Systematic collection of bear–human interaction information for Alaska's national parks

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Abstract: We present a database application designed to standardize the collection and entry of brown and black bear (*Ursus arctos* and *U. americanus*)–human interaction data, formalize data storage methods, and analyze patterns of bear–human interactions in Alaska's National Parks. The National Park Service Alaska Region Bear–Human Information Management System (BHIMS) facilitates the systematic collection of biologically relevant data, consolidates bear management information, helps identify management priorities, facilitates the development of science-based bear management plans, helps evaluate the effectiveness of management strategies, helps provide more effective bear safety messages, creates permanent digital copies of original data, establishes bear management institutional memory, and ultimately improves bear conservation and human safety. The BHIMS can be modified for use in other locales and has applicability to bear management across North America.

Key words: Alaska, American black bear, bear–human interaction, brown bear, database, GIS, Lake Clark National Park, national parks, *Ursus americanus*, *Ursus arctos*

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Populations of brown (*Ursus arctos*) and American black bears (*U. americanus*) occur singly or sympatrically in every National Park Service (NPS) unit in Alaska. The management of bears and protection of their habitat is specifically mandated in the enabling legislation of 10 of Alaska's 16 NPS units. Consequently, one of the NPS Alaska Region's primary management goals for bears is to ensure their conservation and safe coexistence with humans. This involves identifying and minimizing potentially dangerous bear–human interactions in NPS jurisdictions. However, one of the obstacles to understanding and managing bear–human interactions in Alaska's National Parklands is poor documentation. Although all park units collect data on bear–human interactions, there is no unified data collection or analysis within the Alaska Region. This lack of a comprehensive bear-management system results in incomplete and often irrelevant data, which can result in misdirected public education efforts and ill-informed bear management policies. Hence, formal information systems covering bear encounters and attacks are needed (Middaugh 1987, Loe and Roskaft 2004).

We developed the NPS Alaska Region bear–human Information Management System (BHIMS) as a tool for standardizing the collection and analyses of bear–human interaction data at park-specific and regional scales. This system enables a databased assessment of bear–human interactions in Alaska's national parks and provides a scientific framework for preventing negative bear–human interactions. We selected Lake Clark National Park and Preserve (LACL) to demonstrate the potential of BHIMS to improve bear management in a jurisdiction.

National Parks in Alaska

The Alaska Region of the National Park Service contains 16 national park units totaling approximately 22.1 million hectares (54.7 million acres), or two-thirds of the total area within the US National Park system (Fig. 1). LACL was created on 2 December 1980 under the Alaska National Interest Lands Conservation Act (ANILCA; 16 US Code 3111–3126), and encompasses approximately 1.6 million hectares (4.1 million acres). Accessible only by air or water, LACL lies approximately 161 km

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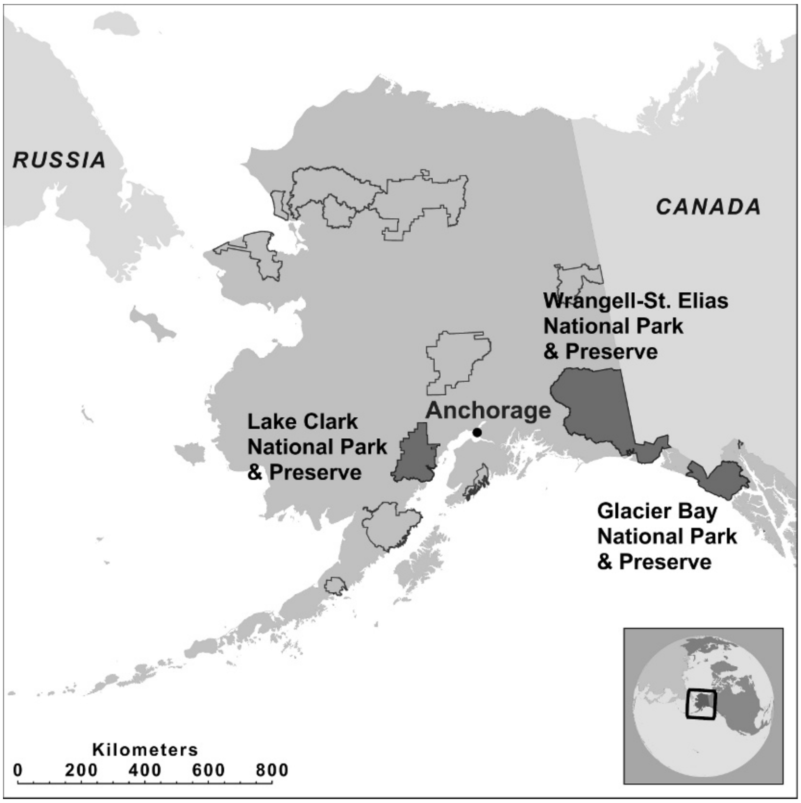

Fig. 1. Lake Clark National Park and Preserve and other National Parks in Alaska.

(100 miles) southwest of Anchorage along the western shore of Cook Inlet on the north end of the Alaska Peninsula and receives approximately 6,200 recreation visits per year (LACL, unpublished data). One small community and many private inholdings are located within the park boundaries. Wildlife in the park includes both brown and black bears. Many lakes and rivers within LACL, including Lake Clark itself, provide critical habitat for salmon (*Oncorhynchus* spp.) in Bristol Bay, one of the largest sockeye salmon (*O. nerka*) fishing grounds in the world. Within the park, the Kvichak River hosts the world's most productive spawning and rearing habitats for sockeye salmon and contributes approximately 50% of the sockeye caught in Bristol Bay (NPS 2004).

In contrast to Alaskan parks created prior to 1980, visitors to parks established under ANILCA, such as LACL, are allowed to carry firearms, and sport hunting and trapping are permitted in the preserve segments of the new parks. Local rural residents may also subsistence hunt in the park portion of the new parks. The differences in management of the park and preserve portions of the new parks were spelled out by Congress in the legislation establishing each area. In general, if Congress made special exceptions for hunting, grazing, mining, timber cutting, and other consumptive uses for a particular area, it was designated a Preserve rather than a Park.

Development of the database

This project was initiated by manually searching Alaskan National Parks' archives for information on bear–human interactions and bear natural history. Requests for bear-related data were also sent to park units that we were unable to visit. Data gathered included archived bear report forms, law enforcement case incident records (CIRs), biologists' field notes, and existing databases. To create the BHIMS structure, we modified a bear–human database created for Glacier Bay National Park and Preserve (GLBA) (T.S. Smith unpublished data) and added additional variables from the published literature that we considered important for analyzing bear–human interactions (e.g., Fleck and Herrero 1988, Mattson et al. 1992, Herrero and Higgins 1998, Herrero 2002).

Three main types of bear data were included in the database: bear sightings, bear–human interaction data, and natural history and management data. bear–human interaction data were sub-divided into encounters, incidents, and legal harvests of bears within the parks. Natural history and management information included all observations and field notes pertaining to bear management in the parks. For example, annual bear management reports, information regarding management problems with concessionaires within the park, management recommendations from former park biologists, and reports of unusual bear behavior (e.g., bears fishing for spawned-out salmon in January) were entered as natural history and management records.

To avoid confusion, we followed Smith et al.'s (2005) definitions of a bear sighting and encounter. A *sighting* is when a person sees a bear, but the bear is apparently unaware of the person. An *encounter* is when a person and bear are mutually aware of one another. Our definition of a bear–human *incident* differed from Smith et al.'s (i.e., an interaction between a one or more bears and one or more people in which the bear acts aggressively) by including all instances where bears obtained food, damaged property, or were judged to be negatively affected by human activities.

Once the main structure of the database was created, we entered data and further refined data categories to incorporate the broad spectrum of information contained in the bear reports. The data quality for each bear record was assessed in 2 categories in the database (*Information Source* and *Data Quality*) according to specific definitions of the quality and reliability of the data source. For example, personal narratives by people involved in an incident were considered the 'best' quality data, whereas historic records with little detailed information accompanying them (i.e., a 'data point') and 'word of mouth,' or hearsay records with no second party verification were considered 'low' quality data. We scanned all original documents (e.g., field notes, newspaper accounts, eyewitness narrative reports, bear forms, case incident records, photos) and appended them to their records in the database to create permanent digital records of source data. We also created maps for each park and digitized the location of each bear record entered into the system in a geographic information system (ArcGIS™, ESRI® Olympia, WA, USA).

The BHIMS database contains a tool which allows for queries of up to 40 fields. All records that match criteria can be linked to ArcGIS using the NPS Arc2Ax dynamic tool (http://science.nature.nps.gov/nrgis/applications/gisapps/gis_tools/8x/arc2ax8.aspx). This tool allows records to be linked to ArcGIS (or ArcView) and spatially displayed in a map project. A dynamic link also displays records in BHIMS based on features selected from an ArcGIS (or ArcView) map. For example, when a user performs a spatial query in ArcGIS, such as selecting all incidents within a specified distance of a geographic feature, the Arc2Ax tool links the records to the database application and displays them in BHIMS. Thus, the Arc2Ax dynamic link tool allows a user to spatially analyze query results, which may reveal patterns in the data that are not evident from tabular data. Reports can also be printed in a user-friendly format.

The BHIMS reduces data entry errors by validating text, numeric, and date values as data are entered. Often, a selection from a drop-down list of values is required during data entry. Relational databases eliminate the need for duplicate data entry, thereby improving data integrity. The user interface application built for this database conceals its underlying complexity. As a result, the user is presented with easily understood data entry windows and prompts. We also developed a manual for the BHIMS to help ensure consistency of data entry. Definitions were created for each data category and the variables in them, with examples for clarity.

Once the database structure was functional, biologists in selected parks tested a beta version and provided feedback on its utility; this resulted in further refinements to the BHIMS. After the BHIMS structure was finalized and data entered, we analyzed bear–human interactions in parks to identify concentrated areas of bear–human incidents, investigate historic patterns of bear–human interactions, and address specific management questions (Fig. 2). We also developed a data form to promote systematic data collection in Alaska. This data form was modeled on the BHIMS structure and based on consultation with bear biologists and recent scientific information regarding bear–human interactions.

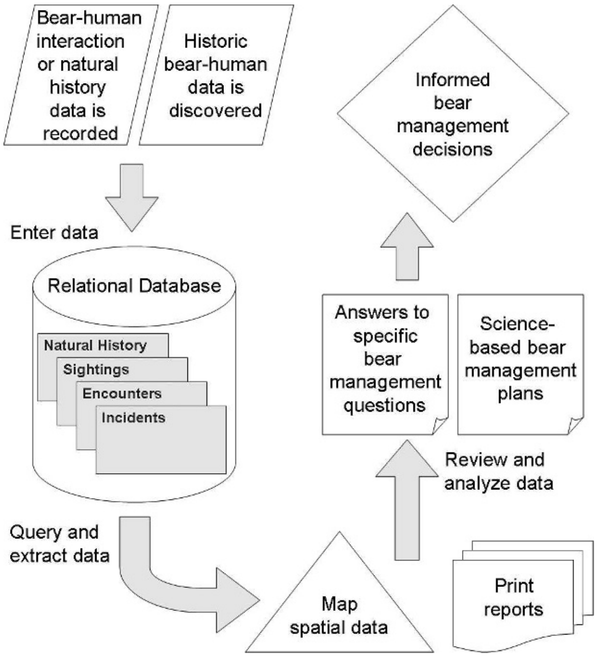

Fig. 2. Bear–human Information Management System (BHIMS) process diagram.

Using the database: Lake Clark National Park

LACL archives provided 190 records of bear–human interactions spanning 24 years (1979–2003), of which 171 were classified as incidents, 13 as natural history records, and 6 as legal bear harvests. Of the 171 incidents, 46% (n = 79) involved bears receiving a food reward. Nearly one-quarter of reported bear–human incidents in the park (n = 40) resulted in bears being killed in defense of life and property (DLP). Property was damaged in 37% (n = 64) of all reported bear–human incidents, and NPS personnel were involved in 15% of reported bear–human incidents in LACL. In the 1970s, there was 1 reported incident (LACL became a park in 1980). There were 56 reported incidents in the 1980s, 77 in the 1990s, and 56 from 2000–2003.

Fifty-one percent (n = 87) of bear–human incidents in LACL occurred along the coast; 74% of these (n = 64) occurred at Silver Salmon Creek, an area of concentrated commercial sport fishing activities along the southeastern coast of the park (Fig. 3). Data analysis revealed a history of bears receiving food rewards, increasing trends in human use and bear viewing, and no consistent NPS presence in this area. Another focal point of bear–human incidents was Port Alsworth, a small in-holding community on the south shore of Lake Clark (Fig. 3). Twenty-three percent (n = 40) of bear incidents reported in LACL occurred in the Port Alsworth area, 33% of which (n = 13) resulted in 21 bears being killed. Additionally, unofficial reports obtained from local residents suggest as many as 17 additional brown bears may have been killed in Port Alsworth in the fall of 2002. Furthermore, 83% (n = 33) of all reported incidents and 77% of all bear killings in the Port Alsworth area occurred in the autumn.

Analysis of data from other Alaskan parks was as revealing as LACL's, and illustrates the value of collecting data on bear–human interactions. For example, in Wrangell–St. Elias National Park (WRST), investigation of bear–human interactions in the Kennecott Valley revealed that local residents were involved in 80% of reported incidents, contrary to what park staff suspected (Wilder 2003). In GLBA, spatial analysis of brown and black bear sightings data revealed relatively disparate geographic distributions (Fig. 4), also contrary to popular belief of some park staff.

Discussion

Prior to the BHIMS, NPS personnel in LACL reported no concentrated areas of bear–human incidents in the park. Once the park's archival bear data were entered in the BHIMS and analyzed, however, it became apparent that such areas did exist (Fig. 3). Forty-six percent of incidents in LACL resulted in bears receiving food rewards, a serious concern given that food-conditioned bears are responsible for the majority of human injuries from bears in national parks (Herrero 2002). Habituated and food-conditioned bears that learn to forage in campgrounds and other areas of human development can become aggressive in their search for anthropogenic foods. Such bears have been found to be 3–4 times more likely to be killed by humans than non-habituated bears (Mattson et al. 1992), which may explain why bears were killed in 23% of reported incidents in LACL.

Spatial analysis of LACL BHIMS data highlights important bear management priorities. For example, 37% of bear–human incidents occurred at one site on the coast (Fig. 3), suggesting a need for proactive management of human activities in this area. Similarly, Port Alsworth, with 23% of all reported

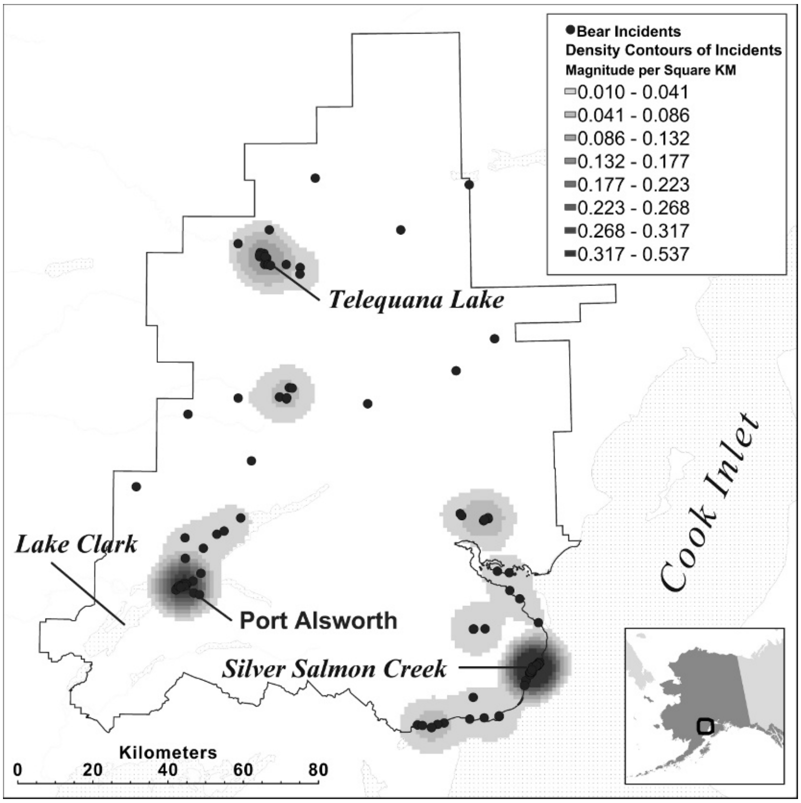

Fig. 3. Relative density of bear–human incidents in Lake Clark National Park and Preserve, Alaska, 1979–2003.

bear incidents in the park, should be a priority for focused bear management efforts. Considering that 33% of reported bear–human incidents at Port Alsworth resulted in bears being killed, that as many as 17 brown bears may have been killed there in 2002, and that the area likely is as a seasonal migration corridor for brown bears moving between the mountains and the lower elevation areas to the west (A. Bennett, National Park Service, Anchorage, Alaska, personal communication, 2003), it is possible that this area functions as a population sink for migrating brown bears. Consequently, increased efforts in public education and cooperative management efforts with local residents are warranted, particularly during the fall when most incidents and bear mortalities occurred.

Other significant areas of bear–human incidents in LACL are apparent when mapped (Fig. 3). For example, an unusual concentration of food-related incidents was located on the northern shore of Telequana Lake in the northwestern corner of the park. Data analysis revealed that 11% of reported bear–human incidents within LACL occurred at this location. Closer examination of these records showed that several private recreational cabins existed there, and that individuals repeatedly fed bears in this area to facilitate photography. Such situations could be addressed by using the BHIMS to focus management efforts on individuals responsible for this behavior and to develop an informed bear management plan for the park. Conversely, the lack of quality bear data, due to poorly designed data forms or a lack of collecting data, hampers the ability of managers to make effective bear management decisions.

For example, in the 1990s park managers in WRST were concerned about increasing numbers of bear–human incidents in the Kennecott Valley, but had little information about causes. In the absence of reliable data, the park assumed that most problems were the result of park visitors and directed management efforts accordingly. The park initiated research to better address the situation and began to collect bear–human interaction data intensively in

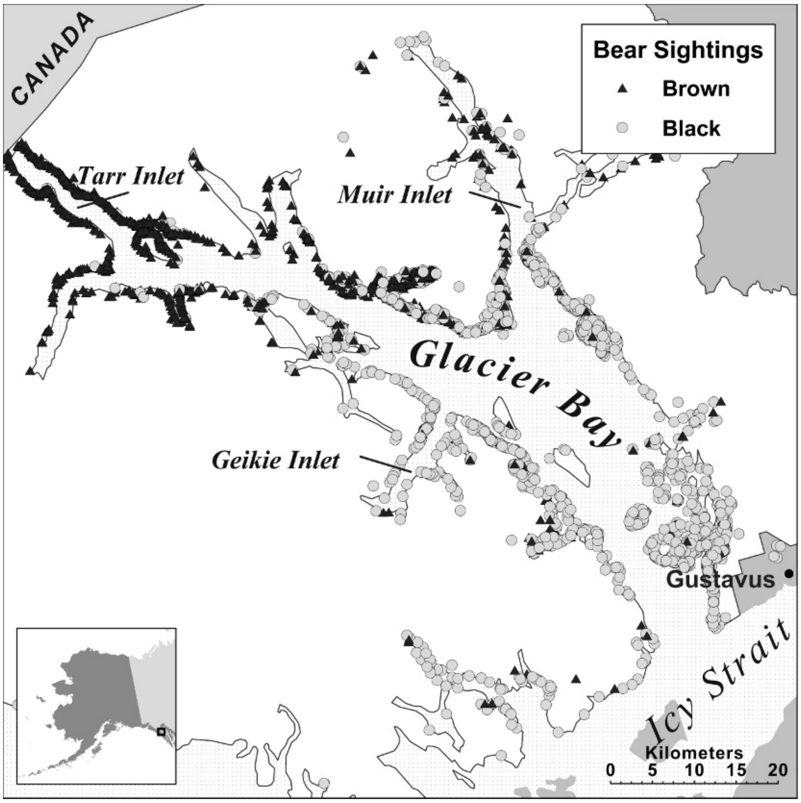

Fig. 4. Bear sightings in Glacier Bay National Park, Alaska, 1932–2000 (*n* = 3673), depicting disparate geographic distribution of brown and black bears in the park.

the Kennecott Valley. The data collected revealed that 80% of all reported bear–human incidents in the Kennecott Valley involved residents and were largely the result of improperly stored food and garbage (Wilder 2003). Based on this information, WRST revised its bear management strategy and developed an educational outreach program targeting residents. WRST also negotiated a cooperative agreement with a local non-profit environmental organization to provide residents with electric fencing and bear-proof storage containers. These cooperative management initiatives helped reduce the number of bears killed in the valley from 9–12/year to 0 in subsequent years. Furthermore, spatial analysis of data from the Kennecott Valley revealed that a proposed NPS campground was in a concentrated area of bear–human incidents (Wilder 2003). WRST abandoned plans to construct the campground.

Differences in the numbers of reported incidents over time do not necessarily reflect changes in frequency of bear–human incidents. Rather, this may be an artifact of the intensity of data collection efforts. Likewise, these data represent *reported* incidents. The number of incidents that actually occur is undoubtedly higher. Therefore, the BHIMS data serves as an index of the types and locations of incidents that occur, and not necessarily the number. This is due in part to relative levels of data collection effort and highlights the importance of systematic and consistent data collection strategies. However, areas of consistent bear–human incidents through time, as revealed through spatial and temporal analysis, may indicate that some annual event triggers increased incident levels (e.g., seasonal occurrence of high quality natural bear foods, unregulated fishing pressures on salmon streams, poor human food and garbage management).

One impediment to effective bear management and education in Alaska's National Parks is the rapid turnover of park staff (DeBruyn 1999). The BHIMS addresses this by establishing institutional memory and providing a scientific framework for the development of effective bear management plans in parks. The BHIMS enables newly-hired biologists to become familiar with the nature of bear–human incidents and the natural history of bears in their park units and provides a scientific foundation for informed decision-making.

The BHIMS also enables park managers to identify and prioritize management problems in their parks and focus limited resources accordingly. For example, the BHIMS could be used to objectively define thresholds for when specific management strategies, such as camping closures, would be used to address bear problems. The BHIMS could be used to evaluate the effectiveness of management solutions. The system also allows problem bears and their involvement in bear–human incidents to be tracked. Additionally, permanent electronic copies of all original data can be appended to each record, increasing record keeping efficiency and security.

The BHIMS facilitates systematic collection of consistent and biologically relevant data and can be modified to meet the needs of agencies. For example, the US Fish and Wildlife Service is modifying the BHIMS for polar bear (*U. maritimus)* management in Alaska. The BHIMS can also be modified for use outside Alaska.

The BHIMS allows park managers to provide more focused and effective bear-safety education messages to the public. Management decisions based on data promote stakeholder buy-in. In Alaska, the NPS is already using the BHIMS to facilitate development of a public bear safety website. Regional managers will work with parks to develop park-specific bear safety messages and to link park websites to this regional education site. Eventually, a controlled access website will be developed to which parks can post information regarding bear–human interactions in their jurisdictions. This site will provide timely and detailed reports on bear–human interactions in the NPS Alaskan region to park biologists and wildlife managers.

We recognize that there are many non-technical aspects to the creation and maintenance of a useful database, and BHIMS is no exception. There were many challenges associated with interpreting and entering disparate data, getting buy-in from users, responding to user requests, and setting policy for system use and archiving. Because biologists are not traditionally trained as computer programmers, this project required inter-disciplinary collaboration with database designer and programmers. This collaboration allowed biologists to devote themselves to creating a realistic model of bear–human interactions. If the biologists involved had had to master computer programming in addition to conducting the biological aspects of this project, it would have taken many times longer and resulted in an inferior product. The value of hiring professional computer programmers to work on resource management projects is an often over-looked staffing need. However, the efficiency and productivity which results from such an investment can help agencies better realize their conservation goals. Anyone contemplating use of BHIMS should consider such aspects and ensure their organization has the time and resources for its proper implementation.

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