Supplementary Materials

Reconstructing historical baseline catches along Highway 101: U.S. West Coast marine fisheries, 1950-2017

Dirk Zeller[a,*], Matthew Ansell[a], Vania Andreoli[a], Haley Harguth[b]; Will Figueira[c]; Darcy Dunstan[d], Lekelia D. Jenkins[e]

[a] *Sea Around Us – Indian Ocean*, School of Biological Sciences, University of Western Australia, Crawley, WA, Australia
[b] School of Marine and Environmental Affairs, University of Washington, Seattle, WA, USA
[c] School of Life and Environmental Sciences, University of Sydney, NSW, Australia
[d] *Sea Around Us*, Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, BC, Canada
[e] School for the Future of Innovation in Society, Arizona State University, Tempe, AZ, USA

We detail the methods and data sources used for reconstructing marine fisheries catches along the U.S. continental Pacific coast, i.e., for the U.S. West Coast states of California, Oregon and Washington for 1950-2017, based on the original technical report for 1950-2010 by Doherty et al. (2015) and as updated to 2017 by Dunstan et al. (2020). Much of the below materials and descriptions focus heavily on earlier periods, for which fewer contiguous data time series or formal sources are available, compared to the more recent years. We derived time series estimates for all sources of unreported marine fisheries catches (landed and discarded) and combined these with the landings data reported by the National Marine Fisheries Service (NOAA-NMFS) to the FAO on behalf of the USA. Thus, we follow the general 'catch reconstruction' methodology and process of Zeller et al. (2016). We define 'reported catch' as that catch that is included in official national and hence international FAO data. Thus, any fisheries catches not included in these international data, such as recreational and discarded catches, are considered 'unreported' in our context.

TABLE OF CONTENTS

COMMERCIAL CATCHES

We used NMFS commercial landings data as our baseline for national reported commercial landings statistics for the three contiguous States on the Pacific coast. As all U.S. data are nationally reported in pounds (lbs), we converted all data to tonnes (metric tons), in line with international data reporting standards.

Shellfish meat to wet weight conversion

The commercial catch statistics are reported in round (or wet) weight in accordance with the FAO data requests, except for univalve and bivalve molluscs (UVBV), which are reported as "pounds of meat weight". To convert UVBV meat-weight landings to wet weight, estimated conversion factors were used prior to converting the derived wet weight (lbs) to tonnes (Supplementary Materials Table S1).

Supplementary Materials Table S1: Conversion factors (CFs) used to convert meat weight to wet weight for major shellfish taxa in the NMFS commercial landings data for U.S. Pacific coast.

Taxa:	**CF**
Abalone (*Haliotis* spp.)	2.5
Blue mussel (*Mytilus edulis*)	3.8
Butter clams (*Saxidomus gigantea*)	2.7
California mussel (*Mytilus californianus*)	4.6
Littleneck clams (*Leukoma staminea*)	2.7
Manila clams (*Venerupis philippinarum*)	7.1
Nuttall's cockle (*Clinocardium nuttallii*)	2.4
Oysters[a]	7.1
Pacific clams (unidentified)	2.7
Pacific gaper clam (*Tresus nuttallii*)[b]	3.9
Pacific geoduck (*Panopea generosa*)	3.0
Pacific razor clam (*Siliqua patula*)	2.3
Scallops (Pectinidae)	8.2
Softshell clams (*Mya arenaria*)	2.3

[a] We used the most conservative value in a range presented by Crapo et al. (2004). There are 4 species of oyster in NMFS landings data, with Pacific oyster (*Crassostrea gigas*) making up most of the catch.

[b] We used 3.9 for Washington and 3.8 for Oregon.

RECREATIONAL CATCHES

California

Recreational catch data were available from logbooks of commercial passenger fishing vessels, or 'party boats', in California and have been collected by the California Department of Fish and Game (CDFG) since 1936 (Hill and Schneider 1999). Party boat logbook data are the basis for many recreational catch estimates reported in the scientific literature (e.g., Chadwick 1962; Mckechnie

and Miller 1971; Collins et al. 1980) and were also used in this study as the main source for recreational catches from 1950-1979 (Supplementary Materials Table S2). Historical records for recreational fisheries in California were also available for chinook and coho salmon (INPFC 1979; PFMC 1993, 2013), rockfish (Ralston et al. 2010), and Pacific halibut (Miller and Gotshall 1965; Skud 1975; Blood 1992-2009; Williams 2010, 2011; Hare 2012; Williams 2012b). These estimates were considered more accurate for these taxa and were used instead of the corresponding CDFG logbook database information.

From 1950 to 1957, landings from the CDFG database were substantially lower than those reported by Young (1969) and CDFG (2001). The data from CDFG (2001) and Young (1969) matched well for major groups between 1950-1957, and were used where available.

The party boat logbook data represent a large component of recreational catches; however, there are also anglers who fish on private boats and from shore (Chadwick 1962; Guel and Clark 1968; Guel 1973; Stevens 1977; Collins et al. 1980; White 1986). We accounted for these additional catches with additional data from various sources, including: 1) Catch data from the 1965 and 1970 salt water angling surveys (Guel and Clark 1968; Guel 1973); 2) Unpublished catch data from Figueira and Coleman (2010); and 3) Independent sources for specific species (Collins et al. 1980; White 1986; Crone et al. 2009). Any data gap years were linearly interpolated (see Supplementary Materials Table S2). For a few taxa, where no estimates were available, we assumed that party boat catches accounted for half of the total recreational catch. This is thought to be conservative, given that the majority of the species in Figueira and Coleman (2010) show higher fractions.

Recreational shellfish catches in California were estimated for some taxa, such as abalone (*Haliotis* spp.) and a variety of clams, although state-wide and historical time series of shellfish catch estimates for California are generally sparse. Catch estimates of abalone (*Haliotis* spp.) were available for some years from 1960-2014 (Haaker et al. 2001; Haaker et al. 2004; CDFG 2010). Estimates prior to 1983 include only the catch obtained by diving from boats (Hobday and Tegner 2000; Haaker et al. 2001), and thus were adjusted to include the proportion from shore pickers and divers. Surveys from 1989-2007 (CDFG 2010) show that shore picking and divers from shore are an important component of the recreational abalone fishery, accounting for between 75-92% of catch. We assumed estimates prior to 1983 accounted for only 25% of the recreational catch and adjusted them accordingly. This is considered conservative, given that catch estimates of red abalone account for as much as seven times the commercial catch in the 1980s, and that recreational catch estimates by Frey (1971) are nearly the same as the commercial landings.

Recreational clamming is a popular activity in the intertidal bays of California and many species make up the bulk of the total catch (Moore 2001a, 2001c). Catch estimates of clams are available for Humboldt Bay for 1975, 1977-1989, and 2008 (McVeigh et al. 2010), for Tomales Bay for 1962-1963 and 1989-1997 (CDFW, unpubl. data, provided by P. Kalvass), and for Morro Bay for 1979-1980 (Mello 1981). These data were used as anchor points to generate estimates of clam catches for 1950-2014 for Humboldt, Tomales, and Morro Bay (see Supplementary Materials Table S2).

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method
All species, unless indicated otherwise	1980, 2003-2014	RecFIN						
	1981-1989, 1993-2002	Figueira and Coleman (2010)						
	1990-1992	Linear interpolation						
CALIFORNIA								
Finfish and Cephalopods:								
Albacore (*Thunnus alalunga*)	1950-1981,1993	CDFG Partyboat database, unpub. data, J. Robertson	1950-1993	10.4	RecFIN (1980-1985)	1950-1965	2.5	Guel and Clark (1968)
						1966-1969		Linear interpolation
						1970	2.7	Guel (1973)
						1971-1979	-	Linear interpolation
						1980, 1981, 1993	2.3	Figueira and Coleman (2010)
Barred sandbass (*Paralabrax nebulifer*)	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1979	0.7	RecFIN (1980-1985)	1950-1979	1.8	Figueira and Coleman (2010)
Cabezon (*Scorpaenichthys marmoratus*)	1950-1979	CDFG (2001)	1950-1979	1.2	RecFIN (1980-1985)	1950-1970	9	Mean from Guel and Clark (1968) & Guel (1973)
						1971-1979	-	Linear interpolation
						1980	13.1	Figueira and Coleman (2010)
California Halibut (*Paralichthys californicus*)	1950-1979	CDFG (2001)	1950-1979	2.8	RecFIN (1980-1985)	1950-1979	8.8	Figueira and Coleman (2010)
California scorpionfish (*Scorpaena guttata*)	1950-1979	CDFG (2001)	1950-1979	0.5	RecFIN (1980-1985)	1950-1979	1.1	Figueira and Coleman (2010)
California sheephead (*Semicossyphus pulcher*)	1950-1979	CDFG (2001)	1950-1960	1.8	Clark (1960)	1950-1970	3.5	Guel (1973)
			1961-1979	-	Linear interpolation	1971-1979	-	Linear interpolation
			1980	1.1	RecFIN (1980-1985)	1980	2.7	Figueira and Coleman (2010)
Chinook Salmon (*Oncorhynchus tshawytsch*)	1950-1961	INPFC (1979)	1950-1960	5.6	Clark (1960)			
	1962-1975	PFMC (1993)	1961-1999	-	Linear interpolation			
	1976-2014	PFMC (2013)	2000-2010	5.8	RecFIN (2000-2010)			
Chub mackerel (S*comber japonicas*)	1950-1961	Young (1969)	1950-1961	0.7	Clark (1960)	1950-1961	2.6	Crone et al. (2009)[b]
	1962-1979	Crone et al. (2009)						
Coho salmon (*Oncorhynchus kisutch*)	1950-1961	INPFC (1979)	1950-1960	3.4	Clark (1960)			
	1962-1975	PFMC (1993)	1961-1999	-	Linear interpolation			
	1976-2014	PFMC (2013)	2000-2010	3.4	RecFIN (2000-2010)			
Halfmoon (*Medialuna californiensis*)	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1960	0.5	Clark (1960)	1950-1980	1.9	Figueira and Coleman (2010)
			1961-1979	-	Linear interpolation			
			1980	0.4	RecFIN (1980-1985)			
Jack Mackerel (*Trachurus symmetricus*)	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1960	0.9	Clark (1960)	1950-1970	2.5	Guel (1973)
			1961-1979	-	Linear interpolation	1971-1979		Linear interpolation

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method
			1980		RecFIN (1980-1985)	1980	1.2	Figueira and Coleman (2010)
Jumbo flying squid (*Dosidicus gigas*)	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1979	1.5	Fishbase[c]	1950-1979	2	Assumed
Kelp bass (*Paralabrax clathratus)*	1950-1980	CDFG Partyboat database, unpub. data, J. Robertson	1950-1979	0.6	RecFIN (1980-1985)	1950-1979	1.9	Figueira and Coleman (2010)
Lingcod (*Ophiodon elongatus*)	1950-1979	CDFG (2001)	1950-1960	3.9	Clark (1960)	1950-1970	6.3	Mean from Guel and Clark (1968) & Guel (1973)
			1961-1979	-	Linear interpolation	1971-1979	-	Linear interpolation
			1980	2.9	RecFIN (1980-1985)	1980	3.5	Figueira and Coleman (2010)
Ocean whitefish (*Caulolatilus princeps*)	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1960	1.2	Clark (1960)	1950-1965	1.2	Guel and Clark (1968)
			1961-1979	-	Linear interpolation	1966-1979		Linear interpolation
			1980	0.7	RecFIN (1980-1985)	1980	1.4	Figueira and Coleman (2010)
Pacific barracuda (*Sphyraena argentea*)	1950-1979	CDFG (2001)	1950-1960	1.2	Clark (1960)			
			1961-1979	-	Linear interpolation			
Pacific bonito (*Sarda chiliensis lineolata*)	1950-1978	Collins et al. (1980)	1950-1979	1.6	Collins et al. (1980)	1950-1979	2	Collins et al. (1980)
	1979	CDFG (2001)						
Pacific Halibut (*Hippoglossus stenolepsis*)	1950-1957	Assumed 0.1 t						
	1958-1960	Miller and Gotshall (1965)	1958-1974	5.4	Skud (1975)			
	1961-1973	Linear interpolation						
	1974	Skud (1975)						
	1975-1976	Linear interpolation						
	1977-2014	IPHC RARA[d]						
Rockfish (*Sebastes spp.*)	1950-1980	Ralston et al. (2010)						
Sandbass genus (*Paralabrax* spp.)	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1960	0.6	RecFIN (1980-1985)	1950-1979	2	Assumed
Spotted grouper (*Epinephelus analogous*)	1950-1980	CDFG Partyboat database, unpub. data, J. Robertson	1950-1979	3.6	Fishbase[c]	1950-1979	2	Assumed
Striped bass (*Morone saxatilis*)	1950-1959	Chadwick (1962)	1950-1959	1.3-5.3[e]	Chadwick (1962)	1950-1968	5.0[f]	White (1986)
	1960-1963	Mckechnie and Miller (1971)	1960	1.8	Clark (1960)			
	1964-1968	CDFG Partyboat database, unpub. data, J. Robertson	1961-1979	-	Linear interpolation			
	1969-1979	White (1986)	1980	1.7	RecFIN (1980-1985)			
Unidentified sharks (Selachimorpha)	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1979	9.3	RecFIN (2000-2010)	1950-1979	2	Assumed
Wahoo (*Acanthocybium solandri*)	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1979	14.4	Fishbase[c]	1950-1979	2	Assumed
White croaker (*Genyonemus lineatus*)	1950-1979	CDFG (2001)	1950-1979	0.2	RecFIN (1980-1985)	1950-1970	8.6	Guel (1973)
						1971-1979	-	Linear interpolation
						1980	14.4	Figueira and Coleman (2010)

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method
White weakfish (*Atractoscion nobilis*)	1950-1979	CDFG (2001)	1950-1960	7.7	Clark (1960)	1950-1970	3.1	Mean from Guel and Clark (1968) & Guel (1973)
			1961-1979	-	Linear interpolation	1971-1979	-	Linear interpolation
			1980	2.3	RecFIN (1980-1985)	1980	3.4	Figueira and Coleman (2010)
Yellowfin tuna (*Thunnus albacares*)	1950-2014	CDFG Partyboat database, unpub. data, J. Robertson	1950-1979	7.7	RecFIN (1993-1999)	1950-2010	2.1	Figueira and Coleman (2010)
Yellowtail amberjack (*Seriola lalandi*)	1950-1979	CDFG (2001)	1965-1972	0.0	Linear interpolation	1966-1969		Linear interpolation
			1973	3.4	Crooke (1983)	1970-1979	2.6	Guel (1973)
			1974-1979	7.3	Crooke (1983)			
Others[g]	1950-1979	CDFG Partyboat database, unpub. data, J. Robertson	1950-1979	0.3-33	RecFIN (1980-1985)	1950-1979	2	Assumed
Shellfish:								
Abalone (*Haliotis* spp.)	1950-1959	Assumed same catch as 1960	1950-2010	0.8-1.7[h]	Pinkas et al. (1974)			
	1960, 1972, 1986, 1989	Haaker et al. (2001)				1960, 1972	4	Assumed based on CDFG (2010)
	1961-1971, 1973-1982	Linear interpolation						
	1983-1985, 1987,1988, 2000	Haaker et al. (2004)						
	1990-1999, 2002-2008	CDFG (2010)						
	2001	Average catch from 2002-2010						
	2009-2014	CDFW, unpub. data, P. Kalvass						
California Spiny lobster (*Panulirus interruptus*)	1950-1964	Assumed 32 MT based on 1965-1972 catch						
	1965-2009	Neilson (2011)						
	2010-2014	Assumed 41% of commercial catch (Neilson 2011)						
Dungeness crab (*Metacarcinus magister*)	1950-2014	1% of Commercial catch (Hankin et al. 2004)						
Pacific Razor Clams (*Siliqua patula*)[i]	1950-1952, 1971-1973	Assume 80,000 clams for entire beach based on average catch from 1974-1989	1950-1989	0.09[j]	Hirschhorn (1962)			
	1953-1970 (odd years)	Assumed 50,000 clams for N. Clam beach based on average catch from 1974-1989						
	1953-1970 (even years)	Assumed 30,000 clams for S. Clam beach based on average catch from 1974-1989						

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method
	1974-1989	CDFW, unpub. data for Clam beach, provided by P. Kalvass						
Pismo clams (*Tivela stultorum) at Pismo beach*[k]	1950	Assumed same catch as 1949 (Pattison and Lampson 2008)	1950, 1975-1983	0.5	Weymouth (1922)			
	1951-1964	Linear interpolation						
	1965	4 million pounds (Frey 1971) assumed to be for 1965						
	1966-1974	Linear interpolation						
	1975-1983	Wendell et al. (1986)						
	1984-2014	Negligible after 1983						
Rock crabs (*Cancer* spp.*)*	1950-2014	Assumed 1:21 ratio per kg of Dungeness crab[l]						
Other clams (Humboldt Bay)[m]	1950-1974	Used 1975-1989 average						
	1976	Linear interpolation						
	1975, 1977-1989, 2008	McVeigh et al. (2010)	1975, 1977-1989, 2008	0.06-0.19	McLean (1978), Lauzier et al. (1998), Bradbury et al. (2005)[m]			
	2009-2014	Assume same catch as 2008						
Other clams (Morro Bay)[m]	1950-1990	Assumed 25% of Humboldt Bay catch based on 1979-80						
	1979-1980	Mello (1981)	1979-1980	0.06-0.19	McLean (1978), Lauzier et al. (1998), Bradbury et al. (2005)[m]			
	1991-2014	Assumed 10% of 1980 catch due to reduced effort (Mello 1981)						
Other clams (Tomales Bay) [m]	1950-1967	Used 1968-1969 average annual catch						
	1970-1988	Linear interpolation						
	1968,1969, 1989-1998	CDFW, unpub. data, provided by P. Kalvass	1962,1963, 1989-1998	0.06-0.19	McLean (1978), Lauzier et al. (1998), Bradbury et al. (2005)[m]			
	1999-2014	Assume 25% of average catch from 1989-1998 (Moore 2001a)						
WASHINGTON								
Finfish:								
Albacore (*Thunnus alalunga*)	1950-1982	Holts (1985)	1980-1982	7.7	RecFIN (1980-2010)			
	1983-1986, 1988-1992	Linear interpolation						
Black Rockfish (*Sebastes melanops*)	1975-1983, 1991-1992	WDFW, unpub. data, E. Kraig	1975-1983, 1991-1992	1.1	RecFIN (1980-2010)			
Chinook salmon	1950-1966	INPFC (1979)	1950-2009	6.7				

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method
(*Oncorhynchus tshawytsch*) – marine	1967-2009	WDFW, unpub. data, E. Kraig						
	2010-2014	RecFIN						
Chinook salmon – freshwater	1950-1975	Assumed 1% of total recreational chinook catch	1950-2010	6.7	RecFIN (1980-2010)			
	1976-2014	WDFW, unpub. data, E. Kraig						
Chum salmon (*Oncorhynchus keta*)	1950-1964	1965-1974 average annual catch	1950-2010	4.8	RecFIN (1980-2010)			
	1966-1967	INPFC (1979)						
	1967-2014	WDFW, unpub. data, E. Kraig						
Coho salmon (*Oncorhynchus kisutch*) – marine	1950-1966	INPFC (1979)	1950-2010	2.0	RecFIN (1980-2010)			
	1967-2009	WDFW, unpub. data, E. Kraig						
	2010-2014	RecFIN						
Coho salmon – freshwater	1950-1975	Assumed 1% of total recreational coho catch	1950-2010	2.0	RecFIN (1980-2010)			
	1976-2014	WDFW, unpub. data, E. Kraig						
Lingcod	1950-1974	1975-1979 average annual catch	1950-1979, 1990-1992	3.1	RecFIN (1980-2010)			
	1975-1979, 1990-1992	WDFW data						
Pacific Cod (*Gadus macrocephalus*)	1950-1974	1975-1979 average annual catch						
	1975-1979, 1990-1995	WDFW, unpub. data, p E. Kraig	1950-1979, 1990-1995	1.4	RecFIN (1980-2010)			
Pacific Halibut (*Hippoglossus stenolepsis*)	1950-1964	Assumed 5 MT based on 1965 catch						
	1965-1974	Skud (1975)	1965-1974	5.4	Skud (1975)			
	1975-1976	WDFW, unpub. data, E. Kraig	1975-1979	5.9	RecFIN (1980-1985)			
	1977-2014	IPHC RARA[d]						
Pink Salmon (*Oncorhynchus gorbusch*)	1950-1966	INPFC (1979)	1950-2010	2.0	RecFIN (1980-2010)			
	1960, 1962, 1964	PFMC (1993)						
	1967-2014	WDFW, unpub. data, E. Kraig						
Rockfish (10 species)[p]	1950-1974	Used 1974-1979 average						
	1975-1979, 1991-1992	WDFW, unpub. data, E. Kraig	1975-1979, 1991-1992	0.2-3.6 [p]	RecFIN (1980-2010)			
Spiny dogfish (*Squalus suckleyi*)	1950-1979	1980-1984 average annual catch						
	1990-1995	Linear interpolation						
Sockeye salmon (*Oncorhynchus nerka*)	1950-1966	1965-1974 average annual catch	1950-2010	2.2	RecFIN (1980-2010)			
	1966-1967	INPFC (1979)						
	1969-2014	WDFW, unpub. data, E. Kraig						
Walleye Pollock	1950-1974	1975-1979 average annual catch						

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method
(*Theragra chalcogramma*)	1975-1979	WDFW, unpub. data, E. Kraig	1975-1979	0.5	RecFIN (1980-2010)			
White sturgeon (*Acipenser transmontanus)*	1950-1979	1980-1984 average annual catch						
	1989-2001	WDFW, unpub. data, provided by E. Kraig	1988-2001	10.6	RecFIN (1980-2010)			
Other fish [q]	1950-1979	Estimated based on average annual catch composition from 1980-2010						
	1990-1995	Linear interpolation						
Shellfish:								
Dungeness crab	1950-1975,1978, 1979, 1982-1994 (even years)	Estimated using average catch per license from 1976-1995						
	1976, 1977, 1980, 1981-1995	WDFW, unpub. data, E. Kraig	1976-1995	0.64[r]	Ainsworth et al. (2012)			
	1996-2014	Data obtained from WDFW: wdfw.wa.gov/fishing/shellfish/crab/estimates.html						
Pacific Oyster (*Crassostrea gigas*)	1950-1971	Estimated using average catch per license from 1972-1981						
	1972-1986	Hood canal catch from WDFW, unpub. data, E. Kraig				1972-1986	1.3	Ratio of total catch to Hood canal harvest from 1990-2001
	1990-1999	WDFW, unpub. data, E. Kraig						
	2000-2001	WDFW, unpub. data, E. Kraig	2000-2001	0.026	Average weight from 1990-1999			
	1987-1989, 2002-2014	Estimated using average catch per license from 1990-2001						
Pacific Razor clam	1950-2014	WDFW, unpub. data, D. Ayres	1950-2010	0.09[j]	Hirschhorn (1962)			
Red rock crab (*Cancer productus*)	1950-1975,1978, 1979, 1982-1994 (even years)	Average catch per license from 1976-1995						
	1976, 1977, 1980, 1981-1995 (odd years)	WDFW, unpub. data, E. Kraig	1976-2010	0.5[s]	Caroll (1982)			

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method
	1996-2014	Average catch per license from 1976-1995						
Spot prawn (*Pandalus Platyceros*	1950-1976, 1978,1979	Average catch per license from 1980-1989						
	1977, 1980-2003	WDFW, unpub. data, E. Kraig						
	2003-2014	Average catch per license from 1993-2002						
Other clams (7 species)[t]	1950-1971	Average catch per license from 1972-1976						
	1972-1986, 1990-2001, 2003-2007	WDFW, unpub. data, E. Kraig						
	1987-1989	Linear interpolation						
	2002, 2008-2014	Average catch per license from 2003-2007						
OREGON:								
Finfish:								
Albacore (*Thunnus alalunga*)	1975-1976, 1978-1992	Estimated as 0.2% of commercial landings based on average proportion observed in 1977 and 1993-1996 catch						
	1977	ODFW (1977)	1977	7.2	RecFIN (1993-2010)			
	2003	ODFW Ocean Recreational Boat Survey www.dfw.state.or.us	2003	9.2	RecFIN (2000-2010)			
Chinook salmon (*Oncorhynchus tshawytsch*) – marine	1950-1966	INPFC (1979)	1950-1970	5.6	Clark (1960)			
	1967-1977	ODFW (1977)	1971-1979	-	Linear interpolation			
	1978-2014	ODFW (www.dfw.state.or.us)[u]	1980-2010	6.7	RecFIN (1980-2010)			
Chinook salmon – freshwater	1950-1967	INPFC (1979)	1950-1970	5.6	Clark (1960)			
	1968-1977	ODFW (1977)	1971-1979	-	Linear interpolation			
	1978-2014[u]	ODFW (www.dfw.state.or.us)[u]	1980-2010	6.7	RecFIN (1980-2010)			
Coho salmon (*Oncorhynchus kisutch*) – marine	1950-1966	INPFC (1979)	1950-1970	3.4	Clark (1960)			
	1967-1977	ODFW (1977)	1971-1979	-	Linear interpolation			
	1978-2014	ODFW (www.dfw.state.or.us)[u]	1980-2010	2.9	RecFIN (1980-2010)			
Coho salmon – freshwater	1950-1967	INPFC (1979)	1950-1970	3.4	Clark (1960)			
	1968-1977	ODFW (1977)	1971-1979	-	Linear interpolation			
	1978-2014	ODFW (www.dfw.state.or.us)[u]	1980-2010	2.9	RecFIN (1980-2010)			
Pacific Halibut (*Hippoglossus stenolepsis*)	1950-1957	Assumed 2 t based on 1958-1960 catch						
	1958-1960	Miller and Gotshall (1965)	1958-1974	5.4	Skud (1975)			
	1961-1973	Linear interpolation						

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method
	1974	Skud (1975)						
	1975-1976	Linear interpolation						
	1977-2014	IPHC RARA[c]						
Pink and Chum salmon (*Oncorhynchus* spp.)	1950-1971 (odd years)	Average of annual catch from 1973-1979 (odd years)	1950-2010	1.3	Mean Pink salmon weight - RecFIN (1980-2010)[v]			
	1950-1972 (even years)	Average of annual catch from 1976-1982 (even years)						
	1973-2014	ODFW (1977); ODFW (www.dfw.state.or.us)[u]						
Other fish[w]	1950-1979	Average annual catch composition from 1980-2010						
Shellfish:								
Dungeness crab	1950-1970	Average catch per license from 1971						
	1971	ODFW (1977)	1971	0.64[r]	Ainsworth et al. (2012)			
	1972-2005	Estimated using catch per license rates, linearly interpolated between 1971-2006 rates						
	2006	Average catch per license from 2007-2011						
	2007-2014	Ainsworth et al. (2012)						
Pacific Razor clam	1950-1954	Average catch per license from 1955-1959	1950-2010	0.09[j]	Hirschhorn (1962)	1950-2010	1.05	ODFW (1977); www.dfw.state.or.us[x]
	1955-2014	ODFW, unpub. data, M. Hunter						
Red rock crab	1950-2014	Assumed ratio of 1:27 per kg of Dungeness crab[l]						
Other clams (5 species)[y]	1950-1969	Average catch per license from 1970-1974						
	1970-1983	Gaumer (1984)						
	1984-2007	Linear interpolation						
	2008	Ainsworth and Vance (2009)						
	2009-2014	Estimated using catch per license from 2008						

[a] 1/2 the max weight listed on Fishbase. [b] Average of annual ratios used by Crone at al. (2009) from 1962-1980. [c] Assumed 1/2 the max length and converted to weight using weight-length conversions. [d] The 1991-2014 sport catch presented in the annual IPHC RARAs from 1992-2015 were reported by state, while the 1977-1990 estimates, taken from Hare (2012), were not. We allocated 59%, 40%, and 1% of annual sport catch from 1977-1990 to Washington, Oregon and California, respectively, based on the average distribution in the catch from 1991-2000. [e] Different mean weight values used for different areas and years. [f] White (1986) estimates party boat catch is 14% of total catch, we assume a more conservative value of 20% for the earlier period. [g] Other taxonomic groups reconstructed using party boat data include; *Acipenser* spp., *Alopias vulpinus*, *Amphistichus argenteus*, *Anoploma fimbria*, Atherinidae, *Atherinopsis californiensis*, *Auxis rochei*, Chondrichthyes, *Citharichthys sordidus*, *Clupea pallasii*, *Coryphaena hippurus*, Cottidae, *Embiotoca lateralis*, Embiotocidae, Engraulidae, *Eopsetta jordani*, *Galeorhinus zyopterus*, *Girella nigricans*, *Hermosilla azurea*, *Heterodontus francisci*, Hexagrammidae, *Hexagrammos decagrammus*, *Hippoglossus stenolepis*, *Hypomesus pretiosus*, *Isurus oxyrinchus*, *Katsuwonus pelamis*, Labridae, *Menticirrhus undulatus*, *Merluccius productus*, *Mustelus henlei*, *Myliobatis californica*, Osmeridae, Osteichthyes, Pleuronectiformes, *Prionace glauca*, Rajiformes, Sciaenidae, Scombridae, Scorpaenidae, *Seriphus politus*, Serranidae, *Squalus suckleyi*, *Stereolepis gigas*, *Tetrapturus audax*, *Thunnus orientalis*, *Triakis*

Supplementary Materials Table S2: Information and sources used to reconstruct the U.S. West Coast marine recreational fisheries catch data. For data sources that listed only the number of fish landed, a weight conversion was used to estimate landings by weight.

Taxa	Estimated # of fish or catch		Estimated weight per fish			Estimated charter boat to private fishing fraction		
	Time period	Source/method	Time period	kg/fish	Source/method	Time period	Fraction	Source/method

semifasciata, Umbrina roncador and 'marine fishes not elsewhere included'. Species specific mean weights from RecFIN were used to convert fish numbers to weight. [h] 1.7 kg for red abalone, 0.8 kg for white abalone and 0.9 for other species (Pinkas et al. 1974). [i] From 1953-1970 and 1974-1989, South and North clam beaches had alternating seasonal closures. No estimates were made for years after 1989 as clam populations declined in the mid-1990s (Moore 2001b). [j] We assumed that the majority of sport catch is at least 1-year old (ODFW 1977). Due to alternating seasonal closures, clams in California may be slightly larger, however we conservatively maintained the same estimate as for Oregon and Washington. [k] Pismo clam harvests declined in the late 1970s and early 1980s due to increased sea otter predation, effectively putting an end to the recreational fishery (Spratt 1982; Wendell et al. 1986; Pattison and Lampson 2008). Weight calculations are based on the minimum 5 inch size limit from 1949-1986 (Pattison and Lampson 2008) and conversions from Weymouth (1922). [l] We used Dungeness crab catch as an indicator of rock crab catch for Oregon and California, as they are caught using the same gear. We assumed a ratio of 1 kg of rock crab for every 21 kg of Dungeness crab in California, which was the geometric mean of the average ratio observed in the CPFV logbooks from 1994-2014. We assumed a ratio of 1 kg of red rock crab for every 27 kg of Dungeness crab caught annually in Washington, based on the average ratio observed in the Washington recreational catch data. [m] Includes estimates of gaper clams (*Tresus* spp.*)*, Washington clams *(Saxidomus* spp.), littleneck clams (*Leukoma staminea*), Nuttall's cockle (*Clinorcardium nuttallii*) and Pacific geoduck (*Panopea generosa*). Assumed an average size of 4 inches for gaper clams (Moore 2001a) and the middle range of lengths from for other species (McLean 1978). Wet weights were obtained using L-W conversions (Lauzier et al. 1998; Bradbury et al. 2005). Tomales Bay estimates were only for gaper clams and we estimated the percentage of other clams harvested based on the proportion of those species harvested in Humboldt Bay. [p] Copper rockfish (*Sebastes caurinus*), quillback rockfish (*S. maliger*), yelloweye rockfish (*S. ruberrimus*), brown rockfish (*S. auriculatus*), canary rockfish (*S. pinniger*), yellowtail rockfish (*S. flavidus*), China rockfish (*S. nebulous*), blue rockfish (*S. mystinus*), bocaccio rockfish (*S. paucispinis*), and widow rockfish (*S. entomelas*). Species-specific values were used for weight conversions and were taken from mean lengths in the RecFIN database over the 1980-2010 period. All reconstructed rockfish catch was assigned as *Sebastes* spp. from 1950-1974, as there was little species specific information for this period. [q] Other species accounted for another 10% of total reconstructed catch estimates for Washington from 1980-2010. From 1950-1979, an additional 10% of catch was allocated to these species in 20 major taxonomic groupings (*Anoplopoma fimbria*, Chondrichthyes, *Citharichthys sordidus*, *Clupea pallasii pallasii*, Clupeiformes, Cottidae, Embiotocidae, Gadidae, Hexagrammidae, *Hexagrammos decagrammus*, *Hypomesus pretiosus*, *Merluccius productus*, Osmeriformes, Pleuronectiformes, Rajiformes, Scombridae, *Scorpaenichthys marmoratus*, Scorpaeniformes, Selachimorpha, and 'marine fishes not elsewhere included'). [r] Midrange of the mean weights observed between 2007-2011 (Ainsworth et al. 2012). [s] Assumed an average length of 5 inches (12.7 cm) based on the minimum retention size in Washington, and estimated weights using length-weight conversions (Caroll 1982). As both females and males are retained, we used the average of the weights calculated for the two sexes. [t] Butter clam (*Saxidomus gigantea*), Manila clam (*Venerupis philippinarum*), Nuttall's cockle, littleneck clam, Pacific gaper clam (*Tresus nuttallii*), Pacific geoduck, and softshell clam (*Mya arenaria*). Individual clam species were not identified for 1972-1986, and we divided this catch among the 7 species based on the catch composition from 1990-1994. [u] Sport catch statistics for salmon are available from the Oregon Department of Fish and Wildlife (ODFW, www.dfw.state.or.us/resources/fishing/sportcatch). These data were provided by S. Beals. [v] We used the mean weight for pink salmon, rather than chum salmon, as this leads to a more conservative estimate. No data were available for 1994 coastal and Colombia river fall chinook catch and these were estimated using the average annual landings from 1990-1994 and 1995-1998. [w] Other species accounted for an additional 58% of total reconstructed catches for Oregon from 1980-2014. From 1950-1979, an additional 58% of catch was thus allocated to these species in 23 major taxonomic groupings (*Acipenser* spp., *Anoplopoma fimbria*, Atherinidae, Chondrichthyes, *Clupea pallasii pallasii*, Clupeiformes, Cottidae, Embiotocidae, Gadidae, Hexagrammidae, *Hexagrammos decagrammus*, *Hypomesus pretiosus*, *Ophiodon elongatus*, Osmeriformes, Pleuronectiformes, Rajiformes, Scombridae, *Scorpaenichthys marmoratus*, Scorpaeniformes, *Sebastes* spp., Selachimorpha, *Squalus suckleyi*, and 'marine fishes not elsewhere included'. [x] ODFW estimates are for Clatsop Beach, which accounts for 90-95% of state harvest (ODFW 1977; www.dfw.state.or.us/mrp/shellfish/razorclams). We assumed an additional 5% of harvest from other Oregon beaches. [y] Butter clam, Nuttall's cockle, littleneck clam, Pacific gaper clam and softhell clam. Softshell harvests were < 1 t from 1974-1983 and no additional harvests were estimated after 1983.

Washington

In addition to RecFIN (Recreational Fisheries Information Network, www.recfin.org) and Figueira and Coleman (2010), the following sources were used to reconstruct recreational catches for Washington (see Supplementary Materials Table S2): 1) Historical records of salmon and marine fish landed by the recreational fishery for 1967-2014 (WDFW, unpubl. data, E. Kraig); 2) Historical salmon landings data for 1946-1976 (INPFC 1979) and for 1950-2014 (PFMC 1993, 2013); 3) Historical records of recreational Albacore tuna catches (Holts 1985); and 4) Historical estimates of recreational Pacific Halibut catches from general reports (Miller and Gotshall 1965; Skud 1975) and from stock assessment and research activities reports (RARAs) for 1991-2014 (Blood 1992-2009; Williams 2010, 2011; Hare 2012; Williams 2012a, 2013, 2014; Kaimmer 2015). This was deemed to account for 90% of the recreational landings from 1980-2014. An additional 10% was subsequently added to the annual reconstructed recreational catches of Washington for 1950-1979, and assigned proportionally to the lesser targeted taxa based on the assumption that species without any data for the 1950-1979 period accounted for the same annual proportions of total state catch as their proportion in the total catch over the 1980-2014 period.

INPFC catch statistics include landings from Puget Sound and the San Juan Islands, and thus were used instead of the PFMC statistics from 1950-1965. Coastal river catches for coho and chinook salmon were available for 1976-2014 (WDFW, unpubl. data, E. Kraig) and accounted for 1% of average annual landings for both species between 1976-1980. We thus assumed they accounted for 1% of total landings from 1950-1975 where there were no species-specific data. This may be a conservative assumption, as records from 1964-1976 (INPFC 1979) show higher annual freshwater salmon landings for Washington than our estimate. We excluded all steelhead catch, as most of these catches were taken in rivers. For the case of Columbia River sturgeon, we only included catch from WDFW Reporting Area 1A at the mouth of the Colombia River, located at the ocean-river interface.

A variety of recreational shellfish data exist for Washington and were obtained from the WDFW: 1) Dungeness crab (*Metacarcinus magister*) and Red rock crab (*Cancer productus*) catches for some years between 1976-1995 (WDFW, unpubl. data, E. Kraig) and for Dungeness crab from 1996-2014[1]; 2) Spot prawn (*Pandalus platyceros*) catches from 1977 and 1980-2002 for Hood Canal and Puget Sound, Pacific oyster (*Crassostrea gigas*) catches from 1972-2001, and clam catches from 1972-1986 and 1990-2007 (WDFW, unpubl. data, E. Kraig); and 3) Pacific razor clam (*Siliqua patula*) catches for 1950-2014 (WDFW, unpubl. data, D. Ayres). These data were used in conjunction with U.S. Fish and Wildlife Service historical recreational fishing license data to generate recreational catch estimates for Washington (see Supplementary Materials Table S2).

Oregon

Chinook and coho salmon have historically accounted for the majority of the recreational catches in Oregon (Schindler et al. 2012). Sport catch statistics for salmon are available from the ODFW[2] and ODFW (1977), and summarize records of the number of chinook and coho landed in coastal rivers, the Columbia River, and from ocean areas. An additional source provide similar estimates

[1]Available at http://wdfw.wa.gov/fishing/shellfish/crab/estimates.html (accessed February 29, 2020)
[2]Available at www.dfw.state.or.us/resources/fishing/sportcatch (accessed on February 29, 2020)

for inland and ocean salmon catch for 1949-1976 that were used to reconstruct coho and chinook catch for 1950-1966 (INPFC 1979).

Salmon landings for 1956-1963 were not distinguish between freshwater or marine catch (INPFC 1979). We separated these data into approximate freshwater and marine components based on the average proportions for 1950-1954 (27% marine and 73% freshwater) and 1964-1968 (68% marine and 32% freshwater). We used the 1950-1954 average proportion for 1955 and the 1964-1968 average proportion for 1963, and linearly interpolated between these ratios to estimate the proportion of freshwater and marine landed salmon for the intervening years. We applied a similar method of establishing anchor points and linearly interpolating to estimate the proportion of coho and chinook in the ocean landings from 1956-1963. To divide total freshwater salmon landings from 1950-1967 between coho and chinook, we used the average annual species ratio in the freshwater landings from the 1968-1977 statistics of 22% coho and 78% chinook (ODFW 1977).

A variety of recreational shellfish data exist for Oregon: 1) Dungeness crab catch for 1971 (ODFW 1977) and 2007-2014 (Ainsworth et al. 2012); 2) Pacific razor clam catch from 1955-2014 (Link 2000; Hunter 2008; ODFW, unpubl. data, provided by M. Hunter); and 3) Oregon Bay clam catches for 1970-1983 (Gaumer 1984) and 2008 (Ainsworth and Vance 2009). These data were used in conjunction with U.S. Fish and Wildlife Service historical recreational fishing license data to generate recreational catch estimates for Oregon (see Supplementary Materials Table S2).

DISCARDS

We define discards as any catch, recreational or commercial, that is not landed ashore, i.e., that is discarded dead or dying at sea. Our estimates do not consider underwater mortality due to fishing gear prior to bringing catch aboard vessels, or mortality caused by abandoned fishing gear (i.e., ghost fishing; Bullimore et al. 2001), thus our overall discard estimates are conservative. We estimated discards of fish that were released both alive and dead, and have adjusted the final discard data, as far as possible, for post-release mortality rates (Supplementary Materials Tables S3, S4).

Groundfish bottom trawl fishery

We utilized unpublished discard data (provided by J. Wallace, NOAA) used in Pikitch et al. (1988) from 1381 trawls, each of which was assigned to one of five trawl-fishing strategies: 1) bottom rockfish; 2) deepwater Dover sole; 3) nearshore mixed species; 4) midwater trawl; and 5) shrimp trawl. The bottom rockfish, deepwater Dover sole, and nearshore mixed species bottom trawl fisheries are not very selective and target multiple groundfish species. These fisheries were considered indicative of the groundfish bottom trawl fisheries, and we used these data to calculate discard to landings (*D/L)* ratios from 1985-1987 (Supplementary Materials Table S5).We used additional sources from the Northwest Fisheries Science Centre (NWFSC, Supplementary Materials Table S4) as well as Somers et al. (2014). NWFSC discard estimates include a discard mortality rate for Pacific halibut, lingcod, and sablefish, whereas only total discards are presented in Somers et al. (2014). To maintain consistency with other NWFSC estimates used, we applied a 50% mortality rate to sablefish and lingcod discards from 2002-2014.

Supplementary Materials Table S3. Discard mortality rates (%) in U.S. West Coast fisheries.

Fishery & gear	Bycatch species	Discard mortality (%)	Source
Non-hake groundfish	Pacific halibut,	20-90	Jannot et al. (2012)[a]
	Sablefish & lingcod	50	Hastie and Bellman (2006, 2007); Bellman et al. (2008; 2010a; 2010b; 2011, 2012)
Sablefish pots	Pacific halibut	18	Jannot et al. (2012) [a]
	Sablefish	20	Hastie and Bellman (2006, 2007); Bellman et al. (2008; 2010a; 2010b; 2011, 2012)
Sablefish longlines	Pacific halibut	16	Jannot et al. (2012) [a]
	Sablefish	20	Hastie and Bellman (2006, 2007); Bellman et al. (2008; 2010a; 2010b; 2011, 2012)
California halibut	Lingcod	50	Hastie and Bellman (2006, 2007); Bellman et al. (2008; 2010a; 2010b; 2011, 2012)
Pacific halibut	Pacific halibut	25	Gilroy and Hare (2012)
Commercial troll salmon	Salmon	26	PFMC (2000-2014)
Recreational salmon	Salmon	14-28	PFMC (2000-2014)
Non-salmon recreational	All species	2-66	See Supp. Mat. Table S4

[a] Discard mortalities for groundfish bottom trawl are based on assessments of viability by the observer.

Supplementary Materials Table S4: Post-release mortality rates used to estimate mortality from catch-and-release discards for U.S. West Coast non-salmon recreational fisheries from 1981-1989 and 1993-2010.

Taxon	Common name	Release mortality (%)	Source	% *B2* catch
Teleosts and Acipenseriformes				
Acipenser transmontanus	White Sturgeon[a,b]	3	Robichaud et al. (2006)	3.7
Ophiodon elongatus	Lingcod	2	Bartholomew and Bohnsack (2005), Muoneke and Childress (1994)	4.0
Morone saxatilis	Striped Bass	17	Bartholomew and Bohnsack (2005), Muoneke and Childress (1994)	1.0
Hippoglossus stenolepis	Pacific Halibut	16	Bartholomew and Bohnsack (2005), Muoneke and Childress (1994)	0.4
Atractoscion nobilis	White weakfish	10	Aalbers et al. (2004)	0.9
Thunnus albacares	Yellowfin tuna	30	Bartholomew and Bohnsack (2005), Muoneke and Childress (1994)	0.0
Sebastes spp.	Rockfish	16-66[b]	PFMC and NMFS (2009)	3.6
Other teleost species	Median value (n=274)	11	Bartholomew and Bohnsack (2005), Muoneke and Childress (1994)	59.3[c]
Elasmobranchs				
Alopias vulpinus	Thresher shark	26	Heberer et al. (2010)	0.9
Prionace glauca	Blue shark	15	Musyl et al. (2011)	2.5
Isurus oxyrinchus	Shortfin mako shark	20	Hight et al. (2007)	0.5
Myliobatis californica	Bat ray[d]	15	Braccini et al. (2012)	3.1
Squalus acanthias	Spiny dogfish [b]	24	Mandelman and Farrington (2007)	8.1
Other Batoidea	Median value (n=3 ray spp.)	7	Braccini et al. (2012)	3.1
Other Selachimorpha	Median value (n=4 shark spp.)	22	Braccini et al. (2012)	8.8

[a] This mortality rate was applied to all *Acipenser* spp. discards. Mortality rates may be an overestimate due to the holding conditions used (Robichaud et al. 2006; Mandelman and Farrington 2007). [b] Range shows mortality rate for 8 rockfish species, a median value of 31.5% was used for all other rockfish species. [c] Includes 126 tonnes of spotted rattail (*Hydrolagus colliei*). [d] This rate was an estimate for the Southern Eagle Ray (*Myliobatis australis*) of the same genus.

Supplementary Materials Table S5: Taxonomic composition of discards and discard to landings (*D/L*) ratios derived for the U.S. West Coast groundfish bottom trawl fisheries.

Time period	**1985-1987**[a]	**2002-2010**[b]
Taxonomic discard composition by weight	***%***	***%***
Skates	13.4	9.7
Spotted spiny dogfish	14.1	9.0
North Pacific hake	12.9	17.2
Other gadiformes	0.6	0.6
Rockfish	20.1	7.1
Thornyheads	4.4	5.2
Lingcod		1.1
Arrowtooth flounder	10.2	11.6
Dover sole	2.4	8.9
English sole	1.2	2.9
Pacific halibut	0.2	2.6
Petrale sole	0.3	1.3
Other flatfish	7.1	6.9
Sablefish	4.4	3.5
Other marine fishes	5.0	6.1
Crabs	2.5	9.5
Echinoderms	1.5	
Others	0.3	
Average *D/L* ratio	**0.47**	**0.44**

[a] D/L ratios are calculated using unpublished data from Pikitch et al. (1988). We assumed a 50% discard mortality for sablefish, lingcod and Pacific halibut. [b] D/L ratios are calculated using 2002-2009 groundfish discards and landings estimates from Bellman and Heery (2013) and Bellman et al. (2011), 2002-2010 Pacific halibut discard estimates from Jannot et al. (2012) and 2005-2010 crab discards from NWFSC (Hastie and Bellman 2006, 2007; Bellman et al. 2008; Bellman et al. 2010a; Bellman et al. 2010b; Bellman et al. 2011). The NWFSC reports included discard mortality estimates for sablefish, lingcod and Pacific halibut and we apply a 50% discard mortality rate to sablefish and lingcod discards from Bellman and Heery (2013).

We sorted the NMFS commercial landings data by bottom trawl gear to determine the primary target species of the groundfish bottom trawl fisheries. Three gear types listed in the NMFS data were considered representative of these fisheries: "otter trawl bottom, fish", "otter trawl bottom, other", and "trawls, unspecified". We excluded Pacific halibut, California halibut, North Pacific hake, and ocean shrimp from the groundfish bottom trawl target species list, as discards from these fisheries are assessed separately (see below). Select species of rockfish[3] and flatfish[4] taxa represent 99% of the landed bottom trawl rockfish and flatfish catch by weight and value (NMFS commercial data) and are considered the primary target groups; however, much of the landings are recorded only as "soles" (prior to 1972) or "rockfish" in the commercial landings data. Thus, it is

[3] Bocaccio rockfish, canary rockfish, chilipepper rockfish, widow rockfish, yellowtail rockfish, Pacific Ocean perch and unidentified rockfish. Unidentified rockfish comprised the bulk of commercial bottom trawl catch (68%) between 1950-2014, and along with Pacific Ocean perch, were the only rockfish taxa recorded prior to 1979.
[4] Arrowtooth flounder, Dover sole, English sole, petrale sole, sand sole, starry flounder, rex sole and unidentified soles and flounders.

difficult to know exactly which species were landed, and for simplicity we include all rockfish and flatfish taxa in our target landings denominator, resulting in a more conservative *D/L* ratio (Supplementary Materials Table S5).

We estimated *D/L* ratios for 1985-1987 and 2002-2010 for the multispecies groundfish bottom trawl fishery (Supplementary Materials Table S5). NWFSC estimates include a discard mortality rate of 50% for lingcod and sablefish (Bellman et al. 2012), and 22%, 55% or 90% for Pacific halibut based on assessments of viability by the observer (Jannot et al. 2012). Based on these assessments, approximately 48% of estimated gross discards of Pacific halibut were estimated to have died in the 2011 bottom trawl fishery (Jannot et al. 2012). We applied a similar discard mortality of 50% for lingcod, sablefish, and Pacific halibut when deriving 1985-1987 *D/L* ratios.

We took the weighted average (by number of hauls in the source material) of *D/L* ratios from 1985-1987 to estimate a *D/L* ratio for this time period. *D/L* ratios from 1985-1987 ranged from 0.38-0.58, but were based on different numbers of hauls observed, and thus a weighted average of these years is likely the best approach to estimate discards for the entire fleet. We also estimated *D/L* ratios from 2002-2010 by dividing the NWFSC discard estimates (Bellman et al. 2011; Bellman and Heery 2013; Somers et al. 2014) by the landings of target species from 2002-2010. We took the average of the 2002-2010 *D/L* ratios and applied these to NMFS commercial landings of target species by bottom trawl gear to estimate discards in earlier years. This approach was considered conservative because discard rates have trended downwards after 2002 (Somers et al. 2014).

Commercial landings of skates (Rajiformes) from bottom trawls are dominated by the longnose skate (*Raja rhina*) and have increased substantially since 1996 due to increased demand in the Asian market (Gertseva and Schirripa 2008). We followed Gertseva and Schirripa (2008) by assuming lower discard rates of skates since 1996. We thus applied the 1985-1987 *D/L* ratio, which had a higher concentration of skates, to estimate discards from 1950 to 1995 and the 2005-2010 *D/L* ratio to estimate discards after 1996. This approach was considered conservative because discard rates have trended downwards (Somers et al. 2014).

California halibut

NWFSC discard estimates for the California halibut fisheries were available from 2007 onwards; we used these data to calculate annual *D/L* ratios from 2007-2011, which ranged from 2.1 to 3.7. We took the average *D/L* ratio from 2007-2011 (Supplementary Materials Table S6) and applied this to NMFS commercial landings of California halibut from bottom trawl gear to estimate discards.

Pacific halibut

In California, Oregon and Washington, 95% of commercial Pacific halibut landings are caught with bottom longlines (Harrington et al. 2005). Commercial landings data are available from the International Pacific Halibut Commission (IPHC) and from the NMFS. The IPHC records halibut catch based on where the fish are caught, whereas the NMFS records catch based on where the fish was landed or reported from (Harrington et al. 2005; www.st.nmfs.noaa.gov). Here, we used the NMFS commercial data to maintain consistency. We recognize that this may lead to some incorrect spatial catch allocation of the *Sea Around Us* catch data within U.S. waters (Zeller et al. 2016).

Supplementary Materials Table S6: Taxonomic composition of discards and discard to landings ration (*D/L*) used to estimate discards for the California halibut bottom trawl fishery for the U.S. West Coast.

***D/L* ratio**	**2.9**
Taxonomic composition of discards by weight	**%**
Skates and rays	20.1
Sharks	1.8
California halibut	5.9
Other flatfish	4.8
Other marine fish	20.0
Dungeness crab	47.3

We used the 2002 expanded longline bycatch data from Harrington et al. (2005) to estimate a *D/L* ratio of 0.15 for non-target species in the Pacific halibut fishery (Supplementary Materials Table S7). We multiplied this ratio by the NMFS commercial landings of Pacific halibut by longline gear to estimate discards of non-target species. This ratio excludes discards of Pacific halibut, which we obtained from IPHC data. The IPHC provides discard mortality estimates of under-sized Pacific halibut that were discarded in the directed commercial halibut fishery from 1974-2014 (Gilroy and Hare 2012; Williams 2014). In order to remain consistent in our methods, which reconstructed catch based on where it was landed and not necessarily where it was caught, we allocated these U.S. discards proportionally to Washington, Oregon, California (as well as Alaska) in accordance with the reported annual NMFS commercial landings data for these states. To estimate under-sized halibut discards prior to 1974, we applied a *D/L* ratio of 0.01 to NMFS commercial longline landings of Pacific halibut from 1950-1973. This ratio was derived as the average ratio of under-sized halibut discards to IPHC commercial landings for the three states.

Supplementary Materials Table S7: Taxonomic composition of discards and discards to landings ratio (*D/L*) used to estimate non-halibut discards from the Pacific halibut fisheries on the U.S. West Coast.

D/L ratio	**0.15**
Species composition of discards by weight	**%**
Spotted spiny dogfish	21.7
Skates	11.1
Other sharks	20.4
Rockfish	1.6
Lingcod	3.7
Arrowtooth flounder	7.2
Other flatfish	0.3
Sablefish	33.1
Other marine fish	0.9

Sablefish fixed gear

U.S commercial landings were small (< 5000 t) and were mostly caught by longline and trawl fisheries until the 1970s (NMFS landings data; Stewart et al. 2011). NMFS commercial landings data for sablefish indicate that they were caught mainly by trawl (47%), lines (34%), and pots (17%). NWFSC discard estimates are available for the nearshore sablefish fishery from 2005. We used these estimates to generate annual *D/L* ratios for the pot and longline fisheries by region. We took the average *D/L* ratios (weighted by the number of sets observed in a given year) for 2005-2010 (Supplementary Materials Table S8) and applied these to the NMFS commercial landings of sablefish by pot and longline gear from 1950. For most years, the NWFSC discards and landings data were separated by regions north and south of $40^0$10' N latitude, and *D/L* ratios for the north were applied to Oregon and Washington, while *D/L* ratios for the south were applied to California.

Supplementary Materials Table S8: Taxonomic composition of discards and discards to landings ratios (*D/L*) used to estimate discards for the sablefish fixed gear fisheries on the U.S. West Coast.

Gear	**Longline**		**Pots**	
Region	**North**	**South**	**North**	**South**
***D/L* ratio**	**0.50**	**0.45**	**0.18**	**0.19[a]**
Species composition of discards by weight	**%**	**%**	**%**	**%**
Skates and rays	10.3	9.7	<0.1	0.0
Spotted spiny dogfish	27.8	15.7	3.9	1.5
Pacific cod and hake	0.1	0.3	<0.1	0.0
Rockfish	3.7	2.9	1.1	1.3
Thornyheads	0.4	1.7	0.1	0.0
Lingcod	0.8	0.4	3.7	2.6
Arrowtooth flounder	9.2	4.0	1.7	0.8
Pacific halibut[b]	6.1	-	-	-
Other flatfish	0.3	0.8	0.6	1.0
Sablefish	25.8	37.5	80.8	83.9
Other marine fish	15.4	26.4	3.1	4.2
Crabs	<0.1	0.6	4.8	4.7

[a] Excludes 2007 data for which there was no pot-specific discard information for the southern region. [b] The Pacific halibut discards used to estimate *D/L* ratios were from Jannot et al. (2012) and were attributed to longline gear in the northern region.

North Pacific hake

The U.S. North Pacific hake fleet can be broken down into two sectors; one delivering to at-sea processors and one delivering to shore-based processors. NWFSC discard estimates are available for at-sea hake fisheries from 2005 onwards, and for shore-based hake fisheries for 2005, 2006, and 2011 onwards (Hastie and Bellman 2006, 2007; Bellman et al. 2008; Bellman et al. 2010a; Bellman et al. 2010b; Bellman et al. 2011, 2012; Jannot et al. 2012; Bellman et al. 2013; Jannot et al. 2014). We used this information to generate annual *D/L* ratios for at-sea and shore-side hake fisheries for years with data (Supplementary Materials Table S9). Unpublished data from a 1985-1987 survey by Pikitch et al. (1988) includes landings and discards data from four midwater trawls which were actively targeting and landing North Pacific hake. These trawls were considered representative of the shore-side hake fishery and had a *D/L* ratio of 0.06, with North Pacific hake comprising 99.6% of total discards (Supplementary Materials Table S9).

We took the average of the 2005-2010 *D/L* ratios for the fisheries supplying at-sea processing (Supplementary Materials Table S9) and applied this to the NMFS at-sea landings data of North Pacific hake to estimate discards. We used the average of the 2005 and 2006 *D/L* ratios for the fisheries supplying shore-based processing (Supplementary Materials Table S9) and applied this to the NMFS landings for shore-based processing of North Pacific hake to estimate discards from 1965-2010. We assumed that the North Pacific hake landed prior to 1965 were mostly bycatch from other fisheries (Nelson Jr. 1985), and thus a discard rate was not applied to these landings.

Supplementary Materials Table S9: Taxonomic composition of discards and discards to landings ratios (*D/L*) used to estimate discards for the U.S. North Pacific hake fisheries supplying at-sea and shore-based processing.

Years	**1990-2004**	**1965-2004, 2007-onwards**
Processing type	**At-sea**	**Shore-based**
***D/L* ratio**	**0.008**	**0.06**
Species composition of discards by weight	**%**	**%**
North Pacific hake	44.4	96.8
Spotted spiny dogfish	35.8	<0.1
Rockfish	16.9	3.1
Others	2.9	<0.1

Ocean shrimp

The following sources were used to estimate discards for the U.S. West Coast ocean shrimp fisheries: 1) NWFSC discard estimates from 2007 to 2014 (Bellman et al. 2008; Bellman et al. 2010a; Bellman et al. 2010b; Bellman et al. 2011, 2012; Bellman et al. 2013; Somers et al. 2014); 2) Logbook and bycatch data from the 2005 Oregon ocean shrimp fisheries for different bycatch reduction devices (BRDs) (Hannah and Jones 2007); 3) Seven datasets from control nets from research surveys between 1981 and 2000 (Hannah and Jones 2007); and 4) Bycatch and landings data from a 1979 survey (Demory et al. 1980). We used these sources to generate *D/L* ratios, which were applied to the NMFS commercial landings data of ocean shrimp to estimate discards (Supplementary Materials Table S10). With the exception of the NWFSC discard estimates from 2007-2014, data sources did not indicate the proportion of bycatch that was landed versus discarded. NWFSC discard estimates indicate that on average 1% of ocean shrimp catch is discarded, and thus we assumed that 1% of caught shrimp is discarded when calculating *D/L* ratios. Otherwise, *D/L* ratios prior to 2007 include landed bycatch of marketable groundfish. Different *D/L* ratios were applied to different periods based on historical developments in the fisheries (Supplementary Materials Table S10).

We did not have estimates of total discards for all years, but rather catch compositions from surveys from 1979-2000. In these cases, *D/L* was derived as:

$$D/L = \frac{(B+0.01S)}{(S-0.01S)}/S$$

Where B = the percentage of non-target (ocean shrimp) species in the catch by weight, and S = the percentage of ocean shrimp in the catch by weight. The formula also accounts for the 1% of caught ocean shrimp that was discarded.

Supplementary Materials Table S10: Discard to landings rations (*D/L*) used for different years in the ocean shrimp fisheries on the U.S. West Coast, and associated explanations and justifications.

Time period	*D/L*	Justification
1950-1988	1.01	Due to lack of additional information, we assumed discard data from surveys in 1979, 1981 and 1986-1987 provided best discard estimates from 1950-1989.
1989-2000	1.28	Discards increased in 1989 and through the 1990s due to an increased abundance of North Pacific hake in the shrimp fishing grounds (Hannah et al. 1996) and are assumed to have remained high until 2001 when BRDs were implemented on a large-scale.
2001-2002	0.7	BRDs were mandatory for only part of the season in 2001/2002 (Hannah and Jones 2000) and thus we assumed an average of the pre-BRD and post-BRD D/L ratios.
2003-2006	0.12, 0.09, 0.12	There has been a large decrease in bycatch since BRDs became mandatory in 2003 (Hannah and Jones 2007). Catch compositions for different BRDs and trip numbers for shrimp vessels in Oregon are available for 2005 (Hannah and Jones 2007). The weighted average % catch composition was assumed the best representation for the west coast
2007-2010	0.16	NWFSC discard estimates.

Historically, only certain marketable taxa were retained for sale and some processing plants are reported to have not accepted bycatch from the shrimp fisheries. The retention of bycatch on any particularly trip is highly variable and depends on a variety of factors such as the quantity of fish being caught, space onboard the vessel, and market demand (Robert Hannah, ODFW, pers. comm.). Based on consultation with Robert Hannah (ODFW), ex-vessel prices from the Pacific Fisheries Information Network (pacfin.psmfc.org), and landed bycatch reported by Demory et al. (1980), we considered lingcod (*Ophiodon elongates*), sablefish (*Anoplopoma fimbria*), yellowtail rockfish (*Sebastes flavidus*), canary rockfish (*Sebastes pinniger*), rougheye rockfish (*Sebastes aleutianus*), Dover sole (*Microstomus pacificus*), English sole (*Parophrys vetulus*), petrale sole (*Eopsetta jordani*), and rex sole (*Glyptocephalus zachirus*) to be the most likely species of bycatch to have been retained and landed. To correct for landed bycatch of marketable species and potential double-counting in our discards, we subtracted NMFS commercial landings caught by "Otter Trawl, Shrimp" for marketable species of groundfish from our estimated discards; this catch was considered to be the landed bycatch of groundfish from the ocean shrimp fisheries.

Salmon

Salmon in commercial troll and recreational fisheries are mainly discarded for three reasons: 1) Regulatory discards of salmon that are below the legal size limit; 2) Regulatory discards of legal sized fish in directed fisheries for other species (i.e., coho caught in chinook-directed fisheries); and 3) Discards of non-marked fish in mark-selective fisheries which allow only for the retention of hatchery fish. Estimates of bycatch mortality (in numbers of fish) from commercial troll and recreational salmon fisheries are available in the PFMC Stock Assessment and Fishery Evaluation (SAFE) reports from 1999-2014 (PFMC 2000-2014). These reports provide estimates of discards and apply a post-release mortality rate to estimate the portion of dead discards (Supplementary Materials Table S11).

We summed the total annual discards and landings for recreational and commercial sectors and divided total discards by total landings to derive *D/L* ratios for the coho and chinook targeted fisheries. Coho landings were reported for mark-selective and incidental discards for select areas, and were carefully assessed to avoid double counting of landings when estimating *D/L* ratios for all discards. We took the median value of these *D/L* ratios (Supplementary Materials Table S10), and multiplied these by the commercial troll landings (obtained from the NMFS database) and reconstructed recreational landings of coho and chinook to estimate discards from the salmon

fisheries for earlier years where no discard estimates were available. As we had no way of distinguishing between fish caught in mark-selective fisheries, we applied the *D/L* values calculated from total discards.

The *D/L* ratios are similar in range to those estimated by Harrington et al. (2005) and PSC (2011) for salmon fisheries on the Pacific west coast during the same time period. We believe that these are reasonable estimates, and that our total salmon discards are conservative given that we do not include discards from salmon fisheries using gillnets, seines, and other gears, which account for nearly half of NMFS commercial coho and chinook landings. We assumed average fish weights of 5.5 kg and 2.4 kg for chinook and coho discards, respectively, (based on RecFIN mean weights of released fish from 2004-2010 for Washington) to convert the 1999-2014 PFMC discards into weights.

Supplementary Materials Table S11: Discards to landings ratios (*D/L*) for coho and chinook salmon fisheries in U.S. West Coast waters, based on discard mortality and landings estimates from PFMC SAFE reports for 1999-2012.

Fishery and discard type	Years with data	Median *D/L*	Range
Chinook:			
Commercial troll - incidental	2001-2012	0.18[a]	0.12 - 0.33
Recreational - incidental	2000-2012	0.12	0.10 - 0.20
Recreational - mark selective	2003-2012	0.56	0.14 - 0.99
Recreational - all discards	2000-2012	0.14[a]	0.10 - 0.34
Coho:			
Commercial troll - incidental	2000-2012	0.39	0.13 - 1.85
Commercial troll - mark selective	2000-2012	0.39	0.14 - 12.15
Commercial troll - all discards	2000-2012	0.43[a]	0.17 - 2.69
Recreational - incidental	2000-2012	0.25	0.14 - 0.42
Recreational - mark selective	1999-2012	0.23	0.10 - 0.38
Recreational - all discards	1999-2012	0.43[a]	0.12 - 0.64

[a] Denotes values applied to landings to estimates discards for earlier years

Non-salmon recreational fisheries

In general, it is believed that there are low discards in the recreational sector and that discards are composed mainly of unwanted species, such as sharks (PFMC 2011a) and under-sized fish (Harrington et al. 2005). Estimates of discards are recorded in the RecFIN database in two ways: 1) So-called *B1* catch; fish that are released dead, used for bait or filleted on board; and 2) So-called *B2* catch; fish that are released alive. The *B1* catch estimates were included in the recreational landings estimates, as it was not possible to disaggregate dead discards from filleted or bait fish.

Estimates of fish that are released alive (*B2*) by recreational anglers are available from 1980-1989 and 1993-2014 from the RecFIN database. Estimates by weight and the number of released fish are available from 2004-2014, while estimates from 1980-1989 and 1993-2003 include only the number of released fish. Average weights of different species or higher order taxa of released fish are available by year and state from 2004-2014. We used the mean average weights from 2004-2014 for specific taxa to convert the 1980-2003 estimates from numbers of released fish into weights. State specific mean weights of released fish were used where available, and when not available, we used the mean weight for total west coast landings. This is an important distinction

as anglers are likely to discard smaller fish than those landed and thus one would expect the mean weights of landed fish to be larger. This is not expected to have substantially influenced our results given that the portion of total *B2* catch that was converted this way accounted for only 1% of our total estimated weight of discards from 1981-2003. We excluded the data from 1980, as estimates for this year were over 20 times the average from 1981-2003.

We then applied post-release mortalities to estimate the portion of released fish (*B2*) that do not survive. Discard mortalities vary by species depending on a variety of factors such as gear type, handling and release techniques, playing time, hook size, hook type, fish size, water temperature, and capture depth. A meta-analysis of 274 catch-and-release mortality estimates for 48 species targeted by recreational fisheries in the U.S. found estimates ranging from 0% to 95% (Muoneke and Childress 1994; Bartholomew and Bohnsack 2005). Given these factors, we recognize that there is large uncertainty with estimating post-release survival rates that may apply to West Coast recreational fisheries. Nevertheless, estimates of post-release mortality were compiled, and, where available, we applied species-specific post-release mortality rates for hook and line fisheries to the major taxa discarded by recreational fisheries. When these data were not available, we used a median post-release mortality value of 11% for teleost species, obtained from Bartholomew and Bohnsack (2005) and Muoneke and Childress (1994).

With the exception of leopard sharks, we were able to find species-specific post-release mortality estimates for hook and line fisheries for major elasmobranch species that were present in RecFIN *B2* discards.

For skate and ray species, we found no studies estimating post-release discard mortality from hook and line fisheries, however several studies estimating post-release mortality from trawling (Laptikhovsky 2004; Enever et al. 2009) and gillnet fisheries (Braccini et al. 2012). We applied the post-release mortality rates from Braccini et al. (2012) for the Southern eagle ray (*Myliobatis australis*) to bat rays, as these species are from the same genus, and used the median value from the three Batoidea species in this study (7%) to estimate discard mortalities for other skate and ray species. We found no estimates of post-release mortalities for chimaeras from recreational fisheries, and thus we also applied the 11% median value for teleosts to spotted rattail (*Hydrolagus colliei*).

Using these estimates of post-release mortality from 1981-1989 and reconstructed estimates of recreational fisheries, we calculated an average annual *D/L* ratio for each state (Supplementary Materials Table S12). The landings denominator included all recreational non-salmon fish catch, i.e., excluding shellfish and crustacean taxa (Supplementary Materials Table S12). We then multiplied these ratios by the reconstructed recreational ocean fish landings for each state, to estimate the portion of dead catch-and-release catches from 1950-1980 and 1990-1992 (1990-1995 for Washington). Discards for Washington from 2004-2014 do not include spotted spiny dogfish, which is the most commonly discarded species, contributing 71% of total discards in Washington from 1980-2003. The average annual *D/L* ratio from 1981-2003 for spotted spiny dogfish in Washington is 0.07 (ranging between 0.02-0.13), and we used this ratio to estimate dogfish discards from 2004 onwards.

Supplementary Materials Table S12: Average discard to landings ratios (*D/L*) for non-salmon U.S. West Coast recreational fisheries in California, Oregon and Washington.

State	Average *D/L* (total discards)	Range	Average *D/L* (dead discards only)[a]	Range
California	0.50	0.25-0.73	0.06	0.03-0.09
Oregon	0.09	0.05-0.13	0.01	0.01-0.01
Washington	0.35	0.19-0.75	0.07	0.03-0.14

[a] These D/L ratios were calculated using dead discards as the numerator, which were estimated using post-release mortality rates.

Highly migratory and small pelagic species

Estimates of discards from highly migratory species such as tunas and swordfish are not included in this study, as these wide–ranging, ocean-basin scale fisheries are examined in a separate, global study (Le Manach et al. 2016; Coulter et al. 2020). The important tuna landings (yellowfin, skipjack and albacore) are caught primarily by trolling and purse seines gears, which generally are not associated with high discards (Kelleher 2005). Although not included in our estimate, discard rates for swordfish drift gillnet and longline fisheries are among the highest discard rates observed for U.S. fisheries, and it is likely that they make up an important portion of actual total discards (Morgan and Chuenpagdee 2003).

Small pelagic species occupy a substantial portion of the total NMFS commercial landings: Pacific sardine (*Sardinops sagax;* 9%), California market squid (*Loligo opalescens*; 7%), California anchovy (*Engraulis morda;* 6%), jack mackerel (*Trachurus symmetricus;* 4%), chub mackerel (*Scomber japonicas*; 3%), Pacific herring (*Clupea pallasii pallasii*; 1%), and Pacific bonito (*Sarda chiliensis lineolata*; 1%). Fisheries targeting these species use roundhaul gear such as purse seines or lampara nets (Harrington et al. 2005; PFMC 2011b). Discards and bycatch are generally low for coastal pelagic species due to the gear used in these fisheries and the most common bycatch are other coastal pelagic species (Harrington et al. 2005). Bycatch of non-prohibited larger species are often retained for personal use or commercial sale (PFMC 2011b). If not retained, larger fish can often be released by lowering a portion of the net or using a dip net (Harrington et al. 2005; PFMC 2011b), and are here assumed to survive.

General comments on discards

Discard estimates have mostly been derived in the last decade, but in contrast to recreational and commercial landings, there is no central reporting database for discards along the U.S. West Coast. It would appear that since at least 2005 (earlier for some fisheries), most major sources of discards along the U.S. West Coast are being accounted for by the various management agencies for assessments and management actions. We attempted to consider these changes in our discard estimates; however, we acknowledge that there is considerable uncertainty for many years in which data are limited, e.g., prior to 1979, where we found zero records of discard or bycatch information. Most discard estimates available do not specify the uncertainty involved therein.

REFERENCES

Aalbers SA, Stutzer GM and Drawbridge MA (2004) The effects of catch-and-release angling on the growth and survival of juvenile white seabass captured on offset circle and J-type hooks. North American Journal of Fisheries Management 24(3): 793-800.

Ainsworth JC and Vance M (2009) Recreational shellfish catch and effort surveys in Oregon estuaries. Oregon Department of Fish and Wildlife, Marine Resources Program, Newport, OR. 1 p. Available at: http://www.dfw.state.or.us/mrp/shellfish/docs/Ainsworth_Vance_Rec_catch_effort.pdf [Accessed: August 10, 2013].

Ainsworth JC, Vance M, Hunter MV and Schindler E (2012) The Oregon recreational dungeness crab fishery, 2007-2011. Information reports # 2012-04, Fish Division, Oregon Department of Fish and Wildlife, Newport, OR. 62 p.

Bartholomew A and Bohnsack JA (2005) A review of catch-and-release angling mortality with implications for no-take reserves. Reviews in Fish Biology and Fisheries 15(1-2): 129-154.

Bellman MA, Al-Humaidhi AW, Jannot J and Majewski J (2011) Estimated discard and catch of groundfish species in the 2010 U.S. west coast fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Services. NWFSC, Seattle, WA. 56 p.

Bellman MA, Al-Humaidhi AW, Jannot J and Majewski J (2012) Estimated discard and catch of groundfish species in the 2011 U.S. west coast fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Services. NWFSC, Seattle, WA. 59 p.

Bellman MA and Heery E (2013) Discarding and fishing mortality trends in the U.S. West Coast groundfish demersal trawl fishery. Fisheries Research 147(0): 115-126.

Bellman MA, Heery E and Hastie J (2008) Estimated discard and total catch of selected groundfish species in the 2007 U.S. west coast fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Services. NWFSC, Seattle, WA. 77 p.

Bellman MA, Heery E, Jannot J and Majewski J (2010a) Estimated discard and total catch of selected groundfish species in the 2009 U.S. west coast fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Services. NWFSC, Seattle, WA. 81 p.

Bellman MA, Heery E and Majewski J (2010b) Estimated discard and total catch of selected groundfish species in the 2008 U.S. west coast fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Services. NWFSC, Seattle, WA. 76 p.

Bellman MA, Jannot J, Mandrup M and McVeigh J (2013) Estimated discard and catch of the groundfish species in the 2012 U.S. west coast fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Services. NWFSC, Seattle, WA. 59 p.

Blood C (1992-2009) Sport fishery. *In* IPHC report of assessment and research activities 1992-2009. International Pacific Halibut Commission (IPHC), Seattle, WA.

Braccini M, Van Rijn J and Frick L (2012) High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? PloS one 7(2): e32547.

Bradbury A, Blake B, Speck C and Rogers D (2005) Length-weight models for intertidal clams in Puget sound (Bivalve regions 1, 5, 6, 7, and 8). Washington Department of Fish and Wildlife. vii + 62 p.

Bullimore BA, Newman PB, Kaiser MJ, Gilbert SE and Lock KM (2001) A study of catches in a fleet of "ghost-fishing" pots. Fish. Bull. 99(2): 247-253.

Caroll JC (1982) Seasonal abundance, size composition, and growht of rock crab, *Cancer antennarius* Stimpson off Central California. Journal of crustacean biology 2(4): 549-561.

CDFG (2001) Recreational catch - Nearshore finfish. pp. 269-272 *In* Leet WS, Dewees CM, Klingbeil R and Larson E (eds.), California's living marine resources: A status report. California Department of Fish and Game (CDFG).

CDFG (2010) Abalone recovery and management plan status report - Northern California red abalone fishery. Marine Region Invertebrate Management Project, State of California, The Resources Agency Department of Fish and Game. 24 p.

Chadwick HK (1962) Catch record from the Striped bass sportfishery in California. California Fish and Game 48(3): 153-177.

Clark JR (1960) The 1960 salt-water angling survey. Fish and Wildlife Service, United States Department of the Interior. iv+36 p.

Collins R, Huppert D, Maccall A, Radovich J and Stauffer G (1980) Pacific bonito management information document. Marine Resourcres Technical Report No. 44, Resources Agency - California Department of Fish & Game. 93 p.

Coulter A, Cashion T, Cisneros-Montemayor AM, Popov S, Tsui G, Sy E, Le Manach F, Palomares MLD, Zeller D and Pauly D (2020) Using harmonized historical catch data to infer the expansion of global tuna fisheries. Fisheries Research 221: 105379.

Crapo C, Paust B and Babbitt J (2004) Recoveries and yields from Pacific fish and shellfish. Marine Advisory Bulletin No. 37. School of fisheries & Ocean Sciences, University of Alaska Fairbanks.

Crone PR, Hill KT, McDaniel JD and Lo NCH (2009) Pacific mackerel (*Scomber japonicus*) stock assessment for USA management in the 2009-10 fishing year. Pacific Fishery Management Council (PFMC), Portland, OR. 197 p.

Demory RL, Barss WH, Golden JT and Robinson JG (1980) Groundfish assessment, regional planning - Pacific ocean perch, other rockfish, lingocd and english sole tagging, and shrimp abundance- by-catch studies. Oregon Department of Fish and Wildlife (ODFW). VI + 41 p.

Doherty B, Harguth H, McCrea-Strub A, Jenkins LD and Figueira WF (2015) Reconstructing catches along Highway 101: Historic catch estimates for marine fisheries in California, Oregon and Washington from 1950-2010. Fisheries Centre Working Paper #2015-81, University of British Columbia, Vancouver. 64 p.

Dunstan D, Tsui G, Chu E, Cashion T, Derrick B, Doherty B, Harguth H, McCrea Strub A, Figueira W, Jenkins LD and Relano V (2020) Marine fisheries catch reconstructions for the continental USA: update to 2018. pp. 144-158 *In* Derrick B, Khalfallah M, Relano V, Zeller D and Pauly D (eds.), Updating to 2018 the 1950-2010 marine catch reconstructions of the *Sea Around Us*. Part II: The Americas and Asia-Pacific. Fisheries Centre Research Reports 28(6), Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, Canada.

Enever R, Catchpole T, Ellis J and Grant A (2009) The survival of skates (Rajidae) caught by demersal trawlers fishing in UK waters. Fisheries Research 97(1): 72-76.

Figueira WF and Coleman CF (2010) Comparing landings of the United States recreational fishery sectors. Bulletin of Marine Science 86(3): 499-514.

Frey HW, editor (1971) California's living marine resources and their utilization. Department of Fish and Game, The Resources Agency, State of California. 148 p.

Gaumer T (1984) 1983 clam studies. Information report 84-14, Fish division, Oregon Department of Fish and Wildlife, Newport, OR. 52 p.

Gertseva VV and Schirripa MJ (2008) Status of the longnose skate (*raja rhina*) off the continental US Pacific coast in 2007. Pacific Fishery Management Council. 131 p. Available at: http://www.pcouncil.org/groundfish/stock-assessments/by-species/longnose-skate/ [Accessed: May 24, 2013].

Gilroy HL and Hare SR (2012) Wastage of halibut in the commercial halibut fishery. pp. 53-60 *In* IPHC Report of Assessment and Research Activities 2011. International Pacific Halibut Commission (IPHC).

Guel DG (1973) 1970 salt-water angling survey. Current fishery statistics No. 6200, US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Washington, D.C.

Guel DG and Clark JR (1968) The 1965 salt-water angling survey. Resource Publication 67, Bureau of Sport Fisheries and Wildlife, Washington, D.C. 50 p.

Haaker PL, Karpov K, Rogers-Bennett L, Taniguchi I, Friedman CS and Tegner M (2001) Abalone. pp. 89-97 *In* California's living marine resources: A status report. California Department of Fish and Game (CDFG).

Haaker PL, Taniguchi I, O'Leary JK, Karpov K, Patyten M and Tegner M (2004) 8. Abalones. pp. 8.1-8.15 *In* Ryan C and Patyten M (eds.), Annual status of the Fisheries report through 2003. California Department of Fish and Game (CDFG).

Hankin D, Warner R, Coller P and Ryan C (2004) 6. Dungeness crab. pp. 6.1-6.13 *In* Ryan C and Patyten M (eds.), Annual status of the Fisheries report through 2003. California Department of Fish and Game (CDFG).

Hannah RW and Jones SA (2000) By-catch reduction in an ocean shrimp trawl from a simple modification to the trawl footrope. Journal of Northwest Atlantic Fishery Science 27: 227-233.

Hannah RW and Jones SA (2007) Effectiveness of bycatch reduction devices (BRDs) in the ocean shrimp (*Pandalus jordani*) trawl fishery. Fisheries Research 85: 217-225.

Hannah RW, Jones SA and Hoover VJH (1996) Evaluation of fish excluder technology to reduce finfish bycatch in the ocean shrimp trawl fishery. Information reports 96, Oregon Department of Fish and Wildlife. III + 46 p.

Hare SR (2012) Assessment of the Pacific halibut stock at the end of 2011. pp. 91-194 *In* IPHC Report of Assessment and Research Activities 2011. International Pacific Halibut Commission (IPHC).

Harrington JM, Myers RA and Rosenberg AA (2005) Wasted resources: Bycatch and discards in U.S. Fisheries. MRAG Americas, Inc. 286 p.

Hastie J and Bellman MA (2006) Estimated 2005 discard and total catch of selected groundfish species. West Coast Groundfish Observer Program. National Marine Fisheries Services. NWFSC, Seattle, WA. 30 p.

Hastie J and Bellman MA (2007) Estimated 2006 discard and total catch of selected groundfish species. West Coast Groundfish Observer Program. National Marine Fisheries Services. NWFSC, Seattle, WA. 36 p.

Heberer C, Aalbers S, Bernal D, Kohin S, DiFiore B and Sepulveda C (2010) Insights into catch-and-release survivorship and stress-induced blood biochemistry of common thresher sharks (< i> Alopias vulpinus</i>) captured in the southern California recreational fishery. Fisheries Research 106(3): 495-500.

Hight BV, Holts D, Graham JB, Kennedy BP, Taylor V, Sepulveda CA, Bernal D, Ramon D, Rasmussen R and Lai NC (2007) Plasma catecholamine levels as indicators of the post-release survivorship of juvenile pelagic sharks caught on experimental drift longlines in the Southern California Bight. Marine and freshwater research 58(1): 145-151.

Hill KT and Schneider N (1999) Historical logbook databases from California's commercial passenger fishing vessel (partyboat) fishery 1936-1997. SIO reference, Scripps Institution of Oceanography, University of California, San Diego. v + 13 p.

Hirschhorn G (1962) Growth and mortality rates of the razor clam (*siliqua patual*) on Clatsop beaches, Orgeon. Contribtuion No. 27, Fish Commission of Oregon, Portland, OR. 55 p.

Hobday AJ and Tegner M (2000) Statues review of white abalone (*Haliotis sorenseni)* throughout its range in California and Mexico. NOAA Technical Memorandum NMFS, US Department of Commerce, NOAA, NMFS, Southwest Region Office. x + 90 p.

Holts D (1985) Recreational albacore, *Thunnus alalunga*, fishery by U.S. west coast commercial passenger fishing vessels. Marine Fisheries Review 47(3): 48-53.

Hunter MV (2008) 2006 Clatsop beach razor clam fishery status report. Shellfish/Estuarine Habitat Projects Data Report, Oregon Department of Fish and Wildlife, Marine Resources Program, Astoria, OR. 17 p.

INPFC (1979) Bulletin number 39: Historical catch statistics for salmon of the North Pacific Ocean. International North Pacific Fisheries Commission (INPFC) Secretariat, Vancouver, BC.

Jannot J, Somers K, Riley NB and McVeigh J (2014) Pacific Halibut Bycatch in US West Coast Fisheries (2002-2013). NOAA Fisheries, NWFSC Observer Program, Seattle, WA. 75 p.

Jannot JE, Al-Humaidhi AW, Bellman MA, Riley NB and Majewski J (2012) Pacific halibut bycatch in the US west coast IFQ groundfish fisheries (2011) and non-IFQ groundfish fisheries (2002-2011). NOAA Fisheries, NWFSC Observer Program, Seattle, WA. 62 p.

Kaimmer S (2015) 2014 Halibut sport fishery review. pp. 37-46 *In* IPHC report of assessment and research activities 2014. International Pacific Halibut Commission (IPHC), Seattle, WA.

Kelleher K (2005) Discards in the world's marine fisheries. An update. FAO Fisheries Technical Paper 470, Food and Agriculture Organization, Rome. 131 p.

Laptikhovsky VV (2004) Survival rates for rays discarded by the bottom trawl squid fishery off the Falkland Islands. Fish. Bull 102: 757-759.

Lauzier RB, Hand CM, Campbell A and Heizer S (1998) A Review of the biology and fisheries of horse clams (*Tresus capax* and *Tresus nuttallii*). Canadian Stock Assessment Secretariat Research Document 98/88, Fisheries and Oceans Canada. 28 p.

Le Manach F, Chavance P, Cisneros-Montemayor AM, Lindop A, Padilla A, Schiller L, Zeller D and Pauly D (2016) Global catches of large pelagic fishes, with emphasis on the High Seas. pp. 34-45 *In* Pauly D and Zeller D (eds.), Global Atlas of Marine Fisheries: A critical appraisal of catches and ecosystem impacts. Island Press, Washington, D.C.

Link T (2000) History and status of Oregon's Pacific razor clam resources. Information Reports 2000-06, Oregon Department of Fish and Wildlife, Marine Resources Program, Astoria, OR. 25 p.

Mandelman JW and Farrington MA (2007) The estimated short-term discard mortality of a trawled elasmobranch, the spiny dogfish (*Squalus acanthias*). Fisheries Research 83(2): 238-245.

Mckechnie RJ and Miller LW (1971) The Striped bass party boat fishery: 1960-1968. California Fish and Game 57(1): 4-16.

McLean JH (1978) Marine shells of Southern California. Natural History Museum of Los Angeles County.

McVeigh BAB, Geibel JJ and Kalvass PE (2010) Sport clamming in Humboldt bay, California during 2008: Comparisons with historical survey data. California Fish and Game 96. 242-255 p.

Mello JJ (1981) A one-year survey of recreational clamming on the Morro Bay mud flats for the period of April, 1979 to March, 1980. Cal-Nevada Wildlife Transactions 1981, Department of Biological Sciences, California Polytechnic State University, San Luis Obispo, CA. 62-67 p.

Miller DJ and Gotshall D (1965) Ocean sport fish catch and effort from Oregon to Point Aruello, California July 1, 1957-June 30, 1961. Fish Bulletin 130, California Department of Fish and Game. 135 p.

Moore TO (2001a) Gaper clams. pp. 445-446 *In* Leet WS, Dewees CM, Klingbeil R and Larson E (eds.), California's living marine resources: A status report. California Department of Fish and Game (CDFG).

Moore TO (2001b) Pacific Razor clams. pp. 443-448 *In* Leet WS, Dewees CM, Klingbeil R and Larson E (eds.), California's living marine resources: A status report. California Department of Fish and Game (CDFG).

Moore TO (2001c) Washington clams. pp. 447-448 *In* Leet WS, Dewees CM, Klingbeil R and Larson E (eds.), California's living marine resources: A status report. California Department of Fish and Game (CDFG).

Morgan L and Chuenpagdee R (2003) Shifting gears: Adressing the collateral impact of fishing methods in U.S. waters. Pew Science Series, The Pew Charitable Trusts. 42 p.

Muoneke MI and Childress WM (1994) Hooking mortality: a review for recreational fisheries. Reviews in Fisheries Science 2(2): 123-156.

Musyl MK, Brill RW, Curran DS, Fragoso NM, McNaughton LM, Nielsen A, Kikkawa BS and Moyes CD (2011) Postrelease survival, vertical and horizontal movements, and thermal habitats of five species of pelagic sharks in the central Pacific Ocean. Fishery Bulletin 109(4): 341-368.

Neilson D (2011) Assessment of the California spiny lobster (*Panulirus interruptus*). California Department of Fish and Game (CDFG), San Diego, CA. 138 p.

Nelson Jr. RE (1985) Historical review of the coastal Pacific whiting, *Merluccius productus*, fishery. Marine Fisheries Review 47(2): 39-41.

ODFW (1977) 1977 Annual report - Fisheries. Oregon Department of Fish and Wildlife (ODFW), Fisheries Division. x + 147 p.

Pattison C and Lampson K (2008) Pismo clam. pp. 6.1-6.11 *In* Barsky K (ed.), Status of the fisheries report - an update through 2006. California Department of Fish and Game, Marine Region.

PFMC (1993) Historical ocean salmon fishery data for Washington, Oregon and California. Pacific Fishery Management Council (PFMC), Portland, Oregon. 259 p.

PFMC (2000-2014) Review of 1999-2014 ocean salmon fisheries: Stock assessment and fishery evaluation document for the Pacific coast salmon fishery management plans.15 separate reports, Pacific Fishery Management Council (PFMC), Portland, OR.

PFMC (2011a) Appendix C: Bycatch in HMS fisheries. p. 51 *In* Fisheries management plan for U.S. west coast fisheries for highly migratory species. Pacific Fishery Management Council (PFMC), Portland, OR.

PFMC (2011b) Status of the Pacific coast coastal pelagic species fishery and recommended acceptable biological catches. Stock assessment and fishery evaluation - 2011. Pacific Fishery Management Council (PFMC), Portland, OR. 85 p.

PFMC (2013) Historical data of ocean salmon fisheries "blue book" - Review Appendix A. Pacific Fishery Management Council (PFMC). Available at: http://www.pcouncil.org/salmon/background/document-library/historical-data-of-ocean-salmon-fisheries/ [Accessed: December 19, 2013].

PFMC and NMFS (2009) Proposed acceptable biological catch and optimum yield specifications and management measures for the 2009-2010 Pacific coast groundfish fishery. Final environmental impact statement including regulatory impact review and initial regulatory flexibility analysis, Pacific Fishery Management Council (PFMC), National Marine Fisheries Service (NMFS), Portland, OR. xlii + 615 p.

Pikitch EK, Erickson DL and Wallace JR (1988) An evaluation of the effectiveness of trip limits as a management tool. NWAFC processed report 88-27, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, WA. 33 p.

Pinkas L, Gates DE and Frey W (1974) California marine fish landings for 1972 and designated common names of certain marine organisms of California. Fish Bulletin 161, California Department of Fish and Game.

PSC (2011) Development of the technical basis for a chinook salmon total mortality management regime for the PSC AABM fisheries. Pacific salmon commission (PSC) - Joint chinook technical committee. xxi + 198 p.

Ralston S, Pearson DE, Field JC and Key M (2010) Documentation of the California catch reconstruction project. NOAA Technical Memorandum NMFS NOAA-TM-NMFS-SWFSC-461, NOAA, NMFS, Southwest Fisheries Science Center. 80 p.

Robichaud D, English K, Bocking R and Nelson T (2006) Direct and delayed mortality of white sturgeon caught in three gear-types in the lower Fraser River. Report prepared for Tsawwassen First Nation Fisheries, , LGL Limited. iv + 44 p.

Schindler E, Freeman M and Wright B (2012) Sampling design of the Oregon Department of Fish and Wildlife's Ocean Recreational Boat Survey (ORBS). Marine resources program, ODFW. 27 p.

Skud BE (1975) The sport fishery for halibut: Development, recognition and regulation. Technical report No. 13, International Pacific Halibut Commission, Seattle, WA. 19 p.

Somers KA, Bellman M, Jannot J, Riley N and McVeigh J (2014) Estimated discard and catch of groundfish species in the 2013 U.S. west coast fisheries. NWFSC Observer Program, NOAA Fisheries, Seattle, WA. 69 p.

Spratt JD (1982) Results of sampling clammers in Elkhorn slouch during 1978 and 1979. Administrative Report No. 82-11, California Department of Fish and Game, Marine Resources, Monterey, CA. ii + 12 p.

Stevens DE (1977) Striped bass (*Morone saxatilis*) monitoring techniques in the Sacramento-San Joaquin Estuary. *In* Van Winkle W (ed.), Proceedings of the conference on assessing the effects of power-plant-induces mortality on fish populations, May 3-6, 1977, Gatlinburg, Tennessee. 91-109 p.

Stewart IJ, Thorson JT and Wetzel C (2011) Status of the U.S. sablefish resource in 2011. National Marine Fisheries Service, Seattle. WA. 442 p.

Wendell FE, Hardy RA, Ames JA and Burge R (1986) Temporal and spatial patterns in sea otter, *Enhydra lutris*, range expansion and in the loss of pismo clam fisheries. California Fish and Game 72(4): 197-212.

Weymouth FW (1922) The life-history and growth of the pismo clam (*Tivela stultorum mawe*). Fish bulletin 7, California Department of Fish and Game. 120 p. Available at: http://www.oac.cdlib.org/view?docId=kt3w100324&query=&brand=oac4 [Accessed: September 15, 2013].

White JR (1986) The Striped bass sport fishery in the Sacramento-San Joaquin Estuary, 1969-1979. California Fish and Game 72(1): 17-37.

Williams G (2010) 2009 Halibut sport fishery review. pp. 53-62 *In* IPHC report of assessment and research activities 2009. International Pacific Halibut Commission (IPHC), Seattle, WA.

Williams G (2011) 2010 Halibut sport fishery review. pp. 43-50 *In* IPHC report of assessment and research activities 2010. International Pacific Halibut Commission (IPHC), Seattle, WA.

Williams G (2012a) 2011 Halibut sport fishery review. pp. 45-52 *In* IPHC report of assessment and research activities 2011. International Pacific Halibut Commission (IPHC), Seattle, WA.

Williams G (2012b) Incidental catch and mortality of Pacific Halibut, 1962-2012. pp. 315-336 *In* IPHC Report of Assessment and Research Activities 2011. International Pacific Halibut Commission (IPHC).

Williams G (2013) 2012 Halibut sport fishery review. pp. 43-52 *In* IPHC report of assessment and research activities 2012. International Pacific Halibut Commission (IPHC), Seattle, WA.

Williams G (2014) 2013 Halibut sport fishery review. pp. 37-48 *In* IPHC report of assessment and research activities 2013. International Pacific Halibut Commission (IPHC), Seattle, WA.

Young PH (1969) The California partyboat fishery 1947-1967. Fish Bulletin 145, California Department of Fish and Game, UC, San Diego. 91 p.

Zeller D, Palomares MLD, Tavakolie A, Ang M, Belhabib D, Cheung WWL, Lam VWY, Sy E, Tsui G, Zylich K and Pauly D (2016) Still catching attention: *Sea Around Us* reconstructed global catch data, their spatial expression and public accessibility. Mar. Policy 70: 145-152.