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ADVANCES IN ANIMAL WELFARE FOR FREE-LIVING ANIMALS

JWD Wildlife Welfare Supplement Editorial Board[1,2]

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ABSTRACT: Over several decades, animal welfare has grown into its own free-standing field of scientific study, from its early beginnings in laboratory animal research to eventually include exhibited animals and farm animals. While it has always been present to some degree, consideration of animal welfare for free-ranging animals has lagged behind, developing as a field of study in the last 20 yr or so. Part of that increase was that animal welfare legislation was finally applied to studies being done on free-ranging animals. But it is the appreciation by the biologists and veterinarians working on wild animals, in which the quality of their results is largely controlled by the quality of the animals they use in their studies, which has resulted in increased attention to the well-being or welfare of the animals that they use. Other important influences driving the recognition of wildlife welfare have been changes in the public's expectations of how wild animals are dealt with, a shift in focus of wildlife professionals from managing animals that can be hunted or angled to include nongame species, the decrease in participation in hunting and fishing by members of the public, and the entry of large numbers of women into fish and wildlife agencies and departments and into veterinary medicine. Technical improvements have allowed the safe capture and handling of large or dangerous animals as immobilization drugs and equipment have been developed. The increasing use of sedating drugs allows for handling of animals with reduced stress and other impacts. A number of topics, such as toe-clipping, branding, defining which taxa can or cannot feel pain, catch-and-release fishing, and more, remain controversial within wildlife science. How we treat the wild animals that we deal with defines who we are as wildlife professionals, and animal welfare concerns and techniques for free-ranging animals will continue to develop and evolve.

Key words: Animal welfare, capture, ethics, fish, handling, sampling, veterinary medicine, wildlife.

INTRODUCTION

Wild animals fascinate people. Witness the many television shows highlighting wild animals as evidence of the popularity of free-ranging animals with the general public. The public is generally supportive of research done on wild animals but has high expectations of how such research is conducted and how wild animals are treated by researchers and managers. The public views wild animals as individuals whereas wildlife professionals tend to view wildlife as populations, which can sometimes lead to controversy. Mentioning the phrase "animal welfare" in relation to wildlife does not represent an accusation or an indictment of the work being done any more than discussing the suitability of the techniques used to gather data or the statistical methods used to analyze them does so. Scientific peer reviews of proposals and publications act as a quality control review of scientific adequacy. Reviews by an Animal Ethics Committee or Institutional Animal Care and Use Committee act as quality control on the use and treatment of animals used in research. Researchers themselves have questioned some conservation projects as being poor science, with animal welfare concerns knowingly or unknowingly at issue (Frank 2013).

What is animal welfare?

Many definitions of animal welfare exist. Perhaps the simplest and most inclusive definition is that offered by the American College of Animal Welfare (ACAW): "Animal welfare refers to the state of the animal. Assessment of welfare includes consideration of the animal's health, behavior, and biological function." (ACAW 2015). In essence, anything that might contribute to or detract from the normal state of the animal is an animal welfare issue.

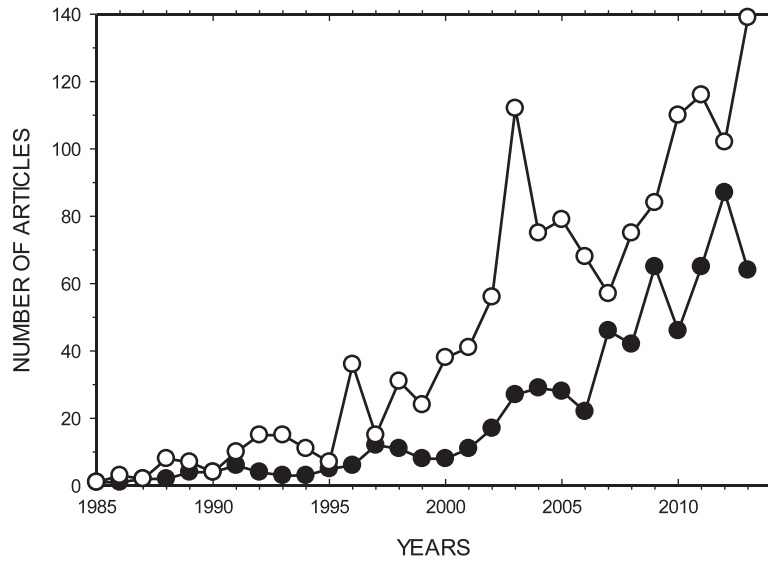

FIGURE 1. Bibliographic analysis of the appearance from 1985 to 2014 of publications on fish (black circles) and wildlife (white circles) specifying animal welfare as a topic. The data were gathered using the Scopus® search engine (http://www.scopus.com/), accessed May 2014, using "animal welfare" and "fish" or "wildlife" as keywords in separate searches of the years 1985–2014.

During research or management actions on wild animals, the main activities that potentially affect animal welfare are chase, capture, restraint, handling, holding, transportation, and procedures directly applied to the animals (e.g., sampling of blood, hair, saliva, or feather, attachment of transmitters or data loggers, tagging or banding, surgery, toe-clipping). There are very few research and management actions that do not have the potential, in some way, for affecting the animals being studied. Even projects that simply observe wild animals can sometimes have an adverse effect (e.g., Carey 2011; McMahon et al. 2012; Zommers et al. 2013).

Why wild animal welfare now?

As a well-established field of both concern and study in laboratory animal medicine, animal welfare has a literature base specific to it (Walker et al. 2014). Animal welfare has only been considered seriously in the fish and wildlife fields in recent years, as reflected by the rapid increase in publications reflecting that concern directly (Fig. 1). That is not to say that wildlife biologists and veterinarians were previously unaware of the effects of their activities on their study animals. The wildlife scientific literature is replete with reports of the presence or absence of adverse effects of field procedures on animals. These reports are evidence of the conscious recognition by wildlife researchers that the welfare of their animals has a direct effect on the quality of the resulting data they are gathering. It is the issue of data quality that links animal welfare as of direct importance to wildlife research and management and is the basis of developing animal welfare as a field of study for wild animals.

Animal welfare legislation now exists in most developed countries with varying coverage of fish and wildlife activities. In the United States, the Animal Welfare Act (7 U.S.C. 2131 et seq.) and its enabling regulations (CFR Title 9) have been in force for decades (see Cardon et al. 2012), although coverage of some taxa and some research organizations has been uneven in regulations (Mulcahy 2003). Perhaps

more influential in increasing compliance with animal welfare regulations has been the requirement for animal ethics committee review of projects before collection permits are issued and before the resulting manuscripts are considered for publication by journals.

Entry of women into wildlife biology

One of the most-positive influences on the welfare of free-ranging animals has been the entry of women in large numbers into the fish and wildlife fields. Elizabeth Beard Losey was the first female wildlife biologist to become a member of The Wildlife Society and, in 1946, the first to be hired by the US Fish and Wildlife Service (Casselman 2006). In 1944, only 2% of the members of The Wildlife Society were women, a number that increased to 22% in 2006 (Nicholson et al. 2008). But women have always contributed to the growth of wildlife scientific knowledge in excess to their proportion: 8.3% of papers appearing in the *Journal of Wildlife Management* in 1937 had a female author; in 2006 the contribution had grown to 45% (Nicholson et al. 2008). Gender is one of the most important indicators of a person's attitudes and opinions about animals, including wild animals (Kellert and Berry 1987; Herzog et al. 1991). Generally, women's views on wildlife issues differ from men's, and women better maintain their views over time (Butler et al. 2003). Female veterinary students have higher "empathy scores" than do male students, and that difference is maintained throughout the veterinary educational process (Paul and Podberscek 2000; Pollard-Williams et al. 2014). A similar gender divergence is also seen in nonveterinary university students (Phillips et al. 2010). The entry of women into the fields of fish and wildlife research and management means that their more-empathetic views about animals, as well as a tendency towards greater emphasis on communication about wildlife and less-consumptive uses of wildlife, has influenced acceptance of the concept that welfare of wild animals is important.

Changes in demographics of wildlife biology and changes in public opinion

The field of fish and wildlife management was initially reductionist, reflecting its initial goals of supporting and managing the consumptive sports of hunting and fishing, and most of the financial support for wildlife management agencies came from the sales of hunting and fishing licenses. Much of the research and management activity on wild animals originated because of the need to regulate, manage, and maintain wild animal populations for hunting and fishing. Nongame species were largely ignored. Most of the people attracted to such careers had backgrounds in hunting and fishing. Initially, such backgrounds somewhat inured biologists to the potential for pain, distress, and suffering of the wild animals that they studied. The social context of wildlife management has changed over the years. Fewer hunting and fishing licenses have been sold annually, forcing agencies to seek support from other sources (Jacobson et al. 2007; Hutchins et al. 2009). Public support for hunting and fishing has decreased as societies have become more urban while public concern and support for animals for nonconsumptive uses has increased (Butler et al. 2003; Jacobson and Decker 2006; Manfredo 2008). The changing human social dimensions of wildlife mean that managers find themselves dealing with multiple opinions, with animal welfare considerations becoming increasingly important (Dubois and Fraser 2013; Dubois and Harshaw 2013).

Appreciation of the increasing complexity of wildlife and management

Fish and wildlife management has largely focused on management of populations whereas animal welfare interests have mainly focused on individual animals. The two approaches are not incompatible if the welfare status of a population of animal populations is considered to be the

collective of the welfare status of the individual animals that compose it. With that understanding, expression of judgments of the welfare of a population is a shorthand for the welfare of the individual animals in it, similar to the way a statistical mean is an expression of the central tendency of a population. This view allows for complexities caused by variations in the welfare states of individuals over time and for a range of welfare states of individuals that might occur within the population (Yeates 2013; Beausoleil et al. 2014; Ohl and Putman 2014). This view also places increased importance on the anthropogenic influences on the welfare of individual animals as they are exposed to the manipulations of managers and researchers.

An increasing appreciation for the complexities of life is influencing research and management of wild animals. The scope for variation is enormous when considering when to sample and how to interpret results. There can be variation between individuals and within an individual as well as between populations, sexes, seasons, life history stages, and the procedural and analytical techniques used in a study. Today's scientist must be aware of how the variations due to the complexity of life can influence the data collected and the conclusions drawn in each study.

Chemical immobilization and sedation

In order to allow wildlife science to progress beyond observations and lethal sampling, it was necessary to develop some means of capturing wild animals alive. For animals that are small and harmless to man, netting, trapping, and physical restraint was sufficient. However, for large or dangerous animals, a means of immobilization and restraint that was essentially harmless to the animal and offered safety to the handlers was required. Chemical immobilization of wild animals started in the 1950s by feeding drugs to animals or by coating the drugs on the surface of darts (Hall et al. 1953). Its development has continued apace (Harthoorn 1970; Kock et al. 2012; Jessup et al. 2014). Chemical immobilization has allowed work to be done on a wide variety of animals while reducing the stress on the animals due to handling. The development of improved immobilization equipment, training opportunities, and drugs has improved both the success of capture efforts and the safety of the animals captured. The use of multiple drugs in the immobilization of wild animals has improved safety margins by reducing the concentration of any single drug by targeting multiple types of receptors. The availability of reversal agents has allowed for the manipulation of immobilization times and improved the safety of chemical immobilization. Books on the capture of wild animals include much information about procedures and drugs and are useful resources whenever a new species is to be captured (Nielsen 1999; Kreeger and Arnemo 2012; West et al. 2014).

Monitoring during field immobilization

Since the beginnings of chemical immobilization of wild animals, measurement of body temperature has been the most common monitoring of animal well-being, with observation of respiration and heart rate (although not necessarily measurements thereof) also done. In recent years the development of portable, battery-powered devices has allowed for direct monitoring of the physiologic state of the animal in real-time. Such devices include pulse oximeters for determining oxygen saturation of hemoglobin, heart monitors for rate and rhythm, electrocardiograms, capnographs for exhaled carbon dioxide, point-of-care devices for clinical pathology, and devices to measure a variety of other analytes including blood gases (for reviews, see Plebani and Lippi 2014; Stoot et al. 2014; see also Harms et al., this supplement). Most of these devices were designed for indoor use, and their use for monitoring wild animal captures offers performance challenges in environmental conditions that are sometimes less than ideal (Louie et al. 2014). Such devices have

proved useful in studies of capture or immobilization of wild animals including such parameters as positioning (Posner et al. 2005; Radcliffe et al. 2014), oxygen supplementation (Bush et al. 2012; Fahlman et al. 2012; Lian et al. 2014), comparison of capture techniques (Cooke et al. 2008; Pfitzer et al. 2014), and prediction of mortality (Hobbs et al. 2010; Sobhian et al. 2012; Stacy et al. 2013). The further use of such monitoring devices during wildlife capture events should permit a more-refined investigation of the potential effects of capturing, handling, and manipulating wild animals that would be the first steps in developing methods to reduce adverse effects.

Noninvasive sampling

Clearly, animal welfare is advanced if adequate samples can be collected without capturing and handling animals. To that end, noninvasive sampling techniques have been developed using hair, feces, breath, saliva, antlers, feathers, eggs, images (using camera traps), body temperature (via thermal imaging), water (for fish), footprints, shed skin, and urine (Fossi 1994; Keay et al. 2006; Darimont et al. 2008; Meyer and Novak 2012; McCafferty 2013; Gu et al. 2014). Noninvasive sampling techniques need to be tested and validated before the results obtained can be considered to be equivalent to those from traditional samples such as blood and biopsies (Palme 2005; Sheriff et al. 2010). Presently, enough results showing variation and issues with noninvasively-gathered samples exist to urge caution when considering using such samples (Martinsen et al. 2014; Mastromonaco et al. 2014; Mesa-Cruz et al. 2014).

Ongoing and future concerns for wild animal welfare

Common sense and self-interest dictate that an effort to minimize adverse effects of research and management activities be an integral part of every field study, remembering that animal welfare determines data quality. Wildlife project proposals need a description of how they will assess the potential for negative effects on their animals in order to assure the quality of the data to be gathered. Further research to examine the effects of techniques used on wild animals, and to identify missing information on the potential adverse effects, will be an essential part of future improvements in wild animal welfare. Publication of adverse effects, as experienced in both controlled experiments and in field studies, will be valuable contributions to improving wild animal welfare. Also, failures of equipment such as transmitters and data loggers need to be documented and published, as deployment of faulty devices represent unfruitful animal capture and handling. Journal editors need to develop and enforce high standards of animal welfare as reflected in the articles that they select and publish. An increased emphasis can be placed on documenting and reducing morbidity of capture and handling (e.g., stress, distress, fear, pain, infection, inflammation) rather than using actual mortality, a cruder measure of the outcome of the procedures used in wildlife research.

Some specific issues can be identified that are of present or rising concern. For example, the issue of whether or not fish can feel pain is currently being vigorously debated (Rose et al. 2013; Sneddon 2015). The effects of clipping fins (e.g., adipose fins) for marking fish are of growing concern (Roques et al. 2010; Petersson et al. 2014). The effects of catch-and-release angling are being actively investigated, particularly from a physiologic viewpoint (Meka and McCormick 2005; Gale et al. 2011; Cooke et al. 2013a). The effects of handling of fish, and especially of exposure to air, is being determined to be of fundamental importance in the quality and survival of targeted and bycatch species (Raicevich et al. 2014; Rapp et al. 2014). Handling and killing of fish caught during commercial fishing and aquaculture harvest has become an important area of research as aquaculturists have discovered that the quality of their product

is directly related to the welfare of their livestock (Lines and Spence 2014; Pettersen et al. 2014; Simitzis et al. 2014). Recently, the necessity of aseptic surgical techniques during the coelomic implantation of transmitters and data loggers into fish has been debated (Mulcahy 2013; Jepsen et al. 2014a, b; Mulcahy 2014; Mulcahy and Harms 2014).

The techniques used to mark wild animals for identification continue to be controversial and an active subject for study, as each technique has advantages and disadvantages as well as proponents and detractors. For amphibians and small mammals, there has been a long controversy over clipping toes as a marking technique, with research showing both the presence and absence of harm to the animals so marked, depending on species, sample size, and statistical technique used (McCarthy and Parris 2004; Parris et al. 2010; Perry et al. 2011). For mammals, concern has been expressed over the possible adverse effects of pulling teeth for aging as well as over the proper use of analgesia during such extractions (Nelson 2002; Mansfield et al. 2006). The techniques used for both lethal- and nonlethal trapping have long been debated, but research is improving understanding of the process (e.g., Warburton et al. 2000; Iossa et al. 2007; Baker and Macdonald 2012; Proulx et al. 2015). Branding of wild animals has been especially controversial, particularly in pinnipeds (e.g., McMahon et al. 2006; Beausoleil and Mellor 2007; McMahon et al. 2007; Wilkinson et al. 2011). That branding is controversial when used on wild animals should not be surprising, as its use on domestic livestock, which stretches back hundreds of years, is still poorly investigated and still attracts criticism and study (e.g., Schwartzkopf-Genswein et al. 1997a, b; Tucker et al. 2014).

Sedation has been used to reduce the stress of handling of large mammals (e.g., Knox et al. 1990; Pang et al. 2006; López-Olvera et al. 2007; Casas-Díaz et al. 2010; Mentaberre et al. 2010; Toosi et al. 2013). Rapid sedation of small animals being captured without chemical immobilization offers them some of the reduction in stress experienced by larger or more-dangerous animals that are captured and handled under a general anesthetic. If a drug with amnesiac qualities (e.g., midazolam) is used, it is possible that the animal will not remember its handling after onset of the action of the drug. The use of sedation to reduce the stresses of capture and handling is being investigated for use in birds and small mammals, (Mans et al. 2012; Sadegh 2013; Heatley et al. 2015). Recently, sedation has been extended to large whales to improve handling for disentanglement efforts (Van Der Hoop et al. 2013; Barratclough et al. 2014). For all taxa, understanding the limits as well as the development and refinement of attachment techniques for tags and electronic devices is a continuing quest (Vandenabeele et al. 2011; Cooke et al. 2013b; Jones et al. 2013).

CONCLUSIONS

The welfare of the animals used in wildlife research is one of the primary determinants of the quality of the data gathered and, hence, the quality of the conclusions and management decisions reached. The attention being paid to evaluate the effects of research and management actions in field studies of free-ranging animals has been receiving increased attention in recent years. It is in the best interests of all stakeholders to expect, consider, and implement improvements in animal welfare in wildlife research. Although wildlife researchers and managers will need to pursue improvements in animal welfare to assure the quality of their work, in the end it will be the opinions of the general public that will judge our efforts in animal welfare.

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