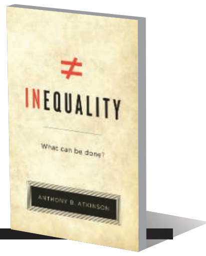
Limits on dark matter and energy *p. 786*

A roadmap for economic equality *p. 797*



PERSPECTIVES

Unnatural selection. Human hunters and fishers (such as Ernest Hemingway, pictured with a marlin) specialize in adult prey and often target large, healthy individuals.

ECOLOGY

A most unusual (super)predator

Effects of human hunting and fishing differ fundamentally from those of other predators

By **Boris Worm**

Modern humans evolved as cooperative hunter-gatherers whose cultural and technological evolution enabled them to slay prey much larger than themselves, across many species groups. One might think that those hunting skills have faded since the advent of agriculture and animal husbandry almost 10,000 years ago. Yet, as Darimont *et al.* show in a global analysis on page 858 of this issue (*1*), we are still the unique superpredator that we evolved to be. Analyzing an extensive database of 2135 exploited wild animal populations, the authors find that humans take up to 14 times as much adult prey biomass as do other predators. Our trophic dominance is most pronounced outside our own habitat, in the oceans (see the chart).

Several recent studies have tracked the impacts of people on past (*2*, *3*) and contemporary (*4*) wildlife populations, as well as their knock-on effects across many ecosystems (*5*). Darimont *et al.* go beyond this previous work to compare land and sea animals across various trophic levels. They show that on land, hunters put much greater pressure on top carnivores than on herbivores. In contrast, fishing pressure appears similarly

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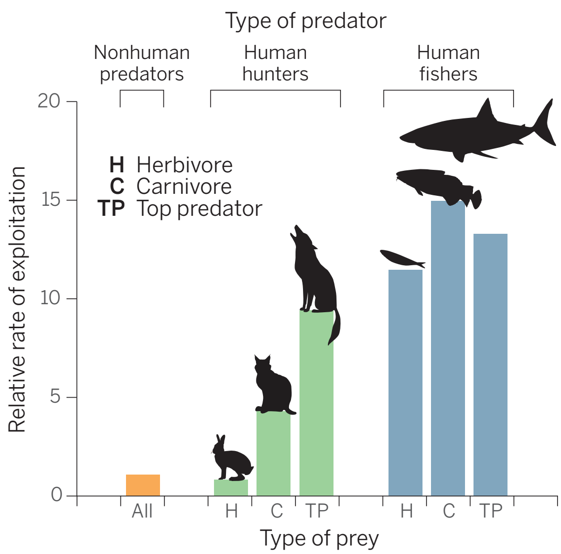
high across different trophic groups (see the chart), a pattern that has been dubbed "fishing through marine food webs" (*6*). Consistent with this hypothesis, the rate of population collapse in small fish low in the food chain, such as herring or anchovies, matches or exceeds that of higher trophic level predators such as sharks and tuna (*7*). One reason for this imbalance between land and sea is likely that fishing is now mainly a mechanized industry, much like agriculture (but unlike hunting) on land. Total marine fish catch (including unreported catch and discards) likely exceeds 100 million tons (Mt) per year (*8*), whereas the terrestrial take is estimated to be less than 5 Mt per year (*9*). Historical shifts from hunting to fishing can locally reverse where fisheries are depleted: Coastal overfishing off West Africa, for example, has caused food scarcity that intensified again the hunt for wild meat on land (*10*).

Why do human hunters and fishers focus so heavily on adults rather than juveniles, the preferred prey for most nonhuman predators? Probably this relates again to our technological means, which, for example, allow killing from a safe distance, and specific culture, for example, hunting for trophy and status (see the photos). This unique preference, however, has implications for the sustainability of exploitation and even the course of evolution. Adult individuals provide the "reproductive capital" of a population, akin to the financial capital in a bank account or retirement fund. The interest that is generated by annual growth is represented by the juveniles produced every year, as well as the physical growth of individuals. Depleting the capital is risky, particularly in long-lived, late-maturing organisms. Trophy hunters and fishers, in particular, often target the largest, healthiest, and fittest organisms (see the photos). This produces a strong selection pressure away from certain traits, such as the ability to grow rapidly to large size. As a consequence, the gene pool of many exploited populations changes in ways that could compromise their potential to recover from previous depletion (*11*).

Two potential biases are associated with research into human effects on contemporary wildlife. First, there is survivorship bias: We only measure what is left. Many vulnerable wildlife species on land have already disappeared during the past 40,000 years in successive waves of extinction on continents and islands that were colonized by people (*3*). Related to that is observer bias: The data-rich populations that are scientifically observed and monitored likely also experience some form of management, which may motivate data collection in the first place. Both biases render the results of Darimont *et al.* conservative. More worrying are populations that are hunted or fished essentially unobserved; at least in the oceans, there is clear evidence (*12*) that these are worse off than the assessed stocks represented in the chart below.

What does this general body of work (*1–5*) tell us then, about our own species? There are three key insights. First, the hunting of large prey is deeply embedded in our identity and remains a powerful ecological and evolutionary force. Second, the ability to target mostly adult individuals across marine and terrestrial prey groups makes us unique among all other predators. And third, we have the unusual ability to analyze and consciously adjust our behavior to minimize deleterious consequences. This final point, I believe, will prove critical for our continued coexistence with viable wildlife population on land and in the sea. ■

Trophy hunt. On land as well as on sea, humans exploit their ability to hunt from a safe distance and hunt for trophies or status.



Wildlife under pressure. Darimont *et al.* show that the rates at which humans exploit adult land mammals and marine fish vastly exceeds the impacts of other predators (*1*). Marine fish experience "fishing through marine food webs," with different trophic groups similarly affected. In contrast, land predators are exploited at much higher rates than herbivores.

PHOTO: PAULA FRENCH/SHUTTERSTOCK; ILLUSTRATION: ADAPTED BY P. HUEY/*SCIENCE*

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