

## The Impact of United States Recreational Fisheries on Marine Fish Populations

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**We evaluate the commercial and recreational fishery landings over the past 22 years, first at the national level, second for populations of concern (those that are overfished or experiencing overfishing), and finally by region. Recreational landings in 2002 account for 4% of total marine fish landed in the USA. With large industrial fisheries excluded (e.g., menhaden and pollock), the recreational component rises to 10%. Among populations of concern, recreational landings in 2002 account for 23% of the total nationwide, rising to 38% in the South Atlantic and 64% in the Gulf of Mexico. Moreover, it affects many of the most valued overfished species, including red drum, bocaccio, and red snapper, all of which are taken primarily in the recreational fishery.**

Many of the ecological and political problems associated with fishing in U. S. waters historically have been attributed to foreign fishers (1, 2). This perspective led to passage of the Magnuson Act nearly 30 years ago to eliminate foreign competition, setting in motion a wave of expansion for U. S. commercial fishing fleets. By 1996, it was clear that removing the foreign fleets had not sufficiently effected conservation (3), and amendments to the Magnuson Act more strongly emphasized reducing the fishing pressure of domestic fleets.

In the years following the amendment, public attention focused on stock depletion, bycatch, and habitat damage caused by commercial fisheries (4, 5), with little attention paid to the recreational sector. The perception that recreational fishing had little influence on stock declines derived from estimates that it contributed only 2% to U. S. landings (6). But marine recreational fishing effort has increased by over 20% in the past 20 years (7), rivaling commercial fisheries for many major fish stocks, including summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), and red snapper (*Lutjanus campechanus*) (8).

We examined data from the National Marine Fisheries Service (NMFS) online databases (9), assuming that these readily accessible datasets were used to produce the existing estimates of recreational landings. Using these data, we produced a similar estimate. But significant inconsistencies in the online databases cloud the relevance of the number, such as the inclusion of commercially caught freshwater species and exclusion of recreational datasets, such as data from the southeastern headboat sector (table S1).

We developed a comprehensive landings database (10) with data provided by the Marine Recreational Fisheries Statistics Survey (MRFSS), NMFS science centers and fishery management councils (FMC), multi-state marine fisheries commissions, and state natural resource agencies (table S2). We included landings data only, and did not include fish discarded at sea either as regulatory discards (for commercial and recreational fisheries) or as a result of catch-and-release (exclusively a recreational fishing practice). After standardizing the data to allow for reasonable comparisons of these diverse data sets (tables S1 to S3), we assimilated a 22-year (1981–2002) time series of commercial and recreational landings.

We conducted analyses for the continental U. S. at national and regional levels, the latter based on the management jurisdictions of the following FMCs: Northeast (combining Northeast and Mid-Atlantic FMCs, Maine through Virginia), South Atlantic FMC (11) (North Carolina through the east coast of Florida), Gulf of Mexico FMC (the west coast of Florida through Texas), and Pacific FMC (Washington through California, and including Alaska only in the nationwide comparisons).

The nation-wide analyses included three successively smaller groups of species: all federally-managed marine fish; all marine fish excluding walleye pollock (*Theragra chalcogramma*, used to produce frozen fish products) and menhaden (*Brevoortia tyrannus* and *Brevoortia patronus*, used almost exclusively to produce fish meal); and all

“populations of concern,” i.e., those populations listed by NMFS (12) as either overfished or experiencing overfishing. Menhaden and pollock were excluded because they have little or no recreational value, and they are not considered overfished (12), although they comprise over half of all U. S. fisheries landings: pollock landings approximate 1.8 million metric tons (4 billion lb) annually, and menhaden landings approximate 0.454 million metric tons (1 billion lb). The regional analyses focused only on the populations of concern.

Our database indicates that the percentage of all U. S. landings of marine finfish attributable to recreational fishing in 2002 is actually about 4%, averaging 5% over 22 years (Fig. 1A). Excluding pollock and menhaden raises the recreational contribution to 10% of the total landings in 2002 (Fig. 1A), whereas focusing on the most relevant populations—the populations of concern—raises it to 23% (Fig. 1B). The regional differences in landings of populations of concern are pronounced (Fig. 1, C to F). In the Gulf of Mexico 64% are taken recreationally (Fig. 1C), in the South Atlantic 38% (Fig. 1D), along the Pacific Coast 59%, averaging 14% over 22 years (Fig. 1E), and in the Northeast 12% (Fig. 1F) (13).

Current management of recreational fisheries focuses on controlling the landings of individual fishermen without restricting the number of individuals allowed to fish. In this open access scenario, control is limited to bag limits and size limits, which increases regulatory discards, thereby increasing fishing mortality (14–20) and sublethal effects on growth and reproduction (21–24). Increased fishing mortality also occurs with non-regulatory discards caused by high grading (wherein fishermen limited by quotas or bag limits discard small, less-valued fish to replace them with larger, more valued fish), and catch-and-release in recreational fisheries. Discards are not included in this analysis, so these results underestimate likely impacts. Current regulatory methods have done little to constrain recreational fisheries, and for some major fish populations, recreational landings in the U.S. outstrip commercial landings, notably for red drum (*Sciaenops ocellatus*) in the South Atlantic (93% recreational), bocaccio (*Sebastes paucispinus*) on the Pacific coast (87%), and red snapper (*Lutjanus campechanus*) in the Gulf of Mexico (59%).

Commercial and recreational fishing have similar demographic and ecological effects on fished populations. They truncate size and age structures, reduce biomass, and alter community composition (25–31). While commercial fisheries fish intensely on both lower (e.g., menhaden and anchovies) and upper (top-level predator) levels of the food web, the recreational sector concentrates on the latter. All these fishery removals can cause cascading trophic effects that alter the structure, function, and productivity of marine ecosystems (1, 32–37). The fact that recreational fisheries

tend to take top-level predators, that the volume of their landings rivals commercial landings in many major stocks, and that there are no commercial fisheries remaining for several species suggests that recreational fishing can have serious ecological and economic consequences. If the goal of fishery management is to sustain viable populations and ecosystems, then recreational as well as commercial fishing require effective regulations.

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8. NMFS defines major stocks as those having annual landings > 200,000 pounds (90,909 kg)
9. Commercial: [www.st.nmfs.gov/st1/commercial/](http://www.st.nmfs.gov/st1/commercial/); recreational [www.st.nmfs.gov/st1/recreational/queries/index.html](http://www.st.nmfs.gov/st1/recreational/queries/index.html). Note NMFS disclaimers on these sites.
10. Materials and methods are available as supporting material on *Science Online*.
11. The South Atlantic refers to the Atlantic off the southeastern United States.
12. NMFS, “Annual Report to Congress on the Status of U. S. Fisheries - 2003” (U. S. Department of Commerce, NOAA, National Marine Fisheries Service, 2004).
13. Although NMFS listed Pacific hake (*Merluccius productus*) as overfished in 2003 (see note 12, above), they footnote that they reversed the designation in March 2004. Thus, we exclude this species from the populations of concern. Pacific hake is an industrial fishery comprising 25% of the Pacific coast landings. It has virtually no recreational value.
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### Supporting Online Material

[www.sciencemag.org/cgi/content/full/1100397/DC1](http://www.sciencemag.org/cgi/content/full/1100397/DC1)

Materials and Methods

Tables S1 to S3

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**Fig. 1.** Time series of marine fisheries landings from the continental U.S. in metric tons (MT) x 1000. **(A)** Total landings commercial and recreational combined (left y-axis, solid lines) with recreational percentage of the total (right y-axis, diamond symbols). All species (gray) and excluding menhaden and pollock (black). **(B-F)** Total (cumulative) landings of populations of concern separated into commercial (light gray) and recreational (black) components. **(B)** All regions combined. **(C)** Gulf of Mexico. **(D)** South Atlantic. **(E)** Pacific Coast (excluding Alaska). **(F)** Northeast. Note: On the Pacific coast, no complete sets of recreational data were collected for the years 1990-1992 from any of the federal or state organizations that maintain these databases.

