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Fear of Humans by Bears and Other Animals (Anthropophobia): How Much is Natural?

Stephen F. Stringham[1*], Lynn L. Rogers[2]

[1]*Bear Communication & Coexistence Research Program, Soldotna, Alaska, USA*

[2]*Wildlife Research Institute, Ely, Minnesota, USA*

***Corresponding author**
Stephen F. Stringham, 39200 Alma Ave., Soldotna, AK 99669-8630, USA
Tel: +1-907-260-9059
Email: wildwatch.llc@gmail.com

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Abstract

Wildlife viewing is a popular form of recreation, an important scientific tool, and a goldmine for communities near wildlife concentrations. Especially popular are animals that continue natural behavior while viewers are within photographic range. Reciprocally, an animal's experience with benign viewers tends to further habituate its fear of humans (its anthropophobia). Yet boldness and habituation by large mammals are widely regarded as unnatural and dangerous. This creates a dilemma for managers of viewable wildlife, especially in America's national parks where maximizing naturalness is mandated. To help resolve this dilemma, we identified 3 criteria of natural fear: a) It does not have to be learned and is typically exhibited even during an animal's first encounter with a human. b) Fear of humans is triggered by key stimuli specific to humans, not by mistaking humans for some other enemy or by xenophobia or some other generic or highly abstract phobia. c) In comparisons among populations or within a population at different times, the level of anthropophobia is directly related to the intensity and duration of human persecution (e.g., during the last 2 – 3 millennia). None of these criteria are met by available data from literature review or from our field observations on brown bears (*Ursus arctos*) and American black bears (*U. americanus*). We found negligible support for the hypothesis that bears are naturally anthropophobic – i.e., no indication that anthropophobia evolved as an adaptation protecting bears against human persecution. Rather, anthropophobia is more likely a side-effect of ursophobia or xenophobia, or the result of learning through aversive interactions with humans.

Abbreviations: ESA: Endangered Species Act

INTRODUCTION

National parks, natural behavior and boldness

Interpretation of the word "natural" can have a substantial impact on how wildlife are managed, both inside and outside American national parks. The National Park Service is mandated by its Organic Act to "*conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations*" [1]. This is often interpreted as a requirement to keep ecological relationships and the behavior of individual species as natural as is feasible - for instance behaving approximately like these species allegedly did in the relatively unhunted buffer zones between warring Indian tribes at the time of the Lewis and Clark expedition in 1804-1806. That is one reason why hunting is typically forbidden in America's national parks.

Cessation of predation pressure on ungulates for several generations tends to erode their fear of non-human predators [7]. Likewise, when humans cease stalking, chasing and wounding ungulates and bears, this can supposedly replace the animals' hyper-anthropophobia (extreme fear of humans) with hypo-anthropophobia -- boldness or even tameness. When Lewis and Clark [2-5,8] explored the Missouri River and Columbia River drainages, they found a direct relationship between the abundance of game animals and their tameness. Both abundance and tameness appeared to peak in buffer zones between the territories of warring Indian tribes, but not between the territories of allied tribes. Repeated encounters with benign people can also teach animals not to fear humans, at least under predictable conditions. An animal's expectation that it will not have to defend itself against offensive aggression by a human (or another animal) is trustful (defensive) boldness. offensive boldness is an animal's expectation that provoking a human (or another opponent) will not trigger effective retaliation - if only because the animal expects to be able to evade or escape any defensive response.

Trust promotes a neutral attitude toward people. If proximity to humans does not alter whether wildlife use any given habitat, their behavior in that habitat, their physiology, or their rates of survival and reproduction, then arguably the habitat is being used naturally, and the animals are behaving naturally. Neutrality toward humans allows fuller use of the habitat, and thus higher realized carrying capacity, than would be the case if the animals avoided humans by a wide margin (e.g., beyond rifle-shot). Animals that tolerate close observation without becoming distressed are a boon to wildlife viewers.

Unfortunately, neutrality toward humans does not guarantee neutrality toward human food or other anthropogenic attractants. Indeed, fear of human retaliation can be the main force preventing some animals from exploiting those resources. As animals learn to associate food or other attractants with humans (attractant conditioning), these lures could overcome fear of being near humans. Neither boldness nor trust for humans, should be equated with aggressiveness. Nevertheless, there are situations where boldness can increase likelihood of encounters so close that there is high risk of the bears conflicting with humans over attractants or of becoming dangerously defensive [9]. Boldness - whether genetically determined or the result of habituation - and attractant-conditioning, are widely regarded as major causes of conflict between humans and a variety of wildlife [10], including canids (e.g., wolves *Canis lupus* and coyotes C. *latrans* [11]), bears (*Ursus* spp. [11-12]), ungulates (e.g., African elephants, *Loxodonta africana* [13-14]) and primates (e.g., baboons *Papio* spp. [15]).

Within North American national parks, no species present more management challenges related to boldness, attractant-conditioning, naturalness, and human safety than brown bears (*Ursus arctos*) and black bears (*U. americanus*). Furthermore, human-bear conflicts embody most of the same kinds of conflict found with other medium- to large-bodied carnivores, omnivores, and herbivores. So bears can serve as a model taxon for developing conceptual frameworks applicable to a wide range of species. The term "brown bear" is used herein for *U. arctos* anywhere in the world, including those far from sea coasts in North America where they are commonly called grizzly bears.

As the frequency and severity of human-wildlife conflicts increase, they can generate a groundswell of public protest demanding cures such as intensifying anthropophobia. Even within America's national parks, fear of humans can be enhanced by inflicting pain (e.g., with pepper spray or rubber bullets), preceded and followed by intimidating the bear (e.g., by one or more people making dominance displays or threats [9,11,16]). However, care must be taken to assure that greater fear does not increase risk of defensive aggression [9]. Whereas black bears are less likely than brown bears to kill or seriously injure someone during a defensive attack, defensive black bears nevertheless do sometimes inflict lesser injuries.

Outside of national parks, the public and wildlife managers typically advocate reducing conflicts by increasing harvest pressure on bears - which may be rationalized as the best means of "restoring their natural fear of humans." Assumptions are made that a) sport hunting would reduce local abundance of bears; b) the bold or aggressive individuals outside of national parks would fall prey; and c) the survivors would be too afraid - by virtue of either genetics or learning - to approach humans or their vulnerable artifacts (e.g., homes and vehicles).

However, killing a bear teaches it nothing, and we know of no proof that killing one bear makes any other bears more wary of humans - even in the case of bears that were accompanying the victim when it was killed. Indeed, we know of cases where that did not happen. If a wounded bear associates its wounding with humans, this might increase its fear of humans; but wounded bears can be especially dangerous to both hunters and "innocent bystanders."

Geist [11] advocates what one might call the "clumsy hunter" technique, wherein hunters who stalk bears are often detected before they can kill the bear, such that the bear has a high chance of escape. Yet, we can imagine hunters doing this only a) by accident, or b) because the bear was not a worthy trophy. We know of no evidence that hunters will purposefully scare away the very bears they want to kill. We see no ways in which hunting bears can increase anthropophobia beyond what can be achieved with non-injurious aversive "training," without also counter-productively increasing risk of defensive aggression.

Additionally, we know of no proof that bears respond differently to hunters than to photographers who stalk or pursue them, or to other people who recreate, work or live in bear habitat -- except in situations where habituation is fostered [9]. Hunting advocates have yet to prove that in areas where bears are most fearful of humans, that heightened anthropophobia is due to hunting, rather than to lack of location-specific habituation. Even in regions where black and brown bears are hunted, they sometimes take refuge near humans at sites where they are secure from persecution. In Northeastern Minnesota, LLR's research station serves as a refuge for black bears from hunters who swarm surrounding land. Some of these bears trust humans at the research station but not elsewhere. Other bears take refuge in the nearby Eagles' Nest Township at the homes of bear viewers who feed them regularly. SFS observed something similar with black bears at garbage dumps in New York's Adirondack (state) Park. Alaskan brown and black bears likewise forage in garbage dumps and salmon streams frequented by humans, yet flee from humans even at short distances away from those sites.

In any event, supposing that hunting bears might sometimes increase their anthropophobia: a) Advocates have yet to demonstrate how hunting could be done without going overboard and making bears unnaturally afraid of humans - i.e., fearful of humans at unnaturally long distances or in unnatural circumstances - hyper-anthropophobia. b) Nor have hunting advocates shown how managers could avoid the detrimental side-effects of hyper-anthropophobia on bears (e.g., disrupting their social organization) or on humans (e.g., impaired viewing and heightened risk of defensive aggression by surviving bears). The whole issue of hunting bears to make them less dangerous appears to be an illogical and unnecessary excuse for hunting.

Proposals to resume hunting have been made even when a

population has just recovered from the brink of extinction - e.g., while protected under the Endangered Species Act (ESA). This has happened with black bears in New Jersey, Nevada [17] and Florida [18], as well as with the Yellowstone brown bears - i.e., brown bears living within the Greater Yellowstone Ecosystem at the junction of Wyoming, Montana, and Idaho [19]. In 2015, shortly after Florida's black bears lost their protected status, the population was opened to trophy hunting. Roughly 300 bears, about 10% of the population, were harvested during the first weekend of the first hunting season in two decades [18]. A similar fate might await brown bears living on the periphery of Yellowstone National Park soon after the population loses its ESA protection, which is scheduled for 2017.

So long as "naturalness" is a mandated criterion for managing wildlife in America's national parks, or a rationalization for sport hunting of allegedly "unnatural" animals outside parks, it is important to conceptualize and define "natural" as rigorously and pragmatically as possible. Natural behavior should not be misinterpreted as unnatural, or vice versa; and animals should not be persecuted because of misinterpretation. Those problems might be minimized through a more nuanced understanding of certain concepts from ethology and comparative psychology.

Criteria of natural phobias

From a management perspective, it might be appropriate to define natural behavior as as behavior which is unaffected by humans on a time scale measured in decades. However, from a phylogenetic perspective, "natural" is more appropriately equated with "innate" - i.e., traits which evolved under the selection pressure for the function(s) they serve. We would consider anthropophobia natural only if it evolved as an adaptation protecting bears from human persecution, as indicated by three criteria: a) It does not have to be learned. Bears typically fear humans even during their first encounter. b) Ursine fear of humans is triggered by key stimuli specific to humans, not by a similarity of humans to some other enemy - e.g., an enemy which has persecuted bears more intensively or for a much longer period. c) In comparisons among populations or within a population at different times, the level of anthropophobia exhibited by bears is directly related to the intensity and duration of human persecution. This paper assesses each of these criteria within the limits of available evidence.

Sources and citations

We sought such evidence through review of published literature and of our own observations. Given that most of our observations were made incidental to other research, they were not documented on an incident by incident basis and quantified. Instead, they are presented as expert opinions based on 7 combined decades of research on the ecology and behavior of brown and black bears by the authors (SFS in Alaska, California, Montana, New York, and Vermont; LLR in Michigan, Minnesota, and Alaska), resulting in nearly 70 publications in refereed journals and books. We have both observed thousands of interactions between bears vs. researchers, students and recreational viewers. Although each of us has observed both brown and black bears, SFS focused on brown bears, LLR focused on black bears. These bears have varied widely in their level of anthropophobia. Observations not previously published are too numerous to warrant citation as "unpublished observations" on a point by point basis. But that source is implied wherever a citation is absent.

DO BEARS FEAR THE FIRST HUMANS THEY ENCOUNTER?

Allegations that anthropophobia is natural or innate are often bolstered by claims that even the first time bears encounter a human, the bears respond fearfully. Without monitoring a bear's entire life until a given encounter, there are only two plausible ways of being reasonably sure that an encounter is really the bear's first: a) encountering a cub in its natal den or shortly after emergence in an area where there is no evidence (e.g., tracks in snow) of recent human presence; b) encountering an older bear in remote habitat where humans are scarce and there is negligible harvest pressure from visiting hunters.

Infants

We have made many visits to dens containing infants. With Minnesota black bears, during the first 6 weeks after a cub's eyes and ears become functional, the cub exhibits negligible fear of a human intruder. Although the cub might be distressed by being pulled away from its mother, it quickly calms down if hugged or stuffed inside a person's coat to stay warm. Cubs readily crawled over LLR investigating him. Some imprinted on him [20-21].

Older ages

In 1804-1806, the Lewis & Clark expedition made the first well-documented exploration of North America between the Mississippi River and the Sierra Mountains [2-3,8]. They encountered grizzly bears mainly in buffer zones between the domains of warring Indian tribes. These bruins were usually described as tame, bold or aggressive, not as timid. Indeed, brown bears far from sea coasts in North America have historically been noted for their relative boldness or defensive aggressiveness [8] - as are large-bodied ungulates such as bison (*Bison bison*), muskoxen (*Ovibos moschatus*), and moose (*Alces alces*). That is consistent which observations by SFS during scores of encounters with cubs, subadult and adult brown and black bears in remote areas of Alaska where they would have had little prior opportunity for interacting with humans. Bears reacted to SFS in any of five ways: as a) a predator; b) a rival; c) prey; d) a novelty; or e) irrelevant - sometimes appearing to ignore him even at distances <50 m, if only after making sure he was not a known enemy. Most black bears tended to be at least mildly fearful, but brown bears were more likely to be neutral, curious, bold, defensive or domineering. In Interior Alaska where brown bears prey on caribou (*Rangifer tarandus*) and other ungulates by stalking or charging, it is not uncommon for a brown bear to approach a human in the same ways, sometimes starting several hundred of meters away. Upon getting close enough to clearly distinguish the human - if only as neither an ungulate nor a fellow bear - the focal bear might continue to approach, lose

interest, or flee. Brown bears have been known to charge or even attack people who chanced to be passing by at distances <100 m, whether on foot, horseback, or boat.

Lack of consistent anthropophobia by human-naïve bears encountered by Lewis and Clark or by SFS does not disprove the hypothesis that anthropophobia is innate. Different degrees of anthropophobia could correspond to different genotypes, giving rise to a variety of phenotypes whose relative frequencies in the population might approximate a bell curve. Natural selection could shift the whole curve toward either higher or lower anthropophobia. Each individual's position on the curve could also depend on its life experiences and other ontogenetic factors. Some of these factors (e.g., body size, health, age, social rank, irritability, and reproductive status) could also predispose a bear toward low or high anthropophobia even during its first encounter with a human.

The one kind of life experience that almost certainly did not differ among the allegedly naïve bears was prior exposure to benign humans - ruling out habituation to humans as an explanation for boldness by some bears toward SFS. Alaskan bears not only injure people, but steal their food and vandalize their property - actions that are especially onerous to people living in remote areas with little access to medical care, and limited means of replacing lost food and damaged property. Any humans that a bear encounters are more likely to be belligerent than innocuous, and thus more likely to increase the bear's anthropophobia rather than to decrease it.

IS NAIVE ANTHROPOPHOBIA DUE TO MISTAKEN IDENTITY?

When an allegedly naïve bear reacted fearfully to SFS, we questioned whether it did so because SFS was human, or because he was mistaken for another creature or class of creatures to which bears might have an innate phobia. How such mistakes might occur, despite the scant similarities between humans vs. other large mammals, becomes plausible in light of certain ethological principles. Given that these might not be familiar to some of the biologists who research or manage bears and other large mammals, we briefly review these principles before discussing their relevance to anthropophobia.

Key stimuli and releasing mechanisms

Fear - like many another kind of behavior - is a response to certain environmental stimuli to which some kind of neurosensory system, known as a "releasing mechanism," is particularly sensitive. The stimuli relevant for triggering any given response are termed its "key stimuli." Releasing mechanisms are selective so that each behavior is triggered mainly by relevant stimuli. For example, key stimuli distinguishing conspecifics from even closely-related allospecifics are particularly important for releasing behaviors that need to be limited to conspecifics – e.g., parental care, mating, mate rivalry, and competition for social rank.

Intraspecific competition involves both winning and losing. Although losers are sometimes killed, they more typically escape or appease the winner with some kind of submissive behavior. [22] Whatever releasing mechanisms assure that appeasement is triggered only by fear of a conspecific, not by fear of a predator, constitute species-specific phobias. In cannibalistic species, the releasing mechanism for submission might even distinguish conspecific domination vs. predation.

Claims that anthropophobia is innate for bears imply that a) bears have evolved a releasing mechanism that is triggered only by key stimuli typical of humans, if not unique to humans; and that b) persecution by humans exerted substantial selection pressure producing or maintaining this phobia. This definition is intended to distinguish evolved phobias from serendipitous ones – those triggered by mistaken identity.

Mistaken identities

Ethological literature is rich with cases of mistaken identity, where responses were released by unrealistic models that nevertheless exhibited a key stimulus. A classic example is herring gull (*Larus argentatus*) chicks pecking at a red spot on a cardboard model of an adult gull head, much as they would have pecked at a red spot on the parent's bill [23]. Bill-pecking is natural; cardboard pecking is not, even though pecking in response to a red dot is innate in both cases.

Now for a bear example: Even in remote areas of Alaska and Minnesota, bears flee from low-flying aircraft, ranging in size from helicopter-drones <1m in diameter [24] to Sky Crane helicopters and C-130 cargo airplanes. Bears also tend to flee from motor boats and ground vehicles, especially those with a loud internal combustion engine. This fear cannot be attributed to an innate phobia specific to motor vehicles. Such vehicles have been in existence for just over one century; and they have not killed or been directly used to kill more than a tiny fraction of any bear population.

A more plausible explanation is that these vehicles evoke a phobia that protects bears from another hazard. Certain elements in the sound of a revving internal combustion engine resemble aggressive vocalizations by bears [25] and many other vertebrates. Vertebrate threat vocalizations generally tend to be relatively low-pitched, harsh, and loud. Their basic form and their aversiveness to recipients both appear to be innate [26-28].

Innate key stimuli identifying predators or other hazards [20, 22,29] could be as crude as the key stimuli which release nursing attempts by neonatal moose calves (i.e., a bulky object separated from the ground by approximately 0.5 m of open space, but connected to the ground by "legs" - which included a high-backed bench and the front end of an off-road truck [30]). If key stimuli provide only an approximate identification of a hazard, this could cause numerous false alarms until experience teaches the animal (e.g., through habituation, respondant or operant conditioning, or cognition) which additional features distinguish true hazards from harmless "mimics" - for instance a) venomous and non-venomous snakes [31]; b) dangerous predators vs. animals that only superficially resemble predators; or c) real vs. simulated

bear growl-like vocalizations. d) There might also be innate fears of particularly loud noises, whether the key stimuli are specific to a hazard such as thunderstorms or earthquakes, or completely generic, related to sensory overload and extreme stimulus contrast [28]. Fast-approaching large objects also tend to trigger an innate generic looming phobia, which may also be related to stimulus contrast [28]. In many respects, even large mammals tend to react to other creatures as bundles of key stimuli, at least initially, although learning can "flesh out" perceptions of those creatures [28].

Again, claims that a phobia is natural, imply that the hazard evoking fear is the same hazard that phylogenetically selected for that phobia - i.e., that being phobic toward that hazard decreased vulnerability to it, thereby increasing fitness. If, however, the fear is merely a result of mistaken identity, then it would not be considered natural, even if the phobia is innate.

Evolution of anti-predator phobias

One would expect enemy phobias to be most apparent against those enemies which have exerted the strongest selection pressure for the longest time. This raises the question of which species have been dangerous to bears, not just during recent millennia, but for much of their phylogeny? Throughout the Pleistocene glacial epoch (2.5 million to 10,000 years ago), brown bears, Asiatic black bears (*Ursus thibetanus*), sloth bears (*U. ursinus*), sun bears (*U. mayalanus*) and perhaps panda bears (*Ailuropoda melanoleuca*), would have faced a variety of large predators including lions - African lion (*Panthera leo leo*) in North Africa and the low latitudes of Eurasia, as well as cave lion (*Panthera leo spelaea*) at higher latitudes up into the subarctic and Arctic [32]. In some areas Eurasian bears also faced tigers, (*P. tigris*), leopards (*P. pardus*) [33], hyenas (*Crocuta crocuta*), or wolves (*Canis lupus*) - all of which might have preyed on small bears that were not hibernating, as well as on even adult bears that were in winter torpor. Occurrence of bones of both cave hyena (*Crocuta crocuta*) and cave bear (*U. spelaeus*) in some caverns suggests that during hibernation, cave bears were particularly vulnerable to hyenas [34].

During much of the roughly 3.5 million years that black bears occupied North America prior to the Holocene, they shared this continent with tremarctine bears including both the giant and lesser short faced bears (*Arctodus simus* and *A. pristinus*), as well as the Florida spectacled bear (*Tremarctos floridanus*). During the Pleistocene, other predators in Beringia and in the Alaska-Yukon ice-free refugium would have included the cave lion. South of the Laurentide and Cordilleran Ice Sheets, North America was also home to the American lion (*Panthera leo atrox*), scimitar-toothed cats (*Homotherium serum*), saber-toothed cats (*Smilodon fatalis* and *S. gracilis*), American cheetah (*Miracinonyx spp*), and puma (*Puma concolor*), as well as dire wolf (*Canis dirus*) [32].

Millions of years of co-evolution by bears with those other predators could have been ample time for evolution of innate phobias. Given that the same defensive tactics – escape, concealment, appeasement, threat and attack – are used against all those enemies, fear of allospecific quadruped mammals might be triggered by a single releasing mechanism generic enough to encompass all of them. Or phobias might differ just enough to trigger a different pattern of defense as required to cope with different predator capabilities. For example, the distance at which escape is triggered might be directly related to each enemy's speed - e.g., initiating flight at a longer distance from a cheetah than from a leopard. Conversely, to the extent that bears employ different defenses against different enemies – e.g., snakes vs. fellow bears - which are triggered by different releasing mechanisms, these would be considered separate classes of phobia – e.g., ophidiophobia vs. ursophobia.

Once brown bears immigrated into North America, beginning around 70,000 years ago [35] they too would have had to contend with this continent's Pleistocene megafauna including *Arctodus*. There were at least 55,000 years for evolution of a phobia by brown bears against *Arctodus*, and 70,000 years for evolution of a phobia by black bears against brown bears. This would have required little or no modification of pre-existing phobias against other bears. After North America's Pleistocene mega predators went extinct, only pumas remained along with brown and black bears; the remaining predator niches were taken over by more recent immigrants from Asia - gray wolves and humans.

Those then are the enemies which North American bears are most likely to have feared during the Pleistocene. We have no way of knowing whether any of the phobias evolved as protection against Pleistocene predators have been retained through the Holocene despite relative freedom from predation during those >10,000 years. Granted, Byers [36] reported that pronghorn antelope (*Antilocapra americana*) retain certain social behaviors and escape abilities that evolved as defenses against cheetahs >10,000 years after the last cheetahs disappeared from North America, despite the lack of any Holocene predator of comparable speed. Certainly, one might argue that even occasional losses of cubs to wolves, coyotes, and pumas, has sufficed to retain those adaptations. Yet, Byers' description of antelope behavior suggests that sexual section had more influence, even on running speed. Furthermore, Berger's [7] findings on moose suggest that even for ungulates, just a few generations without exposure to wolves and bears erodes their fear of these predators. So >5,000 generations with minimal predation pressure could have had even greater impact. Rogers et al. [31] report that black bears responded fearfully to snakes (both venomous and non-venomous) in regions where venomous snakes have been endemic throughout the Holocene, but not in regions where venomous snakes have been absent for millennia – suggesting that termination of selection pressure by venomous snakes led to erosion of ophidiophobia.

The only non-human animals which have continued exerting strong selection pressure on North American and European bears throughout the Holocene are fellow bears. Adult males sometimes target infant conspecifics, perhaps as a means of reproductive competition [37-39]. In other cases big bears dominate or prey upon smaller bears of any age, irrespective of sex or species [38]. On average, large species may dominate or prey upon small species more than the reverse; but the reverse does occur. SFS has observed adult male black bears dominate larger brown bears – adolescents of both sexes, and adult females – during food

competition. Accordingly, the animals that modern bears tend to fear most are fellow bears – conspecifics or allospecifics. This has likely also been true since extinction of giant Pleistocene felids.

Did anthropophobia evolve from ursophobia?

Recapitulating: although some brown bears, and especially black bears, are frightened of the first humans they encounter, SFS has observed many exceptions. Even where a naïve bear was afraid of humans, there was no proof that the fear manifested innate anthropophobia rather than a) xenophobia or b) ursophobia due to initially mistaking the person for a fellow bear. Throughout the Holocene, the enemy phobia subject to the strongest reinforcing selection pressure would have been ursophobia. There are no non-human animals that North American brown and black bears fear more than fellow bears, as well as no enemy for which a human is more readily mistaken than a bear standing bipedally.

On numerous occasions when one of us encountered an Alaskan brown bear, it initially reacted to us as though we were a fellow bear, then shifted to treating us as it normally treated a human. These bears had previously become so familiar with us and with recreational bear viewers, that their reactions to humans could often be distinguished from their reactions toward conspecifics. For example, mother-cub families commonly rested, slept, or even nursed within 20 m of us, whereas they seldom did any of those things within 100 m of other bears, much less wolves. This shifting of a bear's response to us from a bear→bear mode to a bear→human mode, suggested that the bear's initial fear toward us was a side-effect of ursophobia, or possibly of generic xenophobia. We considered this analogous to an animal initially reacting fearfully toward a snake or quadruped mammal before distinguishing that it is not a dangerous species.

The phobia-releasing mechanism requiring least modification to fit humans would have been ursophobia. There are two conceptually simple routes evolution might have taken: a) broadening the ursophobia-releasing mechanism so that it was more readily also triggered by humans; or b) duplicating the ursophobia releasing mechanism and modifying the copy so that it became especially sensitive to human key stimuli. But whether even such a small modification to ursophobia actually evolved would depend on whether human persecution has been intense enough, for long enough.

IS ANTHROPOPHOBIA DIRECTLY RELATED TO HISTORIC PERSECUTION PRESSURE?

To whatever extent that anthropophobia is a product of genetic selection via human persecution, intensity of anthropophobia should be directly related to intensity and duration of persecution. Persecution of brown bears by humans would have been relatively minor throughout the Pleistocene and most of the Holocene, judging from the limitations of weaponry during that period [40], and from cultural reverance for bears by hunter-gatherer peoples during earlier millennia, judging from more recent Native Americans and the Ainu people of Japan.

For the last 2,000 - 3000 years however, humans have been purposefully exterminating brown bears from large areas of the Mideast and Europe [43-47]. This accelerated during the 18th and especially 19th Centuries with the advent of more powerful firearms [43,47]. During the 18th Century, brown bear numbers in Scandinavia (i.e., Norway and Sweden) could have exceeded 10,000, given the official estimate of 4,750 in the middle of the 19th Century, when they were declining rapidly [47] (Figure 1). Persecution intensified around 1800, and even more so during the mid-19th Century. Bounties were paid on nearly 8,000 bears, bringing the population to the brink of extinction, before conservation measures were begun during the last decade of that century. By 1995 the population had regrown to nearly 1,000 bears and has continued to expand [47].

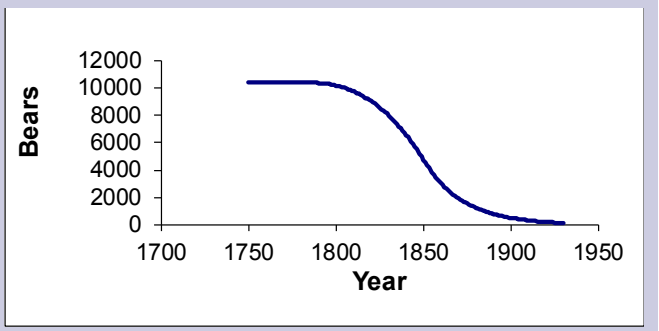

Figure 1: Hypothesized decline of the Scandinavian bear population (schematic). Swenson et al. [61] reported that efforts to exterminate bears began around 1800, and that the population was down to 4700-4800 by 1850, and to 130 by 1930. We fit this curve by assuming that the population was at carrying capacity until 1800, then declined at an accelerating rate as the human population grew and better weapons become available. As of 1850 - 1870, high-powered repeating rifles began replacing single-shot rifles. We followed the precedent of Swenson et al. in assuming a constant rate of decline from 1850 – 1930, which we calculated as lambda = 0.956. This yields a population size estimate of 500 in 1900. Actual carrying capacity prior to 1800 has yet to be determined; a conservative estimate of roughly 10,400 was consistent with the information provided by Swenson et al. Assuming a few thousand bears more or less as of 1800 would not affect our conclusions about relative attack rates in Scandinavia vs. North America.

Table 1: Numbers of brown bears and humans in Sweden and Norway 1750 – 2000

Year	Bears[61]	Sweden Humans[55]	Norway Humans[56]	Sweden & Norway	Bears/1000 Humans
	x 10^3	x 10^6	x 10^6	x 10^6	
1750	10.4	1.78	0.7	2.48	4.19
1850	4.75	3.48	1.49	4.97	0.96
1900	0.5	5.14	2.23	7.37	0.07
2000	1	8.84	4.49	13.33	0.08

[a] Swenson et al. [61] estimated roughly 4750 bears in 1850 declining to 130 by 1930, a mean lambda of 0.0956. See Figure 1 for details.

As of 1800, the North American brown bear population numbered ~50,000 in what is now the contiguous United States and at least that many more in Canada and Alaska [6,48-49]. Those in the contiguous Untied States and southern Canada were not subjected to holocaust until the mid-19th century when grizzly habitat was flooded by immigrants armed with powerful repeating rifles and poison [6,49-50]. By the 1920's grizzlies had been extirpated from most of the contiguous United States [49]. By 1975, <1,000 remained, mainly in the Rocky

Mountains – leading to their classification as Threatened under the Endangered Species Act [48]. Grizzly bears had also been extirpated from the southern Canadian provinces except Alberta and British Columbia [43,50-52].

To the extent that anthropophobia is genetically determined, one might thus predict that a) 2-3 millennia of heavy persecution in the Mideast and Europe would have tended to increase anthropophobia over that period, and b) the small number of Scandinavian bears which survived the genetic bottleneck at the end of the 19th Century would have been especially anthropophobic - as would also be true for their descendants (Figure 2). A similar bottleneck could have been produced in the contiguous United States and southern Canada, but would have done less to increase mean intensity of anthropophobia due to the 20- to 30-fold shorter persecution than in Scandinavia. Although there was a widespread impression during the 19th Century that hunting grizzly bears increased their anthropophobia [8], it is not clear whether this was actually true. If so, how was increased anthropophobia manifest? Were grizzly bears less likely to defend themselves by charging toward a human, even a human that had just wounded the bear? Or were bears likely to avoid humans by an increasingly wide margin - e.g., out of rifle-shot? And if such changes did occur, to what extent were they the result of genetic selection or individual or cultural learning, analogous to the ways in which bears learn from one another about anthropogenic food sources [53-54]?

If a bear survives being wounded by a human, this is likely to increase its fear of humans only if it associates wounding with the human. We would expect wounding to have been most common during the era when bears were being hunted with inadequate weapons - weapons that were not sufficiently powerful or accurate. So it is not clear how improved firearms could have been more effective at teaching brown bears to avoid humans.

It makes sense that improved firearms were more effective at killing, and less effective at educating bears. This could have selected against bears that did not stay out of rifle range, much as poison and steel traps could have selected against bears that did not avoid food tainted with the odors of humans or of steel. But as persecution continued, progressively reducing the sizes of populations, even shy, non-aggressive bears would have been killed too.

Bear attacks in Europe during the 18th – 20th centuries

One way to test the hypothesis of a negative correlation between aggressiveness vs. persecution pressure is by comparing rates of brown bear attacks over time within populations, and among them. This hypothesis might seem to be supported by the fact that only 2 people have been fatally injured by a brown bear in Scandinavia during the 20th Century (1902 and 1906), compared to 25 killed during the previous century-and-a-half – i.e., 1 fatality per 6 years vs. 1 per 50 years, an 8-fold decline. Non-fatal injuries have also been much less common during the 20th Century [47].

However, Swenson et al. do not interpret this as evidence of declining aggressiveness. They point to the conclusion by Bishop Clausson Friis in the early 1600s that even then, brown bears were normally not dangerous unless wounded. Yet the Church considered bear hunting so risky that it was suicidal, which precluded any hunter killed by a bear from being buried on Church grounds. Swenson et al. instead attribute the decline in attack rate to changes in risk factors, particularly to the decline in merely wounding a bear now that hunters have a) more effective weapons, and b) are hunting for sport rather than killing for bounty money - which, during the 18th and 19th Centuries, was commonly done using unmanned setguns at bait sites.

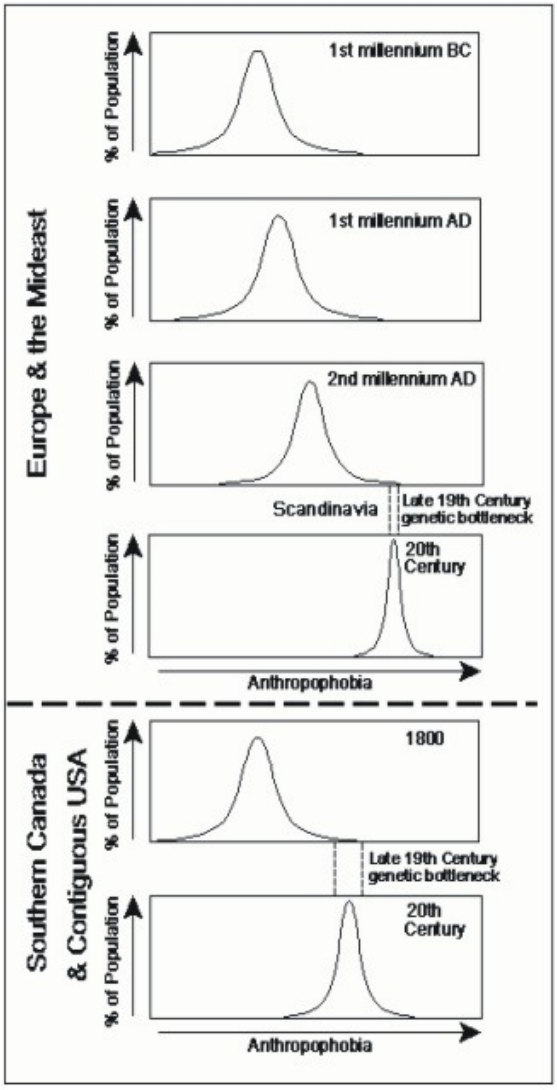

Figure 2. Hypothetical increase in anthropophobia over the past 3 millennia in Europe and the Mideast vs. the past 2 centuries in North America, culminating in genetic bottlenecks at the end of the 19th Century, allegedly leaving hyper-anthropophobic bears in Europe and moderately anthropophobic bears southern Canada and the contiguous United States to found subsequent generations. (Height of bell curves not to scale with width.)

Reviewing the Scandinavian statistics [47], we calculated that during both periods – 1750-1962 and 1976-1995, mauling rate averaged 0.35/yr. However, prior to the 20th century, >25% of maulings were fatal, whereas the only fatalities since then occurred during the early years of the 20th Century. One victim was shot in the chest during his rescue attempt. The other victim was merely wounded but later died of infection – suggesting that improved medical care was one reason for higher survivorship during the 20th Century, much as has occurred for soldiers wounded in battle.

Furthermore, the consistent 0.35/yr mauling rate occurred despite vast changes in human abundance. During 1750-1900, not only did brown bear numbers crash from an estimated ~10,000 down to ~500, but size of the human population almost tripled (2.48 to 7.37 million; [55-56]). While brown bear numbers have since risen to almost 1,000, the human population has also continued increasing (by 6%/decade since 1950). The ratio of bears to humans was >10-fold higher during the mid-19th Century than during the 20th Century. This declining ratio alone might have sufficed to reduce attack rate per year per person.

The consistent mauling rate (0.35/yr) despite the vastly lower bear-human ratio during 1976-1995, and the allegedly lower rate of bears being wounded, suggest that annual mauling rate from non-wounding causes per 1,000 bears has actually *risen* several-fold, along with growth of the human population [55-56]. Positive correlations between conflict rates vs. sizes of both bear and human populations have been well documented in North America [e.g., 57-59]. Recapitulating: These data provide no evidence that Scandinavian bears have become less aggressive - more anthropophobic - over the past 250 years, although this would not preclude higher aggressiveness by their ancestors during earlier centuries and millennia (Figure 2).

Bear attacks in North America during the 19th and 20th centuries

A second way of assessing any possible relationship between intensities of aggression vs. intensity and duration of persecution, is comparing among populations. In these comparisons too, the only way of separating genetic vs. environmental influences on intensity of anthropophobia or on attack rate is by showing associations with risk factors.

Recall that during the 20 years 1976-1995 in Scandinavia, only 7 people (0.35/yr) were mauled, and no one was killed, by a brown bear. By contrast, during the 39 years between 1960-1998, the brown bear mauling rate in Canada's Alberta province was over twice as high (0.74/yr; Table 2); [57]. During essentially that same period (1960-1997) in British Columbia, brown bear mauling rate averaged 1.3/yr, a nearly 4-fold difference [58]. Combining data from the two provinces, the average mauling rate was 2.0/yr – almost 6-fold higher than in Scandinavia.

We found similar differences in predatory attack rates between Scandinavia vs. North America. There are only 9 recorded cases of a human being eaten by a brown bear in Scandinavia over 213 years 1750-1962, i.e., 0.04/yr. All of those predatory attacks occurred during the 140 years 1750-1890 [47] while the population was being reduced to a few hundred bears, i.e., 0.06/yr. During the 116 years 1900-2015, North American brown bears preyed on 24 people [60], or 0.20/yr, a >3-fold higher rate than in Scandinavia. During the 110 years 1900-2010, black bears preyed on approximately 60 people [59], or 0.54/yr, 9-fold higher than in Scandinavia.

Table 2: Brown bear mauling rates: Scandinavia vs. Western Canada

	Scandinavia [47]	Alberta [57]	British Columbia [58]	Alberta & BC
Injuries				
Total	7	29	49	78
Serious		22	41	63
Fatal		7	8	15
Years of data	20 [a]	39	38	38
Injuries/yr				
Total	0.35	0.74	1.29	2.05
Serious		0.56	1.08	1.66
Fatal		0.18	0.21	0.39
Bears (thousands)	1	1	11.5 [b]	12.5
Injuries/yr/ 1000 bears				
Total	0.35	0.74	0.11	0.16
Serious		0.56	0.09	0.13
Fatal		0.18	0.02	0.03

[a] 1976-1995
[b] Population size estimated 10,000 to 13,000 [58], so median 11,500 used.

It might thus be tempting to conclude that Scandinavia brown bears are less aggressive than North American brown bears and less predatory than both North American species. However, when mauling rates are adjusted for bear population sizes, relative mauling rate during the 20th Century turns out to have been 2-fold higher in Scandinavia than in western Canada (0.35 vs. 0.16 total maulings/1,000 bear-years). For just non-fatal maulings, the rate was nearly 3-fold higher in Scandinavia (0.35 vs. 0.13 injuries/1,000 bear-years; Table 2).

The same holds for predatory attacks. For Scandinavia - using the 140-year time span while the population was sliding toward extinction, and assuming that the average number of brown bears was 6,000 - 8,000 (Table 2) - the predatory attack rate (e.g., 9 attacks/140 yrs/6,000 to 8,000 bears) is estimated at 8 - 11 predatory attacks per million bear-years. In North America the 24 predation victims fell prey to 21 [60] of the continent's 60,000 brown bears. This computes to 3.4 predatory attacks per million bear-years - roughly one-third to one-half the estimate for Scandinavia. North America now contains ~1 million black bears, but numbers have increased during the latter half of the 20th Century. Assuming 60 predatory attacks by an average of 0.8 - 1.0 million bears over 1900-2009, this computes to a predation rate of 0.55 to 0.68 per million bear-years – i.e., up to an order of magnitude lower than for Scandinavian brown bears.

Despite uncertainties in these estimates for bear numbers and attack rates, they clearly provide no support for the oft-stated claims that Scandinavian bears are both less defensively aggressive and less predatory than North American brown bears. Furthermore, even if one had more reliable Scandinavian bear population figures during past centuries (perhaps based on habitat carrying capacity, as Mattson & Merrill [49] did for North American brown bears) no firm conclusions could be drawn about differences in bear temperaments between continents, until one had factored out the effects of risk factors that might have differed over time and among populations. For example:

a) **Human population size:** In North America, the attack rate in a population is directly related to size of the human population, as was shown not only for both provinces of southwestern Canada [57-58], but for North America overall [59]. However, Swenson et al. [47] gave no indication of such a trend in Scandinavia. While the human population has continued growing since the 18th Century, size of the bear population first shrank from an estimated ~10,000 bears around 1750 to a few hundred in the 1890's, then resumed growing over the next century to <1,000. Yet the rise in human population sizes was not accompanied by an increase in mauling rate, either while the bear population was shrinking or while it was recovering.

b) **Habitat:** In western Canada, occupied bear habitat has been fairly saturated with bears; so human impacts have tended to further reduce the amount and quality of habitat available per bear decade after decade. By contrast, Scandinavia's small population has been expanding unto relatively vacant habitat [47].

c) **Habituation and the lure of human attractants** tend to increase human-bear interactions in North America. In typical suburban and rural environments, attractant conditioning increases risk of conflict per encounter with humans [for exceptions, 62-64]. This is presumably also true in Scandinavia, although Swenson et al. [47] did not explicitly address it. Perhaps these influences were represented indirectly through their effects on other risk factors (listed below). Likewise, in North America, habituation of brown bears was not so much observed as inferred from the fact that a highly disproportionate percentage of attacks by brown bears - although not by black bears - occurred in national parks [57-59].

d) **Scandinavia's major risk factors:** Most Scandinavian brown bears that mauled someone were either wounded, a mother with cubs, or a bear defending an ungulate carcass or perhaps a den site. Most of the girls and women attacked were tending livestock in forested habitat, where they may have conflicted with a bear attempting to prey on the livestock, or a bear that was guarding a livestock carcass, or was startled or crowded. Most of the boys and men attacked were either gathering – birch bark or wild plant foods – or hunting. Mortality rate was substantially lower for hunters than for herders and gatherers, despite the fact that hunters were most exposed to wounded bears.

e) **Group size:** In North America, most victims of attack were alone or in a group of 2 people (black bears) or 2-3 people (brown bears) [12,57-59]. This too was not explicitly addressed by Swenson et al. [47] but might be implied in noting that most victims were tending livestock, gathering wild plant commodities, or hunting – activities commonly done solo or in small groups. As those methods of livelihood have declined in Scandinavia, mauling rate has also declined [47].

f) **Hunting:** Although hunting is confined to a short period each year in Scandinavia, and is done by a small fraction of wildland users, hunters have historically been among the most predictable victims of mauling - usually by a wounded bear - prior to wide use of high-powered repeating rifles [47]. Whereas people have also been injured by a wounded brown bear in North America, the greatest danger to hunters on this continent has been surprising a brown bear - especially a mother with cubs - often while the victim was stalking an elk (*Cervus elaphus*) or deer (*Odocoileus spp.*). Hunters have also provoked attack when they accidentally crowded a brown bear guarding an ungulate carcass or offal. Less often, a brown bear has attacked someone who interfered with the bear's attempt to steal a carcass from him [12,57-58].

g) **Separation distance:** On both continents, brown bears tend to attack mainly when they are approached too closely in a situation where they can not or will not flee – e.g., when a bear is wounded; is a mother with small cubs that cannot run quickly; is guarding a carcass too large to be readily carried while fleeing; or is trapped. In North America, nearly all attacks were launched when the bear was <100 m, and often <50 m from the person – which is most likely to occur where sight distance is restricted for both bear and human, due perhaps to dense vegetation [12,47,57-58] such as in the forested sites where shepherds and milkmaids were attacked [47].

h) **Site defense:** We have found no mention of den site defense by North American bears; but bears, especially brown bears, have attacked and occasionally killed someone that closely approached an occupied den. Having a predator know the location of one's den is risky.

i) **Dogs:** Although dogs were involved in a number of attacks in Scandinavia, these were primarily or exclusively hunting dogs. Whereas dogs can trigger aggression, this is usually directed at the dog, not the person. However, in North American a few people have been mauled when a dog fled to them, chased by a bear. But generally, hunting dogs have been less of a problem in North America, if only because they are normally used to hunt only black bears, not brown bears.

Conclusions: No rigorous comparison of bear temperaments on the two continents can be made without taking the above risk factors into account, preferably though some kind of multivariate statistical analysis. Meanwhile, available data provide no support for the contention that brown bears are less aggressive in Scandinavia than in North America.

Tolerance for humans by coastal vs. inland brown bears in North America

Although attempts to drastically reduce brown bear numbers in the contiguous United States and southern Canada date back to the mid-19th Century, in Alaska they date back only to the mid-20th Century. Alaska's bear reduction program was originally concentrated near human population centers, due to concerns about human safety, livestock predation, and property damage. Bear numbers were also reduced in coastal areas where they competed with humans for salmon (*Oncorhynchus spp.*), and recently throughout much of the state as managers and the public have realized that bears also compete with humans for wild ungulate prey [43,65].

In Alaska, efforts to reduce bear numbers have been aimed less at brown bears than at black bears because blacks are >3-fold more numerous [66-67] and are less valued by sport hunters. Nevertheless, browns are also targeted - if not as vermin, then as trophies. Trophy hunting has been focused on the Alaskan sea coasts where bears are easily found along shores and salmon streams, and where consumption of salmon and a long growing season have allowed bears to reach enormous sizes. Some brown bears have exceeded 600 kg. Hunting pressure on brown bears has been lighter per square kilometer in the Interior of Alaska, as well as in much of northern Canada and southward through the Rocky Mountains, where they are harder to find and are smaller due to lower consumption of prey rich in protein and lipid. Given the greater hunting pressure on brown bears in coastal habitats than inland, one might predict that anthropophobia would be higher among coastal bears (assuming anthropophobia is innate and has evolved protecting bears from humans). But that's not what we observed.

Coastal bears in southern Alaska (i.e., south of the Matanuska Valley) have an amazingly higher tolerance for humans than do brown bears elsewhere. Not only do they have greater opportunity for habituating to benign humans – mostly bear viewers – but they habituate more readily and more deeply than inland brown bears. In the Greater Yellowstone Ecosystem – at the junction of Montana, Idaho and Wyoming – only a handful of the least anthropophobic brown bears forage adjacent to roads where they find refuge from larger, more aggressive conspecifics [68-69], and where they can be viewed by tourists. Yet these viewable bears seldom tolerate being followed away from a road. By contrast, at Alaska's McNeil River Game Sanctuary and Katmai National Park, brown bears commonly forage, rest, sleep, and even nurse cubs within 20 m of viewers (Figure 3). Viewers can discretely follow some Katmai bears for hours without noticeably disturbing them. No comparable level of tolerance has been publicized for Scandinavian brown bears.

Scandinavian researchers [47] reported having had >800 close encounters with brown bears without provoking aggression, as evidence that those bears are more tolerant than North American brown bears. However, SFS has rarely faced serious aggression during >10,000 encounters with coastal Alaskan brown bears, in areas where it is not uncommon to have >20 bears in sight most of the time, and >50 bears on occasion (X encounters with Y bears = XY encounters).

Figure 3: Aggregation of coastal grizzly bears fishing for salmon in Alaska. Courtesy of Kent Fredriksson.

Some professional bear viewing guides at Katmai National Park or McNeil River State Game Sanctuary have had thousands of encounters per year for decades without being in serious danger. We have found no reports from Scandinavia or elsewhere in Europe of how those brown bears behave toward one another or toward humans at any sites where the bears aggregate to exploit concentrations of salmon or other foods. Nor have we found any other reports of European brown bears developing as much trust for humans as is common at viewing sites on the Alaskan coast.

In any event, the greater tolerance for humans by Alaska's coastal brown bears than by inland brown bears is negatively, rather than positively, correlated with hunting pressure, contrary to what would be expected if anthropophobia were innate and had evolved protecting bears from humans.

The greater tolerance for human proximity by coastal brown bears has been attributed [70-71] to the bears reacting to proximity of humans much as they react to proximity of fellow bears - i.e., to lower ursophobia on coasts than in Inland habitats. Coastal bears have to tolerate close proximity to one another in order to share major sources of lipid-rich meat, especially salmon (Figure 3) and cetacean carcasses (Figure 4). In common cases where salmon schools and whale carcasses provide more food than one or a few bears can consume, any bear(s) trying to exclude other bears from these food sources isn't likely to provide enough additional nutrients to justify the costs, especially the risks of injury, whereas intruding bears have much to gain from fighting for a share. By contrast, in Interior habitats where the main prey are rodents and ungulates, a bear possessing a scarce ungulate carcass has as much or more to gain from defending exclusive access to the carcass as any other bear has from trying to usurp or share it.

During the late Pleistocene, North American brown bears were sympatric with a wide variety of other megafaunal carnivores and herbivores in interior steppe habitat [32,72-73]. By contrast, brown bears occupying coastal rainforests were much less exposed to dangerous steppe megafauna [32]. This too would have tended to reduce tolerance for intruders more among inland brown bears, than among those on sea coasts.

Note that the brown bears in Interior Alaska immigrated 55-70 thousand years ago (kyBP), while the coasts were deep in glacial ice [35]. By contrast, ancestors of southwest Alaska's

coastal brown bears immigrated from Eurasia at the end of the Pleistocene, just before the Bering Land Bridge submerged. The closest Asian source of salmon-adapted bears was the Kamchatka Peninsula where bears also tend to be hypo-anthropophobic [74].

Figure 4: Brown bears feeding on whale carcasses in Alaska. © 2010 S. Stringham

Until the effects of a) adaptation to predation and scavenging in large bear aggregations, and of b) genetic clades, can be distinguished from those of harvest pressure, there is no basis for assuming that - but for said intervening factors - tolerance for humans by brown bears would be positively, rather than negatively correlated with persecution pressure between coastal vs. inland habitats.

SUMMARY AND CONCLUSIONS

a) Although some brown bears, and especially black bears, were frightened of SFS when he was likely the first human they had encountered, other allegedly naïve bears exhibited little if any anthropophobia. There is small likelihood that an allegedly naïve bear's fear of humans had been learned, but virtually zero likelihood that lack of fear toward SFS by some bears was a result of prior habituation.

b) Even where an allegedly naïve bear was afraid of SFS, there was no proof that the fear manifested innate anthropophobia rather than ursophobia due to initially mistaking him for a fellow bear or to generic xenophobia. We have observed many such cases of mistaken identity by brown and black bears.

c) Throughout the Holocene, the anti-predator phobia most strongly reinforced by selection pressure would have been ursophobia.

d) There are no non-human animals that North American brown and black bears fear more than fellow bears.

e) No enemy more closely resembles a fellow bear standing bipedally than does a human. So if humans are mistaken for a specific kind of enemy, it would be most likely a fellow bear. But generic xenophobia is also likely.

f) In Scandinavia (Norway and Sweden) brown bear-inflicted injury and death rates were much lower during the 20th Century than during 1750-1900. Scandinavian biologists attribute this to a reduction in risk factors, especially wounding of bears by hunters. To that list we add better medical care, and a much lower ratio of bears to humans. The brown bear population in Scandinavia crashed from ~10,000 bears in the mid-18th century to a few hundred by the end of the 19th Century, then rebounded to <1,000 by the end of the 20th Century. While the bear population was crashing, the human population was growing - at 6%/decade since 1950.

g) Extermination of brown bears from large areas of the United States and southern Canada did not get underway until the middle of the 19th Century. Yet by 1975, their abundance in the contiguous United States had been reduced from ~50,000 to <1,000. Although there was a perception that brown bears became shyer and less aggressive during those decades, there is no documentation of any change.

h) SFS has observed stark differences in the behavior of brown bears on the Alaska Peninsula between areas where they are vs. are not hunted – even in situations were bears can easily travel between hunted vs. unhunted areas - suggesting that behavioral differences are learned, not genetically determined. Furthermore, some identifiable individuals that trusted people at a sancutuary site did not trust them elsewhere. Whereas we know of no evidence that hunting increases fear of humans by any bears that are not wounded in the process, we know from personal experiments and by observing other people, that stalking or pursuing bears can frighten them, irrespective of whether the person(s) doing so is carrying a firearm or a camera. We also know from firsthand experience how readily some brown and black bears can learn to avoid belligerent humans – if not by staying out of gunshot range (e.g. >300 m) from people, than at least by staying far enough away - e.g. 50 - 100 m - to escape if we charged them as fast as another bear might. In some cases, even belligerence is unnecessary. Along salmon streams in Alaska, SFS has taught black and brown bears to remain at least 5 – 10 m away. If a bear starts crowding SFS, he can usually stop this simply by rising from a sitting position to standing, or if necessary by taking a few steps toward the bear. Conversely, we commonly observe lessening of fear towards humans whom bears learn to trust – which usually occurs where bears are so hungry that they will forage even near humans. We have experimentally demonstrated this in >100 cases, and have observed it happening through interactions between other people and many other brown and black bears.

i) In Scandinavia during the 20th Century, only 2 people were killed by a brown bear, both during the first decade. By contrast, in southwestern Canada (Alberta and British Columbia), a brown bear killed 1 person every 3 years, on average. The number of people per year mauled by a brown

bear was 6-fold higher in western Canada than in Scandinavia. This is consistent with the prediction that aggression would be lower where persecution has been most intense for the longest time. However, given the numerous other risk factors that affect mauling rates, one cannot be sure that higher rate of brown bear maulings – mainly defensive – in North America than in Europe was determined genetically rather than environmentally. Indeed, when those statistics are adjusted for sizes of the bear populations, the non-fatal injury rate per year per 1,000 bears was actually 2-fold higher in Scandinavia.

j) Likewise, although the 9 predatory attacks in Scandinavia were dwarfed by those in North America (24 by brown bears, about 60 by black bears), the rate per million bear-years was up to 3-fold higher for Scandinavian brown bears (8 - 11) than for North American brown bears (3.4), and up to 10-fold higher than for North American black bears (<0.7).

k) Among the least anthropophobic -- most human-tolerant – brown bears known are those living on the sea coasts of Alaska, British Columbia, and Kamchatka. There, any innate anthropophobia is either especially low or particularly susceptible to habituation. Anthropophobia tends to be more intense in the interior of Alaska, British Columbia and the Rocky Mountains where persecution is lower. The unusually low anthropophobia among coastal brown bears might be attributable to the unusually low ursophobia among those bears - which has been interpreted as a behavioral adjustment for salmon predation and whale scavenging. Whether any Scandinavian or other European brown bears also adapted that way for exploiting dense prey concentrations is not known.

l) Taken together, those lines of evidence contradict the hypothesis that intensity of anthropophobia is directly related to intensity and duration of persecution pressure - i.e., that millennia of humans persecuting bears has produced innate anthropophobia. Any innate aversion to humans is most likely "unnatural," due to mistaking the humans for fellow bears (ursophobia) or for other non-human enemies (xenophobia) analogous to the way that bears fear loud revving internal combustion engines.

m) In a follow-up paper, we will explain why these conclusions are also supported by 3 additional lines of evidence: other measures of anthropophobia; prehistoric selection pressure; and heritability of anthropophobia [40].

PRAGMATIC IMPLICATIONS

a) These findings support conventional management priorities that subordinate concern about the naturalness of anthropophobia to the pragmatics of human safety and welfare of bear populations, even in National Parks.

b) The fact that humans have been persecuting bears for millennia does not render the impacts of persecution any more natural than food conditioning is natural just because bears have likely been scavenging human refuse, and usurping food from humans or from their storage sites, as long as humans and bears have coexisted.

c) In lieu of evidence that human persecution of bears has had a measurable effect in evolving and maintaining anthropophobia, an alleged need to maintain a natural level of anthropophobia should not be used as a rational for intensifying lethal persecution of bears.

d) Nor is the history of human persecution appropriate justification for discarding the concept of naturalness as "being free of substantial and recognizable human influence" – for instance as exemplified by a relatively neutral attitude toward benign humans. Bears are appropriately considered to be behaving naturally with regard to humans, if proximity to humans, or behavior of the humans, or other effects by the humans, do not (a) substantially alter where, when and how bears use their habitat, or b) impair their rates of reproduction or survival, population vigor or fitness, or (c) impair bears from fulfilling their ecosystem functions.

e) Although we do not oppose bear hunting per se, we have found no evidence that it increases natural behavior or safety for the general public, much less for hunters. Quite the contrary. Public safety is better enhanced by management based on a deeper, more nuanced understanding of anthropophobia [9]. This begins with distinguishing a bear's fear of human offensive aggression vs. its fear of human defensive aggression - i.e., between its distrust vs. respect for humans. Distrust promotes escape by both black and brown bears when escape is feasible. But when escape is not feasible without abandoning cubs, a large mammal carcass, or perhaps a den site, or when a bear is wounded or trapped, distrust promotes violent defensiveness by brown bears – the primary cause of serious or fatal injuries by this species in North America.

f) In LLR's Minnesota study areas, black bears are normally so shy that their inherent respect for humans almost always precludes any need to enhance it, for instance by punishing them. Nevertheless, respect is commonly overcome by the lure of food in suburban and rural black bear populations elsewhere across North America, and in brown bears. Attempts have been made to curb this using various forms of aversive conditioning, with mixed success. This sometimes takes the form of physically beating and harassing black bears. With brown bears, respect is better enhanced in ways that do not jeopardize trust, lest the decrease in offensiveness be overridden by dangerously increased defensiveness. [9].

g) Maintaining the trust of bears is essential to close-range viewing that meets the expectations of viewers and does not disturb the bears enough to distress them or to drive them away. Viewable bears can be proverbial golden geese for local communities [76-77], so long as viewing is done safely. This requires bears that trust people even at close range (e.g., <100 m) in situations where humans are not perceived by bears as prey or rivals for prized resources – circumstances that are common on the sea coasts of Alaska and parts of British

Columbia, but scarce elsewhere in North America. Millions of person-days of viewing have occurred with Alaska's coastal bears without anyone suffering even a minor assault. That perfect safety record does not include Timothy Treadwell and his companion Amie Huguenard who were killed and eaten by brown bears in 2003 [78]. They were not viewing trustful, respectful bears as was the norm, even for Treadwell. Rather, he had been harassing human-alienated high-ranking adult males for days before the fatal attack.

AUTHORS' CONTRIBUTIONS

Both authors conducted the field research. Concepts were developed jointly. Literature search and writing were done by Stephan F. Stringham (SFS).

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DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. National Park Service, Organic Act of 1916, 16 USC 1.
2. Cutright PR. Lewis and Clark: pioneering naturalists. Univ. Nebraska Press, Lincoln, NB. 1969.
3. Botkin DB. Our natural history: the lessons of Lewis and Clark. Oxford Univ. Press, New York, NY. 1995
4. Martin PS, Szuter CR. War zones and game sinks in Lewis and Clark's West. Conservation Biology. 1999; 13: 36-45. (doi: 10.1046/j.1523-1739.1999.97417.x)
5. Kay C. Were native people keystone predators? A continuous-time analysis of wildlife observations made by Lewis and Clark in 1804-1806. Canadian Field-Naturalist. 2007; 121: 1-16. (dx.doi.org/10.22621/cfn.v121i1.386)
6. Mattson D. Extirpations. 2016.
7. Berger J, Swenson JE, Persson IL. Recolonizing carnivores and naïve prey: conservation lessons from Pleistocene extinctions. Science. 2001; 291:1036-1039. (doi: 10.1126/science.1056466)
8. Schullery P. Lewis and Clark among the grizzlies: legend and legacy in the American West. Falcon Guide, Helena, MT. 2002.
9. Stringham SF. When bears whisper, do you listen? negotiating close encounters with wild bruins. WildWatch. Soldotna, AK. 2009.
10. Sterba J. Nature wars. Crown Pub., New York, NY. 2012.
11. Geist V. Response to Rogers and Mansfield (2011) and Stringham (2011). Human–Wildlife Interactions. 2011; 5: 192-196.
12. Herrero S. Bear attacks: their causes and avoidance. Lyons and Buford. New York, NY. 1985.
13. Hoare RE. Determinants of human-elephant conflict in a land-use mosaic. Journal Applied Ecology. 1999; 36: 689-700. (doi 10.1046/j.1365-2664.1999.00437.x)
14. King LE., Douglas-Hamilton I, Vollrath F. Bee hives as effective deterrents for crop raiding elephants: field trials in northern Kenya. African Journal Ecology. 2011; 49: 431-439. (doi: 10.1111/j.1365-2028.2011.01275.x)
15. Pai M, Aliwo S. A Survey of attitudes towards human–baboon conflicts in a university campus in Ethiopia. J. Biodivers. Manage Forestry. 2014; 3: 1-2. (doi.org/10.4172/2327-4417.1000131)
16. Stringham SF. Aggressive body language of bears and wildlife viewing: a response to Geist (2011). Human-wildlife Interactions. 2011; 5: 177-191.
17. Lackey CW, Beckmann JP, Sedinger J. Bear historical ranges revisited: documenting the increase of a once-extirpated population in Nevada. Journal of Wildlife Management. 2013; 77: 812–820. (doi: 10.1002/jwmg.548)
18. FWC (Florida Wildlife Commission). 2015 Florida black bear hunt summary report. 2016. (Accessed 11/10/2016)
19. Van Manen FT, Haroldson MA, Karabensh BE. (eds). Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2015. U.S. Geological Survey, Bozeman, Montana, USA. 2016.
20. Lorenz, K. Evolution and modification of behavior. Univ. of Chicago Press. Chicago, IL. 1967.
21. Denny, M.R., and S. C. Ratner. Comparative psychology: research in animal behavior. Dorsey Press. Homewood, IL. 1970.
22. Lorenz K. On aggression. Bantam Books, New York, NY. 1966.
23. Tinbergen N, Perdeck AC. On the stimulus situation releasing the begging response in the newly hatched herring gull chick (*Larus argentatus* Pont.). Behaviour. 1951; 3: 1–39. (doi: 10.1163/156853951X00197)
24. Ditmer MA, Vincent JB, Werden LK, Tanner JC, Laske, Iaizzo PA, Garshelis DL, Fieberg JR. Bears show a physiological but limited behavioral response to unmanned aerial vehicles, Current Biology. 2015; 25: 1-6.
25. Wooldridge DR, Belton P. Natural and synthesized aggressive sounds as polar bear repellents. Ursus. 1980; 4: 85-91. (doi: 10.2307/3872848)
26. Owings DH, Morton ES. Animal vocal communications: a new approach. Cambridge University Press, Cambridge. 1998.
27. Tembrock G. Beobachtungen zur Fuchsranz unter besonder Berücksichtigung der Lautgebung. Z. Tierpsychol. 1959; 16: 351-368. (doi: 10.1111/j.1439-0310.1959.tb02061.x)
28. Geist, V. Life strategies, human evolution, and environmental design. Springer-Verlag, New York, New York. 1978.
29. Wyers EJ, Peeke HVS, Herz MJ. Behavioral habituation in invertebrates. In: Peeke HVS, Herz MJ, editors. Habituation: behavioral studies, Vol. I. Academic Press, New York, NY. 1973; 1-58.

30. Stringham SF. Mother-offspring relations in moose. Naturaliste Can. 1974; 101: 325-369.

31. Rogers LL, Mansfield SA, Hornby K, Hornby S, Debruyn T, Mize M, Clark R, Burghardt GM. Black bear reactions to venomous and non-venomous snakes in eastern North America. Ethology. 2014; 120(7): 641–651. (doi: 10.1111/eth.12236)

32. Guthrie RD. Frozen fauna of the mammoth steppe: the story of blue babe. Univ. Chicago Press, Chicago, IL. 1990.

33. Miquelle DG, Smirnov EN, Quigley HG, Hornocker MG, Nikolaev IG, Matyushkin EN. Food habits of Amur tigers in Sikhote-Alin Zapovednik and the Russian Far East, and Implications for Conservation. J. Wildl. Res. 1996; 1: 138-147.

34. Kurtén, B. 1976: The cave bear story: life and death of a vanished animal. Columbia University Press, New York.

35. Davison J, Ho SYW, Bray SC, Korsten M, Tammeleht E, Hindrikson M, Østbye K, Østbye E, Lauritzen SE, Austin J, Cooper A, Saarma U. Late-Quaternary biogeographic scenarios for the brown bear (*Ursus arctos*), a wild mammal model species. Quaternary Science Reviews. 2011; 30: 418-430. (doi:10.1016/j.quascirev.2010.11.023)

36. Byers, J. Built for speed: a year in the life of a pronghorn. Harvard U. Press. 2003.

37. Stringham SF. Roles of adult males in grizzly bear population biology. Ursus. 1983; 5: 140-151.

38. Stringham, S. Responses by grizzly bear population dynamics to certain environmental and biosocial factors. [Dissertation] Knoxville (TN). University of Tennessee. 1984.

39. Stayaert SMJG, Reusch C, Brunberg S, Swenson JE, Hackländer K, Zedrosser A. Infanticide as a male reproductive strategy has a nutritive risk effect in brown bears. Biol. Lett. 2013; 9 20130624.

40. Stringham & Rogers. Bear-human co-evolution: how has this affected ursine fear of humans (anthropophobia)? In preparation.

41. Rockwell D. Giving voice to the bear, North American Indian myths, rituals and images of the bear. Roberts Rinehart Publishers, Niwot, CO, USA. 1991.

42. Shepard P, Sanders B. The Sacred paw: the bear in nature, myth and literature. Penguin, New York, NY, USA. 1992.

43. Schwartz CC, Swenson JE, Miller SD. Large carnivores, moose and humans: a changing paradigm of predator management in the 21st century. Alces. 2003; 39: 41-63.

44. Corbet GB, Harris S, editors. The handbook of British mammals. Third edition. Blackwell Scientific Publications, Oxford, U.K. 1991.

45. Jakubiec Z. *Ursus arctos* - Braunbär. In: Niethammer J, Krapp F, editors. Handbuch der Säugetiere Europas. Aula, Wiesbaden, pp. 254–300. 1993.

46. Breitenmoser U. Large predators in the Alps: the fall and rise of man's competitors. Biological Conservation. 1998; 83: 279–289.

47. Swenson JE, Sandegren F, Soderberg A, Heim M, Sorensen OJ, Bjarvall A, Franzen R, Wikan S, Wabakken P. Interactions between brown bears and humans in Scandinavia. Biosphere Conservation. 1999; 2: 1-9.

48. Servheen, C. The status and conservation of bears of the world. Ursus. Monograph Series #2. 1990.

49. Mattson DJ, Merrill T. Extirpations of grizzly bears in the contiguous United States, 1850–2000. Conservation Biology. 2002; 16: 1123–1136. (doi: 10.1046/j.1523-1739.2002.00414.x)

50. Woodroffe R. 2000. Predators and people: using human densities to interpret declines of large carnivores. Animal Conservation 3, 165–173. (doi: 10.1111/j.1469-1795.2000.tb00241.x)

51. Banci V. The status of the grizzly bear in Canada in 1990. Committee on the Status of Endangered Wildlife in Canada, status report. Ottawa, Canada. 1991.

52. Banci V, Demarchi DA, Archibald WR. Evaluation of the population status of grizzly bears in Canada. Ursus. 1994; 9: 129-142.

53. Mazur R, Seher V. 2008. Socially learned foraging behaviour in wild black bears, *Ursus americanus*. J. Animal Behavior. 2008; 75: 1503–1508.

54. Morehouse AT, Graves TA, Mikle N, Boyce MS. Nature vs. nurture: evidence for social learning of conflict behaviour in grizzly bears. PLoS ONE 1111): e0165425. 2016. (doi:10.1371/journal.pone.0165425)

55. https://en.wikipedia.org/wiki/Demographics_of_Sweden

56. https://en.wikipedia.org/wiki/Demographics_of_Norway

57. Herrero S, Higgins A. Human injuries inflicted by bears in Alberta 1960–1998. Ursus. 2003; 14: 44–54.

58. Herrero S, Higgins A. Human injures inflicted by bears in British Columbia 1960–1997. Ursus. 1999; 11: 209–218.

59. Herrero S, Higgins A, Cardoza J, Hajduk LI, Smith T. Fatal Attacks by American black bear on people: 1900–2009. Journal of Wildlife Management. 2011; 75: 596–603. (doi: http://dx.doi.org/10.1002/jwmg.72)

60. https://en.wikipedia.org/wiki/List_of_fatal_bear_attacks_in_North_America

61. Swenson JE, Wabakken P, Sandegren,F, Bjärvall A, Franzén R, Söderberg A. The near extinction and recovery of brown bears in Scandinavia in relation to the bear management policies of Norway and Sweden. - Wildlife Biology 1995; 1: 11-25.

62. Rogers LL. Does diversionary baiting create nuisance bears and jeopardize public safety? Human-Wildlife Interactions. 2011; 5:287–295.

63. Stringham SF, Bryant A. Distance-dependent effectiveness of diversionary bear bait sites. Human–Wildlife Interactions. 2015; 9: 229–235.

64. Stringham SF, Bryant A. Distance-dependent effectiveness of diversionary bear bait sites: Commentary. Human–Wildlife Interactions. 2016; 10: 128-131.

65. ADF&G (Alaska Department of Fish & Game). Understanding predator management in Alaska. 24 pp. 2007.

66. Pinney, A. Brown bear research in Alaska. 2012.

67. ADF&G (Alaska Department of Fish and Game). Black bear hunting in Alaska: life history. 2008.

68. Mattson DJ, Blanchard BM, Knight RR. Yellowstone grizzly bear mortality, human habituation, and whitebark pine seed crops. Journal of Wildlife Management. 1992; 56: 432–442. (doi: 10.2307/3808855)

69. Wilkinson T, Mangelsen TD. Grizzly – the bears of Greater Yellow-

stone: grizzly 399 and her family of Pilgrim Creek. Rizzoli Publ., New York, NY. 2016.

70. Herrero, S., T. Smith, T. DeBruyn, K. Gunther and C. Matt. From the field: Brown bear habituation to people – safety, risks, and benefits. Wildlife Society Bulletin. 2005; 33: 362-373.

71. Smith, T., S. Herrero, and T. DeBruyn et al. Alaskan brown bears, humans, and habituation. Ursus. 2005; 16(1): 1-10.

72. Herrero, S. Aspects of evolution and adaptation in American black bears (*Ursus americanus* Pallas) and brown and grizzly bears (*U. arctos* Linne.) of North America. Ursus. 1972; 2:221-231. (doi: 10.2307/3872586)

73. Martin, S.M., and R.G. Klein. Quaternary extinctions: a prehistoric revolution. Univ. Arizona Press, Tuscon, AZ. 1984.

74. Russell, C. and M. Enns. Grizzly heart. Random House Canada. 2002.

75. ECONorthwest. The economic importance of Alaska's wildlife in 2011. Summary report to the Alaska Department of Fish and Game, Division of Wildlife Conservation, contract IHP-12-052, Portland, OR. 2014.

76. CRT (Center for Responsible Travel). Economic impact of bear viewing and bear hunting in the Great Bear Rainforest of British Columbia. Center for Responsible Travel, Washington, DC. 2014.

77. Masica, S.E. Memo from the Intermountain Regional Director of the National Park Service to the Director of the U.S. Fish & Wildlife Service. 10 May 2016. Memo NPS Review of GYE GB CS and PR) 051016. 2016.

78. Jans, N. The grizzly maze: Timothy Treadwell's fatal obsession with Alaskan brown bears. Dutton, New York, NY. 2005.

About the Corresponding Author

Dr. Stephen F. Stringham

Summary of background:

- MSc Wildlife management
- PhD Behavioral and Population Ecology
- Director, Bear Communication & Coexistence Research Program
- President, WildWatch (an educational services company providing research, consulting, publication of conservational educational materials, and field courses in wildlife behavior and ecology)
- Specialized in the behavior and ecology of bears, as well as mother-offspring relations in ungulates; social and demographic roles of adult male mammals; communication; human-wildlife conflicts

Websites:
Website - bear-viewing-in-alaska.info
ResearchGate - https://www.researchgate.net/profile/Stephen_Stringham

Current research focus:

- Human-wildlife relationships related to habituation, food-conditioning, and wildlife viewing
- Evolution of cooperative hunting by carnivores
- Ontogeny of predatory behavior by bears
- Communication by bears
- Parent-offspring relations and behavior ontogeny of bears
- Manual dexterity in bears
- Evolutionary parallels between bears and apes

Permanent e-mail address: wildwatch.llc@gmail.com

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