PROCEEDINGS
OF THE
SEVENTH WESTERN BLACK BEAR WORKSHOP

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Preface

The First Western Black Bear Workshop, hosted by Al Lecount and the Arizona Game and Fish Department, was held in Tempe, Arizona in March of 1979, with 88 people in attendance. In the next 20 years 6 more workshops were organized:

Second	Logan, Utah	1982
Third	Missoula, Montana	1985
Fourth	Yosemite National Park, California	1991
Fifth	Provo, Utah	1994
Sixth	Ocean Shores, Washington	1997
Seventh	Coos Bay, Oregon	2000

Attendance has doubled since the first Workshop, attesting to the growing interest of both traditional and non-traditional stakeholders in bear management and research activities. With the increase in numbers and changing demographics of the human population in western North America and the concomitant increase in black bear numbers in most western regions, the interest in and the challenges of bear management will most certainly continue to grow.

Although the focus of the Workshop still remains black bears, grizzly bears were experimentally included within the framework of the Seventh Workshop program. The research and management objectives of these 2 species share many similarities and the incorporation was well received. The synthesis of state status reports was also a change from previous Workshop formats. By standardizing the information requested, we believe the synthesized final report, found on pages 32-55, will give readers an opportunity to make more meaningful comparisons between and among the various states and provinces.

During the business meeting of the Seventh Workshop, organizers and IBA council members decided to seek Workshop sanctioning from the Western Association of Fish and Wildlife Agencies (WAFWA). It was felt sanctioning would encourage participation by member agencies and elevate the Workshop profile. WAFWA Executive Committee members unanimously approved sanctioning during their annual meeting in July 2000. By-laws required for sanctioning can be found on pages 129-130 of these proceedings.

We are grateful to the Hornocker Wildlife Institute for their expeditious commitment to host the Eighth Workshop.

Dave Immell
Workshop Chair

THE CHANGING DYNAMICS OF BEAR MANAGEMENT: ARIZONA'S EXPERIENCE WITH LITIGATION FROM A BLACK BEAR MAULING

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Abstract: In July 1996, a 154 kg, 5-year-old male black bear critically mauled a sleeping teenage girl on Mount Lemmon, 48 km north of Tucson, Arizona. Five days prior to the attack, this particular bear had been captured, eartagged and released within 14.5 km of the capture location by a wildlife manager of the Arizona Game and Fish Department. A lawsuit ensued and 3 years later the Risk Management Section of Arizona's Department of Administration settled for $2.5 million. The victim, innocent of any acts that might have provoked such an attack, was permanently disfigured by the injuries and still faces lengthy medical treatment. This paper details the Arizona Game and Fish Department's work in the area with black bears and discusses some of the dynamics of the settled litigation, including the litigation's possible effects on future bear management.

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Key words: black bear mauling, litigation, habituation, settlement, nuisance policy.

THE ATTACK

Early on the morning of July 25, 1996, a 5-year-old male black bear (*Ursus americanus)* mauled a sleeping 16-year-old female 4H camp counselor on Mount Lemmon in the Santa Catalina Mountains, approximately 48 km from Tucson, Arizona. The camp in which this attack occurred is located on 1 of 6 Sky Island mountains rising from the Sonoran desert floor in southeastern Arizona. The vast majority of the land in the Catalina Mountains is under management jurisdiction of the Coronado National Forest.

The mountain range lies directly north of the city of Tucson, with a human population of 800,000, and rises to an elevation of approximately 2743 m. Over 900 cabins exist on private land holdings and on leased Forest Service lands on the mountain. Some residents remain year round. The small commercial district of Summerhaven is located near the highest elevation of the mountain, and includes about 700 of the cabins, restaurants, bed and breakfast establishments, and a small ski area. Overnight camping occurs throughout the mountain, with most at campgrounds either maintained by the U.S. Forest Service or leased by them to various church and scout groups (the latter concentrated in an area known as "Organization Ridge," an area of about 242 ha).

Of the 10 camps located on Organization Ridge, Camp Lawton is the largest and is capable of hosting almost 200 campers. It is leased from the U.S. Forest Service by the Catalina Council of the Boy Scouts of America. Camp Lawton is comprised of a large kitchen and dining hall building, some administrative buildings and assorted activity areas. Campers sleep in scattered clearings in 2-person tents mounted on wooden platforms. The nearest organization to Camp Lawton is the Baptist Camp. On the far side of the Baptist Camp is the Girl Scout Camp, the second largest on Organization Ridge. Camp Lawton and other adjacent camps are frequently subleased for short periods to other organizations, as was Camp Lawton on July 25, 1996 to a 4H group from Tucson. Bears are indigenous to this mountain and other Arizona upper elevation habitats, although grizzly bears (*U. arctos*) were extirpated from Arizona before 1930. Populations of black bears in the Catalina's reached a population low in 1984 and the Arizona Game and Fish Department (AZGFD) supplemented the small existing population after surveys determined habitat availability was suitable to sustain a larger population.

Commencing in 1985, bears captured in other areas of the State were moved to the mountain. A total of 6 (4 females and 2 males) were transplanted. All were ear tagged and several were radiocollared. By 1989 all efforts to place additional bears on the mountain ceased, although occasionally local, wandering bears were released into the adjacent Rincon Mountains, approximately 48 km from Mount Lemmon. In 1989, human/bear incidents throughout Arizona increased due to a severe drought. On Mount Lemmon, wildlife managers removed 5 bears considered to be habituated to human activity and foods. In an effort to provide standardization of utilized procedures, a policy was established for dealing with nuisance bears (Arizona Game and Fish 1995). This policy categorized bears into specific classifications based on their interactions with humans. The policy was intended to provide guidance to employees based upon the field officer's discretionary classification. This policy allowed for the destruction of problem bears that were judged to be a potential threat to human safety if released, and the transplant of others, depending on the circumstances. Efforts to educate the public regarding bear behavior and management of food and garbage were given high priority. Television and newspapers were frequently employed to heighten public awareness. AZGFD also cooperated with the Coronado National Forest to attempt to refine food and trash management culminating in the Forest Service Forest Supervisor issuing a special closure order restricting the storage of food and garbage on National Forest lands (USDA, Forest Service 1989). A Tucson chapter of the North American Bear Society was formed with encouragement from the AZGFD and Coronado National Forest to assist in education efforts and to raise funds for obtaining bear proof trash containers and food storage boxes.

In 1992, a bear incident occurred at a leased Boy Scouts of America camp in the Chiricahua Mountains of the Coronado National Forest, 177 km southeast of Tucson. As a result, Forest Service rules for leased camps were revised and supplemental regulations were issued, requiring stringent trash and food management practices at leased camps (USDA, Forest Service, 1993).

Favorable weather patterns and isolated bear problems occurred until 1994, when another drought created conditions conducive to bear/human conflicts. AZGFD experimented with aversion techniques including rubber bullets, beanbag shotgun rounds, and taste aversion to try to discourage bears from visiting campsites and residential areas. All of these techniques failed. Concurrently, efforts were made to encourage Coronado National Forest officers to issue notices of violation to offenders of the Forest Food Closure Order and Bear Supplement. To be included were the Forest Service leased commercial camps on Organization Ridge and, more specifically, Camp Lawton, where an open grease sump was known to be attracting bears. No citations were ever issued for violations of the U.S. Forest Service order even though frequent inspections by the Forest Service, accompanied by AZGFD wildlife managers, documented the problem needing correction. At the same time, AZGFD wildlife managers became aware that residents of private property in the area were deliberately feeding bears and when confronted, were unwilling to cease. Intense television and newspaper coverage was used to help deter these activities. An unsuccessful effort was made to obtain the help of the Pima County Board of Supervisors in enacting ordinances that would outlaw intentional bear feeding.

Continued efforts were exerted during the spring and summer of 1995, even though habitat conditions had improved. Nonetheless, conflicts continued between campers and bears. AZGFD wildlife managers captured and removed 1 bear from the mountain complex. Two incidents with injuries occurred. One incident involved a bear that bit a hiker after their unleashed dog attacked a bear cub. The sow bear chased the dog back to the dog owner and a bite occurred. The bear could not be later located. A short time later, a volunteer fire department chief at Summerhaven was bitten when he got between a sow and its cub in the driveway of his cabin. The victim contended the bear was not at fault and he could not identify the animal. AZGFD became concerned with residents not reporting bear incidents and it became known that some of these same people actively resisted efforts to remove offending bears because of fears they would be euthanized rather than moved. Local residents of Summerhaven even named individual bears.

In early spring of 1996, AZGFD recognized that dry conditions in bear habitat would likely make matters worse. AZGFD conducted public meetings in Summerhaven in an attempt to advise local residents of the AZGFD's bear policy and how to deal with the problem of nuisance bears. A professional arbitrator was used to facilitate the meeting. Several hundred residents attended. There were some who advocated the removal of all bears from the mountain, others who demanded AZGFD leave them alone. The deliberate feeding of bears was presented as the problem. It was agreed that bears would only be removed or euthanized if they posed a direct threat to human safety. Estimates were that the mountain's population of bears consisted of less than 20.

In June of 1996, an eartagged bear entered an occupied camp trailer. The previously eartagged and released bear was captured and euthanized. A press release was issued acknowledging this event on June 19th. Substantial opposition occurred, deploring the need for this action.

AZGFD was informed by the Pima County Attorneys Office that a criminal nuisance statute existed in Arizona's criminal code that could be applied to individuals who were feeding bears, but that the County would only prosecute if certain conditions were met. First, AZGFD had to prove that the charged party had been verbally warned to cease the activity and, afterwards, AZGFD was required to videotape this same person in the act of feeding bears. In June of 1996, after frequent efforts to persuade 1 resident to stop deliberate feeding, a female bear and 2 cubs tore a huge hole in a local resident's cabin to obtain food. These same bears were videotaped being fed by the party who had previously been warned. Charges were filed amid much publicity.

The offending bear and its cubs were found near a restaurant in Summerhaven on July 6th. All 3 animals were tranquilized and removed from the mountain. The animals have never been reported seen again.

On July 18, a bear encounter was reported at the Girl Scout Camp on Organization Ridge. It was reported that a Brownie Scout who had eaten marshmallows and chocolate prior to sleeping on the ground outdoors woke at dawn to find a bear sniffing her face. Screaming and recoiling, the 8 year old was scratched in the face as the bear reacted to the sudden disturbance. An adult who witnessed the event came to the aid of the girl and drove the bear away. This witness was able to report some very specific identifying marks on the bear.

The area wildlife manager responded to the incident and set up a camp at the site in an attempt to catch the offending animal. An additional bear trap was brought to the mountain to assist in the capture. Two days later the wildlife manager received information of a bear breaking into an outside freezer at the Methodist Camp, immediately adjacent to the Girl Scout Camp. The wildlife manager loaded a dart gun and walked to the camp early the next morning. Finding the freezer tipped over and a large bear feeding on the contents, the wildlife manager darted the bear. The animal ran down the hill and collapsed on the road next to the Girl Scout Camp. The witness to the earlier incident was certain this was not the bear involved with the earlier scratching incident and expressed concern that AZGFD not harm the animal. The witness insisted that this bear did not have a large gash on its rump, was not the correct color, and even though it was of the same size, could not be the same bear. The bear was eartagged and moved to a release site approximately 14.5 km away. The lack of any eartag, or any previous incidents involving this specific bear, led her to conclude this was not the same bear.

Efforts continued to capture the offending bear and although 2 more animals were caught in live traps, capture of the offending bear was not accomplished. One day after the large male bear was darted and released, the animal, now sporting an ear tag identifying him as #166, was videotaped by a visitor in a nearby Forest Service campground. The video showed that the large bear demonstrated no apparent fear of humans. Immediate efforts to catch this bear were initiated.

Early on the morning of the 25th of July, bear #166 visited the cook shack in Camp Lawton, about 0.8 km from where the department wildlife manager was staying while monitoring capture efforts.

The animal was observed walking by the grease sump and continuing down among the tents where the 4H group slept that night. The animal walked into a 2-person tent occupied by a 16-year-old female camper and attacked her. The commotion alerted other youngsters who attempted to get the bear to cease its attack and leave. The animal remained even after an adult camper retrieved a .44 magnum handgun from his vehicle and fired a warning shot. When this failed, he walked in close and shot the bear behind the shoulder. The animal then ran off.

Along with local Sheriff's deputies, the AZGFD wildlife manager tracked the bear several hundred yards and discovered it critically injured where they immediately dispatched it.

The injured girl was transported by helicopter to a Tucson trauma center where she underwent immediate lifesaving surgery. The attack by this 5-year-old, 154-kg male black bear was judged to be predatory in nature. No evidence of attractants could be found in the tent.

Over the next 3 days, 6 bears were caught and transplanted to other mountains. None of these relocated bears are known to have survived more than 2 years after their release. The same week of the attack, a dead bear was discovered shot near Summerhaven.

Following the incident, the Pima County Board of Supervisors enacted an ordinance prohibiting feeding bears and recklessly leaving foodstuff or garbage physically accessible to bears (Pima County Arizona, 1997). To date, the ordinance has yet to be tested in court.

THE LITIGATION

The victim ("Plaintiff") of the bear attack instituted litigation in the form of 2 separate lawsuits, 1 in federal court and 1 in state court. The federal court action was a Federal Tort Claims Act lawsuit directed against the United States Forest Service, while the state court action named the State of Arizona, AZGFD, the Boy Scouts of America and the local 4H organization. With regard to the Forest Service, the Plaintiff's claims were directed around inadequate efforts to control the nuisance bear problem through enforcement of the Food Closure Order at the public camps and food and garbage provisions contained in the leases for the camps on Organization Ridge.

As to AZGFD, the Plaintiff contended that it was negligent in: (1) transplanting "food condition and habituated bears" into the Catalina Mountains in the late 1980's and early 1990's; (2) failing to educate the public regarding the need to avoid providing bears with access to human food and garbage; (3) failing to enforce Arizona's criminal nuisance statute relating to providing bears access to human food and garbage; (4) failing to remove or euthanize problem bears on Mount Lemmon prior to the summer of 1996; and (5) failing to remove or euthanize the specific bear that attacked the Plaintiff, prior to that attack.

The claim against the Boy Scouts was that it owed a duty to persons at Camp Lawton to exercise reasonable care in the management and operation of the Camp, and also a duty to inform the 4H Club of the danger presented by the continuing presence of human food conditioned bears in the Camp. With regard to the management of the Camp, the allegations were that Boy Scouts failed to train management at Camp Lawton on the proper procedures and precautions regarding bears and failed to take steps to reduce the availability of human food and garbage to bears. It was also alleged that the Boy Scouts failed to report the number and severity of bear-human interactions at Camp Lawton in the time leading up to the attack. Finally, Plaintiff alleged that the Boy Scouts failed to close Camp Lawton despite a known clear high risk of injury from bear attacks to persons using the Camp.

Plaintiff complained that the 4H was negligent in several respects: (1) in not properly investigating the safety of Camp Lawton prior to opening it up to campers; (2) in failing to follow the instructions that were given by the Boy Scouts regarding procedures for dealing with bears; (3) in failing to report bear sightings and problems to the Boy Scouts; (4) in failing to operate Camp Lawton in a sanitary manner, thus attracting bears; and (5) in failing to close the Camp when it discovered the frequent presence of bears that were not fearful of humans.

In the development of the case against the Forest Service, the Plaintiff was able to establish that, despite having enacted the Food Closure Order and the Bear Supplement, in fact no follow-up or enforcement of either of these was ever conducted. Indeed, despite the fact that operations and management plans were supposed to be put in place by the various lessees on Organization Ridge, which would have included food and garbage management, these were never implemented by any of the camps, and in particular the Boy Scouts, despite requests from the Forest Service. The control of problem bears was hampered without active enforcement of rules controlling the food and garbage.

In the case against AZGFD, it was judged that, but for the fact that AZGFD had actually handled bear #166 shortly before the attack, the Plaintiff's claims were weak. Therefore, the Plaintiff's attorneys directed their most specific efforts towards attempting to show that AZGFD had failed to follow its nuisance bear policy in the handling of bear #166. Their strategy in attempting to do this was to take all complaints about any black bear, and attempt to show that in all likelihood it was bear #166, despite some real questions regarding these identification efforts. Plaintiff asserted that when all those various incidents are put together, and all those characteristics were shoehorned into the 1 bear, application of the nuisance bear policy established that bear #166 should have been a Category 1 bear at the time the wildlife manager captured it. Under that scenario, bear #166 should have been destroyed or moved to an entirely different mountain range, pursuant to the policy guidelines.

It was the wildlife manager's testimony that upon determining that the bear she ultimately tagged as #166 was not the bear that had been involved in the Brownie Scout incident, she placed it in Category 3, since she had never seen or heard of the bear before. Category 3 bears require no special handling, which justified her decision to move the bear out of the Girl Scout campground and release it 14.5 km down the backside of the mountain. (There was some argument that she should have placed it into Category 2 because the bear was arguably "doing damage to personal property" when it was observed rummaging through food in an overturned freezer whose lock had been pried open. The wildlife manager explained that since she had not actually seen the bear get into the freezer, and had heard that the freezer had been broken into the night before, it was possible that this bear had just been passing through and was helping itself to food that had been strewn from the freezer.) The Plaintiff argued that it should have been a Category 1 bear on the basis of various acts attributed, though questionably, to this bear which would have suggested that it was "displaying abnormal or aggressive behavior," since aggressive behavior was defined in the bear policy as meaning "any bear not yielding to humans."

The parties retained experts to proffer opinions on whether or not AZGFD had acted properly. The Plaintiffs hired Dr. Stephen Herrero, author of the book *Bear Attacks: Their Causes and Avoidance*. The affidavit prepared by Dr. Herrero outlining his opinions in this matter were critical of the AZGFD (Plaintiff v. The State of Arizona, et al., Arizona 1999). To counter these opinions, AZGFD hired 2 highly regarded black bear experts: Dr. Gary Alt from the Pennsylvania Game Commission, and Dr. Michael Pelton, from the University of Tennessee.

After substantial discovery had taken place, including the deposition of Plaintiff's expert, AZGFD filed a Motion for Summary Judgment to dismiss the case on the grounds that: (a) AZGFD was statutorily immune from liability; and (b) the essential element of duty was lacking. With regard to the first issue, most states have statutes providing immunity for certain governmental acts. In Arizona, immunity attaches to an act or omission of an employee of the State where a fundamental governmental policy is implicated, in addition to an exercise of discretion. The purpose of affording immunity to administrative functions is to ensure that courts refuse to pass judgment on policy decisions in the province of coordinate branches of government where the policy decision involves consciously balancing risks and advantages. There was some precedent in support of this argument. For example, on facts similar to the case at hand, in Gadd v. Utah, (971 F.Supp. 502 Utah 1997), the plaintiff was injured during an attack by a black bear while camping on Forest Service property. In that case, the court held that the State of Utah's Division of Wildlife Resources had immunity for decisions related to the management of wildlife. In so holding, the court found that: (1) the management of wildlife, including the balancing of safety concerns, involves governmental policies and objectives; (2) the identification and evaluation of wildlife management safety issues and the protective steps, if any, to be taken are essential to the goals and policies of the State; (3) wildlife management decisions, including identification and evaluation of public safety matters, require the exercise of judgment and expertise; and (4) the State's Division of Wildlife Resources has the lawful authority to make wildlife management decisions.

In arguing against the existence of a duty, uniform precedent supported the contention that a state is not liable for injuries or harm caused by wild animals by the mere fact that a state has undertaken to protect or manage wild animals by means of game and fish agencies and laws. (Leger v. Louisiana Department of Wildlife and Fisheries, 306 So.2d 391 (La. App. 1975) (Anthony v. State, 204 Misc. 241, 122 N.Y.S.2d 830 (N.Y. 1950) (Barrett v. State, 116 N.E. 99 (N.Y. 1917) (Moerman v. State of California, 17 Cal.App.4th 452, 457, 21 Cal.Rptr.2d 329, 332 (1993) As stated in Leger v Louisiana(1975).

> *If such a duty should be imposed on the state, then it would mean in many instances that the state would have to impound or confine some birds and animals, and they thus would be birds or animals which had been taken, possessed or harbored. It would mean in some cases that the state would have to restrict or interfere with the migration or other habits of our wildlife, or it would have to destroy them. We do not believe that the Legislature intended such a duty be placed on an agency or department of the state.*

It was argued that, in the present case, if AZGFD was found to owe a duty to protect from the type of harm suffered by Plaintiff, AZGFD's mandate to manage and preserve wildlife in Arizona for the benefit of present and future generations would be impossible to achieve. The State would be forced to capture or destroy many species of wild animals in order to avoid liability for their actions. Sound public policy would require that any animals native to Arizona that are arguably dangerous, such as rattlesnakes, mountain lions, coyotes, javelina, and black bears, be eliminated. Obviously, the State's game and fish laws simply were not intended to have this effect. AZGFD was created to preserve wildlife for the enjoyment of the citizens of the State, not protect citizens from the wildlife. In short, it was the State's position that there simply existed no duty on the part of the State of Arizona, or more specifically, the AZGFD, to protect from the type of harm suffered by Plaintiff.

Up to this point in time, all instances where governmental agencies were held liable to individuals for attacks of wild animals involved situations where the governmental agency had either reduced the animal to captivity, e.g. in a zoo, and/or where the governmental agency owned and maintained the property where the attack occurred. In the latter situation, the liability was based on the traditional common law theory that a landowner owes a duty of care to people using their land, i.e. premises liability.

After hearing on the Motion for Summary Judgment, the court dismissed 5 of Plaintiff's 10 theories of liabilities against the State on the basis of statutory immunity. The theories that were dismissed involved: (1) those claims relating to the decision regarding which materials to study and how to study the Catalina Mountains before transplanting bears there; (2) the State's decision to actually transplant bears to the Catalina Mountains; (3) decisions whether to monitor bears there; (4) decisions concerning whether and when to take action regarding aggressive bears; and (5) decisions as to what warnings were provided to the varied populations of people coming on to Mt. Lemmon. Two more theories of liability were dismissed due to absence of evidence from which a jury could reasonably conclude that AZGFD was negligent. Specifically, the claim against agency personnel for the alleged failure to maintain proper lines of communication with the Forest Service concerning complaints of serious bear incidences or attacks was found to be lacking in supporting evidence. Finally, as to the liability theory based upon an argument that the AZGFD officer relocated bear #166 to the wrong location and not 1 called for by the bear relocation policy, the Court found that the officer properly relocated the bear based on the information she had at the time. Summary judgment was denied, however, on the following theories: failure to comply with the Nuisance Bear Policy regarding the removal, release and euthanizing of problem bears; failure to investigate, gather and evaluate information concerning problem bear complaints, especially information about bear #166; and failure to properly respond to reports of aggressive bears, especially bear #166 (Plaintiff v. The State of Arizona, et al., 1999).

In essence, what the trial court did was find that there existed factual issues concerning various allegations that bear #166 had been on the mountain for some time causing various problems and should have been targeted and removed prior to the attack. Based on the trial court's ruling, the matter would have gone to jury trial on those issues.

Subsequent to the ruling, the AZGFD had prepared and filed pleadings seeking appellate review of that portion of the ruling which left certain counts in the complaint for trial. A mediation was also scheduled in an attempt to resolve the matter.

Prior to the mediation, mock jury trials were presented to focus groups in an attempt to ascertain the State's exposure in the litigation. Without going into great detail, suffice it to say that the injuries suffered by the Plaintiff can only be described as horrific. The Plaintiff would be able to present past and future special damages, both medical and non-medical, in excess of $2 million. When the case was presented to the mock juries, the results established that a substantial multi-million dollar verdict was likely, and that there was significant possibility of a runaway verdict. Although the range of fault attributable to AZGFD by the mock juries ranged from relatively small to fairly substantial, all in all, it suggested that AZGFD would have significant exposure in any jury trial. The case settled at mediation with AZGFD paying the Plaintiff and her parents $2.5 million. It is understood that sometime thereafter the remaining Defendants settled for approximately $1.5 to $2 million.

POST LITIGATION ANALYSIS

In the aftermath of the attack and ultimate settlement of the case, AZGFD and its attorneys have engaged in much analysis and soul searching regarding how AZGFD got here. In other words, on initial impressions, it would appear that the AZGFD should have been above criticism for its handling of bears on Mount Lemmon. For example, AZGFD had dedicated and educated wildlife managers attempting to inform users of the mountain of bear and food related issues, and it was collaborating with the Forest Service to enforce food and garbage regulations. AZGFD acted promptly to remove nuisance bears when they became a problem, in adherence to a nuisance bear policy which was considered by many, including Plaintiff's own expert, as a model for the nation. In addition, 2 of the top black bear experts in the country, Drs. Alt and Pelton, agreed AZGFD conduct was above reproach.

Why then did the State pay so much money for settlement of the case, and why did mock juries seem to think that was appropriate? Following such a tragedy, it is always easy to Monday morning quarterback the people responsible. For example, in this instance, the AZGFD had put together a nuisance bear policy to serve as valuable resource and guide to wildlife managers confronted with a bear situation. The Plaintiff, however, was able to use what was supposed to be a discretionary guide as mandatory directives, and then attempt to pigeon hole a particular bear into a category that arguably did not apply. For example, Category 1 designations were designed to deal with bears that were considered an immediate threat to public safety. Unfortunately, 1 subcategory included a definition of Category 1 that "the bear is displaying abnormal or aggressive behavior (aggressive behavior means any bear not yielding to humans)". The vagueness of this categorization, and the breadth of the definition of "aggressive" led to significant problems. For example, 1 wildlife manager was compelled to admit that it was not "normal" for bears to eat human food and therefore that bear was, by definition, "abnormal", in essence putting any campground bear into Category 1. Likewise, "failure to yield" was applied to circumstances where bears happen to be around people and no one made any significant effort to shoo the bear away, other than perhaps yelling at it. (One wildlife manager gave a very good description of her interpretation, and the 1 that makes sense, which is to say, "you press the bear and get inside their comfort zone").

Another problem in defending the matter, and one common to many litigation situations, had to deal with a highly paid expert specifically retained to support the Plaintiff's position in the matter. In our legal system, in any instance where a professional is involved in a situation where a bad result occurs, be that professional a doctor, lawyer, accountant or wildlife manager, the aggrieved party can hire someone from the same field who, with the benefit of hindsight, can attribute the tragedy to a failure of the professional to have acted in a manner consistent with the standard of care owed in the circumstances. The State intended to attack the credibility of the Plaintiff's expert by pointing out that he was rendering opinions that varied widely from his extensive writings with regard to predatory black bear attacks. For example, in his various writings, the expert had concluded that when extremely rare predatory black bear attacks do occur, there were common circumstances that seem to exist: (1) lack of exposure to people; (2) remote areas; and (3) sub-adult males who are not habituated. Here, bear #166 was an adult habituated bear and Mount Lemmon is not a remote, uninhabited area. Thus, anyone relying on Dr. Herrero's writings would have concluded that bear #166 posed absolutely no threat of a serious predatory type attack in the summer of 1996. Indeed, Dr. Herrero acknowledged that some of the opinions he was rendering in the litigation were arguably at odds with his writings, but opined that based on recent experiences he would probably update his theories regarding black bear attacks because he now thinks ". . . there is more danger than I realized from food conditioned, habituated, and aggressive bears, and the combination of the 3. And if I were rewriting that chapter (*The Tolerant Black Bear*), I would emphasize that there are 3 ingredients, habituation, the food conditioning and rewarding aggressive behavior over time that increases the chances of injury." So wildlife managers who had read all the up to date writings by someone who holds himself out to be the world's foremost authority on bear attacks, would have an inaccurate, or at least incomplete, idea of which types of black bears posed any likelihood of being involved in attacks which might cause serious injuries to humans. Furthermore, as of the time of the deposition, Dr. Herrero had neither written nor spoken of this rather significant change in his definition of what might constitute a dangerous black bear. Indeed, just 8 months prior to his deposition, and after he had been retained by the Plaintiff, Dr. Herrero gave a presentation called "Update on Bear Attacks" at the 11th International Conference for Bear Research and Management and never mentioned this important new development in his theories.

Another problem with the case was what AZGFD determined to be public expectations regarding safety in the wild, combined with the average layperson's misguided view of the inherent danger posed by black bears. Unless the mock jurors had extensive experience in the outdoors, and particularly in wilderness areas, they were not willing to accept that the AZGFD owed no duty to protect them from wild animals. Indeed, to the contrary, some of the jurors went so far as to suggest that the State should have put a fence around the campgrounds to protect the people from the animals. Furthermore, jurors were essentially unwilling to accept the notion that black bears were tolerant and could safely co-exist in close proximity to humans. The jury research also indicated that jurors particularly sympathetic to the plight of AZGFD tended to be successful male Republicans, who are very unlikely to end up on a jury in a trial that might last several weeks.

Finally, and importantly, the Plaintiff in this case was one of the most sympathetic individuals you will ever encounter. An attractive girl, honor student, athlete and animal lover, she was every parent's dream daughter. She was courageous, she was not a whiner, and she had suffered extremely serious injuries through no apparent fault of her own. Somebody was going to pay for these injuries, as the average juror would absolutely want to compensate this suffering girl, if at all possible.

AVOIDING FUTURE PROBLEMS

As is obvious from the foregoing, a dedicated wildlife management agency can be doing everything reasonably necessary to fulfill its obligations regarding animals and people, and can still get its head in a noose of liability. Are there ways to avoid or minimize this risk? Yes. For starters, with regard to policies and procedures, such as the Nuisance Bear Policy, it is probably wise to couch policy in terms of discretionary as opposed to mandatory edicts. This makes it much more likely that the agency and/or its personnel can avail itself of any of the discretionary/administrative types of immunities that exist in most jurisdictions. For example, instead of having a policy say that this or that type of bear "shall be removed" or "shall be destroyed", such language could be substituted with "may be destroyed" or "may be moved" at the discretion of the wildlife manager. This also makes it hard to prove that anything was a violation, per se, of the policy.

Another approach, although obviously not a solution, is simply kill more bears. While recognizing that this suggestion is abhorrent to wildlife managers, if every time you have a bear in your possession you have some notion that if you release it and it hurts someone you could be sued for millions of dollars, the killing might come a little easier. It is exactly this sort of pressure on wildlife managers, which has nothing to do with conservation or wildlife biology, that agencies should not succumb to, but rather should do their best to resist.

The most effective way to eliminate the possibility of exposure to liability is to pass a statute, as many states have, providing for specific immunity from attacks by wild animals. Some states that have such statutes currently in place include Colorado, Minnesota, Pennsylvania and Tennessee. Unless a state has a constitutional prohibition against such limitations on a person's right to recover, these provisions should be valid and enforceable.

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NEW ALLIANCE BETWEEN AGENCY AND PUBLIC REDUCES BEAR PROBLEMS

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Abstract: In July 1998, the California Department of Fish and Game (Department) signed an agreement with the Bear Preservation League (BPL), a group of concerned individuals in the Lake Tahoe area. The goal of the alliance is to reduce black bear (*Ursus americanus*) damage incidents through education of the general public, thereby reducing private property damage and the number of bears that are destroyed. Almost all black bear depredation incidents occur because the animals are attracted to homes. Department policy requires the landowner to clean up bear attractants before a kill permit is issued. Often, landowners are not aware that they are attracting bears, and a great deal of effort is expended trying to inform landowners about what needs to be cleaned up, and in what manner. The BPL is a well-organized group of motivated individuals. These volunteers receive training about the Department's policy and how to remove bear attractants. The main role of volunteers is to respond to first-time callers with reports of bear problems and to instruct the landowners or tenants on how to avoid bear problems by removing attractants. After the first year of this program, the amount of time spent by Department employees on bear depredation issues in the area has been significantly reduced. In addition, the number of depredation permits issued in the 3-county area influenced by the BPL has declined from 49 per year (previous 4-year average) to only 29 during the past year. This program appears to be very successful and has application if depredation problems occur in areas with motivated people concerned about the welfare of individual bears.

WESTERN BLACK BEAR WORKSHOP 7:9-12

Key words: depredation, black bear, alliance, education, bear welfare.

Wherever black bears interact with people, a potential problem exists. While people may feel threatened by the presence of a black bear, real public safety problems seldom occur. Rather, most problems are associated with damage to private property by bears. Bear depredation damage occurs to homes, cabins, agricultural crops, beehives and livestock. In most cases, bears are attracted to areas populated by humans because people improperly store food, garbage or other potential attractants. Most bear depredation could be eliminated if the general public was more aware of what attracts bears, and what actions are needed to reduce this attraction.

The current black bear depredation policy of the Department is based upon actions which will eliminate the attraction of bears to humans. A permit to kill a depredating bear is issued to the property owner only after steps have been taken to eliminate the problem attractants, and the bear continues to cause property damage. The Department has adopted the following categories of bear interactions and appropriate actions.

BLACK BEAR DEPREDATION POLICY

Category 1 – *A bear has strayed into a populated area and cannot readily return to bear habitat.*

> In most situations, removal of the antagonists or distractions from the area will allow the bear to return to appropriate habitat and only telephone contact will be necessary. Site response will be necessary in cases where a bear does not leave or other factors indicate that either the safety of the bear or public is compromised. Techniques to remove the bear may include, but are not limited to the use of "bear busters" (rubber slug shot shells) or sling shot projectiles to drive the bear away and/or "bear" dogs to chase and haze the bear out of the area. Unless otherwise specified by a supervisor, a Department employee will accompany any persons using dogs to chase or haze bears. Tranquilizing and removing the bear can be used if other methods are determined to be unsafe or have been unsuccessful.

Category 2 – *A bear has become habituated to humans and may be a nuisance problem (no property damage involved) by tipping over garbage cans, invading compost piles, or walking across porches.*

> Bears which have been previously captured and have later returned to areas of human habitation are included in this category. The investigator should recommend reasonable corrective measures as a solution to the problem. Reasonable corrective measures shall include, but are not be limited to: area cleanup, removal of trash or other food attractants, bear proofing food storage areas, electric fencing, temporary closure of campsites, and/or the techniques listed in Category 1 above. Relocation should not be considered for bears meeting the criteria established in Category 2.

Category 3 – *A bear has caused real property damage to a dwelling(s), structure(s), vehicle(s), apiaries, etc., or is a repeat offender (the bear has been previously captured or hazed by Department employees).*

> If the damage is minor and there are no

other previous reports of damage, the first action should be the implementation of reasonable corrective measures to remove the attractants as outlined for Category 2 bears. As the situation dictates, corrective measures shall be made prior to, or in addition to, issuing a depredation permit. In those cases where a bear has caused extensive and/or chronic damage to private property, such as killed livestock and/or injured livestock, entries into a home(s) or cabin(s), or repeated damage where corrective or bear proofing efforts have failed, the corrective action should be the issuance of a depredation permit. Bears meeting the criteria established in Category 3 shall not be relocated.

As provided for in Section 4181.1 of the California Fish and Game Code, landowners may kill a bear encountered in the act of molesting or injuring livestock as long as this taking is reported to the Department by the next working day (California Fish and Game Code 2000). The carcass also must be made available for inspection. After an investigation, after-the-fact depredation permits can be issued and the Department employee has the option of allowing the landowner to retain the carcass.

When a depredation permit is issued to a property owner, it is the responsibility of the permittee to kill, or arrange to have someone else kill, the offending bear. The property owner must dress out the carcass and make it available to Department personnel. The bear carcass is then delivered to a charitable organization for human consumption (California Code of Regulations, Title 14 2000).

During the 17-year-period of 1983 through 1999, the number of depredation permits issued by the Department has increased annually at a rate of about 13 per year (Table 1). During that period, an average of 179 permits were issued annually, and an average of 74 black bear were killed under the authority of the permits. The increase in the number of permits issued annually is linear (r^2 = 0.68), demonstrating the annual increase in the number of permits issued.

The increase in black bear depredation permits issued is partly a result of the increased size and distribution of the black bear population in California. The statewide black bear population has increased from an estimated 10,500 bears in 1982 to more than 20,000 bears currently (California Fish and Game 2000). In addition to expanding numbers, black bears are expanding their range into areas that were historically occupied by California grizzly bears (*Ursus arctos*).

Table 1. Summary of the number of black bear depredation permits issued statewide and the number of bears killed on those permits from 1983-1999.

Year	Permits Issued	Bears Killed
1983	49	14
1984	45	20
1985	75	27
1986	142	63
1987	140	86
1988	187	78
1989	184	81
1990	212	77
1991	213	107
1992	143	39
1993	216	76
1994	156	56
1995	277	106
1996	223	86
1997	178	65
1998	342	153
1999	259	124

METHODS AND STUDY AREA

Lake Tahoe Area

The Lake Tahoe area is considered suitable black bear habitat. The human population is generally affluent, well-educated and concerned about natural resource issues. Black bears frequently move into the area, which sometimes results in bear depredation problems.

The BPL Program

The Bear Preservation League (BPL) is a group of concerned individuals in the Lake Tahoe area. Through a Memorandum of Understanding with the Department, the BPL responds to nuisance bear complaints. The BPL was formed after a depredation permit caused the death of a well known sow and cub, leaving an orphaned cub. Often, the killing of a black bear for any reason is unacceptable to the general public. News stories usually focus on the killing of the depredating bear and the social trauma associated with the killing. It is difficult to motivate the media to focus on the real problem of eliminating attractants to the bears.

The public outcry surrounding this incident led to the formation of the BPL, which began as a group of 4 friends meeting in a coffee shop trying to find a better way. One year later this organization had 120 card-carrying volunteers and hundreds of supporters. In July 1998, the Department signed an agreement with BPL. Intervention volunteers receive an intensive 1-day training that enables them to respond to a bear call with a good understanding of bear related facts. They are armed with literature that points out attractants and describes deterrents.

When responding to calls, volunteers work in teams of 2 and respond in a geographic area close to their residence. Each volunteer has a numbered photo I.D. identifying them as a BPL intervention volunteer.

Intervention

When a call is received by the Department dispatch, and it is determined not to be a public safety issue, the complaining party is given the opportunity to request an intervention by the BPL. The BPL dispatch is staffed by a volunteer 24 hours a day. The purpose of the intervention is to identify attractants, give advice on deterrents and to provide education about bear behavior. Many reports are handled by phone consultation. Often, people want to feel that someone cares about their problem and are grateful to have someone simply listen to them.

In addition to calls received through the Department, calls come into BPL dispatch from local law enforcement and directly from the public. The BPL dispatch number is widely circulated by word of mouth, flyers, homeowners meetings and newspaper articles throughout the communities served.

Education

There is a significant lack of knowledge among the general population with regard to black bears and their behavior. This lack of information often can cause an unreasonable fear that ultimately leads to a quick fix - the death of a bear ("A Fed Bear is a Dead Bear").

The Department has published a brochure titled "Living with California Black Bears" to inform the general public about ways to avoid attracting bears (California Fish and Game 1997). The Department also produces annual news releases suggesting actions to avoid attracting bears.

The BPL has created public information programs to target specific groups requesting information. Schools, homeowner associations and service organizations most frequently make such requests. The emphasis in these forums is on human responsibility. In addition to personal presentations, BPL provides literature and other informational handouts that are kept in locations easily accessible to residents of the area.

RESULTS

After the first year of this program, the amount of time spent by Department employees on bear depredation issues in the area has been significantly reduced. In addition, the number of depredation permits issued in the 3-county area influenced by the BPL has declined from 49 per year (previous 4-year average) to only 29 during 1999 (Table 2). In that same year, bear deaths from depredation dropped from 20 to 10.

Table 2. Number of depredation permits issued and the number of bears killed with those permits in the 3 county area influenced by the Bear Preservation League from 1995-1999.

Year	Permits Issued	Bears Killed
1995	67	10
1996	48	12
1997	28	8
1998	52	20
1999	29	10

The BPL has discovered that informed people are more than willing to assist in preserving the bear's natural life style. The BPL has found that people respond quickly when they know that depredation bears are killed, rather than relocated. Very few people want to be responsible for the death of a bear.

The heightened public awareness surrounding human-bear conflicts has received the attention of local law enforcement. Historically they have not had the option of local intervention due to the high number of bear related calls to their dispatch. With BPL's formation, they now have a referral for immediate local response. The opportunity to involve and educate law enforcement has led to willingness on their part to institute programs to try to teach the bears to stay away. At the present time both Placer and El Dorado counties are planning to include some bear hazing practices in the upcoming season.

The BPL has developed the support of the media by providing public service announcements and feature stories. Every major newspaper in the State, as well as statewide television coverage, has reported the BPL success story. Regular columns in local papers written by the BPL are effective in maintaining public awareness of living in "bear country." The biggest challenge is educating nonresidents who seldom see local papers or are not even aware they may confront a bear rummaging through their trash. This is why stories in the Los Angeles Times, San Francisco Chronicle and Sacramento Bee have been quite instrumental in our success.

BPL is very effective in communicating information because it is a grassroots organization, with neighbor talking to neighbor. BPL volunteers are not seen as an outside force trying to impose mandates. The willingness to work in partnership with government creates a willingness to join, rather than separate

GOALS

The mission of the BPL is "To save bear's lives through education, information and partnership, reminding people we can live in harmony with bears."

The BPL expects to see this program continue to grow throughout California and eventually expand into other states. The BPL is dedicated to raise the level of awareness of the human responsibility when living with black bears. Through this increased awareness, we look forward to the day when policies and human behavior are formed in an environment of "minimum regret."

CONCLUSION

We believe the BPL has been successful because the BPL founders attacked the problem from a new perspective. Instead of angrily blaming the Department, BPL approached them with a concept of cooperation. By working with the Department, BPL could be far more effective than working separately. It was apparent that lack of staff and financial resources were hampering the Department's ability to effectively reach the public with bear related information. At the same time, BPL felt the public did not have adequate lines of communication to the Department. By first discussing black bear behavior, and then pointing out the cause of most human/bear conflicts, people begin to become aware of their role in preventing these conflicts.

Most importantly, the BPL and the Department shared common interests. There was no attempt to change each other's minds. Common ground was found by focusing on public education strategies that would alter human behaviors and thus eliminate bear attractants.

The goal of the alliance was to reduce bear depredation incidents through education of the general public. This effort was intended to reduce private property damage and the number of bears that are destroyed under the authority of a depredation permit. After only 1 year of activity, it is difficult to measure success by simply counting depredation permits. Success also needs to be measured in the number of contacts made. However, the real success will be measured by the number of children who understand more about bears, the homeowners who made the decision to bear proof their garbage, the number of realtors who provided bear information to renters and the manner in which the Department becomes more responsive to the prevailing will of the public.

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TRENDS IN BLACK BEAR-HUMAN CONFLICTS DURING A 2-DECADE BURGEONING BEAR POPULATION

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In most states and provinces, black bear numbers are increasing. Increasing bear populations provide more recreational opportunities for hunters and outdoor enthusiasts, but also the potential for more negative encounters with people. In Minnesota, the bear population has more than tripled during the past 2 decades. Nuisance and depredation complaints have not kept pace with this increasing population. In fact we found no relationship between overall number of complaints (range = 900-5,600/yr) and number of bears (8,000-27,000). Much of the variation in number of complaints was likely due to year-to-year differences in natural food supply, which may have kept bear nuisance activity in check while the population was growing. Additionally, people may have gotten better at keeping human-related foods away from bears, thereby reducing potential conflicts. It is unclear whether people also have become more tolerant and less threatened by bears. The percentage of cases in which threat to human safety was listed as the sole reason for complaint showed no trend over the years (5-13%). Notably, though, bad food years generated high numbers of complaints, and these peaks have risen in magnitude commensurate with the population increase. Additionally, bears may become bolder and hence more threatening during such years, as atypically high numbers tend to be killed or moved simply because they were perceived as a threat to human safety. An increasing bear population may result in increasing conflicts with humans only in poor food years, but this is reason enough to control population growth through hunting. Moreover, whereas attacks on people are rare, bears may become unusually brazen and unpredictable during bad food years, so management agencies need to carefully consider how to deal with individuals that are perceived as a threat to safety. We discuss this with respect to fluctuating management philosophies in Minnesota.

Key words: food supply, management, nuisance, population, safety.

A COMMON SENSE APPROACH TO WORKING IN BEAR COUNTRY

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Situated in the Slave Geological Province of the Northwest Territories, Canada's first diamond mine operates within an area inhabited by the barren-ground grizzly bear. Consequently, BHP's EKATI™ Diamond Mine has established a common-sense approach to working in bear country. In order to minimize risk of human-bear interactions, EKATI™ has established a grizzly bear awareness program. The program incorporates waste management, training, and established protocols. By incinerating food waste, monitoring the landfill, using electric fencing, providing on-going training, and following emergency procedures, bear incidents have been kept low. No bears have been destroyed or relocated from site. No bears have been attracted to the landfill, No bear or human injuries or near misses have occurred. Within the last year, only 3 encounters have occurred. The establishment of a bear awareness program reduces the risk of human-bear interactions. Following a common sense approach to meet the challenge of human-bear coexistence is proving beneficial for both industry and grizzly bears.

Key words: attractants, grizzly bear, common sense, human-bear interactions.

IMPACTS OF A DRAMATIC INCREASE IN BLACK BEAR AT A WASHINGTON NAVAL BASE

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We had 6 black bear sightings a Naval Submarine Base, Bangor, from 1979 through 1993. During the years of 1994 through 1999, we have had 176 sightings. We have captured and radiocollared 5 animals and have identified 14 individuals through DNA analysis of fecal samples (Wasser, et. al. 1997). Time spent on human-bear interactions now consumes a major portion of the work year. This dramatic increase may be in response to increased human population and habitat loss. North Kitsap County has issued 4, 174 single family dwelling permits since 1995; SUBASE has built 86 multi-family housing units since 1996. Hunting effort has resulted in a 5% mortality rate for black bear since the passage of the referendum banning hounds and bait passed in 1996.

Key words: black bear, DNA analysis, radio telemetry.

BEYOND BIOLOGY: WHERE BEAR MANAGEMENT GETS TOUGH

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The most contentious issues in black bear management are not those for which biological data are lacking. The issues are difficult because they represent fundamental conflicts in values among segments of our human society. Failure to recognize this critical point has led to the failure of the wildlife management profession to adequately address such issues. Most professionals continue to look for biological answers for value-based questions. Such attempts are doomed to fail. The greatest impediment to resolving such issues continues to be the professional culture of wildlife managers. The near-hallowed nature of an agricultural production model as a management paradigm will not work. Species bias has led to the "Icon of the Cloven Hoof' and greatly inhibits progressive management of bears. The role of hunting needs to be clarified prior to attempting resolution of bear hunting issues. Such issues will continue to dominate state agency agendas in the next decade. Resolution of hunting issues is possible, but not without critical examination of the value conflicts. Management of black bear-human conflicts, while having a biological component, is primarily a value conflict where cultural bias limits creative resolution. Whether to permit the sale of black bear body parts has little biological impact on any species of bear. Arguments for or against such sale should focus on the acceptable and appropriate use of wildlife by human cultures. Such an argument should start with a discussion of the bias associated with the term "natural resources". The rigid attempts to control the bounds of management debates by many wildlife professionals suggests a lack of maturity and strength in the profession. State wildlife management agencies continue to fumble with an identity crisis as the agencies move from the producer of wild animal targets to wildlife conservation organizations. Such change will occur; it would be easier if done with internal change agents. Unfortunately, I see little evidence to support such internal change.

Key words: wildlife values, species bias, black bear management, hunting.

COMPARISON OF AN EXPANDABLE RADIOCOLLAR AND AN EARTAG TRANSMITTER FOR MONITORING JUVENILE BLACK BEARS

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We evaluated 2 innovative instruments for radiotelemetry monitoring of juvenile black bears (*Ursus americanus*) in New Mexico. During 1995-1999, 50 bears were fitted with 55 expandable, canvas radiocollars, equipped with a mortality switch, a 2-year battery life (Ursus Technologies [UT]), and a breakaway cotton spacer. During 1999, 38 bears were fitted with eartag transmitters equipped with a 16-hour on/8-hour off duty cycle, a mortality switch, and a 1-year battery life (Advanced Telemetry Systems, Inc. [ATS]). Retention rates of transmitters were similar for the 2 instruments ($X^2 = 6.43$, df = 1, $P > 0.01$). Ten of 55 (18%) radiocollars were shed, most often due to premature breakage of lighter weight expansion stitching. Nine of 40 (23%) eartag transmitters were shed and retention was affected by placement ($X^2 = 20.1$, df = 1, $P < 0.0001$). Seven of 16 (44%) eartags placed on the backside of the ear were shed, while only 2 of 24 (8%) eartags placed on the inside of the ear were shed. Injuries from radiocollars were less frequent than from eartags ($X^2 = 24.4$, df = 1, $P < 0.0001$), however collar injuries were potentially life-threatening. Of 49 collars recovered or observed, 6 (12%) caused severe subdermal injury when the bear outgrew the collar. These injuries occurred both when collars expanded as designed ($n = 3$) and when collars did not expand ($n = 2$). Four of 6 (67%) injuries resulted from collars worn >2 years, because we were prevented from removing them by inaccessible dens, unsuccessful trapping, and loss of signal. Only 2 of the 6 (33%) injuries occurred within the 2-year transmitter life, and both injuries were on male bears. Of 18 eartag transmitters recovered from bears, 5 (28%) caused local infection and 9 (50%) presumably caused minor injury when torn from the ear. Reliability of transmitter units varied by manufacturer ($X^2 = 24.4$, df = 1, $P < 0.0001$). Known or presumed failure occurred in only 6 of 55 (11%) UT transmitters, but 21 of 38 (56%) ATS transmitters. Known cause of failure for the UT transmitters was premature transmitter failure ($n = 1$). Known causes of failure for the ATS transmitters were shifting of duty cycle programming ($n = 4$) and antenna breakage ($n = 2$). Presumed losses for both transmitters were likely from the same causes. Signal strength tests showed that UT and ATS transmitters were weaker than adult-sized radiocollars (Telonics, Inc.), however signal strength was adequate for most aerial monitoring. The expandable radiocollar design shows good potential for future use with further modification of the expansion stitches. Potential injuries can also be alleviated by frequent inspection of collar fit, use of faster-deteriorating spacers, and caution in collaring fast-growing individuals, particularly males. With careful placement, eartag transmitters would be ideal for monitoring fast-growing or dispersing individuals, however reliability of the ATS transmitter needs improvement.

Key words: radio telemetry, black bears, *Ursus americanus*, juvenile.

DIET AND TEMPORAL IMPACTS ON PCR AMPLIFICATION SUCCESS IN BROWN BEAR FECAL DNA SAMPLES

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Fecal DNA samples can be used to obtain minimum population counts, mark-recapture population estimates, genetic diversity estimates, and evaluations of population substructure. Few large scale studies have used fecal samples because fecal DNA is low in quality and quantity making genetic analysis costly and technically difficult. We initiated 2 studies on brown bears to examine the impacts of time spent in the field and diet on PCR amplification success of fecal DNA. Fecal samples less then 24 hours old were collected from captive brown bears. PCR amplification success was tested using a mitochondrial DNA (mtDNA) and a nuclear DNA (nDNA) locus of <200 base pairs. To evaluate the impact of time in the field, 60 feces were collected. At the field site, half of the fecal sample was placed in a grassy field and half in a dense enclosed forest. Microsite weather information was gathered and samples were collected at < 1, 3, 6, 9, 15, 30, and 45 days. Preliminary data indicate time had little impact on PCR amplification success beyond 24 hours but success rates were higher from grassy site samples. For the diet trial 50 fecal samples were collected from bears on each of the following restricted diets: grass, alfalfa, deer, salmon, carrots, and blue berries. Preliminary data indicate salmon scats have lower PCR amplification success rates for nDNA and no significant difference for mtDNA. The results demonstrate that field conditions and diet of the animal may significantly impact PCR amplification success rates for fecal DNA. The information can be used to improve the study design of projects utilizing fecal DNA to maximize success rates and minimize project costs.

Key words: fecal DNA, non-invasive genetic sampling, brown bears.

UPPER COLUMBIA RIVER REGION BLACK BEARS – A DNA STUDY

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DNA hair root samples from black bears (*Ursus americanus*) were collected in the Upper Columbia river region in 1996 as part of a mark-recapture project on the bears in the region. The DNA in the hair roots allowed for genetic tagging using a suite of 6 microsatellite loci. From 953 unmixed black bear hair samples, 193 unique microsatellite genotypes with probability of siblings < 0.05 were identified. The gender of 95% of the samples, determined using Amelogenin gene, resulted in the identification of 100 females and 84 males. Mark-recapture population estimates have been calculated using model M(t) from the program CAPTURE for all individuals (415 with 95% C.I. 332-548), without possible family groups (373 with 95% C.I. 301-491), females only (211 with 95% C.I. 159-311) and males only (160 with 95% C.I. 123-237). The combination of genetic and spatial information has also allowed a comparison of genetic and geographic distances for the population as a whole as well as by gender using the Mantel test. This is the first study to provide a mark-recapture estimate for black bears which has included a comparison of the genetic distance to the geographic distance between the individual bears captured.

Key words: DNA, mark-recapture, individual, spatial location.

GENETICS OF GLACIER NATIONAL PARK BROWN BEARS: DEMOGRAPHICS AND POPULATION STRUCTURE THROUGH NON-INVASIVE HAIR TRAPPING

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Recommendations have been made to de-list brown bears (*Ursus arctos*) of the Northern Continental Divide Ecosystem (NCDE) under the Endangered Species Act, yet no reliable census data exist for this population. Traditional census of bear populations involve aerial surveys, telemetry and various capture methodologies. These methods are time consuming, dangerous to personnel, and disruptive to humans and animals. We are assessing the abundance and population structure of brown bears across 10,000 km^2 of the NCDE through genetic analysis of hair samples collected non-invasively at 350 barbed wire trapping stations. During the 1998 field season, 7000 hairs samples were obtained. All samples with at least 5 hairs follicles (2890) are being genotyped for species, individual, and sex identification. To date, 1070 of 2772 samples processed have been identified as brown bears, and 198 different brown bear genotypes were obtained through nuclear DNA microsatellite analysis. The sex ratio for these 198 individuals is 60% male and 40% female. Comparisons across trapping grids demonstrate that the relative abundance of black and brown bears varies substantially across the landscape. We are currently completing individual identification for the remaining samples, and assessing the spatial and temporal significance of the distribution of genetic 'captures'. We will discuss these results and the benefits and drawbacks of this non-invasive genetic sampling method.

Key words: *Ursus arctos*, genetics, abundance, non-invasive.

ESTIMATING CLOSED POPULATION SIZE USING NEGATIVE BINOMIAL MODELS

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Abstract: Negative binomial models have been proposed as a method for simultaneously estimating the size of multiple closed populations with heterogeneity (Boyce et al. 2001). We discuss some of the underlying principles involved with this method, noting that the main assumptions are closure and independence of the populations, with individuals exhibiting no "trap response." We suggest the negative binomial method is appropriate for estimating the size of at least 4 populations simultaneously if there are at least 30-50 sightings in each population.

WESTERN BLACK BEAR WORKSHOP 7:21-23

Key words: AIC, heterogeneity, model selection, negative binomial distribution, Poisson distribution, population estimation, sighting frequencies.

Determining the size of a population is a goal in many animal studies, with the problem of accurate estimation going back to the early days of modern statistics when Pierre-Simon Laplace (French mathematician/physicist/astronomer) attempted to estimate the population of France in the late 1700's. A variety of methods are now available, from mark-recapture techniques to using sighting frequencies modeled with a statistical distribution. As is true with all forms of data analysis, it is imperative that the method used to estimate population size is consistent with sampling methods and the biology of the animals being studied. Frequently more than 1 analysis method may be appropriate, but often just considering the sampling method or animal biology could eliminate a number of alternatives. Here we shall discuss the method proposed by Boyce et al. (In press), focusing on how the negative binomial distribution (NBD) can be used to estimate the size of closed populations. We will present the underlying principles, required assumptions, and situations in which the method might be appropriate.

PRINCIPLES

The NBD can be used to model population size using the following theoretical justification (Kotz 1988, Boyce 2001): if the number of sightings of individual *i* is a random value from the Poisson distribution with an expected sighting rate of λ_i, and the expected sighting rates for each individual in the population is a random value from the gamma distribution, then the sighting frequencies for all individuals in the population can be described using the NBD. The gamma distribution allows the expected sighting rates to vary among individuals, hence allowing for heterogeneity, i.e., different animals have different sighting probabilities. As the level of heterogeneity decreases, the expected sighting rates become more constant and when there is no heterogeneity the sighting rate is the same for all animals in the population. When sighting rates are equal among individuals in a population, the Poisson distribution is appropriate to describe the frequency of sightings.

Using multiple data sets, various models can be used, based upon the NBD, to describe sighting frequencies for all populations simultaneously (Boyce et al. 2001). Boyce et al. (2001) suggest 6 models with various properties ranging from those that assume no heterogeneity, constant heterogeneity across all populations, or varying levels of heterogeneity. Also explored were alternative models where the fraction of the population observed is assumed constant for all data sets or varies for each. Akaike's Information Criterion (AIC) can be used to select which of the models was "best" for describing the collected data (Burnham and Anderson 1998).

ASSUMPTIONS

Allowing for heterogeneity is important in studies on any animal that maintains a home range, such as bears, because the study design automatically can introduce heterogeneity to the collected data. For example, animals with home ranges that do not overlap (or partially overlap) the area in which observations are being collected, whether at trapping stations or along tracks or roads, will have lower sighting rates than those whose home range is fully included within the sampling region. Ignoring heterogeneity in capture probability will introduce bias in population estimates and typically underestimate the population size (Otis et al. 1978).

The distribution used to describe sighting frequencies applies to the entire population of animals, including individuals observed and unobserved. Because we are attempting to estimate the number of unobserved animals, the relevant distribution is fitted to the number of animals seen once, twice, thrice, . . ., and extrapolated backwards to approximate the number of animals not seen (Fig 1). The NBD and Poisson distributions have been

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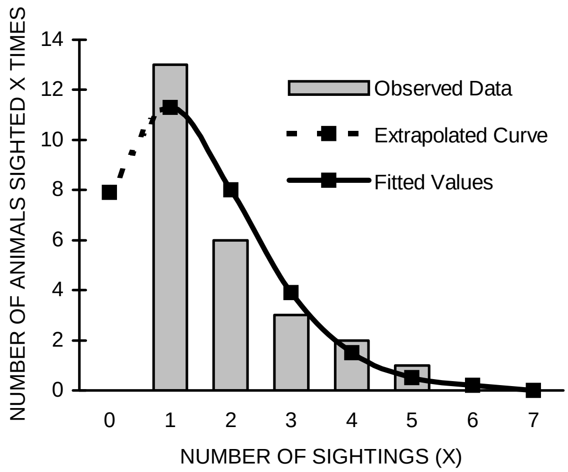

Figure 1. Simulated Sighting Frequencies with Fitted Values and Estimate of the Number of Unseen Individuals.

used by others to estimate population size (see "Population or Sample Size Estimation" in Kotz et al. 1988) and also can be found in textbooks such as Seber (1982).

AIC is a theoretically justified method for selecting 1 model from a set of plausible alternatives (see Burnham and Anderson [1998] for a review). The problem with model selection is that once data have been collected there is a limited amount of information available to be used for estimating parameters. The more parameters estimated, the more thinly the available information is spread amongst parameters, hence the greater the uncertainty in estimates. This may result in a model that is not very useful because of the high degree of uncertainty involved. Conversely, if you estimate too few parameters, the model does not provide an accurate description of the main features of the collected data. AIC is a metric that assists in finding a parsimonious model, i.e., a model with sufficient parameters to capture the main aspects of the data with minimal uncertainty in the parameter estimates (Burnham and Anderson 1998).

The main assumption about the animal population for the method of Boyce et al. (2001) to be valid is that the population is closed for each individual data set, i.e., no births, deaths, immigration, or emigration (Kendall 1999). This is a required assumption of many methods, including mark-recapture, where one is attempting to estimate population size (Seber 1982). Techniques exist for estimating the size of open populations, such as the Jolly-Seber model (Pollock et al. 1990), but we will not address these here. In some circumstances the biology of the animal or the time frame used for data collection may suggest that animals are entering or leaving the population during the study period. However, the best method for ensuring that the population remains closed, as much as possible, is through good study design, accounting for animal behavior or biology while maintaining an appropriate sampling framework for a valid analysis. Kendall (1999) showed that violations of the closure assumption in mark-recapture population estimates tend to introduce bias or a loss of precision depending upon the type of violation, and the same probably is true of other population estimators.

Each data set also is assumed to be independent of the others. The example used by Boyce et al. (In press) involved sightings of female grizzly bears with cubs of the year in the Yellowstone ecosystem from 1986-1998. Observations from each year were assumed to be independent, although this may not be true due to the reproductive cycle of grizzly bears. However in the absence of being able to identify individual female bears in different years it is unclear how the data could have been modeled differently. In other contexts, such as data sets collected from separate populations in different regions, the assumption of independence might hold more strongly. This highlights another possible use of the Boyce et al. (In press) method where it may be appropriate to analyze populations from different regions simultaneously.

Trap response is the final assumption that we shall discuss here. Even though no traps were used in the collection of the grizzly bear sightings modeled by Boyce et al. (2001), the concept is that the probability of an animal being sighted, or its sighting rate, changes once the animal has been sighted for the first time. An animal can become *trap happy* or *trap shy*. Trap response is usually mentioned within the mark-recapture framework where the capture process may be a positive experience, i.e., a food reward, or a negative experience, i.e., capture results in physical injury. When animals are being sighted, a trap response could be introduced if the observers put more or less effort into relocating an animal, once they know it inhabits a particular area. Closed population mark-recapture techniques tend to underestimate population size when animals become trap happy and overestimate when animals become trap shy (Otis et al. 1978). Again we believe that the same probably would be true of other types of population size estimators due to the similarities of the underlying base assumptions.

PRACTICAL RECOMMENDATIONS

The following recommendations follow from the results of the simulation study of Boyce et al. (2001), and through our experience and statistical intuition.

Obviously these recommendations are in addition to the above assumptions being satisfied.

For the range of sample sizes that were investigated, Boyce et al. (2001) found that the 2 models which estimated a separate level of heterogeneity for each data set frequently overestimated population size with estimates that were highly unstable, even when the model was the 'correct' one. They concluded that those models were inappropriate for small sample sizes and it was better to use an approximating model that assumed a constant level of heterogeneity. Simulation results suggest that data sets should include at least 15 unique individuals, with at least a total of 20 sightings. For adequate estimation with a constant level of heterogeneity, we believe it would be best to have 4 or more data sets of at least 30-50 sightings, although the number of data sets may be reduced for larger numbers of sightings.

Again we stress the requirement of satisfying the assumptions discussed above and point out that these assumptions apply not only to the method of Boyce et al. (2001), but are often required for other methods including mark-recapture (Seber 1982). The best time to consider whether the assumptions are likely to be met is during the study design rather than the data analysis. Generally it is easier, and less costly, to design a study well and use a recognized method of analysis, than to attempt to rescue results from a poorly designed study.

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TECHNICAL CONSIDERATIONS FOR HAIR GENOTYPING METHODS IN BLACK BEARS

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Abstract: Eighty black bears (*Ursus americanus*) were captured, radiocollared and tissue sampled for population assessments in a 1800-km^2 study area within the Willamette National Forest in Oregon from 1993 to 1997. In 1998, a 5-week trial hair snag experiment was initiated using 11 barbed wire sets within the study area. Twenty-four black bear hair samples were obtained for DNA analyses. All of the tissue and hair samples were extracted for DNA, PCR amplified and genotyped using 6 bear specific microsatellite loci and a gender specific primer set. Due to lower observed heterozygosity values in this population (59%), P_{sib} values < 0.035 were used to match 11 bears from their hair samples to their corresponding genetic profiles from sampled tissue. Lower match score probabilities, and the age and sex of the individual bears tagged in the hair snag study suggest that capture biases may distort population estimates that rely solely on genetic evidence.

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Key words: black bear, DNA, genotyping, hair, mark-recapture, match probabilities, microsatellites, PCR, *Ursus americanus.*

The ability to extract and amplify DNA from single hairs (Higuchi et al., 1988) has allowed for significant advances not only in human forensics but in wildlife conservation and management as well. Initial methods developed for humans (von Beroldingen et al., 1987) were quickly applied to non-human primates (Morin and Woodruff 1992) and bears (Taberlet and Bouvet 1992). Using a combination of mitochondrial DNA (mtDNA) and nuclear DNA (nDNA) it became possible to identify species, social structure, paternity, and individuals from shed or plucked hair (Morin et al. 1993; Morin et al. 1994*a*,*b*; Taberlet and Bouvet 1994; Foran et al. 1997). Prior to this, such information was only available from long term field observations or blood and tissue specimens.

Koehler et al. (1997) and Woods et al. (1999) described some of the first methods for acquiring bear hair samples using baited wire snags following the development of bear specific microsatellites (Paetkau and Strobeck 1994, Paetkau et al. 1995) for individual profiling. Several research groups have used unique genetic profiles as "marks" and applied these to population estimates using mark-recapture theory (Koehler et al. 1997, Woods et al. 1999, Mowat and Strobeck 2000). We describe here the use of hair sampling and genetic profiling in a population of previously radiocollared black bears. While the results attest to the promise of this technology, they also illuminate potential problems due to capture heterogeneity and its impact on mark-recapture modeling.

STUDY AREA AND METHODS

From 1993–1997, 80 black bear tissue samples were collected upon immobilization after capture using Aldrich foot-snares in a 1800-km^2 study area located within the Willamette National Forest on the west slope of the Cascade Mountain Range approximately 70 km southeast of Eugene, Oregon. Tissue from ear punches was stored in 2.0 ml vials with 0.5 g silica desiccant and frozen until DNA extraction. DNA was extracted using a QiaAmp Tissue Kit as described elsewhere (Wasser et al. 1997) and eluted in 400 µl of TE buffer (10 mM Tris, 0.1 mM EDTA, pH 8.0). Twenty-four black bear hair samples were collected from 11 barbed wire hair snares within the study area during the 1998 capture season and stored dry in paper fish scale envelopes. The number of hairs per sample varied from 1–25 follicles, including guard and underfur hairs.

Follicles were visualized by microscopy and trimmed to 1 cm with sterile forceps and scissors, placed in 400 µl of Buffer X1 (10 mM Tris-HCl pH 8.0, 10 mM EDTA, 100 mM NaCl, 40 mM DTT, 2% SDS, with 50 µg/ml proteinase K added prior to use) and incubated at 37°C until completely digested. Once digested, 400 µl of AL Buffer (Qiagen) and 400 µl of ethanol were added to the samples, applied to Qiagen columns, washed twice with AW buffer and eluted with 200 µl of AE buffer. Additionally, hair samples were "gene cleaned" (BIO101) to remove any remaining PCR inhibitors (Wasser et al. 1997) and eluted in a final volume of 50 µl TE.

Genotypes from tissue and hair samples were obtained by multiplex PCR amplification using bear specific microsatellite primers G01A, G01D, G10B, G10C, G10L and G10X (Paetkau and Strobeck, 1994; Paetkau et al., 1995) with a gender specific set (*SRY* and *ZFX/Y*; Woods et al. 1999) in 15 µl reaction volumes with 1.5 µl of tissue or hair template DNA. Post amplification, 1.5 µl of product was removed (tissue samples were diluted 1:10) and

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added to 13.5 µl of TAMRA/formamide (0.029% TAMRA-500 in deionized formamide), denatured at 95°C for 5 minutes and subjected to capillary electrophoresis (ABI 310 Genetic Analyzer; Applied Biosystems, Foster City, California). Alleles were defined by comparison to the internal size standard, scored by base-calling parameters in Genotyper Software (PE-Applied Biosystems, Foster City, California) and visually confirmed. Genotypes from tissue samples were confirmed at least twice; genotypes from hair were confirmed 2–4 times, depending on the sample. Match probabilities were initially calculated using $P_{sib} < 0.05$ (Woods et al. 1999) after all genotyping was completed in order to eliminate potential scoring biases. If the genotype was unique with no close matches, the sample was designated a new individual. Otherwise, genotype matches between samples were declared when P_{sib} was < 0.035 for further statistical confidence (see Results). Maximum likelihood and relatedness scores were determined using the Kinship software program (Goodnight and Queller 1999) with 1000 simulated pairs. The equations for determining Probability of Identity (P_{ID}) and expected heterozygosity (H_e) were calculated as in Paetkau et al. (1995): $P_{ID} = \Sigma p_i^4 + \Sigma \Sigma (2p_ip_j)^2$ and $H_e = 1 - \Sigma p_i^2$ where p_i and p_j are the frequencies of the *i*th and *j*th alleles.

RESULTS

Genetic Tagging of Oregon Black Bears

Eighty black bears (54 males, 26 females) were captured, radiocollared and tissue-sampled during spring and summer field seasons in the Central Cascades of western Oregon from 1993–1997. Seventy-nine of the tissue samples amplified with 3 or more of the microsatellite/gender primer pairs (99% amplification success) and gave unique genotypes considered genetic "marks". The number of alleles ranged from 5 (G01A, G10C) to 12 (G10L) per locus and the frequencies were calculated based on observed allele distributions (Table 1). Expected heterozygosity values were calculated for each locus and ranged from 0.40 (G10C) to 0.77 (G10B), with an average expected heterozygosity value of 0.59 (Table 2).

Although the average heterozygosity value was lower than observed in other black bear populations (see Discussion), the overall probability of identity — which calculates the chances of 2 randomly selected individuals having the same genetic "mark" — was 1 of 16,667, indicating that individual detection was possible (Table 2). In addition, a Chi^2 test (x^2) was performed on the tissue sample set to determine if any loci deviated from Hardy-Weinberg equilibrium (i.e. null alleles or homozygotic excess

Table 1. Observed alleles and frequency distributions of six microsatellite loci in Central Cascade black bears (n=79) from genotyped tissue samples.

Locus	Allele	Frequency
G01A	181	0.0127
	183	0.0633
	185	0.2089
	187	0.6519
	189	0.0633
G10B	138	0.0127
	148	0.1139
	150	0.0886
	152	0.0380
	154	0.2722
	156	0.3544
	158	0.0949
	160	0.0253
G10C	94	0.7532
	96	0.0063
	98	0.1835
	100	0.0506
	108	0.0063
G10D	166	0.4937
	168	0.0443
	170	0.3481
	172	0.0696
	176	0.0253
	178	0.0190
G10L	130	0.0127
	138	0.0063
	149	0.0190
	153	0.4937
	155	0.0127
	157	0.0886
	159	0.0127
	161	0.1139
	163	0.1772
	165	0.0253
	167	0.0253
	169	0.0127
G10X	123	0.0063
	127	0.0063
	129	0.0063
	135	0.0316
	139	0.0316
	141	0.2215
	143	0.6456
	145	0.0506

resulting from allelic drop-out). Four of 6 loci were below $p < 0.05$ and 2 were slightly above with an increased probability for type II – false negative error (G01D, p=0.09; G10X, p=0.07). For G01D, there was a higher than expected number of 1 genotype combination, 170/170 (expected=9.5, observed=12), and a lower number of the genotype 170/172 than

Table 2. Expected heterozygosity (H_e) and probability of identity (P_{ID}) values for 6 microsatellite loci in Central Cascade black bears. Overall probability of Identity is the product of the individual P_{ID} values per locus.

Locus	Heterozygosity	Probability of Identity
G01A	0.5232	0.2720
G10B	0.7682	0.0859
G10C	0.3964	0.4057
G01D	0.6273	0.2037
G10L	0.7017	0.1173
G10X	0.5295	0.2667
Overall	0.5911	6.04×10^{-5}

expected (expected=3.8, observed=0). The most likely explanation for the deviation is non-random sampling in a genetically related group because there was sufficient DNA (from tissue) and the genotypes were confirmed multiple times by PCR. For G10X, the occurrence of 2 rarer than predicted heterozygotic combinations (129/135 and 139/143) was responsible for the deviation.

Twenty-four hair samples were PCR amplified, genotyped and compared to the tissue sample set, as well as to each other. Ninety-one percent were scored at 4 or more loci and all of the hair samples amplified at least 1 locus. One hair sample (OR13), consisting of 2 follicles, still amplified 2 microsatellite loci and was uniquely "tagged" at 1 of them as a new individual. Using the match score probability of $P_{sib} < 0.035$, 4 previously captured and tissue sampled bears were found to have left hair at several sampling locations (Table 3). Genotypes from the hair samples of 3 bears were sufficiently unique as to be considered new marks (OR11, OR13, OR15; Table 3). Four hair samples (OR7, OR9, OR12 and OR22; Table 3) matched with more than 1 individual from the reference tissue collection, despite clear differences between the genotypes of these animals. They were, accordingly, designated as new captures even though they were statistically supported as matches with $P_{sib} < 0.035$. An additional 4 hair samples remained undetermined (OR5, 8, 10 and 24), due to limited PCR amplification or low match score probabilities ($P_{sib} > 0.05$). The remainder (n=9) of the hair samples were repeats of recaptured or newly tagged animals (Table 3).

A Chi^2 test (x^2) was performed on the hair sample set to determine if the observed genotype values were significantly different from the expected values, as would be the case for allelic dropout resulting from low template DNA (Taberlet et al. 1996, Gagneux et al. 1997, Goossens et al. 1998). Three of 6 loci were well below and 3 somewhat above $p < 0.05$ (G01A, p=0.15; G01D, p=0.08; G10L, p=0.09). In all 3 cases, rare heterozygotic allele combinations were higher than expected. These cases were most likely due to the limited size of the hair sampling with respect to the total population and a theorized higher degree of relatedness between some of the individuals. To investigate the degree of relatedness, particularly in the samples demonstrating low P_{sib} values between multiple individuals, 23 hair sample genotypes and 27 of the closest matching tissue sample genotypes were analyzed using the Kinship software application (Goodnight and Queller 1999). Full sibship was supported by maximum likelihood and significance values ($p < 0.001$) for 4 pairs of the samples: OR7 and OR9; OR12, 14 and 93-020; OR13 and OR15; OR22 and 94-036.

Gender and Age of Tagged Bears

In addition to microsatellite typing, the 11 identified and 4 undetermined samples were typed for gender. Twelve of the samples were from males, 1 was female and the remaining 2 did not amplify. This is in sharp contrast to the radiocollared bears, in which the ratio was 54 males to 26 females (2:1). Six of 7 of the newly identified individuals were males and the sole female had been previously captured (Table 3). The ages of the recaptured individuals ranged from 4–12 years old (Immell et al., Oregon Department of Fish and Wildlife, unpublished report). The minimum ages for 2 bears (93-021 and 95-068) was determined by subtracting the hair capture date (1998) from their foot snare capture date (1993 and 1995, respectively), assuming they were at least 1 year old when first captured. No age data were available for the newly identified animals.

DISCUSSION

Genetic Tagging and Population Estimation

Due to extensive tissue sampling of a radiocollared black bear population and well-preserved hair samples, we were able to identify 20 of 24 collected hair snags (83%). Four of the samples were from previously captured individuals, 7 were new animals, 9 were repeat samples and only 4 were undetermined. All but 2 samples were informative for gender (92%). While microsatellite scoring errors have been reported using low template amounts in hair samples (Taberlet et al 1996, Gagneux et al. 1997, Goossens et al. 1998); in this study, PCR errors were low: hair genotypes were repeated and re-confirmed multiple times and no excess homozygotes were found. The success of this study's identification results are comparable to reports using grizzly bear

Table 3. Match scores (P_{sib}) identify new and recaptured individuals from combined hair-tissue genotype set. (n.d.= not determined).

Hair ID#	ORW ID#	P_{sib}	Mark	Gender	Age
OR1, 2, 3, 4, 6	95-062	0.0154	Recapture	Male	8
OR16, 17, 18	93-021	0.0306	Recapture	Male	8
OR19, 20, 21	95-068	0.0049	Recapture	Female	4[b]
OR23	94-036	0.0339	Recapture	Male	12
OR7	—	0.0290[a]	New	Male	*n.d.*
OR9	—	0.0136[a]	New	Male	*n.d.*
OR11	—	—	New	Male	*n.d.*
OR12, 14	—	0.0315[a]	New	Male	*n.d.*
—	93-020	0.0232[a]	Capture	Male	6[b]
OR13	—	—	New	*n.d.*	*n.d.*
OR15	—	—	New	Male	*n.d.*
OR22	—	0.0353[a]	New	Male	*n.d.*
OR5	—	—	*n.d.*	Male	*n.d.*
OR8	—	—	*n.d.*	Male	*n.d.*
OR10	—	—	*n.d.*	Male	*n.d.*
OR24	—	—	*n.d.*	*n.d.*	*n.d.*

[a]Several matches below $P_{sib} < 0.035$, see text.
[b]Minimum age, see text.

hair near Golden, B.C. (78%, Woods et al. 1999) and the Selkirk Mountains, B.C. (81%, Mowat and Strobeck 2000). We also observed that snags with at least 4 follicles gave the best identification success, as 92% of the samples we examined had 4 or more follicles. In contrast, only 43% of the Waterton Lakes, Alberta bear samples had 4 roots. Consequently, no genetic fingerprints were obtained from 62 of the 166 samples analyzed (Mowat and Strobeck 2000).

It is important to have sufficient variability in a population so that individuals can be uniquely marked by DNA methods. This can best be achieved by determining the most heterozygous loci in a preliminary population of study animals and calculating the probability of identity using the selected loci. Many Canadian populations of black bears have been analyzed with the same 4–9 microsatellite loci (Table 4) and only Newfoundland Island populations exhibited $H_e < 0.78$. Although our overall P_{ID} value was 6/100,000 for 6 selected loci, the average expected H_e value for the Central Cascade black bears was surprisingly low (59%) compared to the Canadian populations. Currently, it is unknown how the Oregon population compares to other black bear populations in the United States and whether or not this group has been affected by geographic isolation or other constraints. Correct matching of samples is a critical component when

Table 4. Comparison of average expected heterozygosity values (H_e) in North American black bears using bear specific dinucleotide repeat microsatellites. The number of loci used to calculate heterozygosity are in parentheses.

Location	Ave H_e	Reference
Golden, British Columbia	0.810 (9)	Woods et al., 1999
Western Slopes, B.C.	0.806 (8)	Paetkau et al., 1998
Banff, Alberta	0.801 (4)	Paetkau and Strobeck, 1994
La Maurice, Quebec	0.783 (4)	Paetkau and Strobeck, 1994
Central Cascades, Oregon	0.590 (6)	This study
Newfoundland Island	0.414 (8)	Paetkau et al., 1998
Terra Nova N.P., NF	0.360 (4)	Paetkau and Strobeck, 1994

using DNA tags as population estimators, since incorrect assignments or identification failures could over or underestimate the size of a population (Mills et al. 2000). In general, $P_{sib} < 0.05$ should be statistically meaningful in populations where heterozygosity is high (Woods et al. 1999). However, in populations where heterozygosity is low, more stringent P_{sib} criteria should be applied, or more loci typed to achieve statistical confidence in match probabilities. Our data also supports the assertion by Woods et al. (1999) that matches must be made on an individual basis in addition to a statistical one, as some genotypes will be more common and others more rare, depending on the allele frequencies in a population.

Capture heterogeneity is another potential source of bias when using a DNA profile as a "mark" (Mills et al. 2000). Mace et al. (1994) and Mace and Waller (1997) found that adult male grizzly bears had the highest capture probability when baited remote camera stations were used; our limited study results suggest a strong gender bias toward black bear males visiting baited hair snags. In other studies in British Columbia, the sex ratios of grizzly bears were more balanced (Golden: 1.2 M: 1.0 F; Selkirks: 1M: 1.3F) although a larger proportion of samples did not amplify for gender compared to our study (Woods et al. 1999; Mowat and Strobeck 2000). Prior capture may also impact subsequent capture probabilities, resulting in trap avoidance or additional site visits when encountering a baited hair snag. Distribution of snare sites may also impact capture probabilities, with larger distances between sites favoring male visitation and capture (Immell et al., Oregon Department of Fish and Wildlife, unpublished report).

Four pairs of bears detected by hair and tissue sampling were statistically supported as full siblings, which suggests a capture bias favoring the detection of close relatives in the smaller hair snagging area, compared to the overall study area size (Garshelis 1992). Mowat and Strobeck (2000) concluded that M_h-jackknife in CAPTURE (Rexstad and Burnham 1991) was the best model for population estimation with their DNA data set, due to weak heterogeneity in capture probabilities. However, when capture probabilities and sample sizes are low with strong heterogeneity, the CAPTURE model may lack sufficient power for population estimation (Menkens and Anderson 1988). Sample sizes may be improved by combining hair sampling with other methods, such as fecal DNA (Kohn et al. 1999). However, some biases in data are difficult to overcome with current analytical procedures, making it imperative that researchers employ appropriate caution in study design.

MANAGEMENT IMPLICATIONS

Genetic tagging using hair is a useful tool to identify new animals in populations that have avoided capture by more traditional means and can be a reliable population estimator if capture heterogeneity is low. The potential for estimation error increases when match score probabilities are weak or capture biases favor 1 gender, certain age classes or behavioral responses. The detection of closely related individuals in study sites calls for more stringent match score criteria as used in this study. Finally, it is important to investigate the genetic diversity of other black bear populations in the United States to help assess the biological significance of the low heterozygosity observed in the Central Cascade black bears.

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GRIZZLY BEAR (*URSUS ARCTOS*) ABUNDANCE AND DISTRIBUTION SURVEY IN THE CENTRAL PURCELL MOUNTAINS OF SOUTHEAST BRITISH COLUMBIA

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Regionally, the grizzly bears occupying southern British Columbia and western Alberta represent the bears living at the southern edges of continuously occupied habitat in North America. Therefore, they are of particular importance in efforts to halt the history of regional extirpation that has occurred in past decades throughout many areas within their historic range. While minimizing mortality is paramount, habitat fragmentation is an increasing threat to the continuity and long term survival of this population. As part of a larger research effort to identify and quantify habitat fragmentation in the region, an abundance and distribution survey of grizzly bears was carried out in the central Purcell mountain range in the southern interior of British Columbia in 1998. The 1650-km^2 study area was designed as a baseline environmental assessment of the local grizzly bear population that may be fragmented and experience increased mortality risk by a proposed all season skiing/recreation resort. The methodology employed was based on a systematic repeated sampling of genetic tissue from hair of free-roaming grizzly bears. Bear hair was collected from barbed wire that surrounded scent-lure bait sites. Genetic markers were used to identify individual bears through microsatellite genotyping. Individual identification was based on 6 loci genotypes and 12 loci genotypes were used in our analysis of familial relationships within and between watersheds. Capture histories were developed for all individuals and form the basis for a snapshot of grizzly bear distribution and a mark-recapture population estimate. We used an intense sampling grid design, 1 sampling station every 25 km^2, in an effort to maximize bear captures, particularly females. We found a non-uniform distribution of grizzlies across the study area and captured 33 individual grizzly bears including 19 females, 10 males and 4 of unknown sex. We captured 14 individuals multiple times resulting in high overall capture probability relative to other DNA-based grizzly population estimates done in British Columbia. Using the heterogeneity model of Chao in program Capture we estimated 45 bears use the study area (37-68, 95% CI). Results of Monte Carlo simulation trials suggested that the Mh Chao estimator was the most robust to forms of capture probability variation detected in the area. We were concerned about potential violation of population closure, and therefore also used the open Jolly-Seber model in program MARK to obtain a population estimate of 45 bears (37-69, 95% CI). We found females to be relatively evenly distributed across the study area where we captured bears and males more concentrated during the 6 weeks sampling period. The capture rates obtained in this study allowed for a reasonable single-season estimate of the numbers of grizzly bears using the study grid and surrounding area during the spring and early summer seasons of 1998.

Key words: grizzly bear, population survey, microsatellites, DNA.

COMBINING NON-INVASIVE DNA AND ENDOCRINE METHODS

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Non-invasive DNA and hormone methods have a number of potential conservation and management applications among Ursids. DNA methods can be used to confirm species, gender and individual identities. Hormone methods can be used to assess reproductive status and physiological stress. The opportunity to combine these methods on the same sample is particularly promising; DNA can be used to confirm individual identities, permitting repeated sampling of an individual's endocrine profile over time. These combined methods can be further facilitated by methods that enhance sample collections using scat detection dogs. This paper describes the potential outcomes that can be achieved by combining DNA, endocrine and scat detection dog methodologies. The talk will emphasize the strengths and weaknesses of each technique, including precautionary considerations for their applications. Examples will be employed from field studies of grizzly and black bears, as well as non-ursid species in the Pacific Northwest.

Key words: Non-invasive, DNA, hormones, detection dogs, scat.

BLACK BEAR STATUS IN WESTERN NORTH AMERICA: SUMMARY OF WESTERN STATE AND PROVINCE BEAR STATUS REPORT SURVEYS

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Abstract: We surveyed 16 western U.S. states, 1 mid-western U.S. state, 4 Canadian provinces, and Mexico to collect information regarding agency management of bears. The survey questionnaire was designed to allow standardization of information concerning populations, harvest, and damage or human safety typically reported at the Western Black Bear Workshop. Additionally, specific questions in the survey allow for a cursory look at social factors impacting bear management in the western United States. Surveys were not limited to black bear (*Ursus americanus*) but also included brown bears (*U. arctos*). We received responses from 15 of 16 (94%) U.S. states, 4 of 4 (100%) provinces from Canada, and none from Mexico. We summarize information and data by topic, issue, or management strategy. Additionally, we provide an annotation of comments received, grouped by general response where possible, as well as a bibliography of recent publications.

WESTERN BLACK BEAR WORKSHOP 7:32-55

Key words: black bear, brown bear, North America, status, *Ursus americanus*, *Ursus arctos.*

In most western states and provinces of North America, black and brown bears are important wildlife species. Bear management objectives may incorporate biological, cultural, social, economic, and human safety concerns and may vary considerably within and between states or provinces. Additionally, as citizens become increasingly involved in decision making processes at all levels, managing agencies are continually challenged with a dynamic political environment. Given the increasingly complex nature of bear management in western North America, information that is timely, accurate, and presented at appropriate scales becomes an extremely valuable tool for all interested agencies, groups, and individuals.

Many managers and researchers obtain information through peer refereed publications (journals). Although they are very useful and timely, refereed journals tend toward publication of specific research projects and it is difficult to publish information on broad scale demographics of populations. Proceedings from species specific meetings also provide a great deal of information for managers. In 1979, the Arizona Game and Fish Department hosted the first Western States Black Bear Workshop. During that and all subsequent workshops all participating states and provinces have been asked to provide reports on the population status of black bears. Although data on population trends, survey methodology, and pertinent issues are present in the resulting published proceedings, comparisons between states and provinces or inference at larger scales (across provinces) is difficult due to differences in reporting formats.

Our objectives in this status report survey were to: 1) provide a standard format for reporting the status of black bears (and brown bears at this workshop) in the western states and provinces; 2) provide a mechanism for synthesis of bear population status information into a format that facilitates comparisons among jurisdictions without losing information pertinent to smaller scales; 3) provide a venue for discussion of issues that may go beyond the biological data traditionally used by bear managers; and 4) streamline the status reporting process within the workshop agenda to provide additional time during the workshop for technical presentations, panel and open forum discussions.

METHODS

We sent surveys to member agencies of the Western Association of Fish and Wildlife Agencies (WAFWA) and Mexico. Surveys were sent primarily to agency leaders for assignment to appropriate personnel for completion. A survey for the state of Minnesota was included at their request to be included in the Western Black Bear Workshop. We allowed late submission of surveys from 3 of the 4 Canadian provinces to ensure as complete a summary as possible. Where necessary, phone conversations were used to clarify confusing entries and complete missing entries.

Surveys requested 5 main types of information including population data, harvest and management strategies, perceptions on bear management issues, current active research, and recent publications. We recognize that much of the information on issue perceptions may be subjective but include it in an attempt to highlight consistencies between jurisdictions. Data and information were summarized and presented by topic or issue. Due to differences in reporting methods, the subjectivity of some data, and lack of reporting for some specific questions, no rigorous statistical analyses were performed. We

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provide an appendix of current research projects and a bibliography of recent publications.

RESULTS

We received responses from 15 of 16 (94%) U.S. states, 4 of 4 (100%) provinces from Canada, and none from Mexico. All 15 state responses and 1 provincial response were received prior to the workshop. One provincial response was delivered at the workshop and 2 provincial reports were received after the workshop. Due to the size and diversity of Alaska, 3 reports were received from that state. Reports received prior to the workshop were published and provided to workshop participants as an addendum to the agenda and abstracts. All reports received prior to and after the workshop are included in the analyses to follow.

Management Guidance

Eighteen agencies provided information on the location of guiding language for bear management (Appendix A, Table 1). Most agencies (61%) manage bears through policy. Seventeen percent of agencies have either statute (6%) or administrative rule (11%) specific to bear management, and 11% utilize guidelines for management direction. Four states (28%) had no management plan, statute, rule, or guideline to help direct bear management. Three (17%) agencies have guiding language located in multiple sources.

Due to the diversity of responses, we subjectively categorized answers to the query for top 3 guiding management objectives into manageable groups based on similarity of responses. Harvest and recreation management was considered an objective by 40% of responding agencies. Other objectives guiding agency management included damage and conflict management (19%), data collection and using good science (16%), attaining specific population objectives (14%), public education and public input process management (5%), preservation or conservation (5%), and reducing litigation (2%).

Distribution and Abundance

Twenty agencies reported on status of black bears (Appendix A, Table 2) and all but South Dakota report having wild populations. Most agencies (71%) reported that black bears occupy 100% of available habitat. Nearly 40% of agencies felt black bear populations were expanding with the remaining agencies reporting stable distributions. Eight agencies provided information on brown bear distribution and status (Appendix A, Table 2). Of those, 3 agencies reported brown bears occupy 100% of available habitat with a stable distribution and 5 agencies report expanding populations with 10–90% of available habitat occupied.

Of those agencies responding to the survey, 12 (53%) attempt to estimate black bear populations (Appendix A, Table 3). Methods used to estimate black bear populations varied considerably between agencies. Most agencies (91%) and the public (100%) reported a reasonable (medium – high) level of comfort with black bear population estimates. Seven of 8 states/provinces reporting brown bear presence indicated they attempt to estimate populations (Appendix A, Table 3) using a variety of methods similar to those used for black bear. Most agencies (71%) appear reasonably comfortable (medium - high level) with brown bear population estimates as opposed to 57% of reporting agencies feeling the public is reasonably comfortable with population estimates.

Only 12 agencies provided population estimates for black bears (Appendix A, Table 4). Black bear population estimates remained relatively stable over the last 10 years with the exception of Minnesota, which reports an 80% increase. New Mexico reported a 17% increase. The total increase in population for the 12 jurisdictions that reported was 3.7% between 1990 (337,335) and 1999 (350,250). Total brown bear populations increased 1.7% between 1990 (30,435) to 1999 (30,949). However, 3 of 7 agencies report brown bear population increases between 34% and 41% while remaining agencies report stable populations.

Most responding agencies also utilized other data to monitor bear populations (Appendix A, Table 5). For black bears, 12 agencies (67%) have mandatory reporting of harvest and mortality data, 10 (56%) require reporting of age data (teeth), and 9 (50%) require reporting damage or conflict. Only 1 agency (Oregon) utilizes reproductive tract data for black bears and providing this information was optional. Reporting brown bear harvest and mortality data was mandatory for 6 agencies (86%), providing a tooth or age data was required by 6 agencies (71%), and reporting damage or conflict information was required by 3 agencies (38%). Brown bear reproductive information was not utilized by any responding agency.

Harvest Management

Of those responding agencies with wild black bear populations, only 2 (Oklahoma, Nevada) do not allow some level of harvest (Appendix A, Table 6). Of the 15 agencies allowing black bear harvest, 5 (67%) allow only fall harvest, 1 (7%) allows only spring harvest, and 9 (60%) allow both spring and fall seasons. Of those agencies allowing spring black bear harvest (10), 40% utilize controlled seasons, 50% utilize general seasons, and 10% (1) utilizes both types of season. For fall black bear harvest, 21% of the agencies utilize controlled seasons, 64% utilize general seasons, and 14% utilize both season types. Black bear bag limit varied between agencies (Appendix A, Table 6) ranging from 1-3 per year irrespective of season, to 1 or 2 per season. Only 4 agencies provided brown bear season information (Appendix A, Table 6) and all but Alberta allow both spring and fall brown bear harvest utilizing primarily controlled seasons. Alberta only allows brown bear harvest during controlled spring seasons. Brown bear bag limit varied from 1 in 4 years in Alaska to 3 a year in the Yukon province. Although variable, 6 agencies report utilizing harvest quotas or objectives (Appendix A, Table 7). All 6 use them for black bears and only Alberta reported a quota for brown bears.

Nine agencies provided harvest data for 1999 (Appendix A, Table 8). Total annual black bear harvest for those agencies providing 1999 data was 12,396. Total annual brown bear harvest for those agencies providing 1999 data was 1,470. Because of the limited availability of harvest data for 1999, we consider these harvest estimates extremely conservative.

Damage Management and Planning

Eighteen agencies provided information on options available for managing black bear damage, and 9 agencies reported on managing grizzly bear damage (Appendix A, Table 9). A high proportion of reporting agencies (≥ 94%) utilize advice to complainants, education, and relocation of animals causing damage for both black and brown bears. All reporting agencies maintain killing black bears as a damage management option and 89% of responding agencies will kill brown bears causing damage. Allowing the public to kill bears as a damage management option is maintained by about 67% of reporting agencies for black bears and less than 50% of reporting agencies for brown bears. Payment for damage and increased regulation to address damage were not prevalent options (22–33%) for either bear species.

When queried about options available for managing bear related human safety situations, agencies responded with results similar to those reported for managing damage, listing advice and education, relocating animals, and agencies killing animals as commonly (≥ 63% of responding agencies) utilized options (Appendix A, Table 10). However, more agencies were willing to allow the public to kill bears in human safety situations (75% for black bear, 63% for brown bear), and fewer agencies utilized payment and increased regulation in response human safety concerns (≤ 25%).

All state or provincial agencies that responded indicated they were the primary agency responding to bear damage and human safety situations (Appendix A, Table 11). Thirteen agencies supplied estimates of percent of situations handled primarily by the state/provincial agency. Of those, 10 (77%) responded ≥ 90% of the time. Federal agencies were utilized by 47% and 38% of state/provincial agencies for situations involving black and brown bears, respectively. Law enforcement agencies were utilized by 42% and 50% of state/provincial agencies when addressing situations involving black and brown bears, respectively.

License fees dominated as a source of funding for managing bear damage and human safety situations (Appendix A, Table 12) with 68% and 75% of responding agencies utilizing this source for black and brown bear situations, respectively. Only 1 state, California, reported tax revenue as a source of funding. Thirty-seven percent and 21% of responding agencies also utilized general and federal funds, respectively, for black bear damage and safety situations. Agencies managing brown bear damage and safety situations received slightly higher portions of general and federal funds (50% and 38%, respectively) than for black bears as reported.

Fifteen agencies provided black bear damage data (Appendix A, Table 13). Although data were not rigorously evaluated, no obvious trends were apparent. Total number of black bear damage complaints received in 1999 (13,873, 11 agencies reporting) did not appear different from that reported in 1994 (13,966, 8 agencies reporting). Total number of black bears killed as a result of damage in 1999 (1,811, 13 agencies reporting) appears to be an increase over 1994 (1,382, 14 agencies reporting). Five agencies provided brown bear damage data. Only 2 agencies provided number of complaints received making it difficult to subjectively assess trend. Similar to black bear, total number of brown bears killed as a result of damage in 1999 (160, 4 agencies reporting) appeared to be slightly higher than during 1994 (124, 5 agencies reporting).

Nineteen agencies reported on black bear interactions with planning and management processes (Appendix A, Table 14). No agencies felt black bear management complimented city or county planning processes. Conversely, 68% of responding agencies felt black bears conflicted city planning and 42% felt black bears conflicted with county planning processes. Additionally, 47% of agencies felt black bear populations conflicted with private land management and only 26% and 16% of agencies felt black bear populations complimented public land management and recreation management, respectively. Trends were similar for brown bear populations. No agencies reported that brown bear populations complimented either city (63% conflict) or county (50% conflict) planning processes. Fifty percent of agencies report brown bear populations conflict with private land management, only 13% report they compliment public land management, and 13% report brown bears compliment recreation management.

Attitudes and Issues

We received variable responses to queries regarding perceived support for selected bear management issues (Appendix A, Table 15). Thirteen agencies were comfortable subjectively evaluating agency support, and 11 were comfortable subjectively evaluating hunter and non-hunter support for issues. As reported, agencies and hunters were perceived to generally support most hunting issues (56-100% supporting) more than non-hunters (0-29%), except that 75% of responding agencies felt non-hunters were supportive of fall hunting. Most bear damage management issues appeared most strongly supported by hunters (38-92%), followed by agencies (29-64%), and non-hunters (0-57%). Relocation and rehabilitation of bears appeared most strongly supported by non-hunters (91% and 89%, respectively), followed by hunters (56% and 83%, respectively), and agencies (29% and 23%, respectively). Surprisingly, the only group that appeared to support bear management to favor other wildlife species was hunters (75%), followed by agencies (27%) and non-hunters (11%).

When asked to predict the single greatest issue in the future, responses were highly variable and again, we subjectively categorized responses into manageable groups based on similarity of responses. Minimizing conflict and damage was expected to be an issue by 38% of agencies responding to the query. Twenty-five percent of the respondents expect habitat maintenance to be a future issue and 67% of those agencies with this expectation feel habitat encroachment will be more of an issue than industrial development. Maintaining public acceptance of bear hunting was felt to be a future issue by 13% of respondents and more than half (57%) of those felt specific hunting methods would be an issue. Responding agencies also felt anti-predator and anti-hunting philosophies would become an issue (13%), as well as maintaining management effectiveness (controlling populations) and data quality (13%).

Current Research Projects

Fourteen states and 3 Canadian provinces are currently conducting bear research (Appendix B). Although reported projects encompass a broad array of objectives, most (63%) describe basic life histories or ecology. About 25% evaluate potential population estimation and modeling techniques. Bear diseases and physiology, damage or conflict management, or human dimension aspects were incorporated as research objectives in 4% of the studies.

DISCUSSION

This survey report attempted to standardize reporting of state and provincial status reports for black and brown bears in western North America. We attempted to consolidate information on population status and distribution, harvest structure and trend, and management objectives in a manner that presents a regional picture without loss of significant details for specific agencies. Throughout, we have avoided statistical inference from these data because of differences in reporting methods, types of data, and the subjective nature of some of our queries. A secondary objective of this effort was to allow more time during the Western Black Bear Workshop. We feel that based on comments we received during the workshop, and based on participation during the discussion forum held in place of status reports, that this effort was successful.

There is only 1 comparison within this survey that needs brief but specific discussion. It became apparent during compilation of the issues agencies felt would become important in the future and the research that agencies are currently conducting, that bear managers may not be adequately equipped with information for the future. We illustrate this with the observation that damage or conflict management and human dimensions of bear management account for 76% of the responses for the single greatest issue agencies will face in the future whereas over 80% of the research currently being conducted focuses primarily on life history attributes of bears.

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Note: *Our attempt here is to provide a list of pertinent publications produced or supported by the agencies responding to the status survey. We attempted to reach authors when citation information was not complete according to the* Journal of Wildlife Management *guidelines but were unable to complete all citations in time for publication. We include incomplete citations in this bibliography with the understanding that the reader may be able to pursue further information with original authors.*

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Appendix A, Table 1. Location of management plans or other language guiding bear management in western states and provinces.

State or province	Location of Guiding Language				
	No Plan	Rule	Statute	Policy	Guidelines
Alaska (Northwest)				X	
Alaska (S.E)				X	
Alberta			X	X	
Arizona				X	
British Columbia				X	
California				X	
Colorado					X
Idaho				X	
Minnesota	X				
Montana		X		X	
Nevada	X				
New Mexico	X				
NW Territories				X	
Oklahoma	X				
Oregon		X		X	
Texas	X				
Washington				X	
Wyoming				X	
Yukon					X

Appendix A, Table 2. Current status of bear distributions by state or province.

State or Province	Black Bear		Grizzly/Brown Bear	
	% Occupied	Status	% Occupied	Status
Alaska				
Northwest	100	Stable	100	Stable
South Central	100	Stable	100	Stable
Southeast	100	Stable	100	Stable
Alberta	100	Stable	Unsure	Expanding
Arizona	100	Stable		
British Columbia	95	Expanding	90	Expanding
California	90	Expanding		
Colorado	100	Stable		
Idaho	100	Stable	10	Expanding
Minnesota	95	Stable		
Montana	100	Stable	60	Expanding
Nevada	100	Expanding		
New Mexico	100	Expanding		
NW Territories	100	Stable	100	Stable
Oklahoma	100	Expanding		
Oregon	100	Stable		
South Dakota	0			
Texas	No Estimate	Expanding?		
Utah	70	Expanding		
Washington	90	Stable		
Wyoming	100	Stable		Expanding
Yukon	100	Stable	100	Stable

Appendix A, Table 3. State-, region-, or province-wide bear population estimation techniques, and relative comfort level with population estimates.

State or Province	Population Estimation		Comfort Level[a]	
	Estimate	Technique	Agency	Public
Black Bear				
Alaska				
Northwest	Yes	Extrapolation	Med	Med
South-Central	No			
Southeast	Yes	Habitat modeling	Low-Med	Low-Med
Alberta	Yes	Density extrapolation	Med-High	High
Arizona	Yes	Density extrapolation	Med-High	Med-High
British Columbia	Yes	Extrapolation	Med	Med
California	Yes	Numerical estimate	Med	High
Colorado	No			
Idaho	Yes	Bait station indices		
Minnesota	Yes	Extrapolation	High	High
Montana	No			
Nevada	No			
New Mexico	Yes	Population modeling	Med	Med
NW Territories	Yes	Extrapolation	Med	Med
Oklahoma	No			
Oregon	No			
Texas	Yes	Sighting, studies	Med	High
Utah	Yes	Hair snag, telemetry	Low	Med
Washington	No			
Wyoming	No			
Yukon	Yes	Density extrapolation	Med	Med
Grizzly Bear				
Alaska				
Northwest	Yes	Mark/recap., extrapolation	Med	Med
South-Central	Yes	Mark/recap., extrapolation	Low-Med	Low-Med
Southeast	Yes	Mark/recap., extrapolation	Low-Med	Med-High
Alberta	Yes	Mortality extrapolation	Low	Low
British Columbia	Yes	Extrapolation	Med	Low
Idaho	Yes	Telemetry, aerial surveys	Low-High	Med
NW Territories	Yes	Density extrapolation	Med	Med
Wyoming	Yes	Mark/recapture	Low	Low
Yukon	Yes	Density extrapolation	Med	Med

[a]Agency and public confidence in population estimates are relative: Low = Low confidence; Med = Medium confidence; High = High confidence.

Appendix A, Table 4. Bear population estimates reported by western states or provinces.

State/province	Year					
	1990	1992	1994	1996	1998	1999
Black Bear						
Alberta	40,000	40,000	40,000	40,000	40,000	40,000
Arizona	2,500	2,500	2,500	2,500	2,500	2,500
British Columbia						120-160,000
California	17,000	21,000	20,000	19,000	20,000	
Idaho						22,500
Minnesota	15,000	17,000	19,000	21,000	25,000	27,000
Nevada	300	300	300	300	300	300
New Mexico	4,500					5,400
NW Territories	10000	10000	10000	10000	10000	10000
Oregon			25,000	25,000	25-30,000	25-30,000
Texas	<35	<35	<50	<50	<50	<50
Washington	30,000	30,000	30,000	30,000	30,000	30,000
Grizzly Bear						
SE Alaska	4,155	4,155	4,155	4,155	4,155	4,155
Alberta	544	669	700	761	806	856
British Columbia						10-13,000
Idaho	20-40	20-40	20-40	20-40	20-40	20-40
Montana	492-687					750
NW Territories	5000	5000	5000	5000	5000	4800
Wyoming	204	259	219	226	344	348
Yukon	6-7,000	6-7,000	6-7,000	6-7,000	6-7,000	6-7,000

Appendix A, Table 5. Types and status of other data used by western states and provinces for monitoring bear populations.

State or Province	Harvest & Mortality	Tooth or Age	Reproductive Tracts	Damage/ Conflict
Black Bear				
Alaska				
Northwest	Mandatory	Optional		Optional
South central	Mandatory			
Southeast	Mandatory	Mandatory		Mandatory
Alberta	Optional			Optional
Arizona	Mandatory	Mandatory		Optional
British Columbia	Optional			
California	Mandatory	Mandatory		Mandatory
Colorado	Mandatory			Mandatory
Idaho	Mandatory	Optional		Mandatory
Minnesota	Mandatory	Mandatory		Optional
Montana	Optional	Mandatory		Optional
Nevada	Mandatory?			
New Mexico	Mandatory	Mandatory		Mandatory
NW Territories				Optional
Oklahoma				Mandatory
Oregon	Optional	Optional	Optional	Optional
Utah	Mandatory	Mandatory		Mandatory
Washington	Mandatory	Mandatory		
Wyoming	Mandatory	Mandatory		Mandatory
Yukon	Mandatory	Mandatory		Mandatory
Grizzly Bear				
Alaska				
Northwest	Mandatory	Optional		Optional
South central	Mandatory	Mandatory		
Southeast	Mandatory	Mandatory		Mandatory
Alberta	Mandatory	Mandatory		Optional
British Columbia	Mandatory	Mandatory		
Idaho	Mandatory	Optional		Mandatory
Montana	Optional	Mandatory		Optional
NW Territories	Mandatory			Optional
Yukon	Mandatory	Mandatory		Mandatory

Appendix A, Table 6. Current bear hunting seasons allowed as reported by western states and provinces (NR = non-resident, Res = Resident).

State or Province	Spring Seasons		Fall Seasons	
	Bag Limit	Season Type[a]	Bag Limit	Season Type[a]
Black Bear				
Alaska				
Northwest	3	General	3	General
South central	1–3	General	1–3	General
Southeast	1 NR, 2 Res	General	1 NR, 2 Res	General
Alberta	2	General	2	General
Arizona	1	Controlled	1	General
British Columbia	2	General	2	General
California	No season		1/season	General
Colorado	No season		1/year	Controlled
Idaho	1	Both	1	Both
Minnesota	No season		1	Both
Montana	2/ year	General	No season	
Nevada	No season		No season	
New Mexico			1	General
Oklahoma	No season		No season	
Oregon	1	Controlled	1	General
Utah			1	Controlled
Washington	1	Controlled	1–2	General
Wyoming	1	General	1	General
Yukon	2	Controlled	2	Controlled
Grizzly Bear				
Alaska				
Northwest	1 in 4 years	Controlled	1 in 4 years	Controlled
South central	1 in 4 years	Controlled	1 in 4 years	Controlled
Southeast	1 in 4 years	General	1 in 4 years	General
Alberta	1	Controlled	No season	
British Columbia	1	Controlled	1	Controlled
Yukon	1–3	Controlled	Varies	Controlled

[a]General = no restriction on tag numbers; Controlled = limited tag numbers, lottery, etc.; Both includes a mixture of controlled and general seasons.

Appendix A, Table 7. Bear harvest quotas or objectives reported by western states or provinces.

State or Province	Spring Black Bear			Fall Black Bear			Grizzly Bear		
	Male	Fem.	Total	Male	Fem.	Total	Male	Fem.	Total
Alberta			2000			2000	65%	35%	2-3%
Arizona		7			97				
California				60%	40%	1750			
Colorado						750			
Mexico						5000			
Wyoming		48			33				

Appendix A, Table 8. Bear harvest for 1999 reported by state or province.

State or Province	Spring Black Bear			Fall Black Bear			Grizzly Bear		
	Male	Fem.	Total	Male	Fem.	Total	Male	Fem.	Total
Alaska (Statewide)	1191	259	1459	658	36	1035	770	342	1125
Alberta			1250			1250	10	7	17
Arizona	1		1						
British Columbia	1621	316	1937	1620	316	1936	169	93	262
California				1093	738	1832			
Colorado						847			
Idaho	633	315	948	529	309	838			
Oregon	123	51	181	568	264	856			
Wyoming	83	40	123	46	28	74			
Yukon	42	3	45	32	13	45	46	20	66

Appendix A, Table 9. How damage causing bears are dealt with by western states and provinces. Options include: Advice to complainant; Education of complainant; Animal relocation; Payment for damage; Increased regulation; and other.

State or Province	Advice	Education	Relocate	Killed by:		Pay	Regulation	Other
				Public	Agency			
Black Bears								
Alaska								
Northwest	X	X	X	X	X			
South central	X	X	X	X	X		X	
Southeast	X	X	X	X	X		X	X
Alberta	X	X	X	X	X	X		
Arizona	X	X	X		X			
British Columbia	X	X	X	X	X		X	
California	X	X		X	X			
Colorado	X	X	X	X	X	X		
Idaho	X	X	X		X	X		
Minnesota	X	X	X	X	X			
Montana	X	X	X		X		X	
Nevada	X	X	X		X			
New Mexico		X	X	X	X			
NW Territories	X	X	X	X	X			
Oklahoma	X	X	X		X			
Oregon	X	X	X	X	X		X	
Texas	X	X	X		X			
Washington	X	X	X	X	X			
Wyoming	X	X	X	X	X	X		
Yukon	X	X	X	X	X			
Brown Bear								
Alaska								
Northwest	X	X	X	X	X			
South central	X	X	X	X	X		X	
Southeast	X	X	X	X	X		X	X
Alberta	X	X	X		X	X		
British Columbia	X	X	X	X	X		X	
California	X	X			X			
Idaho	X	X	X					
Montana	X	X	X		X		X	
NW Territories	X	X	X	X	X			
Wyoming	X	X	X		X	X		
Yukon	X	X	X	X	X			

Appendix A, Table 10. How bears causing threats to human safety are dealt with by western states and provinces. Options include: Advice to complainant; Education of complainant; Animal relocation; Payment for damage; Increased regulation; and other.

State or Province	Advice	Education	Relocation	Killed by:		Payment	Regulation	Other
				Public	Agency			
Black Bear								
Alaska								
Northwest	X	X	X	X	X			
South Central	X	X	X	X	X	X		
Southeast	X	X	X	X	X		X	X
Alberta	X	X	X	X	X			X
Arizona				X	X			
British Columbia	X	X	X	X	X		X	
Colorado				X	X			
Idaho	X	X	X	X	X			
Minnesota	X		X	X	X			
Montana		X	X		X			
New Mexico		X	X	X	X			
NW Territories		X	X	X	X			
Oklahoma	X	X	X		X			
Oregon	X	X	X		X		X	
Texas	X	X	X	X	X			
Washington	X	X	X	X	X			
Wyoming					X			
Yukon	X	X		X	X			
Grizzly Bear								
Alaska								
Northwest	X	X	X	X	X			
South Central	X	X	X	X	X		X	
Southeast	X	X	X	X	X		X	X
Alberta	X	X	X	X	X			X
British Columbia	X	X	X	X	X		X	
Idaho	X	X			X			
Montana		X	X		X			
NW Territories		X	X	X	X			
Wyoming					X			
Yukon	X	X		X	X			

Appendix A, Table 11. Primary agencies responding to damage or human safety situations caused by bears in western states and provinces. Response options include: State or Provincial wildlife agency; Federal wildlife agency; Law enforcement agencies.

State or Province	State/Province	Federal	Enforcement	Other	% by State/Province
Black Bear					
Alaska					
Northwest	X		X		95%
South central	X		X		90%
Southeast	X		X		>50%
Alberta	X		X		
Arizona	X				100%
British Columbia	X		X		90%
California	X	X	X		70%
Colorado	X	X	X		>75%
Idaho	X	X			
Minnesota	X				100%
Montana	X	X			90%
Nevada	X				100%
New Mexico	X	X	X		
NW Territories	X				
Oklahoma	X				100%
Oregon	X	X		X	50%
Texas	X	X	X		
Utah	X	X	X		40%
Washington	X				100%
Wyoming	X	X			90%
Yukon	X			X	
Grizzly Bear					
Alaska					
Northwest	X		X		95%
South central	X		X		90%
Southeast	X		X		0-100%
Alberta	X		X		
British Columbia	X		X		95%
Idaho	X	X	X		100%
Montana	X	X			80%
NW Territories	X				
Wyoming	X	X			90%
Yukon	X			X	

Appendix A, Table 12. Funding sources used by western states and provinces to address and manage damage or human situations caused by bears.

State or Province	License Fees	Tax Revenue	General Funds	Federal Funds	Other Funds
Black Bears					
Alaska					
Northwest	X				
South central	X				
Southeast	X				
Alberta	X		X		
Arizona	X				
British Columbia			X		
California	X	X			
Colorado	X				
Idaho	X				
Minnesota	X				
Montana	X			X	
Nevada	X				
New Mexico	X				
NW Territories			X		
Oklahoma			X		
Oregon	X		X		
Texas				X	
Utah				X	
Washington	X		X	X	
Wyoming	X				
Yukon			X		X
Grizzly Bear					
Alaska					
Northwest	X				
South central	X			X	
Southeast	X				
Alberta	X		X		
British Columbia	X		X		
Idaho	X			X	
Montana	X			X	
NW Territories			X		
Wyoming	X				
Yukon			X		

Appendix A, Table 13. Number of complaints received and number of bears killed as a result of damage by bears as reported by western states and provinces.

State or Province	Complaints				Bears Killed			
	1994	1996	1998	1999	1994	1996	1998	1999
Black Bears								
Alaska					25	35	28	48
Arizona	20	35	5	23	2	9	0	13
British Columbia	9,771	10,914	11,734	10,316	937	991	1,619	1,138
California	148	223	342	241	51	86	153	116
Colorado	811	1,867	716	574	32	17	16	12
Idaho	136	107	434					
Minnesota	2,400	1,300	1,000	1,200	100	50	70	60
NW Territories					14	1		
Oklahoma					0	0	0	0
Oregon	327	561	828	904	151	238	302	288
Texas	1	1	3	2	0	0	0	0
Utah	41	56	79	81	20	35	42	35
Washington	208	556	786	625	10	20	35	36
Wyoming	10	14	22		12	14	4	4
Yukon					28	61	23	61
Grizzly Bear								
Alaska					40	51	72	64
British Columbia	289	315	244	370	47	36	36	82
NW Territories					20	5	14	
Wyoming	7	16	24		4	4	2	2
Yukon					9	13	10	12

Appendix A, Table 14. Bear population interactions with various planning or management processes. Response options were: '--' = conflict with process; NI=no impact; '++' = compliment process; '+/-' = varies.

State or Province	Planning		Management of:		
	City	County	Private Land	Public Land	Recreation
Black Bear					
Alaska					
Northwest	--	+/-	+/-	NI	NI
South central	--	--	--	NI	--
Southeast	--	--	--	+/-	+/-
Alberta	--	+/-	+/-	+/-	+/-
Arizona	--	--	--	NI	--
British Columbia	--	--	--	NI	--
California	--	--	--	++	++
Colorado	--	--	+/-	NI	+/-
Idaho	NI	NI	NI	NI	NI
Minnesota	NI	NI	NI	NI	NI
Montana	--	--	--	NI	NI
Nevada	--	--	NI	NI	NI
New Mexico	--	--	--	++	++
NW Territories	--	NI	NI	NI	NI
Oklahoma	NI	NI	NI	NI	NI
Oregon	--	NI	--	++	+/-
Texas	NI	NI	+/-	++	NI
Utah	NI	NI	--	+/-	--
Washington	--	--	--	++	++
Wyoming	--	--	--	--	--
Yukon	NI	NI	NI	NI	--
Grizzly Bear					
Alaska					
Northwest	--	+/-	+/-	NI	NI
South Central	--	--	--	NI	--
Southeast	--	--	--	+/-	+/-
Alberta	--	+/-	+/-	+/-	+/-
British Columbia	--	--	--	--	--
Idaho	NI	--	--	+/-	--
Montana	--	--	--	++	++
NW Territories	NI	NI	NI	NI	NI
Wyoming	--	--	--	--	--
Yukon	NI	NI	NI	NI	--

Appendix A, Table 15. Perceived support for selected bear management issues by agencies, hunters, and non-hunters. Response categories: '+' = For; '-' = Not for; '+ -' = Not definitive.

State/province	In Spring	In Fall	Using Bait	Using Dogs	Hunting Grizzly	Female Harvest	Increase Hunting	Increase Viewing	Increase Regulation	Damage Payments	Kill Damage Bears	Kill Damage Cubs	Relocation	Rehabilitation	Bear Management for Other Species
Agencies															
NW Alaska	+	+	+		+	+	+	+	-	-	+	+	-	-	+
SE Alaska	+	+	+ -	+ -	+	+	+	+	-	-	-	-	-	-	+ -
Alberta	+	+ -	+ -	-	+	+	+		-	+	-	-	+ -	-	+ -
Arizona	+	+	-	+		+	+			-	+	-	+	-	-
California		+		+		+	+	+	-	-	+	+	-	+	+
Idaho	+	+	+	+	-	+	+	+	-	+	+	-	-	+	-
Minnesota		+	+	-		+	+			-	+	-	-	-	
Oklahoma											-	-	+	-	
Oregon	+	+	-	-		+	+	+	-	-	+	+	-	+ -	-
Texas								+	-		-	-	+	-	-
Utah	=	+	+	+		-	+	+		+	+	-	-	+	-
Washington	+	+				+ -	+ -	+	-	-	+ -	+ -	+ -	+ -	-
Wyoming	+	+	+	-		+	+	+	-	+	+	-	+	-	
Yukon	+	+			+		+	+	+ -		+	+	+ -		-
% For[a]	90	92	56	44	80	80	92	100	0	36	64	29	29	23	27
Hunters															
NW Alaska	+	+	+ -	-	+	+	+	+	-	-	+	-	+		+ -
SE Alaska	+	+	+	+	+	+	+	-	-	-	+	-	-		+
Alberta	+	+	+ -	-	+	+	+		+ -	+	+	-	+		+
Arizona	+	+				+	+			-	+	-			
California		+		+		+	-	+	-	-	+	+	-	+	+
Idaho	+	+	+	+	+	+	+	+	-	-	+	-	-	+	-
Minnesota		+	+	-		+	+				+	-	+	+	
Oklahoma											-	-	+	-	+
Oregon	+	+	+	+		+	+	+	-		+	+			+
Utah	+	+	+	+		-	+	+	-	+	+	-	-	+	
Wyoming	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+
Yukon	+	+			+			+	-		+	+			
% For[a]	100	100	75	67	100	90	90	88	0	38	92	92	56	83	75

[a]Percent of responses where groups were felt to be for or supporting a particular issue.

Appendix A, Table 15. Continued

State/province	In Spring	In Fall	Using Bait	Using Dogs	Hunting Grizzly	Female Harvest	Increase Hunting	Increase Viewing	Increase Regulation	Damage Payments	Kill Damage Bears	Kill Damage Cubs	Relocation	Rehabilitation	Bear Management for Other Species
Non-Hunters															
NW Alaska	+	+		-	+		-	+	+			-	+	+	-
SE Alaska	+	+	-	-	-	-	-	+	+	-	-	-	+	+	+ -
Alberta	-			-	-		-	+	+	+	-	-	+		-
Arizona								+		-		-	+		-
California		-		-		-	-	+	-	+	-	-	+	+	+
Idaho	-	+	-	-	-	+	-	+	-	-	-	-	-	+	-
Minnesota		+				+					+	-	+	+	
Oklahoma											-	-	+	-	
Oregon	-	+	-	-		-	-	+	+		+	-	+	+	-
Utah	-	+	-	-		-	-	+	+	+	+	-	+	+	-
Wyoming	-	-	-	-	-	-	-	+	+	+	+	-	+	+	-
Yukon								+							
% For[a]	29	75	0	0	20	29	0	100	75	57	44	0	91	89	11

[a]Percent of responses where groups were felt to be for or supporting a particular issue.

APPENDIX B: CURRENT RESEARCH PROJECTS

ALASKA - Alaska is currently calculating and modeling sustained harvest levels for female bears. They are also looking at density estimation by using ship/line transect models and studying predation and prey relationships.

ALBERTA - Alberta reported having 3 ongoing grizzly bear projects. They are located in the Eastern slopes, the Foothills Model Forest, and the Northwest Boreal Forest.

ARIZONA - Arizona has been researching the effect of a large (greater than 24291 ha) wildfire on a black bear population in a chaparral/mixed conifer habitat in central Arizona. Initial results indicate resident bears left the area the 1st year, however, returned the 2nd summer and were found in high densities (greater than 2.7/km^2) in "green islands" within the burn. In the last 3 years, the bears are inhabiting the burned areas and density is decreasing.

BRITISH COLUMBIA - Grizzly bear projects are ongoing in the Parsnip River drainage and surrounding area, the Flathead River drainage, the area between Yoho National Park and Glacier National Park, the Taku River drainage, the Prophet River drainage, and in the Northern Cascades. There are several ongoing research projects and are as follows:

1. Determining genetic basis for the kermode color phase.
2. The role of bears in nutrient cycling in coastal ecosystems.
3. Diurnal and nocturnal foraging behavior of black bears during salmon spawning migration.
4. Grizzly bear gene flow and population fragmentation.
5. Bear viewing in coastal ecosystems.

CALIFORNIA - California has been researching the denning characteristics of bears, cub survival, and bear densities in mixed-conifer forests. Ongoing studies of habitat use and distribution of bears are being conducted on the urban fringe.

COLORADO - Colorado has been working on a joint project with the University of Wyoming (Henry Harlow and others) and University of Minnesota (Paul Iazzo) on the mechanisms of Lack of Muscle Disuse Atrophy in Hibernating Bears. This involves taking mechanical measurements of hind leg strength in early December and late March plus numerous studies on tissue samples and enzyme activity.

IDAHO - Idaho is continuing to radio track grizzlies in the Selkirk Mountains of Northern Idaho; cooperatively with the USFWS in the Cabinet-Yaak Ecosystem of Montana/Idaho; and monitor recovery in the Idaho portion of the Yellowstone Grizzly Bear Ecosystem.

MINNESOTA - Minnesota is at the tail end of a 20-year study and is still conducting research on dens of old female black bears. Recently did a hair-snaring population estimate in an unhunted National Park.

MONTANA - Montana is currently in the early stages of implementing a long-term black bear research program. This effort will address all phases of bear population work to determine validity of existing management criteria (median age of 6.0 for females, less that 40% females in annual harvest).

NEVADA - Nevada is currently researching human conflict management issues.

NEW MEXICO - An 8-year bear study will be completed in the year 2000 in New Mexico. There are 2 study areas where examination of the bear populations and development of a population/hunt model is occurring.

NORTHWEST TERRITORIES - The Northwest Territories has many studies occurring. In the Slave Geological Province there are 3 major ongoing research projects. The first is concerning the population ecology of grizzly bears. The purpose of this study is to study nutritional ecology, spatial organization, and habitat selection patterns of grizzly bears inhabiting the low arctic tundra of mainland Nunavut and the Northwest Territories. The second project is to assess the population status of grizzly bears and develop a scientifically based management plan for this species in light of expanding mining and hunting activities. The third project is to analyze existing grizzly bear satellite telemetry data from GPS collars using resource selection function analysis. This will better describe grizzly bear seasonal forage selection and habitat use of the area.

In the Mackenzie Mountains biologists are collecting all relevant information on grizzly bears as a basis for a future co-management plan.

In the Inuvialuit settlement area researchers are in the pilot phase of its research concerning grizzly bear genetics.

In the Amundsen Gulf area researchers are updating polar bear management agreements and delineating between the north and south Beaufort populations using satellite telemetry.

OREGON - Oregon's 2 black bear research projects (NE and SW Oregon) are currently in the final stages of analysis and write-up. Both projects described basic life histories, evaluated potential population estimation techniques and measured compliance with existing rules and regulation. Additionally, human dimensions studies were incorporated during the later stages of research conducted in SW Oregon.

A 3 year project to assess the feasibility of using tetracycline for a mark-recapture density estimate is in it's second year. New methods of DNA collection are being evaluated concurrently with this project.

TEXAS - Natural recovery of black bears into the historic range in western Texas is occurring. The ecology of the black bear in a lower Chihuahuan Desert habitat has not been studied. The research is being conducted on the Black GAPWMA located in southwestern Brewster County on lower elevational desert habitat. The objectives are to determine density, home range, diet, habitat suitability of a desert environment, mortality, cub survival, and movement. Currently 9 bears have been captured and are being monitored with radio telemetry.

UTAH - Utah is currently studying the ecology of Black Bears on East Tavaputs Plateau.

WASHINGTON - On going research project started in 1994, includes 3 study areas. This study emphasizes population characteristics and habitat use. The use of DNA fingerprinting (based on scats and hair samples) is being investigated.

WYOMING - Wyoming is currently estimating a local bear population size using hair collection techniques. Biologists are also monitoring reproductive parameters, including age of first reproduction, litter size, cub survival, juvenile female survival, and juvenile female dispersal.

DENNING ECOLOGY OF GRIZZLY BEARS IN THE PRUDHOE BAY REGION, ALASKA

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Since 1991 we have inspected 143 grizzly bear dens as part of a study of grizzly bear use of the oilfields near Prudhoe Bay. Although the study area reaches from the Beaufort Sea coast to more than 160 km inland, most of it is relatively flat arctic tundra with the highest elevation reaching only 395 m. Much of the landscape is affected by cryogenic processes; thus, thaw lakes, pingoes (conical-shaped mounds with ice cores), and frost hummocks form micro-relief available for denning in the flatter portions of the area. Sand dunes, hills, and stream banks provide other sites. Our results indicate that most dens have a southern aspect, predominately southwestward. This is the direction of the prevailing wind, and ensures that the den site will receive a deep snow cover for insulation. Bears enter dens from late September to late November, and may emerge any time between mid-April to mid-May. The bear's sex, age and reproductive condition, as well as its access to anthropogenic foods in the oil fields, affects the timing of den entrance and emergence. The Prudhoe Bay oilfields are a large-scale industrial development consisting of oil extraction and processing facilities, an extensive road and pipeline network, numerous large and permanent camps, 3 jetports, and an employee population of over 2000 people, depending on the current level of activity. Much of the area surrounding the existing development has been explored by geophysical seismic exploration and by test well drilling, primarily in winter. The effect of oil development and related activity on bear denning will be discussed.

Key words: grizzly bear, denning, disturbance, Prudhoe Bay, *Ursus arctos.*

GRIZZLY BEAR RECOVERY IN THE NORTH CASCADES ECOSYSTEM

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Abstract: The North Cascades Ecosystem harbors a small number of grizzly bears *(Ursus arctos)*. During 1987-1992 an evaluation was conducted to determine the feasibility of pursuing grizzly bear recovery in the North Cascades. In 1992 the Interagency Grizzly Bear Committee recommended to the U.S. Fish and Wildlife Service to pursue recovery and The Grizzly Bear Recovery Chapter for the North Cascades Ecosystem was completed in 1997. Actions that have taken place since the completion of a recovery chapter include completion of a public attitude survey, development of a sanitation policy, and an assessment of core areas throughout the ecosystem. The public attitude survey revealed a high level (64-74% of Washington Residents) of support for grizzly bear recovery. The core area assessment showed that the availability of core areas averaged 65% over 46 bear management units (BMU) (range = 21% to 95%) during the early season. During the mid- and late- seasons the amount of core area averaged 54%/BMU and ranged from 15% to 90%. Additional analyses will be conducted to evaluate the distribution of seasonal foods within core areas for each BMU. The recovery actions to date should provide valuable information should resources become available to complete the necessary environmental analyses needed to address the key recovery action identified in the recovery chapter, augmentation of grizzly bears in the ecosystem.

WESTERN BLACK BEAR WORKSHOP 7:57-62

Key words: grizzly bear, population recovery, North Cascades Ecosystem, *Ursus arctos***.**

The conservation of rare large carnivores in the western United States has received considerable attention in recent years (Noss et al. 1996, Weaver et al. 1996, U.S. Fish and Wildlife Service 2000). Much discussion has centered around the recovery of the grizzly bear and gray wolf *(Canis lupus)*, and the conservation of lynx *(Lynx canadensis)* in the Rocky Mountains, where considerable lands are devoted to national parks, wilderness and national forests. However, large carnivores, such as grizzly bear, have also been documented in the North Cascade Mountains of Washington State and southern British Columbia (BC), Canada, where vast areas are included in wilderness, national parks and other public ownerships.

Large carnivores have been described as "umbrella" species because their space requirements are large and encompass the spatial habitat requirements of many other species (Noss et al. 1996, Gaines et al. 1999). Thus they may be considered an important species in an ecosystem and their status may be indicative of system integrity (Noss et al. 1996). Because of this, large carnivores are often identified as "focal" species for conservation (Noss et al. 1999). Historically, populations of large carnivores were reduced by extensive predator control efforts, unregulated hunting, and trapping. Limiting factors for the recovery of large carnivore populations include: adequate space; small, isolated populations; loss of habitat and disturbance associated with human developments; fragmentation of habitat by highways and other corridors of human activities; and mortality associated with legal and illegal killing (Mech et al. 1988, Knick and Kasworm 1989, Mace et al. 1996, Weaver et al. 1996).

Our objectives in writing this paper include: raising awareness of grizzly bear recovery in the North Cascades Ecosystem (NCE); providing a review of the current status of grizzly bear in the NCE; summarizing the recovery efforts that have been made to date in the NCE; and identifying important areas of research that could aid grizzly bear conservation efforts.

THE NORTH CASCADES ECOSYSTEM

The NCE includes one of the largest contiguous blocks of Federal land remaining in the lower 48 United States. In the USA, the ecosystem encompasses about 24,800 km^2 in north-central Washington State and extends for an additional 10,350 km^2 into south-central British Columbia, Canada (Fig. 1). The USA portion of the NCE consists of about 85% federal lands, 5% state lands, and 10% private lands. About 41% of the USA portion of the NCE is within U.S. Forest Service (USFS) designated wilderness or the North Cascades National Park. Gaines et al. (1994) reported that about 68% of the USA portion of the NCE is composed of areas with no open road access. Of the 32% of the area that is roaded, 10% has a road density of 0.1-1.0 km/km^2; 18% has a road density of 1-3 km/km^2; and 4% has a road density >3 km/km^2. In Canada, protected areas (i.e., provincial parks, ecological reserves, and recreation areas) comprise about 16% of the NCE and about 40% of this is unroaded (Gyug 1998).

Elevations in the NCE range from about 150 m on the west side to 3300 m at the summit of Mount Baker. The Cascade Crest ranges in elevations from 2100 to 3300 m, and elevations extend to ca. 750 m on the eastern edge of the ecosystem. On the west side of the NCE, annual precipitation ranges from

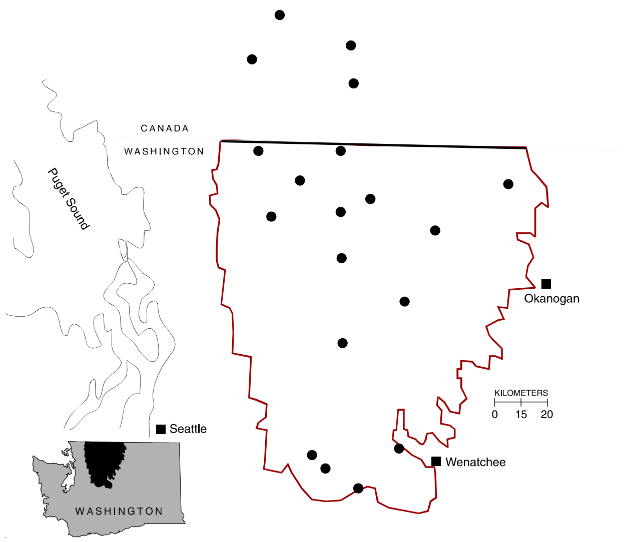

Figure 1. A map of the North Cascades Ecosystem showing the general location and distribution of Class 1 grizzly bear reports.

170-300 cm falling mostly as rain. In contrast, annual precipitation east of the Cascades Crest ranges from 25-50 cm falling mostly as snow. A range of elevations and moisture regimes create diverse vegetation patterns across the landscape. About 62% of the NCE consists of coniferous forests, 22% is composed of non-forested vegetation types such as alpine meadows or dry meadows on the eastern edge, and about 16% is composed of rock and ice. The most common coniferous forest types include areas dominated by subalpine fir *(Abies lasciocarpa),* Engelmann spruce *(Picea engelmannii)*, and lodgepole pine *(Pinus contorta)* on the east side of the NCE, and Pacific fir *(A. amabilis)* and mountain hemlock *(Tsuga mertensiana)* on the west side (Gaines et al. 1994).

The NCE lies to the east of the heavily inhabited Puget Sound Trough, thus extensive human development occurs along the west slopes of the ecosystem. Large population centers located on the west side of the NCE greatly influence human use patterns. Much of the western NCE is heavily used by recreationists and was historically used for resource extraction industries such as logging and mining.

CONSERVATION STATUS OF THE GRIZZLY BEAR

The grizzly bear was listed as a threatened species in the US in 1975. The original recovery plan, completed in 1982, did not identify the NCE as a recovery area because of the lack of information available regarding the status of grizzly bears and their habitat in the region (USFWS 1982). Instead, the NCE was identified as an evaluation area and in 1986 a study was initiated to gather information on the grizzly bear population, important habitat, and human influences on bear habitat. This investigation, completed in 1991, provided evidence that a small number of grizzly bears resided in the USA portion of the NCE, and that sufficient habitat was available for the recovery of a viable population (Almack et al. 1993, Gaines et al. 1994). These results and conclusions were then reviewed and supported by a panel of experts (Servheen et al. 1991). As a result of these findings, the NCE was designated a recovery area and a chapter specific to the NCE was developed for the overall grizzly bear recovery plan (USFWS 1997).

Historical records compiled by Bjorkland (1980), Sullivan (1983), and Almack et al. (1993) indicate that the grizzly bear once occurred throughout the NCE. Its decline was likely a result of intensive killing for the fur trade followed by rapid human encroachment into their habitat (Sullivan 1983, Almack et al. 1993). Sullivan (1983) compiled 233 reports of grizzly bear in the North Cascades and adjacent British Columbia from the mid 1800s through 1983. Almack et al. (1993) documented an additional 33 reports of grizzly bear from 1859-1982, and 153 reports from 1983 to 1991. Twenty of these reports were classified as Class 1 (confirmed) observations (Fig. 1). A Class 1 observation indicated a grizzly bear report that was confirmed by a biologist and/or by a photograph, carcass, track, hair, dig or food cache. Class 2 observations are those considered likely to be grizzly bears, but lack definitive confirmation. Class 1 observations in the NCE included 9 locations of grizzly bear tracks, 1 food cache, 6 visual observations, and a grizzly bear that was killed in 1967. Figure 2 shows the number of Class 1 and 2 observations that have been reported each year from 1990-1999. The decline in the number of reports beginning in 1992 is likely a result of a much-reduced effort in following up and verifying reports. The grizzly bear sighting data led Almack et al. (1993) to conclude that a small number of grizzly bears still resided in the USA portion of the NCE. In the BC portion of the NCE, sighting information and transplants of grizzly bears from other areas led biologists to estimate the number of grizzly bears to be 17 to 23 animals (Gyug 1998). These data suggest that the total number of grizzly bears within the NCE is likely <50 animals (Gaines et al. 2000). Shaffer (1978) and Shaffer and Sampson (1985) discussed the viability of small populations of grizzly bear. Populations of less than 50 individuals are generally in a decline and are of particular concern when isolated, which is likely the situation in the NCE. The nearest population of grizzly

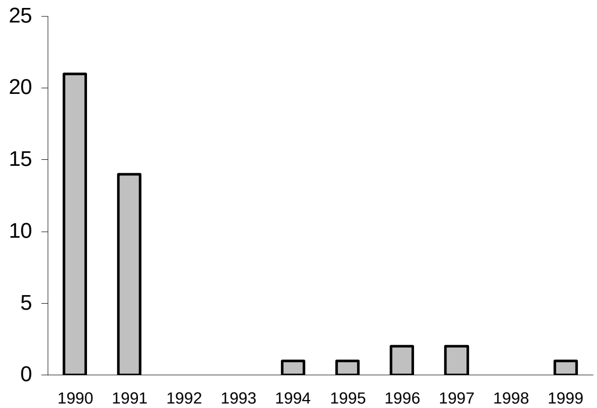

Figure 2. The number of Class 1 and 2 grizzly bear observations for the USA portion of the North Cascades Ecosystem from 1990-1999.

bear to the NCE is a low-density population located 20-30 km to the northwest in BC and is separated by a highway and associated human development along the Fraser River valley. This population is at a low density, has available habitat, and is therefore unlikely to emigrate into the NCE. In addition, the developed Fraser River Valley in BC may be a barrier to grizzly bears trying to disperse to the NCE. The second potential linkage occurs between the NCE and the Selkirk Recovery Area. The distance between these areas is about 170 km and the low density of grizzly bear in the Selkirks (USFWS 1993) makes successful dispersal unlikely. Because of the low potential of grizzly bears to disperse into the NCE from other populations, the few remaining grizzly bears in the NCE are likely isolated. Further information is needed, especially on the potential linkage across the Fraser River Valley to verify this. There are 4 "fractures" that could restrict the movement of grizzly bear within the NCE. These include highways 1 and 3 in BC and highways 2 and 20 in the USA (Fig. 3).

SUMMARY OF CONSERVATION EFFORTS IN THE NCE

The NCE chapter in the grizzly bear recovery plan outlines steps necessary to eventually recover the regional population (USFWS 1997). Some steps in the plan have been completed or are currently underway. These include development of a grizzly bear sighting report process and database, completion of a public attitude survey, adoption of a sanitation plan to minimize negative human-bear interactions in wilderness areas and national forest campgrounds, and an analysis of "core areas" (Puchlerz and Servheen 1994). Core areas are areas of relatively low human use and are 500 m or more from a high use trail, open road or concentrated human use area

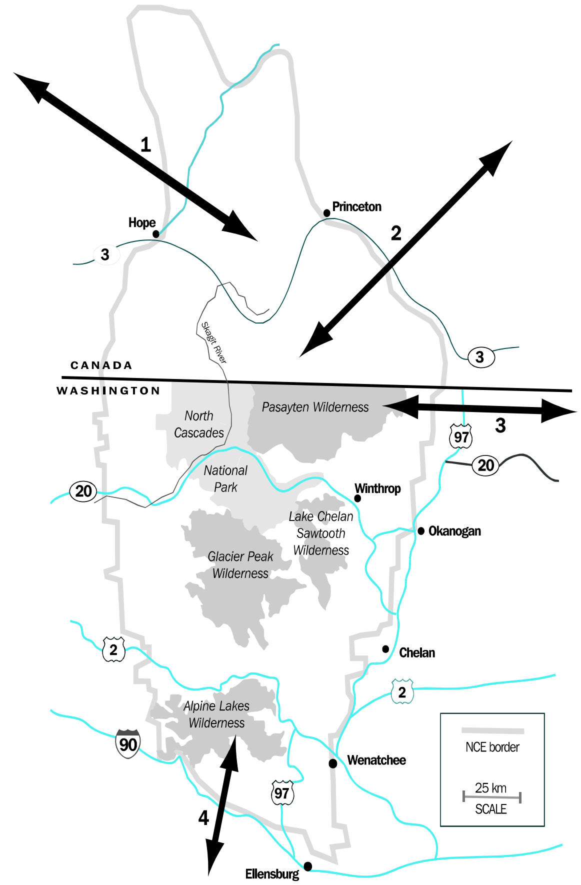

Figure 3. A regional map showing potential linkages and fracture zones (highways) within the North Cascades Ecosystem. (Linkage 1 is the potential for connectivity to grizzly bear populations north and west of the Fraser River. Linkage 2 is the potential for connectivity to grizzly bear populations to the north and east across the Okanogan Valley. Linkage 3 is the potential for connectivity to grizzly bear populations to the east in the Selkirk Mountains. Linkage 4 is the potential for connectivity to the south.)

(e.g., campground, town, etc.). Core areas provide bear habitat that has an inherent quality of isolation from human disturbance, providing solitude and safety for bears.

Public Opinion Survey

In 1996 a public attitude survey of USA-NCE residents was completed and showed a surprisingly high level of support for grizzly bear recovery in the NCE. For example, 64% of the respondents in the eastern NCE and 74% and on the west side supported or strongly supported grizzly bear recovery (Fig. 4) (Duda et al. 1996). In addition, 1,353 letters were received during the comment period on the draft recovery chapter for the NCE (USFWS 1997). A total of 845 comments addressed the issue of population augmentation, considered to be 1 of the

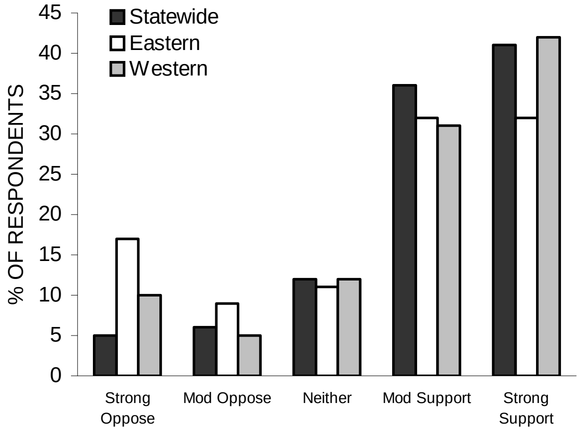

Figure 4. Results of the public opinion survey of Washington State residents about grizzly bear recovery in the North Cascades Ecosystem, 1996 (Based on Duda et al. 1996).

most controversial recovery actions. Of these comments, 526 (62%) were favorable to the idea of augmenting resident bears with grizzly bears from outside the NCE. These data suggest that grizzly bear recovery in the NCE may be acceptable to a majority of the residents.

Sanitation

The North Cascades Grizzly Bear Ecosystem Management Subcommittee (MSC) adopted recommendations to improve sanitation conditions within backcountry and front country camping sites in spring of 1997. These included: 1) resource management agency personnel will follow sanitation practices to reduce the availability of human foods to wildlife; 2) when existing dumpsters and garbage cans are replaced wildlife resistant structures will be used; 3) an information program about safe camping practices and available sanitation devices will be implemented for city and county planners, outfitters/ guides, and agency employees who have regular visitor contacts; and 4) a loan program will be initiated within the NCE to make wildlife resistant panniers and backpacker canisters available to the public and outfitters/guides.

Core Area Analysis and Management

Core areas are important to grizzly bear, and many other wildlife species, for survival and population recovery (Mattson et al. 1987, McLellan and Shackleton 1988, Kasworm and Manley 1989, Puchlerz and Servheen 1994, Mace et al. 1996). An analysis of the availability and location of core areas within the NCE was initiated in 1997, following the process outlined by Puchlerz and Servheen (1994). As an interim measure to protect core areas within the NCE, a "no net loss" strategy was applied to federally owned portions of the NCE. The strategy would remain in place until core area analyses are completed and new management recommendations are developed.

Results of core area analysis showed that the availability of core areas averaged 65% of a bear management unit (there are 46 bear management units in the NCE) and ranged from 21% to 95% during the early-season (den emergence to 31 May) (Fig. 5). During the mid and late-seasons (June 1 to den entrance) the average amount of core area/bear management unit was 54% and ranged from 15% to 90% (Fig. 5). The reduction in the amount of core area in the mid- and late-seasons is largely a result of trails becoming snow free and gaining high use status. A more detailed assessment of the habitat values within these core areas is in process and should be completed in late 2000.

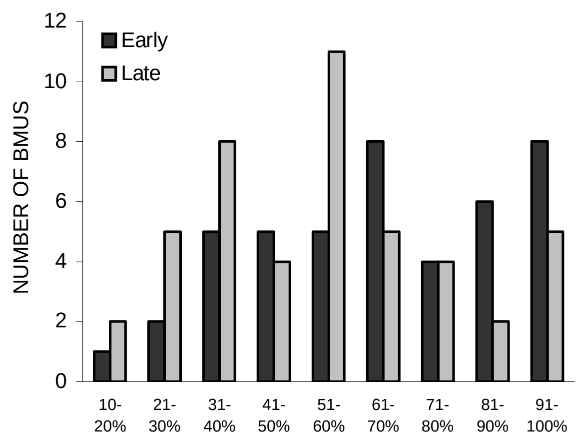

Figure 5. The availability of core areas within the 46 Bear Management Units located in the North Cascades Ecosystem, 1997.

Augmentation

One recovery action that was identified in the NCE recovery chapter was the option of augmenting the small number of resident grizzly bears with individuals from other areas (USFWS 1997). Given the small number of resident grizzly bears in the NCE and its apparent isolation from other grizzly bear populations, the only way to facilitate recovery and mitigate against extirpation is through an augmentation program. To implement an augmentation program it would first be necessary to conduct an environmental assessment that considers a range of options and assesses potential effects of grizzly bear recovery on a variety of social, economic, and ecological issues. Limited resources and competing management priorities for grizzly bears in other recovery areas have prevented the initiation of the environmental assessment process in the NCE.

RESEARCH NEEDS

A grizzly bear research program is needed in the NCE to address important limiting factors. Major needs include an assessment of habitat and area requirements, viability of a small population, impacts of human disturbance and habitat loss, and potential mortality sources. A research agenda that includes 4 basic components is described below.

Biology and Distribution

Basic research is needed to determine the current distribution of grizzly bear in the NCE. Initially, surveys could be conducted to identify areas where bears are present in sufficient numbers to initiate more in-depth research, e.g. radiotelemetry. Further studies could address reproductive ecology, finer-scale habitat use and movement patterns, and genetic analysis of resident bears.

Habitat Assessment

Basic research is needed to determine the habitat relationships for grizzly bear in the NCE. The effects of human encroachment, especially along the major valley bottom habitats, recreational activities, forest roads, timber harvest, and prescribed fire, are of particular concern to managers.

Regional Assessment of Habitat Connectivity

Population isolation is a primary concern for grizzly bear in the NCE (USFWS 1997). Methods have been developed to assess habitat connectivity and could be applied to assess potential linkage zones in the NCE (Sandstrom 1990, Apps 1997). Areas to focus these assessments include the Fraser River Valley and the area between the NCE and the Selkirk recovery area (Fig. 3). An assessment of the effects of fracture zones within the NCE on grizzly bear movements and habitat use could be conducted. Specific areas to address include State Highways 2 and 20, and Canadian Highways 1 and 3 (Fig 3).

Population Monitoring

Population monitoring techniques are important to determine if conservation and management strategies are achieving desired objectives (USFWS 1997, Gaines et al. 1999). A variety of techniques, although typically expensive, have been developed to monitor populations. Research focused on the development of techniques that could be used to monitor grizzly bear in the NCE using DNA technology may prove to be very useful and practical (Wasser et al. 1997, Mowat and Strobeck 2000).

SUMMARY

The NCE is 1 of the few large areas in the lower United States and adjacent Canada where contiguous federal lands and areas of relatively low human use (e.g., wilderness areas) are available in sufficient quantity to recover a viable population of grizzly bears (Servheen et al. 1991). Opportunities like this are extremely limited in much of North America (Noss et al. 1996, Noss et al. 1999, Gaines et al. 2000). We have provided a summary of the population status, conservation actions, and research needs for grizzly bear in the NCE in hopes of raising the awareness of scientists, managers, and the public. We hope this information highlights the tremendous opportunity to recover grizzly bear in this ecosystem while resident bears that evolved in this system still exist. However, without sufficient resources to develop and implement research and conservation strategies in a timely manner, this opportunity may be lost or become much more costly in the near future.

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GRIZZLY BEAR REINTRODUCTION IN IDAHO AND MONTANA

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Currently there are 2 reasonably secure grizzly bear populations south of Canada: The Northern Continental Divide (NCDE) population includes Glacier NP and the Bob Marshall Wilderness Area; and the Yellowstone population. Both populations are thought to number 400-600 bears and are spreading from their core areas to colonize new habitats in adjacent areas. The last grizzlies in Selway-Bitterroot Wilderness areas of Central Idaho and western Montana were shot more than 50 years ago. However, the habitat in this area includes more secure roadless habitat than either the Yellowstone or NCDE recovery areas. This habitat is centered on 2 wilderness areas totaling more than 14,938 km^2 and, including surrounding areas of National Forest lands, includes a experimental population area totaling 65,113 km^2. The amount of roadless secure habitat in this area totals 31,565 km^2, more than in the NCDE (16,997 km^2) or in the Yellowstone ecosystem (21,044 km^2). Although salmon which used to sustain a dense population of bears in this area are now largely gone from the headwaters of the Columbia River, 5 different studies have indicated adequate food resources in the area to support a healthy bear population. The Fish and Wildlife Service has published a final EIS on an innovative plan designed to reintroduce bears into this area and it is essential that the community of bear experts get behind and support this plan. This plan incorporates citizens management of a population designated as "experimental" as provided for in the Endangered Species Act.

Key words: grizzly bear, habitat, reintroduction, citizens management, Endangered Species Act.

EFFICACY OF SUPPLEMENTAL BLACK BEAR FEEDING ON SELECTED DAMAGE SITES IN WESTERN WASHINGTON

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Abstract: Back bear (*Ursus americanus*) damage and often kill coniferous trees during the spring months in their search for food. This study was conducted to assess the efficacy of supplemental feeding to reduce damage by bears to timber stands on the Olympic Peninsula in western Washington. Black bear damage was first assessed on 14, 20-ha stands. Mean damage level on these sites prior to the study was approximately 25% of the trees. A supplemental feeding program then was implemented on half of these stands, while no damage management was practiced on the other half. Bear damage to trees the first year after feeding began was less (P = 0.0003) on treated sites than on untreated sites. The authors conclude that supplemental feeding is a viable tool to alleviate damage. However, they caution that the program should not be regarded as a solution to all bear damage problems.

WESTERN BLACK BEAR WORKSHOP 7:64-67

Key words: black bear, damage, management, supplemental feeding, Pacific Northwest*, Ursus americanus.*

Black bears strip bark from coniferous trees in western Washington to feed on newly forming vascular tissue during spring (Zielgtrum and Nolte 1996). Damage inflicted through this behavior can be extremely detrimental to the health and economic value of timber stands (Kanaskie et al. 1990). Complete girdling is lethal to trees, while partial girdling reduces growth rates and provides avenues for subsequent insect and disease infestations. The severity of loss is compounded because bears tend to select the most vigorous trees within the most productive stands, often after stand improvements, such as thinning and fertilization, have been implemented (Mason and Adams 1989, Nelson 1989).

Bears remove the bark with their claws and scrape sapwood from the heartwood with their incisors (Poelker and Hartwell 1973). Bears most frequently strip bark from the lower bole of trees between 15 and 30 years of age. Any age tree, however, is vulnerable and occasionally a bear strips an entire tree. Damage inflicted by bears is readily identifiable, stripped bark is on the ground around the base of the tree and vertical tooth marks are evident on the bole. A single foraging bear may peel bark from as many as 50 to 70 trees per day (Schmidt and Gourley 1992).

Bears forage on sapwood almost exclusively in the spring, presumably because alternative forages are limited and spring sapwood provides a source of carbohydrates (Radwan 1969, Kimball et al. 1998). Bear preference for a tree species or for an individual tree within a species probably changes with the phenological stage of the tree. Hemlocks (*Tsuga heterophylla*) are generally targeted earlier in spring than Douglas-fir (*Pseudotsuga menziesii*), which reflects the earlier bud burst of hemlock. Damage then declines as berries and other alternative foods become available in early July.

The Washington Forest Protection Association (WFPA) began feeding pellets to bears in 1985 to determine whether this was a feasible non-lethal approach to reduce black bear damage (Flowers 1986). Over the next few years the feeding effort was refined and a program to produce pellets and coordinate feeding efforts was developed. The supplemental feeding program has increased each year. During 1999, WFPA distributed approximately 250 metric tons of pellets through 900 feeding stations in western Washington.

Bear feeding stations are constructed from 55 gallon metal or plastic drums. An opening in the front enables bears to eat from the containers and a self-feeding mechanism restricts bears from playing with the pellets and spilling excessive amounts of food. A plywood roof, insulated with foam, keeps the pellets dry. A single feeder holds approximately 90 kg of pellets. Feeders are normally placed near a road to provide easy access for restocking pellets, but away from public areas to avoid possible conflicts with humans. All feeders are removed from the forest at the end of the feeding season in mid-July.

Pellets are commercially produced as directed by WFPA. Pellets are about 0.6 cm in diameter and 1.3-cm long, with a greenish color, resembling dry, commercial dog food. WFPA regards the granulated sugars as the most important ingredient. The carbohydrate concentration of pellets is approximately 4 times greater than the carbohydrate concentration in Douglas-fir (Kimball et al. 1998), providing an incentive for bears to consistently feed on the pellets (Partridge et al. 2000). Fats, proteins, vitamins, and minerals are included in the pellet formula to provide the bears a nutritionally balanced diet.

STUDY AREA AND METHODS

The study was conducted on timber stands located on the Olympic Peninsula of Washington state. Eight sites were located on the north side of the peninsula along State Route 112, west of the town of Joyce, and 6 were on the west side of the peninsula along U.S. Route 101 near the town of Kalaloch. Most sites were located on land managed by Washington State Department of Natural Resources. Other sites were managed by Northwest Forest Resources, Rayonier, Washington. Management efforts to reduce bear damage to timber resources had not been practiced on any of these sites prior to the study. The primary criteria for selecting timber stands were trees within the age class considered vulnerable to bear damage and recent bear damage identified during a preliminary survey. Stand age on selected sites varied between 15 and 25 years, which is within the age range considered most vulnerable to bear damage. Stands were between 16 and 20 ha, and all stands contained a similar timber stocking rate, approximately 1000 stems per ha, of Douglas-fir and hemlock. Current bear damage served as an indicator of bear presence, but bear densities on these sites were unknown.

Treatments

Initially stands were paired to minimize differences in elevation and growth potential. Treatments were randomly assigned within these pairs. Supplemental feed was provided on 1 stand within each pair and no bear management was practiced on the other stand. Subsequently, intensive bear damage surveys indicated damage levels were not always similar within pairs and the pair connotation was dropped after assigning treatments. Therefore, the experimental design was simple randomization with treatments stratified by location.

The supplemental feeding program was implemented as recommended by WFPA and practiced by several private timber companies in western Washington. Two feeding stations were placed on each of 7 timber stands early in spring before bears began to forage on trees. Beaver carcasses were initially hung near feeding stations to make it easier for bears to locate the pellets. Feeders were visited and stocked with pellets weekly throughout the damage period. No other bear damage management efforts were conducted on the feeding sites. No efforts to reduce bear damage were implemented on control sites.

Bear Damage Surveys

Pre-treatment damage surveys were conducted during the last 2 weeks of March 1999. One edge of each stand was divided into quarters and a belt-transect, 10 m wide, was extended into the stand perpendicular from the edge, starting at a random location within each quarter. Transect placement was stratified to ensure transects ranged across different areas of the stands. Observers trained to recognize bear damage and working in 2-person teams, marked the first 250 trees encountered within each belt-transect. Transects were generally about 300 m long. Thus, 1000 trees were counted and marked on each site. Bear damaged and undamaged trees were counted and marked accordingly with spray paint; red for damaged trees and blue for undamaged trees.

Post-treatment surveys were conducted the following March. These surveys assessed whether trees marked in the pre-treatment survey exhibited signs of additional bear damage. Bears may return and forage on trees minimally damaged in prior years. Thus, it was possible for trees marked as damaged during the pre-treatment survey to be counted again with new damage.

Statistical Analyses

Some trees marked during pre-treatment surveys were not located during the post-treatment surveys, causing the number of trees included in the post-treatment survey to vary among stands. Therefore, a ratio of damaged trees to the total number of trees counted on each site was calculated for the pre- and post-treatment surveys. Thus, high ratios indicate a proportionately high number of damaged trees, while low ratios indicate the opposite. A separate single factor analysis of variance then was used to compare these pre- and post-treatment ratios. An arcsine transformation was conducted on all ratios prior to statistical analysis.

RESULTS

There were a similar ($P > 0.35$) number of trees damaged on feed and non-feed sites prior to treatment (Figure 1). Fewer ($P = 0.0003$) trees, however, were damaged on sites treated with supplemental feeders than were damaged on control sites the first season after feeders were installed (Figure 2).

DISCUSSION

Intensity of bear damage to timber stands prior to the study varied among sites. The number of trees that suffered damage because of bear foraging activities ranged from 2% to 52%, with an average damage value of 26%. Although bear damage varied among sites there was no difference between extent of damage on sites randomly selected for treatment and the untreated control sites. These results indicate that bear activity was similar across treatments prior to the start of the experiment.

The pre-treatment survey also indicates the potential severity of bear impacts to timber

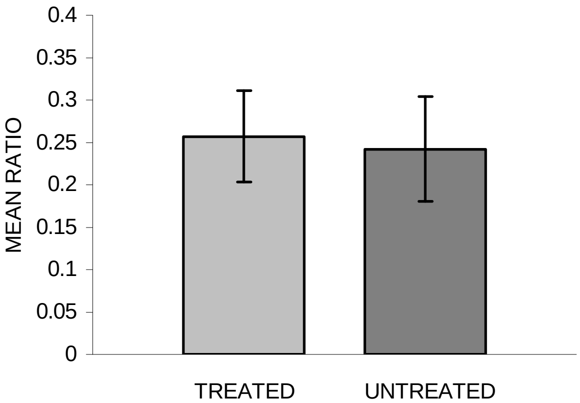

Figure 1. Mean ratio of trees damaged by bears to total number of trees counted during a pre-treatment survey on treatment and control stands on the Olympic Peninsula.

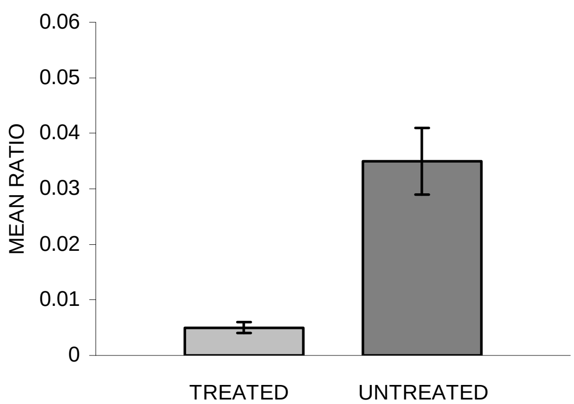

Figure 2. Mean ratio of trees damaged by bears to total number of trees counted during a post-treatment survey on treatment stands when supplemental feed was available and on untreated stands over the same period.

production when no bear management practices are implemented. A quarter of the trees surveyed had suffered at least some damage inflicted by bears. This damage is compounded because these stands had already been thinned to pre-commercial stocking rates. Damage also usually occurs in pockets often resulting in the complete loss of trees on several hectares. Granted, our study criteria required sites containing bear damage, thus this estimate of damage is probably greater than would have been indicated if sites had been surveyed at random. However, at present there are 400,000 ha of industrial forest in western Washington within the age class regarded as vulnerable to bear damage and this figure is anticipated to increase to over 600,000 ha within the next 15 years (Munson 1999). Extensive vulnerable resources combined with an estimated bear population of 25 to 50 thousand bears (Tirhi 1996) renders a high potential for substantial losses of timber in the future unless effective management practices can be implemented.

Substantially fewer trees were damaged in timber stands with feeding stations than in control stands. Damage inflicted in untreated stands was more than 5 times as great as damage on stands with feeding stations. Survey results extrapolated to a 20 ha stand suggests that 769 of the 20,000 stems (1000/ha) on untreated stands would suffer bear damage annually. These figures extended across a 15-year vulnerable period suggest anticipated damage to 11,535 trees. This estimate is only slightly higher (57% trees) than the damage intensity (52%) found on some stands during our pre-treatment surveys. Damage estimates for the stands with feeding stations across the same 15-year period, using the same calculations, would be considerably less, 2,100 trees or approximately 10%. Although less than untreated stands, 2,100 trees is still a considerable financial loss. Some bears, known as “double dippers”, ingest pellets and peel trees. Another study indicated that 20% of bears eating pellets from feeding stations also ingested some cambium (Partridge, 2000). However, damage inflicted the year feeding stations were installed may be a poor indicator of future damage on sites where the supplemental feeding programs is implemented.

Bears require time to locate feeders and establish a pattern of feeding at stations. Bears on sites where the feeding program has been practiced for several years exhibit an awareness of feeder locations. They frequent sites where the feeders are installed and begin to feed soon after feeders are installed each year (Ralph Flowers, WFPA retired, personal communication). Bears need to “discover” feeding stations on new sites and become accustomed to feeding from the feeders. Another study indicated minimum competition among bears at feeding stations placed at the same site for several years (Nolte et al. 2001). However, we speculate this lack of competition may occur because bears have learned that feeding stations provide an unlimited resource, unlike a carcass that provides a definitive limited resource. If true, this response would require time for bears to learn, and competition among bears would be greatest the first year feeders were installed. Competition among bears for access to the feeders would most likely restrict some bears to infrequent or no opportunities to feed at feeders. In turn, these bears would likely peel trees to meet dietary demands. Over time as bears become more accustomed to the feeding program, competition may decline along with peripheral damage.

Another important consideration was the lack of other management activities during our study. Past failures of the supplemental feeding program invariably occurred on sites with high bear densities (Ziegltrum 1994). Historically, sport-hunting activity was encouraged in areas with high bear populations. Recently, bear densities have been reduced with removal efforts targeted in specific areas where damage levels have become unacceptable. Our study incorporated no efforts to restrict damage other than through supplemental feeding. Whether the damage occurring on feeding sites warrants efforts to reduce bear densities would depend on management objectives. However, it is likely that reduced bear numbers would equate to fewer damaged trees. A similar statement could be made for untreated stands, although the number of bears needed to be removed to achieve similar damage levels probably would be far greater than required on treated stands.

MANAGEMENT IMPLICATIONS

This study demonstrated that providing bears an alternative foraging option during spring could reduce damage to timber resources. Therefore, this study supports the contention that the WFPA supplemental feeding program is a viable tool to alleviate damage. However, the program should not be regarded as a solution to all bear damage problems. A mixture of tools will best enable managers to meet their objectives of producing timber while maintaining viable wildlife populations on their land.

ACKNOWLEDGMENTS

The study was conducted in part through funding and guidance provided by the Collaborative Research Team, a group of private, state and federal resource mangers interested in identifying reasonable solutions to difficult problems. The authors want to thank persons hired through the Washington Conservation Corps for their dedicated efforts in assisting with the damage surveys.

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NUTRITIONAL ECOLOGY OF BLACK BEAR DAMAGE IN WASHINGTON FORESTS

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Spring black bear (*Ursus americanus*) damage to managed conifer stands in western Washington is a continuing management concern. Because bear damage may reflect the limited availability of quality dietary items in the spring months, supplemental feeding has been used to decrease damage. Pelleted feed is provided *ad libitum* from April until late June when berries ripen and damage stops. We examined black bear use of supplemental feed during the spring and summer of 1998 and 1999 in western Washington. Bears were captured in areas where supplemental feed was provided and also in areas where no effort to reduce damage occurred. Captures occurred during 2 periods: late spring (April and May) and early summer (June and July). Body composition, weight, and food habits were determined for all bears captured. Bears were radiocollared in the spring capture period to simplify recapture later in the season. Weight gains were 153 ± 123 g/day (x ± SD) for bears in the fed areas and 12 ± 104 g/day for bears in non-fed areas. Fat gain for bears in the fed areas was 44 ± 52 g/day and in the non-fed areas was 4 ± 59 g/day. Stable isotope analysis of plasma and red blood cells was used to determine the percent of nourishment coming from pellets, animal matter, and plants. The diet of bears in the non-fed areas was 10 ± 17% animal matter and 90 ± 17% vegetation. The diet of bears in the fed areas was 61 ± 17% pelleted feed, 1 ± 2% animal matter, and 38 ± 16% vegetation. The dietary percentage of pellets was higher in males (71 ± 15%) than in females (53 ± 11%). Grass and sedge comprised the majority of vegetation consumed in both areas. Horsetail (*Equisetum arvense*), skunk cabbage (*Lysichiton americanum*), cow parsnip (*Heracleum lanatum*), and false dandelion (*Hypochaeris radicata*) were common dietary forbs. The dry matter digestibility of these forbs ranged from 21 to 52%. Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) cambium had lower fiber (22-28%) and higher dry matter digestibility (62-71%) than herbage. Thus, tree damage by cambium-feeding bears has a significant nutritional basis.

Key words: black bear, damage, nutritional ecology.

EFFECTS OF SEX AND AGE ON BLACK BEAR CONIFER DAMAGE AND CONTROL

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Black bear (*Ursus americanus*) feeding damage to conifer stands can result in substantial economic losses. However, little is known about the reasons for black bear damage and the effectiveness of current control methods. We examined frequency, intensity, and total conifer damage by radio-monitoring 13 male and 9 female black bears from 1998 to 1999 to determine which sex and age classes caused the most damage. We also examined which sex and age classes were being affected by control measures (hunting, supplemental feeding) to determine the efficacy of management actions. Adult females were associated with higher frequency ($P = 0.080$), intensity ($P = 0.092$), and total conifer damage ($P = 0.015$) than other sex/age classes. Adult males were associated with lower frequency, intensity, and total conifer damage than other sex/age classes. Adult males comprised the majority of bears removed by hunting (82%) and only subadults appeared to select for supplemental feeders ($P < 0.10$). Current damage control measures do not appear to be effective as they could be. We recommend that hunting be discontinued and/or assessed as a mechanism for damage control.

Key words: black bear, conifer damage, forestry, hunting, supplemental feeding, *Ursus americanus.*

THE ECONOMIC BENEFITS OF BEAR PROOF CONTAINMENT

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Approximately 50 people were injured or killed every year in Yellowstone National Park during the 1930's to the early 1970's. Since then, the incidence of bear attacks has decreased significantly, and according to Dr. Steven Herrero of the University of Calagary, "…One of the reasons for that improvement has been better technology in terms of how we store our food and garbage to keep it away from bears". There's no doubt that better storage and collection technology has had a positive social impact, but what about the economic implications? What is the net economic benefit from implementing animal proof storage and collection systems? When faced with the decision to implement a bear proof system, what economic factors should be considered? Canmore, Alberta, a town of approximately 10,000 in the heart of Kananaskis Country (aka Bear Country), recently implemented a municipal-wide bear proof storage and collection system for all residential and municipal waste. Using Canmore as a case study, this paper illustrates the net economic benefit accrued from implementing a bear proof system. Variables included: animal disposal, containment, tagging, relocation, and monitoring; property damage; human injury; and the net cost difference between conventional and bear proof material storage collection systems.

Key words: bear proof, property damage, relocation, containment.

BLACK BEARS AT THE URBAN-WILDLAND INTERFACE: DO CLUMPED RESOURCES INCREASE REPRODUCTIVE RATES?

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Black bears in Nevada occurred historically in the Sierra-Carson Range and sporadically through some interior Great Basin ranges. Like many areas of the western USA, patterns have changed. In 1950, the Reno-Carson City area had a population of approximately 50,000 people, a population that has now increased more than 6-fold. With urban sprawl advances along the eastern Sierra-Nevada, contact rates between humans and black bears are inevitably increasing. Current population estimates suggest that Nevada's black bear population is approximately 250-350 individuals. To assess possible effects of increased contact with humans, we are testing the hypothesis that bear life history patterns contribute to enhanced positive demographic growth in contact zones with humans. Our study design involves comparisons between individuals at the urban-wildland interface and those individuals in wildland areas. We are interested in examining differences in mortality rates, parasite loads, densities, reproductive rates, and movement patterns between the 2 populations. The primary objective is to understand the extent to which resource distribution affects the 2 study groups. We will present preliminary data from 1999, the first year of the study. To date, we have captured 36 black bears in the following categories: 19 adult males; 7 juvenile (defined here as < 2 years of age) males, 8 adult females, and 2 juvenile females. Of the 36 black bears, 32 are considered to be "nuisance" bears at the urban-wildland interface and 4 are considered to be strictly wildland bears. Nevada's bear population appears to exhibit sexual segregation, as 26 of the 32 "nuisance" bears are males, while all 4 wildland bears are females. As the Sierra-Nevada range and the Tahoe Basin continues to become more highly fragmented it may be that no black bear exists without some minimal contact with humans. Since July 1997, 24 bears have been killed. Of those, 13 were killed by vehicles (7 males and 6 females), 4 were killed for public safety concerns (3 males and 1 female), 4 were killed because of depredation activities (all males), 2 males were shot by landowners, and 1 female died accidentally in a Wildlife Services' snare. We will discuss the prospects of a sustainable population of black bears in Nevada and preliminary data on home range sizes, mortality rates, and movement patterns. Finally, we will discuss preliminary results of the effectiveness of deterrent techniques used upon release of "nuisance" black bears.

Key words: black bears, Nevada, urban-wildland interface.

BLACK BEAR MANAGEMENT IN YOSEMITE NATIONAL PARK: A NEW PROGRAM BEARS SUCCESS

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Conflicts between humans and black bears in Yosemite reached crisis proportions in 1998, with more than 1,500 incidents that year, resulting in $650,000 in property damage. Four bears had to be killed after they became dangerously aggressive. Intense media attention focused on the problem, and overwhelming reaction called for solutions to save the lives of bears. Special funding in 1999 has enabled a concerted effort to eliminate human foods from the diet of park bears by involving all park divisions, the park concessionaire, and cooperating organizations. Nightly patrols contacted visitors to communicate bear concerns and detect food sources. New informational materials, displays, and programs have increased awareness about bears. Increased garbage collection and cleaning of visitor-use areas reduced bear attractants. As a result, human-bear incidents and property damage were reduced by over 60% from 1998 levels.

Key words: black bear, damage, conflict, mitigation.

DEALING WITH NUISANCE AND DEPREDATING BLACK BEARS

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Abstract: Black bears (*Ursus americanus*) are a valued resource in North America, but pose many challenges to resource managers. They may be managed in 1 or more ways, including sustained yield harvests, nuisance animal control, or conservation management. Many black bear populations are stable or increasing, and combined with expanding human populations, increased development, and recreational activities, are leading to an increase in human-bear conflicts. Historically, methods such as relocation, general hunting seasons, or special hunts have been used in an effort to reduce bear density and damage, or to target individual offending animals. Many resource managers now operate under an increased set of constraints and limitations on methods with which to address these problems. There is considerable room for improvement in our ability to manage bear populations and reduce damage levels. New approaches, however, must meet criteria of socio-political acceptability, legal and regulatory authority, effectiveness, costs, and duration of protection. Most successful programs to reduce human-bear conflicts usually employ a diversity of carefully calculated approaches, hence, using truly integrated pest management (IPM) strategies. Bear population management, habitat management, and people management should all be part of the strategy.

WESTERN BLACK BEAR WORKSHOP 7:73-81

Key words: damage, black bear, nuisance, bear-human conflicts, resolution.

Black bears range over much of the forested areas of eastern and western North America. Historically, they were considered pests or threats to human life and property and, hence, were extirpated or reduced to very low numbers in many eastern and midwestern states. The basic biology, ecology, and management of bears has been reviewed by Kolenosky and Strathearn (1987), Pelton (1982, 2000), and Witmer et al. (1998). Currently, black bears are considered common in many of the western states and provinces. Populations appear to be stable or increasing (Whittaker and Burns 2001). Black bears in North America are generally considered to be "charismatic megafauna" and, as such, tend to maintain a high public profile. While views are mixed, it seems that most people have altruistic or humanistic views towards bears, have an appreciation for bears, consider them quite intelligent, and often take an active role in how bears are treated and managed (Kellert 1994). Significant values attributed to black bears include ecological roles, recreational value (both consumptive and non-consumptive), income added to local economies, and the value of "bear products" (both legal and illegal). Black bears, along with other forest carnivores, are often used as an important indicator of forest ecosystem "health" and biodiversity (Witmer et al. 1998).

How black bear populations are managed varies considerably, although state and provincial wildlife agencies have generally relied upon sustained harvest programs to manage populations (Miller 1989, Pelton 2000). Caughley and Sinclair (1994) identified 4 basic approaches to wildlife population management: 1) make it increase (conservation management); 2) make it decrease (damage/conflict control); 3) harvest at a sustained yield (game management); or 4) leave it alone, but monitor.

Growing bear populations, expansion of human habitations and activities into bear habitats, and restrictions on methods used to manage bear populations have all contributed to increased difficulties for resource managers, certain commodity producers, and for landowners dealing with human-bear conflicts. In this paper, we review the nature of black bear-human conflicts, trends in complaints, traditional black bear population management, and other approaches to conflict management.

BLACK BEAR DAMAGE AND COMPLAINT TRENDS

There are many ways in which bears can come into conflict with humans. The main types include compromising human safety and damage to structures, apiaries, crops, livestock, orchards, regenerating forests, and game animal populations (Hygnstrom 1994, Pelton 2000). Type and extent of damage varies by region, time of year, setting, and between years. A decline in availability of natural forages (e.g., hard and soft mast) has often been attributed to increases in damage or conflict (e.g., Stowell and Willging 1992, Jonker and Parkhurst 1997).

Because damage is often localized, the overall amount of damage may seem minor. However, it can still be significant to individual property owners or crop/livestock producers (Vaughan and Scanlon 1989). Furthermore, some types of damage are tolerated more than others. For example, there is little tolerance when human safety is involved or when apiaries are damaged, but some damage to crops or trees is often tolerated.

There appears to be an increased trend in complaints about bear activities and damage. In Oregon, for example, black bear complaints averaged about 155 per year from 1985-89, but increased to about 499 per year from 1993-1997 (Oregon

Department of Fish and Wildlife, unpublished data). In Washington, black bear complaints numbered only 208 in 1995, but averaged 627 per year from 1996-99 (Washington Department of Fish and Wildlife, unpublished data). California, Colorado, and Idaho also reported large (>300) numbers of black bear complaints in 1998 (Whittaker and Burns 2001). There are many possible explanations that might relate to the increasing trend in number of black bear damage complaints (Table 1). Additionally, several factors may be involved in a region and factors may vary by year.

Table 1. Possible factors related to the increasing numbers of black bear complaints; the list is not meant to be all-inclusive and several factors may be involved in a given region or during a given year. Some components required of a black bear depredation management strategy.

A. Possible Factors Related to Increasing Black Bear Complaints:

1. Increasing human population
2. Increasing black bear population
3. Increasing human activity in black bear habitat or new generations of humans less savvy to black bears
4. Changes in land use practices and intensity
5. Changes in habitats and food sources
6. Long- and short-term weather patterns
7. Changes in bear harvest seasons and methods
8. Increased public awareness, media coverage

B. Some Components Required of a Black Bear Depredation Management Strategy:

1. Develop and implement a bear management plan including depredation policies
2. Keep bear population density low in conflict areas and bears sensitive to humans through hunting seasons
3. Monitor bear populations, individuals, and situations
4. Implement preventative measures
5. Capture and relocate or destroy problem bears
6. Education of the public

As noted, types of damage can vary from 1 location to another. In Oregon, for example, most complaints are related to human safety and property concerns, followed by forest damage, agricultural damage, and, lastly, livestock depredation (Oregon Department of Fish and Wildlife, unpublished data). In Washington, most complaints concerned human safety, followed by nuisance bear complaints, other complaints (property damage and agricultural damage), and, lastly, livestock depredation complaints (Washington Department of Fish and Wildlife, unpublished data). All categories showed substantial increases in number of complaints over the last 5 years except livestock depredations which, while low in total numbers, stayed about the same or declined. Black bear depredation to livestock primarily involves sheep and lambs, and the low numbers of complaints may be related to declining numbers of small livestock growers and to the large number of growers using a variety of non-lethal methods to reduce depredations (Connolly and Wagner 1998, Knowlton et al. 1999, National Agricultural Statistics Service 1999). On the other hand, Colorado and Utah each reported over 2,000 sheep and lambs lost to black bears in 1998 (National Agricultural Statistics Service 1999). The small number of forest damage complaints in Washington (versus Oregon) may relate to the fact that spring bear hunts have not been allowed for many years in Washington and the timber industry has relied on a large and growing supplemental feeding program to reduce bear damage to commercial trees (Ziegltrum 1994).

Whittaker and Burn's (2001) survey of western state and provincial wildlife agencies indicated that more than half of the respondents identified conflicts caused by black bears with regard to city/urban development, county land use planning, and private land management. In contrast, rarely was conflict indicated for public land management or recreation management. The respondents also most commonly listed minimizing black bear conflicts and damage as a major challenge facing black bear managers.

TRADITIONAL BEAR MANAGEMENT AND DAMAGE REDUCTION

Traditional bear management has relied heavily on hunter harvest (Miller 1989, Pelton 2000). It is difficult to monitor bear populations and determine densities. Resource managers have relied on monitoring and influencing hunter numbers and bear harvests as a way to indirectly monitor population status. Harvest information is supplemented, in some cases, by evaluation of specific data on age and sex of harvested animals. Harvest regulations involve setting seasons (e.g., spring, fall, and "hot spot" hunts) and methods of take (e.g., firearm type, baiting, use of hounds) within a game management unit system. Often, harvest regulations and objectives must vary by region. For example, bear populations in eastern Oregon and Washington must be managed differently than bear populations in western Oregon and Washington. Historically, spring hunts have accounted for greater hunter success than fall hunts, and harvest using baits or hounds is more successful than rifle or archery hunting not employing these methods (Beecham and Rohlman 1994, Litvaitis and Kane 1994). To a much lesser extent, trap and relocation has been a method of removing problem bears or reducing bear density in an area. While these traditional methods have not entirely held bear populations and damage levels in check, their vigorous application and an attempt to stay ahead of developing situations have been fairly successful in many areas.

It appears, however, that bear populations are still increasing in many areas and we know damage complaints are increasing in many areas. This makes one wonder if traditional approaches to bear management are adequate for reducing conflicts. Indeed, there does not appear to be much correlation between estimated bear population size and bear harvest across states and provinces (Burch 1997, Whittaker and Burns 2001). Reported harvest as a portion of estimated bear population ranges from 2.5% to 15% with only California and Minnesota near the 15% harvest level. The Minnesota black bear population appears to be expanding rapidly despite the 15% annual harvest (D. Garshelis, personal communication). In his review of bear population management in North America, Miller (1989) stated that, while bear populations can be overharvested, most can sustain an annual harvest of 15% without a decline in population. Conservative harvest strategies are probably common with many game species in North America. This situation could be related to any of numerous factors. Many species were managed very conservatively for many decades after previous decades of over-harvest and, in some cases, recovery after extirpation and reintroduction. Wildlife agencies may also manage harvested species conservatively to avoid unintentional over-harvest (important with species difficult to census or monitor) and/or to assure abundant (and increasing) hunting and wildlife viewing opportunities. Additionally, conservative harvest rates may be more acceptable to citizens who accept hunting as a wildlife management tool, but may not hunt themselves. In the case of white-tailed deer (*Odocoileus virginianus*), it has been very difficult for some states to achieve adequate harvests to bring deer population densities down to goal densities (Witmer and deCalesta 1992).

Approaches to bear management have been changing dramatically in recent years. In some areas, number of hunters has been declining, resulting in less hunting pressure and reduced harvests. Additionally, an increasing acreage of lands, both public and private, are being put off-limits to hunting for various reasons. In like manner, when landowners cannot continue making an adequate profit by farming or livestock production, they may sell their land, resulting, in some cases, in further commercial or residential development. Finally, voter initiatives restricting bear harvest seasons and methods have been passed and enacted into law in various states and provinces, including Alberta, California, Colorado, Oregon, and Washington (e.g., Musgrave 1998). Similar initiatives have been defeated in other states (e.g., Idaho, Michigan). As a result, many "tools" used by wildlife managers to accomplish harvest objectives are no longer available. Examples of lost tools include spring hunts, use of hounds, use of bait, and the use of restraint devices (traps and snares). Rationale of members of the public supporting these restrictions may include subjective judgments on the treatment of bears (Pelton 2000). Resource managers fear that the resulting situation will allow bear populations to increase dramatically in some places with a corresponding increase in damage and incidence of human-bear encounters (see discussion in Beck et al. 1995). It appears, however, that some states have been able to recover from an initial decline in bear harvest after loss of methods such as hounds and bait by attracting more hunters and using more liberal seasons (e.g., Boulay et al. 2001).

Clearly, wildlife managers and others concerned with managing bear populations or damage are operating under an increasing set of constraints (Pelton 2000). It could be that black bear management in North America has been evolving and in many areas has moved from encouraging population decrease (persecution) to sustained yield management, but is now moving more towards conservation. In the future, it may approach preservation. This puts wildlife management in North America at a crossroads. What will the public allow or tolerate? What will commodity producers allow or tolerate? Who will have the authority, and to what level, to make wildlife management decisions? Who will pay for the changes in the way we do business? Many of these concepts were being explored in the early 1990s (e.g., Gilbert and Dodds 1992, Hawley 1993) and can be expected to become more acutely debated in the near future.

OTHER APPROACHES TO REDUCTION OF BEAR-HUMAN CONFLICTS

Practitioners of vertebrate pest management work within an arena of socio-political acceptability, legality, regulatory authority, effectiveness, cost and duration, and environmental compatibility (Fall and Jackson 1998). Managers and researchers are challenged to find new or improved methods of counteracting restrictions and limitations on traditional bear population and damage management. A wide array of approaches can be incorporated into an IPM strategy, including population management, habitat management, and people management (Giles 1980, Fall and Jackson 1998).

Other approaches, beyond traditional population management through harvest seasons, can be used to reduce bear conflicts and damage. Bear conflict and damage reduction techniques were reviewed by Hygnstrom (1994) and include cultural methods, exclusion, frightening devices, repellents, trapping, shooting, and public education. Research into other approaches, such as fertility control (Miller et al. 1998) continue as well. Typically, an IPM strategy involves assessment of the situation and application of the least invasive damage reduction methods before more invasive methods are used. This has become true with problem bear management as well and often multiple methods are used, depending on the specifics of the situation (Hygnstrom and Hauge 1989, Vaughan and Scanlon 1990, Calvert et al. 1992, Stowell and Willging 1992, Jonker and Parkhurst 1997, White et al. 1997).

The difficulty of working in this arena is exemplified in agency survey results presented by Whittaker and Burns (2001): agencies, the sportsmen, and the general public often disagreed on their preference for methods to deal with nuisance or depredating bears. Most agencies rely upon education, advice, relocation, and agency kill as methods. Fewer agencies allow the complainant to kill the problem bear. Still fewer agencies use compensation payment or regulations to resolve the problem. Relocation is popular with the public, but much less so for the agencies. On the other hand, agencies prefer to have problem bears killed, which is not very popular with the public. When problem bears are killed, it is usually a state, provincial, or federal agency that conducts the operation. Some components of a management strategy to reduce bear depredations are listed in Table 1.

Cultural Methods

Many cultural methods are used to reduce the likelihood of bear-human conflicts. Perhaps the most widely used and successful method is the removal or adequate containment of human-generated trash and waste foodstuffs. Garbage dumps, dumpsters, and landfills have been relocated, closed, fenced, or otherwise been made inaccessible to bears. Educational programs directed at campers and backpackers have been implemented. There has been great progress in the production of bear-proof garbage containers (Holmshaw 1995, Schirokauer and Boyd 1998). As a result, most human-bear conflicts in many parks are now more likely to involve random encounters (Herrero and Fleck 1989, Gunther and Hoekstra 1998).

It is also important to determine the set of conditions, human activities, or land use practices that encourage conflict situations with bears. For example, certain forestry practices (e.g., thinning, fertilization) tend to produce forest stands more likely to be damaged by black bears (Witmer et al. 2001). Conversely, there are silvicultural options (e.g., species selection, delayed thinning, maintenance of higher levels of canopy closure, pruning lower branches, and genetic selection of tree stock) that can reduce the likelihood of black bear damage (Witmer et al. 2001). However, it is important to acknowledge that foresters, like other commodity producers, already work under a sizeable set of constraints in their land use practices. Additionally, it is often difficult to overcome traditions and customs that have been followed for many generations.

Likewise, crop growers can occasionally vary which crops they grow, where they grow particular crops, and can sometimes alter the surrounding habitats (Stowell and Willging 1992). In many cases, these actions can be used to reduce the likelihood of bear damage. The reader is reminded, however, that prediction of black bear damage is difficult at best.

Livestock producers can and do use numerous cultural (husbandry) methods to reduce the likelihood of losses to predators. Methods include lamb shedding, herding, night penning, and carcass removal (Connolly and Wagner 1998, Knowlton et al. 1999, National Agricultural Statistics Service 1999).

Exclusion

Excluding black bears from areas or structures that they wish to access is not an easy matter, typically is expensive and requires considerable maintenance. Barriers, whether electric or heavy woven-wire or both, are sometimes used to protect apiaries, cabins, back-country camps, landfills, high-value properties, and sheep (Storer et al. 1938, Pratt 1990). Excluding bears from large forested areas would be difficult, expensive, and, in many cases, counterproductive to managing bears as an important and valued part of forested ecosystems. Metal flashing can be used to keep bears out of hunter tree stands or out of highly valued trees. An advantage of exclusionary barriers is that once in place, they usually last a long time with proper maintenance.

Supplemental Feeding

Supplemental feeding is a wildlife management technique used in a variety of situations to support populations or reduce damage, with big game on winter range being a classic example. In response to public aversion to lethal control of black bears, foresters in the Pacific Northwest have been conducting a large and growing supplemental feeding program for bears (Ziegltrum 1994). A pelleted feed, rich in sugars, is placed out in large feeding barrels and replenished regularly from spring through early summer in areas of historic or anticipated high levels of bear tree damage. Although success has not been well documented yet, it appears that this program has greatly reduced bear damage in some areas (G. Ziegltrum, personal communication). The program is costly, and costs increase each year as additional feeders are put out. Additionally, there is some concern that supplemental feeding programs may increase carrying capacity for animals in the area, leading to more problems in the future. For example, black bear females with access to garbage were heavier and more productive than females without access to garbage (Rogers et al. 1974). It has also been speculated that feeders may be dominated by large, adult bears and may be less available to the targeted segment of the bear population—adult female bears and smaller bears. Ongoing research with remote cameras suggests, however, that a variety of bears are actually able to access the feeders at various times. Because bears readily habituate to the feeders, it might be possible, in the future, to place fertility control materials in the feeders and thus reduce the bear population over time. More research is needed to fully understand feeding as an option to reduce bear damage. Specifically, impacts to bear populations (biological and behavioral), benefit-cost analysis, and fertility control should be primary research objectives.

Repellents, Aversive Conditioning, and Frightening Devices

Capsaicin spray is commonly used as a bear repellent for personnel protection (Rogers 1984), but how bears respond to the spray and the duration of the response are variable (Herrero and Higgins 1998). Bears may actually be attracted to areas where capsiacin is applied proactively as a repellent. Loud noises and cracker shells are also used to frighten bears, but again, results are often short-lived and variable (Hunt 1984; Miller 1983, 1986). Rubber and plastic bullets and chemical aversive agents may deter bears in some situations (Colvin 1975, Gillin et al. 1994), but did not deter black bears that were habituated to garbage or were depredating bee hives (Dorrance and Roy 1978, McCarthy and Seavoy 1994). Repellents (a bittering agent, a chemically hot material, and grizzly bear feces) applied to the base of commercial trees vulnerable to black bear damage in northern Idaho appeared to reduce damage in a preliminary field trial (Witmer et al. 2001).

Dogs can be used to keep bears away from human habitations and crops, and to condition bears to be wary and avoid humans (Green and Woodruff 1989, Derr 1999). How well dogs perform in this task depends on the breed as well as how they are reared, trained, and handled (Green 1990).

Relocation and Rehabilitating of Problem Bears

Relocation is still used to help reduce human-wildlife conflicts in some situations. For example, Armistead et al. (1994) reduced sheep depredation from black bears by relocating problem bears to areas without sheep. Relocation, however, is becoming a less acceptable solution for many reasons (Thompson and McCurdy 1995, Washington Department of Fish and Wildlife 1996). Although we now have good capabilities with bear live-traps and snares, trapping and relocating bears is expensive and not without an element of danger to bear and human alike. Released bears usually try to return to familiar territory and long distance movements are common (Rutherglen and Herbison 1977, Alt 1980, Fies et al. 1987, Inglis 1992). Black bears may have to be moved 161 km to have a high probability that they will not return to the original capture site (Alt 1980, Rogers 1986). Mortality rates (from starvation, highway and other accidents, aggressive encounters with resident animals, and other factors) of relocated animals are typically high. Additionally, relocated nuisance bears may continue their nuisance activities after relocation, so that the problem is merely transferred from one location to another. There is also the potential for disease transfer when animals are relocated over considerable distances. It is becoming increasingly difficult to find appropriate and publicly acceptable sites for relocations. The result of all these considerations is that many states have adopted a 2-strikes-you're-out policy with relocated bears (Harms 1977, Oregon Department of Fish and Wildlife 1993, Washington Department of Fish and Wildlife 1996). If the bear gets into trouble with humans after being relocated, it is captured and euthanized.

There continues to be an interest (primarily in the private conservation sector) in attempting to rehabilitate captive nuisance or orphaned bears for eventual release back into natural settings. While it appears that this can be accomplished in some cases, it is difficult, time-consuming, and expensive (Maughan 1995). The costs, liability, and inability to process very many bears may prevent greater use of this approach to the resolution of problem bears.

Damage Compensation

Damage compensation payments are used for bear damage in some states. This approach is generally popular with the public and commodity producers, but not with wildlife agencies and sportsmen (Whittaker and Burns 2001). The latter is probably because of costs involved, who pays, and the fact that compensation programs typically do not address the source of the problem. Colorado has a compensation program for black bear, cougar (*Puma concolor*), elk (*Cervus elaphus*), deer (*Odocoileus hemionus*, *O. virginianus*), and pronghorn (*Antilocapra americana*) damage. The program has annual expenses of about $1.5 million with about $650,000 paid in claims, $450,000 in material purchases (primarily fencing), and $500,000 in personnel and administrative costs (Steve Porter, Colorado Division of Wildlife, personal communication). About 55% (200 claims) of the total claims each year are for bear damage with about $250,000 paid in bear claims each year. The main bear damage areas are livestock depredation, property (bee hives, structures, vehicles) damage, and orchard damage. As another example, Stowell and Willging (1992) discussed the history, advantages and disadvantages of the bear damage compensation program in Wisconsin. There seems to be a general agreement across many states that an adequate harvest of bears during the regular hunting seasons helps keep the number of damage complaints down (Garshelis 1989, Hygnstrom and Hauge 1989). In addition to concerns about having adequate funds for compensation programs, there is concern with escalating costs and sources of program funds. Should general tax revenue funds be used, or should sportsmen's fees entirely fund the program? Can federal, Pittman-Robertson funds be used in these programs? Having adequate numbers of trained personnel to operate the program in a prompt, efficient, and consistent manner is also a concern.

Public Education

It appears that public education and tolerance of wildlife damage are becoming a more important part of vertebrate pest management (Gourley and Vomocil 1987, Garshelis 1989, Kellert 1994, Koch 1994, Thompson and McCurdy 1995). For example, it is our experience that many commercial forestry companies have become more tolerant of wildlife damage and also more sensitive to public relationships regarding how they deal with wildlife damaging their property. Winning public support for lethal control of bear populations in forest damage areas can be difficult with non-hunting members of the public (Gourley and Vomocil 1987). This suggests a strong and growing need to focus damage reduction programs on non-lethal methods, or if lethal methods are used, to not remove animals indiscriminately, but instead to target the individual problem animal (Accord et al. 1994, Knowlton et al. 1999).

In most wildlife damage situations, there is probably some relationship (although not necessarily linear) between the amount of damage and the density of damage-causing species. With carnivores, however, a few individuals can cause substantial problems or damage. Researchers have attempted to develop methods that target offending individuals, but there are usually many limitations to our knowledge of the species' biology and ecology, the circumstances under which the damage is occurring, and the methods available to us (Knowlton et al. 1999). Even if a method is developed that very specifically targets problem animals, there is no guarantee the public will accept its use. An example is the livestock protection collar (LPC) which is placed around the neck of a sheep and contains a lethal dose of Compound 1080 (sodium monofluoroacetate). The only predator affected by the LPC is one that bites into the neck of a sheep wearing the collar. Use of the LPC was recently (1998) made illegal in California through a voter initiative that restricted or banned the use of several wildlife damage management techniques.

Loss of the ability to use common methods for wildlife damage management (toxicants, repellents, immobilizing agents, anesthetizing agents, traps and snares, and dogs) is making the resolution of human-wildlife conflicts more difficult (Pelton 2000). Public acceptability is not the only factor involved. Effectiveness of the method, cost of application, real or perceived hazards, and the interest of the private sector to produce and market products can all affect availability of methods. Research on DNA and radioisotope applications, behavior of problem animals, shock collars, and auto-collaring snares may help target problem animals in the future. Use of appropriate combinations of methods and the use of adaptive management may also improve human-wildlife conflict resolution in the future.

An important part of public education is teaching the public how to reduce the likelihood of adverse encounters with wildlife (Pelton 2000). There will always be some risk to humans when bears are in the vicinity, however, and agencies must weigh the liability when designing and implementing bear management programs.

Educational efforts should not end with the general public. Biologists, pest control operators, and agency personnel must also be "re-educated" to deal with changing wildlife-human interactions, public attitudes, and rapidly changing technologies and communications. Wildlife managers may need to rise above the paradigm that 1) bears that come into repeated contact with humans or occasionally damage resources become habitual problem bears, 2) problem bears should be removed from the population, and 3) it is not always necessary to carefully consider alternatives or the bear's contribution to the gene pool (Taylor et al. 1989). Alternatively, wildlife agencies will need to make difficult, informed decisions regarding human-wildlife conflicts and their resolution and the management of wildlife populations in general. Standing by those decisions, in the face of increasingly polarized segments of society, may be their most difficult challenge.

FUTURE CHALLENGES

Wildlife managers face many challenges in providing for the many public and commercial needs of citizens that relate to wildlife populations and the reduction of adverse interactions. Much of the decision-making authority of wildlife management agencies is now being legislated or strongly directed by political bodies independent of standard legislative and rule-making processes. Managers and researchers will be continuously challenged to find innovative and publicly acceptable methods to maintain a balance between the needs and desires of humans and the needs and propensities of black bears. The involvement of the public will be, and should be, an important part of the process. A list of needs and challenges in dealing with nuisance and depredating bears is provided in Table 2. Although progress is being made in many areas, there are probably too few persons and too few funds being dedicated to the more timely resolution of human-wildlife conflicts.

Table 2. Some needs and challenges of dealing with nuisance and depredating bears.

1. Working across jurisdictions, bio-politics
2. Better population monitoring
3. Better prediction of damage and identifying problem bears
4. Improvements in deterrents and aversive conditioning
5. More application of research findings
6. Apply bear-people management to larger areas
7. More education programs, surveys of the public, involvement of user groups
8. Use of adaptive management
9. Effects of development, habitat protection
10. Use of long-term studies and data sets
11. Economic assessment of damage and control
12. Effective combinations of methods
13. Consistent and timely reporting and damage investigation
14. Adequate personnel and funds for research, management, claims

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BLACK BEAR HABITAT USE IN NORTHEASTERN OREGON

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Abstract: Forest management practices may have a profound effect on bear habitat. Habitat use outside the denning period was compared among adult male (n = 2), adult female (n = 6), and subadult female (n = 4) radiocollared black bears (*Ursus americanus*) in northeastern Oregon. Use of forest type, structural stage, logged areas, landform, stem density, log density, and canopy differed among sex and reproductive classes and activities of bears. Adult males used the most diversified habitats while adult females more consistently used a high percentage of grand fir (*Abies grandis*), old multistory, and unlogged stands. Sites used for bedding and moving had a high degree of security (high stem density and dense canopy closure). More sites used for foraging on logs were in harvested stands and higher on the slope than sites used for other activities. Sites used for foraging on fruit were in more open stands, lower on the slope, closer to roads, and lower in log density than sites used for other activities. Dead wood used for foraging on insects was comprised of 82% logs, 17% stumps, and 1% snags. Bears selected for large-diameter logs with partial or advanced decay. Western larch (*Larix occidentalis)* and Douglas-fir (*Pseudotsuga menziesii*) logs were used more and lodgepole pine (*Pinus contorta*) logs were used less than expected based on availability. Black bear habitat in northeastern Oregon can be enhanced by encouraging management practices that (1) retain stands with old multistory structure with no logging activity, particularly in grand fir forest types, (2) produce fruit-bearing plants, and (3) retain logs $\geq$ 38 cm in diameter.

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Key words: black bear, *Ursus americanus*, habitat, northeastern Oregon.

Black bears are extremely mobile and opportunistic in use of a variety of habitats in the Pacific Northwest (Poelker and Hartwell 1973, Lindsey and Meslow 1977, Beecham and Rohlman 1994, Vander Heyden and Meslow 1999). Bear movements outside of denning are dictated largely by the distribution and availability of food, as well as security cover (Beecham and Rohlman 1994). Therefore, management for habitat that provides food resources and cover is an integral component of managing black bear populations. Little information on the habitat use of black bears in eastern Oregon is available. Data from different geographic areas may not be applicable as black bear populations are a unique product of specific habitat factors that influence their population dynamics, social organization, reproductive potential, food habits, and availability of suitable den sites (Beecham and Rohlman 1994). The objectives of this study were to compare the use of habitat and dead wood among adult males, adult females with and without cubs, and subadult females and describe characteristics of habitats used outside the denning period in northeastern Oregon.

METHODS

Our study area encompassed about 400 km² in the Starkey Wildlife Management Unit in northeastern Oregon located 10-35 km south and southwest of La Grande. Portions of the following watersheds were included in the study area: upper Grande Ronde River, Beaver Creek, Catherine Creek, and North Powder/Wolf Creek. Topography consisted of moderately steep mountains dissected by drainages. Permanent water in the form of springs and streams was abundant; mean annual precipitation was 50 cm. Elevation ranged from 1320 to 1980 m.

Forested habitats were diverse and consisted of grand fir, Douglas-fir, lodgepole pine, subalpine fir (*Abies lasiocarpa*), and ponderosa pine (*Pinus ponderosa*) forest types (Johnson and Hall 1990). All structural stages were within the study area including stand initiation, stem exclusion, understory reinitiation, young multistory, and old multistory stands (Oliver 1992). The majority of the landscape within the study area was harvested in the last 80 years. From 1920 to 1960, timber was selectively logged in most of the subwatersheds, removing large-diameter western larch, Douglas-fir, and ponderosa pine. Since 1970, regeneration cuts and partial cuts occurred in most subwatersheds. Logging activity in the stands was classified as unlogged (no history of harvesting activity), selection cuts, partial cuts, and regeneration cuts. About 90-95% of the study area was forested.

We estimated the percent of area by forest type, structural stage, and logging activity within subwatersheds available to radiocollared bears using GIS (Geographic Information System; data on file at La Grande Ranger District, La Grande, OR 97850 and Baker Ranger District, Baker, OR 97814; Table 1). Information available on logging activity was limited to partial and regeneration cuts since the mid-1970s, and does not reflect the percent of area that had been harvested between 1920 and the mid-1970s (primarily selection cuts). Up to 50% of some subwatersheds had been selectively logged during this time period. About 10% of the area occupied by radiocollared bears was on private land and was not included in the GIS. This private land was lower in elevation, contained more ponderosa pine and Douglas-fir, and had been more intensively harvested

Table 1. GIS determination of percent of area by forest type, structural stage, and logging activity found in subwatersheds used by 12 radiocollared black bears. Data from different subwatersheds were combined under 4 main watersheds.

Characteristics	Watershed				Mean
	Beaver Creek	Upper Grande Ronde River	Catherine Creek	North Powder & Wolf Creek	
Forest type[a]					
Grand fir	57	61	96	84	65
Subalpine fir	31	28	0	9	24
Douglas-fir	11	9	4	5	9
Ponderosa pine	<1	2	0	2	2
Structural stage					
Stand initiation	12	28	21	18	20
Stem exclusion	17	1	0	7	8
Understory reinitiation	47	57	69	68	56
Young multistory	10	4	2	2	5
Old multistory	13	8	13	6	10
Logging activity[b]					
Unlogged					10-20
Selection					30-50
Partial	7	38	10	11	21
Regeneration	7	16	19	11	13
No. Subwatersheds	5	6	1	2	
No. Bears	3	4	1	4	

[a] Lodgepole pine types are included in grand fir and subalpine fir types.
[b] Data not available on harvesting prior to 1970s nor on selection cuts and unlogged stands. Mean percentages of area with selection cuts and unlogged stands estimated from aerial photos and field work.

than other portions of the study area.

We monitored the activity of 12 radiocollared black bears from April 1998 until October 1999. Bears were radiocollared using techniques described by Akenson et al. (2001). The age of each bear was estimated from analysis of cementum annuli on a premolar tooth (Stoneberg and Jonkel 1966) and from field observations at capture (body size, dentition, condition, lactation). We defined subadults as those bears <5 years of age, as some females bred at 5 years in our study area (Jim Akenson, University of Idaho, Taylor Ranch Field Station, Cascade, ID personal communication). Each bear was typically located once a week by ground-tracking during daylight hours from the first week in May until they entered dens in October. We attempted to actually see the bear and observe its activity during this monitoring and did so at 24% of 593 locations. Based on sightings of bears, we believe we were within 50 m of the bear when we detected the signal 0.025 MHz above the actual transmitter frequency. If the bear was not observed, we searched for a bed, tracks, evidence of foraging, or scat to determine the exact location. A GPS (Global Positioning System) receiver provided UTM coordinates at the site. Bear locations were plotted on orthophoto quadrants (scale of 1:15,840).

The activity of the bear was recorded as bedding, moving, foraging on grass, foraging on fruit, foraging on logs, foraging on ungulates, denning, or unknown. At each bear location, a circular 0.05-ha plot was delineated, and habitat characteristics listed in Table 2 were measured within the plot after the bear left the site. Living and dead trees within the plot were counted in 4 categories: saplings (<5 cm in diameter and >0.5 m in height), poles (5-24 cm dbh), mature trees (25-50 cm dbh), and large trees (>50 cm dbh). In addition, forest type, structural stage, logging activity, landform (ridge, upper third of slope, mid-slope, lower third of slope, drainage), number of

Table 2. Mean values (SD) of habitat characteristics by sex/reproductive class of 12 radiocollared black bears in northeastern Oregon, 1998-99.

Characteristic	Adult males	Females with cubs	Females without cubs	Subadult females	*F* statistic, *p*
Stems/0.05 ha					
Saplings[a]	58.3 (8.98)	27.3 (2.35)	46.7 (12.20)	36.2 (3.67)	4.23, < 0.01
Poles[b]	36.4 (4.14)	26.2 (2.06)	31.9 (3.43)	28.2 (1.51)	2.70, 0.04
Mature trees[c]	3.5 (0.34)	4.7 (0.28)	6.2 (0.48)	4.7 (0.27)	7.03, < 0.01
Large trees[d]	0.8 (0.13)	1.5 (0.11)	1.8 (0.18)	1.6 (0.11)	7.05, < 0.01
Logs/0.05 ha					
<25 cm	15.4 (1.75)	7.2 (0.54)	9.7 (0.83)	10.4 (0.83)	10.37, <0.01
25-50 cm	2.8 (0.37)	3.4 (0.28)	2.6 (0.27)	2.4 (0.16)	3.40, 0.02
> 50 cm	0.6 (0.10)	0.7 (0.07)	0.5 (0.11)	0.7 (0.07)	1.71, 0.16
Distance to road (km)	1.0 (0.08)	1.4 (0.08)	1.3 (0.12)	0.6 (0.4)	24.13, < 0.01
Distance to water (km)	0.3 (0.05)	0.3 (0.02)	0.2 (0.02)	0.3 (0.02)	2.68, 0.05
% Canopy closure	66.9 (2.30)	64.4 (1.61)	71.0 (1.95)	64.9 (1.41)	2.52, 0.06
% Slope gradient	23.9 (1.63)	27.6 (1.27)	22.7 (1.70)	28.6 (1.04)	3.91, 0.01
No. bears	2	6	6	4	
No. locations	79	187	101	226	

[a]Trees <5 cm in diameter and >0.5 m in height.
[b]Trees 5-24 cm dbh.
[c]Trees 25-50 cm dbh.
[d]Trees >50 cm dbh.

canopy layers, and slope aspect were recorded at the site. Habitat characteristics were compared among sex/reproductive classes (i.e., adult males, females with cubs, adult females without cubs, and subadult females) and among activities (bedding, moving, log foraging, fruit foraging) using 1-way analysis of variance and Tukey's B test (Snedecor and Cochran 1980) for continuous variables and Kruskal-Wallis (Conover 1980) for categorical variables. Sample sizes of other activities were too small to include in the analysis. A significance value of 0.05 was used.

The area within a 200-m radius of the bear location was searched for recent foraging in dead wood (i.e., logs, stumps, snags). Stumps were defined as < 3 m tall and snags as ≥ 3 m tall. Recent foraging (within a day) was based on the presence of ants, moisture content of wood, absence of needles on the exposed wood, and the condition and position of adjacent vegetation. Tree species, wood condition (sound wood, partially decayed, and soft wood), large-end diameter, length or height, percent of bark remaining on the bole, and evidence of insects were recorded. Evidence of insects included ants or their galleries, yellowjacket (*Vespula* spp. and *Dolichovespula* spp.) nests, and wood boring beetles or their galleries. The nearest log, stump, or snag (≥ 15 cm in diameter) to the one with recent foraging was identified and measured to provide a paired sample of what substrate was available versus what was used. For each type of dead wood, the substrate used for foraging was compared with the sample of available substrate using paired t-tests for continuous variables and Wilcoxon matched-pairs signed-ranks tests for categorical variables.

RESULTS

Activity of 12 radiocollared bears at 593 locations between April 1998 and October 1999 was unknown at 33% of the locations, moving at 21%, bedding at 19%, foraging on logs at 18%, foraging on fruit at 5%, foraging on ungulates at 2%, foraging on grass at 2%, and in dens at 1%. The radiocollared bears consisted of 4 subadult females (226 locations), 6 adult females (288 locations), and 2 adult males (79 locations). An adult female and an adult male were killed by hunters in the fall of 1998, so only 10 bears (of which 1 was a male) were monitored in 1999. Our sample size of individual bears is limited (especially for males), but it does provide some insight as to how bears utilize habitats in the Blue

Mountains. All locations, except 1, were in forested habitat. We believe there was no habitat bias in our use of ground telemetry because bears could not be found < 5% of the time.

Sex/Reproductive Class

Use of forest type by all bears was 62% in grand fir, 16% Douglas-fir, 10% subalpine fir, 8% lodgepole pine, 2% deciduous trees or shrubs, and 2% ponderosa pine. A comparison (not statistical) between available forest types (Table 1) and use by all radiocollared bears suggests that the subalpine fir type was used less and the Douglas-fir type was used slightly more than expected based on availability. The lodgepole pine type in GIS was included with grand fir and subalpine fir types, so a comparison of this type is not feasible. Use of forest type differed among sex/reproductive classes ($X^2 = 16.94$, 3 df, $p < 0.01$). Females with cubs were located in grand fir stands most often and the 2 adult males the least often (Fig. 1).

Use of structural stage by all bears was 43% in old multistory, 20% young multistory, 21% stem exclusion, 12% understory reinitiation, 2% stand initiation, and 2% in shrubs. Overall, old multistory and young multistory stands were used more, and all other structural stages were used less than expected based on availability (Table 1). Use of structural stage differed among sex/reproductive classes ($X^2 = 26.51$, 3 df, $p = < 0.01$), where the most striking difference was the high use of old multistory stands by all females and the lower use by adult males (Fig. 2). The 2 adult males spent a greater percentage of their time in earlier structural stages than did females.

The majority (47%) of all bear locations occurred in unlogged stands, with 35% in selection cuts, 16% in partial cuts, and 2% in regeneration cuts. Overall, partial and regeneration cuts were used in lower proportions, and unlogged stands were used in higher proportions than expected based on availability (Table 1). Logging activity in stands differed among sex/reproductive classes ($X^2 = 15.94$, 3 df, $p < 0.01$), where adult females used the highest percentage of unlogged stands, and subadult females used the least (Fig. 3).

Bear use of landform was 29% on the upper third of the slope, 26% lower third of slope, 17% middle third of slope, 14% drainage, and 13% ridge. Significant differences occurred in use of landform among sex/reproductive classes ($X^2 = 26.44$, 3 df, $p < 0.01$). Adult females without cubs used draws the most and the 2 adult males the least (Fig. 4). No differences in use of aspect occurred among sex/reproductive classes ($X^2 = 4.42$, 3df, $p = 0.22$). Aspect was north at 30% of the locations, east at 34%, west at 16%, and south at 20%. Slope gradient

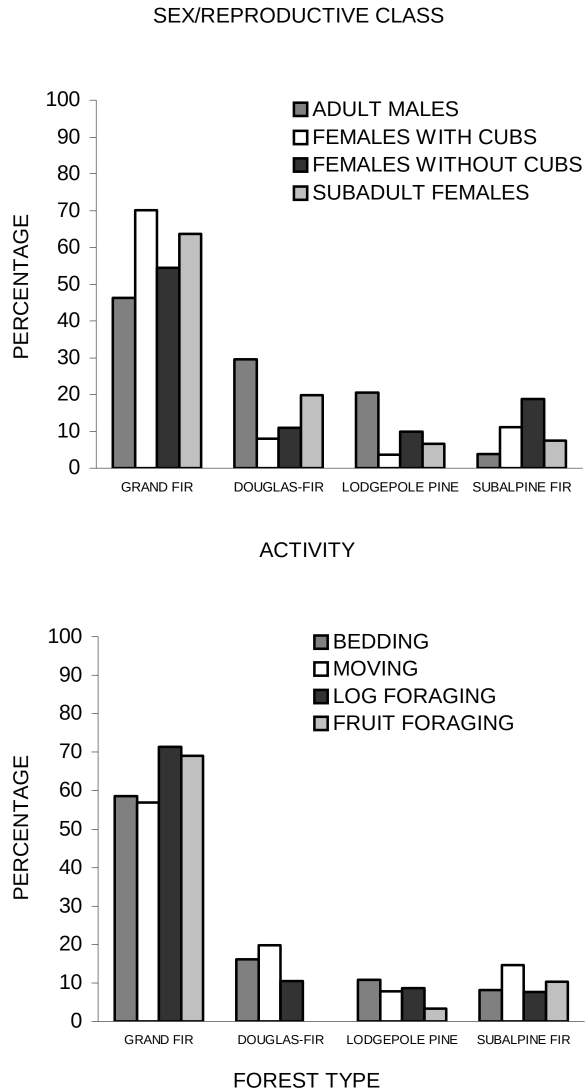

Fig. 1. Percent of occurrence of sex/reproductive classes and bear activity by forest type used by 12 radiocollared black bears in northeastern Oregon, 1998-99.

differed among sex/reproductive classes with subadult females using significantly steeper slopes than adult females without cubs based on Tukey's B analysis (Table 2).

Overall, 52% of stands at bear locations contained 2 canopy layers, 31% contained $\geq$ 3 layers, and 18% contained 1 layer. Significant differences occurred in use of number of canopy layers among sex/reproductive classes ($X^2 = 10.63$, 3df, $p = 0.01$) (Fig. 5), although percent canopy closure did not differ among these classes (Table 2). The majority of stem and log densities were significantly different among sex/reproductive classes (Table 2). Based on Tukey's B analyses: the density of large trees (>50

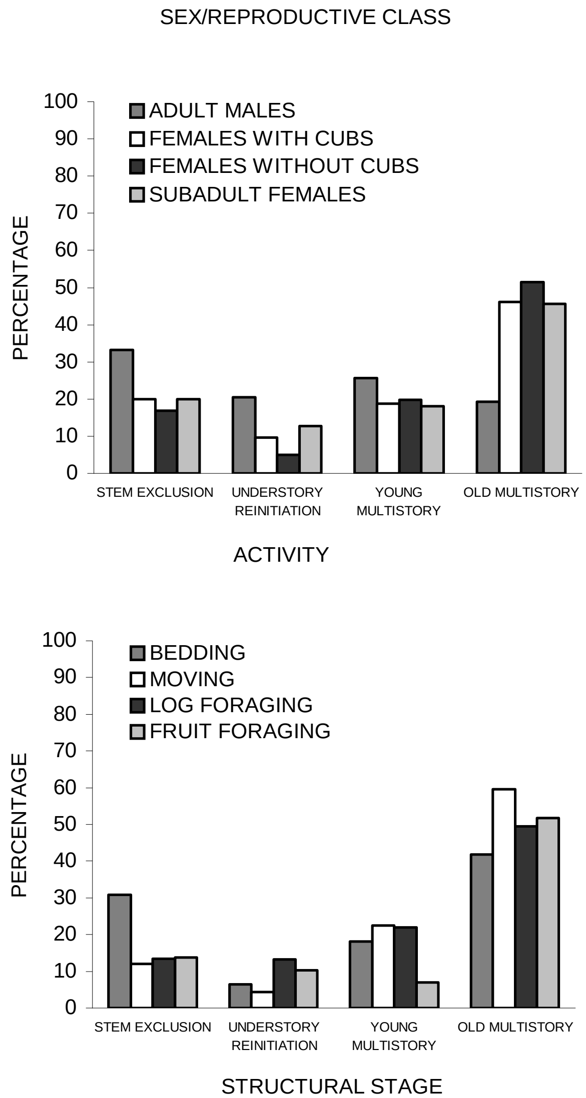

Fig. 2. Percent of occurrence of sex/reproductive classes and activity by structural stage used by 12 radiocollared black bears in northeastern Oregon, 1998-99.

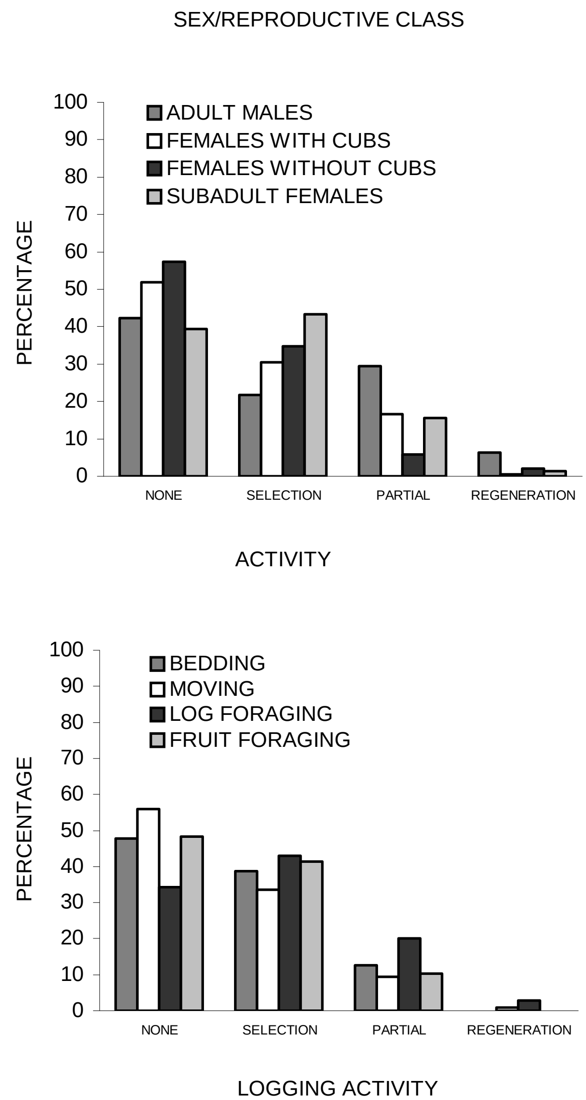

Fig. 3. Percent of occurrence of sex/reproductive classes and activity by logging activity used by 12 radiocollared black bears in northeastern Oregon, 1998-99.

cm dbh) was significantly higher at locations of all females than of males; the density of mature trees (25-50 cm dbh) was significantly greater at locations of subadult females than of the 2 males and greater at locations of females without cubs than all other classes; the density of saplings and poles were significantly higher at locations of males than females with cubs; the density of logs <25 cm in diameter was higher at locations of males than of all females and was higher at locations of subadult females than of females with cubs; and the density of logs 25-50 cm in diameter was higher at locations of females with cubs than of subadult females.

Distance to water and distance to a road differed among both sex/reproductive classes (Table 2). Tukey's B analysis indicated that females without cubs were significantly closer to water than females with cubs. Subadult females were closer to roads than all other bears, and males were closer to roads than females with cubs based on Tukey's B analysis.

Activity

Use of forest type (X^2 = 7.98, 3 df, p = 0.05), structural stage (X^2 = 15.17, 3 df, p = 0.01), and logging activity (X^2 = 12.45, 3 df, p = 0.01) differed among activities (Figs. 1-3). At least 57% of all activities occurred in grand fir stands. Seventeen percent of the locations where bears were foraging

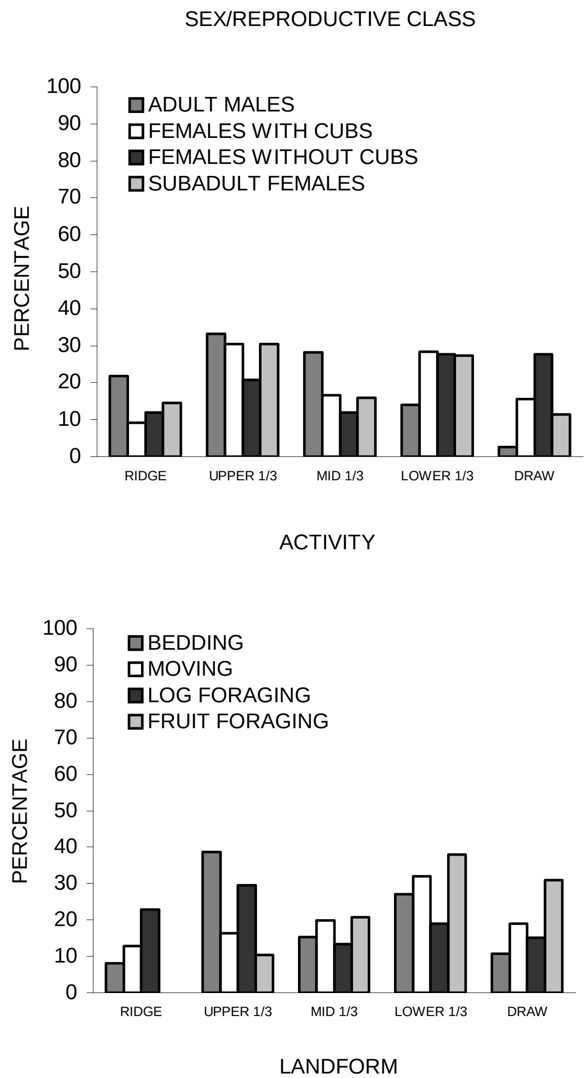

Fig. 4. Percent of occurrence of sex/reproductive classes and activity by landform used by 12 radiocollared black bears in northeastern Oregon, 1998-99.

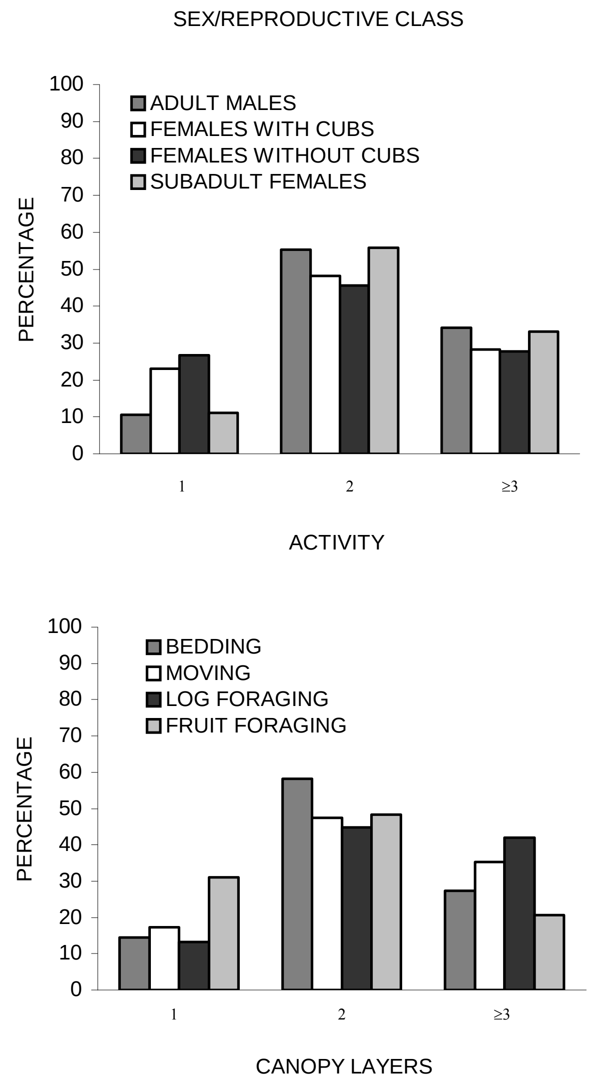

Fig. 5. Percent of occurrence of sex/reproductive classes and activity by number of canopy layers used by 12 radiocollared black bears in northeastern Oregon, 1998-99.

for fruit occurred in hawthorn stands compared to <2% for other activities. Old multistory stands received the highest use for all activities, although 31% of bedding sites were in stem exclusion stands. Bears that were foraging on logs were found less often in unlogged stands and more often in partial cuts than bears conducting other activities. Regeneration cuts were rarely used.

Significant differences occurred in use of landform among activities ($X^2 = 22.00$, 3 df, $p < 01$), although there were no differences in use of aspect ($X^2 = 5.65$, 3 df, $p = 0.13$) or in percent slope (Table 3). Bedding sites were most frequently on the upper third of a slope and seldom on a ridge or in a draw. Fruit foraging occurred most frequently on the lower third of a slope or in a draw (Fig. 4).

The number of canopy layers ($X^2 = 8.11$, 3df, $p = 0.04$) (Fig. 5) and the percent canopy closure differed among activities (Table 3). Generally, sites where bears were foraging for fruit typically had fewer canopy layers than other activities. Bedding sites most commonly contained 2 canopy layers. Tukey's B analysis indicated that bedding and moving had higher canopy closures than log foraging.

The density of stems and logs differed among activities (Table 3). The density of poles and of logs <25 cm in diameter was significantly higher at bed sites than all other activities based on Tukey's B tests. Density of mature trees was greater at sites

Table 3. Mean values (SD) of habitat characteristics by activity of 12 radiocollared black bears in northeastern Oregon, 1998-99.

Characteristic	Activity				*F* statistic, *p*
	Bedding	Traveling	Log foraging	Fruit foraging	
Stems/0.05 ha					
Saplings	43.8 (6.21)	39.4 (10.74)	42.6 (5.24)	17.3 (2.94)	0.89, 0.45
Poles	41.7 (4.43)	25.5 (2.02)	23.9 (1.52)	23.5 (3.12)	8.21, < 0.01
Mature trees	4.2 (0.41)	6.6 (0.40)	5.3 (0.43)	2.8 (0.54)	9.15, < 0.01
Large trees	1.4 (0.13)	1.8 (0.17)	1.4 (0.16)	1.3 (0.27)	1.69, 0.16
Logs/0.05 ha					
<25 cm	13.1 (1.40)	8.7 (0.73)	8.4 (0.78)	5.7 (1.03)	6.11, < 0.01
25-50 cm	2.5 (0.28)	2.7 (0.27)	3.0 (0.30)	2.6 (0.61)	0.53, 0.67
> 50 cm	0.7 (0.10)	0.5 (0.09)	0.8 (0.11)	0.6 (0.19)	1.72, 0.16
Distance to road (km)	0.8 (0.80)	1.1 (0.11)	0.8 (0.08)	0.5 (0.11)	4.72, < 0.01
Distance to water (km)	0.3 (0.04)	0.2 (0.02)	0.2 (0.02)	0.2 (0.05)	4.42, < 0.01
% Canopy closure	71.1 (2.17)	69.4 (1.93)	59.6 (2.02)	63.6 (3.74)	6.27, < 0.01
% Slope gradient	26.8 (1.42)	26.0 (1.68)	23.5 (1.35)	24.3 (3.05)	0.87, 0.45
n	111	116	105	29	

where bears were log foraging or moving than where fruit foraging, and was greater at sites where the bears were moving than at beds.

Both the distance to a road and to water differed among activities (Table 3). Bedding sites were farther from water than locations of moving bears, and moving bears were farther from roads than were bears foraging on logs and fruit based on Tukey's B analyses.

Foraging Substrate

We located 867 foraging sites in dead wood with fresh bear foraging activity; 82% were logs, 17% were stumps, and 1% were snags. The following characteristics were significantly different between logs used for foraging and a sample of available logs: tree species ($Z = -2.74$, $p < 0.01$), wood decay class ($Z = -16.46$, $p < 0.01$), large-end diameter ($t = 19.87$, $p < 0.01$), percent of log covered with bark ($t = -8.71$, $p < 0.01$), and evidence of insects ($Z = -18.21$, $p < 0.01$) (Table 4). Length did not differ between logs used for foraging and available logs. A higher percentage of western larch and Douglas-fir logs and a lower percentage of lodgepole pine were used for foraging than were represented in the available logs. Logs with partial or advanced decay comprised 99% of those with foraging activity, yet only 68% of the available logs. Larger diameter logs with less bark were used more for foraging than were represented in available logs. Of the logs used for foraging 50% contained ant galleries, 21% ants, 4% yellowjackets, 2% wood boring beetle larvae, and 23% had no visible evidence of insects. Less than 6% of the available logs had evidence of insects, although this percentage is likely an underestimate because of the difficulty in determining evidence of insects in these logs because they had not been ripped open. This difference in exposure of the interior wood biased our ability to detect insects.

Significant differences occurred between stumps used for foraging and available stumps for wood decay class ($Z = -5.25$, $p < 0.01$), diameter ($t = 4.28$, $p < 0.01$), percent bark ($t = -3.26$, $p < 0.01$), and evidence of insects ($Z = -7.40$, $p < 0.01$) (Table 3). Tree species and height did not differ between stumps used for foraging and available stumps. Larger diameter stumps, with more decay, and less bark were used more for foraging than were represented by available stumps. Seventy-five percent of stumps used for foraging but only 18% of those available contained evidence of insects.

DISCUSSION

Sex/Reproductive Class

In the following discussion, the reader is cautioned that sample sizes for adult males ($n = 79$) and adult females without cubs ($n = 101$) are limited, and the patterns of use may not be representative of the entire population. Use of forest type, structural

Table 4. Frequency of tree species and decay and mean values (SE) of characteristics of 711 logs and 149 stumps used by black bears for foraging (used) and the nearest available adjacent log or stump in northeastern Oregon, 1998-99.

	Logs		Stumps	
Characteristic	Used	Available	Used	Available
Tree species[a]				
Western larch	25.5	14.6	12.3	11.7
Lodgepole pine	25.2	44.8	6.8	6.9
Douglas-fir	20.8	14.3	8.2	35.9
Grand fir	16.8	16.5	4.8	31.7
Ponderosa pine	10.2	6.8	38.4	9.7
Subalpine fir or spruce	1.4	3.0	29.5	4.1
Wood decay[ab]				
Sound	1.1	32.0	0.7	26.2
Partially decayed	45.0	53.6	43.8	37.9
Soft	53.9	14.4	55.5	35.9
Mean diameter (cm)[ab]	41.5 (0.77)	26.5 (0.46)	55.9 (1.75)	47.2 (1.59)
Mean length/height (m)	10.8 (0.33)	10.9 (0.25)	0.7(0.04)	0.7 (0.07)
Mean percent bark[ab]	8.4 (0.85)	20.9 (1.35)	34.2 (2.41)	46.5 (3.46)

[a]Characteristics with a significant difference between logs used for foraging and available logs.
[b]Characteristics with a significant difference between stumps used for foraging and available stumps.

stage, and logging activity were more diversified for adult males (n = 2) than for all females (n = 10) which were more often in old multistory stands and in grand fir (Figs. 1-3). As a result, males used stands with a higher density of saplings and poles, and a lower density of large trees and logs >25 cm in diameter than females. The home ranges (95% minimum convex polygon) of the 2 males were 14,490 and 16,320 ha and were at least 7 times larger than those of the 6 adult females ($\bar{x}$ = 2,082 ha, range = 1,437-2,740) or of the 4 subadult females ($\bar{x}$ = 1,671 ha, range = 961-2,578) (Wertz et al. 2001). The larger home ranges of the males may explain some of this more generalized habitat use.

Females with cubs were quite specific in their habitat use, concentrating in stands of grand fir, old multistory structure, and with no logging (Figs. 1-3). As a result, habitat attributes associated with old multistory, such as larger logs, were more common at sites used by females with cubs (Table 2). Females with cubs also occurred farther from roads than the other groups of bears (Table 2). Presumably females with cubs stayed in more remote areas with dense cover and large-diameter trees that could serve as security trees (i.e., trees that cubs could climb to escape mammalian predators and male bears). Beecham and Rohlman (1994) reported that females with cubs remained in dense timber, while those without cubs used open timber during spring in Idaho. In the central Cascades of Oregon, closed-canopy mature timber was the most prevalent habitat in 10 of 12 home ranges of adult females (Vander Heyden and Meslow 1999).

Adult females without cubs used the highest percentage of old multistory stands, unlogged stands, and stands of subalpine fir of the groups of bears. There were few other differences when compared with females with cubs. Although subadult females used a similar amount of grand fir and old multistory stands as adult females, they were closer to roads, on steeper slopes, lower on slope, and used more selection cuts than the other groups of bears (Figs. 1-5, Table 2). In Idaho, females without cubs also selected lower slopes, avoiding ridge tops and upper slopes (Beecham and Rohlman 1994).

Activity

The activity of an individual bear largely influenced its habitat use. Bed sites were typically in secure situations with a higher density of poles and logs <25 cm in diameter and a denser canopy closure than other activities (Table 3). Although 42% of the bed sites were in old multistory stands, the greatest use of stem exclusion stands observed was for bedding (Fig. 2). The high use of the upper third of slopes for bed sites relative to other activities may have been a function of availability, temperature gradients, air flow, and observation vantage points. In contrast, adult females in western Oregon made little use of closed-canopy sapling/pole stands (Vander Heyden and Meslow 1999). In Idaho, Unsworth et al. (1989) and Beecham and Rohlman (1994) reported bedded bears avoided open areas, roads, logged areas, and ridge tops and selected steep, northern aspects. Unlike our study area where >90% of the area was forested, only the northern aspects were timbered at the lower elevations in the study area reported by Beecham and Rohlman (1994).

Moving bears appeared to select for secure habitats. This selection is reflected by their high use of unlogged and old multistory stands and the high density of mature and large trees associated with these stands compared to other activities. Moving bears also were farther from roads than other bears, reflecting a selection of secure habitats. In Idaho, north-facing slopes were used as travel corridors because of the timber providing secure habitat (Beecham and Rohlman 1994).

Bears foraging on logs used sites with the highest density of logs >25 cm in diameter relative to the other activities (Table 3); presumably this reflected the larger log size preference of ants (Torgersen and Bull 1995) which the bears were searching for. Twenty-four percent of the diet (% biomass) of the radiocollared bears consisted of insects, the majority being ants (Bull, unpublished data). The sites used for foraging on logs had the lowest canopy closure, highest use of ridges and upper third of slopes, and highest use of stands with selection and partial cuts compared to other activities (Table 3, Figs. 3 and 4). Because ants tend to be temperature-related (Hölldobler and Wilson 1990), we believe bears used these more open stands and stands higher on the slope because there was more solar insolation to the ground and to logs which probably resulted in higher ant density. Log residue from selection and partial cuts may also have provided foraging substrate for bears. In Idaho, bears fed extensively on ants in selection cuts at middle elevations (Beecham and Rohlman 1994).

The highest use of draws and the lower third of the slope occurred during fruit foraging compared to the other activities (Fig. 4), probably because hawthorns occur adjacent to water. Sixteen percent of the diet (% biomass) of the radiocollared bears consisted of fruit with bearberry (*Arctostphylos uva-ursi*), hawthorn (*Crataegus* spp.), and big huckleberry (*Vaccinium membranaceum*) comprising the majority of the fruit (Bull, unpublished data). The low density of saplings and mature trees at sites of fruit foraging may reflect the more open stand conditions that are conducive to production of bearberries, hawthorns, and big huckleberries in our study area. The close proximity of roads to bears foraging on fruit compared to other activities (Table 3), may have been a function of road abundance in draws. Unsworth et al. (1989) and Beecham and Rohlman (1994) also observed that foraging bears were close to roads and that lower slopes and southern exposures were preferred for foraging on hawthorns in Idaho. In southwestern Washington, bears selected for recently logged areas and against older conifer and alder stands (Lindzey and Meslow (1977); they speculated that high berry abundance in the recently logged areas contributed to this preference.

Foraging Substrate

The logs used for foraging probably reflected the places ants occurred that were accessible to the bears. Torgersen and Bull (1995) also found that log-dwelling ants (*Camponoutus* spp. and *Formica* spp.) occurred more in western larch and less in lodgepole pine, and selected for logs >38 cm in diameter. *Formica* used a higher percentage of partially decayed wood and *Camponotus* used more sound wood than other decay classes. Because few logs with sound wood were used for foraging in this study, we suspect bears obtained carpenter ants (which occurred in 40% of the scats containing insects) from logs with more decay. Large-diameter logs lacking decay would be more difficult for a bear to rip open than ones with more decay. The observations by Torgersen and Bull (1995) are consistent with the findings of this study showing a preference for larger diameter logs with partial decay and a strong preference for western larch.

MANAGEMENT IMPLICATIONS

The disproportionate use of grand fir, old multilayered, and unlogged stands suggests the importance of managing these stands for black bears in northeastern Oregon. Stands with these attributes were particularly important for bedding and moving, as well as some foraging, likely due to the high degree of security they offered. Stem exclusion stands, which contained a high density of standing and downed poles, were used particularly by males and subadult females for bedding. Management practices that encourage fruit-bearing plants would enhance foraging opportunities for bears.

Retention of logs of all species ≥38 cm could enhance foraging substrate for bears by increasing the amount of colonizing substrate for ant populations. Logs with partial or advanced decay would provide immediate foraging and colonizing opportunities, while logs without decay would provide future substrate for both ants and bears.

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HABITAT USE BY BLACK BEARS IN THE NORTHEAST CASCADES, WASHINGTON

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Although the black bear is considered an important game species in Washington, information critical for effective black bear management is lacking. Ensuring suitable habitat is 1 important aspect of species management. As such, I examined habitat use of black bears in the northeast Cascade Mountains of Washington, using a vegetation map created for the North Cascades Grizzly Bear Ecosystem to define 14 habitat variables: riparian forest, deciduous forest, ponderosa pine, Douglas-fir, meadow, hemlock, subalpine fir, shrubfield, mosaic, harvest, shrub-steppe, bare/rock/water, fire and other conifers. I obtained 1916 aerial radiolocations for 26 black bears and analyzed habitat selection within annual home ranges with compositional analysis. Compositional analysis suggested black bears in the northeast Cascades exhibited habitat selection. Riparian forest, deciduous forest, ponderosa pine, Douglas-fir, meadow and hemlock habitat types, listed in order of decreasing rank, were used significantly greater than the remaining 8 types. In summary, riparian and mesic sites, and mosaics of open and forested areas seem to be important to black bears in the drier climate of the northeast Cascades.

Key words: compositional analysis, habitat use, Washington.

HOME RANGE AND DISPERSAL PATTERNS OF SUBADULT BLACK BEARS IN NORTHEASTERN OREGON

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Abstract: Movement patterns of subadult black bear (*Ursus americanus*) from 1993 to 1999 were examined to determine whether these patterns influenced animal distribution and habitat use. Movement of subadult bears has been difficult to follow in previous studies. In the Blue Mountains of northeastern Oregon, 11 subadult females and 18 subadult males were radiocollared from 1993-98. We used tracking hounds to capture specific individuals, which enabled us to maintain radiocollars. Average home range size for subadult females was 4,121 ha (95% minimum convex polygon). None of the 11 subadult females left the study area. Seven of 18 subadult males left the study area and moved an average of 63.3 km (range = 33.4 km to 95.8 km). All 7 dispersed west or south out of the study area through a designated wilderness area. This dispersal pattern may indicate a distinct travel corridor to and from our study area. We discuss the influence of connective travel corridors on subadult male movement patterns and impacts on the amount of hunting opportunity and/or tag allocations allowed in the area.

WESTERN BLACK BEAR WORKSHOP 7:93-100

Key words: black bear, dispersal, home range, tracking hounds, Oregon, subadult, *Ursus americanus.*

Lack of information on the subadult portion of any wildlife population can hinder management decisions from both a population and a habitat standpoint. Caughley (1977) states the relationships between each segment of a population (adult, subadult, male, female) are affected by changes in any 1 segment. For example, changes in the subadult male/female segments affect the adult or breeding segments of a population. These changes can occur in several different ways, such as increase/decrease in mortality, immigration/emigration, or habitat manipulation affecting food or spatial requirements. Numerous studies have documented general characteristics of adult black bear movement patterns and habitat use (Jonkel and Cowan 1971, Kemp 1976, Young and Ruff 1982, Rogers 1987 Beck 1991, Beecham and Rohlman 1994, Vander Heyden 1997). However, few studies have been able to gain the same information from subadult black bears (Rogers 1987, Beck 1991). Dispersal is a fundamental component of a species' survival (Caughley 1977), and the documented dispersal rate for subadult male bears was 100% in Colorado (Beck 1991), Minnesota (Rogers 1987) and Idaho (Beecham and Rohlman 1994). Beecham (1983) and Beck (1991) believe the dispersal of subadult male bears and the habitat component used for dispersal could be an increasingly important aspect of black bear management. This information could be used by management agencies when defining population management objectives and determining harvest opportunities.

The primary reason few studies attempted to radiocollar subadult black bears is the inherent difficulty in maintaining radiocollars on individual animals. From birth to 4 years, young bears grow rapidly, making permanent radiocollars a risk to the safety of the animal. Without annual collar adjustments, a young bear could suffer neck abrasions, lose the ability to swallow or choke to death due to the tight collar. Breakaway collars take away the risk of injury, but it is difficult to recapture an animal once contact has been lost, especially if the animal is dispersing. As early as 1979 at the First Western Black Bear Workshop, a discussion was held concerning collars on subadult bears (Beaty 1979). In Minnesota, Rogers (1987) was able to make annual collar adjustments in the dens each winter, because all bears in the study denned on the ground. He also removed collars on yearling males in the dens, eliminating the risk of not locating those bears if they dispersed from the area. Rogers lost contact with a few radiocollared dispersing males, some of which were subsequently recovered as hunting mortalities. Most studies of black bear home range have avoided radiocollaring yearling/subadult bears or have relied on eartags to monitor movements by recaptures or hunting mortality returns (Poelker and Hartwell 1973, Beecham and Rohlman 1994, Vander Heyden 1997).

Our study was part of a larger black bear project looking at denning ecology, reproduction, survival, habitat use, and diet. Our primary objective was to document subadult black bear movement patterns and dispersal in northeastern Oregon; a secondary objective was to determine if tracking hounds are a safe and efficient method for recapturing radiocollared subadult black bears.

STUDY AREA

Our study area was located in the Grande Ronde River Watershed in the Blue Mountains of northeastern Oregon. The area was 570 km^2 in size, ranging in elevation from 840 to 2,640 m.

Approximately 75% of the area is mixed conifer stands of Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), ponderosa pine (*P. ponderosa*), and Englemann spruce (*Picea engelmannii*). Douglas-fir predominates at mid-elevations, ponderosa pine at low elevations, and lodgepole pine and Englemann spruce at high elevations. Approximately 25% of the area is bunchgrass rangeland. Land ownership is 60% public and 40% private. The public land is managed by the U.S. Forest Service, and the private is a mixture of timber company lands and cattle ranches. Most of the area has been intensively managed for timber harvest. The study area is within the Oregon Department of Fish and Wildlife's Starkey Wildlife Management Unit. The bear population in the study area received moderate hunting pressure from September through November during a general bear hunting season. In 1995, baiting and the use of hounds for hunting bears was banned in Oregon. Hunting opportunity was then limited to "spot and stalk" methods or incidental harvest during deer and elk seasons. A spring bear hunting season was instituted in 1998 with 50 tags available for the entire Starkey Unit. In the 1998 spring controlled hunt, no bears were harvested, and the fall general season hunters had a 1% success rate (12 bears harvested for 839 hunters).

METHODS

In 1993, we captured bears only in July as the project was beginning. From 1994-1997 we searched the entire study area for all bears from April through July in an attempt to minimize seasonal and annual variation in sex/age of captured bears (Akenson et al. 2001). In 1998, we searched only the northern portion of the area, because the main project was already completed, and the remaining short-term projects focused on only 10-15 bears (subadult females and adults).

We attempted to radiocollar all bears treed in 1993 through 1995. However, due to safety issues and time constraints, not all bears were immobilized. From 1996 to 1998, we did not attempt to collar subadult males due to limited resources available to locate dispersing bears and the information we already collected on previously dispersed subadult males. We focused capture efforts on subadult females every year (Table 1).

Bears were captured using tracking hounds, using snares, and darting free-ranging animals at bait stations. Hounds accounted for over 95% of the captures. Once the hounds treed a bear, a net was set up around the tree. The bear was darted, fell into the net, and was lowered to the ground for handling. An alternative method was to erect a blind to hide a shooter approximately 5 to 8 m from the tree. The houndsmen, dogs, and other team members would walk out of sight and remain hidden from view. The shooter then darted the bear as it left the tree. If the bear was collared previously, tracking equipment led us to the immobilized animal. If the bear did not have a collar, leashed hounds were used to locate the bear.

Table 1. Sex and age classes of black bears captured in northeastern Oregon from 1993-98.

Year	Adult males	Adult females	Subadult males	Subadult females
1993	5	8	7	3
1994	3	11	8	5
1995	4	1	6	1
1996	3	1	6	2
1997	1	0	2	0
1998	0	1	1	3
Total	16	22	30	14

All bears were eartagged, and age was estimated by cementum annuli analysis from a premolar tooth (Willey 1994). Each bear was given a unique number. In 1996 we inserted AVID microchips (Norco, CA) under the skin behind the ear in newborn cubs of radiocollared adult females to associate offspring with females during subsequent captures. All subadult bears captured after 1996 were scanned for microchips.

We attempted to locate collared bears at least twice a month either on the ground or from the air using a Cessna 180 airplane equipped with a global positioning system. Monitoring began with emergence from the den and ended with den entry, usually April through October. CALHOME (Kie et al. 1996) was used to calculate home ranges of subadult bears located >30 times. Females were considered to be subadult until they produced cubs, generally at 5 or 6 yr. Males <5 yr of age were classified as subadults. The minimum convex polygon (MCP) method (Mohr 1947) and adaptive kernel method (ADK) method (Worton 1989) were used to determine home range size. A utilization distribution of 95% was used in both methods. Dispersal distances for subadult males were calculated by using the farthest distance between initial capture location and dispersal locations. Movement distances for subadult females of unknown origin were calculated by using the distance between the initial capture site and the average center point of the home range polygon. Movement distances for offspring of radiocollared adult females were calculated by using the location of birth and the average center point of the home range polygon.

RESULTS

Females

We captured 14 subadult female bears 1-3 yrs of age from 1993 to 1998. One bear died as a result of capture immobilization, and 1 had cubs at age 4 before we documented 30 locations to calculate home range size. None of the remaining 12 left the study area. Three were killed (23%) during general hunting seasons in 1994 and 1999 (ages 2, 3 and 5), 2 of which we did not document 30 locations to determine subadult home ranges. Seven radiocollared females moved a mean distance of 1.7 km (0.6 km – 3.6 km) from their capture site. Three subadult females moved 0.6, 0.9 and 4.3 km from their location of birth. Average home range size for 10 radiocollared subadult females was 4,121 ha MCP (5,664 ha ADK) (Table 2).

The longest movement documented for any subadult female was 17.6 km. The female SF16 moved north from her original capture area sometime during the first part of August in 1993. She remained there until 21 Sep, when she returned to an area 3 km south of her capture site. We located her on 5 Oct, in the same location 17 km to the north, but she had returned to her original capture area by 26 Oct, where she denned for the winter. We did not document this type of movement for her in subsequent years, and no other subadult female traveled this extensively during the course of the study.

We followed 3 subadult females long enough to document their first litter of cubs and determine their adult home ranges. In each of the 3 cases, the subadult home ranges were approximately twice the size of their adult home ranges. In addition, each adult home range was either totally or partially incorporated into the subadult home range (Fig 1).

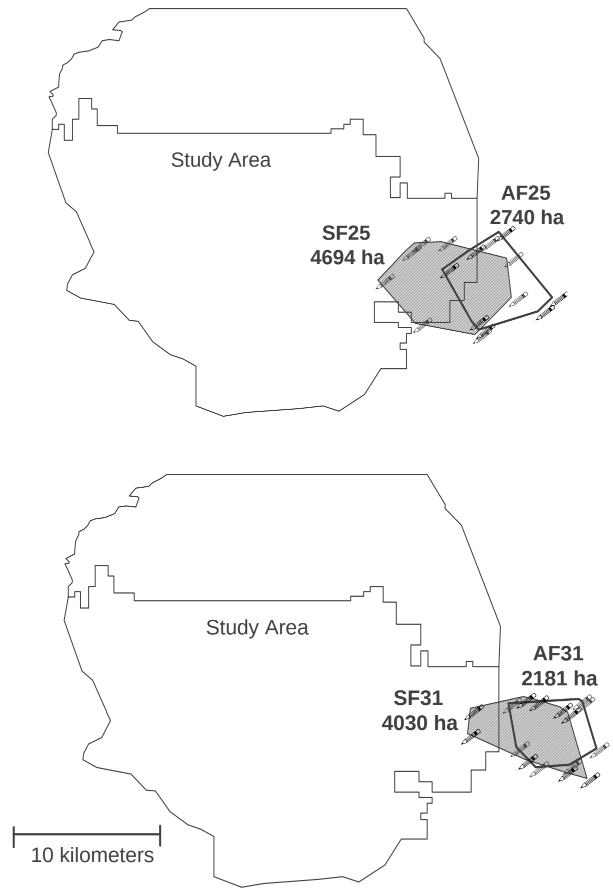

Figure 1. Home range size for radiocollared female black bears as subadults (SF25 and SF31) and adults (AF25 and AF31) in northeastern Oregon during 1994-99. Adult home ranges were smaller (58% and 54%) than subadult home ranges.

Two bears had cubs at age 6, while the other had cubs at age 5. We did not document cubs for the other subadult females at ages 3, 4, or 5. We determined that 3 of the subadult females captured in 1998 (SF74, SF75, SF76) were offspring born in 1996 to radiocollared adult females (AF18, AF12,and AF24, respectively) by microchip identification. AF18 and a cub from her litter of 3 were killed while crossing Interstate 84 in Oct 1996, leaving 2 cubs as

Table 2. Mean home range size and range (ha) calculated with minimum convex polygon (MCP) and adaptive kernel (ADK) methods for radiocollared black bears in northeastern Oregon from 1993-99.

Age / Sex	*n*	Mean MCP 95%	Range	Mean ADK 95%	Range
Subadult females	10	4,121	961-17,910	5,664	1,551-15,200
Adult females	18	3,455	1,437-6,820	5,683	2,133-14,490
Adult males	9	16,264	9,043-24,940	24,268	12,110-38,120

orphans at 10 months old. AF12 and a cub from her litter of 3 were killed illegally by hunters in Sep 1996, also leaving 2 cubs as orphans at 9 months old. The fates of the 4 orphan cubs were unknown until summer 1998. The subsequent capture of SF74 (offspring of AF18) and SF75 (offspring of AF12) confirmed the survival of at least 2 of the 4 of the orphans. They were found in good condition, weighing 41 kg and 50 kg at 2.5 yr. This was within the weight range of other 2.5-year-old bears we captured. The remaining subadult female we identified by microchip identification was SF76, offspring of AF24. She weighed 45 kg at 2.5 yr, having remained with her mother through her first winter and spring. Both SF76 and AF24 were alive at the end of the study. All 3 subadults set up home ranges within their mother's home range, averaging less than half the size of the adult females' home ranges (Fig 2).

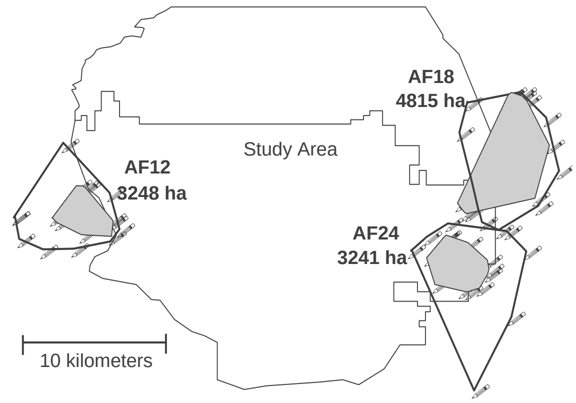

Figure 2. Home range size and location for 3 separate family units of radiocollared adult female black bears (AF12, AF18, AF24) and their radiocollared subadult female offspring in northeastern Oregon during 1993-99. The subadult females home ranges are shaded polygons inside their mothers' home ranges.

Males

Thirty subadult males were captured from 1993 through 1997. Eighteen were radiocollared, 11 were eartagged, and 1 died from capture related activities. Of the 5 radiocollared males estimated to be 4 yr, none dispersed. Of these 4-year-old males, SM54 was found dead during the 1995 general hunting season, but we could not determine the exact cause of death due to the state of decomposition. Bear SM69 was killed by a hunter in Nov 1996. Both SM54 and SM69 were killed before we determined home range or dispersal. The remaining 4-year-old males did not leave the study area, and we were unable to determine if they emigrated into the area. Also, we did not obtain >30 locations to determine their subadult home ranges before they were classified as adults at age 5. Of the 13 radiocollared subadult males, ages 1-3 yr, 9 survived long enough to document dispersal/home range, 4 were killed by hunters, and 1 died of unknown causes. Seven (78%) of the surviving 9 bears dispersed from the study area and moved an average of 69.9 km (Table 3). Six left the area following a westerly course, which moved through the North Fork John Day Wilderness (NFJD). We believed 2 of the dispersing bears (SM8 and SM23) were setting up home ranges in the NFJD when telemetry indicated the bears did not move from the area in over a year. We removed their collars in 1996. Subsequently, bear SM23 was shot in 1998 less than 1 km from where we removed his collar.

One of the 6 subadults moved 63.3 km and had not stopped his westerly course when we lost radio contact in Oct 1994. We lost contact with another dispersing male in Nov 1995. He had dispersed west 47.2 km and then headed 48.6 km north over the Blue Mountains and into the McKay Creek drainage. The

Table 3. Dispersal data of subadult black bears captured during 1993-94 in northeastern Oregon.

Bear	Date Captured	Age (yr)	Dispersal Date	Dispersal Distance (km)	Status
SM8	Jul 93	2	May 94	33.4	Survived
SM9	Jul 93	1	Jul 94	95.8	Lost contact Nov 95
SM20	Jul 93	2	May 94	63.3	Lost contact Oct 94
SM23	Apr 94	2	Jun 94	54.1	Killed Nov 98
SM26	Apr 94	2	Jun 94	68.0	Died Jun 95
SM46	Jul 94	2	Sep 94	35.0	Poached Nov 94
SM49	Jul 94	1	May 95	93.5	Killed Sep 94

last contact documented for both these bears was during a general bear hunting season. Two other dispersing males, SM49 and SM46, were killed by hunters after moving west 93.5 km and 35.0 km, respectively.

One subadult male (SM26) went 21.3 km south through the Elkhorn Mountains, also part of the NFJD, and denned along the mountain crest. The following spring he continued his southerly movement, traveling 67.2 km from his original capture site. He died of unknown causes in late June 1995.

The other 2 radiocollared subadult males did not leave the study area. Bear SM3, age 3 yr, was killed by a hunter in the study area 2 yr after his capture. We estimated his home range to be 37,240 ha. Bear SM32, age 2 yr, moved 26.6 km west in June 1994 and seemed to be heading along the NFJD route. However, he returned 22.8 km east back into the study area the next month where he stayed until winter. He continued this movement in and out of the study area to den each of the next 3 years, using a home range of 36,650 ha. We lost radio contact after SM32 denned in Oct 1997, but treed him with hounds in the spring of 1999 within the area he frequented during the past summers. Both home ranges were more than twice the size of our average adult male home range (Table 2).

Of the 6 radiocollared subadult males (ages 1-3 yr) which did not disperse, 5 (83%) were killed by hunters. Three of the eartagged bears were killed in the study area by hunters, while there was no report of the remaining 8 eartagged males after their initial capture.

Hound Captures

For the 27 radiocollared subadult bears that survived more than 1 year, 24 recaptures were needed to maintain radiocollars from 1994-1999. We used hounds for 22 of the recaptures, which averaged <1 day/capture. Two of the bears took several days to capture, because they continually treed in large-diameter trees where we could not safely immobilize the bears. Only 1 bear was not successfully recaptured with hounds.

DISCUSSION

Females

The home range information for subadult female black bears in northeastern Oregon is more variable than other studies. Jonkel and Cowan (1971), Rogers (1987), Beck (1991), and Beecham and Rohlman (1994) reported subadult females establishing home ranges within a portion of their mothers' home range. Rogers (1987) and Beck (1991) also documented smaller home ranges for subadults than for adults females. The 3 subadult females of known parentage in our study also set up home ranges that were smaller than their mothers' and within the adult's home range (Fig 2). However, 2 of these subadults were orphans and may have filled the void left by their mothers. Rogers (1991) documented orphaned females retaining their mothers home range, although immigrating adult females made it difficult for the subadults to remain in the area. In addition, our average subadult home range size (4,121 ha) was larger than our average adult home range of 3,455 ha (Oregon Department of Fish and Wildlife, LaGrande, OR, unpublished data). Also, the 3 females we followed as subadults and adults used smaller portions of their subadult home ranges (42 - 89%) as adults.

This variation in home range size may be attributed to a number of factors. Several studies indicate food availability and habitat quality directly influenced home range size (Lindzey and Meslow 1977, Pelchat and Ruff 1986, Vander Heyden 1997). Bull et al. (2001) documented that adult females in our study area used unlogged, old multistory stands with multiple canopies in grand fir in higher proportions than expected for bedding, moving and foraging. Only 10-20% of the study area was unlogged, and only 10% was classified as old multistory. Adult females in our study may be finding small pockets of unlogged, old multistory grand fir that offer both food and security. Subadult females may be moving through much larger areas trying to find unoccupied space in those same habitat types which offer high quality food and cover.

The lack of subadult female dispersal in our study area is similar to findings by Rogers (1987), Beck (1991) and Beecham and Rohlman (1994). The lack of dispersal by female offspring that we documented could negatively affect a heavily exploited population by suppressing the ability to repopulate an area. Our population suffered little subadult female mortality from hunting (2 of 11 subadults) and no natural mortality. This lack of mortality may be a stabilizing factor compared to the high mortality documented for subadult males in the study area (7 of 10).

Males

The dispersal distances (33.4 – 95.8 km) and age of dispersal (2 - 4 yr) that we documented for subadult males is similar to other studies (Rogers 1987, Beck 1991, Beecham and Rohlman 1994). The subadult male dispersal pattern to the west and south may indicate bears use continuous forested habitat for travel (Fig 3). Our study area is bordered by Interstate 84 on the east and north, with sparse forested habitats or heavily managed forests in those directions. We documented only 1 bear crossing the interstate to the east during the 7-year study, and she was killed in the attempt along with 1 of her 3 cubs. No movement to the north was documented. The route west through the NFJD crossed only 2 paved roads, both of which had low use. The route south through the Elkhorn Mountains crossed only 1 paved road (also low use) and extended through a portion of the NFJD. Human activity was minimal, except during big game hunting seasons, and the habitat available along those routes contained heavily forested riparian areas. The North Fork John Day River is 1 of the few intact systems (not dammed and unroaded riparian area) in northeastern Oregon and extends westward from the NFJD wilderness units. Heavily managed forests with extensive road systems lie directly south and north of the river, creating a distinctive, continuous corridor of the river and its associated riparian forested habitat.

The maintenance of travel corridors becomes increasingly important considering the high mortality rate (70%) of subadult male bears in our study area that did not disperse. Without the ability to immigrate/emigrate into different areas, populations may be subject to overexploitation or increased competition for available habitat. Hunting pressure could have a greater impact to the population if subadults were not able to utilize travel corridors (Beecham 1983). If a stable population was subjected to an increase in hunting pressure, and surrounding habitat was not adequate for subadult male immigration, the population could face serious decline without the influx of immigrating subadult males. Hunting was the major factor influencing subadult male survival in our study area, even after baiting and the use of hounds for bear hunting were prohibited. Increased hunting pressure could elevate the importance of maintaining movement corridors that offer security for movement in and out of an area.

Hound Captures

The use of trained hounds allowed us to efficiently recapture bears as needed. Because 42% of subadult bears in our study area denned in top entry tree dens and were inaccessible during the winter (Bull et al. 2000), collar maintenance had to be done in the summer. Snares or culvert traps are less precise in targeting specific animals and can take many days of trapping to capture an individual. The use of snares also requires researchers to immobilize captured bears to release them, even if the collars do not need adjustment. In contrast, we could efficiently tree at least 1 bear each day with hounds. Also, treeing

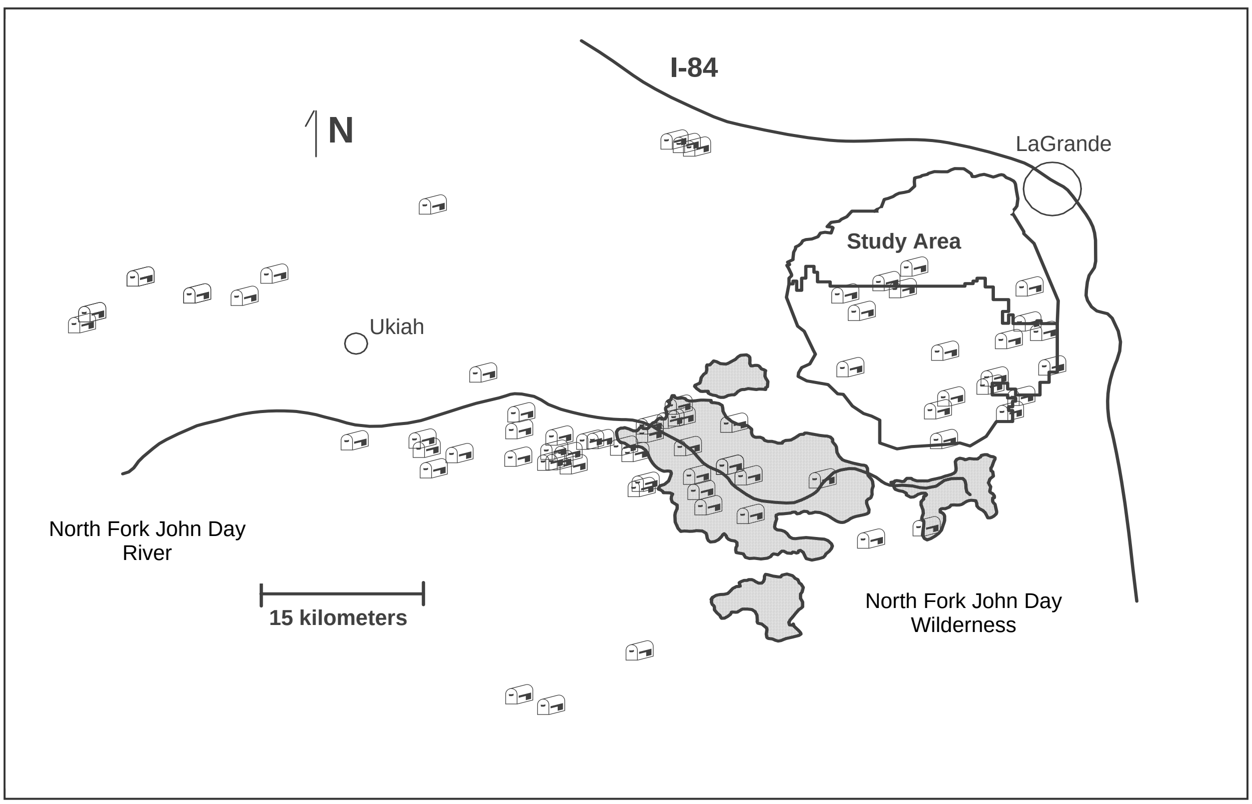

Figure 3. Telemetry locations (solid black squares) of 7 dispersing subadult male black bears (1993-96) from a northeastern Oregon study area through North Fork John Day Wilderness units and North Fork John Day River corridor. No dispersal locations were documented to the north or east of the study area.

bears allowed us to visually inspect an animal to determine if a radiocollar needed adjustment and eliminated unnecessary immobilization.

The low number of subadult females captured may be a function of their limited movement within a home range (Oregon Department of Fish and Wildlife, LaGrande, OR, unpublished data). Although adult bears are moving from late June through July apparently looking for potential breeding partners (Rogers 1987), subadult females may remain localized within a small area making them less likely to cross roads where hounds could scent them. The high number of subadult males captured early in the summer is most likely due to their dispersal activity (Akenson et al. 2001). Our study area had a high density of roads (>2.2 km/km^2) that allowed easy access for the houndsmen and enhanced the probability that a dispersing subadult male would cross a road.

MANAGEMENT CONSIDERATIONS

1. The protection of travel corridors may facilitate subadult immigration and emigration. If corridors do not exist or populations are isolated due to habitat fragmentation, wildlife managers should consider the impacts on the population when increasing tag allocations. Subadult immigration into a population may offset increased mortality within a population due to increases in hunting pressure. Managers may have more flexibility with hunting regulations if adequate travel corridors are available.

2. Consideration of non-traditional capture methods, such as tracking hounds, may increase the ability of researchers to study subadult black bears. Capturing subadult bears with hounds provides a safe and predictable method to maintain radiocollars. Studies designed to incorporate capture by hounds may be able to integrate low-risk, long-term research on subadult movement patterns. Long term research allows for the slow maturation period of bears and the variability in behavior patterns that may be present in some populations.

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DENNING ECOLOGY OF BLACK BEARS IN SOUTHWEST BRITISH COLUMBIA

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Black bear (*Ursus americanus*) denning and hibernation habits were studied during 1994-2000 in the Fitzsimmons Range of the Coast Mountains in southwest British Columbia. The 200-km^2 study area comprised the Whistler-Blackcomb alpine ski resort, Garibaldi Provincial Park, and Whistler Interpretive Forest. Field methods were based on direct observations (non-telemetric) of identified researcher-habituated (no feeding occurred) animals, non-researcher-habituated animals, bear-track surveys, and predictive den site variables. Denning research continues as a component of the 15-year (1994-2008) Whistler Ecosystem Black Bear Project initiated to learn the ecological trends of 3 sub-populations (Blackcomb Mountain ski area, Whistler Mountain ski area, and Whistler Interpretive Forest) of free-ranging, unhunted black bears adjacent to the Resort Municipality of Whistler. Sixty-eight free-ranging black bears (28 males, 40 females) denned with varied chronology from mid-October through mid-May. Attributes measured to delineate bear class chronology were elevation (onset of snowfall), temperature, precipitation, barometric pressure, Vaccinium phenology (productivity of fall feeding areas), *Trifolium* phenology (availability on ski trails), skunk cabbage (*Lysichiton americanum*) emergence (early spring feeding), and accessibility to edible human garbage. One-hundred-twenty black bear dens were located by: 1) tracking 88 individual bears during den entrance from mid-October through early January (N=58 dens); 2) back-tracking 20 individual bears during den emergence from early March through mid-May (N=18); 3) predicting potential denning areas/sites using existing den site use variables (N=34); and 4) incidentally during other types of field work (N=10). Ninety-three percent (112/120) of dens were tree cavity sites with the remaining 8 dens as excavations beneath large boulders or rock outcrops. Den site characteristics delineated were elevation, macro/micro-aspect, tree species, diameter at breast height, entrance aspect, macro/micro-slope position, entrance height above ground, entrance/cavity/bed geometry, bedding material type, den site buffer type, cover type (seral stage), and habitat type (site series). Spatial attributes delineated were den site distance to nearest: vacant den; occupied den; pre-denning daybed; late fall feeding area; early spring feeding area; ski chair lift; summer-groomed ski trail; gladed ski trail; access road; hiking trail; and water source. Attributes recorded every 5 days from observations of 30 hibernating tree cavity-denned black bears were den site entrance exposure (rate of snow cover), snow depth at entrance, distance to nearest ski/snowboard tracks, position of bear, reaction to observer, reaction to winter recreation (skiing/snow boarding and snowmobiling), shivering patterns, ocular activity, respiration rate, ambient temperature, tree cavity temperature, precipitation, and barometric pressure. Researcher-caused den abandonment occurred once on 27 February 1995. Black bear denning ecology studies provide a resource database for ski area development planning, predictive den site modeling in coastal forests, and bear education programs.

Key words: black bear, denning, tree cavities, ski area, southwest British Columbia.

CONSERVATION ASSESSMENT AND RESERVE PROPOSAL FOR BRITISH COLUMBIA'S WHITE BLACK BEARS (*URSUS AMERICANUS KERMODEI*)

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In British Columbia (BC) opportunities still exist to protect species, habitats and ecosystems across large intact areas through a variety of on going provincial and federal conservation initiatives. This paper outlines a conservation biology analysis and core reserve design for the Kermode or Spirit bear (*Ursus americanus kermodei*), one of the 16 recognized subspecies of the North American black bear.

Kermodes are endemic to central British Columbia's north-coast region and are one of the crown jewels of BC's biodiversity heritage. Near Klemtu, on Princess Royal Island (4th largest island in British Columbia), rough estimates indicate 1 in 10 Kermodes are white (not albino). Recent, state-of-art research has failed to elucidate the genetic mechanism or evolutionary origin of this unique color phase. The origin of the white pelage may be linked to periglacial Pleistocene environments, and a small, isolated, insular black bear population. Fossil evidence indicates black bears have been in North American >3 million years, about 100 times longer than grizzly/brown bears, which immigrated relatively recently ~40,000 years ago. Recent mitochondrial DNA studies indicate Pacific coast black bear subspecies have been isolated from mainland interior black bear lineages for approximately 350,000 years. However, details of the phylogeography of the 7 black bear subspecies on the Pacific Northwest coast remains a mystery.

As of today no protected areas have been established for Kermode bears. Those that have been seriously considered by the BC government are grossly insufficient in size to ensure persistence of the subspecies in the face of large-scale liquidation of the region's ancient rainforest by timber companies. BC government GAP analyses for future conservation areas over-represent existing protection of the region's lowland rainforest by lumping coastal and interior areas. On the coast of central BC, commercially operable forests are largely restricted to low-elevation valley bottoms and adjacent hillslopes. It is in these areas that both bear and salmon habitat, and local terrestrial biodiversity, are concentrated. The region's commercial timber industry in its present form is dependent on high-grade clearcut of the most productive lowland conifer stands. Because of the extremely mountainous topography and patchy distribution of prime timber, the industry is forced to build extensive road networks through fragile estuaries, riparian zones, and steep unstable hillsides. International forces promoting intensive timber harvests for lumber and pulp on the BC coast are omnipotent – e.g. ~75% of Vancouver Island has already been logged and exploitation of watersheds on the adjacent mainland is similar. Legal hunting and poaching of black and grizzly bears is widespread throughout the region, especially in log-roaded and other accessible areas, but the extent of hunting impacts on BC's coastal black bear populations is unclear. It has been illegal to shoot a white black bear in BC since the 1950s.

The primary objective of our research is the design and establishment of a reserve suitable for long-term conservation of Kermode bears. Our reserve design methodology combines modern conservation biology principles plus Geographic Information System (GIS) computer mapping, and is not constrained by conflicting environmental or First Nations' interests, BC government timber-harvest quotas or Protected Area Strategy's "12% rule". At a broad scale, we assessed the reported geographic range of white-phase Kermodes, documenting historic records, local and First Nations' knowledge, field observations from a number of reliable sources, and our own data. We identified 2 genetic epicenters where the incidence of white black bear sightings is significantly more common than other areas. All information suggests that the ratio of white to black Kermodes varies considerably across the geographic range of the subspecies, even between neighboring islands or the adjacent mainland. The coastal islands and extreme mountain topography of the region undoubtedly restricts bear dispersal and gene flow, creating meta-population and source-sink population dynamics. We overlaid white Kermode distribution with the location of intact vs. existing roaded and clearcut areas within the region, concluding that the most suitable area for a white Kermode reserve was a large, ecologically intact area centered on Princess Royal Island and its adjacent mainland. Unfortunately, many other island and mainland areas of Kermode habitat have been extensively logged. Several existing large protected areas within the range of *U. a. kermodei* (e.g. Khutzeymateen Grizzly Sanctuary and the huge Kitlope Conservancy) were shown to have a very low incidence of white black bears.

For our study area (including a ~249,000 ha, island-mainland, spirit bear sanctuary originally proposed in 1987) we developed a series of GIS map layers focusing on forest types, black and grizzly bears, Sitka black-tail deer, wolves, salmon, and commercial logging to refine a Kermode conservation assessment and reserve proposal. Map layers were developed at 1:50,000 and 1:20,000 scale, and included a digital elevation model, biogeoclimatic subzone variants, rare old-growth forest types, terrain sensitivity to disturbance, bear habitat capability, bear denning habitat, deer/wolf winter habitat, salmon distribution and abundance, estuaries and riparian zones, existing and planned roads and clearcuts.

We developed a generalized habitat capability model for both Kermodes and grizzlies. However, few grizzlies occur on BC's large offshore islands – probably a consequence of the black bears' ability to preempt limited resources on islands because of their higher reproductive rate, less constraining food requirements, and greater density potential. Based on field surveys of bear food density and abundance, and bear habitat use, combined with information from bear studies from ecologically similar regions, seasonal feeding and denning habitat values were determined for each of the biogeoclimatic subzone variants (our finest-scale regional measure of habitat types). This was combined with local estuary, salmon and riparian values to develop an overall bear habitat ranking. Steep slopes (>60^{o}) were eliminated. We estimate ~169,000 ha (68%) of the proposed ~249,000 ha sanctuary has moderate to very high capability to support black bears and grizzlies. The highest values are obviously restricted to low-elevation valley bottoms and adjacent hillslopes, especially in watersheds with large salmon runs and estuaries. Our model is consistent with intensive bear behavior studies in the nearby mainland Khutzeymateen Grizzly Bear Sanctuary.

Bear activity surveys in high-quality habitats in our study area give some index of bear numbers, but our rough population estimates were mainly derived from reliable density estimates determined in ecologically similar areas (e.g. Mitkof Island, southeast Alaska). We estimate the number of Kermodes within the proposed island-mainland reserve at ~810-1,200, including ~80-120 of the white phase. We suspect black bear numbers are near carrying capacity in the study area since only a small percentage of the proposed park has been disturbed, actual habitat use by bears is widespread, and the intensity of black bear hunting appears to have been comparatively light. Mainland areas of the proposed reserve are estimated to have a potential of ~75-100 grizzly bears, with actual numbers appearing reduced to ~25-40. This is probably due to a combination of poaching and excessive legal trophy hunting. Only 2-5 grizzlies appear to frequent the larger islands of the study area. Both bear species are extremely valuable in Asian medicinal and aphrodisiac markets – poaching is estimated to represent 30-50% of the annual bear kill in BC.

On the BC coast, Pacific salmon runs are critical food for bears, representing near 90% of their late summer-fall diet. Canadian federal Department of Fisheries & Oceans' Pacific salmon escapement data for 1953-1996 document 34 Pacific salmon streams in the proposed reserve; these runs enter watersheds whose combined area represents ~40% of the proposal. Total average annual run size into the proposed reserve is ~160,000 Pacific salmon: 1% chinook, 2% coho, 2% sockeye, 18% chum and 77% pink salmon. Compared to established parks in the region, the proposed Kermode reserve has many widely distributed, comparatively small salmon streams, offering bears optimal fishing opportunities and spreading the risk of annual run failure. Some of the mainland watersheds in the proposal support large runs of all salmon species, including steelhead. Many stocks of salmon on the BC coast have recently been listed as extinct or threatened, a result of the widespread cumulative effects of clearcut logging, hatcheries, overfishing, global warming, and fish farming. Planning new parks on the basis of salmon values alone is justified. The effects of salmon run failure on BC's coastal bear populations have already caused a bear management crisis in some areas, such as Rivers Inlet (1999-2000).

We developed black and grizzly bear den habitat models by overlaying old-growth, elevation and slope steepness coverages. Based on coastal bear studies in ecologically similar areas, black bear appear to rely more on old-growth and lower elevations for winter dens than grizzlies. We estimate that 15% (~37,300 ha) of the study area has high capability for black bear dens, and 25% (~62,340 ha) for grizzly dens. Using Hansen's (1988) black bear den density observations from Mitkof Island (southeast Alaska) of .056 dens/ha, ~2,100 den trees may be available for Kermodes within the proposed reserve.

Our proposed Kermode reserve also has remarkably high value as an intact Sitka deer-wolf predator-prey system compared to other areas in the region. Field surveys indicate that both species use habitats from sea level to the alpine zone during late spring to fall. Approximately 197,000 ha (79%) of the proposed park appears to be suitable for use by deer and wolf at that time. A Sitka deer winter habitat model was developed focusing on high-volume, Western hemlock-dominated forest stands below 500 m, and eliminating slopes >40^{o}. About 30,500 ha (12%) of the proposal supports potential winter deer range. Using density estimates from ecologically similar areas, the proposal may support as many as 4,300-16,000 Sitka deer, and 60-70 wolves, their primary predator.

Logging companies are required to submit 20-year plans for road building and cutblock operations on Tree Farm Licenses and other public lands. Impacts from existing and proposed logging were assessed by development of a GIS road and clearcut layer, and for bears a generally accepted 0.5 km *zone-of-influence* (ZOI). This ZOI width is conservative. Total length of 20-year plan roads is 776 km, and 20-year plan clearcuts total 4,883 ha, resulting in a ZOI of 61,300 ha. Development of logging road networks and forest clearcutting directly impacts bear habitat, salmonid spawning and rearing habitats, critical estuaries and riparian zones, and drastically increases the permeability of the landscape to legal bear hunters and poachers. Near 67% of the ZOI is now old-growth >250 yr.

Approximately 90% of the ZOI is in habitat presently rated high or very high for bears; ~11% is bog forest of comparatively low timber value. Also, using ZOI, we predict ~25% of potential deer winter range will be directly lost over the next 20 years, and ~92% after 100 years at current rates of timber harvest.

As is now the case for most watersheds on BC's south coast, projected impacts from construction of new logging roads and current cut levels for the next 100 years in our study area are expected to be very high for both bear species, salmon, deer and wolves, rare and endangered forest types, and the many critical ecological processes they represent. Loss of bear denning habitat in old-growth will be severe over the long term. Industrial logging's cumulative effects are compounded by the ecosystem's high sensitivity to disturbance due to extreme rainfall, steep mountain slopes, thin unstable soils, frequent gale force winds, and extremely low frequency of forest fires. The projected impacts of logging on Kermode numbers, in addition to potential consequences for white-color phase representation in the Kermode gene pool, indicate that full protection of our reserve proposal is the best option to assure the long-term survival of spirit bears and their habitats, in addition to the region's threatened grizzly population, outstanding wolf-deer system, and unique marine-terrestrial ecosystem processes.

Our proposed Kermode reserve would fill a significant conservation gap in BC by adding protection to a large island-marine ecoregion contiguous via the adjacent mainland's Kitimat Mountains with a very large complex of established protected areas spanning both sides of the Coast Range (Kitlope, Fiordland, and Tweedsmuir). Our spirit bear proposal would add significant quantities of very productive bear, deer and wolf habitat, a diversity of maritime old-growth rainforest types including muskeg and coastal subalpine parkland, and a wide variety of estuary and outer-coast marine habitats not found in the other regions. If a ~249,000-ha spirit bear reserve was established it would represent 15% of a comprehensive, internationally significant, large carnivore conservation area totaling ~1,655,000 ha of intact wildlands from the outer coast to the interior of the province. No other opportunity for such a fully representative and comprehensive conservation-area network exists along British Columbia's Pacific coast.

Key words: Kermode bear, conservation assessment, sanctuary.

PRINTS IN THE DUST: DIFFERENTIAL HABITAT UTILIZATION, MOVEMENT PATTERNS, AND BEHAVIOR OF THE AMERICAN BLACK BEAR FROM HOUND TRANSECTS ON THE EAST TAVAPUTS PLATEAU (ETP), UTAH

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Habitat has been shown to affect reproduction and survival in the American black bear (*Ursus americanus*), but knowledge of the extent to which a bear samples its environment is limited (Craighead 1998). Although many habitat studies have been done throughout North America, they are largely limited to montane or forested regions and analysis focused on large-scale habitat measures, such as land cover or habitat classes (van Manen and Pelton 1997). Although efforts to quantify habitat use and movement of black bears with telemetry, GPS collars, and other conventional methods has been largely successful on a macro-scale, little work has been done to document localized behaviors of bears in patchy habitats. This localized behavior within specific habitats would be particularly important for management of bears in areas that may be considered sub-optimal or marginal. This is the case on the East Tavaputs Plateau (ETP) in eastern Utah. Bears live on a low-elevation desert plateau characterized by large, scattered expanses of sagebrush steppe and minimal water. Since conventional techniques do not adequately provide information on local habitat use, we hypothesized that one could train hounds on leash to backtrack fresh tracks left by bears. These belt transects would approximate the path bears take in their diel movements. By tracking bears with different track sizes, we could in effect sample the population, and this sampling method will provide quantitative data on habitat utilization and spatial measurements of various behaviors. Preliminary analysis of 69 transects contains a distribution of track widths that suggest that hound-derived transects do indeed provide a population sampling method for bear behaviors and habitat utilization. Bears appear to use all available habitats (aspen, oak brush, mountain brush, pinyon-juniper, and sage steppe); however, unlike other studies in the western states, this study reveals that bears use sagebrush steppe in disproportionate amounts to its availability as a foraging substrate for ants.

Key words: black bear, habitat, movement, hounds.

BEAR BEHAVIOR IN THE VICINITY OF SUPPLEMENTAL FEEDING STATIONS IN WESTERN WASHINGTON

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Abstract: Black bear can inflict severe negative impacts on timber stands in the northwestern United States. A supplemental feeding program to provide bears an alternative food source during spring is practiced in the state of Washington, and to a lesser extent in other states. We initiated concurrent studies to assess characteristics of bear that forage at feeding stations, the interactions of bears around feeders, and impacts of the program on bear territories. Numerous bears fed at stations, including females with and without cubs, yearlings, and males. Bear feeding bouts at stations were generally short, less than 15 minutes. Bears generally fed alone, although we observed 2 to 3 adult bears at a feeder simultaneously and feeding partners were not consistent. There was little antagonistic behavior observed around the feeders, and no evidence that this behavior inhibited foraging opportunities for long. On the rare occasion a bear was driven from a feeder it returned later that same day to feed. Bear territories that included feeding stations were similar in size to territories of bears without access to feeders. However, there may be more overlap of territories at feeding sites, and during the spring bears with feeders do not visit some parts of their territory as frequently as those without feeders.

WESTERN BLACK BEAR WORKSHOP 7:106-111

***Key words*:** behavior, black bear, home ranges, interactions, supplemental feeding, Pacific Northwest, *Ursus americanus,* video monitoring.

Black bears (*Ursus americanus*) commonly forage on Douglas-fir (*Pseudotsuga menziesii*) trees during the spring (Ziegltrum and Nolte 1997). They strip the bark to feed on the newly forming vascular tissue which may contain 4 to 5% free floating sugars (Kimball et al. 1998). These vascular tissues are dietary staples for some bears (Noble 1993). Bears feed on the vascular tissue by removing the bark with their claws and scraping the sapwood from the heartwood with their incisors. Bears generally feed on the lower bole of trees in stands between 15 and 30 years of age (Ziegltrum 1994). Any age tree, however, is vulnerable and bears occasionally strip an entire tree. Damage within a stand can be extensive as a single foraging bear may peel bark from as many as 70 trees per day (Schmidt and Gourley 1992). Damage inflicted through this behavior can be extremely detrimental to the health and economic value of a timber stand (Ziegltrum and Nolte 1997). Complete girdling is lethal, while partial girdling reduces growth rates and provides avenues for subsequent insect and disease infestations (Kanaskie et al. 1990). The severity of timber loss is compounded because bears tend to select for the most vigorous trees within the most productive stands or where stand improvements (e.g., thinning) have been implemented (Mason and Adams 1989, Kanaskie et al. 1990, Schmidt and Gourley 1992).

Historically, management to protect timber resources from bear damage generally required lethal removal of bears. Control agents or professional hunters were hired to trap and hunt bears throughout the counties where damage was occurring (Poelker and Hartwell 1973). Private timber mangers began investigating alternative damage control techniques, particular non-lethal methods, during the mid-1980s. The first directed effort to provide bears with an alternative food to reduce bear girdling of trees was attempted in 1985 (Ziegltrum 1994). During the first year, approximately 2,250 kg of pellets were provided through 10 feeders. Since its inception the program has continued to grow. During 1999 approximately 288,500 kg of pellets were offered through approximately 900 feeders spread across western Washington, with a few feeders in Oregon and California.

The supplemental feeding program appears to be an effective means to reduce bear damage in select timber stands (Ziegltrum and Nolte 1997). Bears generally reduce their tree peeling once they begin eating pellets. Some anecdotal evidence, however, suggests that success of the feeding program declines as population densities increase. This decline in the program's efficacy may occur because of competition among bears or through efforts by bears to avoid antagonistic encounters, particularly females with cubs.

The impact of the supplemental feeding program on bear behavior is largely unknown. Interest in possible long-term consequences has increased as supplemental feeding of bears has grown and become more widespread across western Washington. Questions raised by timber and wildlife managers led to a series of studies being conducted through the National Wildlife Research Center's Olympia (Washington, USA) Field Station to assess the effects of supplemental feeding on nutritional status and behavioral characteristics of black bears. This paper presents information pertaining to the characteristics of bears which forage at feeding stations, interactions of bears around feeders, and the impacts of the program on bear territories. The effect of the supplemental feeding program on the bear territories also was presented at the International Bear Conference in Romania (Fersterer et al. 2001).

METHODS

Study Area

The study area was approximately 80 km southwest of Olympia, Washington (USA) between 123°37'30"-123°00'00" longitude and 46°42'30"-47°02'00" latitude. Elevation ranged from 30 m along the Chehalis River to 798 m on Larch Mountain. Bears with access to supplemental feed were located on timber stands of the Weyerhaeuser Company. The supplemental feeding program had been practiced in these stands for several years, and physical characteristics of the stands were similar to state owned timber stands where supplemental feeding had not been practiced. Non-feeding areas were located on the Capitol State Forest and the Lower Chehalis State Forest.

Monitoring Bear Activity Near Feeding Stations

We videotaped bear activity in the vicinity of 4 feeding stations from May 1 until July 10, 1999. Feeders were located within approximately 5 km of each other. Three other feeders also located within the vicinity of the study area were not monitored. Video cameras were mounted on tree stands within 10 m of feeding stations. Camera limitations prohibited nighttime monitoring. Batteries and videotapes were replaced every 2 - 3 days. Platforms were constructed at least 3 weeks prior to videotaping to ensure bears were familiar with their presence. We saw no indication (e.g., bears leaving an area immediately prior to our arrival) that human activities to maintain cameras impacted bear behavior. Our ability to recognize an individual bear was enhanced because several bears had been captured and ear-tagged during another study.

The indicator we used to assess wariness of bears while at feeding sites was the number of times a bear exhibited 3 specific behaviors: 1) Looking Away; 2) Walking Around; and 3) Standing Up. *Looking away* was defined as remaining at the feeder but staring at something off camera for several seconds. *Walking Around* was defined as leaving the feeder and walking to the edge of the feeding site and staring at something off camera for several seconds. *Standing up* was defined as a bear raising on its hind legs and appearing to look around the feeding area.

Equipment used in the study included Panasonic WV-BP310 (black and white series) video-cameras with a fixed-iris lens (Broadcast and Televisions Systems Company; Secaucus, New Jersey), Pelco (MD2001) single channel analog video motion detectors (Pelco; Clovis, California), and Panasonic (model AG1070) direct current time lapse recorders (Broadcast and Televisions Systems Company; Secaucus, New Jersey). All equipment was powered by marine 205-minute reserve capacity batteries. Platforms (2.5 x 2.5 m) were built around a Douglas-fir tree at least 4 m above ground with crossed support beams covered with plywood. All branches below platforms were removed.

Monitoring Bear Movements

The approach used to monitor bear movements was described in Fersterer et al. (2001). Briefly, bears were captured and collared during the spring months of 1998 and 1999. Bears in stands with feeders were captured near feeding stations. Non-feed bears were captured in stands being damaged by bears that had similar timber characteristics. During summer and fall of 1998, movements of 4 bears within feeding areas and 5 bears outside known feeding areas were monitored after feeding had been concluded for the year. An additional 16 bears were incorporated into the study during the spring of 1999 for a total of 17 bears within feeding areas and 8 outside the supplemental feeding sites. Movements were monitored throughout the period when bears were actively feeding at stations (TRT), as well as outside this period (PRE).

Bear locations were identified by triangulating telemetry points. Attempts to locate bears were repeated until all points were within a 35 x 35 m area. The home ranges were estimated using the minimum polygon method with a 5% reduction of area (Kenward 1987). A 3-factor analysis of variance was used to compare home range size differences among bears with treatment (supplemental feed, no supplemental feed), gender (male, female) and period (feeding period, outside feeding period) as factors. Feeding period was defined as the time between May 1 and June 30 when there was high activity around feeders inside the study area.

RESULTS

Bear Use of Supplemental Feeding Sites

Numerous bears fed at stations, including females with and without cubs, yearlings, and males. Overall, 20 bears visited at least 1 feeder. Most bears visited at least 2 feeders and several were observed at all 4 feeders (Table 1). Bears generally fed at stations every 2 or 3 days (Table 2) and their visits were usually short, less than 15 minutes (Table 3). Occasionally, adult males walked through feeding sites without stopping to eat. Bears also used numerous feeding sites, often moving from 1 feeder to the next within a single day. While at feeding sites, bears spent most of their time sitting in front of the feeder. However, the amount of time bears spent with their head inside a feeder, an indicator of eating, was fairly short. The mean for all bears was approximately 1.5 min (Table 3). Cubs played in the feeders. Therefore, they were recorded having their heads in the feeders considerably longer than other bears. Bears spent approximately 25% of their time walking around feeding sites (Table 3).

Feeders were used by bears throughout the study period. Mean hourly activity was calculated for each of 7 consecutive 10-day periods. Bear activity, particularly early in the spring, was greatest early in the morning and then again during late afternoon or early evening. Bears, however, were recorded visiting stations at all hours of the day. There was no indication that 1 class of bears (e.g., females) avoided feeders during times of high use by another class of bears (e.g., large males). Use of feeders declined toward the end of the feeding period, and feeders were removed from the field on July 10.

Alert Activity Exhibited by Bears Near Supplemental Feeding Sites

Alert activities were exhibited by lactating females more frequently than by other bears, while there was a tendency for adult male bears to demonstrate these behaviors the least (Table 4).

Table 2. Mean number of days between visits by bears of different status at four feeders video-taped for activity between May 1 and July 10, 1999.

Bear Status	Mean Number of Days
Females	2.5
Females with cubs	2.1
Cubs (sets)	2.2
Adult Males	2.6
Sub-adult Males	3.1
Yearling	0.9

Bear Encounters Near Supplemental Feeding Sites

Bears generally fed alone, though we observed 2 to 3 adult bears at a feeder simultaneously and feeding partners were not consistent (Table 5). We observed little antagonistic behavior around feeders, and found no evidence that this behavior inhibited foraging opportunities for long. On the rare occasion a bear was driven from a feeder it returned later that same day to feed.

Bear Movements

Home range size varied among bears (Table 6). The home ranges of bears in feeding areas, however, were not different ($P > 0.35$) than the home range of bears in non-feeding areas (Table 7). Male bears had larger ($P = 0.0002$) home ranges than female bears, and this difference was consistent across treatments ($P > 0.35$). Bear movements also were reduced ($P = 0.0286$) during the feeding period relative to the non-feeding period (Table 2), but again this difference

Table 1. The status and number of bears visiting four feeders video-taped for activity between May 1 and July 10, 1999.

Bear Status	Number of Bears Monitored				
	Feeder #1	Feeder #2	Feeder #3	Feeder #4	All Feeders
Females	2	2	2	2	4
Females with Cubs	2	1	1	0	2
Cubs (sets)	2	1	1	0	2
Adult Males	5	5	5	5	5
Sub-adult Males	4	5	2	2	6
Yearling	1	1	1	1	1
Total	16	15	11	9	20

Table 3. Mean number of minutes different status of bears spent at feeding sites, mean time spent sitting in front of feeders, mean time their head was inside a feeder, and mean time spent within the vicinity but not directly in front of a feeder.

Mean Number of Minutes for Bears at Feeding Sites				
Bear Status	Total	Front of Feeder	Head in Feeder	Away from Feeder
Females	14:44	9:53	1:19	4:27
Females with Cubs	13:24	10:36	2:50	3:07
Cubs (sets)	14:05	10:40	5:00	3:25
Adult Males	14:02	11:08	1:02	3:20
Sub-adult Males	14:03	11:14	1:55	2:36
Yearlings	20:13	14:02	0:38	6:05
All Bears	14:50	10:52	1:38	3:49

Table 4. Mean number of times bears exhibited three alert behaviors at four feeders videotaped for activity between May 1 and July 10, 1999.

Frequency of Alert Activity[a]			
Bear Status	Looking Away	Standing Up	Walking Around
Females	5.3	0.1	1.1
Females with Cubs	8.4	3.4	2.7
Cubs	0.4	0.3	0.6
Adult Males	2.7	0.1	0.6
Subadult Males	5.4	0.0	0.9
Yearlings	4.9	0.4	0.8

[a] Looking away was defined as a bear remaining in front of a feeder but staring at something off camera. Standing up was defined as a bear raising on its hind legs and looking around the feeding site. Walking around was defined as a bear leaving the feeder and walking to the edge of the feeding site and staring at something off camera for several seconds.

did not relate to feeding (P =0.2614). There was no interaction between periods and gender (P = 0.1121). The 3-way interaction among treatments, periods and gender also was insignificant (P = 0.0984).

DISCUSSION

Our efforts to videotape bears in the vicinity of supplemental feeding stations was restricted to a single area. Therefore, these results need to be interpreted as a case study rather than a replicated experiment. Although lack of replication restricts our ability to extrapolate these findings across western Washington, the study does provide a glimpse of bear use of supplemental feed and their behavior at these sites.

Table 5. Total number of times multiple bears visited a feeding site at the same time, total number of times an aggressive bear chased another bear from the feeding site (Aggressive) and number of times bears remained at the feeding site together (Non-Aggressive).

Interaction	Total	Aggressive	Non-Aggressive
Female/Female	0	0	0
Male/Male	6	0	6
Male/Female	17	2	15
Male/Female/Male	1	0	1
Female/Male/Female	1	1	0
Total Encounters	25	3	22

We were surprised at the limited amount of time bears spent at feeding sites. They only visited feeders every 2 or 3 days, and then on average remained at feeding sites for only about 15 minutes per visit. These findings were contrary to opinions expressed by several persons familiar with the feeding program who thought large boars probably remained near feeders and dominated use of the pellets. In retrospect, however, reproductive males are normally exploring for partners during this period (Pelton 1982) and perhaps it should have been expected that they would not restrict their movements.

The only bear that made daily visits to a feeding station was a yearling male. Early in the spring this particular bear appeared at feeding stations with his mother and later came to the station alone. Meanwhile the mother began coming to the stations accompanied by different males. While at the station the yearling also remained longer (20 min) than most bears, but spent little time eating from the feeder (38 seconds per visit). Thus, it is probable the yearling was visiting feeder sites because the sites were familiar to him and to locate his mother, rather than solely as a place to feed.

Although single bears at feeding stations were most common, there were 25 occasions when multiple bears were present. Most often these multiple visits consisted of a male and female (17),

Table 6. Mean home range size (Km^2) for male and female bears monitored in feed and non-feed areas, either during (TRT) or (PRE) periods of high feeding activity.

Treatment	Feed Area				Non-Feed Area			
Gender	Male		Female		Male		Female	
Period (n)	Pre (2)	Trt (3)	Pre (2)	Trt (10)	Pre (3)	Trt (1)	Pre (2)	Trt (2)
Km^2	33.05	11.93	7.90	7.49	23.47	20.00	7.20	3.30
(s.e.)	8.75	3.78	2.40	1.64	5.35	0.00	1.90	0.60

Table 7. Mean sizes (Km^2) and statistical comparisons of home ranges for all male and female bears; for home ranges for all bears monitored in feed and non-feed areas, and the home ranges for all bears during (Trt) and outside (Pre) the period when there was high feeding activity at supplemental feeding stations (Fersterer et al. 2001).

		(n)	Km^2	(s.e.)	*p* values
Treatment	Feed	(17)	11.33	2.43	$p > 0.35$
	Non-Feed	(8)	13.92	3.79	
Gender	Male	9)	21.37	3.66	$p = 0.0002$
	Female	(16)	6.98	1.11	
Period	Pre	(9)	18.52	4.28	$p = 0.0286$
	Trt	(16)	8.58	1.53	

less frequent were 2 males (6), and twice we recorded 3 bears at a station (2 males with 1 female, and 2 females with 1 male). Partners at stations were not consistent. One female appeared at a feeding station on separate occasions with 3 different males. During 22 of these multiple encounters bears ignored each other, or 1 bear waited its turn to eat. We observed little antagonistic behavior around the feeders. We could attribute a bear leaving a site to the aggressive behavior of another bear only 3 times. This limited aggression did not appear to inhibit feeding opportunities for long. On the rare occasion a bear was driven from a feeding site it was observed returning later the same day to feed.

Bear behaviors exhibited in the vicinity of feeding stations suggest that bears were not competing with each other for this nutritional resource. We observed no bears remaining at the resource to protect it from intruders, and dual visits were generally non-aggressive. We speculate that the reason a dominant bear does not restrict access to the resource is because feeders provide an unlimited amount of food. Food is always available, regardless of the number of bears that feed at a station or how much each consumes. Therefore, this food source is different than an animal carcass or even a berry patch containing a finite resource. The mechanism by which bears learn to modify their behavior to be less competitive is unknown, although this response is similar to multiple bears feeding adjacent to each other along a stream with abundant trout (Reinhart and Mattson 1990). Perhaps the time required to acquire this behavior is why the efficacy of providing supplemental feed improves over time if used repeatedly in the same area, provided bear populations do not expand.

Radio telemetry data suggested that the supplemental feeding program was not impacting the movement of bears (Fersterer et al. 2001). Bear home ranges were fairly consistent whether they were located in areas with or without ready access to supplemental feed. Males exhibited larger home ranges than females, which is consistent with prior studies (Amstrup and Beecham 1976, Lindzey 1976, Young and Ruff 1982, Koch 1983).

Bear movements were less extensive during the feeding period. However, this response was consistent on areas with and without feeders. The corresponding reduced movements on non-feeding areas suggest that bears were not merely remaining close to feeders. Increased bear movements coincided with the onset of additional food items. For example, 1 male more than doubled his movements during the first few weeks of July. This particular bear moved to an adjoining area to feed on ripening berries and returned only once to a feeder during the last 2 weeks supplemental feed was available.

MANAGEMENT IMPLICATIONS

The efficacy of a supplemental feeding program would be compromised if there were continuous conflicts among animals trying to eat from the feeders. This study suggests that aggressive interactions among bears at feeding stations are minimal and that access to feeders is available to most if not all bears. The results, however, also suggest that numerous bears are probably being encouraged to frequent timber stands that are most vulnerable to damage. This may be problematic if the feeding program is interrupted while trees within these areas remain vulnerable to bear damage, or if bear populations continue to increase until they exceed a threshold where damage levels are likely to increase regardless of the availability of supplemental feed. The supplemental feeding program generally becomes less effective as bear populations increase (Ziegltrum 1994).

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BEAR PREDATION ON MOOSE IN EASTERN INTERIOR ALASKA

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Note: This study is in progress and the following results are preliminary.

Predation and human harvest may be limiting population growth in low density moose (*Alces alces*) populations in Interior Alaska but these factors are not fully understood. This study focused on identifying the sources of mortality on calf and cow moose in a low density moose population (0.98 moose/km^2) in the western Yukon Flats. Previous studies in Alaska have identified predation as a significant source of moose calf mortality. Thirty cow moose were radiocollared in 1998. We then captured and radiocollared 62 moose calves in 1998 (n=29) and 1999 (n=33). Three cows were killed in 1998; 2 were killed by grizzly bears (*Ursus arctos*) and 1 was killed by illegal human harvest. No cow losses have yet been recorded in 1999. Four calves died from trampling by the dam or abandonment. These capture induced mortalities were removed from the sample for survival analysis. We observed 2 still births, 1 each in 1998 and 1999, from sets of twins. Among calves we examined 39 death sites and attributed deaths to: black bears (*U. americanus*) (17); grizzly bears (15); wolf (*Canis lupus*) (1); unknown predators (2); drowning (3); and unknown (1). Bears accounted for at least 82% of deaths at visited sites. Annual survival rates for cow and calf moose in 1998 were 90% and 15%, respectively. Annual survival rates for cow and calf moose in 1999 were 100% and 20%, respectively.

Key words: bear predation, moose calves, survival rates, Interior Alaska.

PRELIMINARY EVALUATION OF A TETRACYCLINE BIOMARKER FOR BLACK BEAR POPULATION ESTIMATION IN SOUTHWEST OREGON

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The Oregon Department of Fish and Wildlife traditionally estimated black bear (*Ursus americanus*) populations by using black bear density estimates in comparable habitat from adjacent states with in-state estimates of available habitat. This method does not account for many spatial and temporal factors that influence black bear densities. The desire to account for these factors and to respond to public challenges of wildlife population estimates led us to test a more accurate method of estimating black bear densities. A mark-recapture method using tetracycline as a biomarker was chosen, based on previous research conducted in Minnesota and Michigan. Marking was accomplished by nailing bacon baits suspended in plastic mesh bags to trees approximately 2.5 m off the ground. Baits contained 45 g of tetracycline and were distributed in a 12.5-km^2 grid throughout the 33,126-km^2 study area. Baits were revisited after 21 days to determine the number of bears marked, with the assumption that each consumed bait represented a marked bear. Three methods were used to verify bait consumption by bears; claw marks on bait trees, hair samples from barbed wire attached to bait trees, and tooth marks on a 100x250x5 mm foam-core board suspended in front of baits. Bears were marked at 67 (16.3%) of the 410 bait sites deployed. Bears were recaptured by collecting a premolar tooth from individuals harvested in the fall hunting season, or killed on damage complaints and vehicle collisions. A network of 46 private vendors was established in the study area to aid in the tooth collection process. A total of 315 teeth were collected for age and fluoresces analysis.

Key words: black bears, tetracycline, bacon baits, density estimates, teeth.

BLACK AND BROWN BEAR COMPATIBILITY: THE ROLE OF CASCADING DISTURBANCE FROM PEOPLE AND SUPERABUNDANT FOOD

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Black bears (*Ursus americanus*) are widely viewed as not able to coexist with grizzly bears (*U. arctos*). We studied both species under conditions where they were relatively compatible, collecting data on interactions between black bears and brown bears at 2 falls on Anan Creek. In 1994 and 1995, 340 and 282 observation hours were logged at the lower falls and upper falls of Anan Creek, respectively. We reliably identified approximately 30 different black bears and 12-15 different brown bears fishing at Anan each season and documented 57 encounters between these 2 species. Black bears fishing at Anan were more likely to be displaced by brown bears when encounters occurred on the same side rather than on opposite sides of the creek. Aggressive encounters were rare (<5%). Whereas black bears were more active during the day, brown bears tended to be crepuscular. At Anan Creek, we attributed the lack of aggression observed in interspecific interactions to the surplus of fish and many alternatives for access. Further, we suspect brown bears were crepuscular at Anan Creek to avoid people, a characteristic that allows black bears more diurnal use of the stream.

Key words: interspecific interactions, *Ursus sp*., Alaska.

A COMPARISON OF NON-INVASIVE SAMPLE COLLECTION TECHNIQUES FOR USE IN GENETIC ANALYSIS

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No reliable information currently exists on the status of the grizzly bear population within Glacier National Park (GNP) or for the Northern Continental Divide Ecosystem in northwest Montana. Recently developed genetic techniques allow us to determine the species, sex and individual identity of bears using DNA extracted from hair and scat samples. We utilized 2 non-invasive sampling techniques to study grizzly bear population status. Hair corrals were established in a systematic grid in the Greater Glacier area to estimate population density. To assess the power of sign surveys to monitor population trends, bear hair and scat were collected along trails in GNP. Different segments of the population appear to be sampled by these 2 methods. Only 16% of the 200 individual grizzly bears identified were detected in both sign surveys and hair traps. The female:male ratio of bears identified from hair trap samples was 1.2:1, whereas the ratio sampled in sign surveys was 1:3. To assist future project planning we compare uses, biases, and costs of estimating population density using genetic techniques to those of traditional telemetry studies.

Key words: genetics, Glacier National Park, survey techniques, non-invasive.

BLACK BEAR MONITORING IN EASTERN INTERIOR ALASKA

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Note: Analysis of annual range is not yet completed, the following results are preliminary.

Although black bears (*Ursus americanus*) are likely the most common large mammalian predator in Interior Alaska, little work has been conducted describing their demographics. This study examines movement and reproductive characteristics of a black bear population in the western Yukon Flats in eastern Interior Alaska. To our knowledge it is the northernmost study of black bears in North America. A total of 53 black bears (includes recaptures) were captured during 230 trap days between 1995 and 1997. Mean trap days per captured bear was 4.3. A total of 914 locations were collected from 24 radiocollared bears which utilized an area approximately 5,038 km^2 (adaptive kernel @ 95% probability) between May and October. Annual range for females varied from 19.9 km^2 to 843 km^2 with a mean of 225 km^2. Annual range for males were between 78 and 4,346 km^2 with a mean of 1,002 km^2. Bears denned in a 526-km^2 area, in close proximity to the capture area (minimum convex polygon method). Annual survival rates for adults ranged from 80 -100%. Dens of adult females were visited annually during March 1996-1999 to determine reproductive status. During this period 14 young (6 females, 8 males) were born to 4 adult females. Litter sizes ranged from 1 to 3 (mean = 2). Survival rates for the 1997 and 1998 cohorts were 20% and 34%, respectively.

Key words: annual range, reproduction, survival rates, Interior Alaska.

ESTIMATING POPULATION SIZE OF THE LOUISIANA BLACK BEAR

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The Louisiana black bear (*Ursus americanus luteolus*) is currently listed as a threatened species under the Endangered Species Act and to date, no attempt to attain a statewide population estimate has been made. We are using microsatellite DNA analysis to identify individual bears and their recapture histories to estimate abundance of 2 Louisiana black bear populations. We sampled 2 regions of south central Louisiana. We placed barbed-wire hair snares in hexagonal sampling grids generated over composite home ranges identified from previous research, including adjacent areas of likely habitat but excluding zones of no trespass. Hair collection schedules consisted of 2 capture periods of 2 weeks separated by a 3-day hiatus. About 50% of our snares were visited at least once with over 900 hair samples collected between the 2 sites. Individuals will be identified through DNA profiling using the repeat nucleotide sequences of microsatellites obtained from hair follicles. We are currently examining 8 different microsatellite loci for genotyping. Proposed estimators include the Lincoln-Peterson model and its small sample analog for closed populations.

Key words: Louisiana black bear, DNA, hair, population estimation.

EXPERIMENTAL PURSUIT OF BLACK BEARS WITH HOUNDS

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In part to address the concerns of managers and citizens about techniques for hunting bears, the Oregon Deptartment of Fish and Wildlife initiated a study in 1993 of the effects of controlled hound pursuit on bears. This study, along with 2 conducted in the eastern United States (R.B.Allen, 1984, 7th Eastern Workshop on Black Bear Research and Management, pp.54-58, Massopust and Anderson, 1984, 7th Eastern Workshop on Black Bear Research and Management, pp.59-65), are to our knowledge the best efforts at documenting the behavior of bears when chased by hounds. These studies are relevant to managers who regulate the use of dogs in bear hunting and to segments of the public who have concerns about bear hunting in general and the use of dogs in particular. Here we present the results of 3 years of experimental pursuit in Oregon, integrate this data with that of the 2 1984 short-term studies, and interpret these data sets in light of the biology, physiology, evolutionary history, and behavioral ecology of black bears.

Key words: black bear, pursuit, hounds.

BLACK BEAR DIETARY MEAT CONSUMPTION AS DETERMINED BY ^{15}N STABLE ISOTOPES IN HAIR SAMPLES

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Historically, bear diets were determined through scat analysis. Meat contributes more protein and nutrition per unit volume than does plant matter but is more digestible and therefore under-represented in digested matter in the scats. The objectives of the study were to: 1) identify what portion of the sample population's and diet consisted of meat, and 2) explore the efficacy and broader implications of the technique. This study analyzed 20 randomly collected hair samples from harvested bears that were stratified using age and sex criteria. Hair was analyzed for the ^{15}N stable isotope to determine the proportion of the bear's nutrition that was identified as meat. Meat consumption as a portion of dietary nitrogen ranged from 2 - 50% and averaged 25% among age and sex groups, which was moderate-high when compared with surrounding ecosystems. There were no significant differences in meat consumption identified between age or sex groups. However, trends in the data suggested that males, especially adult males consumed more meat than females. The technique does not differentiate among the types of meat consumed. The samples were taken from the fall of 1998, during a huckleberry crop failure. Because all age classes were eating high volumes of meat, it was likely that they were consuming easily located and readily available insects instead of normal fall berry foods. New questions arise as a result of the analysis, and shortcomings and prospects of the technique are discussed.

Key words: black bear, diet.

KUIU ISLAND BLACK BEAR HARVEST: A GROWING CONCERN

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Kuiu Island (1929 km^2) is a forested island in Southeast Alaska that is well known by black bear hunters for high bear densities and large male bears. We evaluated hunter harvest data from Kuiu Island black bears to investigate the bear population's response to a growing harvest. This included bear skull size, sex, and age; number of bears killed per hunter, kill location, and length of hunt; and hunter residency, transportation used, and commercial services used. Harvest records imply that southeast Alaska black bears are attracting more trophy hunters. The mid- to late-1990s Kuiu harvest (1993–1998 mean=134 bears) increased 150% over the late-1980s to early-1990s kill (1987–1992 mean=92 bears) and 360% over the mid-1980s level (1983–1986 mean=37 bears). Mean male age and skull size of harvested bears has decreased (1991–1995 mean age=8.5, 1996–1999 mean age=7.4; 1988–1994 mean skull size=18.8, 1995–1998 mean skull size=18.4). Subjective estimates of Kuiu Island black bear densities based on research in the Pacific Northwest suggest the harvest may be approaching the sustained yield limit. We will suggest regulatory options to the Alaska Board of Game in November 2000 in the absence of density or population estimates. We will discuss research efforts to enumerate black bear numbers on a portion of Kuiu Island in the near future.

Key words: harvest data, black bears, density estimates, trophy hunters.

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ORGANIZATION AND FUNCTION
OF THE
WESTERN BLACK BEAR WORKSHOP

BYLAWS

Designation:

This organization shall be known as the "Western Black Bear Workshop" hereafter referred to as the Workshop. The official publication of the Workshop shall be known as the *Proceedings of the Western Black Bear Workshop* hereafter referred to as Proceedings.

Goal:

The goal of the Workshop is to provide information relative to and encourage the perpetuation of bear populations as an ecological, aesthetic, and recreational natural resource in western North America consistent with other proper land uses for public and private lands.

Objectives:

- To provide an opportunity for all persons interested in bears to meet and discuss current research and management of bears and their habitats.
- To provide a vehicle for disseminating research and management findings to various agencies and organizations concerned with bear management.
- To promote research for development of new information on all aspects of bear ecology, life history, and management in western North America.
- To identify particular problems associated with bear management and to formulate recommendations and resolutions to the appropriate agency or organization, including the Western Association of Fish and Wildlife Agencies.
- To promote cooperation among all agencies and organizations concerned with bear management and research, particularly among the various provincial, state, and federal agencies with primary responsibilities of managing bears and their habitats.

Organization:

The Workshop will be open to any person interested in bears and their management.

Voting:

Voting members shall consist of one representative from each of the following:

- Western states, provinces, and countries where bears are present including: Alaska, Alberta, Arizona, British Columbia, California, Colorado, Idaho, Mexico, Montana, Nevada, New Mexico, North Dakota, Northwest Territories, Oklahoma, Oregon, Texas, Utah, Washington, Wyoming, Yukon.
- Federal Agencies: U.S. Bureau of Land Management, Canadian Wildlife Services, U.S. Forest Service, U.S. Fish and Wildlife Service, U.S. National Park Service, U.S. Natural Resources Conservation Service, Parks Canada, and the Direccion General de Fauna Silvestre.
- Universities, Colleges, and Research Institutions: The chair may appoint up to three people to represent colleges, universities, and research institutions. Appointee shall come from any college, university or research institution actively conducting bear research.

Voting representatives for all the states, provinces, countries, or organizations shall be appointed by the agency directly responsible for wildlife management within the above named states, provinces and countries.

- The chair shall request that each of the above named federal agencies appoint one voting member. This request shall be directed to one of the regional offices or service centers in the western United States, Canada, and Mexico.

Voting shall be accomplished only by those authorized representatives in attendance at the business meeting of the workshop.

The Workshop will be scheduled triennially:

- The new host state, province, country, or organization shall be selected and announced at the business meeting of the Workshop. It is the intent of the Workshop that the host state, province, country or organization will be volunteered on a rotating basis among the actively participating member states, provinces, countries and organizations.
- The host state, province, country, or organization shall select the time and place of the meeting. The host shall appoint one of its representatives who will act as chair. Responsibilities of the chair shall be:

  ✓ To serve as chair for the three-year period following his/her appointment.
  ✓ To call for papers and prepare an agenda for the workshop and assemble and distribute any recommendations or resolutions passed at the Workshop.
  ✓ To prepare and distribute the proceedings of the Workshop for which he/she has been responsible.
  ✓ To organize and conduct the meeting and business of the Workshop.
  ✓ To appoint committees as necessary.
  ✓ To maintain the goals and objective of the Workshop.
  ✓ To prepare and make a formal report to the Western Association of Fish and Wildlife Agencies (WAFWA).

The mailing list of the Workshop shall be:

- The Western Association of Fish and Wildlife Agencies.
- The Director and Game or Wildlife Chief of every member state, province, and country.
- All biologists known to be conducting bear research.
- All Bureau of Land Management State Offices and Regional Service Centers in the western United States.
- All Regional Forest Service Offices in the western United States.
- All Fish and Wildlife Service Regional Offices in the western United States.
- All Natural Resource Conservation Service Offices in the western United States.
- All Cooperative Wildlife Research Units in the western United States.
- All persons attending the last Workshop.
- Any person or organization requesting a copy of the proceedings.

The chair shall forward the mailing list and other pertinent material to the new Workshop chair upon completion of his/her responsibilities as chair of the current Workshop.