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# Recreational fisheries in the USA: economics, management strategies, and ecological threats

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**Abstract** Recreational fishing has a long history in the USA, developing from the subsistence fisheries of Native Americans together with a partial subsistence fishery of later immigrants. Marine, diadromous, and aquatic taxa are targeted, including both vertebrates and macroinvertebrates. This paper defines recreational fishing, describes the main fishing techniques, identifies target taxa by region, summarizes the socio-economic values of recreational fishing, and discusses management strategies and major ecological threats.

**Keywords** Angling · Sport fishing · Outdoor recreation · Ecosystem services

## Introduction

Recreational or sport fishing or angling is defined as fishing for pleasure, as opposed to commercial fishing for income or subsistence fishing for survival. Angling is typically conducted with a rod, reel and line with a baited hook, lure or fly attached. Some recreational fishing is conducted with a spear, net, or bow and arrows. In addition to finfish, recreational fishers collect crustaceans by net or trap, mollusks by hand, rake or shovel, frogs by spear or lures, and turtles by net. Fishing may occur from the shore of the water body, by wading in shallow waters, or from

watercraft ranging in size from large multi-passenger live-aboard ocean-going ships to single-passenger kayaks or float tubes. Most of the catch is consumed as food and it may be an important dietary component for some families, especially in rural areas where fishers have ready access to the potential catch. Increasingly, anglers are required by management regulations to practice catch-and-release fishing to conserve a fishery. Numerous finfish and shellfish species are recreationally fished in coastal waters (Appendices 1, 2, 3, 4) and many finfish species are recreationally fished in inland (fresh) waters (Appendices 5, 6).

## Fishery catch and economics

Recreational fishing is an economically and culturally important activity in the USA (Table 1). Based on national census data, an estimated 33 million anglers in 2011 participated in over 443,000 fishing trips and generated over \$40 billion in retail sales. Because of economic multiplier effects, these expenditures produced an estimated \$115 billion economic impact and over 800,000 jobs. Based on marine survey data, an estimated 12 million marine anglers took about 85,000 fishing trips in 2012 and spent nearly \$31 billion, which had an \$82 billion economic impact and provided 500,000 jobs. Although there are more freshwater anglers, marine anglers have a relatively greater economic impact because of the need for larger and more expensive gear and boats. In northern latitude USA states where recreational fishing is economically important, 14–43 % of the population fishes, producing 10,000–38,000 jobs and a \$1.1–4.3 billion economic impact (Table 2). In two river basins in Idaho and Wyoming with high-quality catch-and-release trout fisheries, 341–851 jobs and \$12–29 million in

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**Table 1** Estimated economic impacts of USA recreational fisheries in 2011 (from ASA Web: [http://asafishing.org/uploads/2011\\_ASASportfishing\\_in\\_America\\_Report\\_January\\_2013.pdf](http://asafishing.org/uploads/2011_ASASportfishing_in_America_Report_January_2013.pdf), accessed April 2014; NMFS Web: <http://www.nmfs.noaa.gov/stories/2013/04/docs/>

Data source	No. of anglers (million)	No. of trips (thousand)	Direct sales (\$ billion)	Economic impact (\$ billion)	No. of jobs (thousand)
USFWS Web (US census)	33.1 (marine and freshwater)	443 (freshwater)	41.8	115 (ASA Web)	800 (ASA Web)
NMFS Web (marine surveys)	12	85	31	82	500

**Table 2** Estimated economic impacts of state recreational fisheries in 2011 (ASA Web: [http://asafishing.org/uploads/2011\\_ASASportfishing\\_in\\_America\\_Report\\_January\\_2013.pdf](http://asafishing.org/uploads/2011_ASASportfishing_in_America_Report_January_2013.pdf), accessed April 2014)

State	No. of anglers (million)	Wages (\$ billion)	Economic impact (\$ billion)	No. of jobs (thousand)
Alaska	0.5	0.3	1.1	10
Michigan	1.7	1.4	4.3	38
Minnesota	1.6	1.3	4.1	36

county income were created ([https://henrysfork.org/files/Completed%20Research%20Projects/Economic\\_Value\\_of\\_Recreational\\_to\\_Communities-Loomis.pdf](https://henrysfork.org/files/Completed%20Research%20Projects/Economic_Value_of_Recreational_to_Communities-Loomis.pdf)). Although this paper focuses on recreational fisheries, it is useful to compare them with the USA commercial seafood fisheries (including harvesting, processing, distributing, and sales); in 2012, that industry provided 1.3 million jobs and a \$239 billion economic impact (NMFS Web: [http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012\\_National\\_Overview.pdf](http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2012/FEUS2012_National_Overview.pdf), accessed June 2014).

Fishery catch data are collected from multiple sources and in multiple ways. Individual recreational catches of marine species are estimated through use of coastal telephone surveys, vessel telephone surveys, angler dockside surveys at ports, and state and regional log-books (NMFS Web: [http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus12/03\\_recreational2012.pdf](http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus12/03_recreational2012.pdf)). The data gathered include number of trips, angler residency, species composition and catch rates, and species weights and lengths. The data are combined through use of models to produce catch, effort, and catch per unit effort metrics, which are reported by fish species, fishing method, state, and management region. Economic data for inland fisheries are obtained mostly from national census surveys of householders and state angler surveys. Canada relies on mail surveys of anglers every 5 years to estimate species-specific catch rates [1]. Oregon requires salmon, steelhead, and sturgeon anglers to purchase and complete a punch card for recording the species, number, location, and date of each of those species harvested (DFW Web: <http://www.dfw.state.or.us/resources/fishing/sportcatch.asp>, accessed June 2014).

[naaa\\_rec\\_fish\\_report\\_final\\_web.pdf](http://www.noaa.gov/stories/2013/04/docs/naaa_rec_fish_report_final_web.pdf), accessed April 2014; USFWS Web: <http://www.doi.gov/news/pressreleases/upload/FWS-National-Preliminary-Report-2011.pdf>, accessed April 2013)

## Fisheries management

### Management agencies

In the USA, recreational fisheries are managed at both state and federal levels. State fish and wildlife agencies manage inland (freshwater) and near-coastal (within 5 km of the shoreline) fisheries. These agencies set and enforce fishing dates and times, fishing gear, and catch limits on fish size and number. The National Marine Fisheries Service manages marine fisheries outside the state management limits and regulates anadromous and marine species listed by the USA government as threatened or endangered. The US Fish and Wildlife Service regulates fisheries on listed freshwater species. The following fish species are listed as endangered or threatened by the federal government, thereby curtailing their fisheries: Alabama sturgeon *Scaphirhynchus suttkusi*, pallid sturgeon *S. albus*, Gulf sturgeon *Acipenser oxyrinchus*, shortnose sturgeon *A. brevirostrum*, bull trout *Salvelinus confluentus*, Apache trout *Oncorhynchus apache*, gila trout *O. gilae*, greenback cutthroat trout *O. clarkii stomias*, Lahontan cutthroat trout *O. clarkii henshawi*, Paiute cutthroat trout *O. clarkii seleniris*, black abalone *Haliotis chacherodii*, and white abalone *H. sorenseni*. Ecologically significant units of chum salmon *O. keta*, Chinook salmon *O. tshawytscha*, coho salmon *O. kisutch*, sockeye salmon *O. nerka*, steelhead (anadromous rainbow trout *O. mykiss*); golden trout *O. mykiss aguabonita*, and Pacific eulachon *Thaleichthys pacificus* are listed as threatened or endangered. The number of federally listed threatened and endangered fish species is strongly correlated with economic and population growth [2].

Although they do not manage fisheries, other federal resource management agencies have fisheries programs. Because their land and water management affects fisheries, the US Forest Service, Bureau of Land Management, National Park Service, US Geological Survey, Army Corps of Engineers, and US Environmental Protection Agency (USEPA) employ numerous fishery biologists. The USEPA has implemented a rigorous nationwide ecological monitoring and assessment program of surface waters (lakes, reservoirs, streams, rivers, near-coastal marine, wetlands). See Shapiro et al. [3] for an overview of the program, Paulsen et al. [4] and USEPA [5] for examples of stream

and river assessments, and USEPA [6] for an example of a national lakes assessment.

### Regulating recreational versus commercial fishing

Most conflicts involving relative take by recreational versus commercial fisheries occur in marine ecosystems. Total and relative catch limits in marine systems are set regionally by one of eight regional Fishery Management Councils established by the Fishery Conservation and Management Act of 1976: North Pacific, Pacific, Western Pacific, New England, Mid-Atlantic, South Atlantic, Gulf of Mexico, Caribbean. The voting members of each Council include one National Marine Fisheries Service representative, a representative from each State fishery agency in the Council region, private citizens nominated by State governors, and a representative from tribal or territorial governments in some regions (USFC Web: <http://www.fisherycouncils.org>, accessed June 2014). Because each region supports different types of fisheries and different levels of commercial versus recreational fishing, there are no nationwide rules for decision-making. Differing levels and types of fishing are also affected by whether a species or stock is listed as overfished, vulnerable, threatened, or endangered, by its relative economic value to one type of fishery or another, and by previous take levels. For example, proposed options for allocating catch quotas between commercial and recreational fisheries on red snapper ranged from 51 and 49 % to 0 and 100 %, respectively, with total catch baselines of 4–5 million kg (GMFMC Web: <http://www.gulfcouncil.org/docs/amendments/Amendment%2028%20-%20Allocation%20PH%20Draft%20March%202014.pdf>, accessed June 2014). In addition, if catches exceed established limits, a fishery may be closed for the season or it may be reduced in the subsequent year (GMFMC Web: <http://www.gulfcouncil.org>, accessed June 2014).

### Management funding

Funding for state fishery agencies comes mostly from fishing license sales. In addition, federal excise taxes on fishing gear and boat fuels are dispersed to the states for fishery improvement projects (research, hatcheries, improved access, habitat rehabilitation). The enabling legislation for those taxes is the Dingell-Johnson Act of 1950 (Federal Aid in Sport Fish Restoration Act) and the Wallop-Breaux amendments of 1984. Between 1955 and 2006, those taxes yielded \$36 to \$212 million (in 2009 dollars) annually to the states (ASC Web: [http://asaifishing.org/uploads/Benefits\\_to\\_Business\\_2011\\_Technical\\_Report.pdf](http://asaifishing.org/uploads/Benefits_to_Business_2011_Technical_Report.pdf), accessed April 2014).

### The AFS and recreational fisheries management

The American Fisheries Society (AFS) is the premier society for professionals interested in fish, fisheries, and their ecosystems. Through its efforts, the US government established the US Commission for Fish and Fisheries in 1871, with the requirement that it be led by a fish scientist. The 6,000–9,000 AFS members are employed by federal and state agencies, universities, private contracting firms, and nongovernmental agencies. Although most AFS members reside in the USA and Canada, there are chapters in Mexico and Puerto Rico and members are spread across the globe in 62 nations. As part of its mission, the AFS publishes books, a Fisheries magazine, and five scientific journals (Transactions of the American Fisheries Society; North American Journal of Fisheries Management; Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science; Journal of Aquatic Animal Health; North American Journal of Aquaculture).

Perhaps the most popular AFS book is *Inland Fisheries Management in North America* [7]. That book's chapters describe techniques for managing stream, river, lake, and reservoir fisheries from individual stocks or populations to ecologically significant units or entire species through use of population dynamics [8]. The stock concept has been useful, both for maintaining healthy populations and for rehabilitating threatened populations of marine and freshwater fish. Three key fishery management techniques are regulating harvest [9], using hatchery fish to supplement populations [10], and enhancing the physical and chemical habitat [11]. Typically all three approaches are used in concert. Of course, quantitative data are needed before implementing such techniques, which require rigorous monitoring and assessment programs [12–14], including multistock and multispecies assessments [15].

### Threats to recreational fisheries

#### Historical and current threats

Significant historical and current threats to USA recreational fisheries include intensified land use, physical habitat and hydrological modification, chemical contaminants, eutrophication and hypoxia, overfishing, and introductions of invasive non-native species (including hatchery fish) and diseases. In a study of over 9,000 European river sites, Schinegger et al. [16] reported disrupted connectivity (from dams and road crossings) in 85 % of the catchments and 35 % of the segments; 47 % of the sites were altered by multiple factors and 90 % of lowland rivers had altered water quality, hydrology, connectivity, and morphology. Similarly, in a survey of 1,900

USA sites, USEPA [5] determined that 20–40 % of rivers and streams in the USA were in poor condition because of excess nutrients and disturbed riparian zones. In other words, multiple stressors frequently limit fish assemblages.

#### *Land use*

Land use, particularly intensive silviculture and agriculture, urbanization, and mining fundamentally alter the condition of surface waters, whether they occur in the USA or elsewhere. Mebane et al. [17] found that fish assemblage condition in large Oregon rivers declined with increased catchment agriculture and decreased catchment forest. Snyder et al. [18] reported poor conditions in fish assemblages once urban land use exceeded 7 % in West Virginia catchments, especially with steeper channel slopes. Wang et al. [19] demonstrated that the percent of impervious area that was connected to streams negatively affected fish assemblages and trout densities in Minnesota and Wisconsin streams. Stranko et al. [20] reported brook trout almost never occurred in Maryland streams once catchment impervious cover exceeded 4 %. Trautwein et al. [21] reported that fish assemblage condition in Austrian streams declined with increased levels of catchment agriculture and urbanization and decreased levels of forest. In a series of western USA case studies, Woody et al. [22] summarized the negative effects of metal mining on salmonids. Daniel et al. (unpublished data, 2014) found that mineral and coal mining at the catchment scale had a greater effect on fish assemblages, including game species, than did that mining at the local scale and compared with catchment-scale urbanization or agriculture.

Catchment conditions may have a greater influence on fish assemblages than site conditions, whether they occur in the USA or elsewhere. Roth et al. [23] and Wang et al. [24] determined that catchment agriculture had a greater effect on fish assemblages in Michigan and Wisconsin streams, respectively, than did local riparian vegetation. Van Sickle et al. [25] found that the riparian conditions along Oregon stream networks explained more variability in fish assemblages than did conditions of the entire catchment or at the site. Sály et al. [26] demonstrated that variation in fish species and abundances in Rumanian streams was explained more by catchment and catchment-site shared variables than by site variables alone. For French streams, Marzin et al. [27] reported that anthropogenic variables at network riparian, catchment, shared site-riparian, or shared site-catchment scales explained more variation than site-scale anthropogenic variables. However, Macedo et al. [28] determined that site variables in Brazilian streams explained more variability in fish species richness than did catchment land use variables. For additional reading on

landscape-scale effects on fish assemblages, see the books by Hughes et al. [29] and Yeakley et al. [30].

#### *Hydromorphological modification*

Physical and hydrological modification of fish habitat varies from major dams that fundamentally alter flows and convert rivers to lakes, to local changes in substrate and riparian vegetation. Stanford et al. [31] considered flow regulation the most pervasive change in large rivers, and Poff et al. [32] argued that flow regimes and flood pulses were master variables governing the condition of rivers. Based on studies of 27 large American rivers, Hughes et al. [33] reported that flow and channel alterations resulting from large dams were key factors disturbing fish assemblages. Carlisle et al. [34] determined that flows had been altered in 2,500 USA stream sites and that reduced flow magnitudes were better predictors of fish assemblage condition and impairment than site chemical or physical factors. Sedell and Froggatt [35] described how channelization and large wood removal from the Willamette River, Oregon, separated the channel from its floodplain and removed vast amounts of salmon spawning and rearing habitat. Similarly, in the eastern USA before European settlement, low gradient streams were anastomosing with extensive wetlands (hydromorphologically complex), rather than the single incised channels existing now [36].

#### *Substrate and riparian modification*

Lower fish assemblage condition was associated with excess fine sediments and reduced channel complexity at stream sites in the Oregon and Washington Coast Range [37]. Bryce et al. [38] concluded that surficial fine sediments <5 % were needed to maintain the habitat potential for trout and other sediment sensitive aquatic vertebrates in western USA mountain streams. Habitat simplification and loss of large wood debris in lakes of the midwestern and northeastern USA were associated with reduced game fish populations [39–42]. In a study of northeastern USA lakes, Kaufmann et al. [43] found that the richness of intolerant fish species was positively correlated with greater physical habitat quality, whereas the richness of tolerant fish species declined.

#### *Chemical contaminants*

Chemical contamination of USA waters has been reduced significantly since implementation of the Clean Water Act of 1972. Nonetheless, mercury concentrations exceeded the USEPA 300 ppb fish tissue consumption criterion at nearly half of USA lakes [44]. In a survey of 600 western USA streams and rivers, Peterson et al. [45]

found that large piscivorous game fish exceeded that mercury criterion in 57 % of the assessed stream length. As a result of airborne chemical pollutants, even high elevation and high latitude lakes in national parks contain persistent pollutants that may place their fish and fisheries at risk [46].

#### *Eutrophication and hypoxia*

Despite effective nutrient removal from urban sewage, eutrophication remains a pervasive problem in USA waters, largely as a result of agricultural runoff. USEPA [5] reported that excess phosphorus was associated with poor fish assemblage condition in over 20 % of the USA stream and river length. USEPA [6] found that 50 % of USA lakes and reservoirs were eutrophic or hypereutrophic, with the highest proportions of eutrophic and hypereutrophic lakes in the agricultural central USA (36 and 24 %, respectively). When this nutrient rich runoff reaches near-coastal marine waters, it produces ocean hypoxia. For example, a 20,000 km<sup>2</sup> hypoxic area exists in the Gulf of Mexico as a result of nitrogen and phosphorus from the Mississippi River Basin [47]. Along the USA East Coast, agricultural runoff has led to coastal marine eutrophication [48]. Nationally, Dodds et al. [49] estimated that eutrophication creates over \$2 billion in damages annually.

#### *Overfishing*

Recreational overfishing has been a historical issue for many highly valued species (e.g., GMFMC Web: <http://www.gulfcouncil.org>, accessed June 2014) but its impacts have been reduced by fishery management agencies, and recreational fishing typically has markedly less impact than commercial fishing. Nonetheless, as any angler can attest, additional fishing does not improve one's chances of catching fish or the fishing experience.

#### *Non-native fish*

By sampling 1,000 western USA stream and river sites (representing 90,000 stream kilometers), Lomnický et al. [50] estimated that 52 % of the stream length contained non-native aquatic vertebrates (83 % of large river length). Three different trout were the most commonly occurring non-native species. Sanderson et al. [51] estimated that the effects of non-native species on Pacific salmonids equalled or exceeded that of hatcheries, harvest, hydropower and habitat degradation. In addition to non-native fish, hatchery fish stray onto spawning grounds, diluting the genetic pool of wild salmonids, and increase feeding competition in freshwater [52–56], in estuaries, and at sea [57–60]. Such changes limit the recovery of listed wild salmonids.

#### Developing threats to USA recreational fisheries

Significant developing threats to USA recreational fisheries include endocrine disruptors, nanoparticles, and climate change. All three are pervasive and threaten freshwater and marine recreational fisheries.

#### *Endocrine disrupting chemicals*

For years, we have known about the presence of endocrine disrupting chemicals in aquatic environments, as well as their physiological effects on fish and other aquatic vertebrates [61–63]. Recently, their potential population-level effects in natural environments have been modelled quantitatively [64], as have their management implications [65]. Because of the number of such chemicals in the environment and their developmental and immunological toxicity at very low levels, they are considered a ticking time bomb [66].

#### *Nanoparticles*

The physico-chemical effects of nanoparticles on fish populations are at an early stage of understanding [67], but their rapidly increasing use and widespread distribution are troubling. Shaw and Handy [68] reported that nanocopper was twice as toxic as dissolved copper and that nanoparticles altered respiration and caused gill, liver, intestine and brain tissue pathology. Cedervall et al. [69] found that nanopolystyrene passed up the algae-zooplankton-fish food chain and altered lipid metabolism and halved food consumption rates of fish.

#### *Climate change*

Climate change is predicted to have substantial impacts on USA marine and freshwater recreational fisheries. By 2100, ten states are predicted to lose all their cold and cool freshwater fisheries and in 17 states those fisheries will be halved [70]. Predicted national economic losses range from \$80 to \$320 million, depending on the predictive model used and the degree to which warm water fishery gains offset coldwater fishery losses. Jones et al. [71] predicted that the USA would lose 50 % of its coldwater fisheries habitat by 2100, with only western and northeastern mountainous areas supporting coldwater fisheries under the highest emission scenario. Under that scenario, coldwater fishing days would decline by 6.4 million, resulting in economic losses of \$81 million to \$6.4 billion depending on the emission scenario and discount rate. By altering ocean pH, climate change is a serious potential threat to the zooplankton food base of marine recreational fishes and the ability of marine and estuarine mollusks and corals to fix

calcium carbonate in their shells (AFS Web: [http://fisheries.org/docs/policy\\_statements/policy\\_33f.pdf](http://fisheries.org/docs/policy_statements/policy_33f.pdf), accessed April 2014). Comte and Grenouillet [72] reported that French stream fish, including numerous species fished recreationally, have been unable to shift their ranges to higher elevations to keep pace with temperature changes from 1980 to 2009. Nonetheless, Tedesco et al. [73] noted that current and historical anthropogenic pressures account for more species extinctions than does predicted climate change.

## Conclusions

Individuals and governments around the world value the conservation and sustainable use of recreational fisheries. In the USA and Europe that concern has led, respectively, to the Clean Water Act of 1972 with the goal of swimmable and fishable waters, and the Water Framework Directive with the goal of good water body condition and fisheries by 2015. Although we understand well how to manage sustainable recreational marine and freshwater fisheries, major historical, current and developing threats result from other demands on our lands and waters. Those threats either singly or together have markedly reduced once-substantial recreational fisheries on Great Lakes lake trout and lake sturgeon [74], Pacific salmon [75, 76], Atlantic salmon (WWF Web: <http://awsassets.panda.org/downloads/salmon2.pdf>), and Atlantic cod (IUCN Web: [http://www.sea-fish.org/media/Publications/FS17\\_201003\\_IUCNRedList.pdf](http://www.sea-fish.org/media/Publications/FS17_201003_IUCNRedList.pdf)). Continued human population and economic growth drive those threats and thus fundamentally conflict with healthy and sustainable fisheries on those and many other species [2, 77–79].

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## Appendix 1

Common recreational Atlantic Coast marine finfish fisheries.

- Amberjack, pompano *Seriola*, Carangidae
- Atlantic cod *Gadus*, Gadidae
- Drum (black, red) *Pogonias*, *Sciaenops*, Sciaenidae

- Black sea bass *Centropristis*, Serranidae
- Bluefish *Pomatomus*, Pomatomidae
- Bonefish *Albula*, Albulidae
- Bonito *Sarda*, Scombridae
- Dolphinfish *Coryphaena*, Coryphaenidae
- Marlin (blue, white) *Makaira*, *Tetrapturus*, Istiophoridae
- Plaice *Hippoglossoides*, Pleuronectidae
- Red snapper *Lutjanus*, Lutjanidae
- Sailfish *Istiophorus*, Istiophoridae
- Snook *Centropomus*, Centropomidae
- Spotted sea trout, weakfish *Cynoscion*, Sciaenidae
- Striped bass *Morone*, Moronidae
- Summer flounder *Paralichthys*, Paralichthyidae
- Swordfish *Xiphias*, Xiphiidae
- Tarpon *Megalops*, Megalopidae
- Tautog *Tautoga*, Labridae
- Wahoo *Acanthocybium*, Scombridae
- Yellowfin tuna *Thunnus*, Scombridae

## Appendix 2

Common recreational Atlantic Coast marine shellfish fisheries.

- Clam (hardshell, quahog, razor, softshell, surf) *Merccenaria*, Veneridae; *Ensis*, Pharidae; *Mya*, Myidae; *Spisula*, Mactridae
- Conch *Lobatus*, Strombidae
- Crab (blue, stone) *Callinectes*, Portunidae; *Menippe*, Menippidae
- Lobster (American, spiny) *Homarus*, Nephropidae; *Panulirus*, Palinuridae
- Mussel *Mytilus*, Mytilidae
- Oyster *Crassostrea*, Ostreidae
- Scallop (bay, calico) *Argopecten*, Pectinidae
- Whelk *Busycon*, Buccinidae.

## Appendix 3

Common recreational Pacific Coast marine finfish fisheries.

- Cabezon *Scorpaenichthys*, Cottidae
- Dolphinfish *Coryphaena*, Coryphaenidae
- Greenling *Heagrammos*, Hexagrammidae
- Halibut *Hippoglossus*, Pleuronectidae
- Lingcod *Ophiodon*, Hexagrammidae
- Pacific herring *Clupea*, Clupeidae
- Redtail surfperch *Amphistichus*, Embiotocidae
- Rockfish (black, black-and-yellow, blue, brown, calico, china, copper, gopher, grass, kelp, olive, treefish) *Sebastes*, Sebastidae
- Starry flounder *Platichthys*, Pleuronectidae

Tuna (albacore, yellowfin, yellowtail) *Thunnus*, Scombridae.

#### Appendix 4

Common recreational Pacific Coast marine shellfish fisheries.

Clams (butter, littleneck, gaper, razor, softshell) *Saxidomus*, *Prothothaca*, Veneridae; *Treus*, Mactridae; *Siliqua*, Pharidae; *Mya*, Myidae;

Crab (Dungeness, red rock) *Metacarcinus*, *Cancer*, Cancridae

Mussel *Mytilus*, Mytilidae

Squid *Loglio*, Logliginidae.

#### Appendix 5

Common recreational inland coldwater fisheries.

American shad *Alosa*, Clupeidae

Salmon (Atlantic, coho, Chinook, sockeye) *Salmo*, *Oncorhynchus*, Salmonidae

Sturgeon (lake, white) *Acipenser*, Acipenseridae

Trout (brook, brown, cutthroat, lake, rainbow) *Salvelinus*, *Salmo*, *Oncorhynchus*, Salmonidae.

#### Appendix 6

Common recreational inland warmwater fisheries.

Black bass (largemouth, redeye, smallmouth, spotted) *Micropterus*, Centrarchidae

Bullhead (black, brown, yellow) *Ameiurus*, Ictaluridae

Catfish (blue, channel, flathead) *Ictalurus*, *Pylodictus*, Ictaluridae

Crappie (black, white) *Pomoxis*, Centrarchidae

Pike (northern, muskellunge) *Esox*, Esocidae

Rock bass (Roanoak, rock, shadow) *Ambloplites*, Centrarchidae

Sunfish (bluegill, longear, orangespotted, pumpkinseed, redbreast, redear, spotted) *Lepomis*, Centrarchidae

Temperate bass (striped, yellow, white, white perch) *Morone*, Moronidae

Walleye, sauger *Sander*, Percidae

Yellow perch *Perca*, Percidae.

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