pre-development mean. Area 2; No overall response to development. However in one site within area 2 elk use decreased 98% from pre-development to post-development, but increased thereafter to 26% of pre-development during the study period (three years after post-development). When human were present at a cabin in the study area, elk use decreased 86%. Decrease in elk use was more significant in the areas were disturbance was greatest. In addition, the areas with largest disturbance were at lower elevations, and these sites are preferred due to earlier snow melt and plant green-up each spring. There seems to be indication of habituation to human activity (Morrison et al. 1995). This may however be dependend upon vegetation in the area. Elk exposed to direct human activity may be less likely to acclimatise than elk exposed to physical and mechanical disturbances. Although there was a decrease in elk use of the site during the study period, there was an increase in the number of animals in the entire population during the study period, indicating that the population effect of disturbance in this study was of little importance.

Murphy, S. M., Smith, M. D., White, R. G., Kitchens, J. A, Kugler, B. A. & Barber, D. S. (1993) Behavioral responses of caribou to low-altitude jet aircraft. *Air Force Materiel Command, Wright-Patterson Air Force Base*, Ohio, Final Report. 53pp.
The authors recorded the reactions of 268 groups of caribou to 159 overflights by jets. Approximately 50% of the caribou showed some degree of overt behavioural responses to overflights, but only 13% of the overflights caused the animals to move. Activity budgets were compared between disturbed and undisturbed groups of caribou; no differences were evident in late winter, but during post-calving and the insect seasons overflown animals spent less time lying and more time either feeding (post-calving) or walking (insect season). Daily distance traveled was compared for disturbed and undisturbed animals; no differences were evident during late winter and the insect season, but disturbed caribou traveled farther than did undisturbed caribou during post-calving. They concluded that behavioural impacts generally were mild, but that female caribou reacted to jet aircraft overflights by lying less and moving more, and that these responses were most prevalent in June when newborn calves were present.

Pedevillano, C. & Wright, R. G. (1987) The influence of visitors on mountain goat activities in Glacier National Park, Montana. *Biological Conservation.* **39,** 1-11.
Mountain goat behaviour and use of specially constructed highway underpasses and an adjacent mineral lick was monitored simultaneously with visitor activities at an observation area in Glacier National Park, Montana. Although the site was very popular with park visitors, those using the the observation area did not appear to have an adverse effect on mountain goat use of the mineral lick. Traffic on the highway and visitors standing above the underpasses did,influence behaviour of mountain goats crossing the highway, causing run backs, hesitation, and eliciting visiual alarm responses. The construction of a highway underpass was very effective since only 74% successfully crossed the highway prior to the construction. After the construction all mountain goats observed using the underpasses were eventually successful and no highway mortality was noted. This success may partly be due to that the animals were previously habituated to humans and traffic, and because the mineral lick was important for

them. Mountain goats used the underpasses at times when traffic was least. Visitor presence on the highway increased the time it took goats to cross, and number of visitors at a given time also appeared to be of importance.

Perry, C. & Overly, R. (1976) Impacts of road on big game distribution in portions of the blue mountains of Washington. *Proceedings of elk-logging-roads Symposium for Wildlife and Range Exp. Stn.*,University of Idaho, Moscow. 62-68.
Generally, the authors found that roads reduced big game use of adjacent habitat within 800 m of the road. This impact was greatest along «main» roads and through open vegetation types, and diminshed with reduced road quality and increasing vegetation density.

Richens, V. B. & Lavigne, G. R. (1978) Response of white-tailed deer to snowmobiles and snowmobile trails in Maine. *Canadian Field-Naturalist.* **92,** 334-344.
Use of the trail system was significantly correlated with deer density and with winter severity (temperature, wind, snowfall, and deer sinking depth). Most deer followed snowmobile trails for short distances and used them near major bedding areas. Disturbance of deer by snowmobiles did not cause them to abandon preferred bedding and feeding sites. Sinking depth of deer on snowmobile trails was significantly less than off trails and was inversely correlated with hardness of snowmobile trails. They traveled and fed along 9.1 km of snowmobile trails made in openings adjacent to existing winter concetration areas. Deer were induced to move up to 1.9 km by use of snowmobile trails and chain-saw noise. Response varied between winters, within winters, with time of day, cover type, proximity to deer trails, snow depth, and deer sinking depth in snow, but not with temperature or deer group size.

Root, B. G., Fritzell, E. K. & Giessman, N. F. (1988) Effects of intensive hunting on white-tailed deer movement. *Wildlife Society Bulletin.* **16,** 145-151.
Movement patterns of white-tailed deer were monitored (n=24; 18F, 6M) before, during, and after a 9-day firearms hunting in an area including a refuge (704-ha.). During the hunting season females with established home ranges outside the refuge moved greater distances and had larger home ranges than they did either before or after the season. Females on the refuge showed no similar response. Movements and home ranges of non-refuge females were more extensive than those of refuge females only during the firearms season. Two females, which had used the refuge area before, shifted to the refuge after the firearms season began. There was a weak linear relationship (positive) between human activity levels and deer movement. Non-refuge males did not alter their movement pattern during firearms season.

Russell, D. E. & Martell, A. M. (1985) Influence of the Dempster highway on the activity of the Porcupine caribou herd. (1985) *Proceedings of the 1st North American Caribou Workshop* (eds A. M. Martell & D. E. Russell). pp 22-26.
No significant differences were found between activity budgets of caribou close to, and away from, the highway during winter.

Schaal, A. & Boillot, F. (1992) Chamois and human disturbance in the Vosges mountains. *Ongulés / ungulates 91* (eds F. Spitz, G. Janeau, G. Gonzalez & S. Aulagnier), pp. 639-642. S.F.E.P.M. - I.R.G.M.
Human frequentation and interaction with chamois were studied during summer to determine their general impact on a chamois population in a mountain area. The human frequentation had an intensity varying between 150 and 550 visitors per day and was characterized by three diurnal activity periods. Both morning and evening periods were dominated by chamois-orientated people and accounted for 23% of the daily number of visitors, and 53% of the daily number of visitors hours. Chamois separated their diurnal and nocturnal areas of activity. During night, dusk and dawn they grazed on the ridge grasslands heavily used by visitors and during daylight they used escape areas. Grazing chamois were relatively tolerant towards visitors. When disturbed, they clumped together and fled downwards in nearly all cases. Another main effect of visitor disturbance was a reduction in chamois grazing time on the more attractive grasslands. Both spatial and temporal distribution of chamois activities are directly affected by human summer disturbance. However, no indirect marked effect on the population, e.g., a deterioation of the condition of the animals or a decrease in annual reproduction, has been detected during this study nor during the past years under nearly the same human pressure. But, it is argued that repeated disturbance will lead to an increase in the physiological cost of survival for the animals.

Schultz, R. D. & Bailey, J. A. (1978) Responses of National Park elk to human activity. *Journal of Wildlife Management.* **42,** 91-100.
Results suggested some small effects of traffic volume upon elk, but no trends were statistically significant. People approaching animals off roads usually caused elk to leave open areas. Harassing elk in 2 meadows on alternate weeks during winter and spring did not affect their distribution or observability on winter ranges. Elk made greater use of areas near roads as the winter-spring study progressed, suggesting slight avoidance of roads when forage was more abundant earlier in winter. Wintering elk often used a residental area at night when human encounters were minimal. During winter and spring, elk were approached significantly closer during darkness with artificial lights than during daylight. These elk, which experienced little or no hunting, were very visible and were disturbed little, if at all, by normal on-road visitor activities.

Singer, F. J. & Beattie, J. B. (1986) The controlled traffic system and associated wildlife responses in Denali national park. *Arctic.* **39,** 195-203.
As visitors and number of vehicles increased moose sightings per trip declined (72%), grizzly bear sightings declined (32%), while dall sheep and caribou sightings remained constant over the same period. Allowing unlimited private vehicle access had little influence upon the numbers of wildlife seen. However, more wildlife were put to flight, escape distances increased, more grizzlies were thwarted from crossing the roads, and visitors stopped near and approached wildlife afoot more often with increasing traffic. Wildlife responses were significantly influenced by pre-stimulus behaviour for all four species, the type of human behaviour for moose and grizzlies, sex/age class for moose and caribou, group size for caribou, number of vehicles present for grizzlies, and the presence or absence of vegetation screening for moose and grizzlies. Moose were alert four times as often (32%) when close to the park road than when >1 km away (4.8%), and when close to the road they were alerted to 37% of all road stimuli, while caribou were alerted to only 21% of road stimuli.

Skogland, T. & Grøvan, B. (1988) The effects of human disturbance on the activity of wild reindeer in different physical condition. *Rangifer.* **8,** 11-19.
Two Norwegian wild reindeer herds in different physical condition were compared with respect to effects of human disturbance (hunting). The purpose was to test whether physical condition effected foraging strategy under stress. Before exposure to human disturbance the well-fed herd were ca. 30% larger, and they foraged less and walked more, i.e. were more selective than the other herd, which were in energetically lower condition and foraged significantly more and spent less time moving between habitat patches. After exposure to hunters the well-fed herd aggregated into significantly larger groups than before hunting and stood alert more, while the other herd spent the same minimum amount of time foraging but moved significantly more and spent almost no time standing. The frequency of disturbance, the reindeer's speed of movement after disturbance, and the hunter kill success was similar in the two areas. The energetic costs, measured as relative body weight loss during the hunting season, was higher for the initially less-fed herd, and higher for both herds compared to that from a less disturbed herd.

Skogland, T. & Mølmen, Ø. (1980) Prehistoric and present habitat distribution of wild mountain reindeer at Dovrefjell. *Procdeedings of the 2nd International Reindeer/Caribou Symposium* (eds E. Reimers, E. Gaare & S. Skjenneberg), pp. 130-141.
The authors concluded that the presence of a human, whether as a hiker, skier or hunter, arouses far more flight and avoidance reactions than any type of mechnical device, be it a power transmission line or moving vehicle. Furthermore, it apperead that no type of technical installation poses immediate avoidance reactions as long as it does not physically restrict the animals' presence. The same appears true for access roads. It is human presence on or near the roads that induces avoidance reactions. The combined effect of a railroad, fence, telephone line and the paralell highway caused a obvious physical hindrance. Most crossings have been found to take place during nights when traffic are minor. The combination of a road, railway line and houses along a communication corridor had stopped migration between two areas, that archaelogical evidence (pitfall-traps) indicated were once connected.

Skogland, T. (1986) Movements of tagged and radio-instrumented wild reindeer in relation to habitat alteration in the Snøhetta redion, Norway. *Rangifer.* Special Issue **1,** 267-272.
Skogland concluded that snow conditions (a threshold level is needed to initiate crossing of railroad and highway), traffic on a road lying paralell to a railroad, and the damming of a lake significantly affected annual distribution as compared with expected modern as well as prehistoric distribution. The railroad and the highway prevented a large amount of animals moving to their highly prehistoric wintering areas. The consequence of the lowered use of these wintering areas is most likely an additional trampling of the already denuded lichen heaths in the summer area, caused by a year round existence in that area. This will slow the recovery rate of the overgrazed lichen heaths. Males were more likely to cross barriers than females. Females with young were more shy to human disturbance, and therefore crossed less than males.

Skovlin, J. M., Bryant, L. D. & Edgerton, P. J. (1989) Timber harvest affects elk distribution in the Blue Mountains of Oregon. *Research Paper PNW-RP-415. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Nortwest Research Station.* 10pp.
There was an increased density of elk after logging in study area. Type of cutting were important; Small patches of clearcutting increased density more than did partial cutting. Five years after disturbance, however, elk use declined to near former levels. The increased deer density after logging was explained by more available forage due to the growth of numerous early seral species after clearcutting and slashburning. Elk use of adjacent unlogged forest was also high because it afforded animals good hiding cover. Partial cuts were used least because they offered neither good cover or increased available preferred forage. Furthermore, elk made use of the dense unlogged stands during hunting and other periods of high human activity.

Smith, W. T., Cameron, R. D. & Reed, D. J. (1994) Distribution and movements of caribou in relation to roads and pipelines, Kuparuk development area. *Alaska Department of Fish and Game. Wildlife Technical Bulletin* **12,** 54 pp.
The study was subdivided into temproal categories depending upon the stage of an oilfield development. In

summary; numbers of caribou observed from the road have decreased to initial or preconstruction levels, despite a 4-5 fold increase in herd size. Although there is evidence of some habituation to the road system, caribou avoided areas of intensive human activity, especially before and during calving. This avoidance may have restricted access to a main calving area. By the end of this study, most insect-harassment induced movements of large groups across the road transect occurred near Olitok point and Kuparuk floodplain, and caribou avoided central parts of the transect used during preconstruction and initial construction.

Stockwell, C. A. & Bateman, G. C. (1991) Conflicts in National Parks: a case study of helicopters and bighorn sheep time budgets at the Grand Canyon. *Biological Conservation.* **56,** 317-328.
Bighorn sheep were sensitive to helicopter 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 away from helicopters during the spring after they had migrated to lower elevations. Further analyses indicated a disturbance distance threshold of 250-450 m. They found no effect of sex, age or group size.

Sweeney, J. R., Marchinton, R. L. & Sweeney, J. M. (1971) Responses of radio-monitored white-tailed deer chased by hunting dogs. *Journal of Wildlife Management.* **35,** 707-716.
The responses of white-tailed deer chased by hunting dogs in three different areas were documented. Deer exhibited one of five different escape patterns, or a mix of several patterns during a chase; (1) Remaining bedded, often in dense vegeation, dogs may pass by without finding the hidden animal. If discovered. the deer runs when dogs were very close. (2) Running in straight line for a long distance, quickly leaving its home range and using speed and endurance to lose the hounds. (3) Running a complicated circuitous zigzag pattern frequently crossing its own trail while not leaving its general home range. Deer made brief stops at frequent intervals during the chase, apparently to save energy and check whether hounds had lost trail. (4) Splitting off from group (if in group when started chased by hounds). This often result in hounds chasing another member of the group. (5) Running through water (river swamp or stream) - resulting in hounds loosing trail. In all cases the chase resulted in that deer's escaped the dogs. Mean chasing time was 33 minutes, and average distance covered in the chase was 3.7 km. Deer left home ranges in 78% (51 of 65 cases) of the cases, in 44 of these 51 cases deer stayed within 1.6 km of their home ranges. With one exception all deer returned to their home ranges in 1 day or less. The single remaining deer established a new home range in the vicinity (22 day study period after chase).

Swenson, J. E. (1982) Effects of hunting on habitat use by mule deer on mixed-grass praire in Montana. *Wildlife Society Bulletin.* **10**, 115-120
The habitat use of mule deer before and during the hunting season was studied using systematic aerial surveys. Mule deer decreased their use of praire and increased their use of forest when exposed to human hunting pressure during a defined season. Those deer that had no access to forest used steep hillsides in preference to ridges, plateaus and gulley bottoms. These changes were interpreted as a selection for cover when exposed to disturbance.

Takatsuki, S. (1989) Edge effects created by clear-cutting on habitat use by sika deer on Mt. Goyo, Northern Honshu, Japan. *Ecological Research.* **4,** 287-295.
Takatsuki found that edges, created by clear cutting, increased density of sika deer in the study area. The increase in density was due to increase in preferred forage, resulting from a large increase in available plant production. Additionally, clear cutting secured forest cover. There were less and less deer away from the edge (in forest, adjacent zone, distant zone).

Tyler, N. C. (1991) Short-term behavioural responses of Svalbard *reindeer Rangifer tarandus platyrhynchus* to direct provocation by a snowmobile. *Biological Conservation.* **56,** 179-194.
The first visible responses of Svalbard reindeer to an approaching snowmobile usually involved independent behaviour by different individuals in a group. Flight, by contrast, was a co-ordinated group response. Different response distances are given in tables in the paper. Energy and time budget models indicate that one median flight response can cause an increase in a reindeer's energy expenditure of approximately 0.4% and a loss of daily grazing time also of 0.4 %. In other words, only minor effects on these parameters. The author argue that the results from this study may not be directly transferred to other reindeer sub-species as Svalbard reindeer are not exposed to predators, and therefore have evolved a docile, sedentary behaviour.

Valkenburg, P. & Davis, J. L. (1985) The reaction of caribou to aircraft: a comparison of two herds. *Proceedings of the 1st North American Caribou Workshop* (eds A. M. Martell & D. E. Russell).
Reactions of caribou to aircraft overflights was affected by the herds previous experience with aircraft. The Delta herd which had a long history of exposure to benign overflights showed little response to aircraft and appeared to have become habituated. In contrast the Western Arctic herd, which have little exposure to routine airtraffic, but have been hunted from both aircraft and snowmobiles, showed much higher rates of extreme response.

Valkenburg, P., Boertje, R. D. & Davis, J. L. (1983) Effects of darting and netting on caribou in Alaska. *Journal of Wildlife Management* **47**, 1233-1237.
No effects of helicopter (darting and netting) capture of caribou in winter on calf production were found.

Ward, A. L. (1976) Elk behavior in relation to timber harvest operations and traffic on the Medicine Bow range in south-central Wyoming. *Proceedings of elk-logging-roads Symposium for Wildlife and Range Exp. Stn.,*University of Idaho, Moscow. 32-43.
Ward found that elk preferred to be at least 800 m from people engaged in clear-cut timber harvest or cleanup operations. Elk moved back to the timber harvested areas soon after human activity stopped. Traffic on Forest Service roads (logging, recreation etc.) had little effect on elk activity, especiallly that beyond 400 m from the road. Elk tended to cross were desirable feeding sites were near the road. Slow vehicle speed and low traffic during elk activity periods, usually under low light conditions or at night, limited accidents and elk disturbance.

Waring, G. H., Griffis, J. L. & Vaughn, M. E. (1991) White-tailed deer roadside behavior, wildlife warning reflectors, and highway mortality. *Applied Animal Behaviour Science*. **29**, 215-223.
Deer roadside activity was primarily during night time (1700-0700), and appeared unaffected by weather conditions or traffic volume. Females in general were more relaxed than males when crossing the road. No effect of the reflectors were observed.

Weisenberger, M. E., Krausman, P. R., Wallace, M. C., De Young, D. W. & Maughan, O. E. (1996) Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. *Journal of Wildlife Management*. **60**, 52-61.
This paper is based on the same study as Krausman et al 1993a,b). They compared heart rates and behaviour of mountain sheep and mule deer before, during and after simulated overflights (n=112 overflights/season) during three seasons. The heart rate of ungulates increased related to dB levels during simulated overflights, but they returned ro pre-disturbance levels in 60-180 seconds. Animal behaviour also changed during overflights but returned to pre-disturnbance conditions within < 252 seconds. All animal responses decreased with increased exposure suggesting that they habituated to simulated sound levels of low-altitude aircraft.

Westworth, D., Brusnyk, L., Roberts, J. & Veldhuzien, H. (1989) Winter habitat use by moose in the vicinity of an open pit copper mine in north-central British Columbia. *Alces*. **25**, 156-166.
Results of browse surveys, pellet-group counts and noise level measurements (from general mining activity, machinery, blastings etc.) indicated that moose distribution in the study area was more influenced by differences in browse availability among different habitat types than by disturbance associated with mining (measured as moose use and distance to mine site). The results demonstrate that moose are being attracted to cutover areas (abundant browse supplies in the 10-year old clearcut) on the periphery of the mine site and have habituated to the presence of the mine site since mining started 17 years prior to the study.

Whitten, K. R. & Cameron, R. D. (1983) Movements of collared caribou, Rangifer tarandus, in relation to petroleum development on the arctic slope of Alaska. *Canadian Field Naturalist*. **97**, 143-146.
Bulls were more likely than cows to be observed, and resighted, from the roadsystem associated with the pipeline, and they crossed through the road corridor more often; in contrast, bull and cow resightening patterns in off-road areas were not significantly different. Thus the cow/calf segment of the herd appeared to avoid disturbed areas more so than did bulls. The heavily developed Prudhoe oilfield was an effective barrier to both bulls and cows, and disrupted midsummer movements of the caribou in the area.

Witmer, G. W. & deCalesta, D. S. (1985) Effects of forest roads on habitat use by Roosevelt elk. *Northwest Science*. **59**, 122-125.
They found that elk significantly avoided forest roads open to traffic compared to roads closed for vehicles. Additionally they found that elk spent more time in cover during the hunting season.

Yarmoloy, C., Bayer, M. & Geist, V. (1988) Behavior responses and reproduction of mule deer, *Odocoilus hemionus,* does following experimental harassment with an all-terrain vehicle. *Canadian Field-Naturalist*. **102**, 425-429.
Five radiocollared mule deer does were habituated to an all-terrain vehicle (ATV) during 12 weeks. During this period the vehicle followed the same trail on all occasions. Thereafter three of the females were followed by ATV for 9 minutes per day for 15 days between 1 to 24 october, for a total of 135 minutes. The harassed females, but not the other females, shifted feeding until darkness, used cover more frequently, left their home ranges more often, and increased their flush distance from ATVs. In the following year the three harassed females collectively raised 1 fawn, having had normal reproduction the year before and the year after. Neither the unmarked females in the study area nor the two radio-collared females suffered decreases in reproduction during the study.

B. Annotated bibliography: Carnivores

Albert, D.M. and Bowyer, R.T. (1991) Factors related to grizzly bear-human interactions in Denali National Park. *Wildlife Society Bulletin* **19**, 339-349.
Most interactions between grizzly bears and people in frontcountry in Denali occured in early June and late August, and probably involved bears habituated to humans. Backcountry interactions were strongly correlated to number of people riding shuttle buses and may have been caused by less-habituated bears moving from front- to backcountry areas. Interactions occured on river and gravel bars more frequently and in tundra less frequently than expected. Bears showed a greater tendency to approach people in developed areas along the park road, and in camps than when people were hiking in the backcountry.

Archibald, W.R., Ellis, R. and Hamilton, A.N. (1987) Responses of grizzly bears to logging truck traffic in the Kimsquit river valley, British Columbia. *International Conference on Bear Research and Management.* **7**, 252-257.
A logging road bisected the home ranges of 2 adult female grizzly bears that were intensively monitored. Data from two years of pre-logging and 2 years during logging activity were obtained. During logging activity 3 % - 23 % of their seasonal home range was unavailable to them for 14 hours per day. In areas were concentrated food resources of limited distribution are within the activity zone, this exclusion could limit access to important food sources. If there is a survival cost associated with avoiding this area, grizzly bears will probably move into it and become habituated to the disturbance.

Ballard, W.B., Whitman, J.S., Gardner, C.L. (1987) Ecology of an exploited wolf population in south central Alaska. *Wildlife Monographs* **98**, 1-54.
As part of a study of wolf behaviour, ecology and predation 151 wolves were radiocollared. During the period of study 24 natal dens were found. Pups were usually moved from the dens in July. Two instances of human disturbance at den sites in early June led to these dens being abandoned early. No pup mortality resulted fromthese actions.

Ballard, W. B., Ayres, L.A., Reed, D.J., Fancy, S.G. and Roney, K.E. (1993) Demography of grizzly bears in relation to hunting and mining development in Nortwestern Alaska. *Scientific Monograph. US Dept. of the Interior National Park Service.*
During 5 years 146 grizzly bears were radio-marked and followed. The study presents a substantial amount of demographic data, but their intention of comparing pre- and post-mine development densities failed, because a large proportion of killed bears were not reported.

Brody. A.J. and Stone, J.N. (1987) Timber harvest and black bear population dynamics in a Southern Appalachian forest. *International Conference on Bear Research and Management* **7**, 243-250.
The authors simulated the dynamics of a bear population in an area of Pisgah National Forest under 3 management regimes that facilitated comparison of the effects of different rotation intervals on the population of black bears. They concluded that some timber harvest regimes may improve the biotic suitability of bear habitat in terms of carrying capacity, but that these benefits may be easily outweighed by the concommitant increase in vulnerability to hunting. Under exhisting conditions hunting was a stronger influence on the population than was biotic habitat quality.

Brody, A.J. and Pelton, M.R. (1989) Effects of roads on black bear movements in western North Carolina. *Wildlife Society Bulletin* **17**, 5-10.
17 radio-collared black bears never crossed an interstate highway in the study area. Roads of low traffic volume were crossed relatively more frequently than roads of higher traffic volume. Road crossing ability was not affected by age or sex of bears, season or sanctuary status of the bear's home ranges. Bears may react to increases in road densities by shifting the locations of their home ranges to areas of lower road densities.

Bromley, M. (1985) Wildlife management implications of petroleum exploration and development in wildland environments. *US Department of Agriculture Forest Service General Technical Report* **INT-191** 42pp
The author provides a summary and interpretation of all disturbance studies on wildlife (mainlu carnivores, ungulates and birds) up until 1984. As well as providing a conceptual framework for interpreting the effects of disturbance she examines the value of different mitigation measures. An annotated bibliography is provided.

Carr, P.C. and Pelton, M.R. (1984) Proximity of adult female black bears to limited access roads. *Proceedings Annual Conference South Eastern Assocciation of Fish and Wildlife Commisioners* **38**, 70-77.
Seven adult female black bears showed no avoidance of limited access roads and trails, frequently crossed roads and trails during any given 24-hour period, and used areas around them. Response to seasonally abundant food supplies, rather than avoidance seemed to determine whether bears crossed roads and trails and used areas around them in this protected population.

Chapman, R.C. (1977) The effects of human disturbance on wolves (*Canis lupus* L.). *MS Thesis, University of Alaska, Fairbanks.*
Based on literature review and original observational research the effects of human disturbance on wolf behaviour associated with pup rearing natal-dens were studied. All human approaches to a den (<0.5 km) had a significant probability of causing den abandonment,

however this probability increased with the duration of the disturbance. Pups were moved from between 1.6 km and 16 km. Human presence at distances of around 1 km seemed to have little effect and many dens have been found within 6 km of centers of human activity. Little evidence of pup mortality resulting from human disturbance exists.

Chapman, R.C. (1979). Human disturbance at wolf dens - a management problem. In : Linn, R.M. (ed) *Proceedings, first conference on scientific research in the National Parks*: 1976 November 9 - 12; New Orleans, LA. Vol. 1. Transactions and Proceedings Series No. 5. Washington D.C.: U.S. Department of the Interior, National Park Service, pp: 323-328.
Contains same data as presented in Chapman (1977).

Contreras, G.P. and Evans, K. E. (eds) (1986) Proceedings grizzly bear habitat symposium. *United States Department of Agriculture Forest Service, General Technical Report* **INT-207**. 252 pp.
Contains a series of papers on bear-habitat relations, bear-human conflicts, and the effects of human management on modifying bear habitat.

Davies, N. (1987) Territory. Pages 550-556 in D.McFarland ed. *The Oxford companion to animal behaviour.* Oxford University Press, New York
Contains a theoretical discussion of the importance of territory to a species.

Eberhardt, L. E., Hanson, W. C., Bengtson, J. L., Garrott, R. A. & Hanson, E. E. (1982) Arctic fox home range characteristics in an oil-development area. *Journal of Wildlife Management.* **46**, 183-190.
Radio-collared arctic foxes were studied during the summer in an oil-development area in Alaska. The radio-collared animals seemed unaffected by the human activity and used the disturbed area for hunting and denning. In addition garbage and food handouts may have insulated the population from some of the cyclic swings of neighbouring populations.

Elgmork, K. (1978). Human impact on a brown bear population. *Biological Conservation* **13**, 81-103.
The distribution of brown bear signs and reports are compared with indices of human activities, mainly mechanised forestry including the building of a network of forest roads and the practice of clear-cutting. In the last 10 years of the study extensive building of holyday cabins had taken place. Statistically significant negative correlations existed between the number of bear observations and the density of forest roads. Negative tendencies were also indicated in areas close to cabin concentrations. A positive correlation between the number of bear observations and the length of the timberline in the area was indicated.

Elgmork, K. (1983) Influence of holiday cabin concentrations on the occurence of brown bears (*Ursus arctos* L.) in south-central Norway. *Acta Zoologca Fennica* **174**, 161-162.
Studies aimed at quantifying the influence of holiday cabins within a defined 2 km influence zone. The relative number of observations of bears within the influence zone decreased significantly after the middle of the 1960s and the end points of the curve are significantly different. The decrease is negatively correlated to an increase in the number of cabins and thus inversely related to a considerable increase in the chance of discovery. This indicates a significant negative influence on bear occurence near cabin consentrations due to human disturbance and changes in the environment.

Eliason, J.J. and Berry, W.H. (1994) Effects of military-authorized activities on the San Joaquin kit fox at Camp Roberts. *Transactions of the National Military Fish and Wildlife Association* 4-10.
94 San Joaquin kit foxes were radio-collared between 1988 and 1992. 53 were recovered dead, 11 lost contact and 30 had their collars removed. Three were study related mortalities and were removed from the analysis. Cause of death was determined for 33 of 50 foxes. 76% of these were killed by other predators, mainly coyotes, 6% died from rabies, 6% were poisoned, 3% died from car collisions outside the Camp and 9% died due to military authorised activity (1 hit by car, 1 entangled in barbed wire and bled to death, 1 shot by military hunter). 1067 dens were found from these radio-collared foxes. 334 of these were under buildings on the training site. 98 of 1009 earth dens showed signs of having been driven on by military vehicles, however no dens were destroyed by this activity. Two dens had entrances destroyed by road construction, however foxes were tracked to the den the day before and the day after the construction. Many dens, including ones were pups were reared, were found within several hundered meters of military activity (camps, roads, artillery firing points).

Faro, J.B. and Eide, S.H. (1974) Management of McNeil River State Game Sanctuary for nonconsumptive use of Alaskan brown bears. *Proceedings Western Association of State Game and Fish Comissioners.* **54,** 113-118.
Increasing numbers of photographers and viewers at a popular brown bear salmon fishing place began to cause increasing disturbance. Bears began to avoid the area during peak visitor times and some bears may have abandoned the area altogther. Disturbance was least when visitors acted predictably.

Foster, M. L. & Humphrey, S. R. Use of highway underpasses by Florida panthers and other wildlife. *Wildlife Society Bulletin.* **23**, 95-100.
The use of a series of eight highway underpasses was monitored using event recorders and automatic cameras. Bobcat, Florida panthers, racoons, white-tailed deer and wading birds all used the underpasses successfully during the study. The design of underpasses is reviewed.

Fredrickson, L.H. (1980) Management and lowland hardwood wetlands for wildlife: problems and potensial. *Transactions North American Wildlife and Natural Resources Conference* **45**, 376-386.

Geist, V. (1978) Behavior. In: Schmidt, J.L and Gilbert, D.L. (eds.). Big game of North America, ecology and management. Harrisburg, PA. Stackpole Books. pp. 283-296.
Presents an overview of the process of learning and habituation in mammals, and describes the process by which mammals can habituate, and in the case of bears how this habituation can lead to attacks on people.

Gese, E.M., Rongstad, O.J. and Mytton, W.R. (1989) Changes in coyote movements due to military activity. *Journal of Wildlife Management* **53**, 334-339.
16 coyotes were radio-collared inside a military training area, and 12 were collared outside. The control animals were stable within their home ranges before, during and after military exercises. Coyotes exposed to disturbance responded by expanding, contracting,abandoning or not changing their home ranges. Two animals permanently abandoned their ranges. Coyotes with the greatest amount of cover within their ranges showed the least effects.

Graber, D.M. and White, M. (1978) Management of black bears and humans in Yosemite National Park. *California Nevada Wildlife* 42-51.
The paper describes an increase in rates of bear-attacks on backpackers in Yosemite NP. The increase in human use of the area was hypothesised to have caused a greater degree of habituation among bears, and therefore a greater degree of attacks.

Gunther, K.A. (1990) Visitor impact on grizzly bear activity in Pelican Valley, Yellowstone National Park. *International Conference on Bear Research and Management* **8**, 73-78.
A total of 944 bear observations were recorded in an area managed for 3 levels of backcountry use: open (both day use and overnight camping allowed), restricted (day use only) and closed (no visitors). The average flight distance of grizzly bears to trees following disturbance by backcountry users was 422 m. When the valley was open to visitors, bear activity in areas greater than 500 m from forest cover was significantly reduced and bears avoided areas around occupied backcountry campsites. Foot parties were more likely to be charged during an encounter with a grizzly bear than people on horseback. All incidents in which hikers were charged by bears involved groups of 1 or 2 people.

Gunther, K.A. (1994) Bear management in Yellowstone National Park, 1960-93. *International Conference Bear Research and Management* **9**, 549-560.
From 1931 to 1959, an average of 48 people per year were injured by bears within Yellowstone NP. In 1960 YNP implemented a bear management program designed to reduce the number of bear-caused human injuries and property damages, and to re-establish bears in a natural state. Most management effort went into the removal of potentially hazardous bears. After 10 years of the program, 332 nuisance black bears and 39 nuisance grizzly bears had been removed from the population. However, the number of bear-caused human injuries within YNP decreased only slightly. In 1970, YNP initiated a new more intensive bear management program, involving eliminating all sources of human food and garbage. During the 3 first years, bear-caused human injuries decreased significantly to an average of 10 per year. During the same period, an average of 38 grizzly bears and 23 black bears per year were trapped and translocated from roadsides and developed areas to backcountry areas. In addition 12 grizzly and 6 black bears were annually removed from the population. A modified management program similar to the 1970 program, but with greater emphasis on habitat protection in backcountry areas, was implemented in 1983. Since 1983, bear-caused human injuries have declined to an average of 1 per year. During the first years of these management programs, most bear-human conflicts involved food-conditioned bears that aggressively sought human foods. In more recent years, management problems have involved habituated (but not food-conditioned) bears seeking natural foods within developed areas and along roadsides.

Hanley, T., Hemming, J.E., Morsell, J.W., Morehouse, T.A., Leask, L.E. and Harrison, G.S. (1980) Natural resource protection and petroleum development in Alaska. Report prepared for Office of Biological Services, Fish and Wildlife Service, U.S. Dept. of the Interior, Whasington, DC. 318 pp.
This report describes some of the general effects that human activity might have on wildlife, such as forcing animals to avoid certain habitats, causing pollution and leading to increased direct conflicts.

Harding, L. and Nagy, J.A. (1980) Responses of grizzly bears to hydrocarbon exploration on Richards Island, Northwest Territories, Canada. *International Conference on Bear Research and Management.* **4**, 227-280.
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 drilling camps by 1 km 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 was predicted that the cumulative effects of proposed natural gas production facilities would not be compatible with continued survival of grizzly bears on Richards Island.

Harms, D.R. (1980) Black bear management in Yosemite National Park. *International Conference on Bear Research and Management* **4**, 203-212.
The food conditioning of black bears in Yosemite NP is described, along with an analysis of how their foraging habits have changed following the increase of human use of bear habitats.

Horejsi, B. L. (1986) Industrial and agricultural incursion into grizzly bear habitat: the Alberta story. In pages 116-123 G.P. Contreras and K.E. Evans (eds.) Proceedings Grizzly bear habitat *symposium U.S. Department of Agriculture Forest Service, General Technical Report* **INT-207**
The increase in human activity (agriculture, logging, oil and gas exploration) in an area of western Alberta, led to easier hunter and poacher access and the increased deaths of radio-collared bears. The paper challenges the entire system of land-use in Alberta and calls for an increased awareness of wildlife needs when planning land use.

Jensen, W.F., Fuller, T.K. and Robinson, W.L. (1986) Wolf *Canis lupus* distribution on the Ontario-Michigan border near Sault Ste. Marie. *Can. Field Nat.***100**, 363-366.
In Ontario, road density in areas not occupied by wolves was greater than in areas occupied by wolf (0.93 and 0.38 km/km^2 respectively). High human densities, as indicated by high road densities, apparently served as a barrier to wolf dispersal into Michigan. An evaluation of road densities, in conjunction with other factors, may aid in estimating the impact of development on established wolf populations, or in predicting the likelihood of re-establishing wolf in an area.

Jonkel, C.J. and Cowan, I. McT. (1971) The black bear in the spruce-fir forest. *Wildlife Monographs* **27**, 1-57.
Describes ecology and habitat relations of black bears.

Jope, K.L. (1985) Implications of grizzly bear habituation to hikers. *Wildlife Society Bulletin* **13**, 32-37.
Behaviour of grizzly bears towards hikers in Glacier National Park, Montana, indicated that only hikers who did not wear bear-bells were charged. Charges tended to occur at crepuscular times on cool days in early summer. Although bears were seen as often on heavily used trails as on trail with little human use, full-charges occured primarily on trails with little human use. These findings, together with records on human injuries in the Park, suggest that habituation of grizzly bears to hikers reduces the rate of fear-induced charges and consequent injuries.

Jope, K.L. 1983. Habituation of grizzly bears to people: A hypothesis. *International Conference Bear Research and Management* **5**, 322-327.
In areas with both high and low levels of human activity, females with young were more likely than single adults and subadults to avoid human-use areas and showed little habituation to people. A midseason increase in habituated behaviour by adult and subadult bears occured in both areas, but adults and subadults showed a greater degree of habituation throughout the season in the high-use area.

Kaczensky, P., Knauer, F., Huber, T., Jonozovic, M. and Adamic, M. (in press) The Ljubljana-Postonja highway - a deadly barrier for brown bears in Slovenia? *Symposium paper at The coexistence of large predators and man Poland* (1994)
Since the opening of the Ljubljana-Postojna highway in 1972, nine bears have been hit by cars. For two radio-collared adult females and an adult male the highway clearly represented the home range boundary. Only the male crossed once for a short trip during the mating season. Five crossings of unmarked bears in two tunnels were documented. The highway seems to be a barrier that is rarely crossed by resident bears, but might be crossed by transient bears.

Kasworm, W.F. and Manley, T.L. (1990) Road and trail influences on grizzly bears and black bears in northwest Montana. *International Conference on Bear Research and Management* **8**, 79-84.
Grizzly bears used areas 0-914 m from open roads less than expected based on availability during spring and fall. Black bears used habitat 0-274 m from open roads less than expected during spring and used habitat 0-914 m from roads less than expected during fall. Grizzly bears used habitat 0-122 m from trails less than expected during spring and fall. Black bears used habitat 0-122 m from trails less than expected during spring and used habitat 0-305 m from trails less than expected during fall. Habitat availability appeared related to grizzly bear avoidance of trails, and black bear avoidance of roads and trails. Mean distance from grizzly bear radio locations to a seasonally closed road increased when the road was opened. The benefits of road closures in bear management were discussed.

Klein, D.R. (1974) The reactions of some northern mammals to aircraft disturbance. *Transactions International Union of Game Biologists Congress* **11**, 377-383.
The paper describes some early observations of arctic mammal response to aircraft. The wolves observed appeared to habituate very quickly to aircraft overflights, whereas the grizzly bears observed showed very strong avoidance reactions. The previous experience of the animals to aircraft was considered to be important.

Kull, R., Bowles, A.E., Wisley, S., Francine, J. and McClenaghan, L. (1994) The effects of aircraft overflights on predator-prey relationships. *Transactions of the National Military Fish and Wildlife Association* 11-14.
The paper describes the aims and preliminary results of a project designed to examine the effects of exposure to loud noise on the ability of small predators (kit foxes) to detect their rodent prey with auditory cues, and on the

rodents ability to avoid predation. The hypothesis was that noise exposure would damage their hearing and thus effect the nature of the predator-prey interaction. Preliminary data did not support the hypothesis.

Laurenson, K. & Caro, T. M. (1994) Monitoring the effects of non-trivial handling in free living cheetahs. *Animal Behaviour* **47**, 547-557.
Cheetahs were followed by vehicles, captured and radio-collared and, the maternal lairs with new-born young were visited by the researchers. They were unable to find any effects of their activities on reproduction, survival or hunting success of the cheetahs. This indicates that the cheetahs were very tolerant of researcher (and by extension most tourist) activity.

LeFranc, M.N. Jr., Moss, M.B., Patnode, K.A., Sugg III, W.C. (1987) Grizzly bear compendium. U.S. Fish and Wildlife Service, Missoula, Montana 540 pp.
The compendium summarises almost everything written on grizzly bear behaviour, ecology, physiology, population dynamics, diet and habitat requirements written up to 1985. Large sections on their interactions with humans and human activity, and ways to mitigate these effects are presented. It is especially valuable because it summarises many difficult to obtain, unpublished reports.

Leonard, R.D., Breneman, R. and Frey, R. (1990) A case history of grizzly bear management in the Slims River area, Kluane National Park Reserve, Yukon. *International Conference Bear Research and Management* **8**, 113-123.
A public transit system in the Slim River Area to facilitate visitor access to a large valley glacier was planned but not built, and the valley was managed as a backcountry hiking area for an interim period. During this period visitor use increased. Observations of solitary bears increased from 40% to 84% from 1981 to 1987. Frequency of avoidance behaviour by grizzlies decreased whereas apparent neutral and approach behaviours increased. Serious incidents sharply increased in 1985, and stayed high during the next years. Management actions resulted in the deaths of 5 grixxlies, relocation of 5 grizzlies and partial area closure. Research grizzly bears were not adequately treated in plans and environmental assessments for this area. The authors consider national park management processes to be a valid tool for grizzly management provided they are implemented by trained, knowledgeabble staff that apply adequate information before making decisions.

Lindzey, F.G. and Meslow, E.C. 1977. Home range and habitat use by black bears in southwestern Washington. *Journal of Wildlife Management* **41**, 423-425.
Describes ecology, behaviour and habitat use of black bears.

Lovallo, M. J. & Anderson, E. M. (1996) Bobcat movements and home ranges relative to roads in Wisconsin. *Wildlife Society Bulletin*. **24**, 71-76.
The movement behaviour and habitat selection of 16 radio-collared bobcats was studied in relation to roads in Wisconsin. Unpaved roads were crossed in proportion to their occurrence within home ranges, but crossing of paved roads was avoided.

Mace, R., Aune, K, Kasworm, W., Klaver, R. and Claar, J. (1987) Incidence of human conflicts by research grizzly bears. *Wildlife Society Bulletin* **15**, 170-173.
The fate of 81 research grizzly bears from 4 areas was investigated to document the percentage of bears involved in human conflicts subsequent to capture and handling. 84% of the bears did not conflict with man, and 84% of the conflicts were directly related to the presence of livestock. There was no indication that capturing and handling of grizzly bears lead to an artifically high level of human conflict.

Manville, A.M. (1983) Human impact on the black bearts in Michigan's lower peninsula. *International Conference Bear Research and Management* **5**, 20-33.
Positive effects of humans on bears included; changes in hunting regulations possibly resulting in an increased bear population; bears frequently using oil pipeline right-of-ways, oil well service lanes, and lumber roads as travel routes; early-successional vegetational stages induced by roadside cutting, commercial lumbering, clear-cutting deer management projects, and controlled burns, and bee-keeping all improved habitat quality. Negative effects included loss of habitat due to human encroachment, heavy automobile traffic, hunting aided by service roads, marked bears and females being shot, and bears which fled their dens when approached. Questionable impacts included proximity of den sites to centers of human activity, closure of most sanitary landfills, and disturbance by small game and deer hunters.

Martinka, C.J. and Kendall, K.C. (1986) Grizzly bear habitat research in Glacier National Park, Montana. Pages 19-23 in G.P. Contreras and K.E. Evans eds. Proceedings Grizzly bear habitat symposium U.S. Department of Agriculture Forest Service, General Technical Report INT-207.
The paper describes the mapping of grizzly bear habitat availability, patterns of bear habitat use, and patterns of human use in Glacier NP. The aim of the research was to minimise bear-human conflict.

Mattson, D.J. (1990) Human impacts on bear habitat use. *International Conference on Bear Research and Management* **8**, 33-56.
Human effects on bear habitat use are mediated through food biomass changes, bear tolerance of humans and their impacts, and human tolerance of bears. Large scale changes in bear food biomass have been caused by conversion of wildlands and waterways to intensive

human use, and by the introduction of exotic pathogens. Bears consume virtually all human foods that have been established in former wildlands, but bear use has been limited by access. Air pollution has also affected bear food biomass on a small scale and is likely to have major future impacts on bear habitat through climatic warming. Major changes in disturbance cycles and landscape mosaics wrought by humans have further altered temporal and spatial pulses of bear food production. Although bears tend to avoid humans, they will also use exotic and native foods in close proximity to humans. Subadult males and adult females are more often impelled to forage closer to humans because of their energetic predicament and because more secure sites are often preempted by adult males. Although male bears are typically responsible for most livestock predation, adult females and subadult males are more likely to be habituated to humans because they tend to forage closer to humans. Elimination of human-habituated bears predictably reduces effective carrying capacity and is more likely to be a factor in preserving bear populations where humans are present in moderate to high densities. If humans desire to preserve viable bear populations, they will either have to accept increased risk of injury associated with preserving habituated animals, or continue to crop habituated bears while at the same time preserving large tracts of wilderness free from significant human intrusion.

Mattson, D.J., Blanchard, B.M, and Knight, R.R. (1992) Yellowstone grizzly bear mortality, human habituation, and whitebark pine seed crops. *Journal of Wildlife Management* **56**, 432-442.
The authors hypothesize that high mortality of adult females and subadult males during poor seed crop years was a consequence of their tendency to range closest to human facilities; they also had a higher frequency of human habituation compared with adult males. Human-habituated and food-conditioned bears were 2.9 times as likely to range within 4 km of development and 3.1 times as likely to be killed by humans compared with nonhabituated bears. They argue that destruction of habituated bears that use native foods near humans results in a decline in the overall ability of bears to use available habitat; and that the number and extent of human facilities in occupied grizzly bear habitat needs to be minimized unless the habituated bears are preserved and successful ways to manage the assiciated risks to humans are developed.

Mattson, , D.J., Knight, R.R. and Blanchard, B.M. (1987) The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. *International Conference on Bear Research and Management* **7**, 259-273.
Grizzly bear occupancy of habitat near human facilities was reduced, efficient foraging strategies were disrupted, and cohorts tending to be subordinate or security-conscious were displaced into habitat nearer developments by more dominant cohorts, particulary during summer and fall. Adult females and subadult males residing closer to developments were management-trapped at a higher rate than animals of the same class residing farther away. Adult females and subadults bore a disproportionate part of the costs associated with avoiding roads and developments. For this reason and because females are generally thought to operate under considerable energetic duress in the Yellowstone area, avoidance of developments and roads may have resulted in higher mortality and lower productivity among the adult female cohort.

McCrory, W., Herrero, S. & Whitfield, P. (1986) Using grizzly bear habitat information to reduce human-grizzly bear conflicts in Kokanee Glacier and Valhalla Provincial Parks, BC. In pages 24-30 G.P. Contreras and K.E. Evans (eds.) Proceedings Grizzly bear habitat *symposium U.S. Department of Agriculture Forest Service, General Technical Report* **INT-207**
Data on grizzly habitat use and availability was collected and used to plan paths, campsites and cabins so as to minimise conflicts.

McCullough, D.R. 1982. Behavior, bears and humans. *Wildlife Society Bulletin* **10**, 27-33
Habituation, the loss of fear of humans through lack of negative reinforcement, can occur where bears and humans come into frequent, innocuous contact and is not necessarily dependent upon food conditioning. An active program of negative conditioning may be necessary in situations where habituated bears cause incidents. No programs will eliminate bear problems, but stalemate through reinforcement of mutual fear and respect may be a more appropriate model for minimizing human-bear interactions in parks than «peaceful coexistence».

McLellan, B.N. (1986) Use-availability analysis and timber selection by grizzly bears. In pages 163-166 G.P. Contreras and K.E. Evans (eds.) Proceedings Grizzly bear habitat *symposium U.S. Department of Agriculture Forest Service, General Technical Report* **INT-207**
The paper discusses some of the technical problems of monitoring habitat selection for bears where some habitats are most abundant, and heavily used. The importance of forest for bears is emphasised.

McLellan, B. N. (1989a) Dynamics of a grizzly bear population during a period of industrial resource extraction. I. Density and age-sex composition. *Canadian Journal of Zoology* **67**, 1856- 1860.
This paper presents background information on the density and age-sex structure of the study population. The density of bears was high and actually increased during the period of study while the area was being disturbed.

McLellan, B.N. (1989b) Dynamics of a grizzly bear population during a period of industrial resource

extraction. II. Mortality rates and causes of death. *Canadian Journal of Zoology* **67**, 1861-1864.
No mortalities were directly attributable to industrial (timber harvest and gas exploration) activities. Resource extraction industries do contribute to grizzly bear mortality indirectly through the construction of roads, which provide easy access to hunters, poachers and settlers. Road access planning and post-operational control of vehicles are recommended management actions.

McLellan, B.N. (1989c) Dynamics of a grizzly bear population during a period of industrial resource extraction. III. Natality and rate of increase. *Canadian Journal of Zoology* **67**, 1865-1868.
Industrial activities (timber harvest and gas exploration) did not appear to have a significant detrimental effect on the dynamics of a grizzly bear population, but the roads built provided easy access for hunters and poachers.

McLellan, B.N. (1990) Relationships between human industrial activity and grizzly bears. International Conference on Bear Research and Management 8:57-64.
Grizzly bears are able to adapt to many habitat changes and a temporary increase of human presence. In most cases, increased motorized access that results in a long term increase of human activity and/or settlement with consequent increase in bears being shot is the most significant aspect of industrial developments. If an industrial activity is conducted with adequate guidelines to maintain important habitats, properly locate camps, incinerate garbage, restrict use of firearms, and close motorized access after the job is complete, the bear population probably will be maintained at a satisfactory level.

McLellan, B.N. (1994) Density-dependent population regulation of brown bears. pp 15-24 in Taylor, M. (ed). Density-dependent population regulation of black, brown, and polar bears. *International Conference on Bear Research and Management Monograph Series* **3**, 1-43 .
This review covers brown and grizzly bear population dynamics and searches for the effects of both high and low density. A vital review for understanding the dynamics of brown bear population ecology.

McLellan, B.N. and Shackleton, D.M. (1988) Grizzly bears and resouce extraction industries: effects of roads on behaviour, habitat use, and demography. *Journal of Applied Ecology* **25**, 451-460.
Most bears used habitats within 100 m of road less than expected. This was equivalent to a habitat loss of 8-7 %. This is significant because many areas close to roads contained important bear food. Avoidance of roads was independent of traffic volume, suggesting that even a few vehichles can displace bears. Roads and nearby areas were used at night but avoided in the day, and roads increased access for legal and illegal hunters, the major source of grizzly mortality.

McLellan, B.N. and Shackleton, D.M. (1989a) Immediate reactions of grizzly bears to human activities. *Wildlife Society Bulletin* **17**, 269-274.
Bears responded more strongly to ground-based human activities, such as humans on foot or moving vehicles, when in the open than when in cover. Cover had less effect on their response to fixed-wing aircraft. Bears generally displayed stronger reactions to human activities, other than to people on foot, that occured < 76 m than farther away. The strongest response of bears was to people on foot, and these reactions were most extreme in areas of low human use.

McLellan, B.N. and Shackleton, D.M. (1989b) Grizzly bears and resouce extraction industries: habitat displacement in response to seismic exploration, timber harvesting, and road maintenance. *Journal of Applied Ecology* **26**, 371-380.
The location of radio-collared bears were related to human activity. No clear avoidance of areas surrounding human activity was noted for most of the bears.

Mech, L.D. (1966) The wolves of Isle Royale. Fauna Series 7. Washington D.C.; U.S. Department of the Interior, National Park Service 210 pp.
Apart from presenting the results of a study of wolf-moose interactions the report describes the manner in which wolves reacted to human disturbance. Wolves soon became habituated to a low-flying fixed wing aircraft to the extent that it was possible to use the circling aircraft as a platform for making behavioural observations. However, wolves reacted to human scent on the ground and were easily scared from a kill. They did not appear to react to human structures with no recent scent.

Mech, L.D. (1989) Wolf population survival in an area of high road density. *American Midlands Naturalist* **121**, 387-389.
Wolf mortality in a high-road-density area exceeded that in an adjacent wilderness, and was primarily human-caused. The wolf population was maintained primarily by ingress from adjacent wilderness areas. A area with a road density of 0.58 km/km² could still support wolves if it was adjacent to extensive roadless areas.

Mech, L.D., Fritts, S.H., Radde, G.L. and Paul, W.J. (1988) Wolf distribution and road density in Minnesota. *Wildlife Society Bulletin* **16**, 85-87.
Data presented are consistent with the findings by Thiel (1985) who stated that wolves do not occur in areas with more roads than 0.58 km/km². These results, however, probably would not apply to areas with different human population density or road use than in the Minnesota study area, or to roads on which public access was restricted.

Mike, G. (1977) Animal feeding: problems and solutions. Special Report No. 14. Anchorage, *Alaska: Joint State/Federal Fish and Wildlife Advisory Team.* 11 pp.
The report describes the extent to which wild animals were fed by workers on the Alaska pipeline construction project. The behavioural effects of this feeding included changes to the animals natural foraging behaviour and an increased risk of conflict with food conditioned bears.

Olson, T.L., Gilbert, B.K and Fitkin, S.H. (1990) Brown bear behavior and human activity at salmon streams in Katmai National Park, Alaska. *Report to The National Park Service*, Anchorage, Alaska.
Observations of brown bears were carried out in stream segments which varied significantly in their disturbance from people, low-level aircraft, and motorboats. At Brooks River there was a clear and graded relationship between human numbers and use of river zones by non-habituated bear families, while no such trend was found for habituated animals. For non-habituated families they found an inverse relationship between human use and bear activity. Family groups of bears acconted for 76 % of the aggressive interactions recorded compared with 33% of the total observations.

Reynolds, P.E., Reynolds, H.V. and Follmann, E.H. (1986) Responses of grizzly bears to seismic surveys in Northern Alaska. *International Conference on Bear Research and Management* **6**, 169-175
None of the bears left their dens as a result of seismic exploration activities. In undisturbed winter conditions, heart rates of 2 denned bears ranged 12-26 beats/min, but rose to 30-50 beats/min for brief periods at least once or twice in 24 hours. Signal amplitudes and collar temperatures, monitored in 1 bear, did not vary. During 3 days when seismic crews were working near 1 den, changes in signal amplitude and collar temperatures, accompanied by increases in heart rate to a maximum of 64 beats/min, indicated that the bear moved several times. Heart rates of 2 bears recorded during midwinter overflights were the same as those measured midwinter from the ground in undisturbed conditions. About the time of emergence, heart rates were higher than those recorded in mid-winter and during undisturbed resting behaviour in mid-June.

Russell, C.R. Jr. and Litvaitis, J.A. (1994) Application of harvest data to examine responses of black bears to land-use changes. *International Conference on Bear Research and Management* **9**, 275-281.
The authors investigated the potential use of annual harvest data for assessing impacts of habitat alteration on local bear abundance. They compared bear harvest within townships of New Hampshire to changes in human populations, road densities, and land use patterns during 1961-84. Harvest tended to be negatively related to human-population density, roads in town, road subject to bars and gates, and developed land. Harvest tended to be positively related with national forest roads and agricultural land. Comparisons of long-term harvest data with human demographic variables also may provide baseline information on threshold densities of human demographic variables that effect local bear abundance.

Schallenberger. A. (1980) Review of oil and gas exploitation impacts on grizzly bears. *International Conference of Bear Research and Management* **3**, 271-276.
A review of literature on grizzly bears indicates that exploration and development will be generally detrimental to the bears. Construction of roads into previously unroaded areas and increased use of the land by people appear to have the gratest impacts. Problems of man-bear confrontations in the Alaska pipeline experience include nonresidents' difficulties coping with resident wildlife species, illegal shooting of animals, attraction of animals to garbage at field camps, and harassment from aircraft and other motorized vehicles. Conflicts with grizzly bear prior to development of oil and gas must be determined in order to assess the effects of resource exploitation, including the cumulative influence of various land uses. Habitat essential for the survival of the grizzly bear must be identified and protected. If development occurs in areas of occupied grizzly bear habitat before adequate management data for grizzly bears are available, it should proceed cautiously, thus preventing irreversible damage to the habitat and the bear populations. If full development is unvoidable, restrictions should be placed on road-building, exploration, wells, fuel production, and associated activities, especially at times when grizzly bears make heavy use of a locality.

Schoen, J. (1990) Bear habitat management: a review and future perspective. *International Conference on Bear Research and Management* **8**, 143-154.
Throughout the world, bears are declining in numbers and range as habitat is reduced and bear-human interactions increase. Although ursids are widely distributed and inhabit a variety of habitats, they possess a number of biological characteristics that make them particulary vulnerable to conflict with humans. The habitat concept is discussed relative to the unique characteristics of bears. Because bears are a wide-ranging species landscape and habitat relationships must be evaluated on a broader context than habitat types per se. Human activities and land use must be factored into bear habitat relationships. Forest clearing and road building are common problems for the conservation and management of many bear populations. An understanding of the processess of habitat fragmentation and population extinction is necessary for maintaining viable bear populations in the face of increasing habitat destruction and isolation.

Schoen, J. and Beier, L.R. (1989) Brown bear habitat preferences and brown bear logging and mining relationships in southeast Alaska. *Alaska Department of Fish and Game, Division of Wildlife Conservation*

Federal Aid in Wildlife Restoration Research Progress Report.
In general roads were detrimental to bears because they increase opportunities for human-bear interactions. Another byproduct of development is waste disposal. Human garbage has been implicated as one of the major contributors to bear attacks on humans, and many of these habituated bears are being shot. The impacts of human activity and development on bears need to be incorporated into an analysis of the effect of land management activities on brown bears..

Smith, R.B. and Van Daele, L.J. (1990) Impacts of hydroelectric development on brown bears, Kodiak Island, Alaska. *International Conference on Bear Research and Management* **8**, 93-103.
Bears that resided near a hydroelectric development project used approximately the same areas each year, making only minor shifts to areas with dense cover during construction. In areas near the project, bears used alpine habitat less, and midslope and lowland habitat more than expected, based on availability. Over 90% of the bear location in alpine habitat near the project were made after construction activities ceased, suggesting that bears avoided these open areas during construction. Dense, brushy cover in midslope and lowland habitats gave bears secure cover, so they continued to use preferred feeding areas near the project both during and after construction. Impacts on denning were less than predicted because most bears denned in areas remote from, and at elevations above, project features. Improved vehicular and foot access provided by construction roads and powerlines, and the increased insentive for development of rural lands provided by surplus electric power, is expected to have long-term impacts on bears through increased disturbance and killing of bears by recreationists and settlers.

Thiel, R.P. (1985) Relationship between road densities and wolf habitat suitability in
Wisconsin. *American Midlands Naturalist.* **113**, 404-407.
Wolves failed to survive when road densities exceeded 0.58 km/km². Recent telemetry data supported this observation. Road densities were an important predictor of the capability of an area to sustain a breeding population of wolves. Wolf habitat management plans should incorporate road density limits which should not exceed 0.58 km/km².

Thomson, P.C. (1992) The behavioural ecology of dingoes in northwestern Australia. II Activity patterns, breeding season and pup rearing. *Wildlife Research* **19**, 519-530.
Approaching dingo dens always lead to the dens being abandoned and the pups moved, often over distances greater than 1km. No increased pup mortality was seen to result from this disturbance.

Thurber, J.M., Peterson, R.O., Drummer, T.D. and Thomasma, S.A. (1994) Gray wolf response to refuge boundaries and roads in Alaska. *Wildlife Society Bulletin* **22**, 61-68.
The results indicated that wolf absence from human-settled areas and heavily used roads in and around the Kenai National Wildlife Refuge seemed to be caused by wolf behavioural avoidance. The results further indicate that human presence, even without direct wolf attrition, was sufficient to cause wolf avoidance of settled areas and year round public roads. There was a nonlinear relationship between wolf avoidance of raods and traffic density. Roads with medium traffic levels had greater effects on wolves than highways or roads with very little traffic. Thus, continual exposure of wolves to harvest is not required to separate wolves from human activities.

Tietje, W.D. and Ruff, R.L. (1980) Denning behavior of black bears in boreal forest of Alberta. *Journal of Wildlife Management* **44**, 858-870.
The denning behaviour of bears in northern Alberta is discribed. Many bears denned close to human activity, although in a few cases bears were disturbed from their winter dens. Weight loss during hibernation was greater for those bears that were disturbed than for other, non-disturbed bears.

Tietje, W.D. and Ruff, R.L. (1983) Responses of black bears to oil development in Alberta. *Wildlife Society Bulletin* **11**, 99-112.
Despite a relatively high level of human activity associated with oil-field development a black bear population appeared to suffer no adverese effects. The general pattern of the black bear's high tolerance of oil development appeared to be related to 3 factors. First, unhunted populations had a higher tolerance level for human disturbance than hunted populations. Second, the magnitude of response was limited in part by black bear social relationships and differential behaviour patterns between cohorts. Third, development activities were of short duration and low intensity.

Tracey, D.M. (1977) Reaction of wildlife to human activity along Mount McKinley National Park road. *M.S. Thesis, Univ. Alaska, Fairbanks.* 260 pp
There was much individual variation in response of wolves, bears and foxes to human traffic, with some individuals habituating and others displaying clear flight behaviour. One observation of a wolf den being displaced is presented. Generally, non-stopping vehicles had much less effect than people on foot or vehicles that stopped.

U.S. Dept. of the Interior, Bureau of Land Management (1976) Alaska natural gas transportation system - final environmental impact statement. *U.S. Department of the Interior, Bureau of Land Management* 825 pp.
The effects of construction of a gas compressor on wildlife are described. Reactions to disturbance varied between species. Wolves appeared to habituate to aircraft if they were not subject to aerial hunting.

Van Dyke, F.G., Brocke, R.H., Shaw, H.G., Acerman, B.B., Hemker, T.P. and Lindzey, F.G. (1986) Reactions of mountain lions to logging and human activity. *Journal of Wildlife Management* **50**, 95-102.
Studies of reactions of mountain lions to logging and various human activities showed that resident lions rarely were found in or near (1 km)of sites logged within the past 6 years. Younger lions visited logged areas but did not maintain residence there. Mountain lions shifted their activity pattern as a response to human disturbance. In selected home ranges road densities were lower than the study area average. All disturbances examined appeared to have at least potential adverse impacts on mountain lions, especially on dispersing juveniles.

Young, D.D. and Beecham, J.J. (1986) Black bear habitat use at Priest Lake, Idaho. *International Conference on Bear Research and Management* **6**, 73-80.
Black bears habitat use in northern Idaho was studied. Habitat availability was estimated with a random-dot technique and habitat use was determined from 676 radiolocations of 9 adult bears (5 female, 4 male). Black bears preferred selectively logged areas during spring, summer and fall, clearcuts were avoided during all seasons. Habitat selection differed significantly between sexes. Female bears preferred timber habitats and avoided roads, males used timber and roads in proportion to their availability.

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