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Alaska Department of Fish & Game Statewide Rockfish Initiative

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Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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by

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The Special Publication series was established by the Division of Sport Fish in 1991 for the publication of techniques and procedures manuals, informational pamphlets, special subject reports to decision-making bodies, symposia and workshop proceedings, application software documentation, in-house lectures, and became a joint divisional series in 2004 with the Division of Commercial Fisheries. Special Publications are intended for fishery and other technical professionals. Special Publications are available through the Alaska State Library, Alaska Resources Library and Information Services (ARLIS) and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and peer review

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ABSTRACT

Currently there are no overarching management or assessment strategies for black rockfish *Sebastes melanops* or yelloweye rockfish *S. ruberrimus* across the Gulf of Alaska. Alaska Department of Fish and Game's management of these species has been largely area- or region-specific and management has not been well coordinated across fishery divisions. Guideline harvest levels are used for managing commercial fisheries; however, these are applied to management areas rather than populations and are primarily based on levels of historical harvest. Sport fisheries are managed to constrain harvest levels (e.g., bag limits), but typically without an adequate understanding of how those harvest levels translate to exploitation rates of populations. Because rockfish are known to be particularly vulnerable to exploitation, and harvests are believed to be increasing in recent years, proactive measures are needed to ensure long term sustainability of these fisheries. In 2017, the Alaska Department of Fish and Game initiated an interdivisional, statewide initiative focused on developing long-term management and assessment strategies for these 2 species. This report describes the need to develop comprehensive management strategies for black and yelloweye rockfishes, provides information on the basic biology and ecology of each species, and summarizes historical and current management and assessment throughout the Gulf of Alaska. This report also summarizes progress to date to develop sustainable management strategies, including the outcomes of multiple workshops attended by management and research staff involved in rockfish fisheries. The goal of the workshops and future efforts is to develop long-term collaborative management strategies that support stable populations and sustainable black and yelloweye rockfish fisheries across the Gulf of Alaska.

Key words: black rockfish, *Sebastes melanops*, yelloweye rockfish, *Sebastes ruberrimus*, stock assessment, harvest control rule, spawning potential ratio, management strategy, distribution, fishing mortality, fisheries management, growth, life history, movement, natural mortality, reproduction, workshop

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) has primary management authority for black rockfish *Sebastes melanops* and yelloweye rockfish *S. ruberrimus* in state waters of Alaska (0–3 nmi) and for black rockfish in federal waters (3–200 nmi) of the Gulf of Alaska (GOA). Both species are harvested in commercial, sport, personal use, and subsistence fisheries, with management responsibility delegated by region and division. Divisions often have overlapping geographical boundaries, but with differing management plans, management tools, and data collection methods. For most fisheries, historical harvests prior to the 1980s were not recorded. Management strategies between regions and divisions have evolved independently of each other based on fishery needs: currently there are no overarching management strategies for these 2 species. For example, the Division of Commercial Fisheries has developed guideline harvest levels (GHLs) in each region based largely on levels of historical harvest, whereas Division of Sport Fish has taken management actions (e.g., reduced daily bag limits), but has no documented management strategies.

Over 30 species of rockfish *Sebastes* inhabit the GOA. Rockfish are often characterized into assemblage by shared ecological characteristics. Black rockfish are included in the pelagic shelf rockfish (PSR) assemblage, and yelloweye rockfish are typically associated with the demersal shelf rockfish (DSR) assemblage. PSR are typically associated with nearshore, rocky reef areas, and may exhibit a midwater schooling behavior (Rumble et al. 2017). DSR are associated with rocky reef areas, tend to be bottom dwelling, and often occur at greater depths than PSR species (Bechtol 2000). Key life history characteristics differ between the 2 assemblages; DSR typically have greater longevity, older age at sexual maturity, and stricter site fidelity than PSR (Blain-Roth et al. 2017). However, both assemblages share the same physiological characteristics, including a physoclistic (closed) swim bladder that often leaves them susceptible to barotrauma and its associated injuries when brought to the surface.

Rockfish species have life history characteristics that make them vulnerable to overexploitation, necessitating thoughtful consideration of sustainable management of these species. For example, yelloweye rockfish was declared overfished in Washington, Oregon, and California in 2002 (Wallace et al. 2005). Wallace (2001) estimated that once yelloweye rockfish populations were depleted, populations in Northern California will take 25 years to rebuild—with no fishing. A lack of information regarding black and yelloweye rockfish populations in the GOA, combined with concerns over increasing harvest numbers, prompted ADF&G staff to advocate for development of holistic management strategies. Rather than create area- and fishery-specific strategies that might conflict, it was important to gather staff from across the GOA into an interdivisional effort to pool information, identify management goals, and address research needs.

The *ADF&G Statewide Rockfish Initiative* (Initiative) was launched in 2017 as an interdivisional, statewide effort focused on developing long-term collaborative management strategies for black and yelloweye rockfishes. A Leadership Planning Team (LPT) made up of representation from sport and commercial fisheries across GOA regions was assembled in summer 2017. To facilitate collaborative development of management strategies, the LPT decided to host a series of in-person workshops, as well as other supporting activities. Initial phases of the Initiative have included assessing the state of knowledge of black and yelloweye rockfishes in the GOA, developing statewide management priorities, sharing existing data between regions and divisions, identifying key data gaps, and generating draft management objectives. As this work continues, staff will develop more detailed management objectives and make progress on filling data gaps.

This publication serves as 1 method for tracking shared learning and progress as interdivisional management and assessment strategies are developed. This report is also intended to summarize both the current state of knowledge and the historic and current management and assessment of GOA black and yelloweye rockfishes. Although all acronyms and abbreviations are introduced on first mention, a reference table is provided (Appendix A1).

ROCKFISH LIFE HISTORY, ECOLOGY, AND BIOLOGY

BLACK ROCKFISH

Species Range

Black rockfish range from California to Alaska, are found as far west as Amchitka Island in the Aleutian Islands (Hart 1973; Love et al. 2002; Mecklenburg et al. 2002), and have been recorded as far north as the Pribilof Islands in the Bering Sea (Berkeley et al. 2004; C. Worton, Commercial Fisheries Biologist, ADF&G, Kodiak, personnel communication).

Habitat preference

Black rockfish primarily inhabit shallow nearshore rocky areas of 73 m or less but have been recorded to depths of 366 m (Butler et al. 2012). Juvenile young-of-year black rockfish settle out of the water column into shallow nearshore habitats of eelgrass, algae, and in kelp beds, and then migrate into rocky areas as they mature (Butler et al. 2012) Adults generally school over high-relief rocky habitats amid the kelp beds that grow within rocky areas. As a pelagic species, they occupy the ocean bottom and spend time throughout the water column, and their extensive diurnal vertical movements are tightly linked to sunrise and sunset (Parker et al. 2007).

Movement

Although tagging studies have documented individual black rockfish miles offshore (Culver 1986; Ayres 1988), the majority of black rockfish have strong associations to specific nearshore sites (Parker et al. 2007; Greene and Starr 2011). Tagging studies in Oregon have demonstrated small home ranges (0.55 km^2) with individuals living in restricted areas for long periods, and suggested that longer absences are linked to reproductive season because females are absent significantly more in the winter months (Parker et al. 2007). Tagging studies in Alaska have shown comparable patterns of high site fidelity, with small home ranges, short absences (77% of black rockfish were absent less than 10 days in length), with fish returning to the same area where they were tagged (Worton 2008a). Some movements are most likely linked to finding food resources.

Size, demographics, and growth

Black rockfish are slow growing, long-lived, have low natural mortality rates, and a late age at maturity (Leaman 1991; Wallace and Tagart 1994). In Alaska, the maximum age for black rockfish is estimated at 56 years (ADF&G, Division of Sport Fish, Homer, unpublished data) and the maximum total length (TL) recorded is 69 cm from a fish in Kodiak, Alaska (Butler et al. 2012). In Oregon, black rockfish older than 17 years are rarely harvested (Bobko and Berkeley 2004). In populations throughout their range, females grow faster and larger than males, but males grow older than females (Six and Horton 1977; Wallace and Tagart 1994; Cope et al. 2015).

Rockfish populations are characterized by high variability in year class strength; larger recruitment events are considered important to the maintenance of the populations and act as a buffer against years of recruitment failures (Leaman and Beamish 1984). Strong year classes of black rockfish in 1979, 1990, 1991, 1996, 2002, 2004, and 2008 are seen throughout the GOA harvests, but recruitment failures in 1976–1977, 1982–1983, 1986–1987 are also apparent, suggesting that large oceanographic events have significant influence on rockfish population dynamics (Worton and Rosenkranz 2003; Richardson et al. 2018).

A genetic study surveyed the population structure of black rockfish from 10 locations across the GOA and used populations from Washington as an outgroup (Seeb 2007). Samples were collected from the commercial and sport fisheries between 1998 and 2003. Population structure was evident; i.e., a large cluster of samples west of Yakutat was easily discernable from those in the Eastern GOA (EGOA, east of Yakutat) and those from Washington.

Diet

Primary prey for juvenile young-of-year black rockfish consists mainly of amphipods and copepods (Studebaker and Mulligan 2009), but adults are considered piscivores, feeding mainly on pelagic species such as sand lance *Ammodytes hexapterus*, Pacific cod *Gadus macrocephalus*, and other juvenile rockfish species, and also on euphausids *Thysanoeesa inermis* and occasionally jellyfish (Worton 2008b).

Natural mortality

Black rockfish are considered a slow-growing, long-lived species with low natural mortality. Sources of natural mortality include predators such as lingcod *Ophiodon elongates* (Beaudreau and Essington 2007), and marine mammals including Steller sea lions *Eumetopias jubatus* (Sinclair et al. 2013) and harbor seals *Phoca vitulina* (Howard et al. 2011).

Natural mortality estimates have not been determined for black rockfish in Alaska, but differences between sexes are apparent—there was lack of females over 30 years old in the fishery samples. Whether females have a higher natural mortality rate than males, or older females are inaccessible to the fishery, is unknown. However, apparent differences in natural mortality between sexes are observed throughout populations along the west coast (Six and Horton 1977; Wallace and Tagart 1994; Cope et al. 2015). Stock assessments for Washington, Oregon, and California use different natural mortality rates for males (0.16) versus females (assume 0.16 up to age 10, and linearly increases to 0.24 up to age 15, then remaining constant for remainder of ages) to account for the lack of older females in the fishery samples and a longevity of only 27 years for females (Sampson 2015).

Reproductive biology

Age and size at maturity

Black rockfish age and length at maturity can vary geographically (Wyllie Echeverria 1987; Bobko and Berkeley 2004). Black rockfish generally reach maturity between 6 and 8 years old, although this may vary based on latitude, temperature, and other environmental conditions. Oregon black rockfish females reached 50% maturity at 39.4 cm fork length (FL) and 7.5 years of age (Bobko and Berkeley 2004). In Kodiak, Alaska, the age and size at which 50% of fish are mature has been estimated at 30.8 cm FL and 4.8 years for males and 46.3 cm FL and 9.8 years for females (Worton and Urban 2005).

Reproductive Phenology

Rockfish are ovoviviparous (internal fertilization; Moser 1967), develop their larvae internally, and supply nutrients to developing embryos before bearing live young (Boehlert and Yoklavich 1984). Female black rockfish mature between May and November and the majority of males in the Kodiak area of the GOA are in spawning condition in July and August (Worton and Urban 2005). Recent underwater video taken in Kodiak in August documented mating behavior and corroborated mating timing (C. Worton, Division of Commercial Fisheries Biologist, ADF&G, Kodiak, personal communication). In *Sebastes*, mating generally occurs before completion of ova maturity (Wyllie Echeverria 1987). Females have the ability to store sperm prior to fertilization (up to 4 months), delaying fertilization until the ovary has completed vitellogenesis. Histological examination of female black rockfish gonads confirms the presence of spermatozoa outside the ovary wall; mating may occur as early as June in the Kodiak area (Worton and Urban 2005). Although the gestation period is likely to vary with temperature and latitude, Boehlert and Yoklavich (1984) determined gestation to be 37 days for Oregon black rockfish. Parturition (the release of larvae), generally occurs in the winter months, December through February, with the peak of parturition occurring earlier in the southern end of the species range (Wyllie Echeverria 1987). During this time, females with eyed larvae are rarely observed in the fisheries as they “go off the bite” or move offshore and are unavailable to hook and line gear (Bobko and Berkeley 2004; Dunn and Hitz 1969; Welch 1995; Worton and Rosenkranz 2003; Parker et al. 2007).

Fecundity

In Alaska, estimates of total fecundity range from 615,409 to 2,777,293 oocytes for fish ranging from 42.0 to 52.2 cm FL and 7 to 19 years of age (Worton and Urban 2005). The fecundity estimates for Oregon black rockfish were lower, ranging from 299,302 to 948,152 fertilized

oocytes for females aged 6 to 16 years (Bobko and Berkeley 2004). Larger, older females are considered important to rockfish stock productivity and stability: fecundity is documented to increase with size and age; larger females have greater success carrying eggs through development; older females spawn earlier, extending the reproductive season and larval survival; and growth is greater in offspring of older black rockfish (Berkeley et al. 2004; Bobko and Berkeley 2004; Rideout et al. 2005; Hixon et al. 2014).

Skip Spawning and Atresia

Female black rockfish may not successfully spawn every year—a common phenomenon particularly among first-time spawners (Nichol and Pikitch 1994). Atresia, or abortive maturity, occurs when fish stop maturing and reabsorb advanced oocytes, which serves to conserve energy during years of poor nutrition and/or environmental conditions (Hunter and Macewicz 1985). Discerning abortive maturity from immature fish can be problematic. Mature fish in this condition could be considered immature when in fact they may be mature. The incidence of skip spawning (i.e., nonannual spawning) is unknown in black rockfish but is considered widespread among rockfish species (Rideout and Tomkiewicz 2011). Recent studies are starting to investigate skip spawning in some Alaskan rockfish species (Conrath 2017).

YELLOWEYE ROCKFISH

Species range

Yelloweye rockfish range from Baja, California, to the Aleutian Islands and have been recorded as far west as Umnak Island and on the north side of Unalaska Island (Mecklenburg et al. 2002). They are most common from the western end of the Alaska Peninsula to central California (Butler et al. 2012).

Habitat preference

Primarily found living on or near the bottom, yelloweye rockfish have been documented at depths of 11–549 m, but typically are found at depths of 91–180 m. Adults live in shallower water in the more northerly part of their range (Love et al. 2002). From low relief mud to high relief pinnacles and cliff faces, submersible surveys in Alaska have documented subadult and adult yelloweye rockfish over all habitat types, most frequently over broken rock and boulder fields where they occupy spaces such as cracks, caves, and overhangs (O'Connell and Carlile 1993).

Movement

Although there have been few tagging studies of yelloweye rockfish movements, they appear to be nonmigratory, mostly solitary benthic dwellers (Coombs 1979; DeMott 1983; Gertseva and Cope 2017). On occasion, yelloweye rockfish have been recorded in small aggregations (Love et al. 2002; P. Tschersich, Division of Commercial Fisheries Biologist, ADF&G, Kodiak, personal communication).

Size, demographics, and growth

Little is known of the pelagic larval phase of yelloweye rockfish in Alaska, but studies from Washington, Oregon, and California estimate the pelagic larvae period (3–7 mm) to last 1–2 months, where they occupy waters at depths less than 300 m, with dispersal largely influenced by physical oceanographic transport (Loeb et al. 1995; Kokita and Omori 1999; Yamanaka et al. 2006). During this time larvae develop into pelagic juveniles (20–70 mm) prior to settling into benthic habitats

(Bjorkstedt et al. 2002) between 30–90 mm and 6–9 months of age (Love et al. 2002; Yamanaka et al. 2006). Generally, rockfish settle to nearshore rocky habitats at shallower depths and move deeper with age (Love et al. 1991; Lea et al. 1999; Yamanaka et al. 2006).

Genetic stock identification of yelloweye rockfish in Alaska has been limited, but more work has been done in the southern part of their range. At least 2 populations of yelloweye rockfish are thought to occur between Southeast Alaska and Oregon (Yamanaka et al. 2001, 2006). These 2 distinguishable units include an "inside" Strait of Georgia unit between Vancouver Island and the mainland coast of British Columbia and possibly north to southern Queen Charlotte Strait, and the "outside" unit extending from Southeast Alaska to Northern Oregon and including the whole of British Columbia's offshore coast. Isotopic signatures from otolith nuclei also suggest there may be a single spawning stock along the Washington and Oregon coast (Wallace et al. 2005). Site fidelity, along with minimal mixing after settlement, leads to discrete subpopulations corresponding to high-relief rocky areas, established from a much larger genetically diverse meta-population (Yamanaka et al. 2006; Wallace et al. 2005).

Yelloweye rockfish are long-lived, with populations maintained by episodic large recruitment events occurring every 15–20 years (Yamanaka and Lacko 2001). The maximum age for yelloweye rockfish in Alaska has been estimated at 121 years old (O'Connell et al. 2003). Maximum age estimates in British Columbia range from 97 years for males to 115 years for females. Fish recruit to the fishery as early as 6 years old for males and 7 years for females and are fully recruited to the fishery between 16 and 18 years old (Yamanaka and Lacko 2001). Using radiometric ageing (age determination) techniques, Andrews et al. (2002) verified break and burn growth zone age estimates between 30 and 100 years, confirming that yelloweye rockfish longevity exceeds 100 years (Wallace et al. 2005). There is a general truncation of the age structure of yelloweye rockfish populations in British Columbia—older individuals are not being replaced in a population (Kronlund and Yamanaka 2001; Yamanaka and Lacko 2001). This truncation is greater with decreasing latitude and is likely related to greater harvest rates in these areas (Yamanaka and Lacko 2001).

Maximum size recorded for yelloweye rockfish is 91 cm FL (Love et al. 2002). Females are generally larger and older than males, but males reach their maximum length earlier than females. The effects of latitude on growth and age and size at maturity have not been determined for yelloweye rockfish in Alaska, but size at age is thought to generally increase with increasing latitude (Kronlund and Yamanaka 2001; Yamanaka and Lacko 2001). However, differences in growth among fishes off the Washington, Oregon, and California coasts are not apparent (Wallace et al. 2005).

Diet

Pelagic juvenile rockfish feed on copepod nauplii and invertebrate eggs; as they develop, they move to larger prey, such as adult copepods and euphausids (Moser and Boehlert 1991; Yamanaka et al. 2006). Larger juveniles and adult yelloweye rockfish feed primarily on other rockfishes, Pacific herring *Clupea pallasii*, flatfishes, sand lance, juvenile gadids, crab, shrimps, and occasionally on lingcod eggs and green sea urchins *Stongylocentrotus droebachiensis* (Washington et al. 1978; Rosenthal et al. 1988; Reilly et al. 1994; Wallace 2001; Love et al. 2002; Wallace et al. 2005; Yamanaka et al. 2006).

Natural mortality

Estimates of natural mortality given a maximum age for yelloweye rockfish of 118 was calculated at 0.0389 for the British Columbia population (Yamanaka and Lacko 2001). Prior stock assessments of yelloweye rockfish completed in Washington, Oregon, and California assume natural mortality to be time independent (0.045) and constant throughout age. However, the absence of older age fish in the catch suggests natural mortality may increase with age or may be related to fishery selectivity (Wallace et al. 2005).

Predators of yelloweye rockfish include harbor seals, Steller and California sea lions *Zalophus californianus* (DFO 2012), orcas *Orcinus orca* (Ford et al. 1998; Love et al. 2002), sharks, and dolphins. Juveniles are taken by birds, porpoises, Chinook salmon *Oncorhynchus tshawytscha*, lingcod, and cabezon *Scorpaenichthys marmoratus* (Yamanaka et al. 2006).

Reproductive biology

Studies of yelloweye rockfish reproductive life history in Alaska have been limited, and latitudinal effects are generally unknown. Life history information comes largely from studies done in Washington, Oregon, and California.

Age and size at maturity

For Southeast Alaska yelloweye rockfish, Rosenthal et al. (1982) initially estimated length at 50% sexual maturity to be 50–52 cm for females and 52–60 cm for males, but more recent estimates of length and age at 50% maturity were determined to be 41.8 cm and 22 years for females and 43.1 cm and 18.3 years for males (O'Connell et al. 2003). From the coastal waters off Vancouver Island, British Columbia, age at 50% maturity was initially estimated at 18 years for females and 15 years for males (Yamanaka and Kronlund 1997). A later study from 4 sites off Vancouver Island and Queen Charlotte Island estimated length and age at 50% maturity to be 42.1–49.1 cm and 17.2–20.3 years (Kronlund and Yamanaka 2001). For yelloweye rockfish sampled off Oregon, length at 50% maturity was estimated to be 41 cm by Barss (1989) and 45 cm by McClure (1982), and for yelloweye rockfish collected off California, length at 50% maturity was 40 cm (Reilly et al. 1994; Wallace 2001).

Reproductive phenology

In British Columbia, the mating season for yelloweye rockfish begins in November and extends into the winter months. Females can mate with several males and store sperm for several weeks prior to fertilizing the eggs (Wyllie Echeverria 1987; Yamanaka et al. 2006). Although not known for yelloweye rockfish specifically, the gestation period for rockfishes is generally 1–2 months (Love et al. 2002). Parturition occurs between April and September with a peak in May and June (Yamanaka et al. 2006) in British Columbia and April and May in Alaska (O'Connell 1987).

Fecundity

Female fecundity for yelloweye rockfish in Washington, Oregon, and California ranges between 1.2 and 2.7 million eggs (Love et al. 2002; Yamanaka et al. 2006). Alaskan-specific studies of yelloweye rockfish fecundity are currently underway (D. Arthur, Division of Sport Fish Biologist, ADF&G, Anchorage, personal communications).

Skip Spawning and Atresia

The incidence of atresia and frequency of skip spawning in yelloweye rockfish are unknown.

FISHERY INFORMATION

STATEWIDE

Rockfish are harvested throughout the GOA in subsistence, personal use, sport, and commercial fisheries. Rockfish fisheries occur in both state (0–3 nmi offshore) and federal waters (3–200 nmi offshore). Federal management of rockfish fisheries occur in federal waters for species and fisheries identified in established federal fishery management plans (FMP), otherwise ADF&G manages harvests for species or fisheries in federal waters not specifically addressed in these FMPs. The Alaska Board of Fisheries (BOF) extended existing state regulations governing the sport fishery for all marine species into the waters of the U.S. Exclusive Economic Zone (EEZ; <200 nmi) off Alaska in 1998. Currently, sport and commercial harvests of black rockfish and sport harvests of yelloweye rockfish are exclusively under state management throughout the EEZ, but yelloweye rockfish commercial harvest management occurs under state authority in state waters and federal authority in the remainder of the EEZ. Generally, state management of commercial and sport rockfish fisheries by ADF&G have occurred independently from each other, and subsistence and personal use rockfish fisheries have not been actively managed.

Prior to the 1976 Magnuson Fishery Conservation and Management Act, commercial groundfish harvests in Alaska were largely foreign fisheries. With inadequate catch reporting and no reporting prior to 1964, estimates of historic rockfish removals are unknown (NPFMC and NMFS 2004). Once the Magnuson Fishery Conservation and Management Act was implemented in 1977, this gave National Marine Fisheries Service (NMFS) authority to regulate fisheries in the EEZ, and as a result the foreign and joint venture FMPs were developed to manage groundfish fisheries off Alaska. Preliminary FMPs sought to control directed fishing and establish bycatch controls for halibut, crab, salmon, shrimp, and herring, but contained few species-specific regulations for other groundfish such as rockfish. Historically (1977–1979), foreign catch records did not identify rockfish by species; *Sebastes* in Alaska were managed under Other Species or Pacific Ocean Perch Complex (Tribuzio et al. 2017).

Currently NMFS manages multiple rockfish species together under species assemblages. Typically, these assemblages encompass those species that share similar habitat preferences, behavior, and often life history strategies. Yelloweye rockfish are considered to fall in the Demersal Shelf Rockfish (DSR) assemblage, along with other bottom-dwelling rockfish species: quillback *S. maliger*, tiger *S. nigrocinctus*, china *S. nebulosus*, canary *S. pinniger*, copper *S. caurinus*, and rosethorn *S. helvomaculatus* rockfish. The only directed commercial fishery for yelloweye rockfish occurs in Southeast Alaska within the Eastern GOA (EGOA) regulatory area, and in this area this species is managed under the DSR Complex. However, in the Central GOA (CGOA), Western GOA (WGOA), and Bering Sea-Aleutian Islands federal regulatory areas, NMFS manages yelloweye rockfish in the Other Rockfish group. Since the mid-1990s, directed commercial fishing has not been allowed for the Other Rockfish group in the WGOA and incidental catches have remained low (Tribuzio et al. 2017). Because yelloweye rockfish are considered the most vulnerable species in the GOA demersal subgroup, proposed (but not enacted) changes in federal management have included moving yelloweye rockfish out of the Other Rockfish group and into a GOA-wide DSR complex with the goal to improve management (Ormseth and Spencer 2011; Tribuzio et al. 2017).

The pelagic shelf rockfish (PSR) assemblage is composed of 6 nearshore schooling species: black *S. melanops*, dark *S. ciliatus*, blue *S. mystinus*, dusky *S. variabilis*, yellowtail *S. flavidus*, and

widow *S. entomelas* rockfish. Prior to 1997, black rockfish were managed by NMFS (NPFMC and NMFS 2004) under the FMP for the groundfish fishery in GOA federal waters (3–200 nmi) as part of the PSR group. In 1998, the North Pacific Fishery Management Council (NPFMC) removed black rockfish from the GOA groundfish FMP, and full management authority of the black rockfish fishery was transferred to the State of Alaska (Lunsford et al. 2009). The transfer of management authority was due to concerns that the species was not well assessed by federal surveys, and that federal management practices were inadequate to prevent localized depletion while allowing for controlled development of the fishery (NPFMC 1998). Consequently, the state currently manages all black rockfish fisheries in both state and federal waters.

The quality of harvest information and biological characteristics of harvest vary substantially among the state-managed fisheries; combining and standardizing information from different types of fisheries is challenging. Commercial fisheries rely on mandatory fish tickets to document biomass of rockfish harvested, reported in weight by species. Biological characteristics of commercial harvest are measured through sampling programs that vary regionally. Likewise, sport harvest creel programs provide information on biological characteristics of the harvest, including species composition of the harvest. Creel sampling programs vary regionally in their history, design, and information collected. Subsistence and personal use rockfish fishery harvests have not been well assessed across the GOA, are relatively very small, and available programs to assess these harvests vary regionally.

Magnitude of sport fishery harvests are measured, in numbers of fish, through a variety of programs, primarily a statewide harvest survey (SWHS), a guided angler logbook program, and creel survey programs at primary ports. The SWHS was initiated in 1977 as an annual mailout survey (Jennings et al. 2011). Response to this survey is voluntary and survey design provides for statewide harvest in numbers of fish, effort, and catch (since 1990) for rockfish (all species combined) by private and guided anglers. Information gathered in the SWHS accounts for all rockfish species together and resulting estimates are not geographically consistent with either sport fishery management areas or commercial fisheries management areas. Because of this, additional data sources are used to apportion black and yelloweye rockfish harvests to each management area as appropriate. The statewide saltwater guided angler charter logbook program was established in 1998 to acquire information on guided industry harvests and effort (Powers 2015). This program is mandatory and provides a census in numbers of fish harvested; since 2006, this program has required anglers to differentiate between pelagic, nonpelagic, and yelloweye rockfish.

Given this disparity in kinds of data available in each fishery, some of the associated challenges include converting different measurement units into a common unit (weight for commercial fisheries, numbers for sport fisheries), identifying geographic boundaries and standardizing information associated with these boundaries, and using available information to produce species-specific harvest information. Standardizing and combining historical harvests would be extremely important in any stock assessment analysis for these species.

Although a comprehensive management strategy across state-managed rockfish fishery types does not currently exist, other efforts have been made to adhere to the sustained yield principle. Among these, regulatory changes will become effective statewide in 2020 requiring the use of deep-water release devices for discarded rockfish in sport fisheries. Due to the unvented nature of their swim bladders, rockfish brought to the surface from depths in excess of 20 meters often suffer from decompression trauma (Wilde 2009). Deep-water release devices improve the release survival of rockfish and better allow for successful resubmergence (Hochhalter and Reed 2011;

Hochhalter 2012). Considerable effort has been invested in educating anglers of the risks and consequences of overharvesting rockfish, and fostering fishing practices that avoid bycatch and waste in rockfish fisheries.

Harvest Trends

Commercial fishery characteristics and historical harvest patterns have been dramatically different in the EGOA (Southeast Alaska, east of 144°W) compared to the CGOA/WGOA (west of 144°W). EGOA harvest typically contributes less than 5% of the total black rockfish commercial harvest (Figure 1). Directed commercial fisheries for black rockfish are active in the Kodiak area and the North Gulf District of Cook Inlet (CI) area, but little to no directed commercial harvest occurs elsewhere in the GOA. Directed commercial fisheries for yelloweye rockfish occur in the EGOA, but CGOA/WGOA harvests are primarily from bycatch in other fisheries. Most yelloweye rockfish harvest occurs in the EGOA, though those harvests have been proportionally less dominant in recent years (Figure 2). Maintenance of static GHLs contribute to recent stable commercial fishery harvests.

Statewide sport harvests of rockfish species have increased in the past decade compared to prior years (Figure 3). Information from creel survey and interview programs throughout the GOA suggest that black and yelloweye rockfishes comprise most of the reported rockfish sport harvest. Although black rockfish tend to dominate sport catches, yelloweye rockfish are prominent in certain locations, such as Prince William Sound (PWS). Numbers of rockfish harvested are similar in both the EGOA and CGOA/WGOA (Figure 3). Although proportionally more rockfish have historically been released in the EGOA, over the past decade similar proportions of rockfish have been retained throughout the GOA, and only about one-third of sport caught rockfish are currently released (Figure 4). These changes in angler behavior, along with the recreational harvest dynamics (including abundance, availability, and fuel prices) of other species (e.g., salmon, halibut) have contributed to current rockfish sport harvest patterns.

Data Gaps and Needs

Harvest Information

Improved catch accounting of all retained and discarded catch—current and historical—is needed for all GOA black and yelloweye rockfish fisheries. Subsistence rockfish harvests are often infrequently or poorly assessed. For example, rockfish bycatch in federal subsistence halibut fisheries is typically not recorded. Also likely is underreporting of commercial rockfish discards in federal fisheries, and thus accounting for total removals from those waters may be problematic. Statewide total fishing mortality of black and yelloweye rockfishes from all fisheries has yet to be reconciled because commercial and sport harvests are measured in different units (pounds vs. numbers of fish) and have different resolutions in terms of geographic and taxonomic scale reported. There is also little to no information on personal use fisheries harvest for rockfish. Estimation of discard mortalities in commercial and sport fisheries present additional challenges for understanding total fishing mortality.

Historical harvests of both commercial and sport fisheries are incomplete. For example, in Westward Region commercial fisheries, data only goes back to 1984; harvests from foreign vessels in the 1970s and early 80s are not well documented. Given the long lifespan of rockfish species, much of Alaska's harvest information fails to span even 1 generation of the populations being harvested, despite fisheries existing for much longer. More work is needed to quantify total fishery

mortality rates, including discard mortality, in Alaska's black and yelloweye rockfish fisheries as far back in time as possible.

Specific harvest location information is needed for designing stock assessments and evaluating the implementation of specific management actions. Mandatory logbook programs exist in both commercial and sport fisheries; however, the scale of geographic resolution is coarser for sport harvest (primary statistical area of the entire fishing trip) compared to commercial fisheries (latitude and longitude). Additionally, sport logbook data are only available for guided harvests. Port sampling programs can provide additional location information for nonguided sport anglers, but these programs are confined to specific ports. Finer-scale spatial resolution of harvest data, especially sport harvest, is needed to evaluate the possibility of localized depletions. This information would also assist in evaluating the possible use of spatial management options.

Outreach and Education

Better species identification in all fisheries through continued education and fishing accountability is necessary to improve harvest estimates. The commercial fish ticket system requires reporting of all species landed, but misidentifications cannot always be corrected or enforced. For sport fish anglers, an online electronic reporting format may help decrease the bias introduced in the SWHS due to poor recall, species misidentification, or a lack of reporting (S. Meyer, Division of Sport Fish Coordinator [retired], ADF&G, Homer, personal communication).

Population Dynamics and Abundance Information

Fishery-independent abundance information is ideal for assessing stock status and is one of the most challenging data gaps of the Initiative. Relatively few black or yelloweye rockfish abundance indices or estimates are available annually; a notable exception is a hydroacoustic survey of Kodiak black rockfish and a remotely operated vehicle (ROV) survey of Southeast Alaska yelloweye rockfish. Continuing established surveys for Kodiak black rockfish and Southeast Alaska outside waters yelloweye rockfish is important. Long-term annual funding of large field projects is a significant challenge and staff are exploring the development of cost-effective surveys to obtain this kind of data.

In Central/Southcentral Alaska, abundance of black rockfish from outside waters in the region (North Gulf District CI, Outside District PWS) would be a top priority for new abundance assessment projects because most harvests from commercial and sport fisheries occur in these waters. A review of the historical fishery-independent survey approach for yelloweye rockfish in Central/Southcentral Region should be completed to evaluate future survey design and determine how estimates would best inform a harvest strategy.

Even for existing fishery-independent surveys, there are opportunities to improve the quantity and quality of information provided. For example, although fishery-independent surveys exist for assessing yelloweye rockfish in Southeast Outside Subdistrict (SEO) waters, no data are available for population assessment in inside waters. Additionally, surveying SEO management units more frequently and consistently would allow for more accurate biomass estimates; in the absence of a survey, the most recent density estimate for a management unit is used in determining biomass estimates for SEO, which can be misleading in areas where fishery catch has occurred. Stratification of the yelloweye rockfish survey areas would also help in assigning weights to high-, moderate-, and low-density locations.

Detailed information on habitat, through mapping high resolution bathymetry (multibeam sonar), is needed to effectively design stock abundance assessment projects. Some detailed bathymetric data are available in certain areas, such as Kodiak, northern GOA, and Southeast Alaska, but considerable work remains. For species such as yelloweye rockfish that have a high affinity for specific habitats, knowing the extent and quality of habitat type (especially seafloor substrate) is particularly valuable even if habitat-based surveys are not conducted. With the inclusion of habitat suitability models, acquiring a greater portion of higher resolution bathymetry data for Southeast Alaska would result in a more definitive estimate of black rockfish habitat. Once black rockfish habitat has been estimated for all SEO waters, ROV surveys, survey analyses, and biomass estimates would need to be designed and implemented. These would most likely mirror the research methodology for yelloweye rockfish in Southeast Alaska. Because of extensive resources required to do multibeam sonar habitat mapping, filling this data gap is unlikely to be accomplished by the Initiative. Analytical methods should be explored to address the potential of combining relatively limited multibeam sonar data with far more ubiquitous low-resolution single beam, bottom sample, and fishery data to develop a synoptic seafloor characterization sufficient for understanding the extent and quality of available rockfish habitat.

An understanding of the genetic population structure and spatial connectivity through recruitment, and how these relate to management units is needed. This information would better allow assessments of the interface between management actions and population dynamics of harvested black and yelloweye rockfish stocks. An understanding of population spatial dynamics is particularly important for understanding potential impacts of specific management measures.

Reproductive and Life History Information

Reproductive life history characteristics including age and size at maturity, reproductive seasonality, and fecundity estimates are also needed to improve understanding of stock dynamics and to use in stock assessment models. With few exceptions (notably Kodiak area black rockfish), comprehensive reproductive biology assessments are lacking in Alaska. A student at the University of Alaska Fairbanks is currently conducting his thesis on the reproductive biology of yelloweye rockfish in PWS, the results of which will significantly improve our understanding of yelloweye rockfish fecundity and maturity at the more northern end of its habitat range. Little is known about how the timing of parturition for black or yelloweye rockfish affects recruitment or postlarval survival. Since rockfish are known for having highly episodic recruitment, a recruitment index for black and yelloweye rockfishes would improve modeling estimates for total biomass of these species. Accurate information across their range of habitats will be important for management of these species. For example, although yelloweye rockfish fecundity is currently being studied in PWS, comparable information is not available in Southeast Alaska where fecundity patterns could differ. Additionally, data on the age of maturity and fecundity estimates should be collected on a periodic basis to monitor any changes in rockfish life history parameters that may be associated with changing climate.

It is also critical that basic biological/life history characteristics of harvested fish continue to be collected (length, weight, sex, maturity status, etc.) and that the collections be strengthened where possible. Growth should be examined to determine if significant differences occur within or between regions (e.g., inside and outside waters of PWS) so that area-specific parameters can be used for population models moving forward.

WESTWARD

Description of Fishery Area

Fishery area boundaries are dependent on the type of fishery and whether authority falls under state or federal management. The ADF&G Westward Region encompasses management of commercial rockfish fisheries in the WGOA south of a line east from Cape Douglas at lat 58°51.10'N, west of long 149°W, east of long 170°W, including all waters south of the northern boundary of the South Alaska Peninsula area in the North Pacific Ocean to the EEZ boundary (3–200 nmi), and state waters (0–3 nmi) within the Bering Sea-Aleutian Islands area (Figure 5; ADF&G 2017a). The Westward Region is divided into 4 management areas: Kodiak, Chignik, South Alaska Peninsula (SAP), and the Bering Sea-Aleutian Islands. These management areas are further divided into districts: 7 in the Kodiak area, 3 in the Chignik area, 2 in the SAP, and 2 in the Bering Sea-Aleutian Islands area (Figure 6). The Aleutian Islands District is then further divided into 3 additional sections and 9 subsections (Figure 7).

The Kodiak Management Area (KMA) of the Southwest Alaska management areas (part of the Division of Sport Fish Southcentral Region) for sport fisheries overlaps with commercial fisheries in the Westward Region and includes all salt waters circumjacent to the Kodiak Archipelago; the Alaska Peninsula; the Aleutian Islands (coastline west of the longitude of Cape Douglas); and the Bering Sea coastline south of the latitude of Cape Menshikof (lat 57°28.34′N), including the Pribilof Islands and all waters to the EEZ (200 nmi) boundary (Figure 8; ADF&G 2018; T. Polum, Division of Sport Fish Biologist, ADF&G, Kodiak, personal communication).

The Alaska state subsistence finfish fisheries are designated by area and are not specific to commercial or sport fishery region designations. Southwest Alaska includes several subsistence areas that overlap with both the commercial fishery districts of the Westward Region and the sport fishery areas of KMA; these include Kodiak Island, Chignik, Alaska Peninsula, and Aleutian Islands areas defined in the State of Alaska Subsistence and Personal Use Fishery Regulations (Figure 9; ADF&G 2017b). State and federal subsistence management boundaries are similar, except federal subsistence marine fisheries only occur in a small fragment of marine waters of Alaska and are managed by the U.S. Fish and Wildlife Service (Figure 10).

Black Rockfish

Commercial Fishery Management

The commercial black rockfish fishery in the Kodiak, Chignik, South Alaska Peninsula, and Bering Sea-Aleutian Islands areas opens January 1 and remains open until December 31 unless closed by emergency order. Mechanical jigging machine and hand troll gear are the only legal gear in the directed commercial black rockfish fishery. In 2000, a voluntary logbook program was initiated for commercial black rockfish fisheries to obtain CPUE estimates and more detailed harvest location information, but the effort saw little participation. As a result, the logbook program was made mandatory in 2005.

All black rockfish commercially harvested by jig gear, either through directed effort or as bycatch to other jig gear fisheries (e.g., Pacific cod), are managed for the area, district, section, or subsection GHLs and closed to directed fishing upon achieving the GHL (Richardson et al. 2018). ADF&G establishes GHLs for commercial harvest of black rockfish across Westward Region management districts or sections to distribute effort and has the authority to change the GHLs on an annual basis if necessary. GHLs were initially established at 75% of the average historical harvest for Kodiak,

Chignik and SAP. GHLs for each district or section have generally been reduced or eliminated since their inception (Richardson et al. 2018). Fishermen may retain up to 20% black rockfish by weight of the directed groundfish species as bycatch from other directed jig fisheries and 5% for non-jig gear groundfish fisheries. Bycatch limits are often decreased to 5% inseason by emergency order to prevent exceeding the GHLs. Bycatch occurs sporadically in the longline, pot, and trawl gear fisheries, but only bycatch in jig fisheries are counted against the GHLs. In 2003, Kodiak area trip limits were established to facilitate management of fisheries and prevent exceeding the GHLs.

After NPFMC removed black rockfish from the GOA Groundfish FMP in 1998, the Aleutian Islands pelagic rockfish fishery was modified to a black rockfish only fishery, and expanded to include all waters south of Cape Sarichef and west of Scotch Cap Light and federal waters of the Pacific Ocean between Scotch Cap Light and long 170°W (Figure 5). Currently, only state waters in the Aleutian Islands black rockfish fishery management area have GHLs.

Few waters are closed to rockfish commercial fisheries in the Westward Region. Monashka Bay, on the Northeast side of Kodiak Island, is the only closed waters area for commercial rockfish fishing in the Kodiak area. This area was closed to commercial fishing in 1989, prior to establishing state managed black rockfish in the Westward Region, due to its importance for juvenile rockfish. Additionally, in 2000, waters from the south end of Green Bight to Talus Point located in the Akutan Island Subsection of the Aleutian Islands were closed to black rockfish fishing due to concerns of localized depletion (Figure 7).

Sport Fishery Management

The KMA is composed of 2 sport fish regulatory areas: the Kodiak Regulatory Area and the Alaska Peninsula-Aleutian Islands Regulatory Area (AP-AIRA). In 1993, a defined season (January 1 to December 31) and the first bag limit for rockfish of 10 per day and 20 in possession was put into regulation. In 1992, an onsite creel survey program for the Southcentral Region was established in primary ports to collect information on species, age, sex, length, and weight of the sport harvest, and to conduct angler interviews to gather data on the geographic distribution of effort and harvest in the KMA (Meyer 2000). Samplers are stationed at ports from May to September.

Several factors have influenced growth in the KMA rockfish sport fishery, including restrictions for guided sport halibut harvests that pressure guided anglers to pursue historically less valuable fish species as alternative targets, increasing demand for rockfish for consumption, and anglers' increasing awareness of rockfish availability (Polum and Worton 2018). Due to rapidly increasing rockfish sport harvest, bag limits were reduced in 2011 to 5 per day, of which only 2 may be nonpelagic species and 1 may be yelloweye rockfish (Polum 2016). Over the following years, sport harvest appeared unaffected by these bag limit reductions, particularly in Chiniak Bay near the city of Kodiak, and it was estimated that sport harvests in the Northeast District surpassed those from the commercial fishery (Polum and Worton 2018). In 2017, the BOF again reduced the bag limit of pelagic rockfish, specifically in Chiniak and Marmot bays, to 3 per day, of which only 2 may be nonpelagic and 1 may be yelloweye rockfish. The AP-AIRA bag limit came into effect in 1995 and remains at 10 rockfish per day and 20 in possession with no restrictions on species harvest. There are no size or annual limits established for either KMA or AP-AIRA regulatory areas, and no annual harvest reporting requirements for private anglers (ADF&G 2018).

Subsistence and Personal Use Fishery Management

Within Southwest Alaska, the Kodiak area is the only area that regulates rockfish subsistence harvest. Under state subsistence management, rockfish may be taken only by a single hand-held line or a single longline, none of which may have more than 5 hooks attached to it, except that rockfish taken incidentally in another subsistence finfish fishery may be retained for subsistence purposes. This incidental rockfish catch is restricted to 10 rockfish per day and 20 in possession and a person may not possess rockfish under sport fish regulations on the same day. No permit is required and there is no reporting requirement. The Division of Subsistence conducts a voluntary comprehensive mail-out household survey (the primary data collection method); the results are then compiled in the Community Subsistence Harvest Information System. At a minimum, the harvest survey questionnaire requires users to report the number of black rockfish and the number of "red" rockfish harvested; however, users often report harvest by species (D. Koster, Division of Subsistence Research Analyst, ADF&G, Anchorage, personal communication).

Federally managed subsistence fisheries occur in a small portion of marine waters of Alaska, authorizing the use of rod and reel to harvest bottomfish (any marine fish, except halibut, osmerids, herring, and salmonids). To date, the Kodiak National Wildlife Refuge has issued only a few rod and reel permits and the federal subsistence management program has not received any reported harvest of rockfish in Alaska since the inception of the program in 1980 (G. Pappas, State Subsistence Liaison, U.S. Fish and Wildlife Service, Anchorage, personal communication).

There are no personal use fisheries in the Westward Region.

Harvest trends

The Westward Region black rockfish commercial fishery is the largest in the state both geographically and in terms of harvest. Earliest reported harvests started in 1983 as bycatch in nonpelagic bottom trawl fisheries and continued through 1990 (Figure 11). Prior to state management, harvests peaked at 870,000 lb in 1991, primarily from the jig gear fishery in the Kodiak area (Figure 11; Richardson et al. 2018). Under state management, with established GHLs and trip limits, harvests have stabilized and have averaged approximately 169,000 lb over the past 10 years (Figure 11). Black rockfish harvests occur primarily in the Kodiak area, though some substantial harvests have occurred in Chignik and SAP. Very little directed commercial harvest effort occurred for black rockfish in the Aleutian Islands area in recent years; there is only 1 vessel sporadically targeting black rockfish.

Current commercial management strategies and regulations, along with a close relationship with the jig fleet, allow managers to effectively constrain harvest to the GHLs (Richardson et al. 2018). However, not all catch reporting is accurate or complete. Large harvests of black rockfish bycatch are occasionally reported in the trawl fishery landings, but species identification is suspect. Dark or dusky rockfish, which are more commonly captured in trawl gear, are often discarded or processed at sea, precluding species verification during port sampling. Without monitoring trawl deliveries, species identification cannot be verified. In addition, accurate discard rates of black rockfish in other fisheries (e.g., halibut longline) are unknown because this information is rarely recorded on fish tickets.

Sport rockfish harvests (all species) in the KMA have steadily increased over the past decade (Figure 12). The Kodiak Regulatory Area rockfish (all species) sport harvests reported in the SWHS comprise 91% of the total KMA rockfish sport harvests (Polum 2016). Pelagic species have

historically made up most of the rockfish harvest, and pelagic harvests consist primarily of black and dusky rockfishes (Polum 2016). Harvests in the KMA have doubled since 2006, approximately 68% of which are estimated to be black rockfish (Polum 2016). Recent efforts to develop sport harvest estimates for KMA in comparable units to those reported for commercial harvests have revealed that the KMA sport harvest in 2016 may have been similar in magnitude to the commercial harvest, but more concentrated in the Northeast District where twice as much black rockfish biomass is estimated to have been taken in sport fisheries than in the commercial harvest (T. Polum, Division of Sport Fish Biologist, ADF&G, Kodiak, personal communication). Changes in federal regulations managing halibut have restricted both the number of guided anglers and the number of boats participating in the fishery, causing anglers to target other species such as rockfish (Polum 2016). Rockfish catches in the AP-AIRA have remained a small percentage of the KMA total. AP-AIRA harvest averages 1,260 rockfish per year (Polum 2016). Without a port sampling program in this area, there are no estimates of species composition of the harvests taken in the AP-AIRA.

The state subsistence black rockfish harvest is a small proportion of the total harvests in the Westward Region. The largest subsistence harvest estimate of black rockfish occurred in 1991 with 22,232 lb (Table 1), but in recent years estimates remain low or unrecorded. Data collection is funding-dependent so surveys may not occur on an annual basis and anglers do not consistently identify harvested species, creating data gaps and affecting accuracy of these estimates. Rockfish removals from the federal subsistence fisheries do occur but are poorly documented (Table 2). Rockfish bycatch data in the NMFS halibut subsistence fishery program are of limited use because specific rockfish species are not recorded, and there is no bycatch data after 2012.

Research Summary

Biological characteristics of harvest

Sampling programs measuring biological characteristics of rockfish were initiated in 1992 for sport harvests and in 1993 for commercial harvests. No biological sampling occurs in any subsistence fisheries, so the composition of those harvests is unknown.

The commercial dockside sampling program collects data on FL, weight, gonadal maturity, otoliths for age determination, and skippers are interviewed for information on effort, location, and bycatch. Rockfish sampling concentrates on black and dark rockfishes with opportunistic sampling of other miscellaneous *Sebastes* species. One hundred fish are sampled per delivery with the goal of 1,000 samples for each management area. A total of 53,070 black rockfish FL were collected from 1993 to 2018, ranging from 25 to 65 cm with the majority between 44 and 50 cm (Figure 13). Males dominate commercial fishery landings, making up 70% of the catches, suggesting possible differences in fishing selectivity between males and females (Worton and Rosenkranz 2003). Between 1993 and 2018, over 20,000 otoliths in the Westward Region have been sampled for age determination, with 97% of the samples from the Kodiak area. Fish recruit into the fishery at about 4 years old; presumably juveniles are not vulnerable to the fishing gear and do not inhabit the nearshore high rocky reefs where the fisheries are executed. Ages ranged from 4 to 56 years with several predominant age classes persisting throughout the data time series (fish born in 1979, 1990, 1991, 1996, 1997, 2002, and 2008, Figure 14). The age distribution of fish sampled suggests a significant proportion of the population is under 10 years old and might be harvested at or before the onset of sexual maturity (Worton and Rosenkranz 2003). Males make

up the majority of the oldest age classes, whereas females only reach 30 years of age before disappearing from the fishery samples (Figure 14).

The Southcentral Region Division of Sport Fish also collects harvest and fishery information on rockfish as part of the harvest assessment program. Rockfish sampling objectives included estimation of species composition; age, sex, and length composition of primary species; and the spatial distribution of effort and harvest by port. From 1992 to 2017, a total of 7,402 rockfish were measured from the sport fish harvests (TL), with converted FL sizes ranging from 22 to 61 cm (Figure 15). Males dominate the harvests (63–73% in the last 4 years) and make up the majority of the larger sizes harvested. Between 1992 and 2017, a total of 6,551 otoliths were sampled for age determination and show the same strong age classes that were evident in commercial harvests (Figure 16). The age differences seen in the males and females are also apparent in the sport fishery harvests, where older age classes are predominantly males, and females older than 27 years are rarely harvested (Figure 16).

Population characteristics and ecology

Focused black rockfish research in Westward Region from 2000 through 2010 included age, sex, and length, feeding habits, reproductive biology, movement patterns through acoustic tagging, underwater video observations, and hydroacoustic survey development (Tschersich and Gaeuman 2019). The development of a hydroacoustic survey began in 2006, with the goal of determining the spatial distribution of both black and dark rockfishes and estimating abundance for black rockfish in the Kodiak area (C. Worton, Commercial Fishery Biologist, ADF&G, Kodiak, unpublished data). Federal funding from 2007 to 2018 allowed ADF&G to conduct hydroacoustic surveys in the Kodiak, Chignik, and the SAP. Continued funding for this project allowed ADF&G to expand survey effort and generate abundance indices for all districts in the Kodiak area and the Shumagin Islands Section of the SAP. Some districts have received multiple surveys over the lifetime of the project in order to establish an abundance time series. Survey estimates and other life history data are used to assess and develop commercial fishery GHLs for black rockfish. Improvements in the survey methods are ongoing, but preliminary estimates indicate stable populations in those areas where a time series of hydroacoustic data are available. Current effort is focused on developing a stereo camera system to improve estimates of black rockfish biomass.

Yelloweye Rockfish

Commercial Fishery Management

In the Westward Region there are no directed state-managed fisheries for yelloweye rockfish. ADF&G uses emergency order authority to establish parallel fisheries in state waters—all the federal regulations for groundfish applied in federal waters are adopted in state waters. This includes season, closed waters, bycatch limits, and allowable gear types. Commercial fisheries for yelloweye rockfish in the Westward Region are managed by the NPFMC within the EEZ as a bycatch species in the Other Rockfish complex. There are 2 groups with the Other Rockfish complex: the slope subgroup consisting of 18 species, and the demersal subgroup consisting of 7 species—and of the demersal subgroup, yelloweye rockfish are the predominant species (Tribuzio et al. 2017). Since it is not a targeted fishery, limited or no information is collected on yelloweye rockfish harvested in this region (AFSC 2017). The Other Rockfish complex in the GOA is assessed on a biennial basis through trawl surveys. The NPFMC sets overfishing limits, acceptable biological catch, and total allowable catch (TAC) harvest limits for the Other Rockfish

complex as a whole. Since there is no targeted fishing on Other Rockfish in the GOA, all the catches of these species are taken incidentally in the directed rockfish trawl fisheries for Pacific Ocean perch *S. alutus*, northern rockfish *S. polyspinis*, and dusky rockfish, and in longline fisheries for sablefish and Pacific halibut. The demersal subgroup, of which yelloweye rockfish are a significant component, are primarily harvested as bycatch in the hook and line fisheries and often retained (Tribuzio et al. 2017).

Sport Fishery Management

From 1993 to 2010, yelloweye rockfish were managed in the KMA under a total sport fish bag limit of 10 rockfish (all species) per day and 20 in possession. Starting in 2011, yelloweye rockfish became the only species anglers are required to specifically identify. Currently, KMA sport fishing regulations for harvesting rockfish are split between the 2 regulatory areas. In the Kodiak Regulatory Area, the daily bag limit is 3 rockfish and 6 in possession, only 2 per day and 4 in possession may be nonpelagic species, and only 1 per day or 2 in possession may be a yelloweye rockfish. In AP–AIRA waters, beginning in 1995, the combined species bag limit is 10 rockfish and 20 in possession. There are no size or annual limits established for either regulatory area and no annual harvest reporting requirements for private anglers. The nonpelagic species harvested in the KMA waters consist mainly of yelloweye rockfish (Polum 2016).

Subsistence and Personal Use Fishery Management

Yelloweye rockfish have a long history of being harvested for subsistence purposes (NPFMC and NMFS 2004). Subsistence longlines are used where multiple hooks are attached to a single line and laid along the ocean floor. There are no separate regulations for yelloweye rockfish; the subsistence permit allows anglers to fish up to 5 hooks on a hand line, but numbers and species of rockfish are not required to be recorded on the permit. State subsistence mail-out census asks anglers to identify the number of "red" rockfish harvested by town or village. Often anglers will identify to species, and this information is captured in the data if possible. Rockfish removals do occur in the federal subsistence fisheries, but harvests by species are not required to be recorded in any of the federal subsistence fisheries.

There are no personal use fisheries in the Westward Region.

Harvest Trends

Prior to 1985, large rockfish harvests were mainly in the foreign and joint venture fisheries and catch was not identified by species. Commercial harvests of yelloweye rockfish have been recorded by the State of Alaska since 1984. Westward Region commercial harvests peaked in 1986; over 980,000 lb was harvested as bycatch in the longline and the nonpelagic/bottom trawl fisheries (Figure 17). Between 1986 and 1990, foreign fishing was eliminated, and by 1990 harvests substantially decreased (NPFMC and NMFS 2004; Figure 17). Conservative harvest strategies for other groundfish species and various restrictions on gear to minimize bycatch and harvests on juvenile components of groundfish stocks significantly decreased yelloweye rockfish harvests. By 2010, the bycatch of yelloweye rockfish in the nonpelagic/bottom trawl fisheries increased when NPFMC adopted the CGOA Rockfish Program, which increased allocations and directed effort on harvesting groundfish (NPFMC and NMFS 2004). The annual harvest for yelloweye for the last 10 years has averaged approximately 132,000 lb (Figure 17).

Yelloweye rockfish are the main nonpelagic species captured in the sport fisheries in the KMA and average 5.6% of the rockfish sport harvest each year (Polum 2016). Although overall rockfish

harvest has increased over time (Figure 12), harvest of yelloweye rockfish has been estimated to be lower in the last few years; only 2.7% in 2016 and 4.8% in 2015 of the harvest were yelloweye rockfish. To improve accuracy of harvest numbers, beginning in 2006 the Division of Sport Fish, Southcentral Region's guided angler charter logbook program required identification of yelloweye rockfish in the catch. Estimates of rockfish removals in the AP-AIRA are estimated to be small but are generally unknown.

Research Summary

Biological characteristics of harvest

Little information on age, sex, and length of yelloweye rockfish commercial harvests has been collected because there are no directed fisheries in the Westward Region. For rockfish fisheries, the NMFS Federal Groundfish Observer Program prioritizes sampling Pacific Ocean perch, northern rockfish, thornyheads, shortraker/rougheye, dusky rockfish, and dark rockfish *S. ciliatus* (AFSC 2017) so biological data on yelloweye rockfish are not taken from the federal fishery harvests, even when they are the predominant species in the catch (AFSC 2017). In the Westward Region's state fisheries, yelloweye rockfish samples are taken opportunistically when harvested as bycatch in other state-waters fisheries. Of 137 sampled yelloweye rockfish from commercial fisheries since 1993, sizes ranged from 41 to 88 cm FL. Ages ranged from 12 to 96 years old; male maximum size and age was 70 cm FL and 61 years old, but females made up the largest (>71 cm FL) and oldest samples. One predominant cohort of 31-year-old fish (i.e., fish born in 1968) was apparent in the 1999 samples.

A total of 443 yelloweye rockfish samples were taken from the sport fishery between 1992 and 2017. Within a given year, the number of samples ranged from 1 to 39. Sizes ranged from 27 to 87 cm TL and ages ranged from 6 to 87 years old. The older fish (>50) were mostly female (77%). Predominant age classes were not apparent due to the low sample sizes taken each year.

Biological sampling of subsistence fisheries does not occur, so the composition of the harvests is unknown.

Population characteristics and ecology

There are no surveys or stock assessments for yelloweye rockfish in the Westward Region, and currently the status of the yelloweye rockfish stock is generally unknown. Efforts were made in 1999 to genetically delineate stocks from around the state; 69 yelloweye rockfish samples were taken in the Kodiak area. This analysis has not yet been completed.

CENTRAL/ SOUTHCENTRAL

Description of Fishery Area

Fishery area boundaries in the Central/Southcentral Region are dependent on the type of fishery. For both commercial and sport fisheries, the PWS area consists of all marine waters of Alaska west of the longitude of Cape Suckling (long 144°W) and east of the longitude of Cape Fairfield (long 148°50.25′W). For commercial fisheries in federal waters, the westward boundary along Cape Fairfield continues south to the latitude of Cape Douglas at lat 58°51.10′N, then west to long 149°W, then south along long 149°W. The commercial PWS area is split into the Inside and Outside districts (Figure 18). For commercial fisheries, state management boundaries were extended in 1997 from territorial or state waters (3 nmi) to include waters of the EEZ (3–200 nmi). For sport fish management, PWS is split into defined reporting areas (Figure 19).

The commercial CI area and sport fish Cook Inlet–Resurrection Bay Saltwater area includes territorial waters west of Cape Fairfield and north of the latitude of Cape Douglas (lat 58°51.10′N). The commercial CI area is divided into 2 districts with different management measures for rockfish: the Cook Inlet District and the North Gulf District (Figure 18). The majority of rockfish habitat is located in the North Gulf District. The sport fish Cook Inlet–Resurrection Bay Saltwater area is divided into the North Gulf Coast (NGC) and Lower Cook Inlet management areas (Figure 20). The NGC consists of marine waters east of the longitude of Gore Point (long 150°57.85′W) to Cape Fairfield. Lower CI includes CI waters south of Ninilchik (including all of Kachemak Bay) to the latitude of Cape Douglas and east to the longitude of Gore Point.

Black Rockfish

Commercial Fishery Management

Historically, commercial rockfish fisheries in the Central Region were not actively managed until management plans were established for PWS (1989) and CI (1993) areas. GHLs were initially established in each management area based on historical harvest levels for all rockfish species combined. Black rockfish is the main species harvested in the pelagic shelf rockfish (PSR) assemblage, and harvest occurs primarily in the CI-directed fishery with mechanical jig and hand troll gear (termed collectively as jig gear). CI currently has the only directed commercial rockfish fishery in the region; directed rockfish harvest was eliminated in PWS in 2000 by the BOF. Regulations adopted since 2005 made the directed rockfish fishery in CI a PSR-only fishery. At this time, harvest documentation using logbooks was also made mandatory in the directed CI PSR fishery. Retention of all rockfish in groundfish fisheries is mandatory in both PWS and CI. There is very little PSR bycatch in PWS because most rockfish are caught by longline gear as bycatch in Pacific cod and halibut fisheries. Black rockfish is actively managed in state waters using rockfish GHLs, trip limits, and bycatch allowances set in regulation: GHLs are 150,000 lb for PWS (bycatch only of all species) and 150,000 lb for CI (PSR-directed catch and bycatch of all species).

Sport Fishery Management

Black rockfish harvested in this region have primarily been managed using bag and possession limits. The sport rockfish fishery in PWS had no bag limit until 1989 when limits were set at 20 rockfish per day and 20 in possession, only 5 of which could be “red” rockfish. In 1973, the BOF adopted the first bag limits in the Cook Inlet–Resurrection Bay Saltwater area: 10 rockfish per day and 10 in possession. Sport fishery bag limits for all rockfish species have been reduced periodically since these initial state regulations were set because rockfish harvest in this region continued to increase. Bag limit changes and required retention policies have also been adopted to shift more of the rockfish harvest to PSR species (e.g., black rockfish). Currently PWS sport rockfish management includes a year-round bag limit of 4 rockfish per day and 8 in possession, of which only 1 per day and 1 in possession may be nonpelagic, with no size limit. Harvest limits for rockfish in the NGC align with those for PWS, except 2 nonpelagic rockfish may be in possession instead of 1. Current rockfish regulations in CI, effective since 1996, include a year-round season, a bag limit of 5 per day and 10 in possession, of which no more than 1 per day and 2 in possession may be nonpelagic species.

Black rockfish are a substantial proportion of the rockfish sport harvest in the Southcentral region. (Meyer et al. *In prep*); black rockfish are approximately 56% of the rockfish sport harvest in CI, 70% in NGC, and 50% in PWS. Although available year-round, most rockfish are harvested in the sport fishery from May through early September.

Subsistence and Personal Use Fishery Management

In PWS and CI, subsistence rockfish fishing gear is limited to a single hand troll, single hand-held line, or a single longline, none of which may have more than 5 attached hooks. Rockfish may be taken for subsistence at any time outside of designated nonsubsistence use areas in this region. Amounts deemed reasonably necessary for subsistence uses are 7,500–12,500 rockfish (all species) in PWS and 750–1,350 rockfish (all species) in CI. The PWS subsistence harvest limit is 4 rockfish per day and 8 in possession, of which only 2 per day and 2 in possession may be nonpelagic rockfish (May 1 to September 15); and 8 rockfish per day, of which only 2 per day and 2 in possession may be nonpelagic rockfish (September 16 to April 30). In CI, the subsistence daily bag limit is 5 rockfish and 10 in possession, of which only 1 per day and 2 in possession may be nonpelagic rockfish.

There are no personal use rockfish fisheries in PWS or CI areas.

Harvest Trends

Black rockfish is the main component of the PSR assemblage in PWS and CI commercial fisheries. Because there is a directed PSR fishery in CI and rockfish may only be retained as bycatch in PWS, black rockfish commercial harvests are relatively low in PWS. Commercial fishery harvests are recorded by weight; however, mean individual fish weight (derived from sampling commercial harvests) is used to estimate numbers harvested from reported harvest biomass and these data are available starting in 1998 for the Central Region. Commercial harvest of black rockfish peaked in Central Region fisheries in 1995, with almost 600,000 lb harvested (Figure 21). The most recent 10-year average commercial harvest (2009–2018) was approximately 43,000 lb for the region (Figure 21), with the majority coming from the North Gulf District of CI.

Sport harvest and release data are reported according to port of landing, and currently the Division of Sport Fish does not have a consistent method of apportioning SWHS estimates from trips landed in ports where the harvest may come from more than 1 management area. Rockfish harvest has been estimated since 1977 and has been apportioned into species-specific harvest estimates since 1996. Sport harvest of black rockfish has steadily increased since 1996 (Figure 22). Black rockfish are the dominant rockfish species caught in this region's sport harvest (50–60%) by numbers of fish in recent years. From 1977 to 2016, black rockfish harvest increased from 20,000 to 95,000 fish annually (Figure 22). In 2017 black rockfish harvest decreased to 65,000 fish.

There is limited data on subsistence harvest of rockfish in PWS and CI. Subsistence harvest information from the State of Alaska Community Subsistence Information System and the federal Subsistence Halibut Registration Certificate surveys suggests annual reported black rockfish harvest from 1984 to 2014 was approximately 20–4,000 fish in PWS and 30–8,300 fish in CI for those years reported (Table 3).

Research Summary

Biological characteristics of harvest

Dockside sampling of rockfish species harvested from the Central Region commercial fisheries began in 1991; however, sampling was inconsistent during early years—sample sizes were few, and sex often not identified. Consistent sampling with sex differentiation began in 1999. ADF&G dockside sampling staff conduct interviews with commercial fishermen to obtain fishing location and effort data, and to collect biological samples for fish length, weight, sex, maturity stage, and age structures (otoliths). PSR species composition reported on commercial fish tickets differs

somewhat from dockside sampling indices, suggesting a systematic underreporting of dusky and dark rockfishes, and overreporting of black rockfish in reported landings. The majority of sampled PSR are from landings of directed fishing with jig gear, which tend to have a higher percentage of other species besides black rockfish and may be contributing to species composition discrepancies.

Most commercial fishery black rockfish biological samples come from the CI fisheries, with relatively few from PWS (<500 samples collected 1993–2017). Due to low sample sizes, biological characterization of black rockfish commercial harvests is focused on CI samples. Mean annual black rockfish weight from CI has ranged between 1.7 and 2.6 kg since 1991. Mean length has ranged from 46 to 53 cm FL (Figure 23) and mean age has ranged from 12 to 21 years in CI harvests (Figure 24). Three cohorts, born approximately 1979, 1991 (the largest), and 2002 (Figure 24), have been tracked consistently through the time series in CI commercial harvests. Like other black rockfish stocks, female age distribution is truncated; larger, older specimens encountered tend to be males.

Length, weight, sex composition, and age composition have been estimated for rockfish sport harvest in Southcentral Alaska since 1991 from port sampling programs, though sample sizes were low during the early years of the reporting period. Black rockfish mean total length and weight were highest during the mid-2000s, averaging 2.4 kg and 51 cm TL (Table 4). Black rockfish weights decreased to 2.0 kg and 49 cm TL by 2016. Black rockfish mean ages were between 14 and 16 years old with little variation, and sex composition ranged from 50% to 60% female, although it was as high as 80% female in 1991.

Population characteristics and ecology

The first fishery-independent rockfish survey in the Central Region occurred in 1981 along the NGC, and subsequent surveys occurred annually through 1984 (Morrison 1981, 1982; Rance Morrison, Lower Cook Inlet Groundfish Research Biologist, Outer Coast Rockfish Surveys, 1983 and 1984, unpublished data). Though all species of rockfish were the focus, black rockfish were the most represented species in the samples. These surveys focused on collecting basic biological data (size, sex, age, reproduction), identifying areas of high congregations, and experimenting with mark–recapture methods. Between 2001 and 2005, ADF&G staff conducted a series of research projects to assess black rockfish populations within the North Gulf District (Byerly and Bechtol 2005; Byerly and Worton 2007). One goal of these studies was to develop a standardized approach to index the abundance of black rockfish and associated species in nearshore waters. To monitor population trends, initial surveys attempted to estimate local abundances of black rockfish in areas that might serve as long-term survey locations. Mark–recapture and scuba transects were used to estimate local abundances. Size, sex, age, and CPUE data were also collected during these surveys. Low recapture success and biases detected during scuba transects made these methods unusable. A follow-up study evaluated the use of hydroacoustic counts and mechanical jigging CPUE as low-cost methods to index black rockfish population abundance on a management district scale. Mechanical jigging CPUE was found not to be a predictable index of abundance, although hydroacoustic counts showed promising results (Byerly and Worton 2007). Remotely operated vehicle (ROV) surveys were initiated along the NGC in 2004 to assess the local abundance of lingcod and DSR. Black rockfish were enumerated in the first assessment survey in 2005, but due to their pelagic nature, schooling behavior, and attraction to the ROV, were found to be a poor species to assess using this technology, which surveyed close to the substrate. They have not been enumerated in subsequent ROV surveys. There

are currently no fishery-independent estimates of abundance for black rockfish in the Central/Southcentral Region.

Yelloweye Rockfish

Commercial Fishery Management

Commercial FMPs were first established for PWS (1989) and CI (1993) areas, instituting GHLs in each management area based on historical harvest levels for all rockfish species combined. Yelloweye and quillback rockfishes are the most common DSR species commercially harvested in Central Region and are often caught with longline gear during Pacific cod and halibut fisheries or with jig gear during the directed PSR fishery in CI. In 2000, changes to the PWS rockfish management plan included limiting rockfish harvest to a bycatch-only fishery, requiring mandatory retention of all rockfish caught as bycatch, and setting rockfish bycatch allowances. In CI, despite regulations in 1999 enacted to shift effort from PSR to DSR, the highest historical harvests of DSR (primarily yelloweye rockfish) occurred from 2001 to 2004 by vessels using jig gear (Rumble et al. 2016). In 2005, regulatory changes required mandatory retention of rockfish species in CI groundfish fisheries and restricted the CI-directed commercial fishery to PSR only, resulting in DSR being managed as a bycatch species. Yelloweye rockfish bycatch is actively managed in state waters based on combined rockfish bycatch allowances and trip limits set in regulation.

Sport Fishery Management

In PWS, CI, and NGC, more restrictive bag and possession limits have been set for the longer-lived and less productive nonpelagic species (like yelloweye rockfish) to discourage targeted harvest. Currently PWS sport rockfish management includes a year-round bag limit of 4 rockfish per day and 8 in possession, of which only 1 per day and 1 in possession may be nonpelagic, with no size limit. Harvest limits for rockfish in the NGC align with those for PWS, except 2 nonpelagic rockfish may be in possession instead of 1. Current regulations in CI, effective since 1996, include a year-round season, a bag limit of 5 rockfish per day and 10 in possession, of which no more than 1 per day and 2 in possession may be nonpelagic species.

In NGC 14% of rockfish harvested are yelloweye, and in PWS and CI 8% of the rockfish harvested are yelloweye (Meyer et al. *In prep*). Although available year-round, most rockfish are harvested in the sport fishery from May through early September.

Subsistence and Personal Use Fishery Management

In PWS and CI, subsistence rockfish fishing gear is limited to a single hand troll, a single hand-held line, or a single longline, none of which may have more than 5 attached hooks. Rockfish may be taken for subsistence at any time outside of designated nonsubsistence use areas in this region. Amounts deemed reasonably necessary for subsistence uses are 7,500–12,500 rockfish (all species) in PWS and 750–1,350 rockfish (all species) in CI. The PWS subsistence harvest limit is 4 rockfish per day and 8 in possession, of which only 2 per day and in possession may be nonpelagic rockfish (May 1 to September 15); and 8 rockfish per day, of which only 2 per day and in possession may be nonpelagic rockfish (September 16 to April 30). In CI the subsistence daily bag limit is 5 rockfish and 10 in possession, of which only 1 per day and 2 in possession may be nonpelagic rockfish.

There are no personal use rockfish fisheries in PWS or CI areas.

Harvest Trends

Yelloweye rockfish tend to be the major component of the DSR assemblage harvest in the Central Region commercial fisheries. Commercial fishery harvests are recorded by weight; however, mean individual fish weight is used to estimate numbers harvested from reported harvest biomass and these data are available starting in 1998 for the Central Region. Peak commercial harvest of yelloweye rockfish occurred in 1992, primarily due to a particularly large harvest of approximately 106,000 lb in CI (Figure 25). The Central Region's commercial yelloweye rockfish harvest for the recent 10-year period (2009−2018) ranged from approximately 30,000 to 79,000 lb (Figure 25). Though variable in any given year, similar harvest levels tend to occur in PWS and CI commercial harvests. The majority of commercial yelloweye rockfish harvest is from the Inside District of PWS and in the North Gulf District of CI.

Sport harvest and release data are reported according to port of landing, and currently the Division of Sport Fish does not have a consistent method of apportioning SWHS estimates from trips landed in ports where the harvest may come from more than 1 management area. Rockfish harvest has been estimated since 1977 and has been apportioned into species-specific harvest estimates since 1996. Yelloweye rockfish harvest has been less variable than black rockfish harvest and has ranged from 6,000 fish in 1977 to 21,000 fish in 2004 (Figure 26). Harvest levels were similar at the beginning and at the end of the reporting period and were highest between 2000 (15,000 fish) and 2010 (18,000 fish; Figure 26).

There is limited data on subsistence harvest of rockfish in PWS and CI. Subsistence harvest information from State of Alaska Community Subsistence Information System and federal Subsistence Halibut Registration Certificate surveys suggests annual yelloweye or "red" rockfish harvest was approximately 50–6,500 fish in PWS and 1–1,400 fish in CI for those years reported (Table 3).

Research Summary

Biological characteristics of harvest

A total of 4,319 PWS yelloweye rockfish and 6,537 CI yelloweye rockfish were sampled from commercial fisheries for length, weight, sex, and age from 1991 to 2017. Annual mean weight of yelloweye rockfish ranged from 2.6 to 5.2 kg, with an average of 3.3 kg. Mean annual FL for years with sample sizes more than 100 ranged between 47 and 62 cm FL in CI, and between 51 and 58 cm FL in PWS (Figure 27). To date, a total of 6,937 yelloweye rockfish otoliths have been assessed for age determination from the Central Region commercial fisheries and show a minimum age of 4 years and a maximum age of 107 years (Figure 28). For years with sample sizes exceeding 100, yelloweye rockfish mean ages were between 24 and 38 years and sex compositions ranged from 38% to 66% female.

Length, weight, sex composition, and age composition have been estimated for rockfish sport harvest in Southcentral Alaska since 1991, though sample sizes were low during the early years of the reporting period. In years when sample sizes were adequate, yelloweye rockfish mean length ranged from 48 to 61 cm TL and mean weights ranged from 3.3l to 4.6 kg (Table 5). Yelloweye rockfish mean ages were between 28 and 34 years old with little variation, and sex composition ranged from 43% to 66% female (Table 5).

Population characteristics and ecology

Central Region initiated a survey program to assess DSR (primarily yelloweye rockfish) and lingcod using an ROV in inside and outside waters of PWS in 2012 and along the NGC from 2005 to 2014 (Byerly et al. 2015). This approach used a habitat-based assessment to index lingcod and DSR density and abundance at select study areas within Central Region using ROV transect sampling, and to monitor population trends though repeat surveys. Criteria for selecting study areas includes (1) those having a spectrum of current and historical harvest histories including at least 1 area that is a *de facto* reserve for groundfish; (2) those that tend to be relatively isolated rocky banks or rocky reef complexes contiguous with either land masses, deep fjords, or expanses of deeper soft substrates; (3) those that are spread evenly geographically across Central Region and have a high likelihood of encompassing the oceanographic and benthic habitat requirements of the species; and (4) the availability of existing high resolution multibeam bathymetry. Multibeam data have been collected at some of the areas and the rocky habitat has been delineated for all areas. Survey areas are on the order of hundreds of km^2.

Strip transects were used for surveys from 2005 until 2010; after that, line transect sampling using stereo cameras has been used. The index approach is reliant on building a time series over many years; however, to date only 1 area has been resurveyed. Survey estimates have been evaluated relative to local harvest as a proxy for exploitation rates, but have not directly informed management or resulted in harvest recommendations. Due to increasing harvest of yelloweye rockfish in PWS and a pressing concern that historic and current exploitation rates may be too high, the spatial extents of the habitat-based survey methods were enlarged for a 2016 survey, with the focus on obtaining an abundance and biomass estimate for PWS. No surveys are currently being conducted.

SOUTHEAST

Description of fishery area

The Eastern GOA regulatory area for groundfish management encompasses all waters from Dixon Entrance (lat 54°30′N) northwestward along the outer coast to long 144°W (Figure 29). Seven state groundfish management areas organized into 4 subdistricts have been established in the Southeast District (Figure 29):

1. Icy Bay Subdistrict
2. Southeast Outside Subdistrict (SEO)
    a. East Yakutat Section (EYKT)
    b. Northern Southeast Outside Section (NSEO)
    c. Central Southeast Outside Section (CSEO)
    d. Southern Southeast Outside Section (SSEO)
3. Northern Southeast Inside Subdistrict (NSEI)
4. Southern Southeast Inside Subdistrict (SSEI)

For the purposes of this document, black rockfish management areas Southern Southeast Outer Coast Sector and Southern Southeast Internal Waters will be referred to as SSEO and SSEI.

Southeast sport fisheries are typically managed regionally or by geographical areas that correspond to a management objective. For example, nonpelagic rockfish are managed in outside waters separately from nonpelagic rockfish in inside waters in order to keep the sport fishery within its

allocation specific to outside waters. In Southeast Alaska, sport fishery management areas include Yakutat, Haines/Skagway, Juneau/Glacier Bay, Sitka, Petersburg/Wrangel, Ketchikan, and Prince of Wales.

Management areas in Southeast Alaska are not consistent between commercial fisheries and sport fisheries. For example, the SWHS gathers information on rockfish harvest in the Sitka area, which encompasses all of Baranof Island and large portions of Chichagof Island; however, the commercial fisheries groundfish management areas do not correspond to this area. The Sitka area referenced in the SWHS includes all the Central Southeast Outside Waters (CSEO), and portions of the Northern Southeast Outside Waters (NSEO) and Northern Southeast Inside Waters (NSEI). When applying statewide harvest information to these commercial fisheries management areas, harvest is apportioned to each respective area based on other sources such as logbook and creel information.

A no-take groundfish marine reserve (Edgecumbe Pinnacles Marine Reserve) is located in Southeast Alaska in a 3.2 nm^2 area surrounding the Cape Edgecumbe pinnacles off the southwest coast of Kruzof Island (Figure 29). This area was closed to all removals of groundfish from all fisheries in 1998 by the BOF, and to halibut and groundfish in 1999 by the NPFMC. This represents the first no-take groundfish marine reserve in Alaska.

Black Rockfish

Commercial Fishery Management

Black rockfish account for the largest proportion of commercial landings in the PSR assemblage in inside and outside waters and are taken primarily as bycatch in longline and salmon troll fisheries, and in a small directed fishery occurring in SEO. The directed fishery is open-access, year-round, and is prosecuted only in SEO areas, and prohibited in NSEI and SSEI management areas along with 5 areas along the outer coast (Figure 30; Olson et al. 2017). The directed fishery is prosecuted through a miscellaneous finfish permit and is managed using area-specific GHLs, vessel registrations, gear restrictions, logbooks, port sampling, and small area closures. Gear allowed in the directed fishery includes mechanical jigging machines, dinglebar, and hand troll gear. Full retention of black rockfish has been required since 2000; harvests that exceed the legal landing limits are forfeited to the State of Alaska. The directed fishery has (1) management area-specific GHLs that are based on data from historical harvest in Southeast Alaska; (2) GHLs from the Kodiak black rockfish commercial fishery (Jackson and Ruccio 1998); and (3) and a minimum estimate from a 1996–2002 CSEO mark–recapture study that was extrapolated to the remaining management areas and suitable black rockfish habitat within 18–55 m (Tydingco and Brylinsky 1999; Olson et al. 2017). In 2000, regulations were implemented to define *allowable gear* in order to reduce bycatch in the longline fisheries, and bycatch retention requirements were implemented. In 2006, all inside waters closed due to a lack of suitable habitat to support a commercial fishery, and certain areas in SEO also closed to provide research opportunities and some stock protection. In 2009, a regulation was repealed to allow the sale of black rockfish bycatch in inside waters to reduce waste, and in 2012 a year-round season definition was established (Olson et al. 2017).

In recent years, the commercial fishery has had minimal participation; the majority of black rockfish harvest occurs as bycatch in longline and salmon troll fisheries. Since 2015, bycatch in the salmon troll fishery has been assigned to both a salmon and groundfish statistical area on fish tickets due to difficulty in prior years determining where to properly allocate harvest based on

salmon statistical areas. In order to maintain bycatch harvest at low levels, bycatch harvest allowances for black rockfish range from 0% to 15% dependent upon gear and target fishery. Harvest is tracked inseason through logbooks and fish tickets, and biological data (including length, weight, sex, and age) is collected during port sampling to assess changes in stock and population trends throughout the region.

Sport Fishery Management

Sport fishing regulations for rockfish in Southeast Alaska south of Cape Fairweather were first established in 1989 and consisted of bag limits of 5 rockfish (pelagic and nonpelagic combined) per day and 10 in possession, of which only 2 per day and 4 in possession could be yelloweye rockfish. Exceptions to the regionwide limits were enacted in 1989 for the Ketchikan and Sitka areas where the bag and possession limits were set at 3 rockfish, of which only 1 could be a yelloweye rockfish. In 1994, the Southeast Alaska regionwide regulations for rockfish were modified by the BOF to provide bag limits for the pelagic and nonpelagic assemblages, as well as for yelloweye rockfish specifically. Bag limits for pelagic species were set at 5 fish per day and 10 in possession. The bag limits for other species were also 5 fish per day and 10 in possession, of which only 2 per day and 4 in possession could be yelloweye rockfish. These Southeast Alaska regionwide regulations were also extended to include the Yakutat area. Given the lack of stock status information and increasing sport harvests, ADF&G reduced the pelagic bag and possession limit in the Sitka area to 3 fish per day and 6 in possession for 2016 and 2017. In 2018, the BOF implemented a 3-fish bag limit for nonresidents only; resident harvest limits then reverted to the 5-fish regional limit.

Subsistence and Personal Use Fishery Management

There are no daily bag, possession, or annual limits for subsistence caught rockfish and no restrictions on the amount of gear permitted for fishing.

There are no daily bag and possession limits for the personal use rockfish fishery except within the vicinities of Ketchikan and Sitka where no more than 3 rockfish may be in possession, of which only 1 may be a yelloweye rockfish. Gear is restricted to longline and handheld only, and a permit is not required when personal use fishing for rockfish. Most personal use rockfish harvest is caught and retained as bycatch in the sablefish personal use and subsistence fishery (permit required) and halibut subsistence fishery.

Harvest Trends

Commercial harvest of black rockfish has been recorded in Southeast Alaska since 1983; however, ADF&G did not have management authority in federal waters until 1998 when black rockfish was removed from the federal FMP. In the late 1980s, black rockfish harvest peaked at 383,744 lb with most of the harvest occurring as bycatch in the longline fishery. ADF&G was concerned about these high harvest levels given that there was no reliable stock assessment for black rockfish; the federal GOA trawl survey was primarily targeting dusky rockfish and therefore was not representative of black rockfish populations present on nearshore reef habitats. These concerns resulted in the development of a directed fishery with gear restricted to mechanical jig or troll gear and full retention requirements, allowing for more conservative management in the region. Harvest in the directed fishery peaked in 1997 at 123,950 lb prior to the state obtaining management authority in 1998 (Figure 31). Since then, the directed fishery harvests topped out at less than

91,000 lb (in 2002 and 2003) and have since decreased due to low participation. Most of the commercial harvest now occurs as bycatch in the salmon troll fishery (Figure 31).

Black rockfish make up a large portion of the entire Southeast Alaska rockfish sport harvest, but this proportion is different between inside and outside waters. Quillback rockfish are the most commonly caught rockfish species in SSEI waters (Ketchikan) and tiger rockfish are a commonly caught species in NSEI waters, but black rockfish are the largest single contributors to the rest of the Southeast Alaska areas. Overall, black rockfish account for 91% (range 86–94%) of the pelagic rockfish harvested in the sport fishery across the region, though the contribution varies by fishery management area. The regional harvest of pelagic rockfish, predominantly black rockfish, has been on an increasing trend since the early 2000s (Figure 32). Between 2009 and 2014, the regional pelagic rockfish sport harvest more than doubled, increasing from 45,000 fish in 2009 to 113,000 fish in 2015 (Figure 32). Although harvest has increased throughout the region, the Sitka area (CSEO) has seen the greatest increase in pelagic harvest.

Data for subsistence harvest of black rockfish are available from 1984 to 2016, and show an average harvest of 894 lb per year across multiple communities in Southeast. Data for personal use harvest of black rockfish are not available. Biological data from subsistence and personal use fisheries have not been sampled to date.

Research Summary

Biological characteristics of harvest

Harvest of black rockfish in the directed commercial fishery has remained low since 2005 and as a result, sampling for age, sex, and length has become opportunistic. There was no sampling from 2007 to 2015 due to landings occurring where staff were not available and landings being too small and infrequent. Length distributions for black rockfish ranged from 27 to 65 cm FL with an average length of 46.8 ± 5.2 cm for females (n = 2,278), and from 26 to 65 cm FL with an average length of 47.4 ± 5.2 cm for males (n = 3,456; Figure 33). Age distributions for black rockfish ranged from 4 to 51 years of age with an average age of 13.5 ± 4.6 years for females (n = 1,460), and from 4 to 52 years of age with an average age of 17.8 ± 6.6 years for males (n = 2,379; Figure 34).

Biological sampling of the black rockfish sport fishery has occurred since 2006, although not all biological parameters have been collected during the entire timeframe. Length characteristics have been collected continuously since 2006 for black rockfish, but age and sex information has only been collected since 2016 (2016–2018), and only in Sitka (generally CSEO). Length distributions for black rockfish from 2006 to 2018 ranged from 17 to 88 cm FL with an average length of 44.3 ± 7.2 cm (n = 25,336; Figure 35). Age samples from Southeast Alaska sport harvested black rockfish are only available from Sitka area (2016–201) and range from 4 to 29 years of age with an average age of 12.1 ± 4.1 years for females (n = 610) and from 4 to 41 years of age with an average age of 16.4 ± 6.0 years for males (n = 1,075).

Biological sampling of personal use and subsistence fisheries does not occur, so the composition of theses harvests is unknown.

Population characteristics and ecology

Tagging project

A series of tagging projects aimed at obtaining black rockfish population estimates occurred in 1999 (Tydingco and Brylinsky 1999), 2000,[1] and 2002.[2] Though tagging locations varied, surveys were similar in that fish were tagged with numbered dart tags. In 1999, of 766 tagged black rockfish, only 1 was recaptured that year (Tydingco and Brylinsky 1999). In 2000, of 2,483 tagged black rockfish, 16 were recaptured from the 1999 tagging event, and 3 were recaptured from the 2000 tagging event.[1] In 2002, 278 black rockfish were tagged, but recaptures from that event were not reported.[2] Analyses to estimate abundance only incorporated tagging survey data from 1999 and 2000. CPUE and cumulative removals over time within station and by vessel were used for analysis. An evaluation of tag returns suggested that black rockfish exhibited limited movements over time. The median distances from tagging locations to recapture locations in 1999 and 2000 were between 0.4 km (341 and 411 days at-large) and 0.63 km (281 days at-large).[3] Although black rockfish density was estimated to be 11,435 rockfish/km^2 at 1 sample station, researchers believed these results were still not adequate for representing the population, and suggested that future research efforts focus on habitat mapping to quantify available black rockfish habitat.[3]

Habitat Modeling and Remotely Operated Vehicle Surveys

Starting in 2018, black rockfish numbers and lengths have been recorded in yelloweye ROV surveys as an incidental species. At this time, black rockfish have been enumerated in the SSEO and the CSEO.

Groundfish staff have also transcribed commercial black rockfish logbook data to a digital format. This information documents the location of nearly 12,000 black rockfish harvested from 1996 to 2018. These data were used to create a habitat suitability model for black rockfish in the CSEO (management area with the highest resolution bathymetry data). The results from this habitat suitability model, identifying approximately 1,600 km^2 of highly suitable habitat in the CSEO, were then used to identify test ROV dive locations. Three test locations identified prior to the yelloweye CSEO ROV survey in August of 2018 were added to the regular yelloweye survey. Unfortunately, the first attempted test dive was aborted midway through the 1 km transect due to high relief terrain in shallow water (~30–40 m deep). These conditions made it difficult for the ROV to maneuver along the designated transect. Despite the challenges, 5 black rockfish were identified and recorded on this initial test dive. The 2 other test dives were cancelled due to a lack of time and unfavorable environmental conditions. Although there were issues with the test dives, the ability to find and document black rockfish in areas defined as *highly suitable* from the habitat suitability model is encouraging.

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[1] C. Brylinsky, project leader; and D. Carlile and T. O'Connell, principal investigators. Unpublished report. Standard comprehensive report: Southeast black rockfish research (NA96FN0195 Project 3), July 1, 1999 to June 30, 2000. Available from Kellii Wood, Alaska Department of Fish and Game groundfish biologist, Petersburg.

[2] C. Brylinsky. Unpublished report. Black rockfish stock assessment cruise report 2002. Available from Kellii Wood, Alaska Department of Fish and Game groundfish biologist, Petersburg.

[3] C. Brylinsky, D. Carlile, and T. O'Connell, principal investigators. Unpublished report. Southeast Alaska black rockfish research 1999 to 2002. Available from Kellii Wood, Alaska Department of Fish and Game groundfish biologist, Petersburg.

Yelloweye Rockfish

For federal waters, a total allowable catch (TAC) is set annually for DSR in the SEO as part of the NPFMC stock assessment process (Olson et al. 2017). The TAC varied between 211 and 960 metric tons (465,000–2,116,000 lb) from 1988 to 2017 and has steadily declined since the mid-2000s. DSR fishery mortality occurs in the directed commercial fishery, sport fishery, subsistence fishery, and as bycatch and unreported mortality in the commercial groundfish and halibut fisheries. After the projected subsistence harvest of DSR has been subtracted from the TAC, the remainder of the TAC is allocated between sport and commercial fisheries (5 AAC 28.160(c)). Current allocations in SEO waters are 16% for sport fisheries and 84% for commercial fisheries. Prior to 1989, the commercial DSR fishery was managed under the federal FMP for outside waters east of long 140°W. The federal groundfish FMP was amended in 1989 to improve fishery management by providing regulatory authority for shared state and federal management of DSR. Since then, ADF&G has been implementing regulatory changes for inside and outside waters by shifting harvest opportunity to a directed fishery and minimizing bycatch in other fisheries. The NPFMC delegated sport fishery management of DSR species in the SEO to the State of Alaska under the federal FMP for groundfish of the GOA.

Commercial Fishery Management

The DSR-directed commercial fishery is managed among 6 management areas commonly referred to as inside (NSEI and SSEI) and outside (EYKT, CSEO, NSEO, and SSEO) water management areas (Figure 29). The DSR fishery began in 1979 as a small shore-based jig fishery in Sitka Sound. Upon the introduction of longline gear, the dynamics of the fishery shifted towards targeting primarily yelloweye rockfish. Commercial harvest increased rapidly throughout the 1980s and harvest limits were implemented to reduce overharvest and localized depletion.

Current management plans include provisions for open access commercial fisheries that provide the following:

- Area-specific GHLs for NSEI and SSEI allocated between winter and fall seasons.
- Harvest trip limits.
- Hook and line gear only.
- Full bycatch retention of DSR.
- Yelloweye rockfish fishery permit requirements.

Management plans also provide for allocations among sport and commercial fisheries. For outside waters (EYKT, NSEO, CSEO, and SSEO), opening the DSR commercial fishery depends on the availability of recent survey biomass estimates and harvest limits in the directed halibut fishery. Due to limited funding and vessel availability, the DSR ROV survey occurs annually in 1 of the 4 outside waters management areas. As a cautionary approach to reduce fishery impacts on the stocks, fishery openings are rotated among areas, only occurring in an area where a survey has been completed. Before an area opens to the directed fishery, ADF&G estimates DSR bycatch levels in the directed halibut fishery prior to setting a directed DSR fishery GHL. Seasons generally open in early February and close at the start of the commercial halibut season or until the harvest limit is reached, whichever occurs first. In order to maintain bycatch harvest at low levels in all areas, bycatch harvest allowances for DSR range from 0% to 10% depending on gear and target fishery. Harvest is tracked inseason through logbooks and fish tickets, and biological data (length,

weight, sex, and age) is collected during port sampling to assess changes in stock and population trends throughout the region.

Sport Fishery Management

Sport fishing regulations for rockfish in Southeast Alaska south of Cape Fairweather were first established in 1989 and allowed a bag limit of 2 yelloweye rockfish per day and 4 in possession. Exceptions to the regionwide limits were enacted in 1989 for the Ketchikan and Sitka areas: the yelloweye rockfish bag and possession limits were restricted to 1 fish. In 1994, Southeast Alaska regionwide regulations were extended to include the Yakutat area.

Current sport fishery management plans include the following:

- Allow emergency order authority to reduce bag and possession limits for nonresident anglers.
- Require retention of all DSR caught by a nonresident angler until the nonresident bag limit is reached.
- Prohibit charter operators and crew from retaining DSR while clients are on board the vessel.
- Set annual limits for DSR for nonresident anglers.
- Reduce bag and possession limits for resident anglers.
- Require retention of all DSR caught by resident anglers until the resident angler's bag limit is reached.
- Set annual limits for DSR for resident anglers.
- Institute time and area closures.

In response to a decrease in TAC since 2006, ADF&G has used increasingly restrictive management measures to maintain the sport harvest within its allocation. After exceeding the allocation in 2015 and 2016, the most restrictive management measures were implemented in 2017, and again in 2018 and 2019. These measures included closing the nonpelagic rockfish sport fishery in SEO for 21 days from August 1 to August 21 in 2017, extending the closure for 31 days from August 1 to August 31 in 2018, and further extending the closure for 38 days from July 25 to August 31 in 2019. Despite the more restrictive measures enacted in 2017 and 2018, preliminary mortality estimates indicate the sport fishery exceeded its allocation in these years. Unlike the SEO waters, no TAC is set for nonpelagic rockfish in Southeast Inside waters for the sport fishery.

Subsistence and Personal Use Fishery Management

There are no daily bag, possession, or annual limits for subsistence caught rockfish and no restrictions on the amount of gear permitted for fishing. There are no daily bag and possession limits for the personal use rockfish fishery except within the vicinities of Ketchikan and Sitka where no more 1 rockfish in possession may be a yelloweye rockfish. Personal use gear is restricted to longline and handheld only and a permit is not required when personal use fishing for rockfish. Most personal use rockfish harvest is caught and retained as bycatch in the sablefish personal use and subsistence fishery (permit required) and halibut subsistence fishery.

Harvest Trends

Commercial harvest of yelloweye rockfish has been recorded in Southeast Alaska since 1992. In 1993, yelloweye rockfish harvest peaked at 246,315 lb in inside waters (NSEI and SSEI) with the

majority of the harvest occurring in the directed fishery. By 1996, the harvest had rapidly declined to 54,022 lb (Figure 36). Harvest increased again, peaking at 140,895 lb in 2000, and declined shortly thereafter. Most of the commercial harvest in NSEI and SSEI occurs as bycatch in the halibut Individual Fishing quota (IFQ) fishery due to low participation in the directed fishery (Figure 36). In outside waters, commercial yelloweye rockfish harvest peaked in 1994 at 1,229,652 lb with the majority of the harvest occurring in the directed fishery. By 2011, harvest had declined to 245,673 lb (Figure 37). Incidental harvest in the halibut IFQ fishery continues to remain high, and as a result the directed fishery for DSR in outside waters has rotated management area openings based on the latest stock assessment survey information.

Onsite creel sampling data indicate that yelloweye rockfish accounted for an average of 66% of the annual sport harvest of DSR in SEO from 2013 to 2017. The majority of yelloweye rockfish sport harvest in Southeast Alaska comes from 2 commercial fisheries groundfish management areas that are roughly equivalent to Sitka (SSEO) and Ketchikan (SSEI) sport fishery management areas. These 2 areas account for 70% of the average regional yelloweye rockfish harvest (11,889 fish) over the last 5 years (Figure 38). Throughout the Southeast region, the proportion of yelloweye rockfish harvest over the last 5 years is split relatively evenly between charter anglers (57%) and private anglers (43%), though charter anglers harvest the majority of the total yelloweye rockfish in CSEO.

Data for subsistence harvest of yelloweye rockfish are available from 2012 to 2016 with an average harvest of 2,962 lb per year across the communities of Angoon, Haines, Hoonah, Hydaburg, Whale Pass, Sitka, Yakutat, and Hoonah combined. Data for personal use harvest of yelloweye rockfish are not available.

Research Summary

Biological characteristics of harvest

Harvest of yelloweye rockfish in the directed commercial fishery has remained low since 2005, and as a result, sampling for age, sex, and length has become opportunistic. Sampling did not occur from 2011 to 2017 in NSEI and SSEI. For inside waters, length distributions of yelloweye rockfish ranged from 28 to 83.5 cm FL with an average length of 54.3 ± 8.2 cm for females (n = 9,193) and from 26 to 82 cm FL with an average length of 54.3 ± 9.4 cm for males (n = 6,984; Figure 39). For outside waters, length distributions of yelloweye rockfish ranged from 19 to 90 cm FL with an average length of 55.6 ± 7.23 cm for females (n = 28,429) and from 26 to 96 cm FL with an average length of 55.4 ± 7.62 cm for males (n = 26,013; Figure 39). For inside waters, age distributions of yelloweye rockfish ranged from 6 to 121 years of age with an average age of 42.4 ± 20.6 years for females (n = 3,200) and from 6 to 117 years of age with an average age of 35.4 ± 17.8 years for males (n = 2,357; Figure 40). For outside waters, age distributions of yelloweye rockfish ranged from 10 to 122 years of age with an average age of 40.3 ± 17.3 years for females (n = 15,087) and from 8 to 113 years of age with an average age of 34.1 ± 13.6 years for males (n = 1,605; Figure 40).

Biological sampling of the yelloweye rockfish sport fishery has occurred since 2006, although only length characteristics were captured. Length distributions for yelloweye rockfish ranged from 21 to 109 cm FL with an average length of 56.3 ± 10.4 cm (n = 22,263; Figure 41).

Biological data from subsistence and personal use fisheries have not been sampled to date.

Population characteristics and ecology

Although no population studies have occurred in inside waters, distance sampling methodology is used to estimate yelloweye rockfish density in SEO waters with submersible (1988–2009) and ROV (2012–present) surveys. Density estimates are limited to adult and subadult yelloweye rockfish, the principal species targeted and caught in the directed DSR fishery. Biomass of adult yelloweye rockfish is derived as the product of estimated density, the estimate of rocky habitat within the 200 m contour, and average weight of fish for each management area. Variances are estimated for the density and weight parameters, but not for area. Estimation of both transect line lengths and total area of rocky habitat are difficult and contribute to uncertainty in the biomass estimates.

Past yelloweye rockfish research in SEO waters incorporated manned submersible dive surveys. In a typical submersible dive, 2 line transects were completed per dive with each transect lasting 30 minutes. Yelloweye rockfish were enumerated by life history type using direct observation and cameras mounted on the submersible (Buckland et al. 1993). Hand-held sonar guns were used to calibrate observer estimates of perpendicular distances.

ROV surveys were implemented in 2012 to replace the manned submersible surveys and are currently utilized for research purposes. Random dive locations for line transects (Figure 42) are selected in preferred yelloweye rockfish habitat using Geographic Information Systems (GIS). Random locations were removed from the survey design if they were thought to be greater than 200 m deep, which is the maximum operating depth for the ROV. Transects of 1 km length were mapped at each suitable random point with 4 possible orientations along the cardinal directions crossing through the random point. The number of planned transects is based on yelloweye rockfish encounter rates from previous surveys and our targeted precision (CV less than 15%). Fish are recorded on the right and left side of the centerline of the line transect when reviewing video. The video reviewer identifies and enumerates adult and subadult yelloweye rockfish for density estimation. Juvenile yelloweye rockfish, other DSR, black rockfish, lingcod, and halibut are also enumerated to determine species composition. As time allows, other large-bodied fish are identified and enumerated as well.

Total fish length is recorded for individual yelloweye rockfish, lingcod, halibut, and black rockfish (2018). Fish behavior and maturity stage are recorded for yelloweye rockfish only.

ADF&G STATEWIDE ROCKFISH INITIATIVE

ADF&G recognizes the unique life history characteristics of rockfish species that make them particularly vulnerable to overfishing, the current lack of stock status information for many black and yelloweye rockfish stocks, increasing fishing effort on black and yelloweye rockfishes throughout Alaska, and that multiple user groups harvest the same stocks of these species. ADF&G intends to maintain sustainable black and yelloweye rockfish fisheries throughout the state by following, to the extent practicable, the standards developed through this *ADF&G Statewide Rockfish Initiative*. The Initiative began in 2017 and focused on developing long-term collaborative management and assessment strategies for these 2 species. A key recognition at the onset of the Initiative was the need to truly collaborate across regions and divisions, share information, and build capacity among staff to further develop management approaches and research programs for black and yelloweye rockfishes. The Initiative builds upon prior efforts by ADF&G but is unique in the commitment of resources and staff time to realizing substantial long-term progress in rockfish management strategy development.

PRIOR ROCKFISH EFFORTS

Concern for sustainable management of rockfishes in Alaska has been ongoing for some time. Prior workshops, symposia, and similar meetings have occurred in 2003, 2005, 2006, 2010, 2011, and 2016. Unfortunately, previous efforts lacked the level of commitment and funding support needed from ADF&G leadership, statewide staff, and regional staff to ensure lasting progress. However, information shared during these prior efforts is being used under the current initiative. Files archived from workshops include initial planning materials, workshop agendas, lists of attendees, copies of presentations, and meeting minutes. All materials are accessible to staff engaged in the current statewide rockfish management strategies initiative via a SharePoint website.

2003 Black Rockfish Workshop (Anchorage, February 11–12)

The Division of Commercial Fisheries organized a 2-day workshop in February 2003, focused on black rockfish. Participants included ADF&G staff from the divisions of Commercial Fisheries and Sport Fish from across the GOA, University of Alaska, NMFS, Department of Fisheries and Oceans, Washington Department of Fisheries and Wildlife, Oregon Department of Fish and Wildlife, and the University of California Sea Grant Program. The workshop had 4 primary goals: (1) acquaint ADF&G staff with the various black rockfish fisheries occurring around the state, and the research done to date on black rockfish stocks in both Alaska and other parts of the black rockfish range; (2) identify and prioritize key knowledge gaps that may impact the sustainability of Alaskan black rockfish fisheries; (3) identify potential assessment techniques; and (4) develop Nearshore Marine Fisheries Research projects and assign staff to those projects.

2005 Rockfish Symposium (Anchorage, September 13–15)

The 23rd Wakefield Fisheries Symposium organized by Alaska Sea Grant hosted a 3-day symposium focused on a variety of topics—all related to promoting sustainability and conservation for rockfish species in the North Pacific. This symposium took place in tandem with the 135th annual meeting of the American Fisheries Society, bringing participants from nearly every state and federal management entity on the west coast (including Alaska), as well as university researchers and other stakeholder groups. The overarching goal of the symposium was to convene scientists, fishery managers, and industry to discuss rockfish biology, taxonomy, assessment techniques, and management strategies to promote sustainability and conservation on both sides of the North Pacific. It was also a prime opportunity to address future research needs. The symposium was broken into 6 oral presentation and accompanying poster sessions that included the following: (1) biology and life history, (2) genetics and speciation, (3) ageing and growth, (4) fishery management, (5) habitat requirements, and (6) stock assessment. In addition to symposium materials archived on the ADF&G SharePoint site, a Proceedings Book was also published and is available through the Alaska Sea Grant program.

2006 ADF&G Statewide Groundfish Meeting (Anchorage, April 10–11)

ADF&G convened a 2-day meeting with staff from the divisions of Commercial Fisheries and Sport Fish involved with groundfish research and management in April 2006. The primary purpose of the meeting was for all regions of the GOA to exchange information.

The meeting was composed of several sessions and included the following: (1) overviews of Division of Commercial Fisheries groundfish management and assessment/research in the

Westward, Southcentral, and Southeast regions; (2) overviews of Division of Sport Fish groundfish management and assessment/research in the Southcentral and Southeast regions; (3) demonstration of eLandings; (4) overview of Age Determination Unit activities; (5) groundfish maturity; (6) groundfish ageing; (7) GIS coordination; and (8) current and prospective groundfish assessment approaches and reference points. The division of Commercial Fisheries produced a Special Publication (Carlile 2006) that provided a detailed account of each session, including summaries of presentations and the ensuing dialogue.

2011 ADF&G Statewide Groundfish Meeting (Anchorage, April 26–27)

Another statewide groundfish meeting was assembled in 2011 and included presentations covering a number of relevant groundfish management and research/assessment topics as well as a group discussion. The presentations included the following short list of topics: (1) region- and area-specific overviews of the Division of Commercial Fisheries groundfish management and research/assessment (Westward, Southcentral, and Southeast); (2) region- and area-specific overviews of the Division of Sport Fish groundfish management and research/assessment (Southcentral and Southeast); (3) total catch accounting; (4) overview of groundfish Age Determination Unit activities; (5) update on eLandings; (6) overview of Enterprise Sharing and Data Warehouse; (7) overview of population assessments, including submersible, ROV, and hydroacoustic surveys; (8) overview of rockfish barotrauma research; and (9) overview of GIS applications, issues, and opportunities.

2016 Black Rockfish Workshop (Juneau, October 19–20)

The Division of Commercial Fisheries organized a 2-day workshop focused on black rockfish in 2016. Participants included staff from the divisions of Commercial Fisheries and Sport Fish from across the GOA. In addition to ADF&G staff, there was representation from NMFS, the Washington Department of Fisheries and Wildlife, and the Oregon Department of Fish and Wildlife. The workshop consisted of presentations followed by discussion topics germane to the presentations. The workshop had 3 primary goals: (1) to determine the best, cost-effective methods to assess black rockfish for management; (2) to determine limitations in assessment methods and how to best deal with these; and (3) to present and discuss research ideas to help manage black rockfish.

Presentations focused on the following topics: (1) general overview of research, sampling, and surveys for black rockfish; (2) specific research and survey methods employed by different agencies and within the divisions of Commercial Fisheries and Sport Fish; (3) stock assessment and the role of PIT tagging; and (4) stock assessment and focus on large fecund females.

STATEWIDE ROCKFISH INITIATIVE PROGRESS TO DATE

The Initiative relies on a dedicated team of lead staff from across divisions and across the GOA to facilitate collaborative development of management and research strategies. This Leadership Plan Team (LPT) has devised several approaches for the Initiative that are expected to provide more successful and lasting outcomes than prior rockfish efforts: (1) initiating a series of regularly scheduled, in-person workshops to encourage shared learning and progress among all staff engaged in GOA rockfish research and management; (2) forming topic-specific workgroups that are intended to make progress on Initiative work between regular workshops; (3) hosting training and capacity-building opportunities for rockfish staff; (4) planning regular meetings of the LPT to maintain momentum; (5) developing a strategic plan for the rockfish initiative; and (6) developing

communication tools, such as this report, to share information with the public and ADF&G leadership on progress of this initiative. Additionally, the LPT has established a means of archiving and sharing information gained through this process that is accessible to all rockfish staff. Archived documents include workshop agendas, detailed minutes from workshops and breakout working groups, participant lists, presentations, shared reports, and lists of staff assignments. Four workshops have been held to date under the Initiative: September 2017, April 2018, September 2018, and April 2019. Additionally, the LPT hosted a workshop with outside experts from British Columbia and the U.S. West Coast in April 2019, to take advantage of lessons learned in other rockfish fisheries.

Workshops and Capacity Building Opportunities

Fall 2017 Workshop

Approximately 35 staff members from the divisions of Sport Fish and Commercial Fisheries participated in a workshop held September 26–28, 2017 in Anchorage, Alaska, to address ADF&G's management and research strategies for black and yelloweye rockfishes. The planning and coordination of the workshop was carried out primarily by members of the LPT with the assistance of a contracted facilitator. Because most of the rockfish harvest in the state is composed of black and yelloweye rockfishes, these species would be the focus of this effort. Additionally, advancement of management and assessment strategies for these species would similarly extend to other rockfish species, given overlap in their distribution and life history strategies. Staff members from all regions across the GOA contributed to the planning, development, and participation in the workshop.

Six key meeting objectives were identified for the workshop and included the following: (1) present information about past and current management and stock assessment of black and yelloweye rockfishes in the GOA; (2) build relationships between regions and divisions in order to support ongoing development of management strategies and research projects; (3) establish a common vocabulary and level of literacy across a broad spectrum of topics related to black and yelloweye rockfish life history and management strategies; (4) discuss and identify candidate strategies for management of black and yelloweye rockfishes and find commonalities in strategies among divisions and regions; (5) identify key data gaps and ways that current assessment data may address needs; and (6) identify next steps to further craft management strategies and create timeline, meeting schedule, and staff assignments.

The workshop consisted of presentations to share information, facilitated discussions, and facilitated workgroup sessions. A presentation symposium consisted of 2 primary topics: fishery-specific management, and area- and fishery-specific research and assessment. Participants defined a wide range of terms and concepts relevant to rockfish—life history/ecology, research and assessment, analytical and modeling procedures, and management strategies—in order to establish a common level of literacy among ADF&G staff. Participants discussed options for advancing management strategies, taking into consideration available data and inherent data gaps. The regions and fisheries have been sampled differently, and the resulting varying data availability and data gaps inevitably led to different management approaches. The group identified desired outcomes and the steps necessary to achieve these goals. A timeline, future meeting schedule, and relevant staff assignments were developed. Participants agreed that interim or short-term approaches would be necessary for ADF&G to achieve more robust, long-term management

strategies. This information was documented in a management strategy framework, developed by workshop participants and LPT members.

Spring 2018 Workshop

In April of 2018, a second workshop was held in Anchorage, Alaska, to advance management and research strategies for black and yelloweye rockfishes. This workshop involved approximately 25 staff members from both divisions representing GOA regions. The workshop had the following meeting objectives: (1) share overviews of compiled black and yelloweye rockfishes assessment data from each region; (2) discuss modeling tools to use in development of long and short-term management strategies; (3) identify opportunities to use existing data in building management strategies; (4) identify limitations and gaps in existing data that present obstacles to crafting and implementing management strategies; (5) identify next steps to further craft management strategies; and (6) create timeline, meeting schedule, and staff assignments.

The workshop consisted of facilitated discussions and breakout groups interspersed with topic-specific presentations. Progress of the *ADF&G Statewide Rockfish Initiative* was reviewed, and included an assessment of data compilation efforts from all fisheries and regions in the GOA into a standardized template, and discussions of potential modeling and stock assessment approaches. Several important data compilation and integration issues were either reiterated or emerged, notably the following: (1) it is imperative that all data be in a standard, consistent format and that all measures be expressed in the same units; (2) there were numerous examples of unique data or datasets that did not conform to the initial template; (3) data from divisions and regions were being stored and archived in different databases or repositories that do not allow direct communication (e.g., import/download, cross queries, etc.); (4) a bottleneck of data processing and availability was a common issue across all divisions and regions and it was suggested that ADF&G could benefit from a dedicated programmer or database team; (5) there were significant differences in the duration and extent of various datasets (e.g., age data for sport harvested black rockfish included a timeframe dating back to 1996 in Southcentral, but was just initiated in 2016 in Southeast Alaska); and (6) within a region, there are differences between the spatial areas defining a fishery and the areas where data is collected, making compiling data across all fisheries challenging. Key modeling approaches explored required various types of data, ranging from data-limited applications to age-structured models. The pros and cons of each approach were discussed, including identifying where data gaps in a particular region or fishery would prohibit application of one model over another. Participants explored short-term actions and strategies that would tie directly into more robust strategies desired for long-term sustainable management. Regional workgroups were assembled to make progress on near-term fishery-specific strategy development.

Fall 2018 Workshop

On September 25 and 26, 2018, a third interdivisional workshop was held in Anchorage, Alaska, to advance management and research strategies for black and yelloweye rockfishes. Approximately 30 ADF&G staff from both divisions and representing all GOA regions were in attendance. The workshop included the following objectives: (1) provide updates to ongoing work; (2) review draft statewide priorities for long-term management of black and yelloweye rockfishes; (3) develop management objectives tiered to statewide priorities; (4) identify priority data needs; (5) identify research and assessment activities for upcoming field seasons; and (6) review collaborative management process and progress.

The workshop included topic-specific presentations, facilitated discussions, and break-out groups. The group identified what successful management of black and yelloweye rockfishes would look like over the next 5, 10, and 50 years. Regional break-out groups reviewed the statewide priorities for long-term rockfish management, provided feedback, and worked to develop management objectives tiered to these priorities. Small groups identified next steps and staff assignments for each of the following topics: (1) data assimilation, (2) identifying and filling data gaps, (3) developing stock assessments, and (4) increasing public awareness of the Initiative. Workshop participants identified a priority need for a decision-making framework that incorporates varying levels of uncertainty in data, modeled after the tier approach used by NPFMC. Additionally, a process for this effort was reviewed and membership in both the LPT and the larger group dedicated to the Initiative was solidified.

Spring 2019 "Outside Experts" Workshop

In order to advance staff learning, ADF&G leadership recommended convening with experts from British Columbia and the U.S. west coast to acquire lessons learned from rockfish fishery management in those areas. On April 2 and 3, 2019, LPT members met in Anchorage, Alaska, with representatives from Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, Fisheries and Oceans Canada, and NOAA Fisheries. The focus of this meeting was to address the following questions: (1) How were rockfish management strategies developed by other agencies elsewhere? (2) What fisheries-dependent and fisheries-independent data were required for development of these strategies? and (3) What has and hasn't worked for transforming strategies into implementable management actions?

Notable lessons learned included: (1) yelloweye rockfish populations declined dramatically in the 1980s and 1990s south of Alaska, which has led to prolonged fisheries closures and highlights the importance of proactive steps for sustainable management of this species; (2) experience from fisheries where rockfish stocks were overfished demonstrate that implementing management actions is simpler before the species in question are at a crisis point; (3) it is beneficial to involve public stakeholders as early as possible in the process of developing management strategies; (4) data-limited approaches to stock assessments have worked well in areas around the world and reliable harvest control rules can be developed even when stock assessment data are incomplete; and (5) standardized data assimilation and a centralized database are key components to management success.

Spring 2019 Workshop

A fourth interdivisional workshop was held in Anchorage, Alaska, April 16 and 17, 2019. Participants included 30 ADF&G staff from both divisions and representing all GOA regions. Workshop objectives included the following: (1) provide updates to ongoing work; (2) review information from "outside experts" meeting; (3) review draft strategic plan; (4) review draft decision-making framework; and (4) advance group work on management policy and implementation, research and assessment, and communications.

Participants reviewed a draft strategic plan developed to guide the Initiative. The plan outlines activities for 2019–2020 and focused on creating statewide standards for black and yelloweye rockfish management, and developed processes and structures that will support long-term adaptive management. Following participant feedback during this workshop, the draft strategic plan was updated.

Workshop participants identified a growing need to communicate with the public about rockfish conservation measures, explain the work of the Initiative, and solicit feedback and input to aid further discussions and progress towards statewide management standards for black and yelloweye rockfishes. Participants identified target audiences and key messages important to convey to those audiences. This work formed the basis of a communications plan drafted in the summer of 2019 by a communications workgroup and submitted for subsequent review.

Following discussion at the September 2018 workshop, a small workgroup developed a draft decision-making framework to guide management decisions for black and yelloweye rockfishes. Workshop participants were asked to provide input on framework structure, preferred methods for handling uncertainty, and appropriate periodicity of stock assessment review. Participants expressed support for the following: (1) using a step framework (as opposed to a threshold or ramp framework); (2) addressing data uncertainty by buffering harvest control rules and integrating potential use of marine protected areas; and (3) a periodicity of stock status review of 3 or 6 years, timed with the BOF cycle.

Breakout groups at this workshop focused on advancing group work on management policy and implementation, and research and assessment. The research and assessment group began developing a table of available data to better track the quality and status of existing data. The management group discussed specific, measurable management objectives that could be designed to fit in the draft decision-making framework. Regional workgroups were also assembled to make progress on regional fishery-specific strategy development.

Key Accomplishments to Date

Statewide Management Priorities

In the summer of 2018, the LPT developed statewide priorities for management of black and yelloweye rockfishes. These priorities were based upon common areas of concern and interest identified during the Fall 2017 and Spring 2018 workshops, and were reviewed and approved by participants in the Fall 2018 workshop. These are meant to provide direction as staff develop more detailed management strategies, harvest control rules, and specific management objectives. The 3 statewide priorities that will form the foundation of statewide rockfish management strategy development are as follows:

1. Identify an appropriate harvest level or harvest rate.

2. Maintain an optimum spawning population.

3. Maintain and sustain fishing opportunity through collaborative management.

Strategic Plan

A strategic plan for the Initiative has been published and will guide ADF&G through the process of completing Initiative goals, defining indicators of success and deliverables, and outlining an appropriate timeline (Howard et al. 2019a). The strategic plan frames efficient pathways for achieving goals given budget, regulatory, and logistical considerations. The purpose of the strategic plan is to provide a common vision and shared set of expectations as management strategies for black and yelloweye rockfishes are developed. Goals have been identified for each of the 3 pillars of the Initiative: (1) research and assessment, (2) management policy and implementation, and (3) communications. These goals include the following themes:

1. Research and Assessment

- Support management standards through improved understanding of black and yelloweye rockfishes (geography, habitat, genetics, stock status, etc.).
- Coordinate research in support of management priorities.
- Improve communication between staff involved in rockfish research.
- Develop best practices to guide research and assessment of black and yelloweye rockfishes across divisions and regions.
- Provide departmental support for projects that fill identified data gaps/address research priorities.
- Share data between divisions and regions, and support consistency and standardizing of data.
- Establish both a short and long-term research and monitoring plan.
- Analyze data and use assessment and modeling tools to inform management.

2. Management Policy and Implementation

- Manage all fisheries under an appropriate harvest level or harvest rate.
- Maintain optimum spawning populations.
- Maintain and sustain fishing opportunity through collaborative management between fishery divisions.
- Manage black and yelloweye stocks in a manner that is coordinated statewide between regions and divisions.
- Update policy in response to new research and assessment information.

3. Communications

- Support joint management of black and yelloweye rockfishes.
- Support interdivisional and interregional collaboration and logistical coordination of efforts.
- Provide staff a statewide understanding of black and yelloweye stock status and management needs.
- Establish a staff peer-learning network in order to share updates to research and assessment, and share best practices and lessons learned.
- Effectively communicate updates and ongoing learning with ADF&G leadership, BOF, and the public.
- Increase public awareness and engagement in the *ADF&G Statewide Rockfish Initiative*.

Draft Decision-Making Framework

There has been considerable effort to date in developing a draft decision-making framework. Harvest strategies and decision-making frameworks aim to keep the exploitation rate at moderate, sustainable levels when the stock status is healthy and promote rebuilding when stock status is low, ensuring a low risk of irreversible harm. A harvest strategy applies to all sources of mortality, regardless of user group or whether the mortality is directed catch or incidental to other target species. The operational components of decision-making frameworks are harvest control rules: pre-agreed guidelines that determine how much fishing can take place based on indicators of a targeted stock's status. The decision-making framework can employ varying complexity of harvest

control rules. This interdivisional, interregional decision-making framework will be a guiding resource for actions towards long-term sustainable rockfish fisheries management.

Statewide Rockfish Initiative Supported Research and Communications

One of the fundamental strengths of the Initiative is a modest, dedicated annual fund to both support facilitation and administration of this collaborative initiative, and to conduct projects that address important data gaps or communication and outreach needs. Preliminary statewide data compilation and assessment have identified various immediate needs to be addressed. Projects supported by the Initiative will have operational plans published and available on the ADF&G website to provide public access to Initiative-supported activities.

The primary communications project funded to date is the design and printing of rockfish playing cards. Card decks will be distributed at area offices for stakeholders throughout the GOA. The purpose of these playing cards is to better educate stakeholders on rockfish species identification and basic understanding of rockfish biology and life history—with the intent that this will increase public understanding of this resource and improve data quality.

Given identified data gaps and needs for GOA black and yelloweye rockfishes, additional research will be critical to developing robust and sustainable management strategies. Seed money has been provided to support fishery-independent stock assessment surveys that index abundance in key areas of commercial and sport harvests—namely hydroacoustic surveys for black rockfish in the Kodiak and northern GOA areas. As many stock assessment tools require knowledge of basic reproductive characteristics, and studies providing those data specific to Alaskan waters are severely lacking, the Initiative is supporting studies examining the reproductive biology of these species in Southeast Alaska, PWS, northern GOA, and Kodiak areas. Also, to aid in stock assessments, the Initiative has funded genetic analysis of black and yelloweye rockfishes stock structure throughout the GOA (Howard et al. 2019b). This project is expected to provide a better understanding of population structure and how management area boundaries do or do not align with population-level dynamics of black and yelloweye rockfishes.

STATEWIDE ROCKFISH INITIATIVE NEXT STEPS

Staff efforts from 2017 to present have been focused on 2 things: the development of statewide standards for black and yelloweye rockfish management, and development of structures to support sustainable management. Future work by ADF&G should focus on achieving this through the activities outlined in the strategic plan (Howard et al. 2019a). An important product of continued efforts will be to finalize the decision-making framework. It will be critical for the Initiative's success to incorporate public input and guidance in the products and outcomes of this work.

Specific research projects have been financially supported by the Initiative and continuing that support will be necessary into the future to address critical data needs. As is evident in data presented in this report, because rockfish harvests are assessed differently in commercial and sport fisheries, there is currently no ability to examine overall exploitation on a species. Work needs to be done to address harvest occurring in different units (numbers of fish vs. biomass), different spatial resolution, different degree of species specificity, and where estimates are derived under different assumptions. Robust and well-documented estimates of overall harvest levels on stocks are critical for future stock assessment purposes, and statewide analyses should be a priority and should be completed in the near future. Initiative efforts to date have also recognized how compartmentalized rockfish data collection has been across divisions and regions; this has led to

challenges in sharing information and assimilating data to explore patterns on a scale consistent with rockfish population dynamics. Efforts to establish and maintain consistency of biological data collection and storage, to assimilate historical datasets, and to provide broader access and transparency of available data have been initiated, but continued work is needed to facilitate future stock assessment analyses.

From the work to date, it is also evident that future steps must include building capacity for rockfish stock assessment. Additional training opportunities for staff will include using data-limited tools for groundfish stock assessments and developing harvest control rules in data-limited situations. Given the data-limited nature of most black and yelloweye rockfish fisheries in the GOA and the budgetary constraints limiting the acquisition of new data collection programs, this training will be essential to enabling ADF&G to establish stock assessments supporting sustainable rockfish fishery management.

Although significant progress has been made, many additional activities and products will be necessary to fully realize the Initiative's goals for research and assessment, management policy and implementation, and communications. It is currently envisioned that these activities may require concerted effort through at least December of 2020 to develop management standards, and then will require some future maintenance so that these standards are adaptive to the changing needs of GOA black and yelloweye rockfish fisheries.

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TABLES AND FIGURES

Table 1.–State subsistence harvest estimates in pounds of rockfish in the Kodiak Island, Chignik, Alaska Peninsula, and Aleutian Islands areas, 1982–2015.

Year	Black rockfish	Rockfish	Unknown rockfish	Red rockfish	Yelloweye rockfish	Total
1982	ND	ND	736	3,616	ND	4,354
1983	ND	ND	ND	ND	ND	ND
1984	ND	ND	ND	ND	ND	ND
1985	ND	ND	ND	ND	ND	ND
1986	ND	ND	135	910	ND	1,045
1987	22	66	ND	ND	ND	88
1988	ND	66	ND	ND	ND	66
1989	1,245	ND	ND	208	ND	1,453
1990	2,050	ND	48	616	ND	2,714
1991	22,232	ND	712	10,177	ND	33,126
1992	13,751	ND	149	10,685	ND	24,590
1993	19,532	ND	12	3,519	ND	23,065
1994	3,473	ND	60	6,654	ND	10,190
1996	ND	ND	ND	ND	ND	ND
1997	1,800	ND	26	1,079	ND	2,906
1998	20	ND	ND	336	ND	356
1999	ND	ND	ND	ND	ND	ND
2000	ND	ND	ND	ND	ND	ND
2003	3,253	ND	2	2,028	ND	5,284
2004	ND	ND	ND	ND	ND	ND
2005	ND	ND	ND	ND	ND	ND
2006	ND	ND	ND	ND	ND	ND
2008	308	ND	ND	44	ND	353
2009	ND	ND	ND	ND	ND	ND
2010	ND	ND	ND	ND	ND	ND
2011	ND	ND	ND	ND	ND	ND
2012	57	ND	58	ND	31	145
2013	21	ND	ND	ND	ND	21
2014	ND	ND	ND	ND	ND	ND
2015	ND	ND	ND	ND	ND	ND
Total	67,764	132	1,938	39,872	31	109,756

Note: ND = no data.

Table 2.–Rockfish bycatch (numbers) in the Federal Subsistence Halibut Program in the Westward Region, 2003–2012.

Area	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Chignik area	43	107	107	345	328	127	118	33	17	80	1,304
Eastern Aleutians - East	912	475	475	230	89	125	148	402	104	68	3,029
Eastern Aleutians - West	40	71	71	17	11	6	4	4	1	1	226
Kodiak Island - Other	833	1,476	911	831	1,093	1,181	892	1,101	767	583	9,667
Kodiak Island Road System	955	1,522	934	1,840	1,089	662	1,173	1,528	1,089	784	11,576
Lower Alaska Peninsula	197	218	218	669	338	381	770	209	284	81	3,366
St. George Island	ND	ND	ND	ND	27	ND	13	50	ND	ND	89
St. Paul Island	93	ND	ND	ND	ND	ND	ND	ND	ND	ND	93
Western Aleutians - East	5	3	3	9	5	16	24	ND	ND	3	68
Total	3,078	3,872	2,719	3,941	2,980	2,498	3,142	3,326	2,262	1,599	29,418

Note: ND = no data.

Table 3.–Subsistence harvest of rockfish in numbers of fish for Prince William Sound and Cook Inlet areas, 1984–2014.

	Prince William Sound area			Cook Inlet area		
Year	Black rockfish[a]	Yelloweye or "red" rockfish[a]	Unidentified or other rockfish[a,b]	Black rockfish[a]	Yelloweye or "red" rockfish[a]	Unidentified rockfish[a,b]
1984	546	76	-	-	-	-
1985	1,613	1,632	-	-	-	-
1986	ND	ND	ND	ND	ND	ND
1987	30	882	ND	720	7	ND
1988	3,310	4,447	1,376	ND	ND	ND
1989	21	75	ND	156	319	ND
1990	41	434	119	445	96	ND
1991	1,555	5,490	731	1,257	465	321
1992	4,026	6,235	515	2,184	486	ND
1993	1,847	6,466	1,960	1,144	390	73
1994	ND	ND	ND	ND	ND	ND
1995	ND	ND	ND	ND	ND	ND
1996	ND	ND	ND	ND	ND	ND
1997	2,313	2,429	855	275	53	14
1998	ND	ND	ND	1,009	1,414	267
1999	ND	ND	ND	ND	1	ND
2000	ND	ND	ND	8,302	1,394	84
2001	ND	ND	ND	ND	ND	ND
2002	ND	ND	ND	ND	ND	ND
2003	1,285	1,713	1,130	1,196	19	827
2004	ND	ND	911	ND	ND	934
2005	ND	ND	1,522	ND	ND	247
2006	ND	ND	719	ND	ND	330
2007	ND	ND	640	ND	ND	720
2008	ND	ND	739	ND	ND	860
2009	ND	ND	405	ND	ND	614
2010	ND	ND	1,051	ND	ND	612
2011	ND	ND	352	ND	ND	480
2012	ND	ND	333	28	9	600
2013	163	51	40	ND	ND	ND
2014	1,124	257	365	497	34	120

Note: ND = no data.

[a] *Source*: State of Alaska Community Subsistence Information System queried by region and community to determine area; yelloweye, copper, and quillback rockfish identified beginning in 2014 (prior to that only black, red, and unknown rockfish). For 2014 red and yelloweye rockfish combined as yelloweye rockfish in table.

[b] *Source*: Federal Subsistence Halibut Registration Certificate (SHARC) mail-out survey - rockfish data (not identified to species) only collected 2003–2012.

Table 4.–Average total length, average weight, average age, sex ratio, and corresponding sample sizes of sport harvested black rockfish in Central/Southcentral Region (excluding Kodiak), 1991–2017.

Year	Average length (cm)	*n*	Average weight (kg)	*n*	Average age (years)	*n*	Percent female	*n*
1991	51	315	1.9	13	15	285	80%	242
1992	50	629	2.1	51	14	434	62%	363
1993	49	635	1.9	107	14	551	57%	346
1994	49	623	1.9	262	14	523	54%	332
1995	50	472	2.1	217	15	446	59%	281
1996	51	339	2.0	206	14	303	56%	184
1997	50	362	2.1	212	14	358	57%	174
1998	50	475	2.2	245	15	481	47%	224
1999	48	722	2.1	304	14	687	50%	359
2000	48	482	2.1	178	13	478	56%	258
2001	48	641	2.2	265	13	626	58%	365
2002	51	720	2.4	613	14	687	64%	466
2003	51	1,189	2.3	1,006	14	1,142	61%	704
2004	51	1,476	2.3	1,381	15	820	59%	870
2005	51	895	2.3	709	15	847	64%	540
2006	52	1,187	2.3	1,006	15	837	62%	738
2007	52	1,436	2.6	1,220	16	1,118	60%	848
2008	51	1,288	2.4	1,034	16	1,003	56%	706
2009	51	2,058	2.5	786	16	1,180	52%	1,046
2010	52	1,984	2.4	558	17	1,334	52%	1,019
2011	51	1,809	2.4	352	18	1,200	44%	794
2012	51	2,037	2.4	541	17	1,225	50%	965
2013	51	2,451	2.3	480	16	1,724	49%	1,151
2014	50	2,512	2.4	415	17	1,605	48%	1,147
2015	48	2,226	2.0	338	15	2,211	48%	1,065
2016	48	2,680	2.0	338	15	1,587	52%	1,308
2017	48	1,598	2.0	61	14	1,603	54%	870

Note: *n* = sample size.

Table 5.–Average total length, average weight, average age, sex ratio, and corresponding sample sizes of sport harvested yelloweye rockfish in Central/Southcentral Region (excluding Kodiak), 1991–2017.

Year	Average length (cm)	*n*	Average weight (kg)	*n*	Average age (years)	*n*	Percent female	*n*
1991	48	397	2.6	6	28	422	54%	197
1992	55	628	3.5	18	28	317	50%	263
1993	57	838	4.5	30	31	802	46%	349
1994	57	388	3.3	108	32	390	50%	177
1995	58	362	3.5	124	31	329	47%	168
1996	61	104	5.9	53	34	103	57%	59
1997	58	312	3.8	187	33	295	49%	136
1998	59	292	4.2	140	34	275	50%	149
1999	57	627	3.9	303	32	606	46%	272
2000	60	677	4.4	376	33	663	48%	307
2001	59	577	4.5	401	32	559	49%	251
2002	60	521	4.1	465	30	505	43%	235
2003	59	778	4.4	579	33	760	51%	374
2004	59	892	4.3	728	33	907	45%	411
2005	59	527	4.0	405	33	529	50%	262
2006	59	654	4.1	509	31	642	56%	363
2007	60	458	4.5	373	33	452	55%	229
2008	61	577	4.5	452	32	575	50%	248
2009	59	694	4.6	430	31	671	53%	301
2010	60	765	4.2	368	33	735	46%	333
2011	58	549	3.9	211	31	487	46%	218
2012	58	721	4.3	287	29	682	57%	363
2013	58	682	4.2	277	31	626	44%	280
2014	57	610	3.7	160	29	541	50%	296
2015	57	573	4.4	185	29	531	55%	281
2016	55	499	4.3	78	28	462	66%	279
2017	57	361	3.5	11	30	345	51%	181

Note: *n* = sample size.

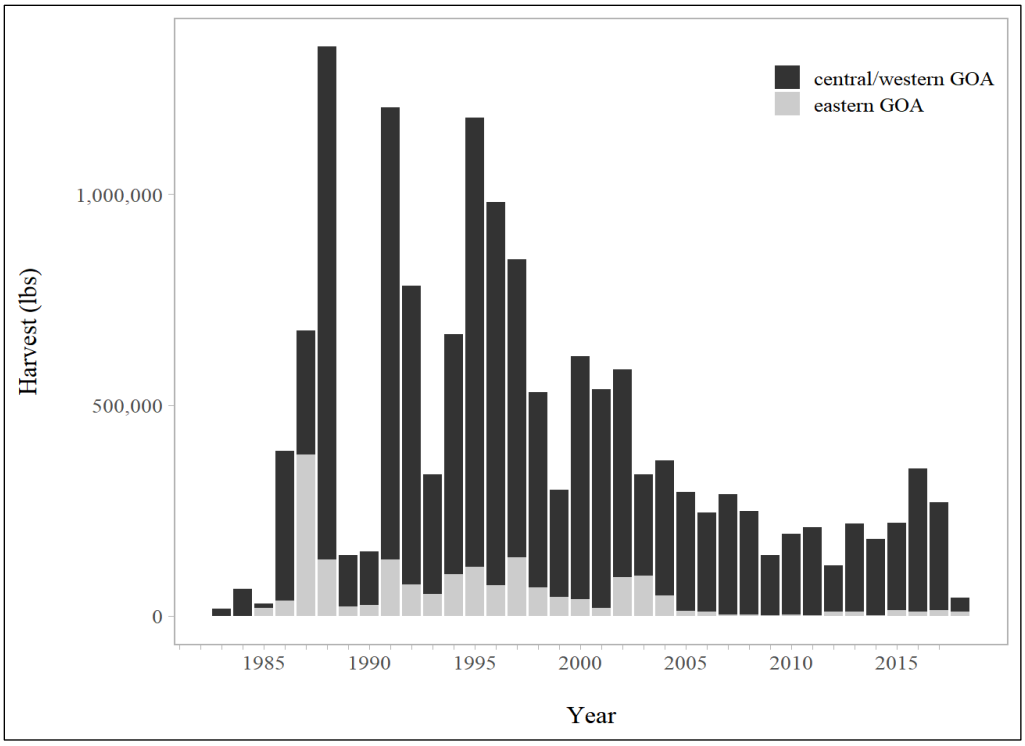

Figure 1.–Black rockfish commercial harvest in pounds from the eastern and central/western Gulf of Alaska.

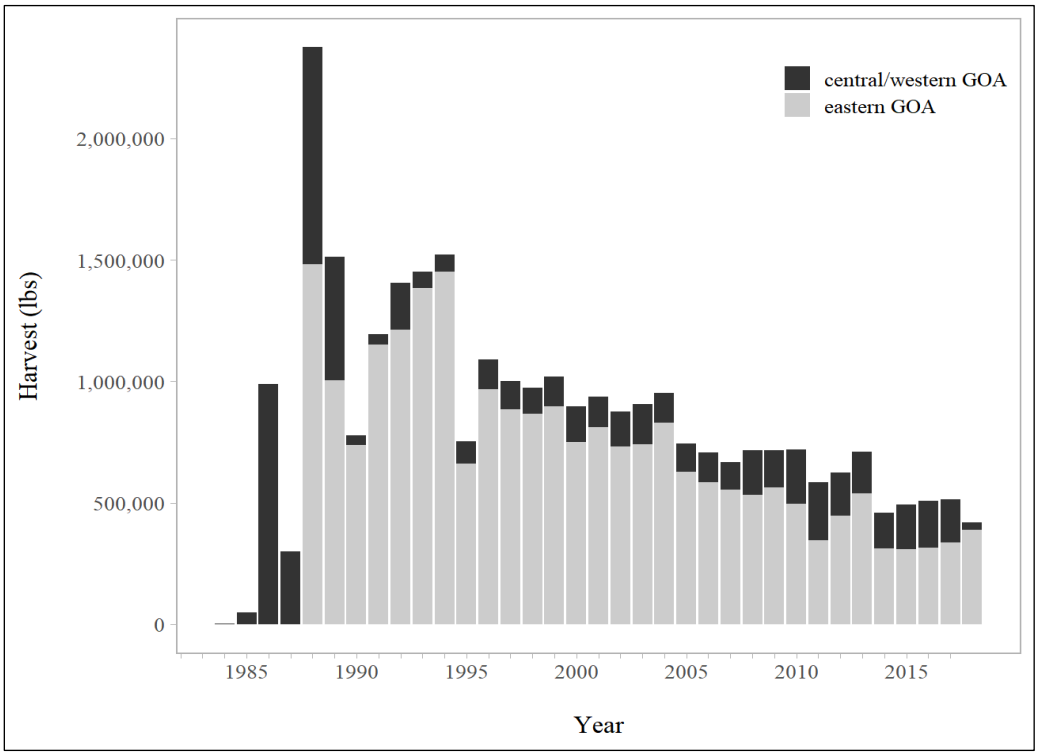

Figure 2.–Yelloweye rockfish commercial harvest in pounds from the eastern and central/western Gulf of Alaska.

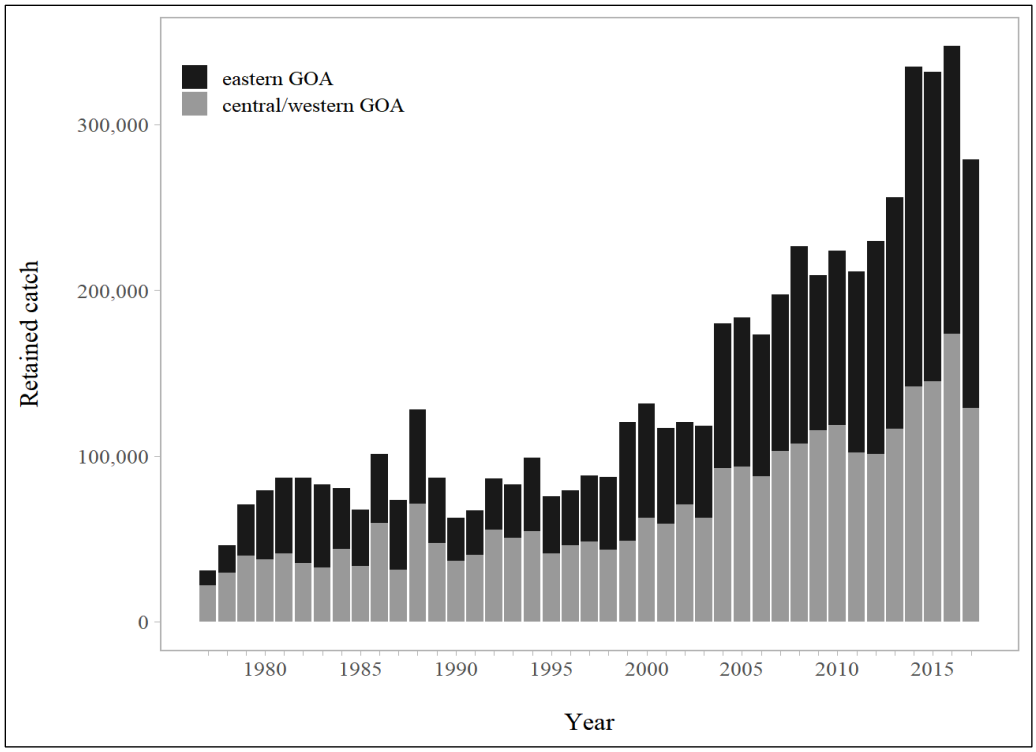

Figure 3.–Statewide sport rockfish (all species) harvest in numbers of fish from eastern and central/western Gulf of Alaska, 1977–2017.

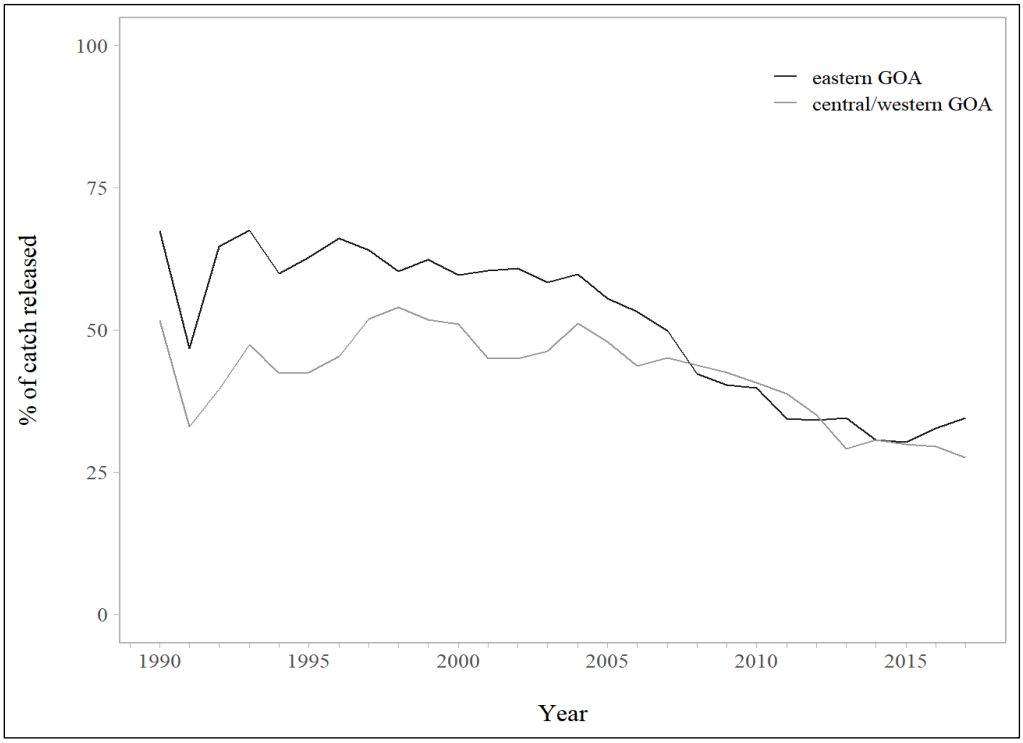

Figure 4.–Percent of sport rockfish catch (all species) released in numbers of fish from eastern and central/western Gulf of Alaska, 1990–2017.

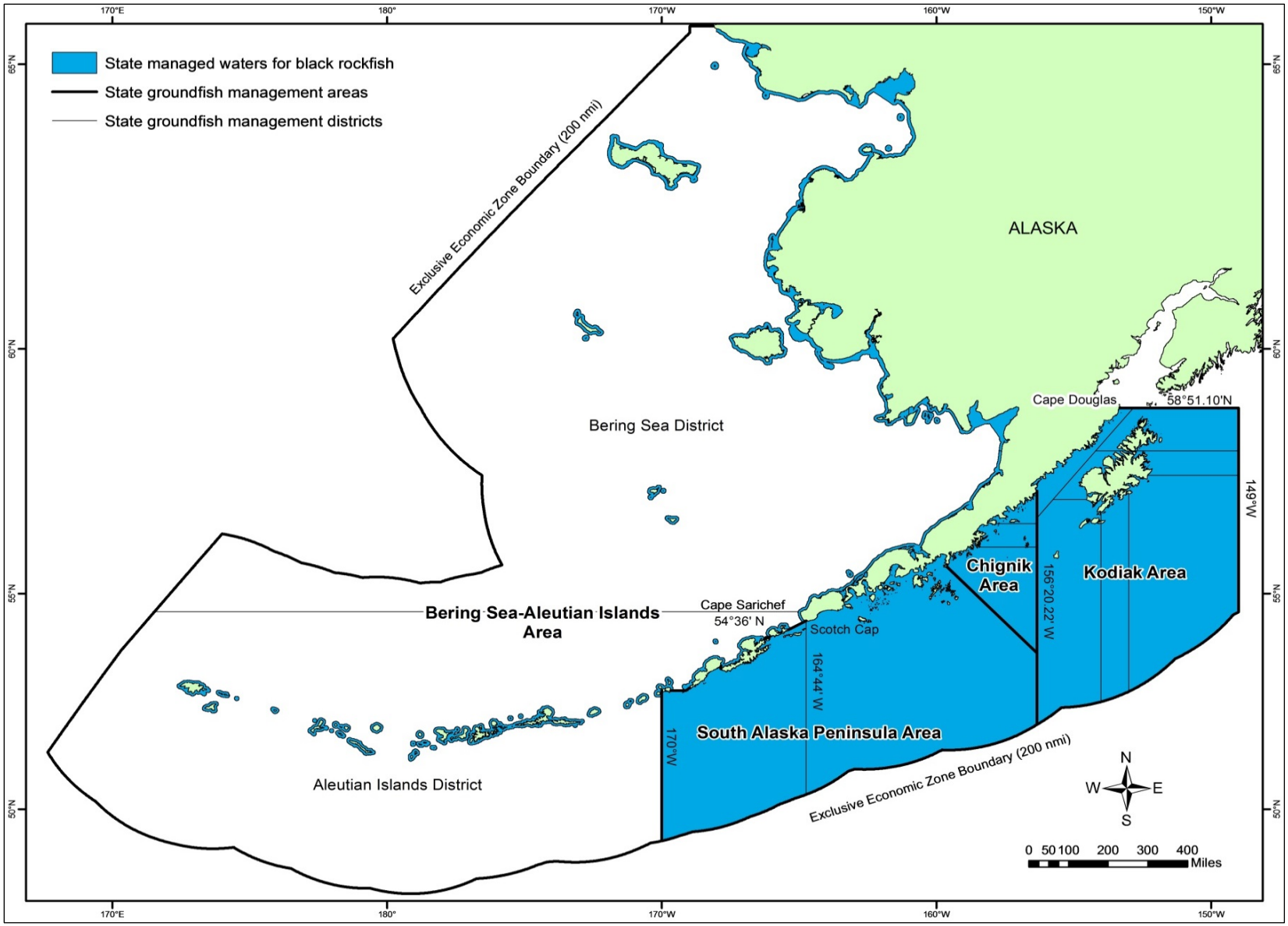

Figure 5.–Westward Region state managed waters for commercial black rockfish fisheries.

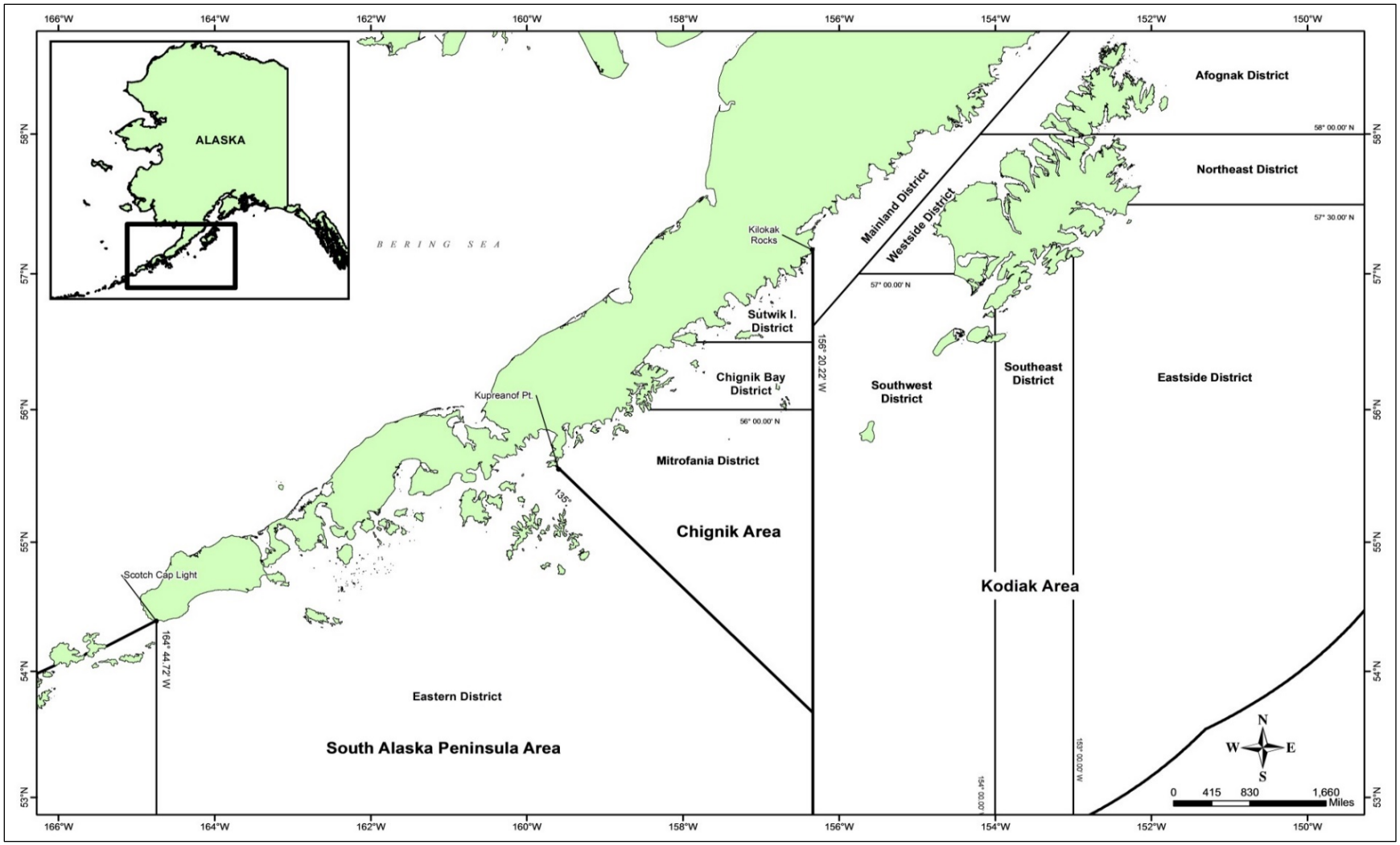

Figure 6.–Kodiak, Chignik, and the South Alaska Peninsula black rockfish commercial fishery management areas and districts of the Westward Region.

Source: US Department of the Interior (2019).

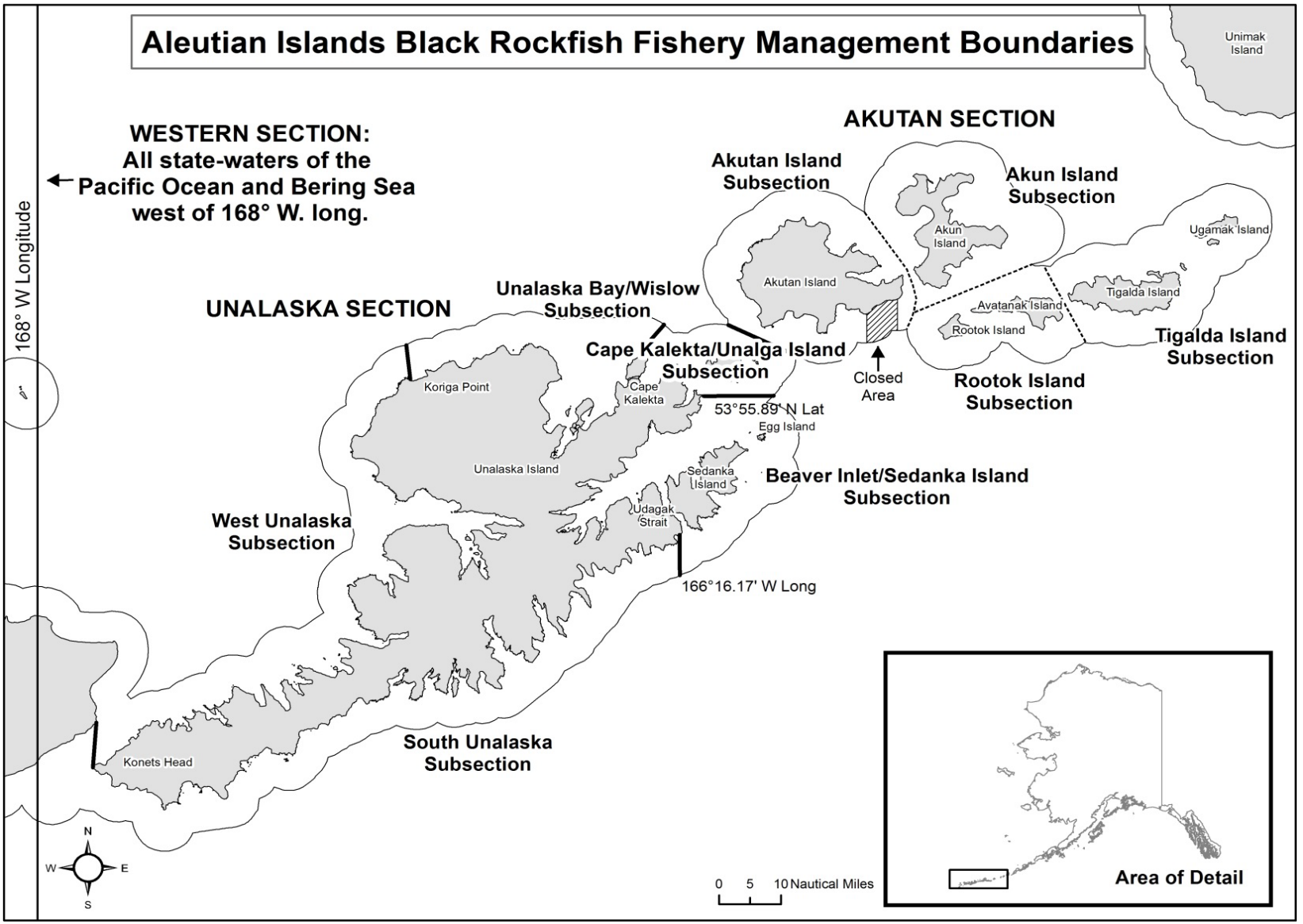

Figure 7.–Aleutian Islands black rockfish commercial fishery management boundaries with the Unalaska and Akutan sections and subsections detailed.

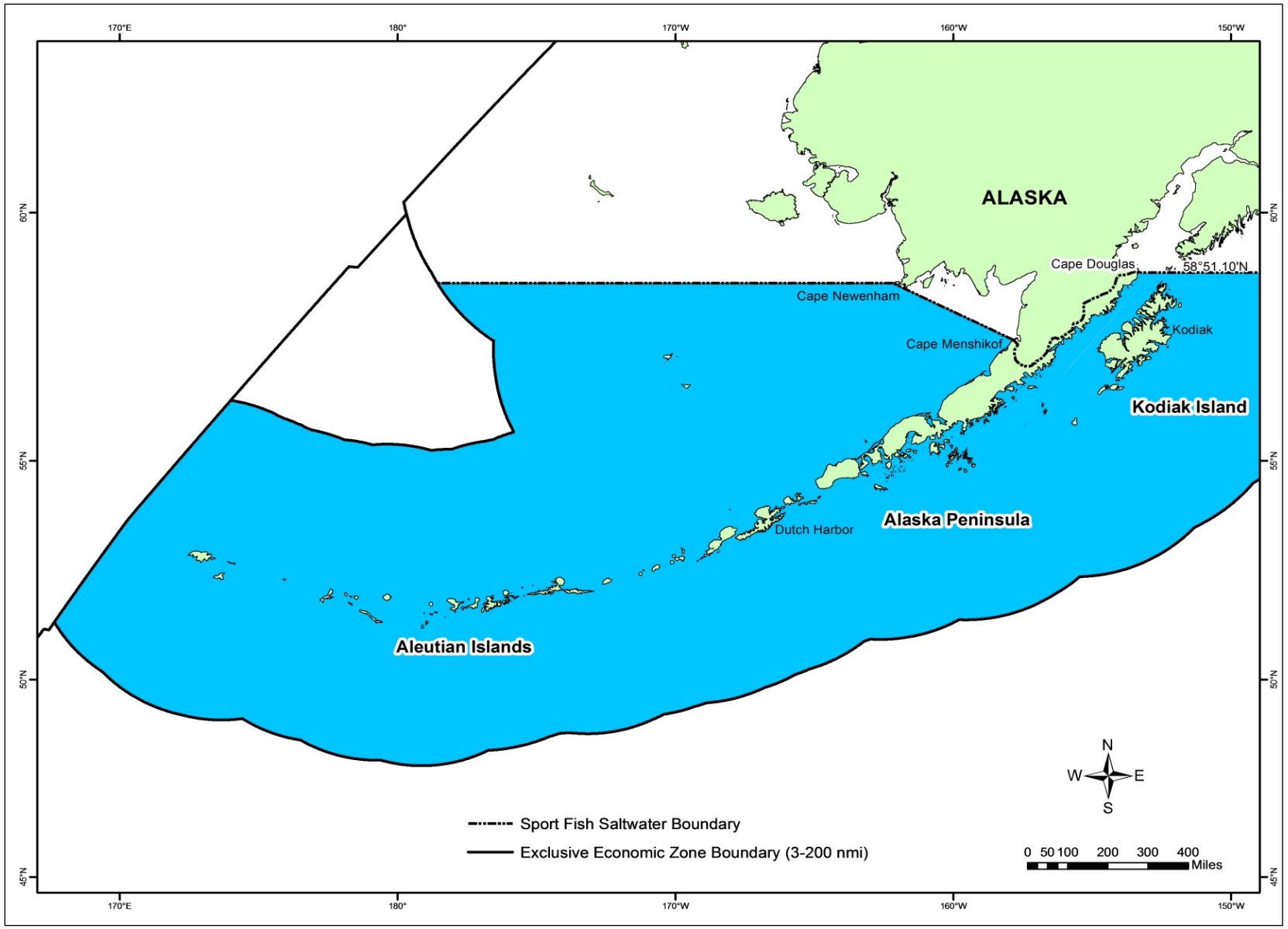

Figure 8.–Sport fishery saltwater boundaries of Kodiak Island, Alaska Peninsula, and the Aleutian Islands.

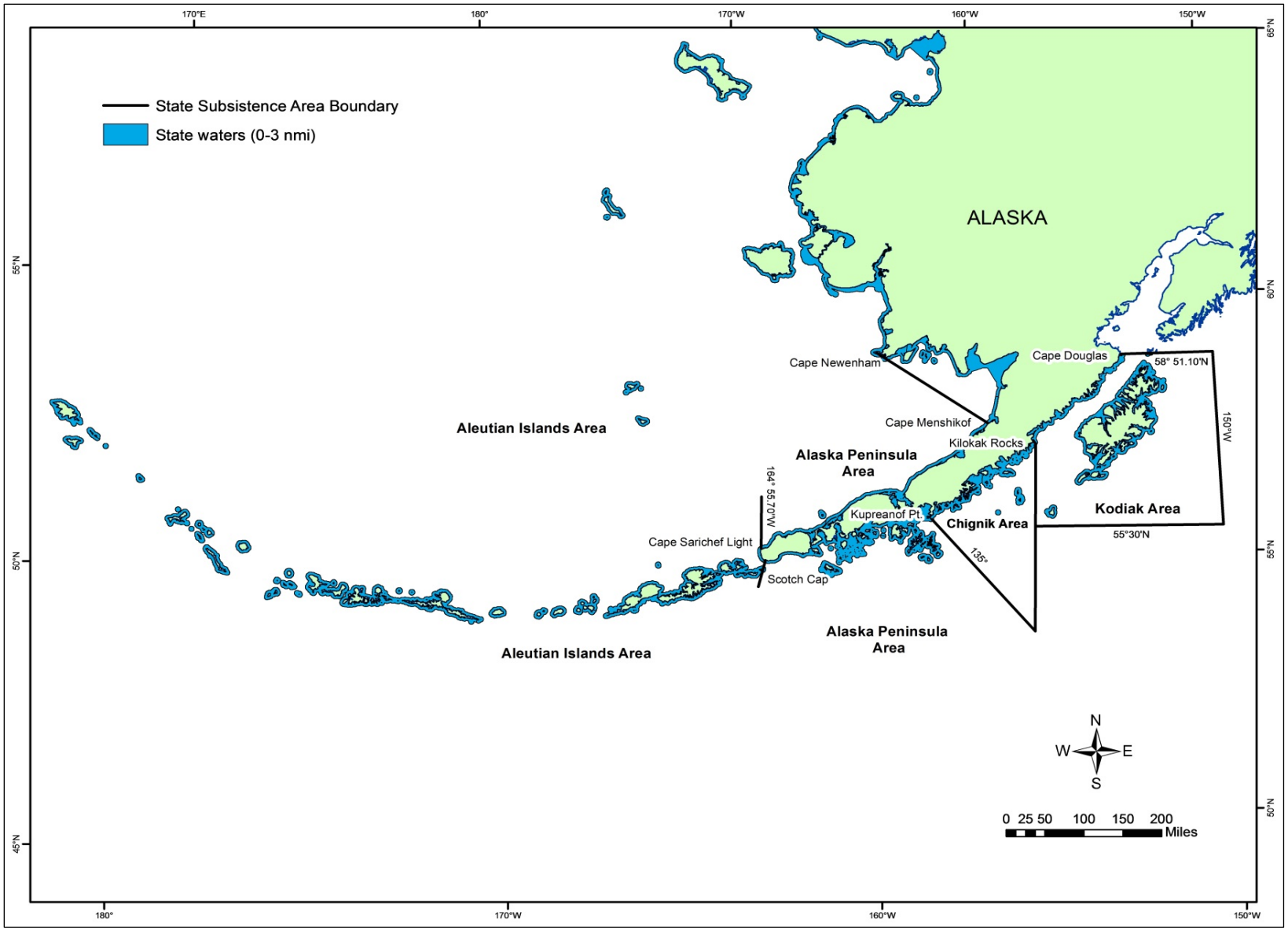

Figure 9.–Alaska state subsistence boundaries of the Kodiak, Chignik, Alaska Peninsula, and Aleutian Islands areas.

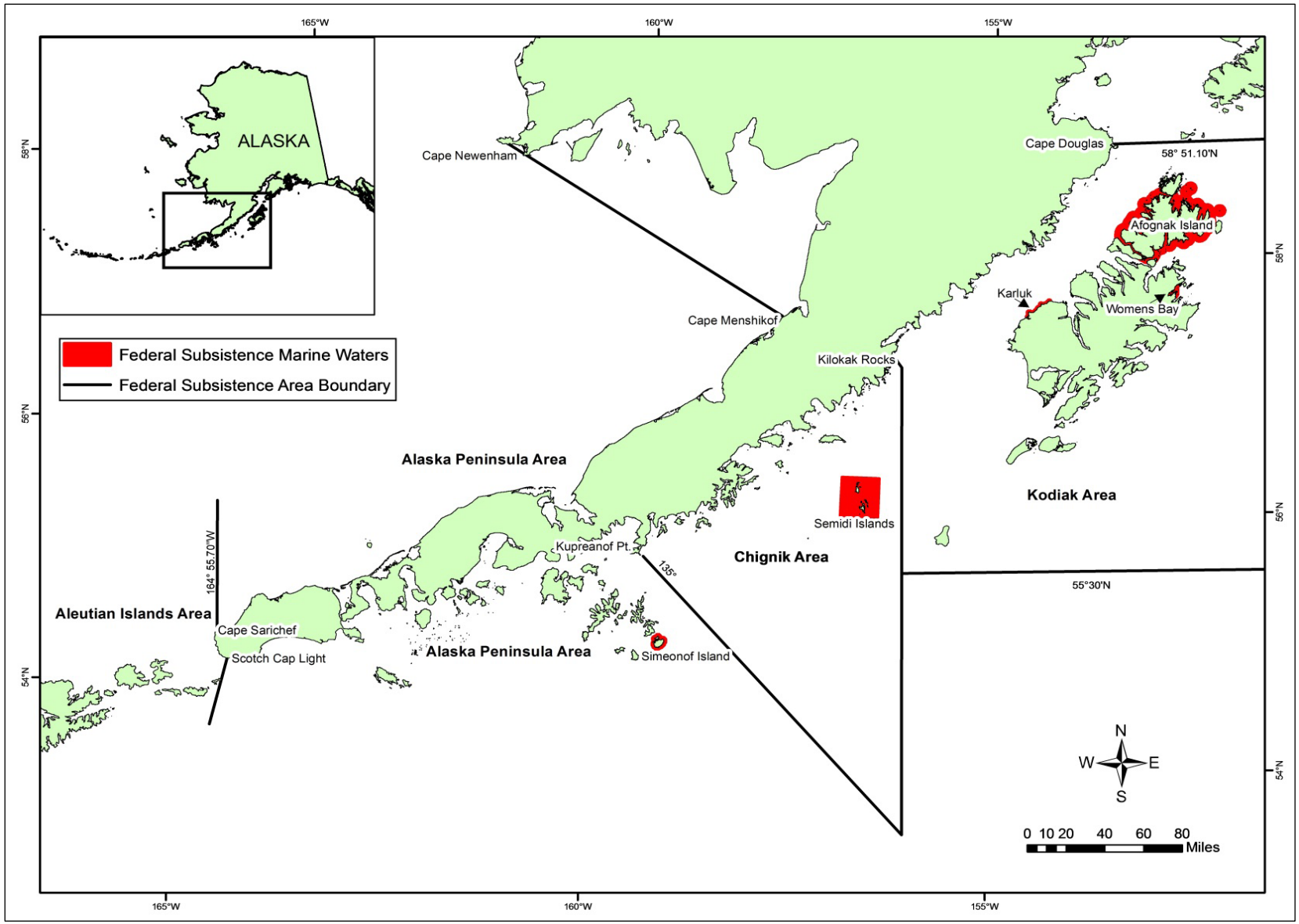

Figure 10.–Federal subsistence marine waters in the Kodiak, Chignik, Alaska Peninsula, and Aleutian Islands areas.

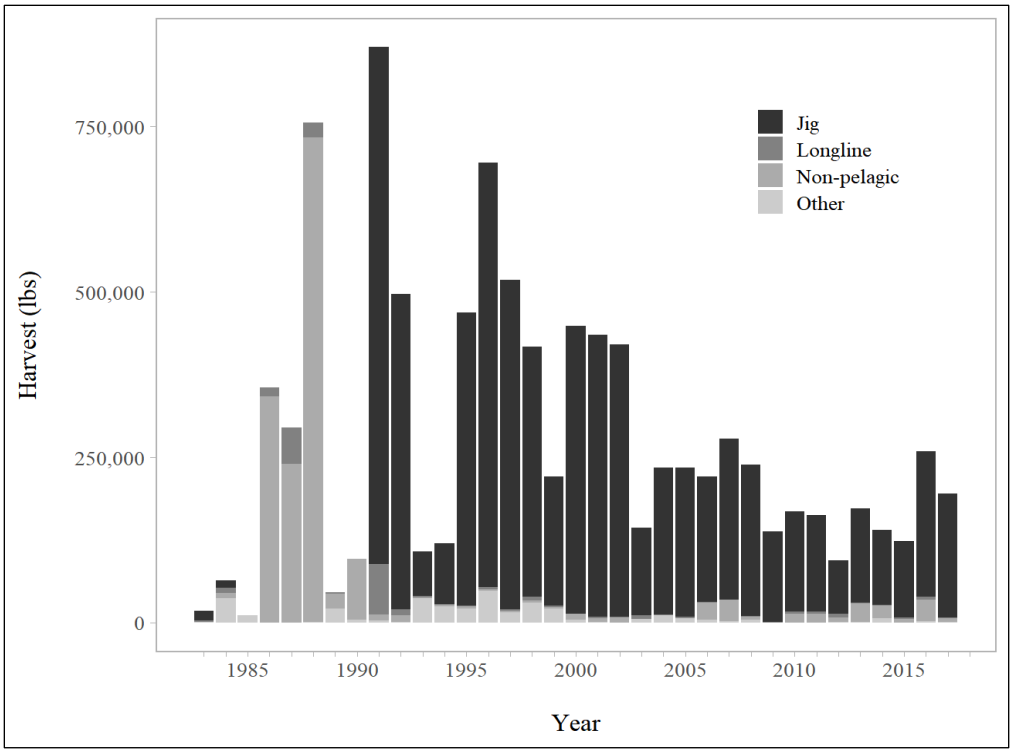

Figure 11.–Westward Region black rockfish harvest by fishery gear type from the commercial fisheries, 1983–2017.

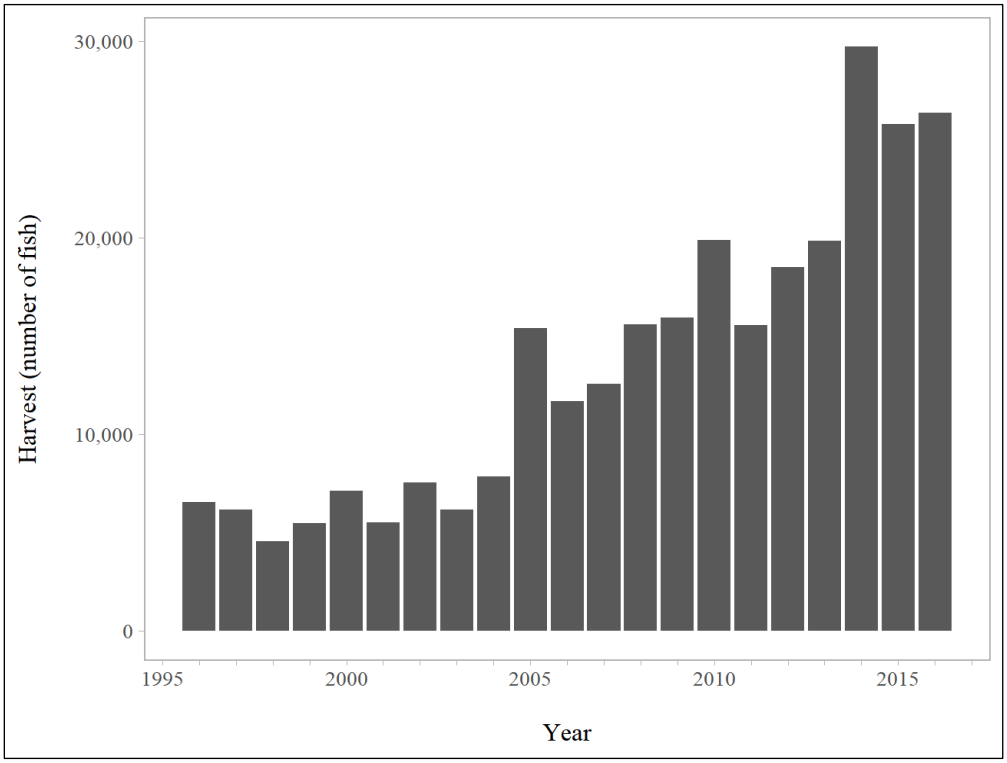

Figure 12.–Kodiak Management Area rockfish harvest (all species) from the sport fisheries, 1996–2016.

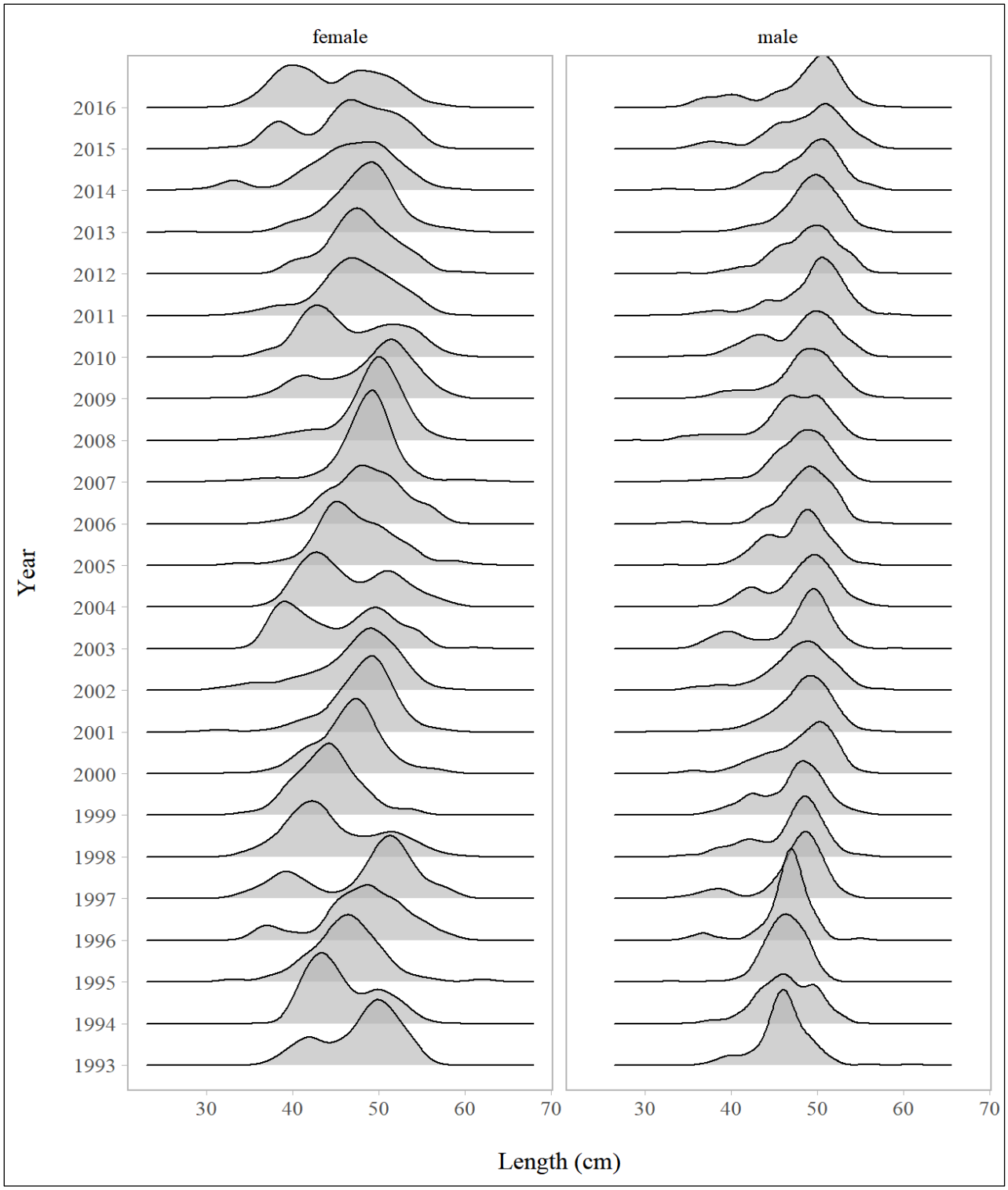

Figure 13.–Kodiak area black rockfish fork length relative frequencies (cm) for males and females from the commercial fishery harvest, 1993–2017.

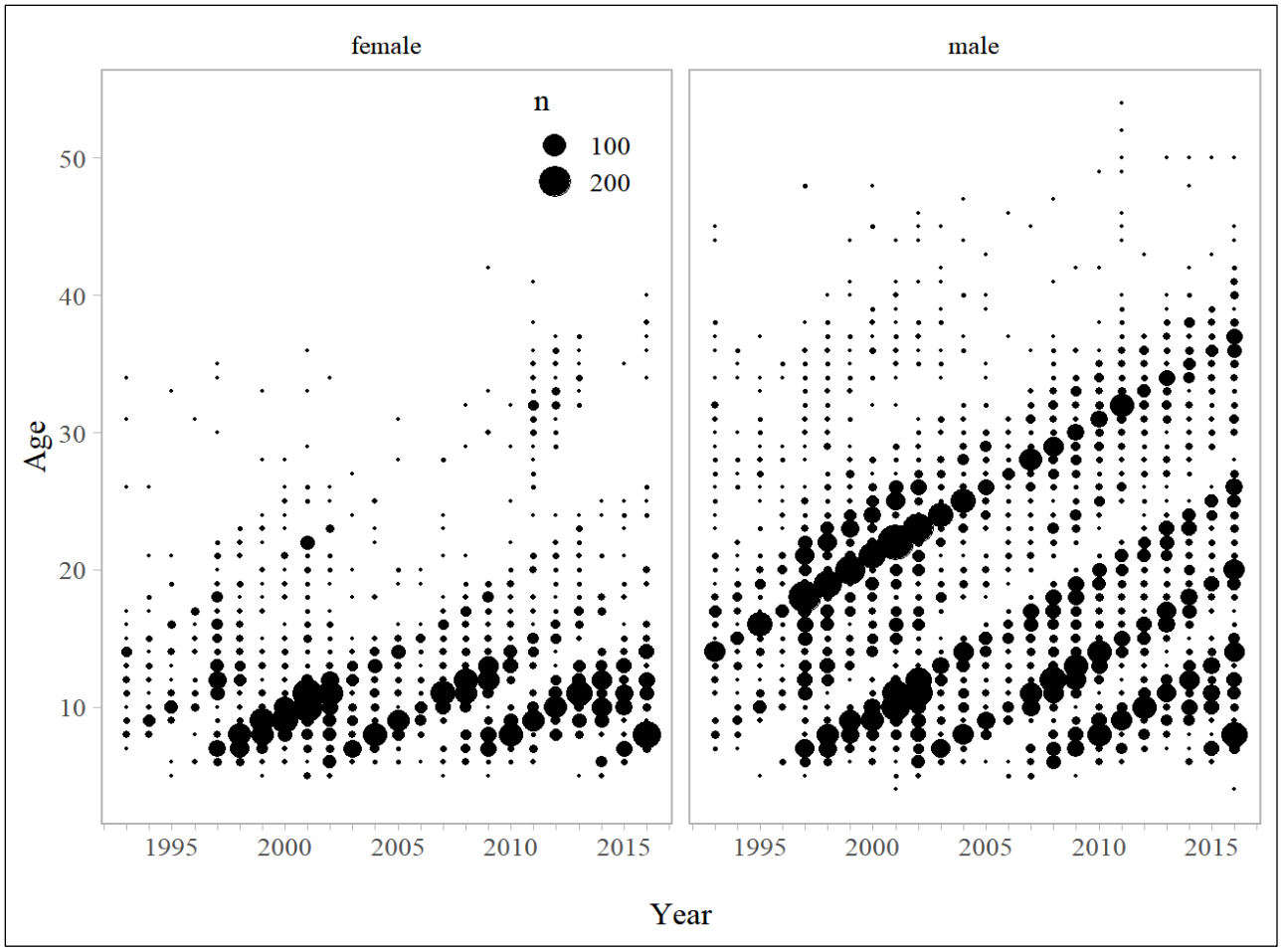

Figure 14.–Westward Region black rockfish age frequency from commercial fishery harvest samples, 1993–2017.

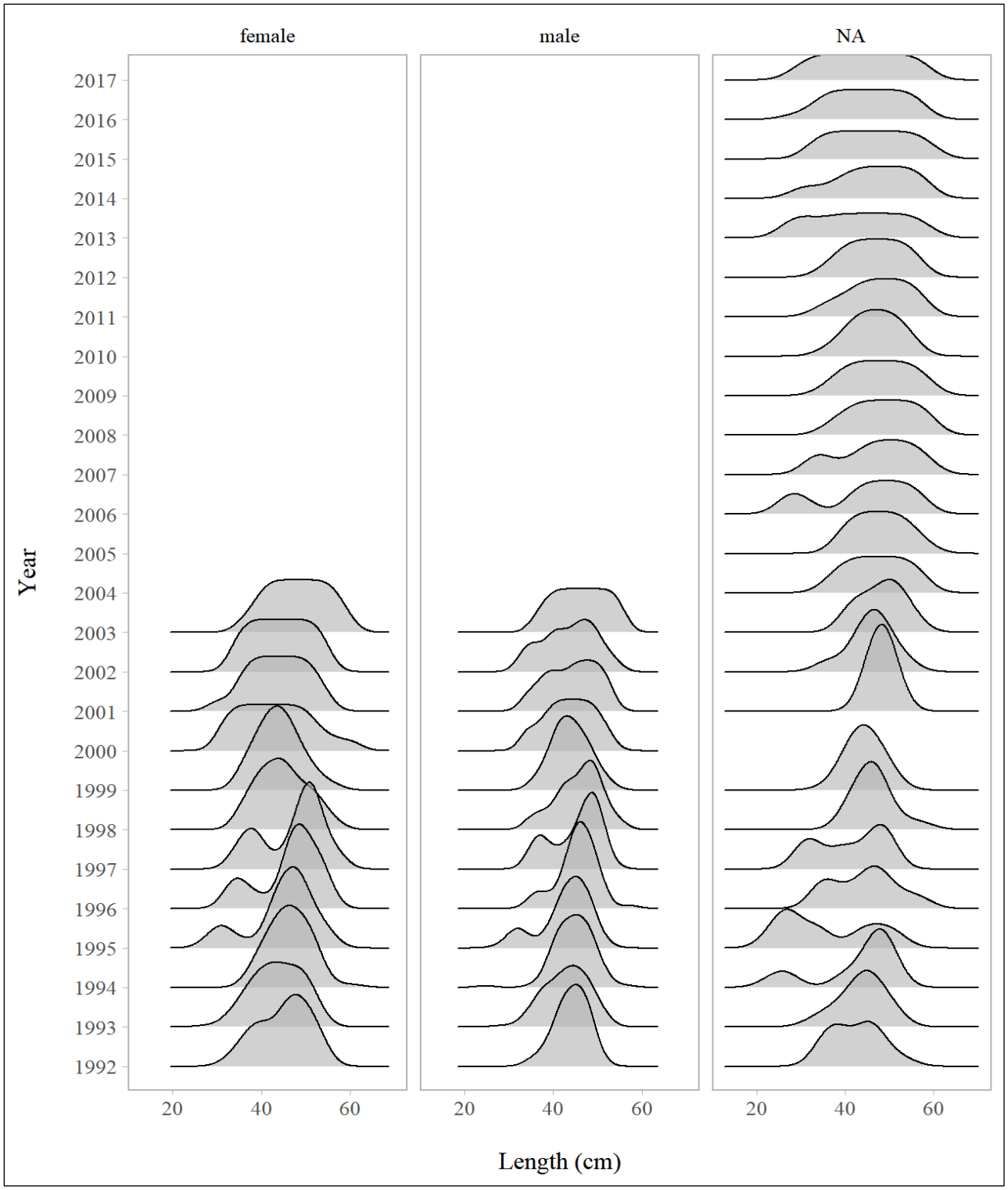

Figure 15.–Kodiak Management Area black rockfish fork length (cm) relative frequencies from the sport fishery harvest, 1992–2017.

Note: Total lengths were converted to fork lengths using a linear regression equation y = 0.983x–1.421.

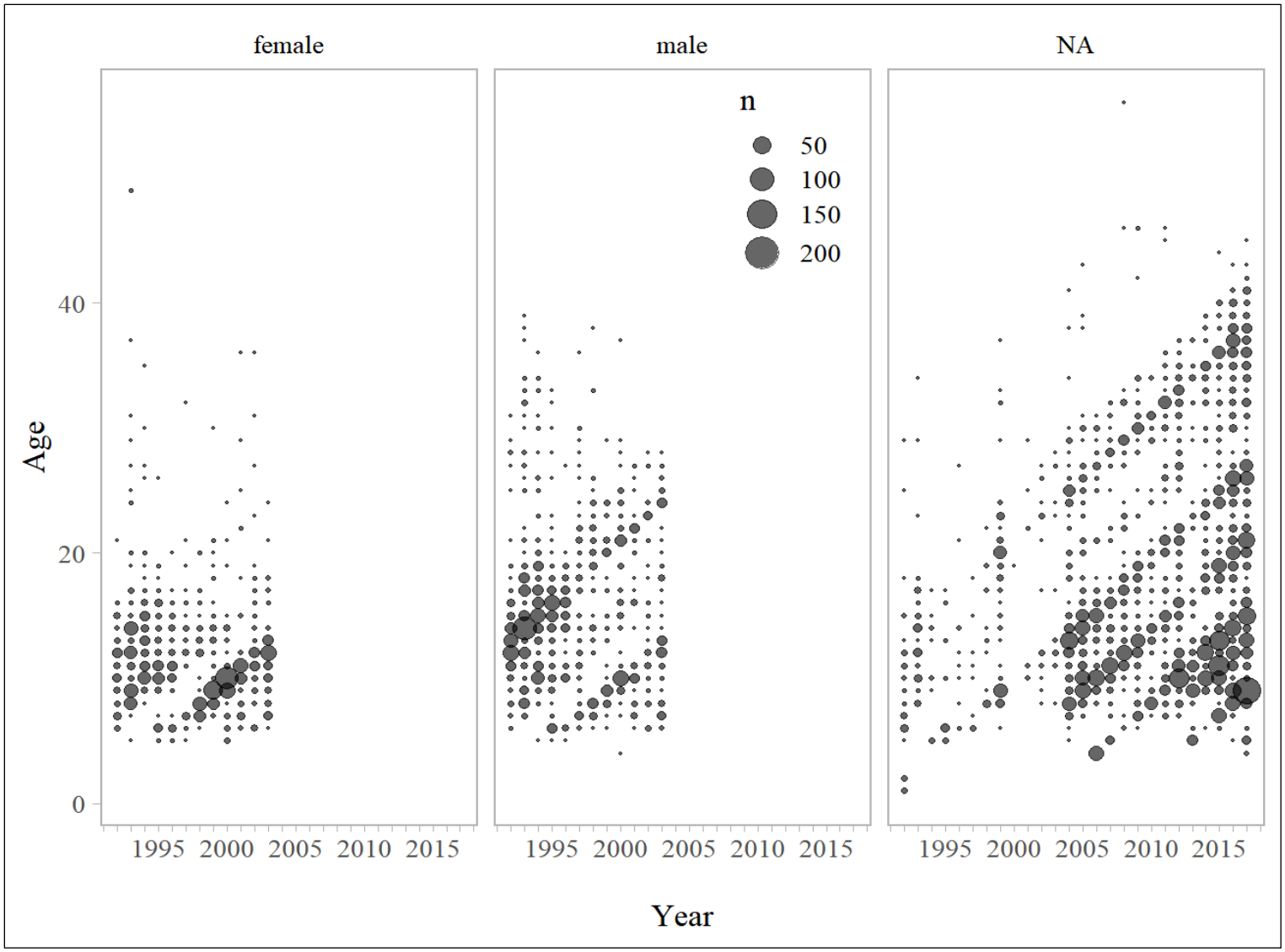

Figure 16.–Kodiak Management Area black rockfish age frequency from sport fishery harvest samples, 1992–2017.

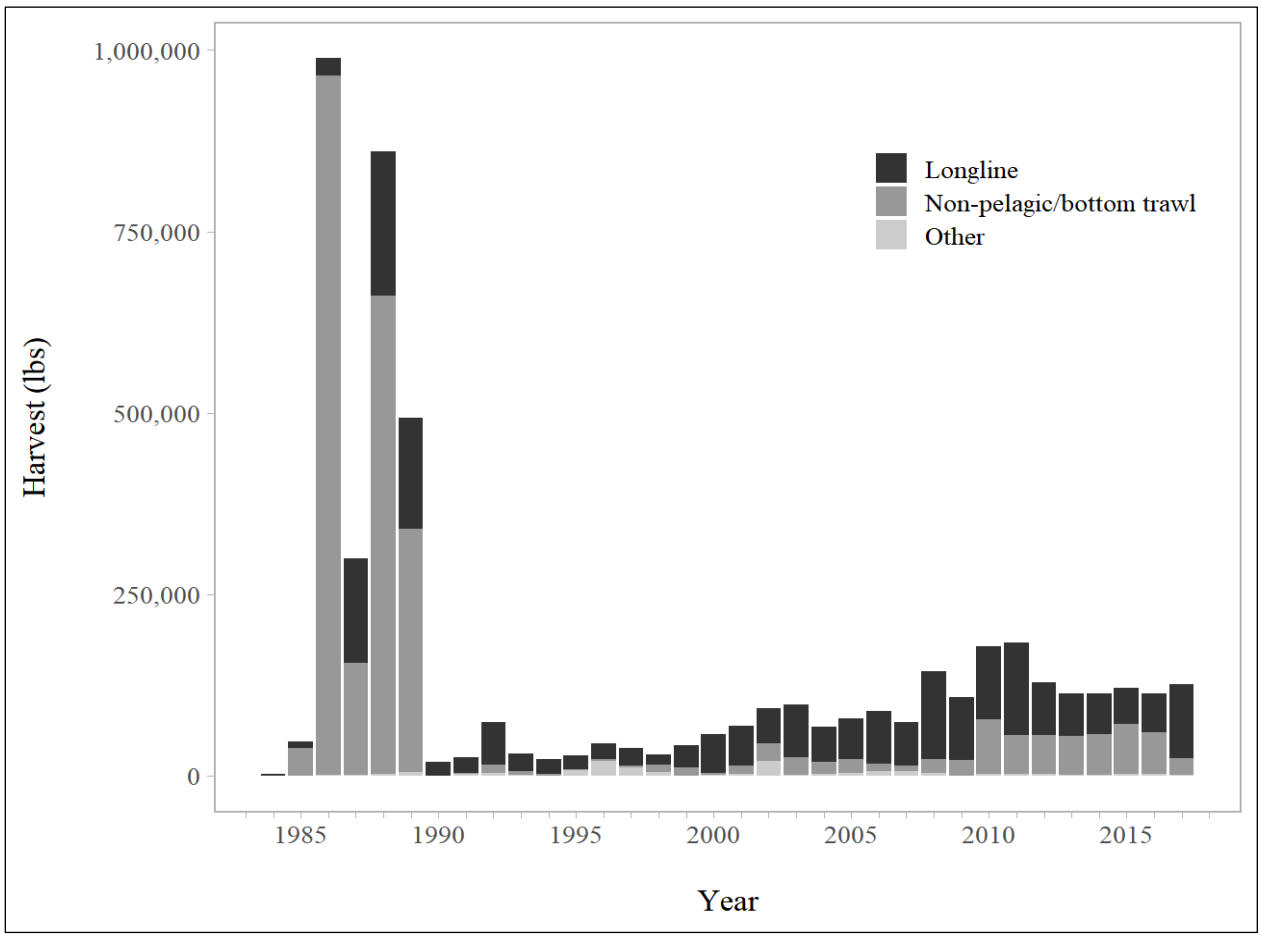

Figure 17.–Westward Region yelloweye rockfish harvest by fishery gear type from the commercial fisheries, 1984–2017.

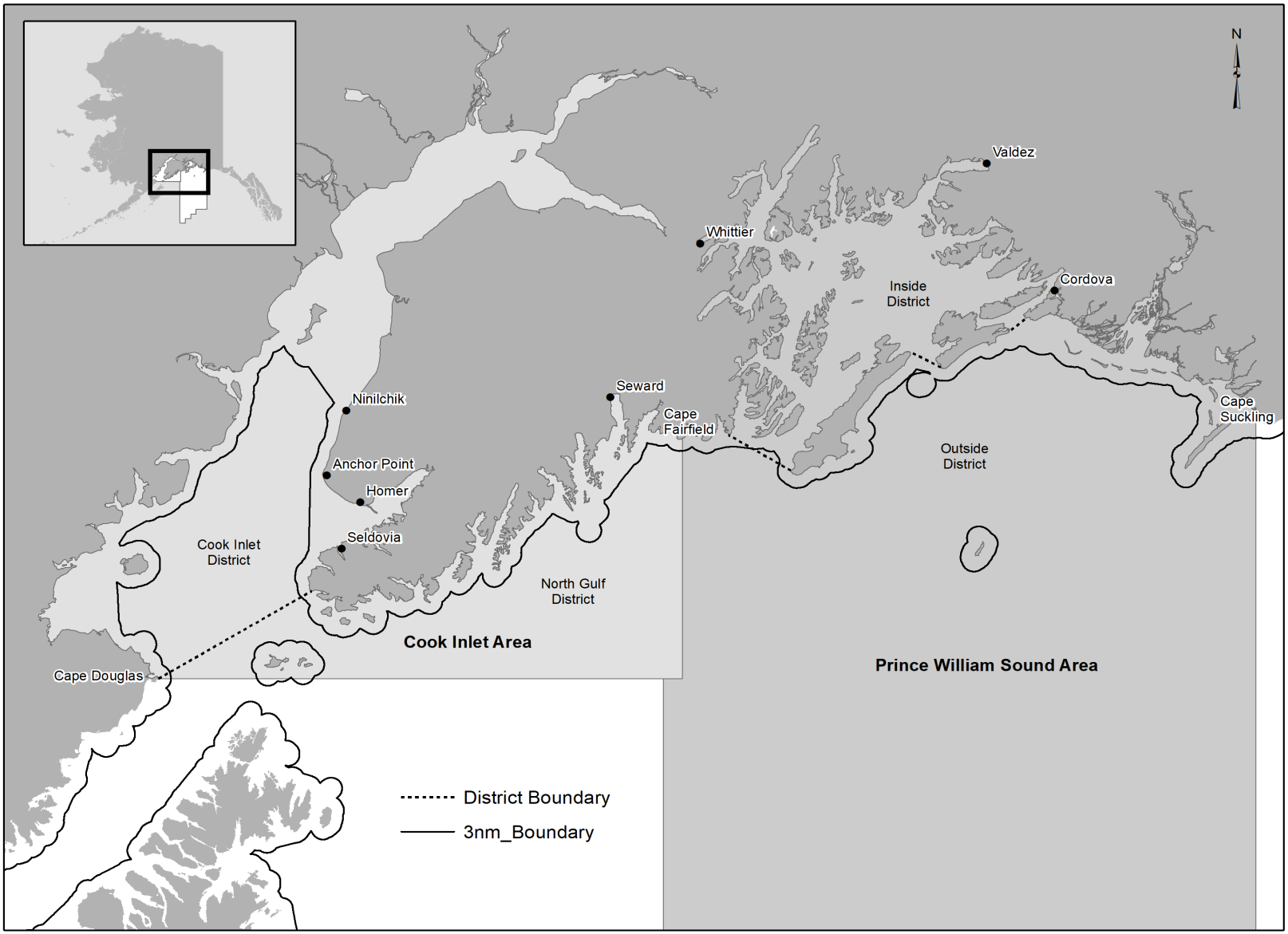

Figure 18.–Prince William Sound (dark grey) and Cook Inlet (light grey) groundfish management areas for commercial fisheries, including districts.

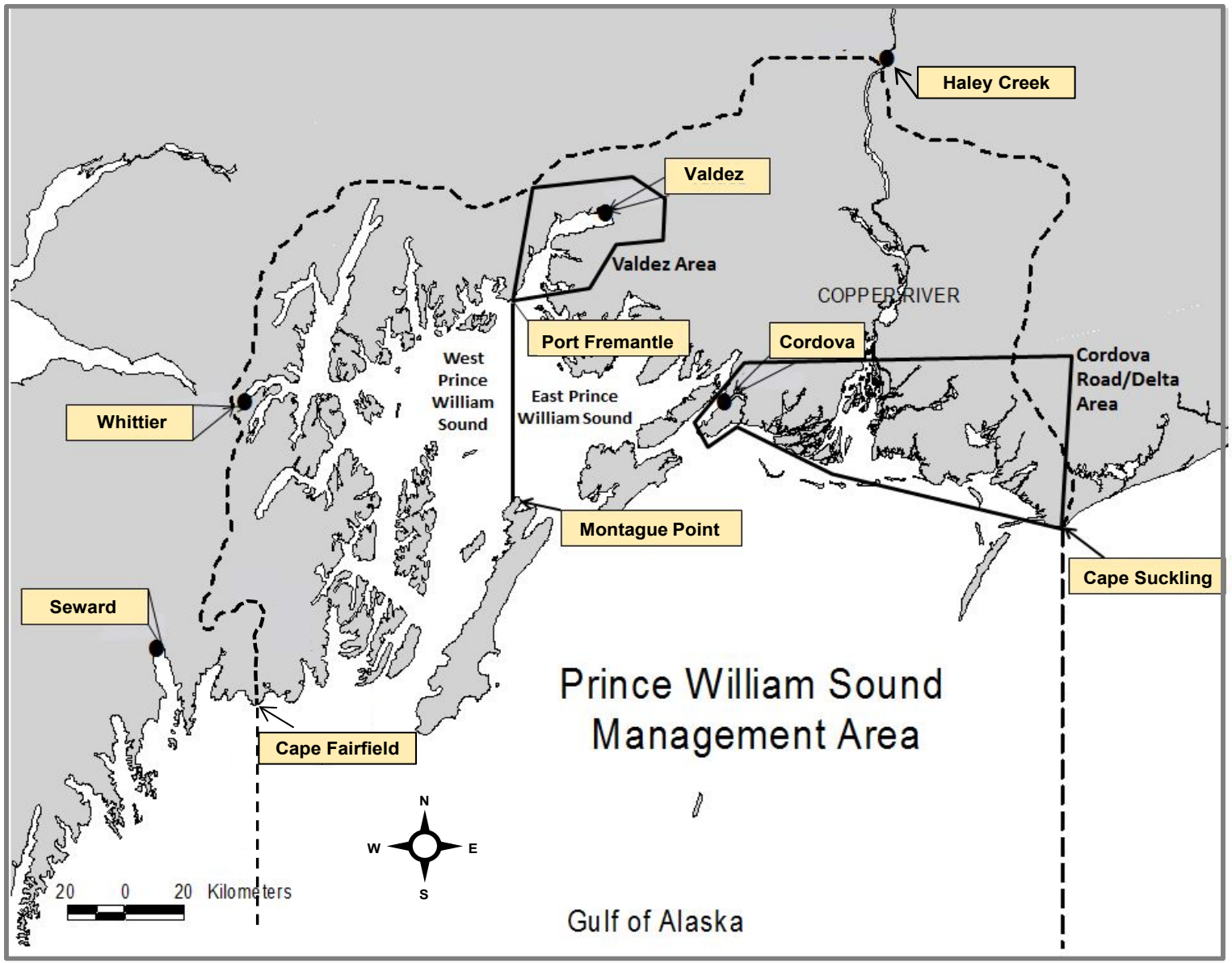

Figure 19.–Map of the Prince William Sound Management Area for sport fisheries with defined reporting areas.

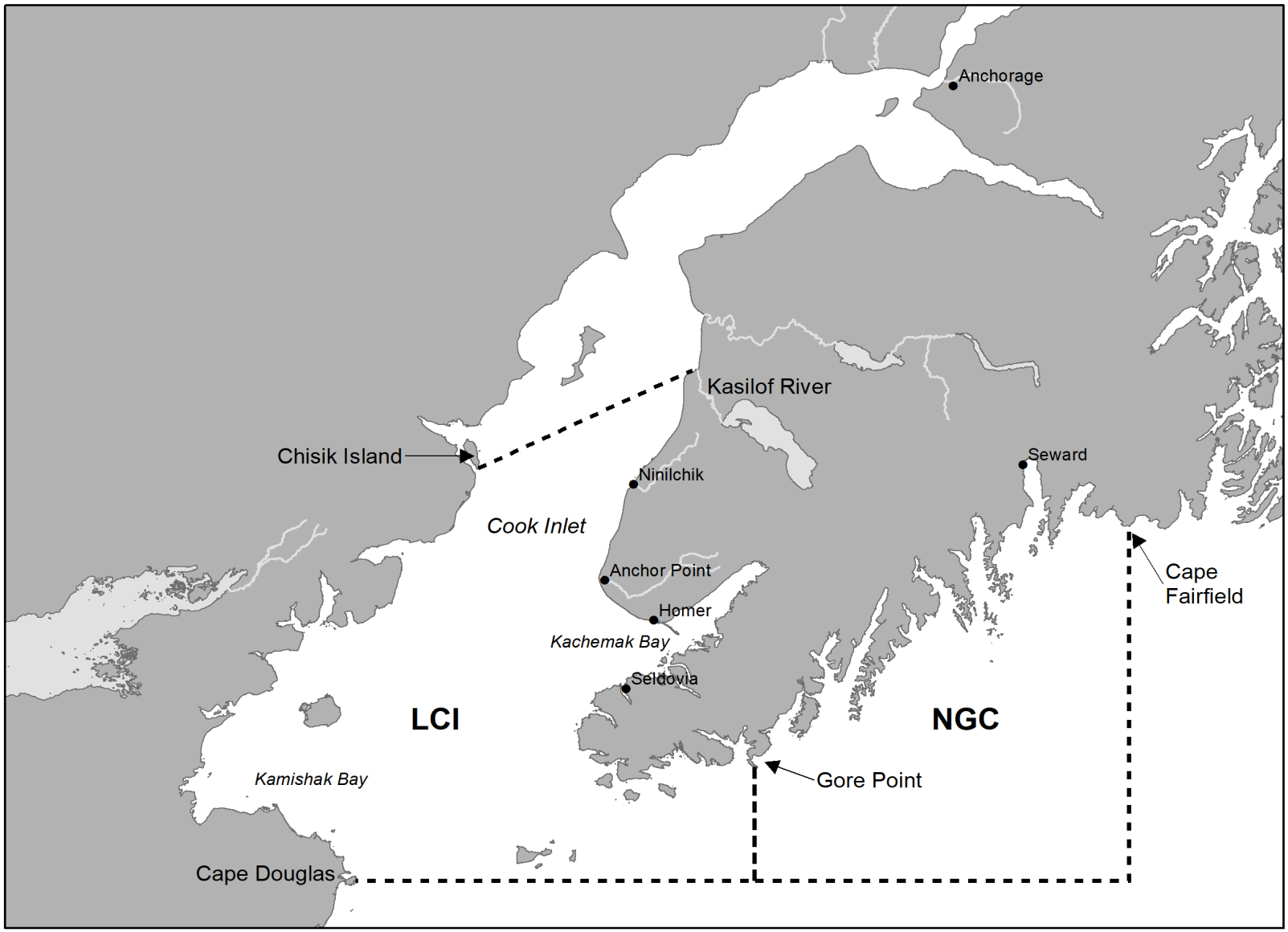

Figure 20.–North Gulf Coast (NGC) and Lower Cook Inlet (LCI) management areas for sport fisheries.

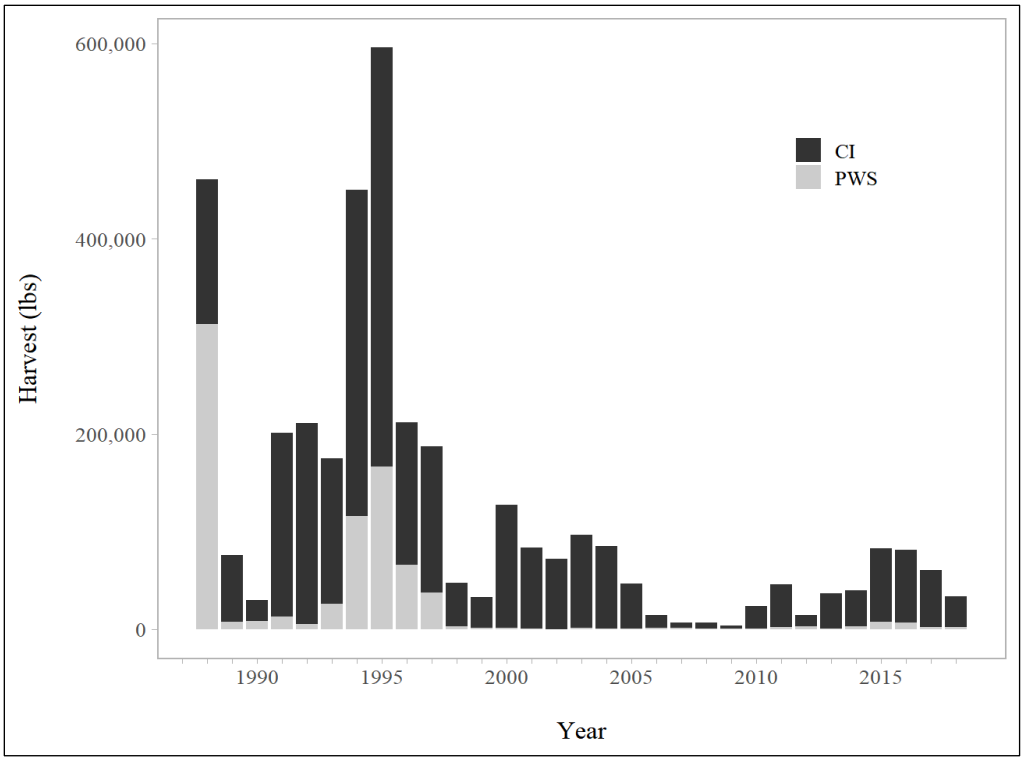

Figure 21.–Central Region commercial black rockfish harvest in pounds, includes black rockfish from federal waters, 1988–2018.

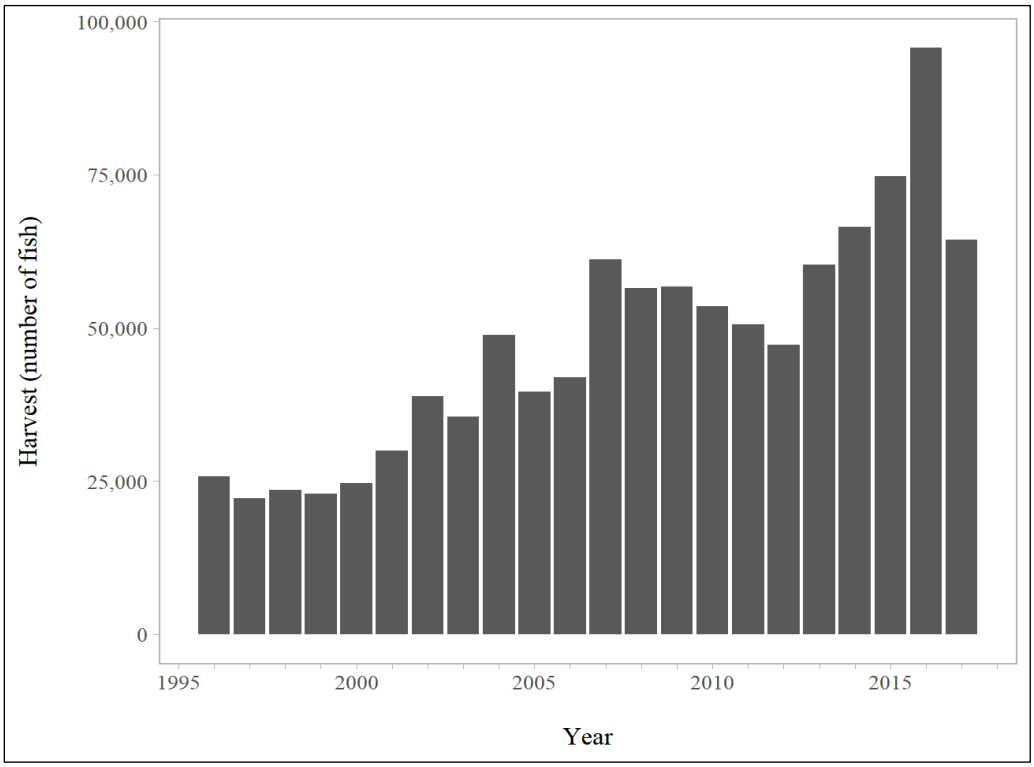

Figure 22.–Black rockfish sport harvest in numbers of fish across Lower Cook Inlet, Prince William Sound, and North Gulf Coast sport fishery management areas, 1996–2017.

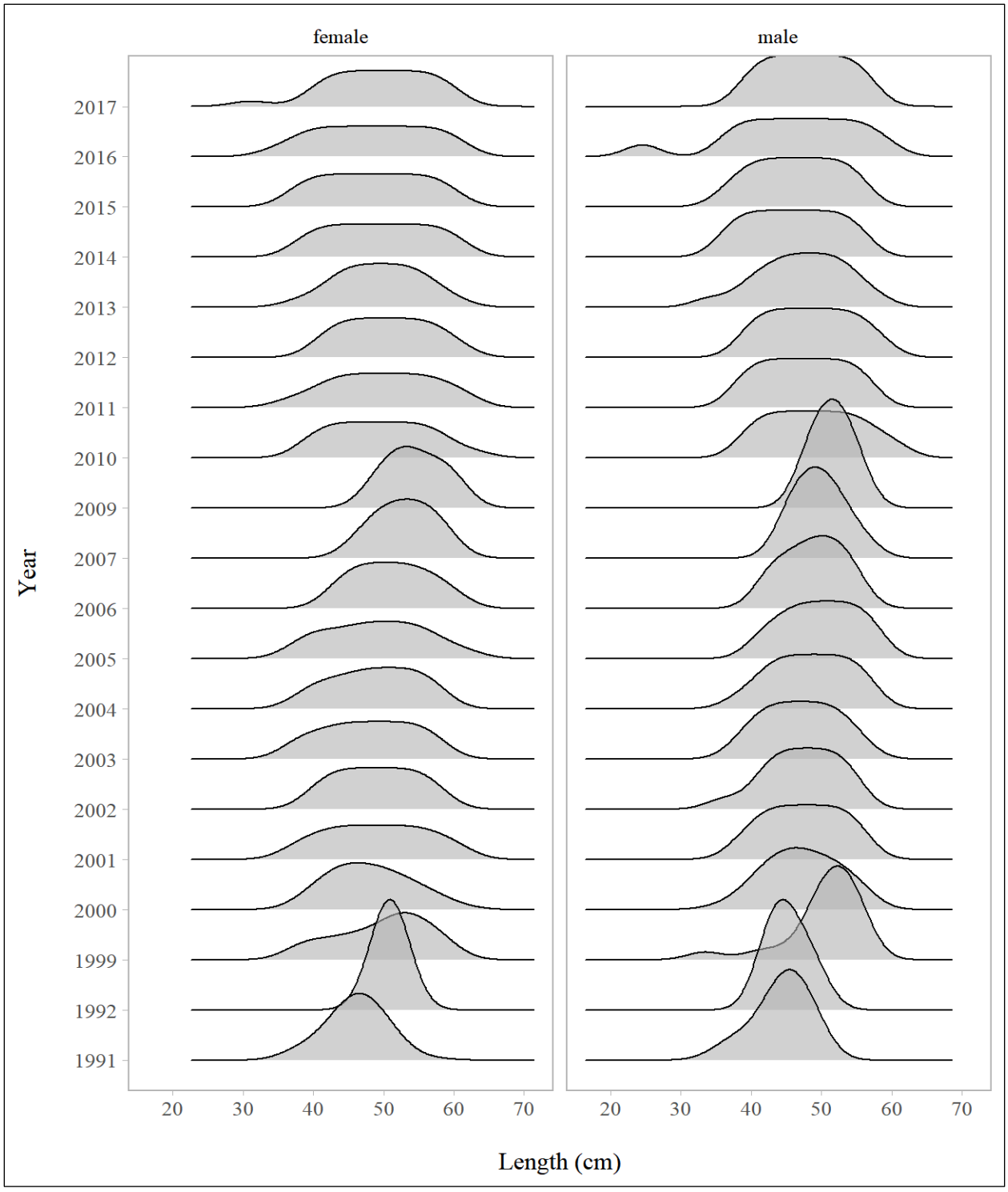

Figure 23.–Length distributions of female and male black rockfish sampled from Cook Inlet area commercial fisheries, 1991–2017.

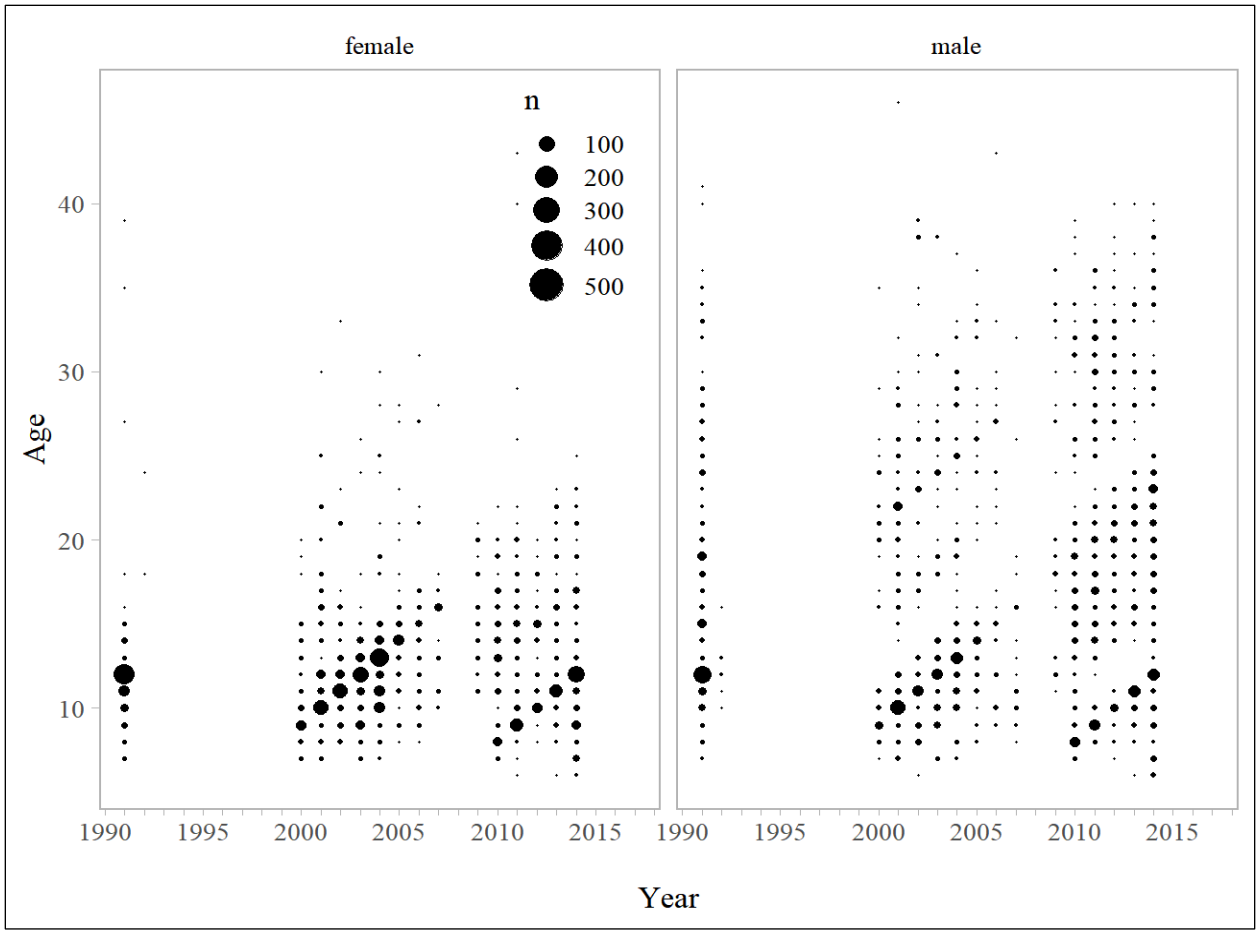

Figure 24.–Age frequency of female and male black rockfish sampled from Cook Inlet area commercial fisheries, 1991–2014.

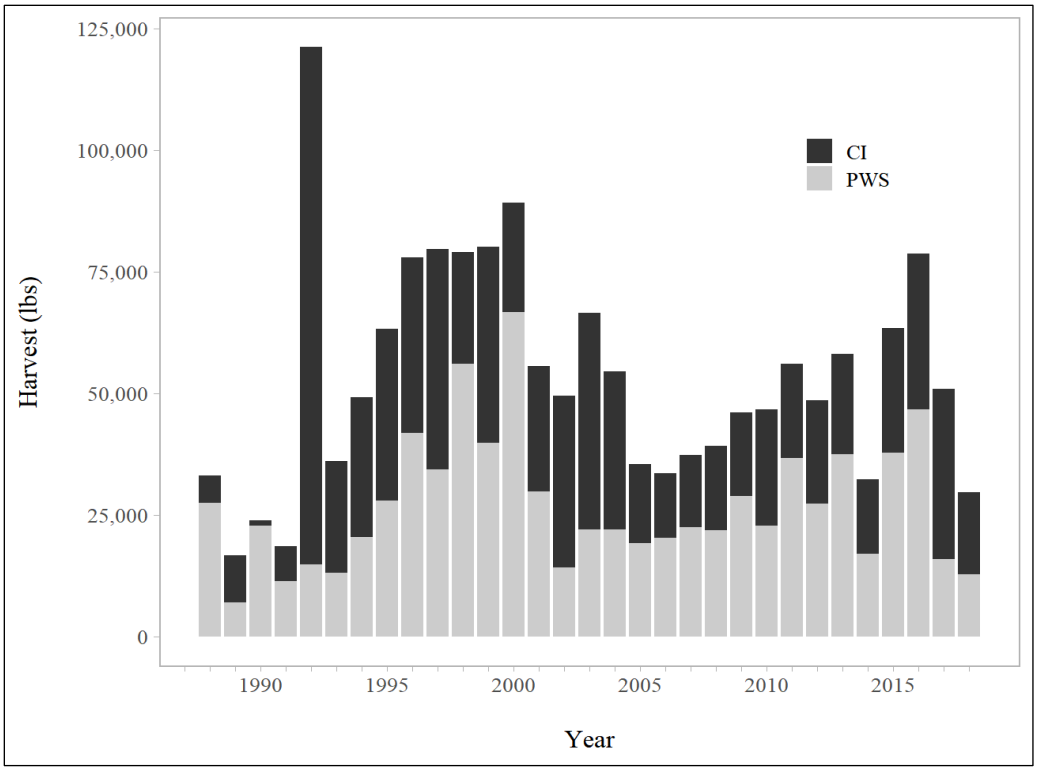

Figure 25.–Central Region commercial yelloweye rockfish harvest in pounds, 1988–2018.

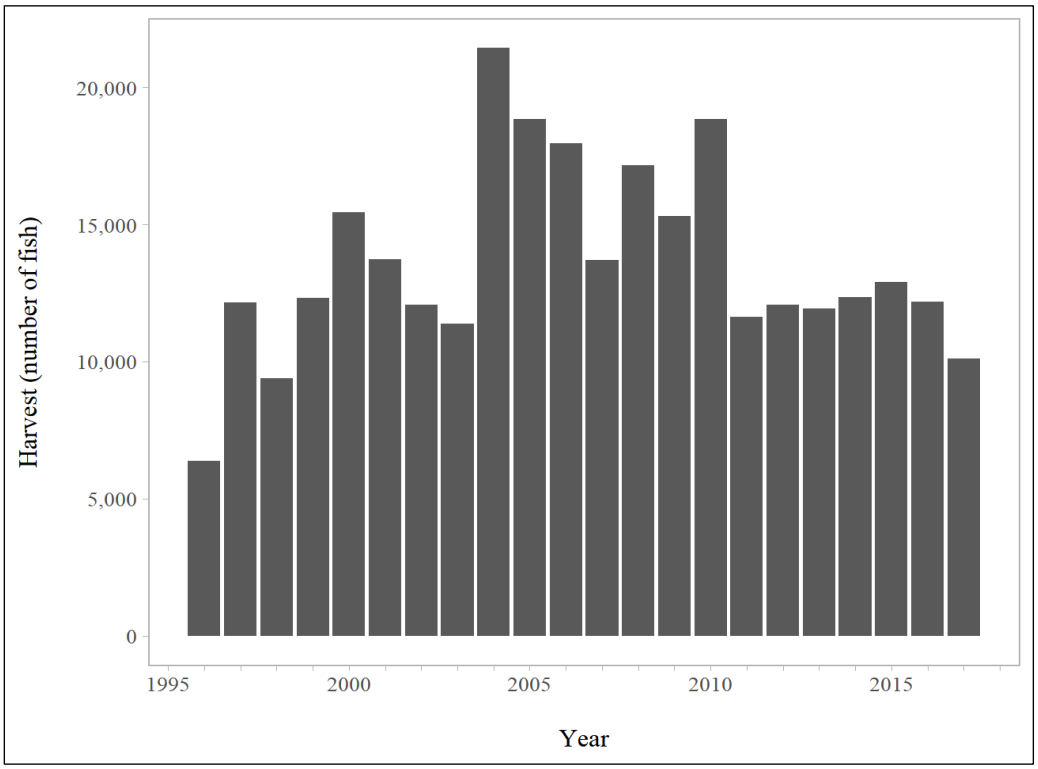

Figure 26.–Yelloweye rockfish sport harvest in numbers of fish across Lower Cook Inlet, Prince William Sound, and North Gulf Coast sport fishery management areas, 1996–2017.

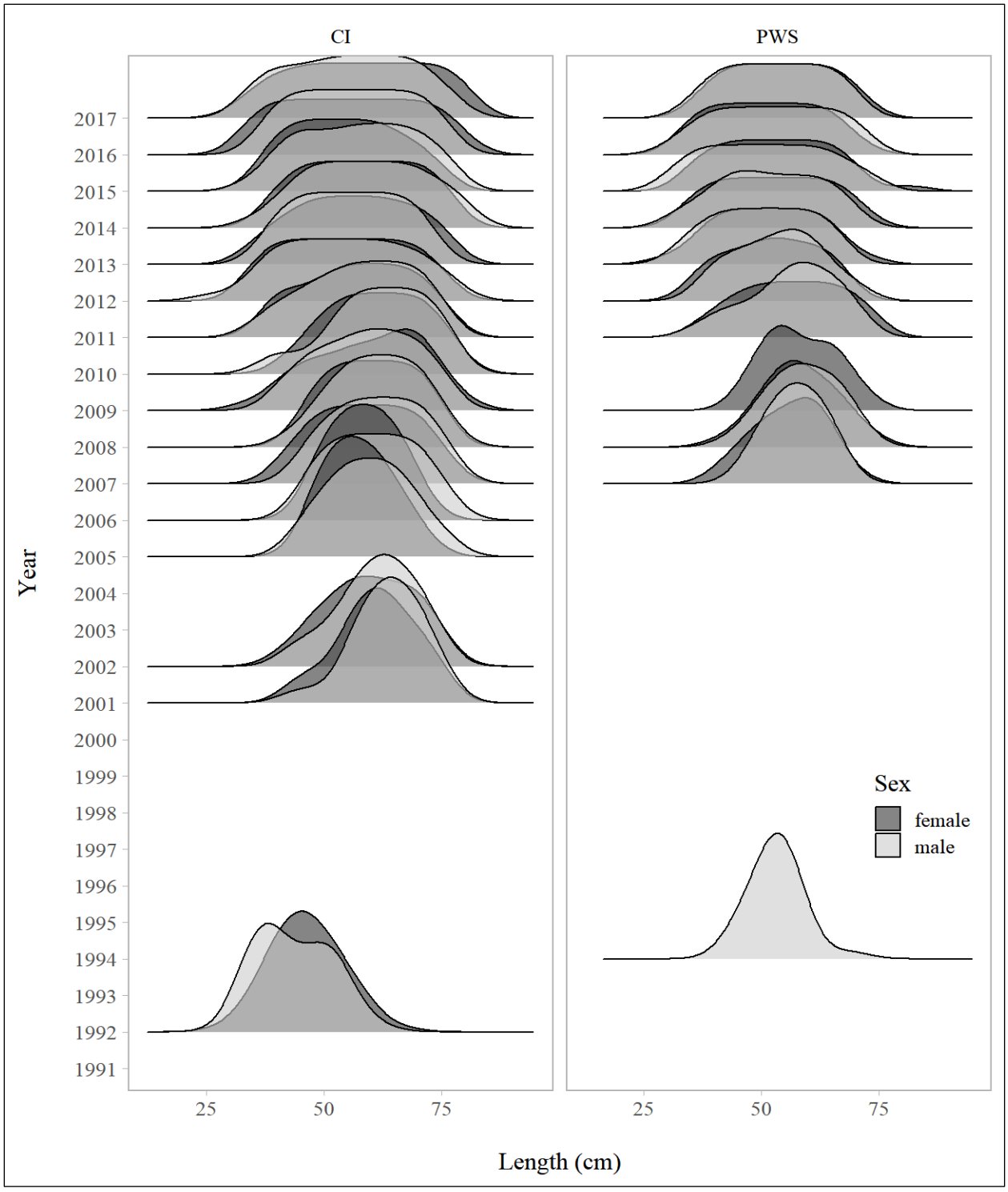

Figure 27.–Length distributions of female and male yelloweye rockfish sampled from Cook Inlet area and Prince William Sound area commercial fisheries.

Note: Sample sizes less than n =30 not included.

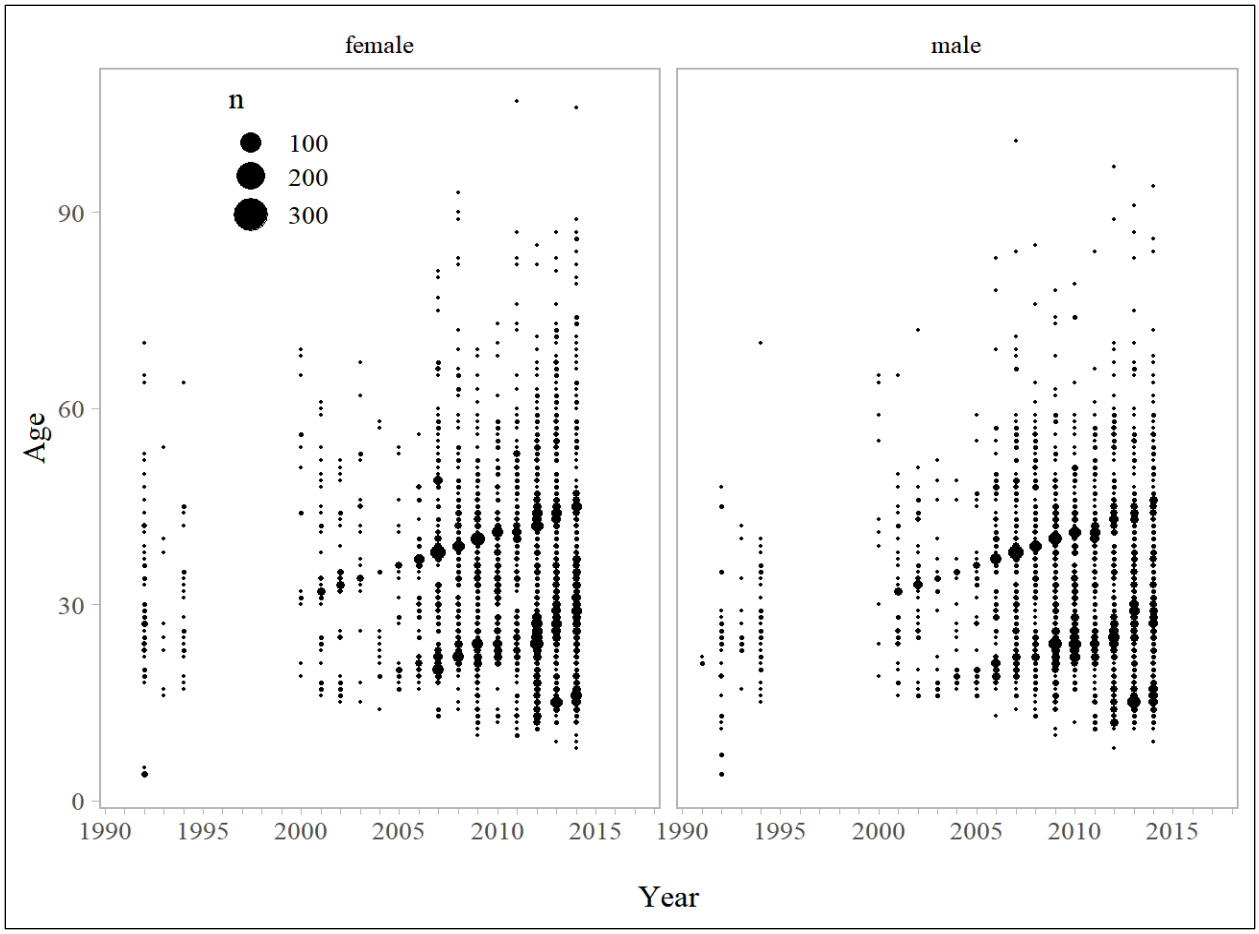

Figure 28.–Age frequency of female and male yelloweye rockfish sampled from Cook Inlet area commercial fisheries.

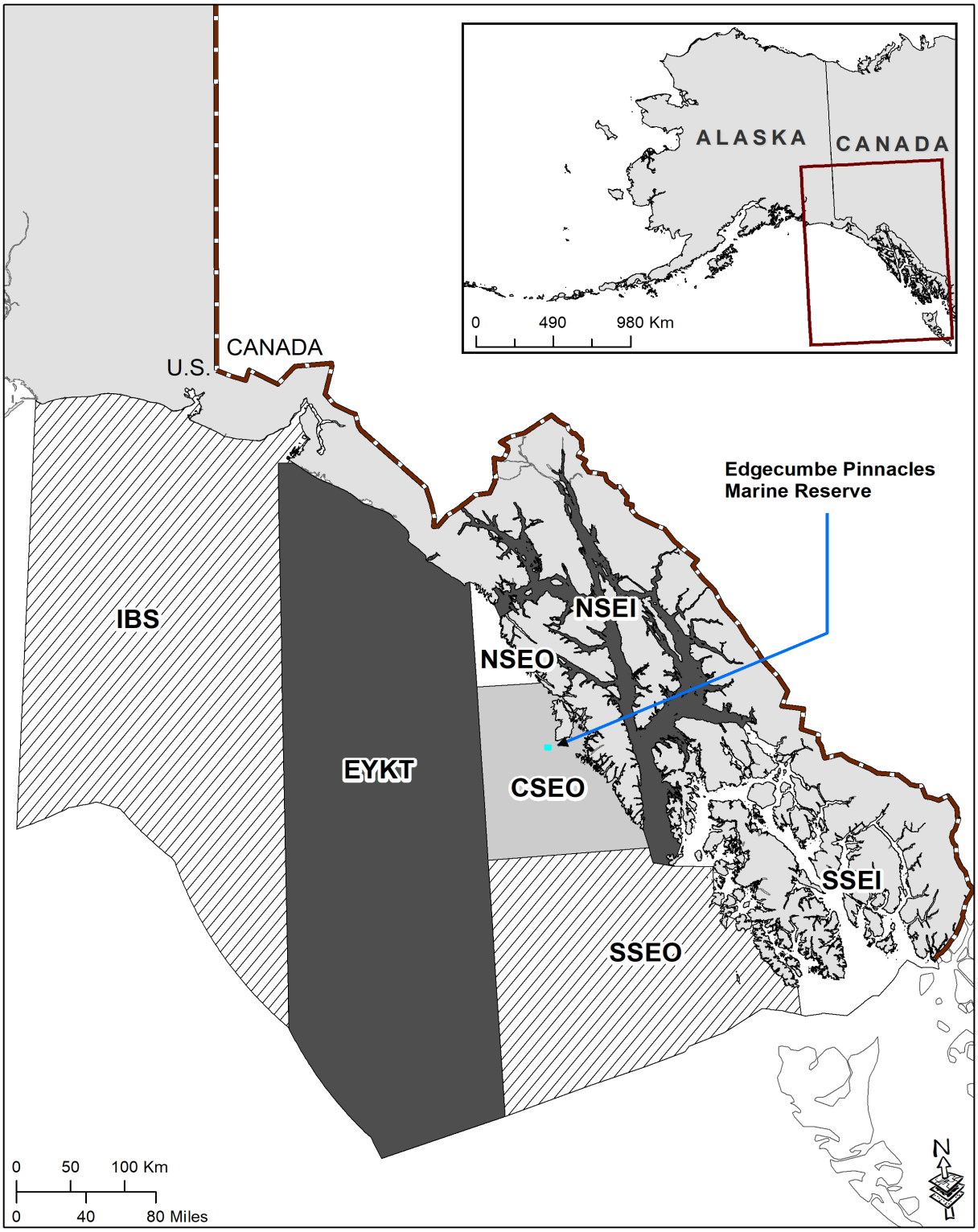

Figure 29.–Map of Southeast Alaska rockfish management areas, and the location of Edgecumbe Pinnacles Marine Reserve.

Note: The Southeast Outside Subdistrict (SEO) consists of the following management areas: EYKT = East Yakutat Section; NSEO = Northern Southeast Outside Section; CSEO = Central Southeast Outside Section; and SSEO = Southern Southeast Outside Section).

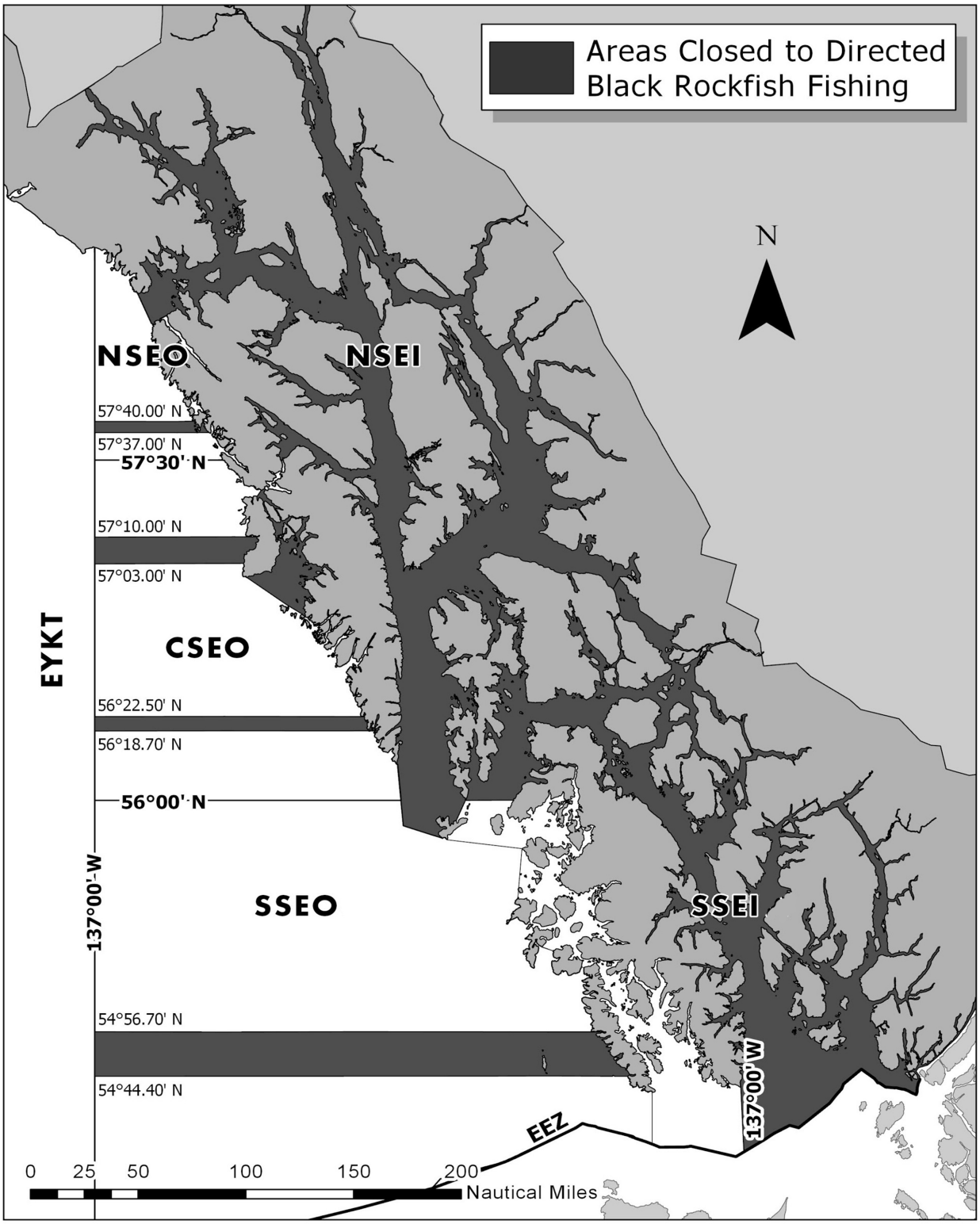

Figure 30.–Areas closed to the directed commercial black rockfish fishery in the Southeast Outside Subdistrict (SEO).

Note: EYKT = East Yakutat Section; NSEO = Northern Southeast Outside Section; CSEO = Central Southeast Outside Section; and SSEO = Southern Southeast Outside Section.

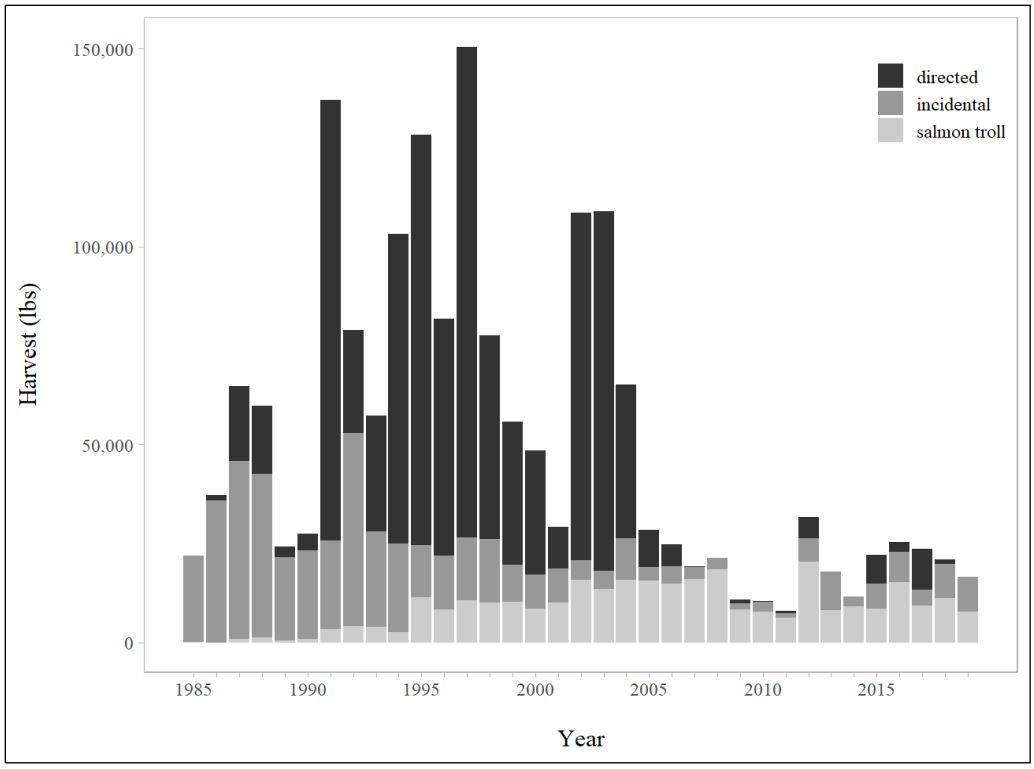

Figure 31.–Harvest of black rockfish in Southeast Alaska from the commercial (direct, incidental, and salmon troll) fisheries.

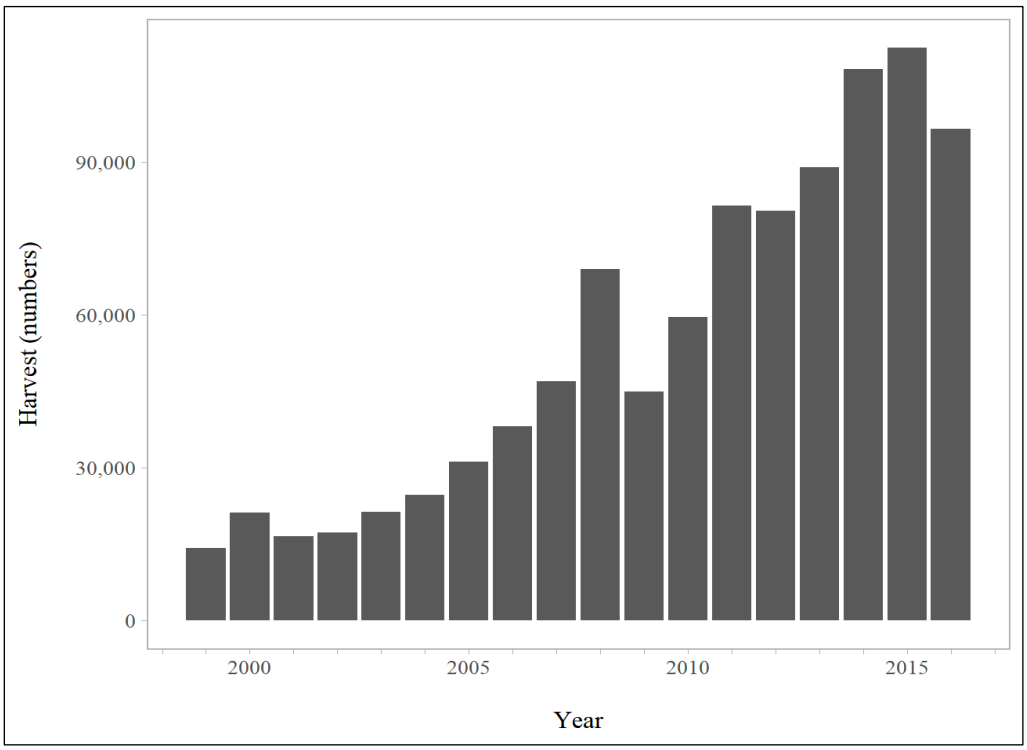

Figure 32.–Number of harvested pelagic rockfish as reported on charter vessel logbooks in Southeast Alaska, 1999–2016.

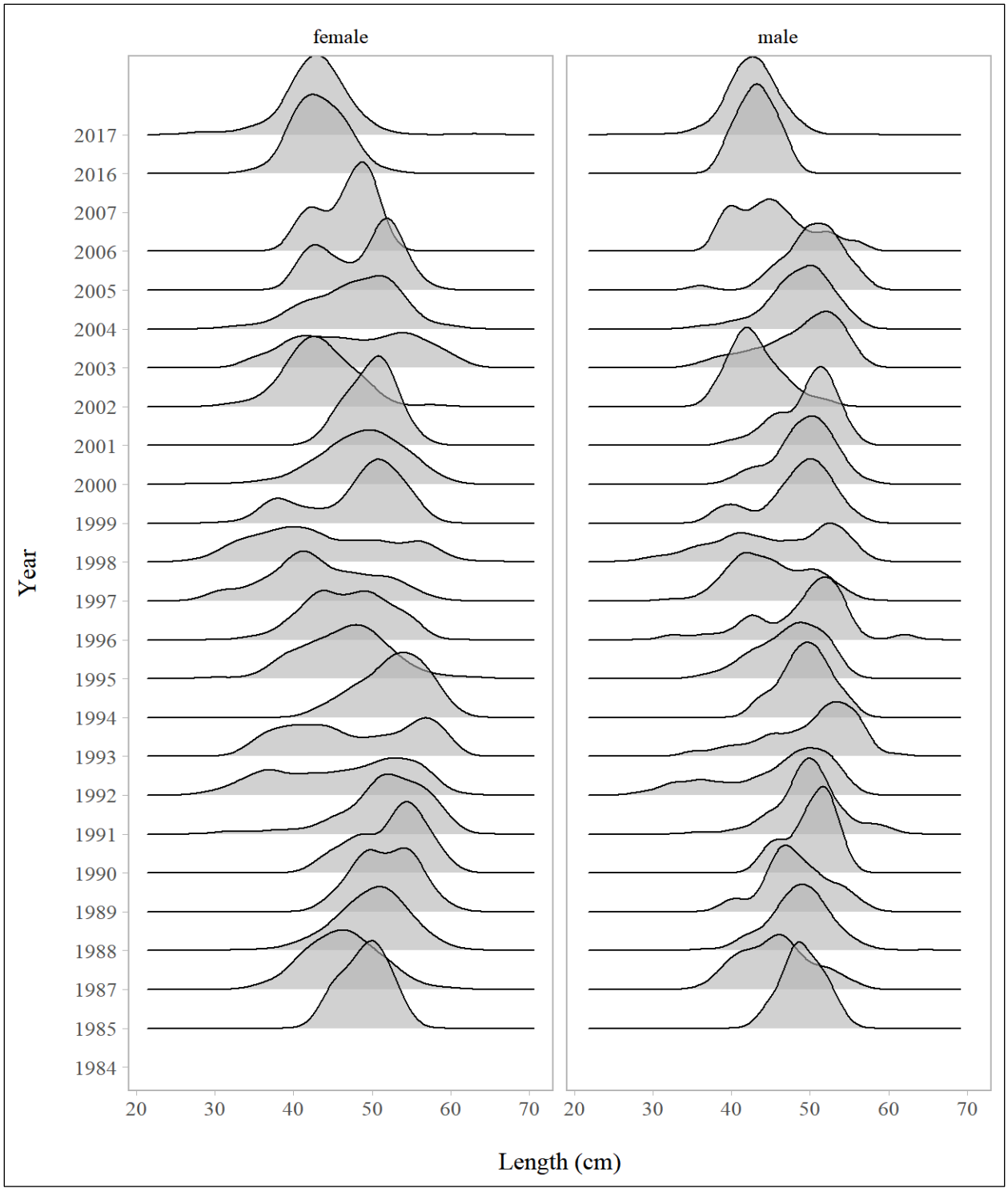

Figure 33.–Length distributions (fork length) of female and male black rockfish sampled from the commercial fishery.

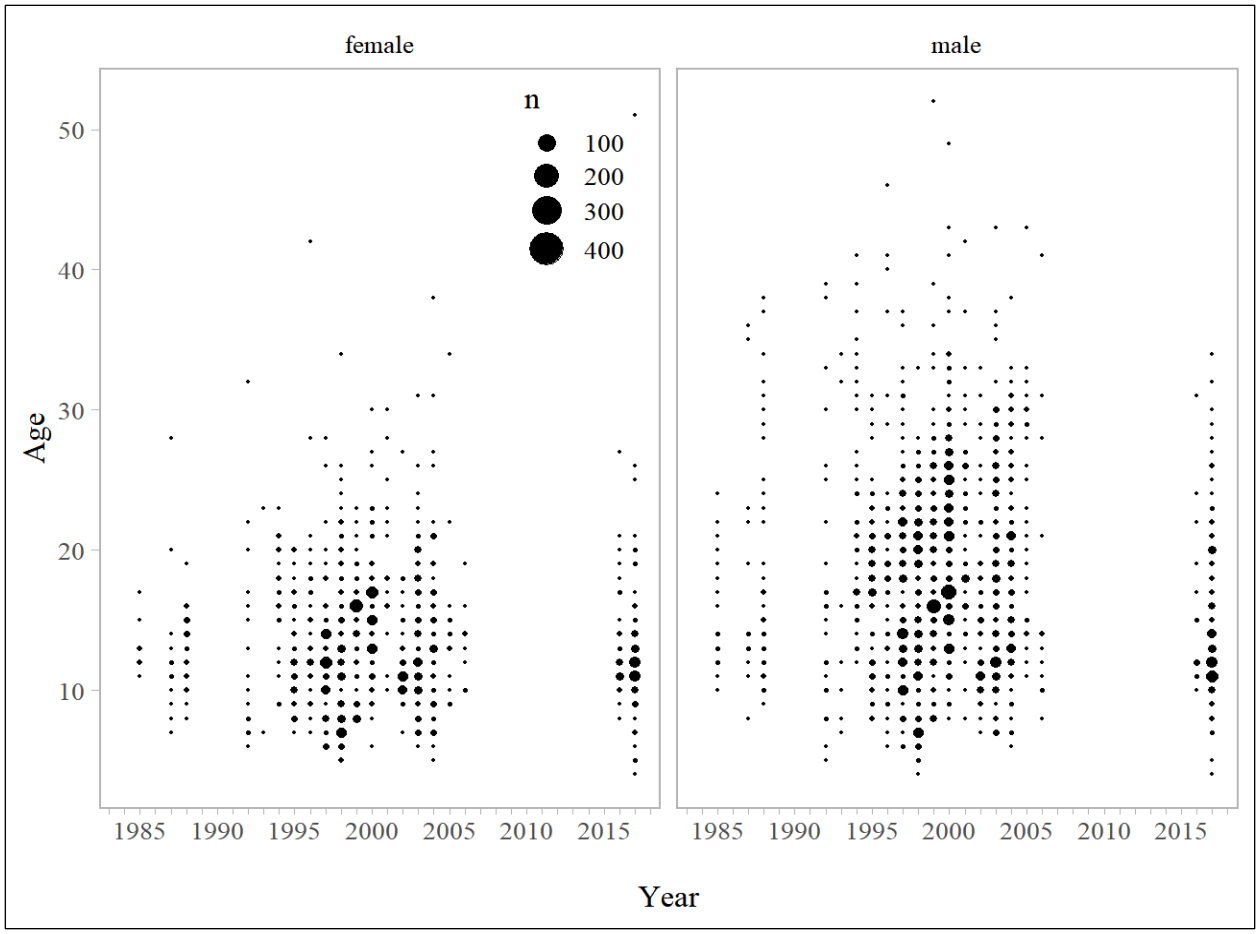

Figure 34.–Age frequency of female and male black rockfish sampled from the commercial fishery.

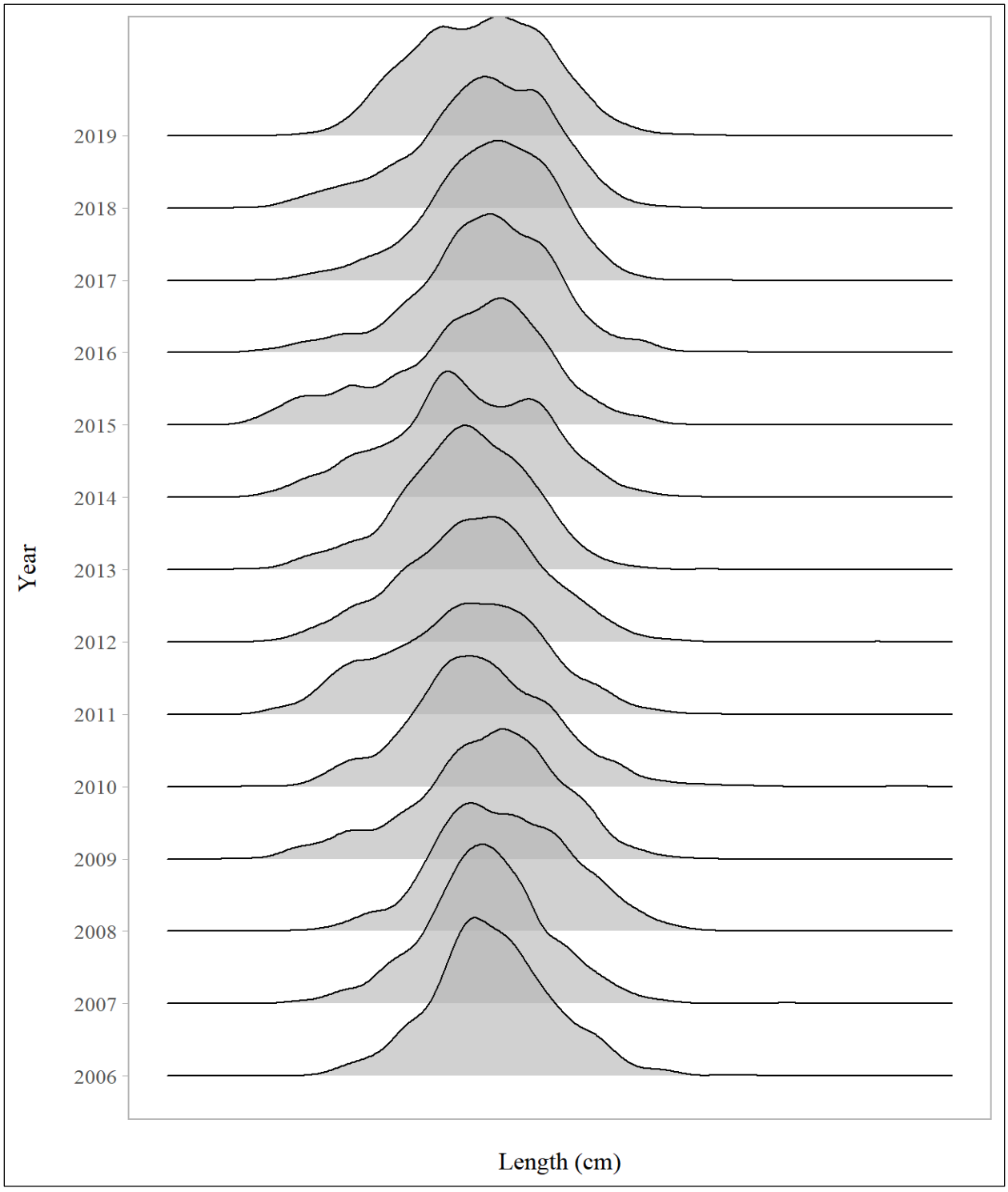

Figure 35.–Length distributions of black rockfish sampled from the sport fishery in Southeast Alaska, 2006–2019.

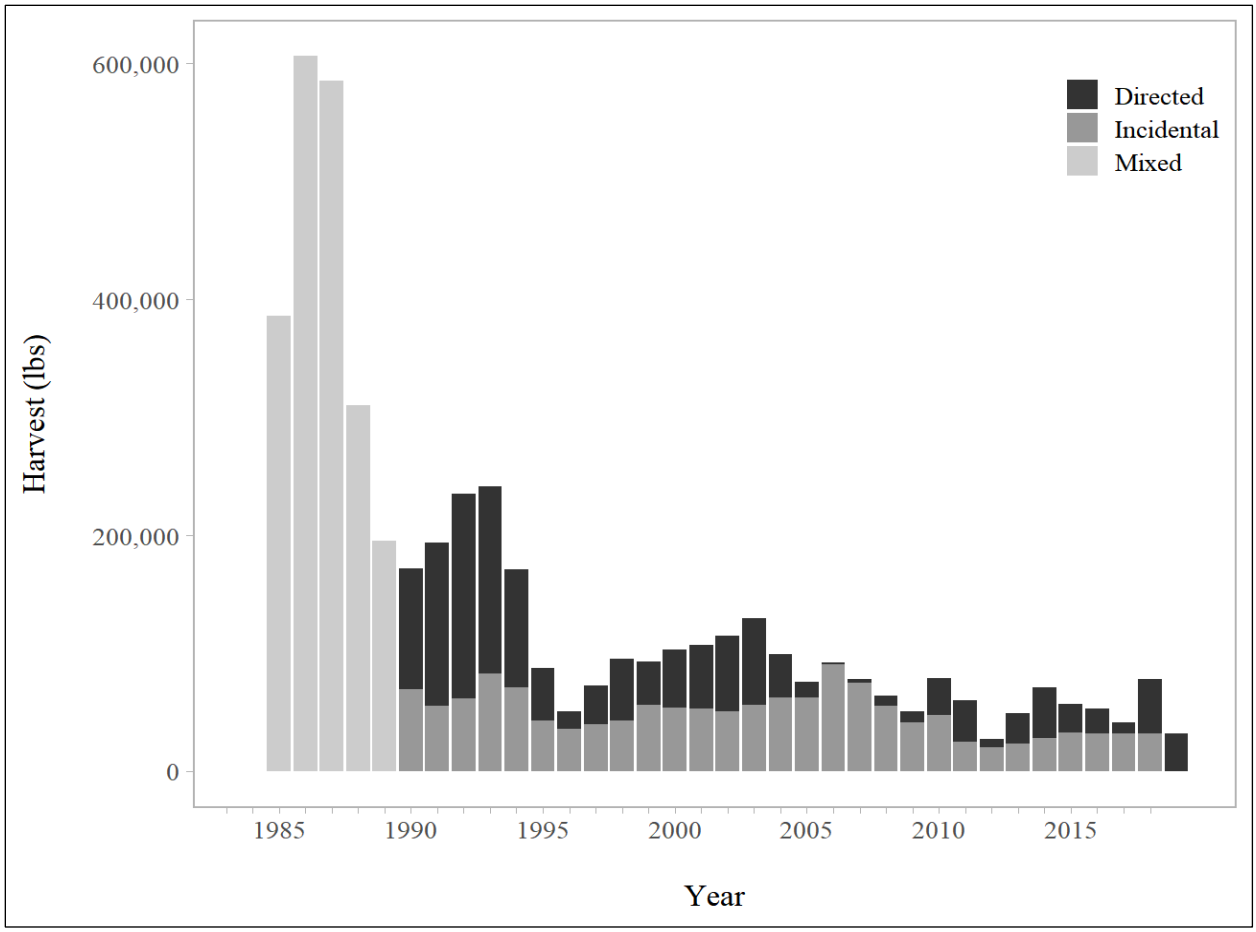

Figure 36.–Harvest of yelloweye rockfish in Southeast Alaska for inside water management areas (NSEI and SSEI) from the commercial (direct and incidental) fisheries.

Note: NSEI = Northern Southeast Inside Subdistrict; SSEI = Southern Southeast Inside Subdistrict.

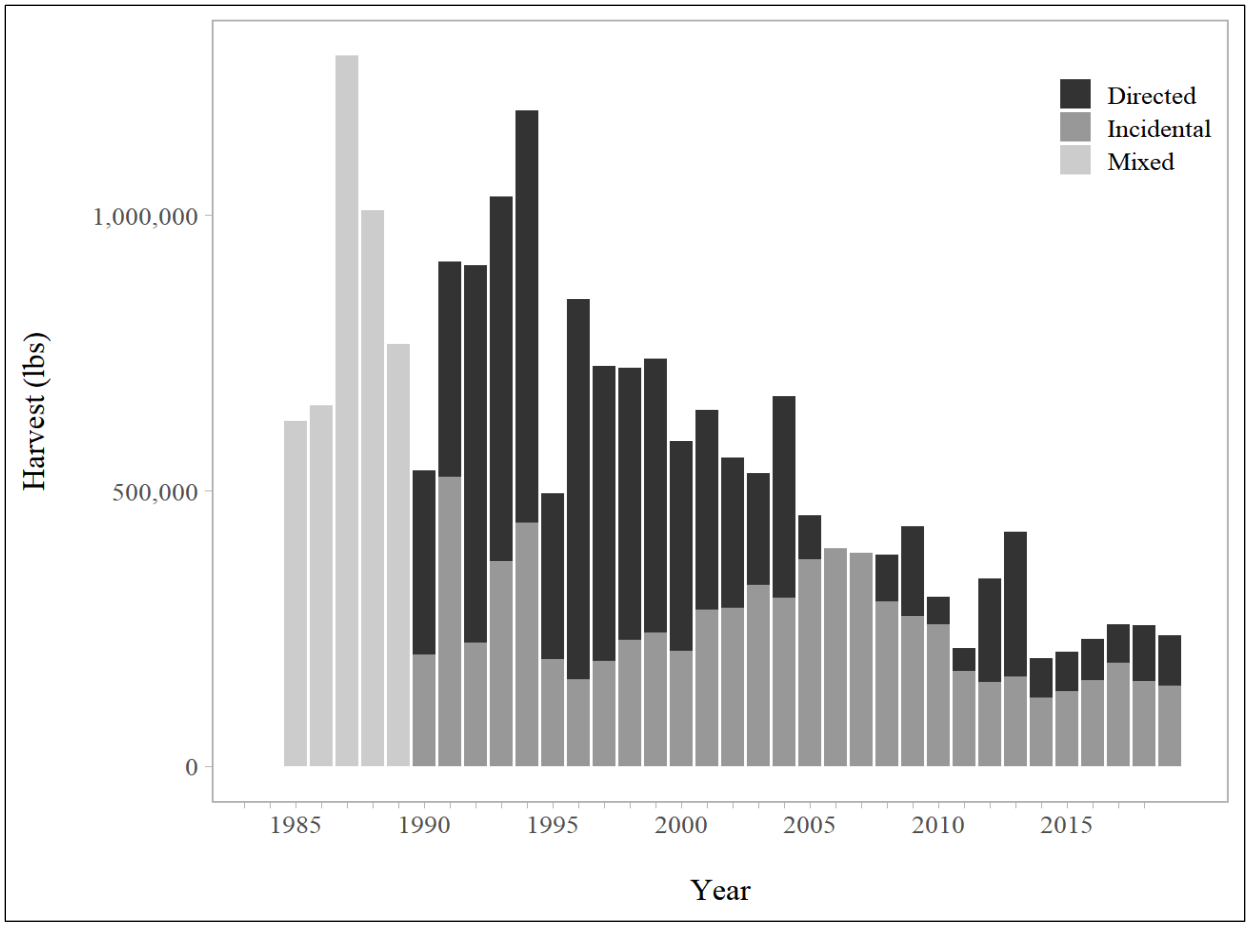

Figure 37.–Harvest of yelloweye rockfish in Southeast Alaska for outside water management areas (EYKT, NSEO, CSEO, and SSEO) from the directed and incidental commercial fisheries.

Note: EYKT = East Yakutat Section; NSEO = Northern Southeast Outside Section; CSEO = Central Southeast Outside Section; and SSEO = Southern Southeast Outside Section.

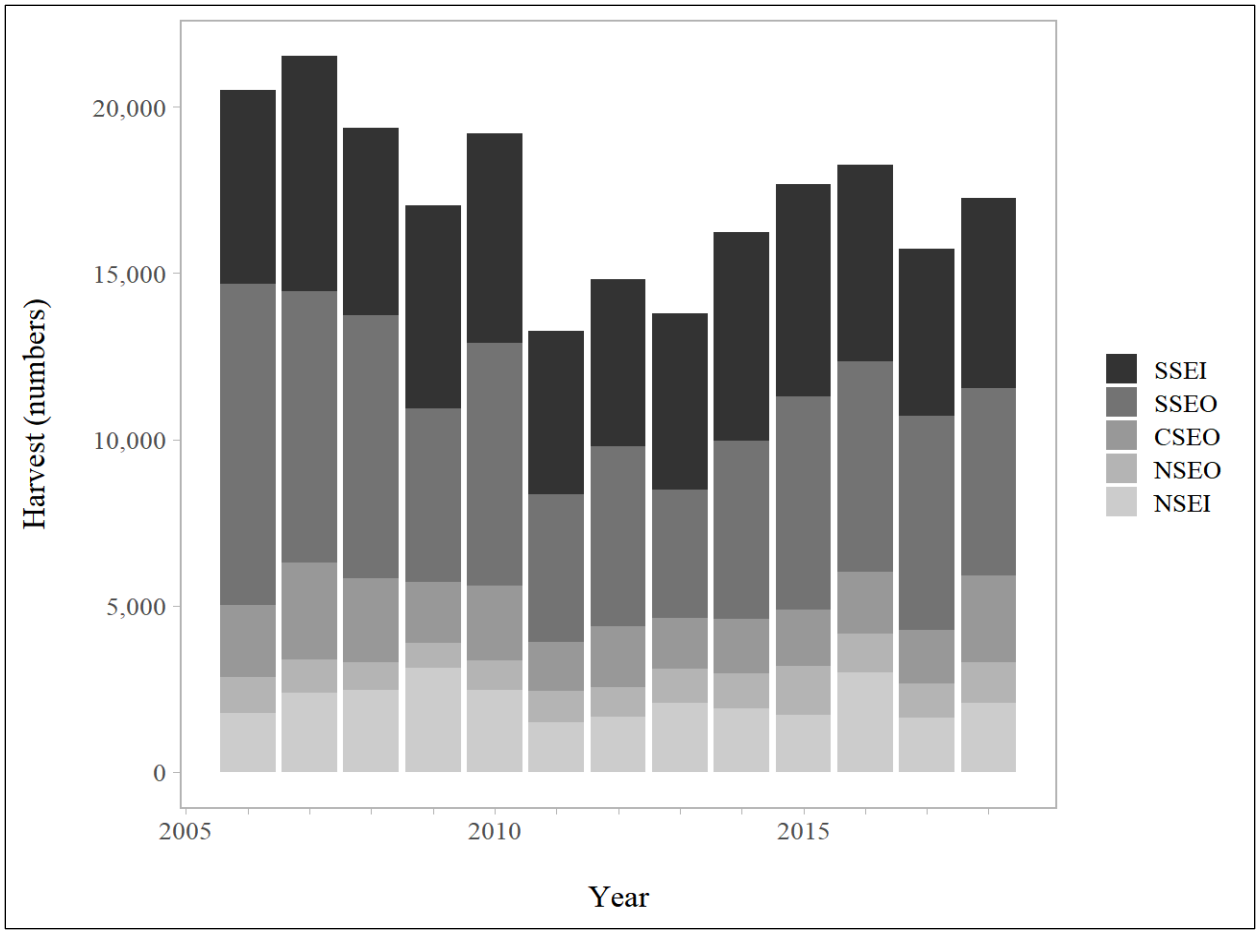

Figure 38.–Harvest (in numbers of fish) of yelloweye rockfish in Southeast Alaska by district in the sport fishery, 2006–2018.

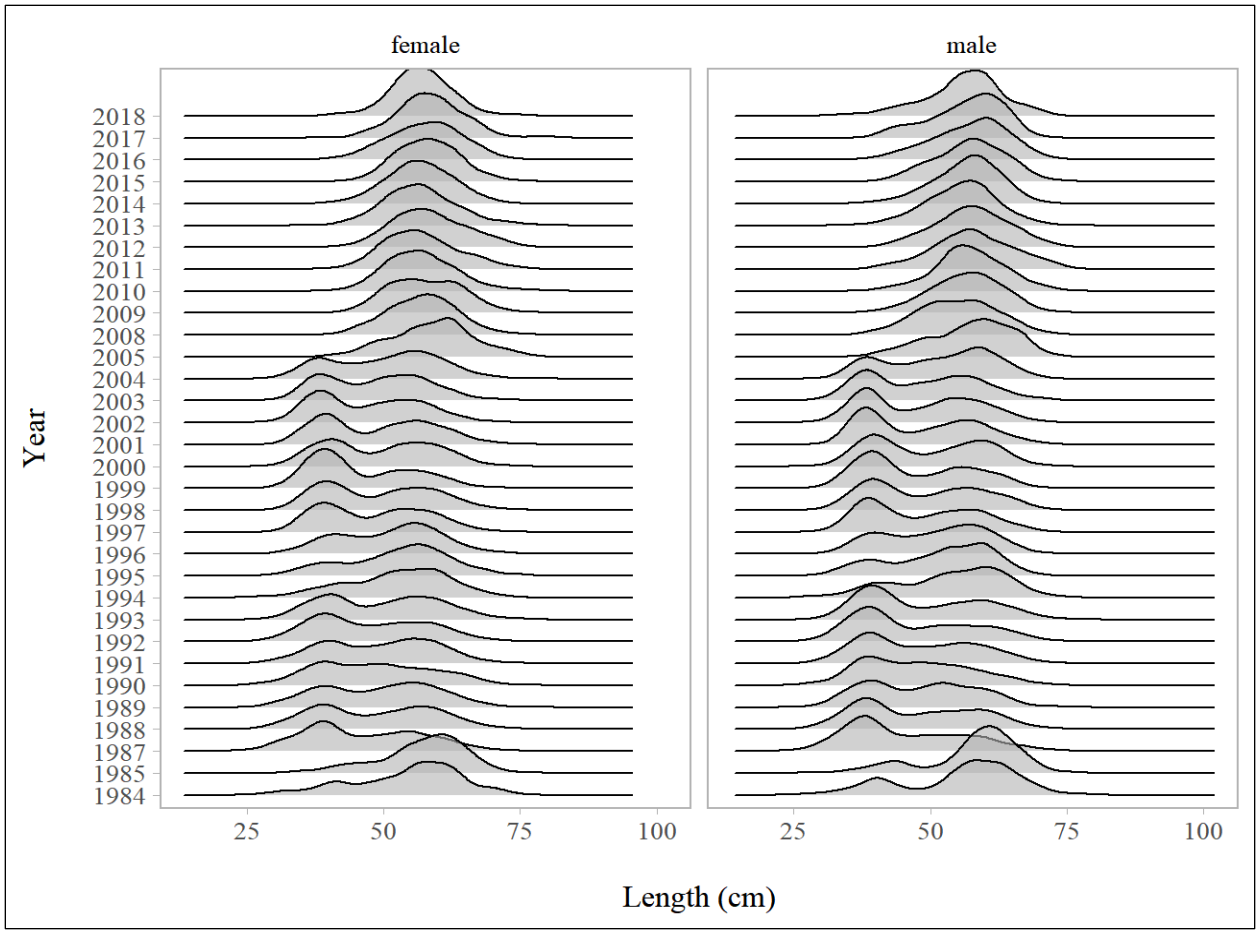

Figure 39.–Commercial fishery length distributions (fork length) of female and male yelloweye rockfish in southeast Alaska.

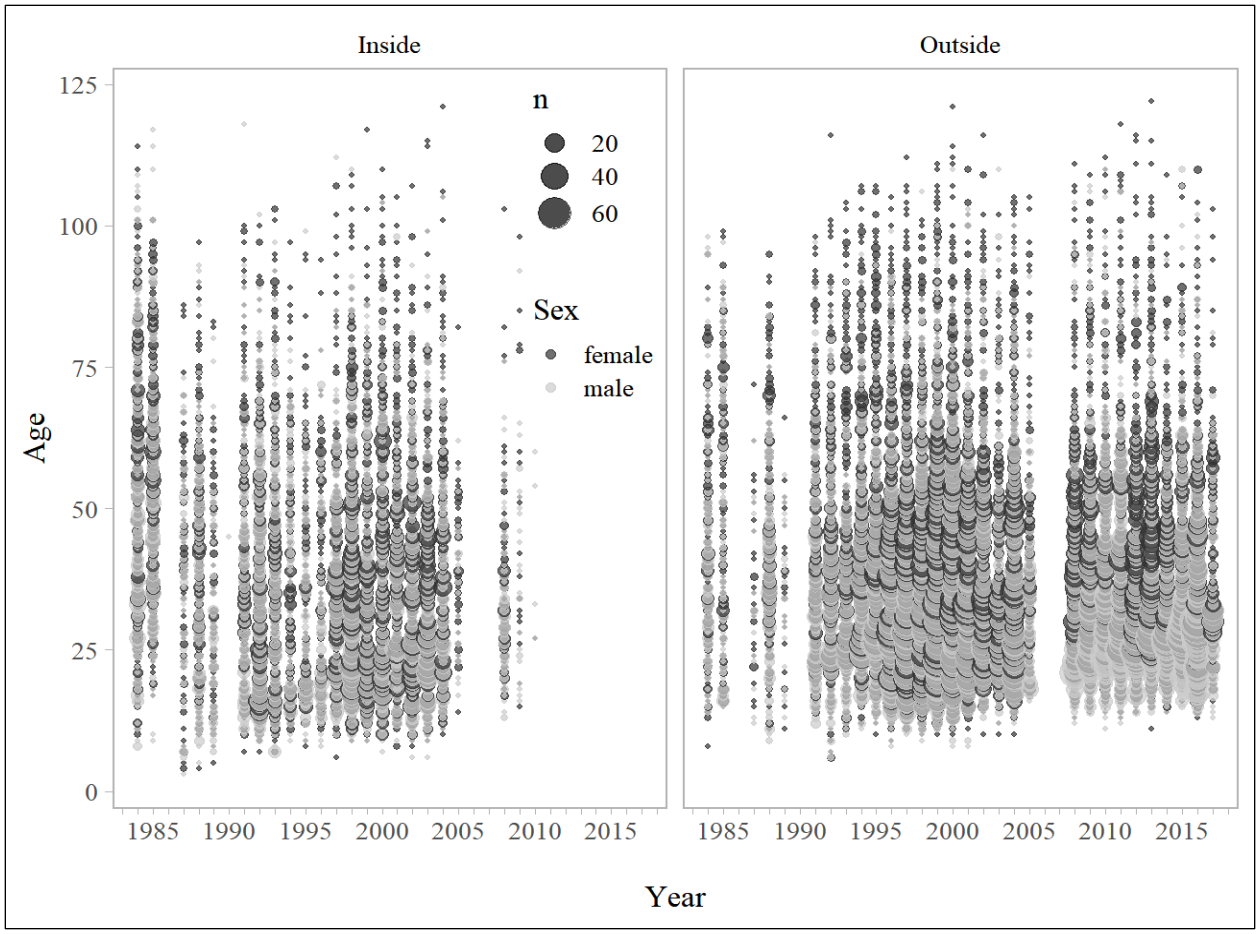

Figure 40.–Age frequency of female and male yelloweye rockfish sampled from commercial fishery harvests in Southeast Alaska.

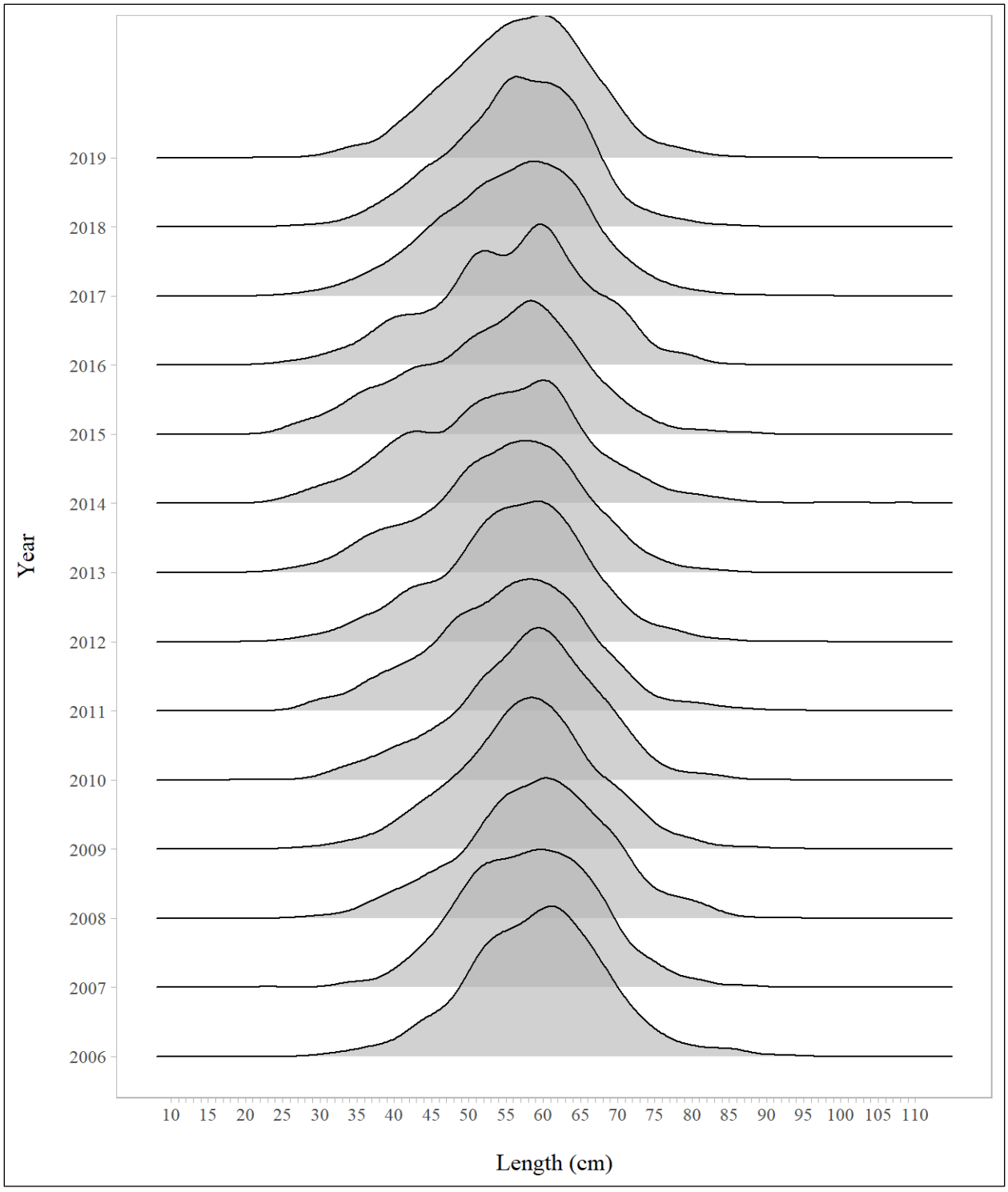

Figure 41.–Length distributions of yelloweye rockfish sampled from the sport fishery in Southeast Alaska.

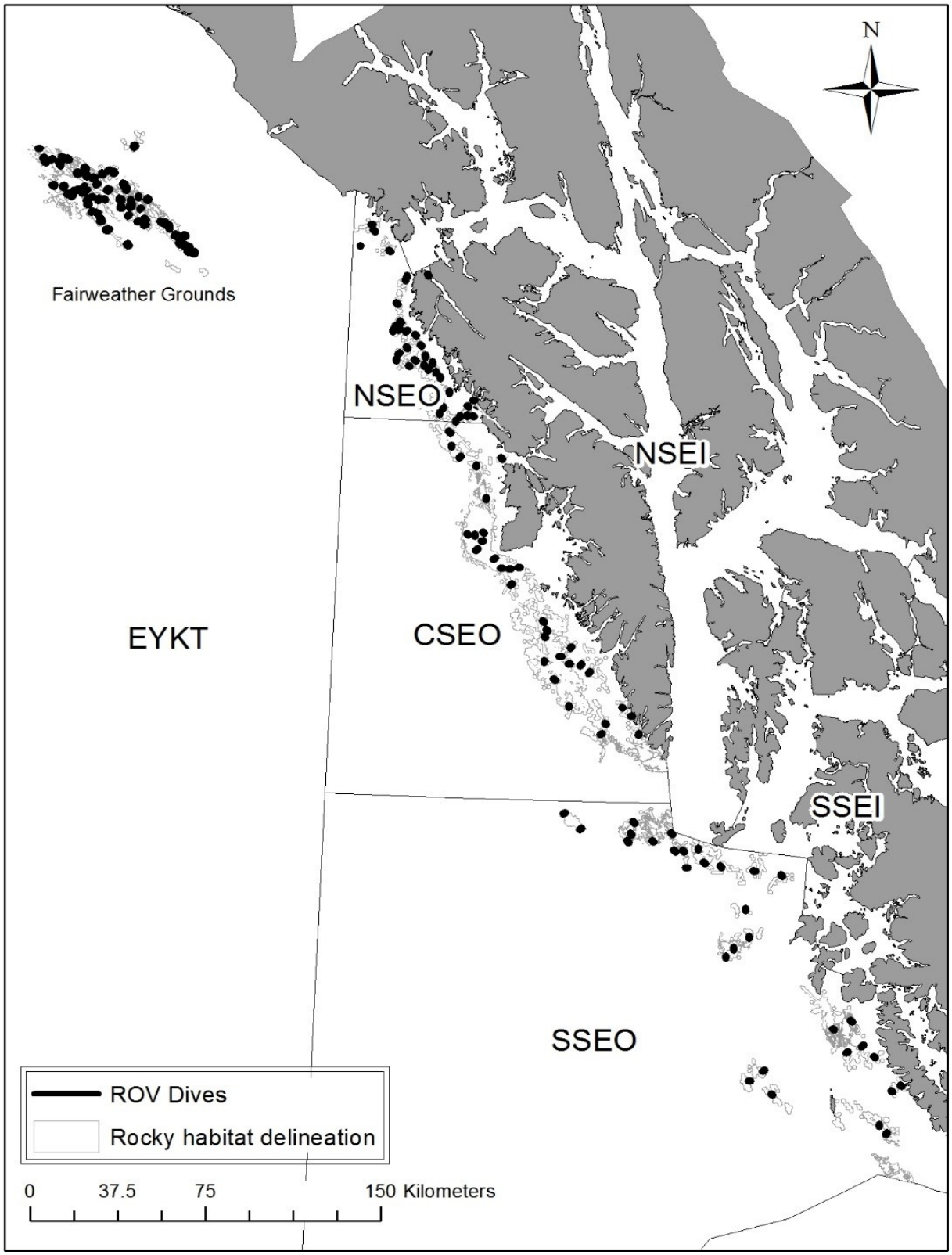

Figure 42.–ROV transect locations for Northern Southeast Outside Section (NSEO) and Central Southeast Outside Section (CSEO) in 2016, East Yakutat Section (EYKT) in 2017, and Southern Southeast Outside Section (SSEO) in 2018.

APPENDIX A: ACRONYMS AND ABBREVIATIONS

Appendix A1.–Acronyms and abbreviations used in this document and not previously defined for this report series.

Acronym/ Abbreviation	Definition
ADF&G	Alaska Department of Fish and Game
AFSC	Alaska Fishery Science Center
AP-AIRA	Alaska Peninsula-Aleutian Islands Regulatory Area
BOF	The Alaska Board of Fisheries
CGOA	Central Gulf of Alaska
CI	Cook Inlet
CPUE	Catch per unit effort
CSEO	Central Southeast Outside Section
DSR	Demersal shelf rockfish
EEZ	Exclusive economic zone
EGOA	Eastern Gulf of Alaska
EYKT	East Yakutat Section
FMP	Fishery Management Plan
FL	Fork length
GHL	Guideline harvest level
GIS	Geographic Information Systems
GOA	Gulf of Alaska
KMA	Kodiak Management Area
LPT	Leadership Plan Team
NGC	North Gulf Coast
NMFS	National Marine Fisheries Service
NPFMC	North Pacific Fishery Management Council
NSEI	Northern Southeast Inside Subdistrict
NSEO	Northern Southeast Outside Section
PSR	Pelagic shelf rockfish
PWS	Prince William Sound
ROV	Remotely operated vehicle
SAP	South Alaska Peninsula
SEO	Southeast Outside Subdistrict
SSEI	Southern Southeast Inside Subdistrict
SSEO	Southern Southeast Outside Section
SWHS	Statewide Harvest Survey
TAC	Total Allowable Catch
TL	Total length
WGOA	Western Gulf of Alaska