



NOTE

Exploitation of endangered mammals in the United States

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ABSTRACT: Overexploitation is a pervasive threat to mammal species worldwide and ranks second to habitat destruction as the major cause of their decline in the United States. Fine-scale analyses and quantitative studies on the threats to endangered species are lacking, which can undermine conservation and recovery efforts. Using threats data gathered from official Federal Register notices and recovery plans from the US Fish and Wildlife Service and National Marine Fisheries Service, I quantified the extent to which anthropogenic exploitation threatens the mammal species, subspecies, and populations that are protected under the US Endangered Species Act. Of the federally endangered mammal species in the United States, 65% are threatened by intentional or incidental exploitation by humans, including all endangered ungulates and whales. The most prevalent threats to endangered mammals are harvesting for raw materials (53%), incidental shooting, trapping, and poisoning (37%), and persecution (32%). A significantly higher proportion of marine than terrestrial mammals are threatened by exploitation (96 vs. 57%; $\chi^2 = 10.3$, $df = 1$, $p = 0.001$). The results from this fine-scale analysis can be used to understand the relative importance of threats in order to guide the distribution of conservation resources and develop context-specific conservation strategies.

KEY WORDS: Endangered mammals · Exploitation · Overexploitation · United States Endangered Species Act · Threats · National Marine Fisheries Service · US Fish and Wildlife Service

INTRODUCTION

The overexploitation of species is considered a major factor in the decline of the world's biodiversity (Wilson 1992). Studies have found that overexploitation ranks second to habitat destruction as the major threat to mammals at both domestic and international scales (Wilcove et al. 1998, Mace & Balmford 2000, Hoffmann et al. 2011). This type of threat can take a broad variety of forms, including both lethal and nonlethal harvesting from populations by humans (Taylor & Dunstone 1996) (see Table 1). Few quantitative studies on the relative importance of specific threats facing threatened species have been conducted in the United States (Wilcove et al. 1998, Lawler et al. 2002, Yiming & Wilcove 2005). A lack of understanding of the threats facing endangered spe-

cies might deter and undermine recovery efforts in the US (Lawler et al. 2002). Moreover, there is a need to better understand the threats facing mammal populations; more specifically, threats caused by human utilization of mammals (Taylor & Dunstone 1996). A clear identification of the specific forms of exploitation threatening endangered mammals and the relative importance of those threats can help guide the distribution of often-scarce resources available for conservation (Hayward 2009).

In this study, I quantified the extent to which exploitation by humans threatens the mammal species, subspecies, and populations that are protected under the federal US Endangered Species Act, and that are found at the national scale. Exploitation is defined as direct anthropogenic harvest from a population, whether lethal or nonlethal, and whether intentional

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or incidental (see Table 1). I also analyzed the prevalence of different types of exploitation among different mammal groups, and among marine and terrestrial systems.

MATERIALS AND METHODS

NatureServe, a non-profit organization that provides resources for conservation practitioners and academics, maintains an up-to-date, peer-reviewed database on imperiled species in the United States (Wilcove & Master 2005). Using NatureServe's data portal (NatureServe Explorer 2015), I created a database of all US mammal species, subspecies, and populations that were categorized as federally threatened or endangered, or that had been formally proposed for listing (hereafter referred to as endangered species) as of January 2016. The broad mammal group was further subdivided into 6 finer-scale groups (bats, carnivores, rodents, ungulates, whales, and other mammals), and into marine and terrestrial mammals.

Similar to methods employed by Wilcove et al. (1998), threats data were collected from official Federal Register notices and from recovery plans and reviews from the US Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS). A species was scored as 'threatened by exploitation' when it was known that any individual of the species had been directly harvested by humans, whether intentional or unintentional. A species was not scored as threatened when the threat was 'potential' or 'hypothetical.' In some cases, NatureServe Species

Comprehensive Reports were consulted to verify threats data. The types of exploitation were divided into different threat categories (Table 1). Types of intentional exploitation were defined by the intent of the harvesting (e.g. hunting for recreational purposes vs. hunting for subsistence). Due to lack of information, no distinction was made between major and minor threats or between current or historical threats. It should be noted that my views of what constitutes as a threat to a species might not reflect the views of the FWS or the NMFS.

Chi-squared contingency tests (2-tailed) were used for all comparisons of threats by mammal group and habitat type. Significance level was set at $p < 0.05$ for all cases. All tests were conducted using JMP 12 statistical software (JMP).

RESULTS

Threats data were available for 100% of the federally endangered mammal species, 65% of which are threatened by exploitation. All endangered ungulates and whales are threatened by exploitation. Moreover, a significantly higher proportion of marine than terrestrial mammals are threatened by exploitation (96 vs. 57%; $\chi^2 = 10.3$, $df = 1$, $p = 0.001$). The relative importance of exploitation (overall), intentional exploitation, and incidental exploitation across mammal groups is shown in Fig. 1.

Table 2 presents the percentages of endangered mammals threatened by each type of harvest. A higher proportion of mammals are threatened by intentional harvest (88%) than incidental harvest

Table 1. Types of exploitation (direct anthropogenic harvest) used in this analysis

Intentional harvest	Intentional harvest of individuals from a population, whether lethal or non-lethal
Sport hunting	Legal and illegal game and sport hunting (recreational purposes)
Persecution	Harvest of pests due to public health concerns, competition with livestock, and fear; indiscriminate killing, eradication campaigns
Scientific/educational activities	Captivity and specimen collection, harvesting for experiments
Raw materials	Hunting to extract raw materials (fur, meat, bones, baleen) for commercial, subsistence, and ceremonial purposes; not sport hunting
<i>Subsistence harvest, specifically</i>	Sub-category of 'raw materials' focused specifically on subsistence hunting
Incidental harvest	Incidental, lethal harvest
Shooting, trapping, poisoning	Death due to shooting, trapping, or poisoning meant to target other species or organisms
<i>Bycatch, specifically</i>	Sub-category of 'shooting, trapping, poisoning' focused specifically on bycatch from entanglement in fishing gear or shellfish traps
Scientific/educational activities	Death during relocations, surveys, and monitoring due to potential mishandling techniques or complications
Road kill	Death due to collisions with road vehicles
Ship strikes	Death due to collisions with ships and other water-borne vessels

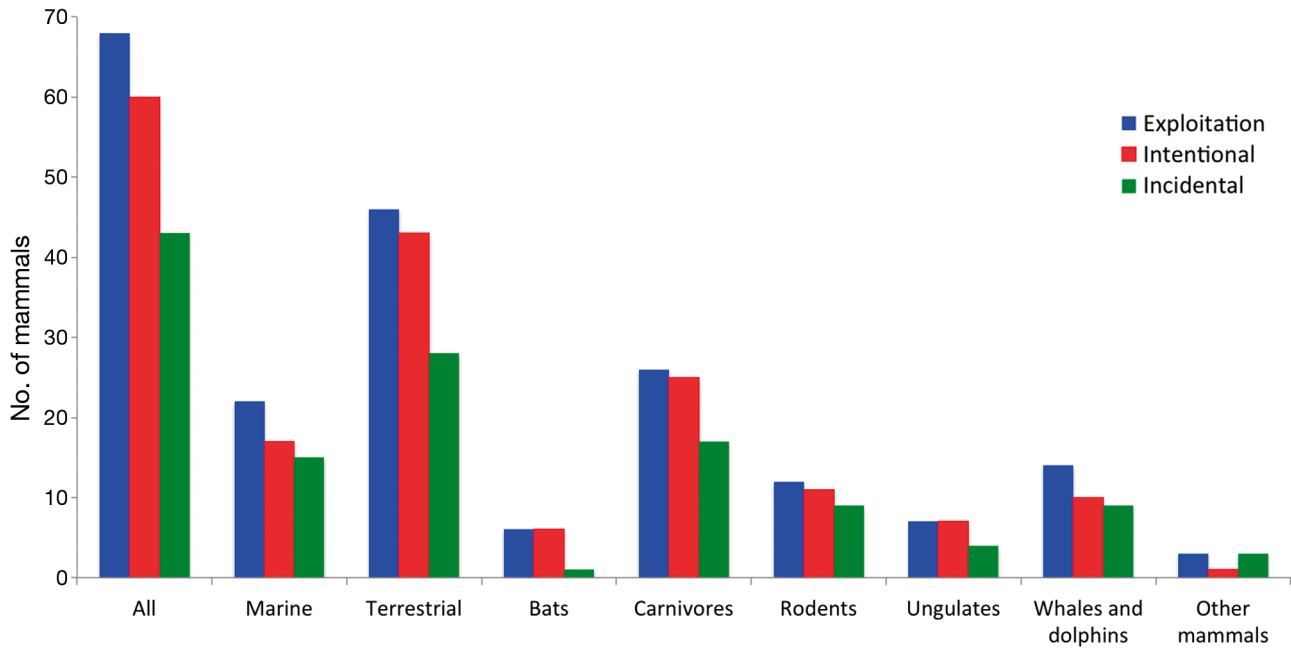


Fig. 1. Number of federally endangered mammal species, subspecies, or populations that are threatened by exploitation (direct anthropogenic harvest)

(63%). Among the finer-scale categories, the most prevalent threats to endangered mammals are harvesting for raw materials (53%), incidental shooting, trapping, and poisoning (37%), and persecution (32%). Fig. 2 shows the relative importance of the finer-scale threat categories according to the number of mammal species threatened by each form of exploitation.

Terrestrial mammals are more significantly threatened by persecution than are marine mammals (43 vs. 9%; $\chi^2 = 6.55$, $df = 1$, $p = 0.01$). However, marine mammals are more threatened by harvesting for raw materials and incidental shooting, trapping, and poisoning than are terrestrial mammals (raw materials: 86 vs. 37%; $\chi^2 = 12.67$, $df = 1$, $p < 0.001$; incidental shooting, trapping, and poisoning: 72 vs. 20%; $\chi^2 =$

Table 2. Percentages of federally endangered, threatened, or proposed mammal species, subspecies, or populations that are threatened by various types of exploitation (direct anthropogenic harvest). The categories are nonexclusive and thus do not sum to 100. *Significant difference when comparing marine vs. terrestrial mammals ($\chi^2 = 6.55$, $df = 1$, $p = 0.01$); **Significant difference when comparing marine vs. terrestrial mammals ($\chi^2 = 12.67$, $df = 1$, $p < 0.001$); ***Significant difference when comparing marine vs. terrestrial mammals ($\chi^2 = 15.88$, $df = 1$, $p < 0.001$)

Threat	Overall (n = 68)	Marine (n = 22)	Terrestrial (n = 46)	Bats (n = 6)	Carnivores (n = 26)	Rodents (n = 12)	Ungulates (n = 7)	Whales (n = 14)	Other mammals (n = 3)
Intentional harvest	88	77	93	100	96	92	100	71	33
Sport hunting	9	0	13	0	8	33	0	0	0
Persecution*	32	9	43	100	46	8	29	7	0
Scientific/educational activities	18	14	20	0	12	50	14	14	0
Raw materials**	53	86	37	0	69	0	71	86	33
<i>Subsistence harvest, specifically</i>	16	45	2	0	19	0	0	43	0
Incidental harvest	63	68	61	17	65	75	57	64	100
Shooting, trapping, poisoning***	37	72	20	0	54	0	0	71	33
<i>Bycatch, specifically</i>	24	72	0	0	19	0	0	71	33
Scientific/educational activities	15	0	22	0	4	67	0	0	33
Road kill	26	0	39	17	38	17	57	0	33
Ship strikes	12	36	0	0	0	0	0	50	33

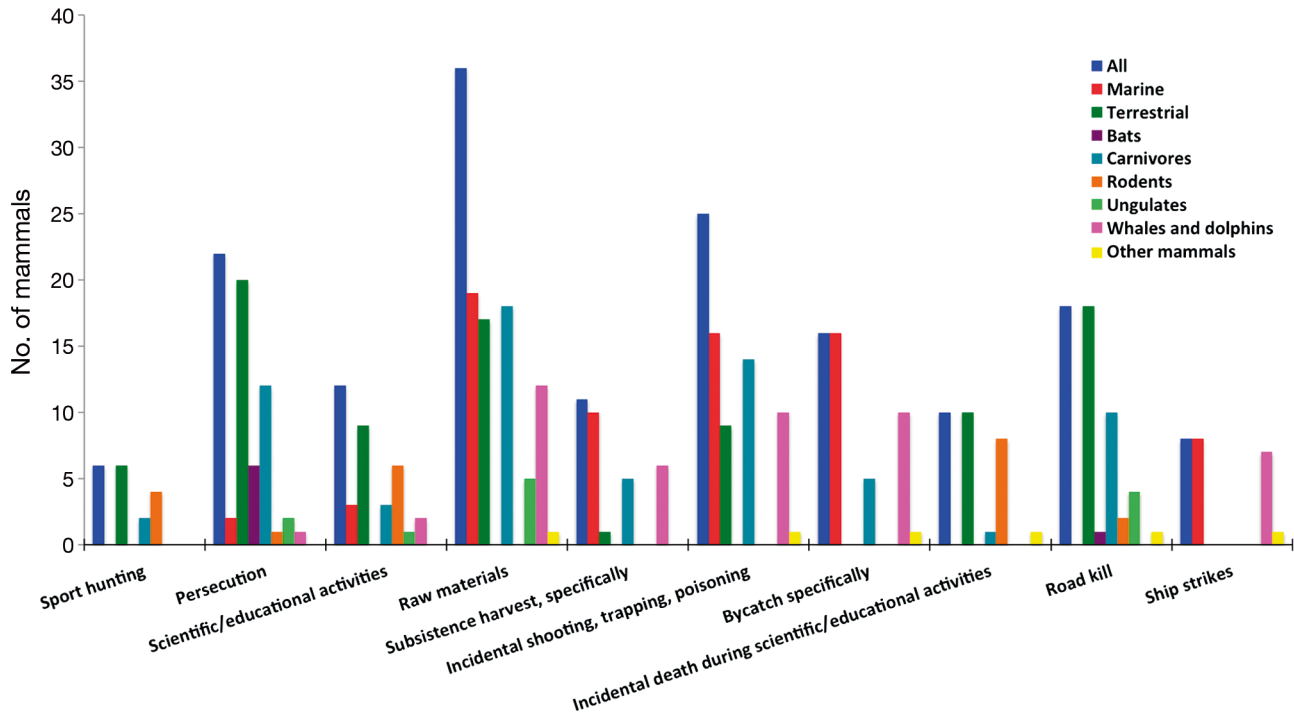


Fig. 2. Number of federally endangered mammal species, subspecies, or populations that are threatened by different forms of exploitation (direct anthropogenic harvest)

15.88, $df = 1$, $p < 0.001$). Mortality from ship strikes is a threat as prevalent amongst marine mammals as is mortality from road vehicles amongst terrestrial mammals.

DISCUSSION

Wildlife in the United States has faced a myriad of threats since humans crossed the Bering Strait into what is now present-day Alaska. Thereafter, threats to mammals and other species intensified with the arrival of European settlers (Wilcove 1999). Gaining an understanding of the threats facing species, geographically or by taxon, is essential for the development of conservation plans that aim to reduce the rate at which species are becoming extinct (Yiming & Wilcove 2005). This study found that about two-thirds of federally endangered mammal species, subspecies, and populations in the United States are threatened by intentional or incidental exploitation by humans. This is a higher percentage than the results identified by Wilcove et al. (1998), who found that 45% of federally endangered mammals were threatened by exploitation. The discrepancy in the results may be explained by differences in what encompassed the definition of exploitation in this

study (e.g. the inclusion of direct harvest from collisions with road and water-borne vessels, incidental harvest during scientific activities, etc.).

In Canada, about 66% of imperiled mammals are threatened by exploitation (Venter et al. 2006), which is comparable to the 65% of threatened mammals identified in this study. The prevalence of death due to collisions with road vehicles and persecution is higher in terrestrial mammals in the US than in Canada. In the US, the most prevalent threats to endangered mammals are harvesting for raw materials, incidental shooting and trapping, and persecution, whereas in China the most prevalent threats are harvesting for food, medicines, and other raw materials (Yiming & Wilcove 2005). These latter authors hypothesized that the differences in prevalence of various forms of exploitation between China and the United States may be due to differences in the sizes and socioeconomic status of rural human populations and the traditional use of wildlife. The differences in prevalence and types of exploitation identified between the US, Canada, and China further highlight the need to develop context-specific conservation strategies and policies, which can be informed by analyses such as this one.

Carnivore populations in particular have undergone substantial declines since European settlement

in North America (Dunlap 1988), and are still facing many of the threats that were initially responsible for their endangerment (Clark et al. 1996). Prevailing negative attitudes and perceptions towards carnivores are a result of the interacting roles of basic values towards animals and nature held by humans, physical and behavioral characteristics of different species, public conservation awareness, and interactions between humans and carnivores (Kellert 1996). Conservation plans aimed at protecting North American endangered carnivores (and other endangered mammal groups) should use an interdisciplinary approach that integrates the areas of cultural history, valuation, ecology, management systems, and the policy process (Clark et al. 1996). Moreover, particular emphasis should be placed on species-specific management and education programs that target negative attitudes (Kellert et al. 1996). These approaches should treat endangered carnivores and other mammals as 'public trust assets', where conservation is informed by public trust thinking, and solutions are geared toward just sustainability in the common interest (Clark et al. 1996, Treves et al. 2017). Challenges to these approaches have been illustrated by the case of gray wolves *Canis lupus* in the US, where eradication of populations from National Parks and National Forests, followed by reintroduction and conservation efforts nationwide, have resulted in continued legal and biological challenges with little consensus on the sustainability of lethal control methods (Treves et al. 2017). Efforts should be directed towards identifying effective and evidence-based lethal and non-lethal control methods, particularly for predators and other mammals often deemed as pests by the general public (Treves et al. 2016).

Despite the significant pressures that marine mammals face from broad- and fine-scale forms of exploitation when compared to terrestrial mammals, efforts from the International Whaling Commission and policies such as the federal Marine Mammal Protection Act and the Endangered Species Act have succeeded in the protection and recovery of US marine mammal stocks (Read & Wade 2000, Hoffmann et al. 2011), thus the proportions of species that are considered threatened by harvesting for raw materials in this study may be an overestimate given that no distinction was made between current and historical threats. Nevertheless, alternate measures to protect marine mammal species and populations are urgently needed, especially under the anticipation that human utilization of marine mammals as an important protein source is expected to increase in the

future (DeMaster et al. 2001, Huntington 2009). Furthermore, incidental trapping continues to be a pervasive threat to marine mammals, with over 6000 individuals recorded as bycatch between 1990 and 1996 in the United States (Read et al. 2006).

Results on the fine-scale analyses of threats from studies such as this one can be used to inform public awareness campaigns and educational efforts. Potential areas of further research can also be identified, as exemplified by the identification that marine mammals are almost as susceptible to mortalities from motor vehicles as are terrestrial mammals. Better-understood threats tend to warrant more attention in recovery plans than those that are not as thoroughly understood (Lawler et al. 2002), and the relative importance of the specific forms of exploitation presented in this study can help guide the distribution of scarce resources available for conservation (Hayward 2009). Terrestrial mammals will benefit from conservation programs that use an interdisciplinary approach aimed at modifying human behaviors, attitudes, and perceptions, while aquatic mammals will benefit from mitigation strategies that reduce bycatch mortalities and transform fishery-wildlife conflicts. The Endangered Species Act, the Marine Mammal Protection Act, and efforts from the International Whaling Commission have proven critical in the conservation of endangered mammals in the United States. However, the incorporation of results from fine-scale threat analyses that consider the relative importance of threats into wildlife recovery programs and educational efforts should be prioritized if we are to deter and prevent the loss of our endangered mammal species in the near future.

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