Opportunistic Research and Sampling Combined with Fish and Wildlife Management Actions or Crisis Response

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Abstract

Currently most of the activities of state, federal, first nation, and private conservation agencies, including management of and field research on free-ranging wildlife, are not regulated under the Animal Welfare Act (AWA) and thus not subject to National Institutes of Health guidelines or routine institutional animal care and use committee (IACUC) review. However, every day thousands of fish and wildlife management activities occur across North America that provide an opportunity to take observations, measurements, biological specimens, or samples that may have research value. Most of these opportunities are secondary to ongoing and often mandated wildlife management or conservation actions. Strange as it may seem to the academic and research community, the full research potentials of these opportunities are rarely utilized. IACUCs and research institutions should strive to facilitate such research, which by its very nature is often more opportunistic than designed. They can do this by ensuring that their policies do not unnecessarily impede the rapid research responses needed, or over burden researchers with inappropriate reporting requirements designed for laboratory research. The most prominent reasons for failures to utilize wildlife research opportunities include lack of the following: personnel and expertise to collect and use the information; preparation for inevitable (or predictable) events (e.g., oil spills); resources to preserve and curate specimens; a mandate to conduct research; and recognition of the value in data or sample collection. IACUC support of open protocols and generic sampling plans can go a long way toward improving the development of useful knowledge from animals that will otherwise be lost. Opportunities to sample wildlife are categorized generally as dead sampling (road kill surveys, harvest sampling, lethal collection, and "die-offs"); live sampling (handling for marking, relocation or restocking; and captures for field or biological studies); and crisis response (e.g., population salvage operations or oil spills). Examples of the many unique situations in each category serve to illustrate how valuable research and sampling can be accomplished opportunistically. Several unique limitations of sample collection situation are described. It is recommended that IACUCs have mechanisms in place to facilitate good research in all of these circumstances.

Key Words: collection; crisis response; harvest; oil spill; opportunistic; research; wildlife

Introduction

The management of wildlife in North America is generally an active, rather than a passive, process. In this article, the term *wildlife* includes fish, all other vertebrate species, and the ecosystems on which they depend. Relatively few, if any, intact ecosystems remain where natural processes can, or are allowed to, regulate wildlife populations. Human intrusion in the form of anthropogenic chemicals, invasive species introductions, climate change, and impacts on species abundance are present even in the absence of obvious signs of intrusion (e.g., roads; extractive activities such as mining, grazing, and timber production; agriculture or development; and population centers). All of these intrusions affect the viability of wildlife populations and ecosystem processes. Laws established to protect wildlife and the basic components of viable ecosystems (intact habitats, clean air, and water) require measurements, studies, monitoring, and in some cases corrective actions. As a result, monitoring of wildlife populations is conducted routinely at some level in North America by federal, state, provincial, regional, and local governments, as well as first nations, private companies, private nonprofit organizations, educational institutions, and individuals. Many types of monitoring inherently include opportunities to sample wildlife and thus have research potential. Nevertheless, when university researchers whose work is related to provisions of the Animal Welfare Act (AWA[1]) attempt to tap this potential, they can face a significant challenge explaining to IACUCs the basis of their research designs that quite frequently are only vaguely related to the experimental designs IACUCs are accustomed to evaluating.

Research per se is not often the goal of legally mandated wildlife conservation or management programs. Most such

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[1]Abbreviations used in this article: AWA, Animal Welfare Act; IACUC, institutional animal care and use committee; NMFS, National Marine Fisheries Service; OWCN, Oiled Wildlife Care Network.

programs are goal driven (e.g., maintaining air or water of a certain purity, maintaining harvest opportunities or fish/wildlife populations of a certain size), and although research may be a component of such programs, monitoring and sampling are emphasized and are more common. Designed and designated research is often reserved for species or situations in which declines or threats are seen as significant and the cause is unknown, or where charismatic animals or irreplaceable resources are seen to be at risk. Government often considers the research to be in the realm of the academic institution or corporation. Thus, a significant base for research can be provided, depending on how monitoring and sampling are conducted. In addition, current trends in scientific thinking and pressures to take more holistic approaches appear to be influencing the traditionally narrow view of government agencies. These trends appear to be increasing larger-scale efforts; on ecologically, rather than politically, defined boundaries; and on maintaining intact ecological processes and "health," rather than waiting until signs of collapse or "disease" are detected.

If data are recorded, almost any wildlife management action has the potential to be the subject of research. This concept includes essentially all monitoring and sampling activities and many other activities that may not be obvious at first. The concept involves engendering cooperation and building collaborations. Even if the agency or entity does not include research as part of their mission, valuable or necessary, the potential exists for the development of relationships that can change this status. Provision of missing resources also helps bridge the gap. If one needs or wants information someone else is collecting, one must determine whether access to those data is restricted in some way and what is needed or missing that could make the data available. This process may be as simple as providing the vision for its value; an easy way to collect, store, or use the data or samples; some relatively small financial resources; or provision of reports to reflect findings. Those who are already doing the sampling or monitoring will want to know how long the project will last and how it will affect their workload. Their management may want to know how the data will be used, where and if it will be published, and how use of agency resources will be credited.

One of the challenges for young and enthusiastic biologists may be to limit the amount of data they collect to what they can use, whereas for older biologists, the challenge may be to remain open to sampling opportunities. The very collaborative nature of this type of research can cause interesting challenges for investigators seeking IACUC approval. Investigators may have little or no authority for determining anesthesia protocols, handling methods, or euthanasia methods. These policies may be determined by the lead agency or by a project committee. Similarly, the investigator may have little control over the number of animals with which they can work, perhaps due to the vagaries of capture or the overall ranking of priorities in the intervention. IACUC committees should understand these limitations and focus on the specific protocols of the investigators they are evaluating in these circumstances.

Basic differences exist between research and monitoring or sample collection. Classic research is hypothesis driven, sometimes unlike sampling or monitoring programs. Most research efforts that use data have statistical assumptions and sample size requirements that may or may not be met by sampling and monitoring programs. As a general rule, if a research project can be successfully completed without significantly altering existing monitoring or sampling protocols or management actions, one is likely to have a successful collaboration. However, if one can provide sufficient reason and incentive, agencies and organizations have been known to make major changes in existing programs to accommodate research. Nevertheless, IACUC members should not feel compelled to force investigators to make large demands of accommodation on agencies and organizations in charge of wildlife interventions. They should, instead, try to evaluate whether the information that will be gained would add to a base of knowledge that might contribute to better understanding of the issue being examined. If researchers are prepared in advance of inevitable events (or events of high probability), research protocols may be better implemented.

Sampling Opportunities

Many sampling opportunities and many of the data that make them valuable for research efforts involve collecting information on nonbiological, or at least not living, things. Information such as event time and location are almost always required; temperature, wind, and weather conditions may be important but are usually available in retrospect from weather databases; human activity at critical times and locations may or may not be available directly or via satellite or surrogate data; and distribution of microscopic organisms or invisible things (gases, sonar, radiation) can often only be inferred. Although recording information of a nonbiological nature may be just as important as recording biological information, a complete description of the topic is beyond the scope of this article. The following descriptions and examples of basic types of biological and wildlife sampling opportunities appear below: dead animal sampling (harvest sampling and collection), live animal sampling, repeat sampling, and crisis response sampling.

Dead Animal Sampling

Every opportunity to examine a dead wild animal has some potential scientific or research value. Probably the ultimate source of dead animal information is the analysis of road kills. This statement may seem like a joke, but it is surprising how much useful information can be gathered from such an ignominious situation. For example, in many states and

provinces, the "highway department" is required to remove dead animals from the roadway. When they respond, they are usually required to record the species, location, and date.

One of the road kill species of greatest interest is the deer. Its age and sex may or may not be recorded, but because this information is relatively easy to determine, it is not significantly more trouble for motivated highway department personnel. From this simple information alone, one can determine the hazardous locations and possible migratory routes or road designs that result in most deer/car collisions. The seasonal and year-to-year influences of road collisions on the subject population demographics can be determined. Long-term trends may reflect population size. If one can assume that does and bucks are equally likely to be on a highway and be killed, the buck-to-doe ratio may be estimated as well as many other interesting and useful things. If an effort is made to examine some of the road-killed deer, the body (nutritional) condition of the deer population can be estimated, and the fecundity rates and presence or absence of parasites can be determined. Some of the first indications that endangered Key deer were infected with paratuberculosis came from sampling road-killed carcasses. If jaws are collected, the age structure of the population can be estimated, and other biological or veterinary information can be gathered (Salwasser and Jessup 1978).

If road kill information is collected and analyzed appropriately, it has the potential to improve road design, reduce human injury and death, and reduce human impacts on keystone herbivores. It can be combined with satellite imagery and other forms of remote sensing to help correlate forest density and management practices with deer movement. The usefulness of road kill sampling and data is quite variable; however, it is one basic example of how scientifically relevant information can be gathered in an opportunistic and inexpensive manner. IACUC approval should not be necessary for these types of studies even though animals are "being used." Most reasonable individuals would argue that any animal killed by a vehicle would no longer have potential for suffering pain or discomfort. Similar issues need to be considered with regard to research that might use animals euthanized in animal control activities or animals harvested by hunters.

Private and publicly funded animal control activities that involve wildlife species provide another potential avenue for data and sample collection. In some Western states, carnivores and pest species are trapped and killed on public and private lands to protect livestock. Blood samples taken on specially treated paper strips (Nobuto strips) from coyote, bear, ground squirrels, and other species have provided a means of plague surveillance and forecasting where human exposures were likely to occur (Ruppanner et al. 1982). In urban areas across North America, pest wildlife species are trapped and removed under the loose supervision of government. Some basic data are collected on all animals, and it is possible to utilize trapping and collection agencies to take samples and provide data.

Harvest Sampling

Every year hunters and fishermen harvest millions of animals. Because these activities are regulated and licensed, they can provide opportunities to gather information, data, and samples. The number of licenses sold yearly may reflect the relative popularity (and future income) of the sport, as well as the influence of increasing costs and decreasing individual success. Because many state and provincial programs are supported by harvest revenues, this information is absolutely critical to management and thus readily available to researchers.

The date and location that animals are harvested may or may not be recorded precisely. When hunting or fishing takes place on refuges or hunt clubs, or when these activities are subject to check stations or enforcement, information is more likely to be recorded and accurate. Location may be a jealously guarded secret, so its accuracy is often limited (there are millions of deer killed on "Buck Mountain" each year and fish caught at "big hole"). Harvest information provides management agencies information on age structure, survival rates, and relative abundance. Sex-specific information is usually available for mammals because often there are different seasons and bag limits for the sexes.

Many hunters and fishermen are willing to allow inspection of the animals they have harvested. It is possible to facilitate this process by meeting with hunters and fishermen before the season to let them know what information is sought and why it is important to them and the future of their avocation. Popular publications, handouts at licensing locations, and informational meetings before special opportunity hunts or fishing all comprise possible ways to optimize participation. Rewards for the return of tags from fish result in significant information capture. The establishment of check stations where hunters can have their tags validated and animals weighed and evaluated also increases cooperation. For years blood and other samples taken opportunistically at hunter check stations were used to determine disease status and gather forensic data of wild ungulates in Alaska, California, and Colorado (Adrian 1992; Behymer et al. 1989; Chomel et al, 1994; Zarnke and Crawford 2002). In some cases, game meat processors or taxidermists can be utilized to take samples from harvested species or trophy animals.

It is sometimes possible to obtain body condition information, determine obvious disease or parasite presence, and take blood samples from great vessels. Blood and even lung fluids have been used to determine rates of tularemia exposure in hunter-harvested game animals in Sweden (Morner et al. 1988). Nobuto strips have been used for decades to track plague exposure in a wide variety of carnivores and rodents in western North America (Gage and Montenieri 1994). Under certain circumstances, hunters have been willing to take blood samples in sterile vials and return them. Obviously the more accurate the information provided by the hunter or fisher person, the greater the level of participation and the proportion of quality samples. Similarly, the

better the processing or preservation, the better the overall success of the program.

Private hunt clubs and wildlife management areas can provide even better access and compliance with sampling needs as well as support in sample processing if management or owners are convinced of the value of the project. The location and life histories of the animals are often well known to managers; in some cases, excellent datasets will have been collected for decades. The Welder Ranch in Texas and the Tejon Ranch in California (Jessup 1985) are two examples of large private holdings with a history of professional management and cooperation in research. The Turner Endangered Species Fund manages a series of very large ranches from Montana to New Mexico and has staff biologists and a veterinarian who can facilitate research on both hunted and nonhunted species.

Currently hunters are being asked to cooperate in the examination and sampling of white-tailed deer carcasses in Michigan for bovine tuberculosis and examination of several cervid species for evidence of infection with the chronic wasting disease prion in many western states. It should be emphasized that determining the prevalence and spread of these diseases and assessing the effectiveness of management programs are possible only with this cooperation.

Each year millions of waterfowl are harvested on federal, state, and provincial refuges and private lands. Access to waterfowl refuges and private duck clubs is often on a "check in" and "check out" basis. Under these circumstances, it is possible to obtain very accurate temporal, spatial, age, and sex data. If bands are present, it is also possible to determine some history of the individual animal. The vast amount of conservation and management research on waterfowl, which greatly exceeds the level and quality of information available on many other avian species, is a reflection of the types of monitoring programs developed for hunted species. Examples of waterfowl sampling programs include the following: prevalence of lead in the digestive system and levels of lead in blood (Locke and Thomas 1996), exposure to duck plague (Brand and Docherty 1989), avian influenza, and possibly now West Nile virus. Research efforts that gather information by taking advantage of "takes" or harvests should be encouraged and facilitated by allowing open-ended sampling limits because investigators have little control in many circumstances over the numbers encountered, and the alternative to sampling does not alter the outcome for the animal.

Collection

Under certain circumstances, wildlife management agencies collect (kill or remove) wildlife from the environment. Scientists and others may also be allowed to do this work under scientific collection permits. Because these activities are planned and conducted by government staff or their designees, cooperation in the gathering of data for research purposes and quality of data are often quite good.

When anadromous fish are returned to government and private hatcheries, they are collected for their eggs and milt. Collection of the heads of returning fish allows the reading of wire transponder tags that were imbedded into the cartilage of the skull before they were released. This information provides some life history and age data, and these programs allow fisheries managers to know, for example, year-to-year survival rates by class and location and potential effects of treatments or rearing program changes. It may also be possible with some additional biological sample collection to obtain information on ocean conditions and the abundance and composition of food supplies. Sampling programs for exposure to xenobiotics, or diseases and parasites, may be facilitated by the existing tagging program.

Although government agencies usually prefer to use the hunting and fishing public to manage wildlife abundance, this approach is not always possible or effective. When some native wildlife species or non-native species become overabundant—particularly when it could result in damage to critical or unique habitats, extirpation of sensitive species, spread of disease, or other negative impacts—agencies sometimes undertake lethal population reduction programs. These programs may be conducted on islands or in parks or protected areas where hunting programs are not allowed or feasible. These types of programs can be unpopular with animal welfare organizations and are subject to intensive scrutiny. As a result, requests to cooperate with collection of data or samples that might have scientific value are often incorporated to improve the justification for and benefits of collection(s).

Some of the largest wildlife collections are those that reduce or eliminate non-native fish such as pike or brown trout. Electro shocking and rotenone poisoning can result in the collection of tens of thousands of fish. Although these methods present unique sampling opportunities, the sheer scales of such programs also require researchers that want cooperation to be well organized and staffed. Where water is pumped out of bays or estuaries in large volume for agriculture, fish become trapped on the screens that protect the pumps. In some cases, efforts are made to salvage as many live fish as possible and truck them to other locations; however, loss due to death is often enormous. Again, sampling for research projects is quite possible.

Examples of animals collected from parks and wildlife areas and of the cooperative research that may result include the following: exotic deer from Pt. Reyes National Seashore (Reimann et al. 1979), mountain goats from Olympic National Park), and urban deer from California (McCullough et al. 1997) and many locations in the eastern United States. Wild pigs were collected on several of the Channel Islands during the time they were being acquired for a national park and tested for exposure to a number of important and exotic pathogens (Nettles et al, 1989; Stallknecht, et al. 1986). Exotic species that are subject to collection or hunting can even be used as exposure monitors for native species (e.g., pheasants collected on hunt clubs in California may be tested for West Nile virus exposure). In summary, collection

opportunities are less frequent and more closely proscribed than hunting/fishing sampling opportunities; however, they can provide higher quality data, and the researcher may have more influence on sample size and sample design. In these situations, IACUCs should approve the removals by means normally used in recreational hunting.

Live Animal Sampling

Wildlife agencies, private organizations, and universities have many opportunities for live capture and for sampling a wide diversity of wildlife. These occasions are often the result of studies that have the following goals: to establish population data (presence, critical habitat use, home range, and/or migratory routes) that justify conservation efforts; to allow tagging, marking, or radio collaring for tracking and behavioral observation; to determine genetic identity or diversity; to determine population health or exposure to contaminants or disease; or combinations of these efforts. Another major opportunity for live animal sampling arises when wildlife are captured for relocation and restocking efforts (Jessup et al. 1993). In most cases, these animals can be sampled only once. Because these efforts are planned and undertaken by professionals, data and sample collection can be relatively well planned and implemented. Although the primary conservation mission and animal welfare concerns may not allow all of the researchers' goals to be fulfilled, opportunities to sample live healthy individuals and wildlife populations can be quite valuable and productive. Whenever live animal sampling takes place, the welfare of the animal must be paramount. Research procedures that might significantly increase handling time may have to be modified for acceptability and efficiency.

By its very nature, field work on live free-ranging wildlife is very unpredictable ("good days vs. bad days"). The author has experienced situations in which it was imperative to alter anesthesia or capture protocols radically for the success of the mission. On another day, efforts to capture 40 elk resulted in the capture (and subsequent processing, handling, treatment and sampling) of 77 animals. Yet on other occasions, results have been far short of goals. In these variable situations, the IACUC must consider a more open-ended research protocol to allow researchers in AWA-regulated scientific institutions to benefit from the opportunity to collect data and samples (AWA 1996). For example, it might be advisable for the IACUC to specify only general types of anesthesia to be used—several drugs or drug combinations, or the combination of physical and chemical capture methods in use by the primary researcher or agency—and to forego specifying specific drugs dosages and methods. It might also be necessary to leave sample sizes relatively open ended so that management actions are allowed to determine the availability of samples, rather than the IACUC researchers' minimum needs.

One-time sampling schemes of live-captured or hunter-killed wildlife are useful primarily to develop "snapshots" of factors such as health, disease, or contaminant exposure. Wildlife serosurveys serve a number of valuable purposes besides providing information of value for managing wildlife health, including revealing where and to what extent wild animals carry disease that may affect human or domestic animal health (Campbell et al. 1989; Jessup et al. 1983). In some studies, livestock and adjacent wildlife have been compared (Singer et al. 1997). One criticism of the wildlife health literature has been that such serosurveys predominate and that long-term spatial and temporal information is lacking. Although correct, this lack is most often a reflection of the fact that wildlife health assessments are poorly funded or not funded at all, and they are clearly a secondary priority for wildlife management and conservation agencies. When they are willing to spend the time and money to do prospective and designed studies that could reveal much more, the expertise and techniques are available.

The following basic premise merits emphasis: Each and every opportunity to handle a live captured wild animal offers a unique opportunity to take samples and learn more about their biology, ecology, and health. Facilitation of the ability of researchers to conduct these types of research will require some flexibility on the part of IACUCs.

The full potential for taking data and samples from captured wildlife, archiving them, and most importantly optimizing the information gained has not yet become a common expectation of wildlife agencies and scientists. When the author started working with a wildlife agency 27 yr ago, his supervisor, the lead person in a state wildlife research laboratory, could see little value in taking blood samples from Tule elk that were being captured for relocation. The job was simply to catch and move them. Samples were taken from all animals, and this process resulted in a database, combined with subsequent data on additional species, which became the backbone of wildlife health surveillance in California. It has helped to establish prevalence patterns for common diseases in elk (Jessup et al. 1993), deer (Behymer et al. 1989; Chomel et al. 1994), antelope and bighorn sheep (Clark et al. 1985; Dunbar et al. 1985), wild pigs (Clark et al. 1983), bear (Ruppanner et al. 1982), cougar and wild turkeys (Jessup et al. 1983), and many other species. Assisted by information from these databases, we now know that free-ranging elk in California are free of Brucellosis (Drew et al. 1992) and several other diseases (allowing movement for restocking); where and below what elevations orbivirus endemic areas occur (Jessup 1985); the distribution of nutritional deficiencies (Direnfeld and Jessup 1990); pregnancy and reproductive potential; and other information of management significance.

When the California legislature mandated the study of bighorn sheep populations (after almost 50 yr of benign neglect) and the gathering of basic distributional information, it was decided that baseline health, capture-related physiology, disease exposure, and genetic and other types of data should also be collected. Over a 10-yr period, Califor-

nia progressed from knowing next to nothing about a sensitive and valuable species to having vast amounts of biological information, much of which was eventually published and has helped improve species conservation (Clark et al. 1993; Crosbie et al. 1997; Elliott et al. 1994; Jessup et al. 1993; Mazet et al. 1992).

Basic rules for live capture sampling include the following:

Recognize that some opportunities to sample live wildlife are spontaneous and do not allow much preplanning.

When possible, develop a study plan before the field sampling occurs. This plan should entail consulting the epidemiologist or statistician before collecting data.

Determine the required sample size before starting sample collection. Use formulas to determine needed sample sizes and error probabilities.

Keep in mind that wildlife sampling is seldom truly random. It is more often opportunistic or haphazard.

Organize all material (e.g., data forms, sampling equipment) into kits well ahead of time and sufficiently train the assigned people to accomplish all tasks efficiently.

Work quietly and efficiently. No animal's life or the success of the mission should be compromised by secondary research efforts.

Know the sensitivities and limitations of your testing methods (whether a particular method has been adapted for and/or verified on the species of interest) and keep sample processing and stabilization practical.

Learn from, but do not repeat, your mistakes. Any research or sampling effort can be improved.

Repeat Sampling

Some wildlife studies allow the opportunity for recapture and resampling. This opportunity most often occurs when long-lived predators or ungulates with large home ranges are studied and replacement of telemetry is required. This type of project may allow longitudinal or cohort-type study designs. Risk factors for particular outcomes can be determined when study designs are coupled with observational research on the following factors: behavior, movements (determined by direct observation, very high frequency [VHF] radiotelemetry, satellite, or global positioning system [GPS]), body temperature, habitat, food habits, and other activities. It is possible to determine the relationships between complex behavioral and physiological events and health as well as disease incidence (as opposed to prevalence). Landmark studies of this type have occurred on wolves, grizzly bears, a number of ungulates, and sea otters.

As an example, sea otter studies currently use telemetry and time depth recorders to determine the daily location of animals, their seasonal movement, to what depth they dive, what they eat, their mating and maternal behavior, how these factors affect body temperature, and other information of behavioral and ecological importance. Some study animals may be captured and sampled as many a three or four times over 5 to 6 yr. Biomedical sampling performed or available at each recapture includes, but is not limited to, baseline health, disease and contaminants exposure, immunological function, genetics, and nutrition. Animals that die can be relatively quickly retrieved and subjected to intensive postmortem examination The primary justification for the work is based on the prospective gain of valuable biological and ecological information. Although the process is still "opportunistic sampling," accommodations have been made for the biomedical sampling. Two federal agencies, two state agencies, and several universities and nonprofit organizations are coordinating research and sampling needs and cooperating to optimize the information to be gained. This work may continue for nearly a decade and should result in a very detailed understanding of factors that determine life, health or disease, death, and the role of anthropogenic changes in the environment in those outcomes.

In some states and provinces of North America, wildlife can be owned and raised in captivity. They may be housed in facilities or grounds of variable size and design variously referred to as game ranches or game farms. Some, but not all, such facilities are relatively isolated from free-ranging wildlife. In general, wild animals housed under these conditions have different health problems from those that are free-ranging.

Crisis Response Sampling

Various types of crises involving wildlife may afford opportunities for wildlife research and sampling. One example is the periodic mass stranding of dolphins or small whales. Although these events occur unpredictably, the National Marine Fisheries Service (NMFS[1]) has developed a series of stranding networks both to deal with the animals needs and to obtain scientific data and samples. Summary stranding network data are reported to NMFS yearly, and grants have recently become available to help with costs associated with sample collection and archiving. Sampling and data collection are becoming more routine and standardized compared with prior years, when all efforts were strictly volunteer. Marine mammal research and sampling efforts have helped to implicate emerging diseases (*Morbilivirus*), marine biotoxins, boat strikes, parasites, and military sonar as causal agents in strandings (Dierauf and Gulland 2001; Lipscomb et al. 1994; Scholin et al. 2000).

Catastrophic events such as severe storms and cold weather can result in vast numbers of wildlife, sometimes of only a few species, being killed or unable to care for themselves. Birds are quite vulnerable to hail, high wind, and sudden cold snaps. In such cases, losses may be so large and unpredictable that simply sampling and archiving a subset of the animals involved and deriving an order of magnitude estimate of losses may be all that is possible. Because responsibility for the wide variety of bird species is divided among international, two federal, and many state and provincial authorities, sampling is far less organized than it is

for marine mammals. For this reason, it is more difficult to organize opportunistic research and sampling. In many locations, private organizations like Audubon chapters and wildlife rehabilitation organizations are often better equipped and organized that the government to deal with these events. There is little opportunity to define sample size, sampling methods, and even dates or locations when events occur on a landscape or continental scale. The opportunity for AWA-regulated researchers to contribute to the advancement of knowledge in these situations depends on having very open IACUC protocols in place.

Some catastrophic events are caused by humans. The building of large dams in several locations around the world have required or allowed efforts to remove wildlife in the path of flooding and the attendant opportunity for research and sampling efforts. Project Noah, which was instituted in the late 1960s and early 1970s with the closing of Kariba Dam on the Zambezi River, is one noteworthy example of an effort to salvage wildlife. Other than recorded information on wildlife immobilization and capture-related health problems, the technology available at that time did not result in the successful conduct of many other types of research projects. More recently, a similar event in Guyana resulted in taking, preserving, and archiving valuable biological samples and records from many of the species handled. When large-scale efforts were undertaken to relocate black rhino to deter poaching, samples were taken that subsequently allowed serosurveys to determine relative risks for exposure to leptospirosis in different parts of the Zambezi Valley (Jessup et al. 1992), levels of naturally occurring vitamins and minerals, exposure to reportable diseases, and other factors.

One example of a man-made disaster that resulted in serious efforts at opportunistic research and sampling was the Exxon Valdez oil spill (Loughlin 1994). Because of the long duration and wide geographic areas involved, a large number of mammals, birds, fish, invertebrates, plants, and microorganisms were involved to some extent. Sea otters were the most intensively studied mammals (Bodkin et al. 2002; Williams and Davis 1995), but impacts on other species were also measured. Many birds, from eagles to marine ducks, also were affected by that oil spill; and research efforts and studies have helped determine the extent and duration of negative impacts (Esler et al. 2002). Oil spill response efforts in California are specifically designed to optimize the collection of ephemeral data. There are yearly opportunities for researchers to develop and submit research proposals, and funds have been set aside for follow-up studies. Fees paid by the oil industry support the research, which is funded on a competitive basis, overseen by an independent scientific review board, and administered by a major university. Wildlife response to oil spills is also mandated under the Federal Oil Spill Pollution Act of 1990; however, wildlife care expectations, wildlife research, and sampling activities are not specified.

A major problem with "crisis response sampling" if the crisis is something like an oil spill is that any samples taken and any research conducted may be considered evidence if it is a litigious situation. This means that samples may be locked up for years until a legal settlement is reached, and it may not be possible to publish the data. On the positive side, if the research is pertinent to proving environmental impacts, the settlement funds, fines, and penalty money may become available subsequently to pay for additional research. Such has certainly been the case for selected Exxon Valdez research (Bodkin et al. 2002; Esler et al. 2002).

The care and management of captive free-ranging wildlife during a crisis such as an oil spill are not regulated under the AWA. As noted above, such events are characteristically unpredictable. It serves little purpose for an IACUC to argue that sample sizes and these animals' clinical care should be AWA regulated for university personnel to participate or benefit from sampling opportunities. In addition, during a crisis, one of the last things responders are willing to do is to complete animal care and use protocols. In California, care and sampling of oil-affected wildlife are carried out under state and federal trustee agency-approved protocols. Interestingly, California law requires "best achievable treatment" and "best achievable care" of wildlife. These state laws have resulted in the development of detailed peer-reviewed treatment protocols for most common species supported by extensive literature searches.

The Oiled Wildlife Care Network (OWNC[1]), the state-university-private nonprofit cooperative that responds to oil spills, has duplicated and perhaps exceeded the level of oversight that could be provided by an IACUC. IACUC members could, and perhaps should, consider such research exempt from review; they could approve very open-ended protocols; or they could consider retrospective approval of the use of data and samples based on the existence of comparable government oversight. The research grant program operated by the OWCN states that all prospective oiled wildlife research that it funds must comply with the AWA and that appropriate research proposals must be approved by the IACUC. In many ways, such programs serve as the first exposure of government agencies to the concepts embodied in the AWA, which may positively influence government attitudes toward animal welfare.

Summary

Wobeser (1994) states,

> "The most important consideration during any type of sampling is to ensure that the samples are representative of the population from which they are drawn. Samples may be nonrepresentative because of random error or because of bias. Of the three basic types of bias (selection, measurement, confounding), selection bias is the most common in samples collected from wild animal populations. It may be impossible to totally prevent bias . . . but it is usually possible to determine its direction and to use this information in interpreting results" (p. 101).

Wobeser also emphasizes that random sampling may be less desirable than stratified, cluster, systematic, or multistage sampling. However, a different type of sampling is not often practical when biomedical sampling is opportunistic rather than designed.

Although routine wildlife management and research are not regulated under the AWA, they are regulated under other federal laws such as the Marine Mammal Protection Act, the Endangered Species Act, and the Migratory Bird Treaty Act, in addition to many state laws. In many cases, these laws or agency policies provide similar types or levels of review of project design and animal use. Opportunities do exist or occur (and sometimes recur) for scientific research and opportunistic sampling. It would be very unfortunate if IACUCs were to reduce or eliminate the opportunistic wildlife research opportunities of AWA-regulated researchers.

Although opportunistic research can never replace well-designed research trials, and the number of uncontrolled variables are often limiting and confounding, it can be more relevant to conservation and can allow the researcher access to animals and situations that could never be provided in the laboratory or by purposeful research. Ironically, those who are interested in taking advantage of unpredictable events and disasters can best do so by being very organized. In such cases, every hour or day lost may reduce the window of opportunity. It is also possible to develop purposely vague research protocols that still encourage organization and planning for animal welfare needs under AWA but that allow researchers to take advantage of unpredictable opportunities.

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