Section 11

Assessment of Shortraker Rockfish and "Other Slope Rockfish" in the Gulf of Alaska

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November 2009 Plan Team Draft

11.0 EXECUTIVE SUMMARY

11.0.1 Summary of Major Changes

Assessment methodology in this report is identical to that used in the last full assessment for Gulf of Alaska shortraker rockfish and "other slope rockfish" in 2007. The only major new information in this assessment is biomass estimates from the 2009 trawl survey. As in all previous assessments for shortraker rockfish and "other slope rockfish", current exploitable biomass is based on averaging the biomass estimates in the last three Gulf of Alaska trawl surveys (currently 2005, 2007, and 2009). This results in an exploitable biomass of 40,626 mt for shortraker rockfish and 76,867 mt for "other slope rockfish". The exploitable biomass for shortraker rockfish is very similar to the value computed in the 2007 assessment, but exploitable biomass for "other slope rockfish" has decreased almost 15% compared with 2007. Much of the decrease for "other slope rockfish" has been caused by a sharp decline in biomass for silvergray rockfish since 2003.

Shortraker rockfish and the various "other slope rockfish" species have always been classified into tier 5 in the NPFMC's ABC and OFL definitions, except for sharpchin rockfish which have been in tier 4 for a number of years. The tier 5 definitions state that $F_{ABC} \leq 0.75M$. Applying this definition to the exploitable biomass of shortraker rockfish results in a recommended ABC of 914 mt in 2010. For "other slope rockfish", applying an $F_{ABC} \leq F_{40\%}$ rate to the exploitable biomass of sharpchin rockfish (tier 4) and an $F_{ABC} \leq 0.75M$ rate to that of the other species (tier 5) results in ABCs of 931 mt and 2,818 mt, respectively, or a combined recommended ABC of 3,749 mt for the "other slope rockfish" management group in 2010.

Geographic apportionment of the ABCs amongst management areas of the Gulf of Alaska is based on a weighted average of the percent exploitable biomass distribution for each area in the three most recent trawl surveys (2005, 2007, and 2009). In these computations, each successive survey is given a progressively heavier weighting using factors of 4, 6, and 9, respectively. The new apportionment values for shortraker rockfish are: Western area, 14.63%; Central area, 35.56%; and Eastern area, 49.81%. Applying these percentages to the recommended ABC of 914 mt yields the following apportionments for the Gulf in 2010: Western area, 134 mt; Central area, 325 mt; and Eastern area, 455 mt. Apportionment values for "other slope rockfish" are: Western area, 5.65%; Central area, 13.53%; and Eastern area, 80.82%. Applying these percentages to the recommended ABC of 3,749 mt yields the following apportionments for the Gulf in 2010: Western area, 212 mt; Central area, 507 mt; and Eastern area, 3,030 mt. The Eastern area for "other slope rockfish" is further divided into the West Yakutat area and the East Yakutat/Southeast Outside area. Based on a procedure identical to the other apportionment calculations (a 4:6:9 weighted average percent biomass of the three most recent trawl surveys), the Eastern area apportionment is subdivided as follows: West Yakutat, 9.01%; and East Yakutat/Southeast Outside, 90.99%. This translates into an ABC of 273 mt for West Yakutat and 2,757 mt for East Yakutat/Southeast Outside in 2010.

Overfishing for a tier 5 species such as shortraker rockfish is defined to occur at a harvest rate of $F=M$. Therefore, applying the estimate of M for shortraker rockfish (0.03) to the estimate of current exploitable biomass (40,626 mt) yields an overfishing catch limit of 1,219 mt for 2010. Overfishing is defined to occur at the $F_{35\%}$ (in terms of exploitable biomass per recruit) value of 0.064 for sharpchin rockfish, a tier 4 species. For the remaining species of "other slope rockfish", all of which are in tier 5, overfishing is defined to occur at the $F=M$ rate, with M=0.05 for sharpchin and silvergray rockfish, M=0.10 for redstripe rockfish, and M=0.06 for harlequin and redstripe rockfish and all the minor species in the group. Applying these Fs results in an overfishing catch limit of 4,881 mt for the "other slope rockfish" group in 2010.

11.0.2 Summary of ABCs and Overfishing Levels for 2010

Shortraker rockfish ABC: Gulfwide, 914; Western Area, 134; Central Area; 325; Eastern Area, 455.

Shortraker rockfish overfishing level: Gulfwide, 1,219.

"Other slope rockfish" ABC: Gulfwide, 3,749; Western Area, 212; Central Area, 507; West Yakutat, 273; East Yakutat/Southeast Outside, 2,757.

"Other slope rockfish" overfishing level: Gulfwide, 4,881.

11.0.3 Age-Structured Model for Shortraker Rockfish

Survey age data for shortraker rockfish in the Gulf of Alaska first became available in the last full assessment in 2007. These data were for the 2005 trawl survey, and since the 2007 assessment, age data have also become available for the 1996 and 2003 surveys. However, the aging methodology is experimental, and interpretation of annuli on otoliths of shortraker rockfish is still considered among the most difficult of all rockfish species. To provide direct validation of the new aging method, in 2008 a validation study by the AFSC age-and-growth program was conducted based on carbon 14 levels in shortraker rockfish otoliths. Results were unsuccessful, however, because carbon 14 could not found in sufficient quantity in the otoliths. Thus, alternative validation techniques will be necessary to verify the aging methodology.

Because of the lack of direct validation for the aging method, and the consequent uncertainty about the ages, production aging for shortraker rockfish has now been put on hold. Due to this uncertainty, use of an age-structured model to assess Gulf of Alaska shortraker rockfish is not recommended at present. Although we hope to move to an age-structured assessment at some time in the future, better validation of the shortraker rockfish aging methodology is needed before we do so.

11.0.4 Summaries for Plan Team

All values are in metric tons.

Stock Assemblage	Year	Biomass	OFL	ABC	TAC	Catch[1]
Shortraker Rockfish	2008	39,905	1,197	898	898	598
	2009		1,197	898	898	535
	2010	40,626	1,219	914		
	2011		1,219	914		

Stock Assemblage	Area	2009 OFL	2009 ABC	2009 TAC	2009 Catch[1]	2010 OFL	2010 ABC	2011 OFL	2011 ABC
Shortraker Rockfish	W		120	120	150		134		134
	C		315	315	186		325		325
	E		463	463	199		455		455
	Total	1,197	898	898	535	1,219	914	1,214	914

[1]Current as of October 3, 2009 (National Marine Fisheries Service, Alaska Region, Sustainable Fisheries Division, P.O. Box 21668, Juneau, AK 99802.).

Stock Assemblage	Year	Biomass	OFL	ABC	TAC	Catch[1]
Other Slope Rockfish	2008	90,283	5,624	4,297	1,730	809
	2009		5,624	4,297	1,730	846
	2010	76,867	4,881	3,749		
	2011		4,881	3,749		

Stock Assemblage	Area	2009 OFL	2009 ABC	2009 TAC	2009 Catch[1]	2010 OFL	2010 ABC	2011 OFL	2011 ABC
Other Slope Rockfish	W		357	357	395		212		212
	C		569	569	379		507		507
	WYak		604	604	61		273		273
	EYak/SEO		2,767	200	11		2,757		2,757
	Total	5,624	4,297	1,730	846	4,881	3,749	4,881	3,749

[1]Current as of October 3, 2009 (National Marine Fisheries Service, Alaska Region, Sustainable Fisheries Division, P.O. Box 21668, Juneau, AK 99802.)
Note: all values for "other slope rockfish" include northern rockfish in the eastern Gulf of Alaska.

11.0.5 Responses to SSC Comments

There were no SSC comments specific to this assessment in their Dec. 2007 or Dec. 2008 minutes, nor were there SSC comments in general that needed to be addressed in this assessment.

11.1 INTRODUCTION

The North Pacific Fishery Management Council (NPFMC) established shortraker rockfish as a separate management category in the Gulf of Alaska in 2005, whereas "other slope rockfish" has been a distinct management category in this region since 1991. Previously, shortraker rockfish had been grouped from 1991 to 2004 with rougheye rockfish in the "shortraker/rougheye" management category because the two species are similar in appearance, share the same habitat on the upper continental slope, and often co-occur in hauls. Both species were assigned a single overall ABC (acceptable biological catch) and TAC (total allowable catch), and fishermen were free to harvest either species within this TAC. However, evidence from the NMFS Alaska Groundfish Observer Program indicated that shortraker rockfish were being harvested disproportionately within the shortraker/rougheye group, which raised the possibility that shortraker could become overexploited (Clausen 2004). Because of this concern, the NPFMC decided to establish separate management categories for shortraker and rougheye rockfish starting with the 2005 fishing season.

Although shortraker rockfish and "other slope rockfish" are distinct management categories and each is assigned its own value of ABC and TAC, they are discussed together in this SAFE chapter because all species in the groups are classified into tiers 4 or 5 in the overfishing definitions. This results in the use of a similar assessment approach to each group based primarily on survey biomass estimates rather than age-structured modeling. The common and scientific names for each species in the two management categories are listed in Table 11-1.

Shortraker rockfish ranges from Hokkaido Island, Japan, north into the Sea of Okhotsk and the Bering Sea, and through the Aleutian Islands and Gulf of Alaska south to southern California. Its center of abundance appears to be Alaskan waters. In the Gulf of Alaska, adults of this species inhabit a narrow band along the upper continental slope at depths of 300-500 m; outside of this depth interval, abundance decreases considerably (Ito 1999). Shortraker rockfish attains the largest size of all *Sebastes*, with a maximum reported total length of 120 cm.

In contrast to shortraker rockfish, nearly all the 15 species that comprise the "other slope rockfish" group in the Gulf of Alaska are at the northern edge of their ranges; the center of abundance for most of these species is farther south off British Columbia or the U.S. west coast. One exception is harlequin rockfish, which is mostly an Alaskan species. Also, the center of abundance for silvergray rockfish based on recent trawl surveys now appears to be southeast Alaska and British Columbia. Within the Gulf of Alaska, "other slope rockfish" are most abundant in the eastern Gulf and become increasingly scarce in areas farther west. (Note: northern rockfish as a member of "other slope rockfish" is a special circumstance that applies only to the eastern Gulf of Alaska and will be discussed later in this section.)

Life history information on shortraker rockfish is extremely sparse. The fish are presumed to be viviparous, as other *Sebastes* appear to be, with internal fertilization and incubation of eggs and with the embryos receiving at least some maternal nourishment. There have been no fecundity studies on shortraker rockfish. One study on reproductive biology of the fish in the northeastern Pacific (most samples were from the Gulf of Alaska) indicated they had a protracted reproductive period, and that parturition (larval release) may take place from February through August (McDermott 1994). Another study indicated the peak month of parturition in Southeast Alaska was April (Westrheim 1975). There is no information on when males inseminate females or if migrations occur for spawning/breeding. Genetic techniques have been used recently to identify a small number of post-larval shortraker rockfish from samples collected in epipelagic waters far offshore in the Gulf of Alaska, which is the only documentation of habitat for this life stage (Kondzela et al. 2007). No data exist on when juvenile fish become demersal in the Gulf of Alaska; in fact, few specimens of juvenile shortraker rockfish <35 cm fork length have ever

been caught in this region, so information on this life stage is virtually unknown. Off Kamchatka, juvenile shortraker are reported to become demersal starting at a length of about 10 cm (Orlov 2001). Orlov (2001) has also suggested that shortraker rockfish may undergo extensive migrations in the north Pacific. In his theory, which is mostly based on size compositions of shortraker rockfish in various regions, larvae/post-larvae of this species are transported by currents from the Gulf of Alaska to nursery areas in the Aleutian Islands, where they grow and subsequently migrate back to the Gulf of Alaska as young adults. More research is needed to substantiate this scenario. As mentioned previously, adults are particularly concentrated in a narrow band along the 300-500 m depth interval of the continental slope. Much of this habitat is steep and difficult to trawl in the Gulf of Alaska, and observations from a manned submersible also indicated that shortraker rockfish seemed to prefer steep slopes with frequent boulders (Krieger and Ito 1999). Adult shortraker rockfish may also be associated with *Primnoa* spp. corals that are used for shelter (Krieger and Wing 2002). Within the slope habitat, shortraker rockfish tend to have a relatively even distribution when compared with the highly aggregated and patchy distribution of many other rockfish such as Pacific ocean perch (Clausen and Fujioka 2007).

Genetic studies of shortraker rockfish have indicated evidence of stock structure in the Gulf of Alaska (Matala et al. 2004; Gharrett et al. 2003), but additional research is needed to better define this structure. Although not conclusive, the genetic studies do not support Orlov's theory of extensive migrations for shortraker rockfish. No research has been done on the stock structure for any of the "other slope rockfish" species.

Information on life history, biology, and habitat of the "other slope rockfish" species is even sparser than that for shortraker rockfish. An exception is silvergray rockfish, for which a study of biological characteristics has been done in British Columbia waters (Stanley and Kronlund 2005). This study found that during the summer, silvergray rockfish were most abundant on the outer continental shelf at depths 100-200 m, whereas in late winter they were concentrated deeper at depths 180-280 m. The study also indicated that the fish are almost never caught in mid-water and that anecdotal reports suggest they are found on relatively hard bottom. Parturition was in May-July, which is similar to the parturition dates of May-June reported for this species based on a small number of samples in Southeastern Alaska (O'Connell 1987). Anecdotal observations of fishermen and research scientists in Alaska for three of the most abundant "other slope rockfish" species, sharpchin, redstripe, and harlequin rockfish, suggest that they also are frequently found on relatively hard bottom, in contrast to species such as Pacific ocean perch that are usually found on softer substrate.

In practice, the NPFMC apportions the ABCs and TACs for both shortraker rockfish and "other slope rockfish" in the Gulf of Alaska into three geographic management areas: the Western, Central, and Eastern Gulf of Alaska. Since 1998, trawling has been prohibited in the Eastern area east of 140 degrees W. longitude. Because most species of "other slope rockfish" are caught exclusively with trawl gear, this closure could have concentrated the catch of these fish in the Eastern area in the relatively small area between 140 degrees and 147 degrees W. longitude that remained open to trawling. To ensure that such a geographic over-concentration of harvest would not occur, since 1999 the NPFMC has divided the Eastern area into two smaller management areas: West Yakutat (area between 147 and 140 degrees W. longitude) and East Yakutat/Southeast Outside (area east of 140 degrees W. longitude). Separate ABCs and TACs are now assigned to each of these smaller areas for "other slope rockfish".

Because of the extremely low abundance of northern rockfish in the Eastern area and the consequent difficulty of managing northern rockfish as a separate species in this area, in 1999 northern rockfish in the Eastern area was reassigned to the "other slope rockfish" category for this area only. Therefore, northern rockfish is listed as an "other slope rockfish" species in Table 11.1, but only for the Eastern area.

11.2 FISHERY

11.2.1 Description of the Fishery

Throughout the 1991-2004 period that shortraker/rougheye rockfish existed as a management category in the Gulf of Alaska, directed fishing was not allowed, and the fish could only be retained as "incidentally-caught" species. This incidental catch status has continued for shortraker rockfish since it became a separate category in 2005. Shortraker rockfish can both be caught with either trawls or longlines. The percent caught in each gear type is listed in the following tables for the years 1993-2009[1]. Note that for 1993-2004, information on catch by gear is only available for the shortraker/rougheye category and not for shortraker alone.

Shortraker/Rougheye Rockfish												
Gear	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Trawl	66.1	51.9	68.9	67.2	66.3	52.8	55.5	57.1	40.1	57.1	61.1	41.8
Longline	33.9	48.1	31.1	32.8	33.7	47.2	44.5	42.9	59.9	42.9	38.9	58.2

Shortraker Rockfish					
Gear	2005	2006	2007	2008	2009
Trawl	48.9	51.8	53.9	46.0	52.5
Longline	51.1	48.2	46.1	54.0	47.5

Since 2005, when separate data for shortraker rockfish became available, trawl and longline gear have each comprised about half the annual catch. Nearly all the longline catch of shortraker rockfish appears to have come as "true" incidental catch in the sablefish or halibut longline fisheries. In rockfish trawl fisheries, however, some of the shortraker is taken by actual targeting that some fishermen call "topping off" (Ackley and Heifetz 2001). "Topping off" works in this way: fishery managers assign all vessels in a directed fishery a maximum retainable amount (MRA) for certain species that may be encountered as incidental catch. If a vessel manages to not catch its MRA during the course of a directed fishing trip, or the MRA is set overly high (as data presented in Ackley and Heifetz [2001] suggest), before returning to port the vessel may be able to make some target hauls on the incidental species and still not exceed its MRA. Such instances of "topping off" for shortraker rockfish appear to take place in the Pacific ocean perch trawl fishery, especially because shortraker rockfish is the most valuable trawl-caught *Sebastes* rockfish in terms of landed price.

In most years, trawling has accounted for a substantial majority of the "other slope rockfish" catch, as indicated in the following table that shows the percent caught in trawls vs. longlines for years 1993-2009 (updated through 3 October 2009):

Gear	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Trawl	96.8	91.9	92.1	87.6	88.8	86.8	86.1	73.7	55.3	84.9	65.7	86.3
Longline	3.2	8.1	7.9	12.4	11.2	13.2	13.9	26.3	44.7	15.1	34.3	13.7

[1] National Marine Fisheries Service, Alaska Region, Sustainable Fisheries Division, P.O. Box 21668, Juneau, AK 99802. Catches updated through 3 October, 2009.

Gear	2005	2006	2007	2008	2009
Trawl	84.7	78.6	74.5	80.5	85.2
Longline	15.3	21.4	25.5	19.5	14.8

The predominance of trawl catches is not surprising, as the most abundant "other slope rockfish" species such as sharpchin and harlequin rockfish are thought to feed on plankton and thus are likely not attracted to longlines. There has been little or no directed fishing for "other slope rockfish", with two exceptions: 1) in 1993, it appears some targeting by trawlers occurred in the eastern Gulf of Alaska for silvergray and yellowmouth rockfish, two larger sized species that can be caught in bottom trawls; and 2) in 2004 and 2005, a small experimental fishery occurred in Southeastern Alaska that used modified trolling gear to catch silvergray rockfish (Alaska Longline Fishermen's Association 2005).

In 2007, the Central Gulf of Alaska Rockfish Pilot Program was initiated to enhance resource conservation and improve economic efficiency for harvesters and processors who participate in the Central Gulf of Alaska rockfish fishery. This is a five-year rationalization program that establishes cooperatives among trawl vessels which receive exclusive harvest privileges for rockfish management groups (for details, see North Pacific Fishery Management Council 2008). The primary rockfish management groups for the program are Pacific ocean perch, northern rockfish, and pelagic shelf rockfish, but there is a small allocation for shortraker rockfish. As a result of this program, catches of shortraker rockfish taken by trawlers in the Central Gulf decreased considerably in 2007 (North Pacific Fishery Management Council 2008) and this reduction has apparently continued in 2008 and 2009. Catches of shortraker rockfish in this area are now at some of their lowest levels in the whole time series of catch data. Effects of this program to catches of "other slope rockfish" in the Central area are less uncertain, but their catches also appear to have decreased in the past three years that the program has been in effect. Other effects of the pilot program include: 1) mandatory at-sea and plant observer coverage for vessels participating in the program, which greatly improves observer data for rockfish in the Central Gulf; and 2) extending the season when most of these rockfish are caught. Previously, most were taken as incidental catch during the directed "derby-style" trawl fisheries for Pacific ocean perch, northern rockfish, and pelagic shelf rockfish, which mostly occurred during July. In the pilot program, trawling can occur anytime between May 1 and November 15, and catches are now spread over this period.

11.2.2 Bycatch

The only analysis of bycatch in shortraker/rougheye rockfish fisheries of the Gulf of Alaska is that of Ackley and Heifetz (2001), in which they examined data for 1994-96 only. In the hauls they identified as targeting on shortraker/rougheye, the major bycatch was arrowtooth flounder, sablefish, and shortspine thornyhead, in descending order by percent.

11.2.3 Discards

Gulfwide discard rates[2] (% of the total catch discarded within management categories) of fish in the two management categories are listed as follows for the years 1991-2009 (data are not available for "other slope rockfish" in 1991-92):

[2] Source: National Marine Fisheries Service, Alaska Region, Fishery Management Section, P.O. Box 21688, Juneau, AK 99802-1688. Data are from weekly production and observer reports through 3 October, 2009.

Year	Shortraker/ Rougheye	Other slope rockfish
1991	42.0%	-
1992	10.4%	-
1993	26.8%	48.9%
1994	44.8%	65.6%
1995	30.7%	72.5%
1996	22.2%	75.6%
1997	22.0%	52.1%
1998	27.9%	66.3%
1999	30.6%	68.7%
2000	21.2%	52.8%
2001	29.1%	47.9%
2002	20.8%	58.0%
2003	28.3%	56.7%
2004	27.6%	62.1%
	Shortraker	Other slope rockfish
2005	15.1%	32.6%
2006	23.0%	61.9%
2007	22.2%	41.2%
2008	18.1%	54.1%
2009	26.6%	53.1%

The above table indicates that discards of both the shortraker/rougheye category and shortraker as a separate category were generally moderate over the years, whereas the rates for "other slope rockfish" were consistently higher. The high discard of "other slope rockfish' is not surprising, as most of the abundant species in this category, such as harlequin and sharpchin rockfish, are small in size and of low economic value. Consequently, fishermen likely have less incentive to retain these fish.

11.2.4 Catch History

Official fishery catch statistics for shortraker rockfish are only available for 2005-2009, when the species was first reported separately for management purposes (Table 11-2). However, catch statistics are available for shortraker and rougheye rockfish combined for the years 1991-2004, when both species were classified together into one management group, and these are also listed in Table 11-2. Catch data for "other slope rockfish" are available for the complete period 1991-2009 (Table 11-3). Previous to 1991, shortraker rockfish and all the "other slope rockfish" species were classified into larger management groups that included Pacific ocean perch and other species of *Sebastes*, and it is generally not possible to separate out the catches of shortraker rockfish or "other slope rockfish" species.

Although official catch statistics for shortraker rockfish started only in 2005, unofficial estimates of the Gulfwide catch of shortraker rockfish for the years 1993-2003 were computed in Clausen (2004). These unofficial estimates are shown in Table 11-4. The estimates are based on a combination of data from the observer program and the NMFS Alaska regional office, and take into account differences in catch by area and by gear type. The estimates indicate that annual shortraker catch was generally around 1,000-1,500 mt during these years. Annual TACs for the shortraker/rougheye group were the major determining factor of these catch amounts; as shown in Table 11-2, the total Gulfwide catch of shortraker/rougheye for a given year was generally very similar to the corresponding TAC. The 2005-2009 shortraker rockfish official catches have been consistently lower than any of the unofficial estimates in previous years. These

low catches in the last five years correspond to the years when shortraker rockfish has been in its own management category separate from rougheye rockfish. This suggests that the breakup of the shortraker/rougheye group may have caused the subsequent reduction in catch of shortraker rockfish, but the exact reasons for the lower catches are unclear. The Central Gulf of Alaska Rockfish Pilot Program (see discussion in previous section 11.2.1), in effect since 2007, also caused a reduction in catches.

With the exception of 1993, Gulfwide catches of "other slope rockfish" have always been <1,700 mt (Table 11-3). In most years, the catch has been considerably less than either the ABC or TAC. Catches of "other slope rockfish" in the Eastern area (where these species are most abundant) have been especially small in the years since 1998, when trawling was prohibited east of 140 degrees W. longitude.

Research catches of shortraker rockfish and "other slope rockfish" are shown in Table 11-5.

11.2.5 Species Composition of the "Other Slope Rockfish Catch"

Species composition data for the commercial catch of "other slope rockfish" in the 1992-2008 commercial fishery can be estimated from information collected by the domestic observer program (Table 11-6). These estimates were computed by first totaling the catch weight of each "other slope rockfish" species by year and Gulf of Alaska management area (Western, Central, and Eastern) for all observed hauls. Next, a percentage value for each species was calculated relative to the total observed weight of all "other slope rockfish" within each area/year combination. Finally, these species percentages were applied to the official "other slope rockfish" catches in Table 11-3 for each area/year combination and then summed over areas to yield the Gulfwide estimated values for each year in Table 11-6. One caveat is that the species data are based only on trips that had observers on board. Consequently, they may be biased toward larger vessels, which had more complete observer coverage. For "other slope rockfish", however, the problem of bias in the observer coverage may be minor. This is because most of the catch is taken by trawlers, and these are generally larger-sized vessels with relative high rates of observer coverage. Also, observer coverage in the central Gulf of Alaska has increased due to requirements of the rockfish pilot program.

These data indicate that for the "other slope rockfish" category, harlequin and sharpchin rockfish have always been the predominant species caught, and that redstripe, silvergray and yellowmouth rockfish have also sometimes been taken in relatively large amounts. For unknown reasons, the catch of harlequin rockfish has especially dominated in the five most recent years calculated, 2004-2008.

11.2.6 Management Measures

A timeline of management measures that have affected shortraker rockfish and "other slope rockfish" is listed in the following table.

Year	Management Measures
1988	The NPFMC implements the slope rockfish assemblage, which includes shortraker rockfish and the species that will become "other slope rockfish", together with Pacific ocean perch, northern rockfish, and rougheye rockfish. Previously, *Sebastes* in Alaska were managed as the "Pacific ocean perch complex" or "other rockfish".
1988	Apportionment of ABC among management areas in the Gulf (Western, Central, and Eastern) for slope rockfish assemblage is determined based on average percent biomass in previous NMFS trawl surveys.
1991	Slope rockfish assemblage is split into three management subgroups with separate ABCs and TACs: Pacific ocean perch, shortraker/rougheye rockfish, and "other slope rockfish".
1993	Northern rockfish is split as a separate management entity from "other slope rockfish".
1997	Area apportionment procedure for shortraker/rougheye and "other slope rockfish" is changed. Apportionment is now based on 4:6:9 weighting of biomass in the most recent three NMFS trawl surveys.
1998	Trawl closure becomes effective in the Eastern Gulf east of 140 degrees W.
1999	Northern rockfish in the Eastern Gulf is reassigned to "other slope rockfish"
1999	Eastern Gulf is divided into West Yakutat and East Yakutat/Southeast Outside, and separate ABCs and TACs are assigned for "other slope rockfish" in these areas.
2005	Shortraker rockfish is split as a separate management entity from rougheye rockfish and now has its own ABC and TAC.
2007	Amendment 68 creates the Central Gulf Rockfish Pilot Program, which affects trawl catches of rockfish in this area.

11.3 DATA

11.3.1 Fishery Data

11.3.1.1 Catch

Detailed catch information for shortraker/rougheye, shortraker rockfish, and "other slope rockfish" is listed in Tables 11-2 through 11-6.

11.3.1.2 Size and Age Composition

The numbers of lengths sampled by observers for shortraker rockfish and "other slope rockfish" in the Gulf of Alaska commercial fishery have been too small to yield meaningful data. Few age samples for any of these species have been collected from the fishery, and none have been aged.

11.3.2 Survey Data

11.3.2.1 Longline Surveys in the Gulf of Alaska

Two longline surveys of the continental slope of the Gulf of Alaska provide data on the relative abundance of shortraker rockfish in this region: the earlier Japan-U.S. cooperative longline survey, and the ongoing NMFS domestic longline survey. These surveys compute relative population numbers (RPNs) and relative population weights (RPWs) for fish on the continental slope as indices of stock abundance. The surveys are primarily directed at sablefish, but also catch considerable numbers of shortraker and rougheye rockfish. Results for both surveys concerning rockfish, however, should be viewed with some caution, as the RPNs and RPWs do not take into account possible effects of competition for hooks with other species caught on the longline, especially sablefish. A recent analysis of the survey data indicated there was a negative correlation between catch rates of sablefish and shortraker rockfish in the Gulf of Alaska, and that there was likely competition for hooks between species in the surveys (Rodgveller et al. 2008). The study concluded that further research and experiments are needed to better quantify the effects of hook competition and to compute adjustment factors for the surveys' catch rates.

The cooperative longline survey was conducted annually during 1979-94, but RPNs for rockfish are only available for the years 1979-87 (Sasaki and Teshima 1988). These data are highly variable and difficult to interpret, but suggest that abundance of shortraker rockfish remained stable in the Gulf of Alaska (Clausen and Heifetz 1989). The data also indicate that shortraker rockfish are most abundant in the eastern Gulf of Alaska.

The domestic longline survey has been conducted annually since 1988, and RPNs and RPWs have been computed for each year (Table 11-7). For shortraker rockfish, Gulfwide RPNs have ranged from a low of ~11,000 in 1994 to a high of ~32,000 in 2000. Similarly, lowest and highest Gulfwide RPW values were in these same years. Definite trends in these data over the years are difficult to discern, and the fluctuations in RPN and RPW may reflect random variations in the survey's catch rates, rather than true changes in abundance. The fluctuations may also be related to changes in the abundance of sablefish, as discussed in the previous paragraph regarding competition for hooks among species.

Similar to the cooperative longline survey, the domestic survey results show that abundance of shortraker rockfish is highest in the eastern Gulf of Alaska: the Yakutat area consistently has by far the greatest RPN and RPW values for shortraker rockfish.

11.3.2.2 Biomass Estimates from Bottom Trawl Surveys

Bottom trawl surveys were conducted on a triennial basis in the Gulf of Alaska in 1984, 1987, 1990, 1993, 1996, and 1999, and these surveys became biennial in 2001, 2003, 2005, 2007, and 2009. The surveys provide much information on shortraker rockfish and "other slope rockfish", including estimates of absolute abundance (biomass) and population length compositions. The trawl surveys have covered all areas of the Gulf of Alaska out to a depth of 500 m (in some surveys to 1,000 m), but the 2001 survey did not sample the eastern Gulf of Alaska. To compensate for this lack of sampling in 2001, substitute values of biomass were computed for this area in 2001 by averaging the eastern Gulf biomass estimates in the three previous trawl surveys (for details, see Heifetz et al. 2001). Also, the 1984 and 1987 survey results should be treated with some caution. A different, non-standard survey design was used in the eastern Gulf of Alaska in 1984; furthermore, much of the survey effort in the western and central Gulf of Alaska in 1984 and 1987 was by Japanese vessels that used a very different net design than what has been the standard used by U.S. vessels throughout the surveys. To deal with this latter problem, fishing power

comparisons of rockfish catches have been done for the various vessels used in the surveys (for a discussion see Heifetz et al. 1994). Results of these comparisons have been incorporated into the biomass estimates discussed here, and the estimates are believed to be the best available. Even so, the reader should be aware that an element of uncertainty exists as to the standardization of the 1984 and 1987 surveys.

Biomass estimates for shortraker rockfish have sometimes shown rather large fluctuations between surveys; for example, biomass was 42,851 mt in 1987 and then decreased to 12,681 mt in 1990. However, the confidence intervals have usually overlapped and differences in the estimates do not appear significant, with three exceptions: the 2003, 2005, and 2009 estimates (42,023, 42,568, and 44,185 mt, respectively) appear to be significantly greater than the 1990 estimate (12,681 mt) (Tables 11-8 and 11-9; Figure 11.1). There has been a general upward trend in the biomass estimates since 1990, and the 2009 biomass of 44,185 mt is the largest value of any in the time series. Spatial distribution of the catches of shortraker rockfish in the last three Gulf of Alaska trawl surveys indicate the fish are rather evenly spread along an offshore band, with only a few large catches and virtually no catches near shore (Figure 11-2). Compared with many other species of *Sebastes*, the biomass estimates for shortraker rockfish show relatively moderate confidence intervals and low coefficients of variations (CVs; compare CVs for shortraker in Table 11-9 vs. those for sharpchin, redstripe, harelequin, and silvergray rockfish in Table 11-10). The low CVs are an indication of the generally even distribution of shortraker rockfish that was noted in the introduction (Section 11.1).

Despite this relative precision, however, it is uncertain whether the trawl surveys are accurately assessing abundance of shortraker rockfish. Nearly all the catch of these fish is found on the upper continental slope at depths of 300-500 m. Much of this area is not trawlable by the survey's gear because of the area's steep and rocky bottom, except for gully entrances where the bottom is more gradual. Consequently, biomass estimates for shortraker rockfish are mostly based on the relatively few hauls in gully entrances, and they may not be showing a true picture of abundance or abundance trends. An example of one possible problem in the trawl survey results can be seen when RPWs by statistical area for shortraker rockfish in longline surveys are compared with corresponding biomass estimates in the trawl surveys (see Table 11-7 vs Table 11-9). The longline surveys consistently indicate that shortraker rockfish are most abundant in the Yakutat area, and that this area usually comprises >50% of the Gulfwide RPW for this species. In contrast, the trawl survey results by area are much more variable, and the Yakutat area does not stand out as a particular area of abundance. In this case, the longline survey may be providing a better index of abundance by area, as the longline gear can be fished nearly anywhere in the steep 300-500 m slope environment inhabited by shortraker rockfish.

For "other slope rockfish", the biomass estimates indicate that five species have comprised most of the biomass for this management group: sharpchin, redstripe, harlequin, silvergray, and redbanded rockfish (Table 11-8). Geographically, most of the biomass for these species is found in the eastern Gulf of Alaska, especially the Southeastern statistical area (Table 11-10). Harlequin rockfish is the one exception, as its highest biomass has often occurred in other areas west of Southeastern. Broad confidence intervals are associated with most of these biomass estimates, and the CVs for the estimates are generally much higher than those for shortraker rockfish. For example, CVs for redstripe rockfish range from 36% to 72%, compared to a range of only 17% to 33% for shortraker rockfish.

The biomass estimates for most species of "other slope rockfish" have often been highly variable from survey to survey. One extreme example of this is harlequin rockfish, whose biomass estimate increased from 2,625 mt in 1984 to 72,405 mt in 1987, and then decreased to 17,664 mt in 1990 (Table 11-8). Again, its biomass estimate increased nearly ten-fold from 2003 to 2005, followed by large declines in 2007 and 2009 to nearly the 1984 level. Such wide fluctuations in biomass do not seem reasonable given the slow growth and low natural mortality rates of all *Sebastes* species; in the particular case of harlequin

rockfish, fishing mortality was also considered to be low over the period of these surveys. Large catches of aggregating species, such as most "other slope rockfish" appear to be, in just a few individual hauls can greatly influence biomass estimates and may be a source of much variability. For example, in the 2003 survey, a very large catch of 5 mt of silvergray rockfish in one haul was mostly responsible for the extremely large biomass estimate of that species in the Southeastern area. In past slope rockfish SAFE reports, we have also speculated that a change in availability of rockfish to the survey, caused by unknown behavioral or environmental factors, may explain some of the observed variation in biomass. It seems prudent to repeat this speculation in the present report, while acknowledging that until more is known about rockfish behavior, the actual cause of changes in biomass estimates will remain the subject of conjecture.

One notable observation is that since the large Gulfwide biomass of almost 52,000 mt for silvergray rockfish in 2003, the estimates for this species have declined substantially in each of the following three surveys. The 2009 biomass of 9,851 is the lowest it has been since the very low values in 1984 and 1987.

11.3.2.3 Trawl Survey Size Compositions

Size compositions for shortraker rockfish from the 1990-2007 trawl surveys were all unimodal, with almost no fish <35 cm in length (Figure 11-3). However, results from the recent 2009 trawl survey were different because for the first time, there was a modest catch of small fish that ranged in sized between 10 and 35 cm long. The reason these small fish occurred in 2009, and not in previous surveys, is unknown. The size compositions indicate that mean length of the shortraker rockfish population in the Gulf of Alaska progressively declined from 61.0 cm in 1990 to 53.9 cm in 2003, followed by sharp increases in 2005 and 2007. In 2009, the mean size decreased again, which can be attributed in part to the catch of small fish <35 cm in length. The 2001 results may be biased by the fact that they do not include fish from the eastern Gulf of Alaska (this area was not sampled that year). Gulfwide trawl surveys (e.g., Martin and Clausen 1995; Martin 1997; von Szalay et al. 2008) have shown shortraker rockfish to be larger in the eastern Gulf of Alaska, and the 2001 survey seems to be missing many fish >70 cm in length compared to the other surveys.

11.3.2.4 Survey Age Compositions

Shortraker rockfish have long been considered among the most difficult rockfish species to age. The usual method for determining rockfish ages, i.e., counting annular growth zones on otoliths, did not appear to work because the growth pattern of shortraker otoliths is so unclear. However, Hutchinson (2004) developed a new aging method for this species based on using thin sections of otoliths and on applying an innovative set of aging criteria to determine which growth bands correspond to an annulus. A comparison between his results and those of a previous radiometric study of shortraker rockfish age (Kastelle et al. 2000) indicated general agreement and provided a limited degree of validation. This new aging methodology was used to determine the age compositions of shortraker rockfish in the 1996, 2003, and 2005 Gulf of Alaska trawl surveys (Figure 11-4). Ages ranged from 5 to 146 years, and the results indicate the shortraker rockfish population in the Gulf of Alaska is quite old (mean age varied between 32 and 44 years, depending on the survey). To provide direct validation of the new aging method, in 2008 a validation study was conducted based on carbon 14 levels in shortraker rockfish otoliths from nuclear bomb testing in the 1960s. Results were unsuccessful, however, because carbon 14 could not found in sufficient quantity in the otoliths[3]. Thus, alternative validation techniques will be necessary to verify the

[3] C. Hutchinson, National Marine Fisheries Service, Alaska Fisheries Science Center, REFM Division, 7600 Sand Point Way NE, Seattle WA 98115. Pers. commun. Jan. 2009.

aging methodology. One possibility is to conduct an updated and more detailed radiometric study than the previously mentioned Kastelle et al. 2000 study, which was done before the shortraker aging technique had been developed and was somewhat problematic because it was based on using length of the fish as a proxy for age.

Because of the lack of direct validation for the aging method, and the consequent uncertainty about the ages, production aging for shortraker rockfish has now been put on hold. Due to this uncertainty, use of an age-structured model to assess Gulf of Alaska shortraker rockfish is not recommended at present. Although we hope to move to an age-structured assessment at some time in the future, better validation of the shortraker rockfish aging methodology is needed before we do so.

For the "other slope rockfish" species, age compositions are available for sharpchin, redstripe, harlequin, and silvergray rockfish in the Gulf of Alaska (Figures 11-5 and 11-6). The ages are all based on the break-and-burn technique of aging otoliths. No age validation has been done for any of these species, so the results should be considered preliminary. However, aging of the sharpchin, redstripe, and harlequin rockfish was reported to be relatively easy[4] when compared with other rockfish species such as Pacific ocean perch or rougheye rockfish. In contrast, silvergray rockfish were relatively difficult to age[5]. The age compositions for sharpchin, redstripe, and harlequin were for the 1996 trawl survey only. Sharpchin ages ranged from 2 to 44, redstripe from 4 to 36, and harlequin from 3 to 47. Mean population age was highest for redstripe (14.4), followed by sharpchin (13.4) and then harlequin (12.0). The 1986 year class appeared to be strong for both sharpchin and harlequin, whereas 1982 or 1983 were strong for sharpchin and redstripe. Age compositions for silvergray rockfish are available for three Gulf of Alaska trawl surveys: 1993, 1996, and 1999. Mean population age increased from 17.0 in 1993 to 19.2 in 1996, and then decreased to 18.2 in 1999. Much of the increase in 1996 appears to be due to the passage of a large 1981/1982 year-class through the population. The existence of a large 1981 year-class is also supported by data from northern British Columbia, where an extremely large 1981 year-class was observed[6]. The 1981 year class is no longer especially prominent in the 1999 age composition, perhaps because age determination of older fish may be less precise. However, a strong 1987 year-class is apparent in the 1999 sample. The large increase in biomass for silvergray rockfish seen in the 1990s and early 2000s may be partially attributable to strong 1981 and 1987 year classes.

11.4 ASSESSMENT PARAMETERS

11.4.1 Mortality, Maximum Age, Female Age- and Size-at-50% Maturity, and Age-of-Recruitment

Estimates of mortality, maximum age, and female age- and size-at-50% maturity are shown in Table 11-11 for shortraker rockfish and some of the "other slope rockfish" species. The mortality rates based on the catch curve method are actually estimates of the total instantaneous mortality (Z) and should be considered as upper bounds for the natural mortality rate (*M*). The mortality rate for harlequin rockfish (0.127-0.157) is probably an overestimate because it was based on a small sample size of just 100 fish in which the oldest fish was only 34. Other aging results (discussed previously in section 11.3.2.4) based on a much larger sample show a maximum age of 47 for harlequin rockfish, which indicates the mortality rate should be considerably lower than the range of values in Table 11-11. The two values for maximum age of shortraker rockfish in the Gulf of Alaska (146 and 157), if true, would make this species one of the longest-lived of all fishes. Age- and size-at-maturity information for females is only available for

[4] B. Goetz, National Marine Fisheries Service, Alaska Fisheries Science Center, REFM Division, 7600 Sand Point Way NE, Seattle WA 98115. Pers. commun. Jul. 2003.

[5] K. Munk, Alaska Dept. Fish and Game, P. O. Box 25526, Juneau AK 99802. Pers. commun. Oct. 2007.

[6] R. Stanley, Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, British Columbia, Canada V9T 6N7. Pers. commun. Jan. 2006.

shortraker, sharpchin, and silvergray rockfish. McDermott (1994) determined that size-at-50% maturity for female shortraker rockfish was 44.9 cm based on samples collected in several regions of the northeast Pacific, including the Gulf of Alaska. Hutchinson's (2004) experimental aging study of shortraker rockfish computed von Bertalanffy growth parameters for females, and he used these parameters to convert McDermott's size-of-maturity to an age-of-50% maturity of 21.4 years. Because it was based on experimental aging, however, and was also determined indirectly, the estimate needs to be confirmed by additional study.

The only information on age-of-recruitment for shortraker rockfish or any of the "other slope rockfish species" is for female silvergray rockfish in British Columbia, which are about 50% recruited at age 14, and >90% recruited at age 20 (Stanley and Kronlund 2005). It appears that nearly all the females are mature when they recruit to the British Columbia fishery.

11.4.2 Length- and Weight-at-Age

Length-weight coefficients and von Bertalanffy parameters for shortraker and "other slope rockfish" are shown in Tables 11-12 and 11-13. The von Bertalanffy parameters for female shortraker rockfish are based on the previously discussed Hutchinson (2004) study which has been only partially validated, so they should be used with caution.

11.5 ANALYTIC APPROACH

Due to the lack of biological information for shortraker rockfish and "other slope rockfish" (especially an absence of validated age data), past assessments for these two categories have all used a biomass-based approach based on trawl survey data to calculate ABCs. I continue to use this approach in the present assessment. As previously mentioned, we anticipate moving to an age-structured assessment for shortraker rockfish at some time in the future if the aging methodology can be successfully validated.

11.5.1 Determination of Current Exploitable Biomass

In all the past SAFE reports, exploitable biomass for shortraker rockfish and "other slope rockfish" in the Gulf of Alaska has been determined based on the average Gulfwide biomass for the three most recent trawl surveys. Before the 2007 assessment (Clausen 2007), exploitable biomass computations did not include the biomass in the 1-100 m depth stratum. This was a holdover from a period in the late 1980s when shortraker rockfish and "other slope rockfish" were part of a much larger management group that included all slope rockfish, such as Pacific ocean perch and northern rockfish. Pacific ocean perch in the 1-100 m stratum were thought to be mostly small juveniles and therefore not exploitable. However, in the 2007 assessment for shortraker rockfish and "other slope rockfish", an analysis indicated that excluding the 1-100 m stratum in the exploitable biomass calculations was unnecessary because catches of shortraker rockfish and "other slope rockfish" in this stratum are negligible in the surveys (Clausen 2007). Since 2007, the exploitable biomass determinations for shortraker rockfish and "other slope rockfish" have included all the strata covered by the trawl surveys.

Therefore, for both shortraker rockfish and "other slope rockfish", current exploitable biomass is calculated based on the average Gulfwide biomass estimates (including the 1-100 m stratum) for the three most recent trawl surveys in 2005, 2007, and 2009 (Table 11-14). These averages yield the following values of current exploitable biomass: 40,626 mt for shortraker rockfish and 76,687 mt for "other slope rockfish". It should be noted that the exploitable biomass for "other slope rockfish" is based on the

values in Table 11-14, instead of those in Table 11-8, because Table 11-14 includes northern rockfish in the Eastern area, where northern rockfish is a member of this management category.

11.6 ABC RECOMMENDATIONS AND OVERFISHING LEVELS

11.6.1 ABC Recommendations for Shortraker Rockfish

When the shortraker/rougheye category was created in 1991, there was no estimate at that time of *M* or *Z* for shortraker rockfish. Therefore, the SSC suggested the following computation for a proxy estimate of *M*: use the ratio of maximum age of rougheye to shortraker (140/120) from British Columbia and then multiply this value by the mid-point of the range of *Z* for rougheye rockfish in British Columbia (mid-point = 0.025) to yield an *M* of 0.03 for shortraker rockfish. In a later study, *M* for shortraker rockfish was estimated to range between 0.027 and 0.042 (McDermott 1994), so the original estimate of 0.03 for *M* seems reasonable.

In previous assessments, shortraker rockfish were always classified as "tier 5" in the NPFMC definitions for ABC and Overfishing Level (OFL) based on Amendment 56 to the Gulf of Alaska FMP. The population dynamics information available for tier 5 species consists of reliable estimates of biomass and natural mortality *M*, and the definitions state that for these species, the fishing rate that determines ABC (F_{ABC}) is $\leq 0.75M$. Now that age and maturity data are available for shortraker rockfish, theoretically they could be moved into tier 4, where $F_{ABC} \leq F_{40\%}$. However, because of the uncertainty of the present aging method and the lack of age validation, I recommend keeping shortraker rockfish in tier 5 for the present assessment. Thus, the recommended F_{ABC} for shortraker rockfish is 0.0225 (i.e., 0.75 X *M*, where *M* = 0.03). Applying this F_{ABC} to the estimate of current exploitable biomass of 40,626 mt for shortraker rockfish results in a Gulfwide ABC of 914 mt for 2010. This is a slight increase compared to the 2008 and 2009 ABCs of 898 mt.

In all previous years, annual allocation of the Gulfwide ABC for shortraker rockfish amongst the three regulatory areas in the Gulf has been based on the geographic distribution of the species' exploitable biomass in the trawl surveys. Since the 1996 SAFE report, this distribution has been computed as a weighted average of the percent exploitable biomass distribution for each area in the three most recent trawl surveys. In the computations, each successive survey is given a progressively heavier weighting using factors of 4, 6, and 9, respectively. This 4:6:9 weighting scheme was originally recommended by the Gulf of Alaska Groundfish Plan Team, and had already been used for Pacific ocean perch in the 1996 fishery. The Plan Team believed that for consistency among the rockfish assessments, the same weighting should be applied to shortraker/rougheye rockfish. The Plan Team's scheme was adopted for the 1997 fishery, and the scheme has continued to be used in the years since. Therefore, based on a 4:6:9 weighting of the 2005, 2007, and 2009 trawl surveys, the percent distribution of exploitable biomass for shortraker rockfish biomass in the Gulf of Alaska is: Western area, 14.63%; Central area, 35.56%, and Eastern area, 49.81% (Table 11-15). Applying these percentages to the recommended Gulfwide ABC of 914 mt yields the following apportionments for the Gulf in 2010: Western area, 134 mt; Central area, 325 mt; and Eastern area, 455 mt.

11.6.2 ABC Recommendations for "Other Slope Rockfish"

In past SAFE reports, "other slope rockfish" species have all been classified as tier 5 species, with the exception of sharpchin rockfish which has been tier 4 for a number of years. For tier 5, F_{ABC} is defined to be $\leq 0.75M$. Values of *M* in the computations are the same as those in the 2007 assessment (Clausen 2007) and are based on the mortality rates listed in Table 11-11. An estimate of *M* for redstripe rockfish

of 0.10 can be obtained directly from the table. For silvergray rockfish, an *M* of 0.05 is used for the computations, which is the approximate midpoint of the 0.041-0.057 range shown in Table 11-11 for this species in the Gulf of Alaska. In all previous assessments, an *M* of 0.06 was used for harlequin and redbanded rockfish and the minor species, based on the average *M* for northern, sharpchin, redstripe, and silvergray rockfish. As discussed in section 11.4.1 and in Clausen (2007), the natural mortality estimates for harlequin rockfish in Table 11-11 are probably too high**.** Hence**,** continued use of an *M* of 0.06 for harlequin rockfish is recommended until better estimates of natural mortality are available for this species. Based on all these recommended values of *M* and on the NPFMC definitions for tier 4 and tier 5, calculations of ABC for "other slope rockfish" are summarized in the following table:

Species	Tier	current exploit. biomass	*M*	$F_{40\%}$	F_{ABC} definition	F_{ABC} recommended	ABC (mt) (F_{ABC} x exploit. bio.)
Sharpchin	4	17,574	0.05	0.053	$F_{ABC} \leq F_{40\%}$	$F_{ABC} = F_{40\%}$	931
Redstripe	5	11,594	0.10	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	870
Harlequin	5	13,290	0.06	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	598
Silvergray	5	26,495	0.05	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	994
Redbanded	5	6,436	0.06	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	290
minor species	5	1,478	0.06	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	67
All species		76,867					3,749

Therefore, the recommended combined ABC for "other slope rockfish" in 2010 is 3,749 mt. This is a decrease of about 13% compared to the 2008 and 2009 ABCs of 4,297 mt. Much of this decrease is attributable to the low biomass estimate for silvergray rockfish in the 2009 trawl survey. Geographic apportionment of the 2010 ABC is based on the same "4:6:9 weighted average" method as that used for shortraker rockfish. The weighted average values for "other slope rockfish" are: Western area, 5.65%; Central area, 13.53%, and Eastern area, 80.82% (Table 11-15). Applying these percentages to the recommended ABC of 3,749 mt yields the following apportionments for the Gulf in 2010: Western area, 212 mt; Central area, 507 mt; and Eastern area, 3,030 mt.

Because the Eastern area is divided into two management areas for "other slope rockfish", i.e., the West Yakutat area and the East Yakutat/Southeast Outside area, the ABC for "other slope rockfish" in the Eastern area must be further apportioned between these two smaller areas. A procedure identical to that used for the previous geographic apportionments is also applied here: a 4:6:9 weighted average of the percent biomass estimates in the last three trawl surveys, i.e., 2005, 2007, and 2009. The weighted average of the "other slope rockfish" biomass in these three surveys for West Yakutat is 9.01%, and that for East Yakutat/Southeast Outside is 90.99%. This translates into an ABC of 273 mt for West Yakutat and 2,757 mt for East Yakutat/Southeast Outside in 2010. The West Yakutat ABC includes a very small amount of northern rockfish (~3 mt) that was allocated to this area because all the northern rockfish biomass in the Eastern area occurs in West Yakutat.

11.6.3 Overfishing Levels for Shortraker rockfish and "Other Slope Rockfish"

Based on Amendment 56 in the Gulf of Alaska FMP, overfishing for a tier 5 species such as shortraker rockfish is defined to occur at a harvest rate of *F=M*. Therefore, applying the estimate of *M* for shortraker rockfish (0.03) to the estimate of current exploitable biomass (40,626 mt) yields an overfishing catch limit of 1,219 mt for 2010.

Overfishing is defined to occur at the $F_{35\%}$ (in terms of exploitable biomass per recruit) value of 0.064 for sharpchin rockfish, a tier 4 species. For the remaining species of "other slope rockfish", all of which are in tier 5, overfishing is defined to occur at the *F=M* rate. Applying these *F*s results in an overfishing catch limit of 4,881 mt for the "other slope rockfish" group in 2010.

11.6.4 Summary

A summary of tiers, current exploitable biomass, values of *F*, and recommended ABCs and OFLs for shortraker rockfish and "other slope rockfish" is in Table 11-16.

11.7 HARVEST SCENARIOS TO SATISFY REQUIREMENTS OF NPFMC'S AMENDMENT 56, NEPA, AND MSFCMA

For species such as shortraker rockfish and "other slope rockfish" that are not assessed with an age/length-structured model, multi-year projections are not possible but yields for just the year 2010 can be computed (Table 11-17).

11.8 ECOSYSTEM CONSIDERATIONS

In general, a determination of ecosystem considerations for shortraker rockfish and "other slope rockfish" is hampered by the lack of biological and habitat information. A summary of the ecosystem considerations presented in this section is listed in Table 11-18.

11.8.1 Ecosystem Effects on the Stock

Prey availability/abundance trends: similar to other rockfish species, stock condition of shortraker rockfish and "other slope rockfish" is probably influenced by periodic abundant year classes. Availability of suitable zooplankton prey items in sufficient quantity for larval or post-larval rockfish may be an important determining factor of year-class strength. Unfortunately, there is no information on the food habits of larval or post-larval rockfish to help determine possible relationships between prey availability and year-class strength; moreover, identification to the species level for field collected larval rockfish is difficult. Visual identification is generally not possible, although genetic techniques allow identification to species level for larvae of most slope rockfish (Gharrett et. al 2001). Some juvenile rockfish found in inshore habitat feed on shrimp, amphipods, and other crustaceans, as well as some mollusks and fish (Byerly 2001). Adult shortraker rockfish are apparently opportunistic feeders that in Alaska prey on shrimp, deepwater fish such as myctophids, and squid (Yang and Nelson 2000; Yang 2003; Yang et al. 2006). Little if anything is known about abundance trends of these rockfish prey items.

Predator population trends: Rockfish are preyed on by a variety of other fish at all life stages, and to some extent by marine mammals during late juvenile and adult stages. Whether the impact of any particular predator is significant or dominant is unknown. Predator effects would likely be more important on larval, post-larval, and small juvenile rockfish, but information on these life stages and their predators is nil. Due to their large size, older shortraker rockfish likely have few potential predators other than very large animals such as sleeper sharks or sperm whales.

Changes in physical environment: Strong year classes corresponding to the period around 1976-77 have been reported for many species of groundfish in the Gulf of Alaska, including Pacific ocean perch, northern rockfish, sablefish, and Pacific cod. Therefore, it appears that environmental conditions may

have changed during this period in such a way that survival of young-of-the-year fish increased for many groundfish species, including slope rockfish. The environmental mechanism for this increased survival remains unknown. Changes in water temperature and currents could have an effect on prey item abundance and success of transition of rockfish from the pelagic to demersal stage. Rockfish in early juvenile stage have been found in floating kelp patches which would be subject to ocean currents.

Changes in bottom habitat due to natural or anthropogenic causes could affect survival rates by altering available shelter, prey, or other functions. Associations of juvenile rockfish with biotic and abiotic structure have been noted by Carlson and Straty (1981), Pearcy et al. (1989), Love et al. (1991), and Freese and Wing (2003). A study in the Gulf of Alaska based on observations from a manned submersible found that adult "large" rockfish had a strong association with *Primnoa* spp. coral growing on boulders: less than 1 percent of the observed boulders had coral, but 85 percent of the "large" rockfish were next to boulders with coral (Krieger and Wing 2002). Although the "large" rockfish could not be positively identified, it is likely based on location and depth that many were shortraker rockfish. The Essential Fish Habitat Environmental Impact Statement (EFH EIS) for groundfish in Alaska (NMFS 2005) concluded that the effects of commercial fishing on the habitat of groundfish is minimal or temporary based largely on the criterion that stocks were above the Minimum Stock Size Threshold (MSST). However, a review of the EFH EIS suggested that this criterion was inadequate to make such a conclusion (Drinkwater 2004). The trend in shortraker abundance suggests that any adverse effect has not prevented the stock from increasing since 1990.

11.8.2 Fishery Effects on the Ecosystem

Fishery-specific contribution to bycatch of HAPC biota: In the Gulf of Alaska, bottom trawl fisheries for shortraker/rougheye and "other slope rockfish" account for very little bycatch of HAPC biota (Table 11-19). This low bycatch may be explained by the fact that little targeted fishing occurs for these fish.

Fishery-specific concentration of target catch in space and time relative to predator needs in space and time (if known) and relative to spawning components: Unknown.

Fishery-specific effects on amount of large size target fish: Unknown.

Fishery contribution to discards and offal production: Annual fishery discard rates during 2007-2009 have been 18 - 27 % for shortraker rockfish and 41 – 54 % for other slope rockfish. The discard amount of species other than shortraker rockfish in hauls targeting shortraker rockfish is unknown.

Fishery-specific effects on age-at-maturity and fecundity of the target fishery: Unknown.

Fishery-specific effects on EFH non-living substrate: unknown, but the heavy-duty "rockhopper" trawl gear commonly used in the rockfish fishery can move around rocks and boulders on the bottom.

11.8.3 Data Gaps and Research Priorities

There is little information on larval, post-larval, or early stage juveniles of these species. There is a particular lack of information on juvenile shortraker rockfish, which are very seldom caught in any sampling gear. Habitat requirements for larval, post-larval, and early stages are mostly unknown. Habitat requirements for later stage juvenile and adult fish are mostly anecdotal or conjectural. Research needs to be done on the bottom habitat of the fishing grounds, on what HAPC biota are found on these grounds, and on what impact bottom trawling has on the grounds. Investigation is needed on the distribution and abundance of shortraker rockfish in areas of rough bottom that cannot be sampled by trawl surveys. Further analyses of the longline survey should be completed to help determine if longline data can be

used to assess stock condition of shortraker rockfish. Additional age validation studies are especially needed for shortraker rockfish before this species can be assessed with an age-structured model. Age validation is also needed for the sharpchin, redstripe, harlequin, and silvergray rockfish that have been aged.

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Table 11-1.--Species comprising the shortraker rockfish and "other slope rockfish" management categories in the Gulf of Alaska.

Common name	Scientific name	Management category
Shortraker rockfish	*Sebastes borealis*	Shortraker rockfish
Sharpchin rockfish	*S. zacentrus*	Other slope rockfish
Redstripe rockfish	*S. proriger*	Other slope rockfish
Harlequin rockfish	*S. variegatus*	Other slope rockfish
Silvergray rockfish	*S. brevispinis*	Other slope rockfish
Redbanded rockfish	*S. babcocki*	Other slope rockfish
Yellowmouth rockfish	*S. reedi*	Other slope rockfish
Bocaccio	*S. paucispinis*	Other slope rockfish
Greenstriped rockfish	*S. elongatus*	Other slope rockfish
Darkblotched rockfish	*S. crameri*	Other slope rockfish
Pygmy rockfish	*S. wilsoni*	Other slope rockfish
Splitnose rockfish	*S. diploproa*	Other slope rockfish
Blackgill rockfish	*S. melanostomus*	Other slope rockfish
Chilipepper	*S. goodei*	Other slope rockfish
Stripetail rockfish	*S. saxicola*	Other slope rockfish
Vermilion rockfish	*S. miniatus*	Other slope rockfish
Northern rockfish[a]	*S. polyspinis*	Other slope rockfish

[a]Northern rockfish are members of the "other slope rockfish" management group only in the Eastern area of the Gulf of Alaska.

Table 11-2.--Commercial catch (mt) of fish in the shortraker/rougheye rockfish and shortraker rockfish management categories in the Gulf of Alaska, with Gulfwide values of acceptable biological catch (ABC) and total allowable catch (TAC), 1991-2009. Updated through October 3, 2009.

	Area of Gulf			Gulfwide	Gulfwide	Gulfwide
Year	Western	Central	Eastern	total	ABC	TAC
			Shortraker/Rougheye Rockfish			
1991	123	408	171	702	2,000	2,000
1992	115	1,367	683	2,165	1,960	1,960
1993	85	1,197	650	1,932	1,960	1,764
1994	114	996	722	1,832	1,960	1,960
1995	216	1,222	812	2,250	1,910	1,910
1996	127	941	593	1,661	1,910	1,910
1997	137	931	541	1,609	1,590	1,590
1998	129	870	735	1,734	1,590	1,590
1999	194	580	537	1,311	1,590	1,590
2000	137	887	721	1,745	1,730	1,730
2001	126	998	852	1,976	1,730	1,730
2002	263	631	429	1,323	1,620	1,620
2003	225	856	321	1,402	1,620	1,620
2004	277	337	383	997	1,318	1,318
			Shortraker Rockfish			
2005	70	223	205	498	753	753
2006	91	303	270	664	843	843
2007	194	164	250	608	843	843
2008	133	244	221	598	898	898
2009	150	186	199	535	898	898

Sources: Catch: National Marine Fisheries Service, Alaska Region, P.O. Box 21668, Juneau, AK 99802; ABC and TAC: 1991-2007, Clausen (2007); 2008 and 2009, North Pacific Fishery Management Council website (http://www.fakr.noaa.gov/npfmc/Council0910specs.pdf).

Table 11-3.--Commercial catch (mt) of fish in the "other slope rockfish" management category in the Gulf of Alaska, with Gulfwide values of acceptable biological catch (ABC) and total allowable catch (TAC), 1991-2009. Updated through October 3, 2009.

	Area of Gulf			Gulfwide	Gulfwide	Gulfwide
Year	Western	Central	Eastern	Total	ABC	TAC
			Other Slope Rockfish			
1991	n.a.	n.a.	n.a.	278[a]	10,100[b]	10,100[b]
1992	76[a]	854[a]	745[a]	1,674[a]	14,060[b]	14,060[b]
1993	342	2,423	2,658	5,423	8,300	5,383
1994	101	715	797	1,613	8,300	2,235
1995	31	883	483	1,397	7,110	2,235
1996	19	618	244	881	7,110	2,020
1997	68	941	208	1,217	5,260	2,170
1998	46	701	114	861	5,260	2,170
1999	39	614	135	788	5,270	5,270
2000	49	363	165	577	4,900	4,900
2001	25	318	216	559	4,900	1,010
2002	223	481	70	774	5,040	990
2003	130	700	248	1,078	5,050	990
2004	245	534	106	885	3,900	670
2005	92	514	109	715	3,900	670
2006	244	541	146	931	4,152	1,480
2007	252	338	100	690	4,154	1,482
2008	300	435	74	809	4,297	1,730
2009	395	379	72	846	4,297	1,730

n.a. = data not available

[a]Catch estimated based on data from the Groundfish Observer Program.
[b]Includes northern rockfish, which were part of the "other slope rockfish" group in these years .

Sources: Catch: National Marine Fisheries Service, Alaska Region, P.O. Box 21668, Juneau, AK 99802; ABC and TAC: 1991-2007, Clausen (2007); 2008 and 2009, North Pacific Fishery Management Council website (http://www.fakr.noaa.gov/npfmc/Council0910specs.pdf).

Table 11-4.--Estimated commercial catch (mt) of shortraker rockfish in the Gulf of Alaska, 1993-2003, based on data from the NMFS Alaska Observer Program database and from the NMFS Alaska Regional Office. See Clausen (2004) for an explanation of how these numbers were estimated.

Year	Catch
1993	1,348
1994	1,254
1995	1,545
1996	1,102
1997	1,065
1998	1,069
1999	992
2000	1,214
2001	1,385
2002	1,051
2003	1,010

Table 11-5.--Catch (mt) of shortraker rockfish and "other slope rockfish" taken during NMFS research cruises in the Gulf of Alaska, 1977-2009. (Does not include catches in longline surveys before 1996; tr=trace).

Year	Shortraker rockfish	Other slope rockfish
1977	0.1	0.8
1978	0.6	9.5
1979	0.5	0.4
1980	1.0	0.4
1981	6.2	16.3
1982	2.4	2.9
1983	0.2	0.1
1984	6.8	3.4
1985	3.5	1.7
1986	0.9	0.0
1987	15.5	19.8
1988	0.0	0.7
1989	0.1	0.1
1990	2.4	11.8
1991	tr	tr
1992	0.1	0.0
1993	3.0	11.3
1994	0.1	0.0
1995	tr	0.0
1996	10.2	16.9
1997	11.1	0.0
1998	30.4	2.4
1999	109.6	51.6
2000	10.0	0.0
2001	8.1	0.7
2002	6.6	tr
2003	9.8	8.7
2004	4.7	tr
2005	8.6	11.0
2006	5.7	tr
2007	12.6	8.1
2008	8.3	tr
2009	15.0	4.2

Table 11-6.--Estimated commercial catch (mt) for species in the "other slope rockfish" management category in the Gulf of Alaska, 1992-2008. See text for an explanation of how these catches were estimated. (Because of rounding, numbers may not add exactly to totals.)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Sharpchin rockfish	434	1,345	330	342	278	316	319	169	274	162	276	226	119	69	89	102	129
Redstripe rockfish	261	1,222	207	198	134	291	51	107	51	44	13	42	38	20	56	51	46
Harlequin rockfish	745	1,864	789	667	403	492	443	438	186	281	365	732	674	601	716	450	555
Silvergray rockfish	130	487	219	123	8	34	8	19	19	18	52	20	17	4	8	40	17
Yellowmouth rockfish	102	498	40	15	6	63	1	2	13	8	15	10	5	0	0	0	0
Redbanded rockfish	-	-	23	22	30	15	20	21	25	36	35	38	31	21	34	40	55
Minor "other slope rockfish" species	2	16	4	31	23	6	21	32	10	11	17	9	trace	1	28	6	6
Total, all species	1,674	5,433	1,613	1,397	881	1,217	861	788	577	559	774	1,078	885	715	931	690	809

Note: Data are not available for redbanded rockfish in 1992 and 1993.

Table 11-7.--Relative population number (RPN) and relative population weight (RPW) for shortraker rockfish in the Gulf of Alaska NMFS domestic longline survey, 1988-2009. Data are for the upper continental slope only, 201-1,000 m. depth (gullies are not included).

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Shortraker RPN:											
Shumagin	4,492	3,272	3,015	3,074	1,660	1,523	2,549	5,765	4,098	2,888	4,630
Chirikof	1,290	858	773	776	572	229	613	531	646	918	973
Kodiak	2,332	2,691	3,476	2,412	1,374	1,067	1,040	1,325	2,231	2,200	2,498
Yakutat	5,830	6,492	9,281	10,575	9,130	7,121	5,222	7,992	8,409	12,408	15,295
Southeastern	1,420	1,972	1,403	2,247	1,479	2,199	1,862	2,427	1,967	2,459	3,258
Total	15,364	15,285	17,948	19,085	14,214	12,139	11,286	18,039	17,352	20,873	26,654
Shortraker RPW:											
Shumagin	4,869	4,301	5,004	5,953	2,078	2,192	3,956	7,940	5,946	4,468	6,716
Chirikof	2,591	1,449	1,216	1,384	914	293	1,174	812	1,007	1,471	1,422
Kodiak	5,043	5,833	6,787	4,874	2,802	1,912	2,649	2,554	4,657	4,273	5,201
Yakutat	13,320	13,335	19,093	20,585	17,033	14,411	11,046	15,248	17,352	26,830	30,685
Southeastern	2,474	3,384	2,214	3,546	2,053	4,124	3,102	4,034	3,377	3,970	5,818
Total	28,297	28,302	34,313	36,343	24,880	22,932	21,927	30,588	32,338	41,013	49,842

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Shortraker RPN:											
Shumagin	5,011	9,481	5,150	3,386	3,576	6,477	2,041	3,901	3,566	3,349	4,633
Chirikof	823	1,298	1,031	951	809	474	274	931	714	813	482
Kodiak	3,078	2,904	3,703	1,982	1,510	1,409	1,807	3,080	4,200	3,748	5,967
Yakutat	13,394	13,995	14,177	9,942	7,312	7,519	6,963	7,970	13,169	12,517	10,124
Southeastern	3,167	4,025	2,646	3,098	3,951	2,874	1,905	2,106	2,876	2,536	2,292
Total	25,473	31,703	26,706	19,358	17,158	18,754	12,990	17,989	24,524	22,964	23,498
Shortraker RPW:											
Shumagin	6,954	15,050	7,314	4,978	5,874	9,678	3,458	5,830	4,944	4,827	6,390
Chirikof	1,165	1,607	1,682	1,324	1,420	624	378	969	1,067	1,129	659
Kodiak	5,562	5,553	7,413	3,305	2,908	2,496	3,144	6,086	8,003	6,120	11,487
Yakutat	26,500	28,754	28,382	18,314	14,583	14,292	12,751	14,056	22,684	21,605	17,340
Southeastern	4,569	7,099	4,574	5,598	7,455	5,045	2,946	3,203	4,914	4,140	3,541
Total	44,750	58,063	49,365	33,518	32,240	32,134	22,677	30,144	41,612	37,821	39,416

Source: C. Lunsford, National Marine Fisheries Service, Alaska Fisheries Science Center, Auke Bay Laboratories, 17109 Pt. Lena Loop Rd., Juneau AK 99801. Pers. commun. October 15, 2009.

Table 11-8.--Comparison of Gulfwide biomass estimates (mt) for the shortraker rockfish and "other slope rockfish" management categories in the Gulf of Alaska, based on bottom trawl surveys conducted between 1984 and 2009.

	Year										
Species	1984	1987	1990	1993	1996	1999	2001[a]	2003	2005	2007	2009
Shortraker rockfish	18,557	42,851	12,681	19,710	20,258	28,231	27,914	42,023	42,568	35,125	44,185
				"Other Slope Rockfish"							
Sharpchin rockfish	6,612	80,439	38,334	23,676	64,570	20,841	34,169	7,094	21,193	19,037	12,493
Redstripe rockfish	5,364	26,519	27,064	29,619	14,964	8,226	17,564	8,025	21,691	11,501	1,592
Harlequin rockfish	2,625	72,405	17,664	9,281	20,026	9,877	14,480	3,545	33,125	4,057	2,686
Silvergray rockfish	4,817	5,426	14,149	18,979	24,127	37,641	24,032	51,916	39,837	29,798	9,851
Redbanded rockfish	1,430	1,822	3,285	3,675	4,594	10,941	6,409	3,441	5,667	7,198	6,442
Darkblotched rockfish	7	37	174	291	121	272	227	91	232	161	1,121
Splitnose rockfish	0	3	3	0	0	7	2	5	42	6	20
Greenstriped rockfish	14	65	174	268	352	467	362	423	392	676	356
Vermilion rockfish	0	0	0	20	0	0	7	0	0	0	0
Bocaccio	505	36	173	106	137	0	81	132	0	104	0
Pygmy rockfish	0	406	88	3	283	187	141	127	137	137	266
Yellowmouth rockfish	497	260	1,876	3,563	923	5,570	3,346	387	0	475	43
Total, other slope rockfish	21,870	187,416	102,983	89,480	130,096	94,027	100,819	75,184	122,315	73,148	34,870

[a]The 2001 survey did not sample the eastern Gulf of Alaska. Substitute estimates of biomass for this region in 2001 were obtained by averaging the eastern Gulf biomass in the 1993, 1996, and 1999 surveys. These eastern Gulf of Alaska estimates have been included in the 2001 biomass estimates listed in this table.

Note: because these are Gulfwide estimates, they do not include the biomass for northern rockfish, which is a member of the "other slope rockfish" management group only in the Eastern Gulf of Alaska.

Table 11-9.--Detailed biomass estimates (mt) for shortraker rockfish in the Gulf of Alaska, by statistical area, based on bottom trawl surveys conducted between 1984 and 2009. Gulfwide 95% confidence bounds, variance, and coefficient of variation (CV) are also shown for each year.

	Statistical areas						Gulfwide			
							95% Conf. bounds			
Year	Shumagin	Chirikof	Kodiak	Yakutat	South-eastern	Gulfwide Total	Lower	Upper	Biomass variance	Biomass CV (%)
					Shortraker Rockfish					
1984	4,874	659	4,685	6,288	2,051	18,557	4,600	32,515	34,829,252	31.8
1987	3,232	13,182	18,950	4,408	3,079	42,851	13,392	72,311	196,602,336	32.7
1990	284	1,729	3,027	6,037	1,604	12,681	6,412	18,951	9,085,499	23.8
1993	2,775	2,320	4,973	7,740	1,903	19,710	11,575	27,845	15,297,336	19.8
1996	1,905	2,406	7,726	4,523	3,699	20,258	10,652	29,865	20,532,868	22.4
1999	2,208	3,931	8,459	9,788	3,845	28,231	16,798	39,664	30,388,211	19.5
2001*	4,313	1,589	11,513	7,350	3,149	27,914	18,819	37,008	21,530,717	16.6
2003	11,166	2,996	14,292	11,936	1,633	42,023	23,572	60,474	81,168,454	21.4
2005	5,946	6,342	10,741	16,866	2,673	42,568	25,603	59,532	69,018,739	19.5
2007	2,492	1,911	8,275	8,197	14,250	35,125	17,296	52,954	66,950,870	23.3
2009	8,810	3,209	13,541	12,518	6,109	44,185	25,332	63,039	79,840,212	20.2

*The 2001 survey did not sample the eastern Gulf of Alaska (Yakutat and Southeastern areas). Substitute estimates of biomass for these areas in 2001 were obtained by averaging the Yakutat and Southeastern biomass in the 1993, 1996, and 1999 surveys. These eastern Gulf of Alaska estimates have been included in the 2001 biomass estimates, confidence bounds, biomass variances, and biomass CVs listed in this table.

Table 11-10.--Detailed biomass estimates (mt) for major species of "other slope rockfish" (sharpchin, redstripe, harlequin, silvergray, and redbanded rockfish) in the Gulf of Alaska, by statistical area, based on bottom trawl surveys conducted between 1984 and 2009. Gulfwide 95% confidence bounds, variance, and coefficient of variation (CV) are also shown for each year.

	Statistical areas						Gulfwide			
							95% Conf. bounds			
Year	Shumagin	Chirikof	Kodiak	Yakutat	South-eastern	Gulfwide Total	Lower	Upper	Biomass variance	Biomass CV (%)
					Sharpchin Rockfish					
1984	0	25	1,921	2,332	2,334	6,612	1,693	11,531	5,803,215	36.4
1987	3,366	12	31	20,367	56,663	80,439	13,859	147,018	995,675,631	39.2
1990	2	3	3,360	2,706	32,263	38,334	9,326	67,341	201,789,069	37.1
1993	74	1	7,046	5,314	11,241	23,676	8,063	39,289	58,459,837	32.3
1996	72	840	1,081	18,871	43,705	64,570	23,139	106,001	420,270,040	31.7
1999	0	15	2,841	15,125	2,860	20,841	0	54,401	188,096,993	65.8
2001*	23	4	1,770	13,103	19,269	34,169	0	85,559	687,440,998	76.7
2003	38	24	266	1,638	5,128	7,094	0	14,338	10,571,214	45.8
2005	195	28	10,730	4,827	5,413	21,193	7,442	34,943	46,289,971	32.1
2007	53	68	3,979	3,826	11,111	19,037	5,792	32,282	42,070,721	34.1
2009	15	12	643	2,763	9,061	12,493	3,006	21,979	19,558,735	35.4
					Redstripe Rockfish					
1984	0	5	134	9	5,216	5,364	922	9,806	4,732,655	40.6
1987	1,263	0	1,820	1,785	21,651	26,519	0	53,639	157,644,113	47.3
1990	0	0	15	3,147	23,903	27,064	0	56,675	195,093,233	51.6
1993	5	96	16	2	29,500	29,619	0	64,739	268,061,624	55.3
1996	152	91	0	13	14,709	14,964	0	31,716	65,560,357	54.1
1999	0	8	131	40	8,047	8,226	0	16,618	16,374,663	49.2
2001*	3	7	117	18	17,419	17,564	0	42,415	160,764,784	72.2
2003	5	0	175	0	7,845	8,025	2,109	13,942	8,313,938	35.9
2005	2,796	5	12,822	137	5,931	21,691	0	51,372	157,510,783	57.9
2007	15	4	651	0	10,830	11,051	0	26,535	49,124,778	60.9
2009	1	26	22	0	1,542	1,592	47	3,136	535,783	46.0
					Harlequin Rockfish					
1984	65	29	1,284	555	692	2,625	972	4,277	682,693	31.5
1987	7,491	407	19,842	15,233	29,433	72,405	28,945	115,865	452,965,027	29.4
1990	125	434	13,150	1,141	2,814	17,664	0	36,735	80,922,933	50.9
1993	84	258	8,271	384	284	9,281	301	18,260	19,280,318	47.3
1996	773	258	2,625	2,073	14,298	20,026	0	46,293	164,490,940	64.0
1999	7	167	8,396	1,046	261	9,877	1,313	18,440	17,587,024	42.5
2001*	2,987	221	5,157	1,167	4,948	14,480	0	34,638	105,778,063	71.0
2003	25	968	530	1,097	924	3,545	313	6,776	2,504,458	44.6
2005	26,668	222	1,708	4,408	119	33,125	0	77,144	454,826,845	64.4
2007	834	1,814	89	307	1,014	4,057	384	7,730	3,373,252	45.3
2009	44	74	766	716	1,086	2,686	274	5,099	1,328,629	42.9

(Table continued on next page).

Table 11-10.--(Continued)

	Statistical areas						Gulfwide			
							95% Conf. bounds			
Year	Shumagin	Chirikof	Kodiak	Yakutat	South-eastern	Gulfwide Total	Lower	Upper	Biomass variance	Biomass CV (%)
					Silvergray Rockfish					
1984	0	0	52	1,071	3,693	4,817	1,336	8,298	1,833,053	28.1
1987	37	6	144	1,917	3,322	5,426	858	9,994	4,642,273	39.7
1990	0	4	277	5,178	8,691	14,149	1,996	26,301	35,417,352	42.1
1993	0	82	462	1,244	17,191	18,979	6,682	31,276	33,645,705	30.6
1996	0	28	1,525	2,934	19,641	24,127	10,958	37,297	41,592,853	26.7
1999	0	0	6,745	6,456	24,440	37,641	12,371	62,911	153,140,523	32.9
2001*	0	16	47	3,545	20,424	24,032	13,742	34,321	27,558,377	21.8
2003	0	37	28	3,067	48,784	51,916	0	130,981	1,453,296,905	73.4
2005	18	652	421	10,834	27,912	39,837	8,250	71,424	244,273,608	39.2
2007	0	86	273	8,754	20,685	29,798	13,588	46,007	60,382,205	26.1
2009	0	8	86	4,229	5,528	9,851	939	18,763	17,671,366	42.7
					Redbanded Rockfish					
1984	0	39	130	727	534	1,430	531	2,330	198,019	31.1
1987	21	391	213	762	435	1,822	600	3,044	353,367	32.6
1990	0	32	187	1,420	1,646	3,285	887	5,683	1,302,634	34.7
1993	11	116	318	1,084	2,147	3,675	1,513	5,837	1,105,665	28.6
1996	61	40	160	1,497	2,836	4,594	1,476	7,711	2,379,370	33.6
1999	118	45	358	1,344	9,076	10,941	1,350	20,532	20,254,925	41.1
2001*	61	51	303	1,308	4,686	6,409	0	15,063	19,497,202	68.9
2003	19	672	218	548	1,984	3,441	1,907	4,974	563,886	21.8
2005	41	180	830	2,211	2,405	5,667	3,051	8,283	1,466,795	21.4
2007	52	294	870	2,772	3,211	7,198	3,315	11,081	3,277,015	25.1
2009	34	643	1,377	1,249	3,139	6,442	4,215	8,669	1,214,410	17.1

*The 2001 survey did not sample the eastern Gulf of Alaska (Yakutat and Southeastern areas). Substitute estimates of biomass for these areas in 2001 were obtained by averaging the Yakutat and Southeastern biomass in the 1993, 1996, and 1999 surveys. These eastern Gulf of Alaska estimates have been included in the 2001 biomass estimates, confidence bounds, biomass variances, and biomass CVs listed in this table.

Table 11-11.-- Mortality rates, maximum age, and female age and size at 50% maturity for shortraker rockfish and some species of "other slope rockfish". Size is fork length in cm. Area indicates location of study: West Coast of USA (WC), British Columbia (BC), Gulf of Alaska (GOA), Aleutians (AL), and eastern Bering Sea (EBS).

Species	Mortality rate[a]	Mortality rate method	Maximum age	Age at Maturity	Size at Maturity	Area	References
Shortraker	-	-	120	-	-	BC	2
	0.027-0.042	GSI	-	21.4	44.9	WC,GOA,AL,EBS	6,4
	-	-	157	-	-	GOA	7
	-	-	146	-	-	GOA	8
Sharpchin	0.05	CC	46	-	-	BC	1
	0.056-0.059	A&C - H	58	10	26.5	GOA	5,3
Yellowmouth	0.06	CC	71	-	-	BC	1,2
	-	-	99	-	-	BC	7
Darkblotched	0.07	CC	48	-	-	BC	1
Harlequin	-	-	43	-	-	BC	2
	0.127-0.157	A&C - H	34	-	-	GOA	5
	-	-	47	-	-	GOA	8
Redstripe	0.10	CC	41	-	-	BC	1,2
	-	-	55	-	-	BC	7
	-	-	36	-	-	GOA	8
Silvergray	0.01-0.07	CC	80	-	-	BC	1,2
	0.041-0.057	A&C - H	75	-	-	GOA	5
	-	-	82	9	-	BC	9
	0.06	H	-	-	-	BC	10

[a]Mortality rates determined by the catch curve method are rates of total instantaneous mortality (Z), and those determined by other methods are rates of instantaneous natural mortality (M).

Mortality rate methods:
GSI: gonad somatic index (Gunderson and Dygert (1988); CC: catch curve analysis to compute total mortality rate Z; A&C - H: combination of Alverson and Carney (1975) method and Hoenig (1983) method (see Malecha et al. 2007); H: Hoenig (1983) method.

References:
1) Archibald et al. 1981; 2) Chilton and Beamish 1982; 3) Heifetz et al. 1997; 4) Hutchinson 2004; 5) Malecha et al. 2007; 6) McDermott 1994; 7) Munk 2001; 8) this report; 9 Stanley and Kronlund 2005; 10 Stanley and Kronlund 2000.

Table 11-12.-- Length-weight coefficients for shortraker and sharpchin rockfish in the Gulf of Alaska. Length-weight coefficients are from the formula $W = aL^b$ where W = weight in kg and L = length in cm. (Based on data in Martin 1997).

Species	Sex	a	b
Shortraker	combined	9.85×10^{-6}	3.13
	males	1.26×10^{-5}	3.07
	females	1.02×10^{-5}	3.12
Sharpchin	combined	1.13×10^{-5}	3.07
	males	8.89×10^{-6}	3.15
	females	1.19×10^{-5}	3.06

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Table 11-13.--Von Bertalanffy parameters for shortraker, sharpchin, silvergray, and harlequin rockfish, by area and sex. (BC = British Columbia; GOA = Gulf of Alaska; AI = Aleutian Islands: EBS = Eastern Bering Sea).

Species	Area	Sex	t_0	k	L_{inf} (cm)	Reference
Shortraker	GOA/AI/EBS	female	-3.62	0.030	84.60	2
Sharpchin	BC	combined	-2.21	0.095	34.90	1
	GOA	combined	-0.81	0.131	32.64	3
	GOA	male	-0.48	0.167	28.44	3
	GOA	female	-0.75	0.122	35.02	3
Silvergray	GOA	combined	-1.68[a]	0.100	59.80	3
	GOA	male	-1.68[a]	0.110	57.14	3
	GOA	female	-1.68[a]	0.093	62.25	3
Harlequin	GOA	combined	-3.86	0.099	31.51	3
	GOA	male	-4.76	0.091	30.60	3
	GOA	female	-3.26	0.110	32.32	3

1) Archibald et al. 1981; 2) Hutchinson 2004; 3) Malecha et al. 2007.

[a] t_0 for silvergray rockfish could not be accurately estimated from the data, therefore t_0 was constrained at the average value for all other rockfish species.

Table 11-14.--Biomass estimates (mt) for shortraker rockfish and "other slope rockfish" in the Gulf of Alaska, by NPFMC regulatory areas, in the 2005, 2007, and 2009 trawl surveys.

	Area			
Species	Western	Central	Eastern	Total
	2005			
Shortraker rockfish	5,946	17,083	19,538	42,568
Sharpchin rockfish	195	10,757	10,241	21,193
Redstripe rockfish	2,796	12,827	6,068	21,691
Harlequin rockfish	26,668	1,930	4,528	33,125
Silvergray rockfish	18	1,073	38,746	39,837
Redbanded rockfish	41	1,010	4,616	5,667
Minor species[a]	0	1	962	962
Total, "other slope rockfish"	29,718	27,598	65,160	122,475
	2007			
Shortraker rockfish	2,492	10,186	22,447	35,125
Sharpchin rockfish	53	4,048	14,937	19,037
Redstripe rockfish	15	656	10,830	11,501
Harlequin rockfish	834	1,902	1,321	4,057
Silvergray rockfish	0	359	29,439	29,798
Redbanded rockfish	52	1,164	5,982	7,198
Minor species[a]	4	15	1,577	1,596
Total, "other slope rockfish"	957	8,144	64,085	73,186
	2009			
Shortraker rockfish	8,810	16,749	18,626	44,185
Sharpchin rockfish	15	655	11,823	12,493
Redstripe rockfish	1	48	1,542	1,592
Harlequin rockfish	44	840	1,802	2,686
Silvergray rockfish	0	94	9,757	9,851
Redbanded rockfish	34	2,020	4,388	6,442
Minor species[a]	0	234	1,642	1,876
Total, "other slope rockfish"	94	3,891	30,955	34,940

[a]Estimates for minor species in the Eastern area include northern rockfish.

Table 11-15.-- Percentage of biomass by area for shortraker rockfish and "other slope rockfish" based on the biomass estimates shown in Table 11-15 for Gulf of Alaska trawl surveys in 2005, 2007, and 2009. Weighted averages use weights of 4:6:9 for the 2005, 2007, and 2009 surveys, respectively.

	Area		
Management group	Western	Central	Eastern
	2005		
Shortraker rockfish	13.97%	40.13%	45.90%
Other slope rockfish[a]	24.26%	22.53%	53.20%
	2007		
Shortraker rockfish	7.10%	29.00%	63.91%
Other slope rockfish[a]	1.31%	11.13%	87.56%
	2009		
Shortraker rockfish	19.94%	37.91%	42.16%
Other slope rockfish[a]	0.27%	11.14%	88.59%
	4:6:9 weighted average		
Shortraker rockfish	14.63%	35.56%	49.81%
Other slope rockfish[a]	5.65%	13.53%	80.82%

[a] Includes northern rockfish in the Eastern area.

Table 11-16.--Summary of computations of ABCs and overfishing levels for shortraker rockfish and "other slope rockfish" for the Gulf of Alaska in 2010. Biomass and yields are in mt. Since actual ABCs and overfishing levels for "other slope rockfish" are based on the overall management category, individual species are shown only for illustrative purposes. (Because of rounding, numbers may not add exactly to totals.)

		Exploit.	ABC		Overfishing	
Species	Tier	biomass	*F*	Yield	*F*	Yield
Shortraker rockfish	5	40,626	$F = 0.75M = 0.0225$	914	$F = M = 0.030$	1,219
Sharpchin rockfish	4	17,574	$F_{40\%} = 0.0530$	931	$F_{35\%} = 0.064$	1,125
Redstripe rockfish	5	11,594	$F = 0.75M = 0.0750$	870	$F = M = 0.100$	1,159
Harlequin rockfish	5	13,290	$F = 0.75M = 0.0450$	598	$F = M = 0.060$	797
Silvergray rockfish	5	26,495	$F = 0.75M = 0.0375$	994	$F = M = 0.050$	1,325
Redbanded rockfish	5	6,436	$F = 0.75M = 0.0450$	290	$F = M = 0.060$	386
Minor species	5	1,478	$F = 0.75M = 0.0450$	67	$F = M = 0.060$	89
Total, other slope rockfish		76,867		3,749		4,881

Table 11-17.--Set of yield projections for shortraker rockfish and "other slope rockfish" for 2010 in the Gulf of Alaska. This set of projections encompasses scenarios designed to satisfy the requirements of Amendment 56, the National Environmental Protection Act, and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). Biomass and yields are in mt.

	Exploitable	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
Species	biomass	*F*	Yield	*F*	Yield	*F*	Yield	*F*	Yield
Shortraker	40,626	0.0225	914	0.0225	914	0.0113	457	0.0155	630
Sharpchin	17,574	0.0530	931	0.0530	931	0.0265	466	-	-
Redstripe	11,594	0.0750	870	0.0750	870	0.0375	435	-	-
Harlequin	13,290	0.0450	598	0.0450	598	0.0225	299	-	-
Silvergray	26,495	0.0375	994	0.0375	994	0.0188	497	-	-
Redbanded	6,436	0.0450	290	0.0450	290	0.0225	145	-	-
Minor spp	1,478	0.0450	67	0.0450	67	0.0225	33	-	-
Total, other slope rockfish	76,867		3,749		3,749		1,874	0.0087	671

Scenario 1: F is set equal to max F_{ABC}.
Scenario 2: F is set equal to the recommended $F_{ABC.}$
Scenario 3: F is set equal to 50% of max F_{ABC}.
Scenario 4: F is set equal to the average F for 2005-2009 (i.e., the most recent five years with catch data).

Table 11-18.-- Analysis of ecosystem considerations for shortraker rockfish and "other slope rockfish".

Indicator	*Observation*	*Interpretation*	*Evaluation*
ECOSYSTEM EFFECTS ON STOCK			
Prey availability or abundance trends	important for larval and post-larval survival, but no information known	may help to determine year class strength	possible concern if some information available
Predator population trends	unknown		little concern for adults
Changes in habitat quality	variable	variable recruitment	possible concern
FISHERY EFFECTS ON ECOSYSTEM			
Fishery contribution to bycatch			
Prohibited species	unknown		
Forage (including herring, Atka mackerel, cod, and pollock)	unknown		
HAPC biota (seapens/whips, corals, sponges, anemones)	fishery disturbing hard-bottom biota, i.e., corals, sponges	could harm the ecosystem by reducing shelter for some species	concern
Marine mammals and birds	probably few taken		little concern
Sensitive non-target species	unknown		
Fishery concentration in space and time	little overlap between fishery and reproductive activities	fishery does not hinder reproduction	little concern
Fishery effects on amount of large size target fish	unknown		

Indicator	***Observation***	***Interpretation***	***Evaluation***
Fishery contribution to discards and offal production	discard rates moderate to high for other slope rockfish	some unnatural input of food into the ecosystem	some concern
Fishery effects on age-at-maturity and fecundity	unknown		

Table 11-19. Average bycatch (kg) and bycatch rates during 1997 - 99 of living substrates in the Gulf of Alaska; POT - pot gear; BTR - bottom trawl; HAL - Hook and line (source - Draft Programmatic SEIS).

		Bycatch (kg)				Target	Bycatch rate (kg/mt target)			
Target fishery	Gear	Coral	Anemone	Sea whips	Sponge	catch (mt)	Coral	Anemone	Sea whips	Sponge
Arrowtooth flounder	POT	0	0	0	0	4	0.0000	0.0000	0.0000	0.0000
Arrowtooth flounder	BTR	58	99	13	24	2,097	0.0276	0.0474	0.0060	0.0112
Deep water flatfish	BTR	1,626	481	5	733	2,001	0.8124	0.2404	0.0024	0.3663
Rex sole	BTR	321	306	11	317	2,157	0.1488	0.1417	0.0053	0.1468
Shallow water flatfish	POT	0	0	0	0	5	0.0000	0.0000	0.0000	0.0000
Shallow water flatfish	BTR	53	4,741	115	403	2,024	0.0261	2.3420	0.0567	0.1993
Flathead sole	BTR	3	267	1	136	484	0.0071	0.5522	0.0019	0.2806
Pacific cod	HAL	28	4,419	961	33	10,765	0.0026	0.4105	0.0893	0.0030
Pacific cod	POT	0	14	0	1,724	12,863	0.0000	0.0011	0.0000	0.1340
Pacific cod	BTR	34	5,767	895	788	37,926	0.0009	0.1521	0.0236	0.0208
Pollock	BTR	1,153	55	0	23	2,465	0.4676	0.0222	0.0000	0.0092
Pollock	PTR	41	110	0	0	97,171	0.0004	0.0011	0.0000	0.0000
Demersal shelf rockfish	HAL	0	0	0	141	226	0.0000	0.0000	0.0000	0.6241
Northern rockfish	BTR	25	90	0	103	1,938	0.0127	0.0464	0.0000	0.0532
Other slope rockfish	HAL	0	0	0	0	14	0.0000	0.0000	0.0000	0.0000
Other slope rockfish	BTR	0	0	0	0	193	0.0000	0.0000	0.0000	0.0000
Pelagic shelf rockfish	HAL	0	0	0	0	203	0.0000	0.0000	0.0000	0.0000
Pelagic shelf rockfish	BTR	324	176	3	245	1,812	0.1788	0.0969	0.0017	0.1353
Pacific ocean perch	BTR	549	90	5	1,968	6,564	0.0837	0.0136	0.0007	0.2999
Pacific ocean perch	PTR	7	0	0	55	1,320	0.0052	0.0000	0.0000	0.0416
Shortraker/rougheye	HAL	6	0	0	0	19	0.3055	0.0000	0.0000	0.0000
Shortraker/rougheye	BTR	0	18	0	0	21	0.0000	0.8642	0.0000	0.0000
Sablefish	HAL	156	154	68	27	11,143	0.0140	0.0138	0.0061	0.0025
Sablefish	BTR	0	0	0	0	27	0.0000	0.0000	0.0000	0.0000
Shortspine thornyhead	HAL	0	0	0	0	2	0.0000	0.0000	0.0000	0.0000
Shortspine thornyhead	BTR	0	9	0	1	2	0.0000	4.8175	0.0000	0.4069

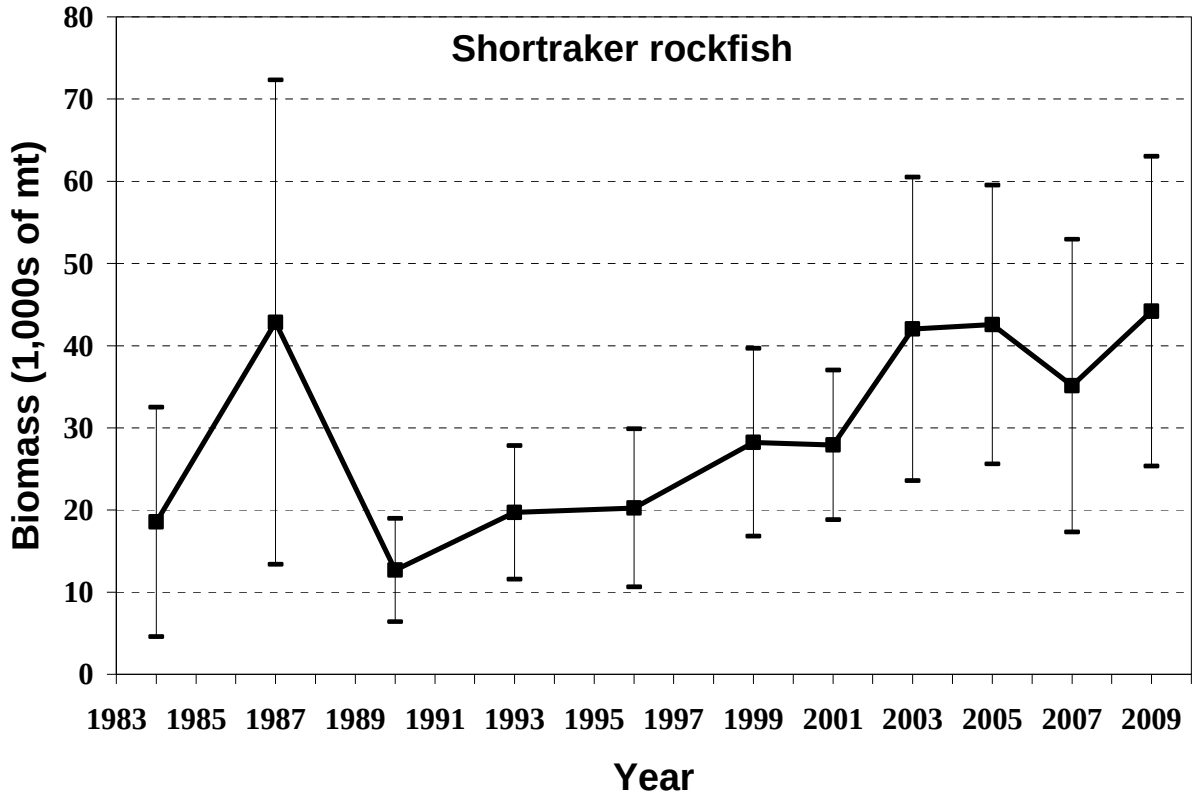

Figure 11-1.--Estimated biomass of shortraker rockfish in the Gulf of Alaska based on results of bottom trawl surveys from 1984 through 2009. The vertical bars show the 95% confidence limits associated with each estimate. The eastern Gulf of Alaska was not sampled in the 2001 survey, but substitute estimates of biomass and confidence limits for this region in 2001 were calculated and included in the above graph.

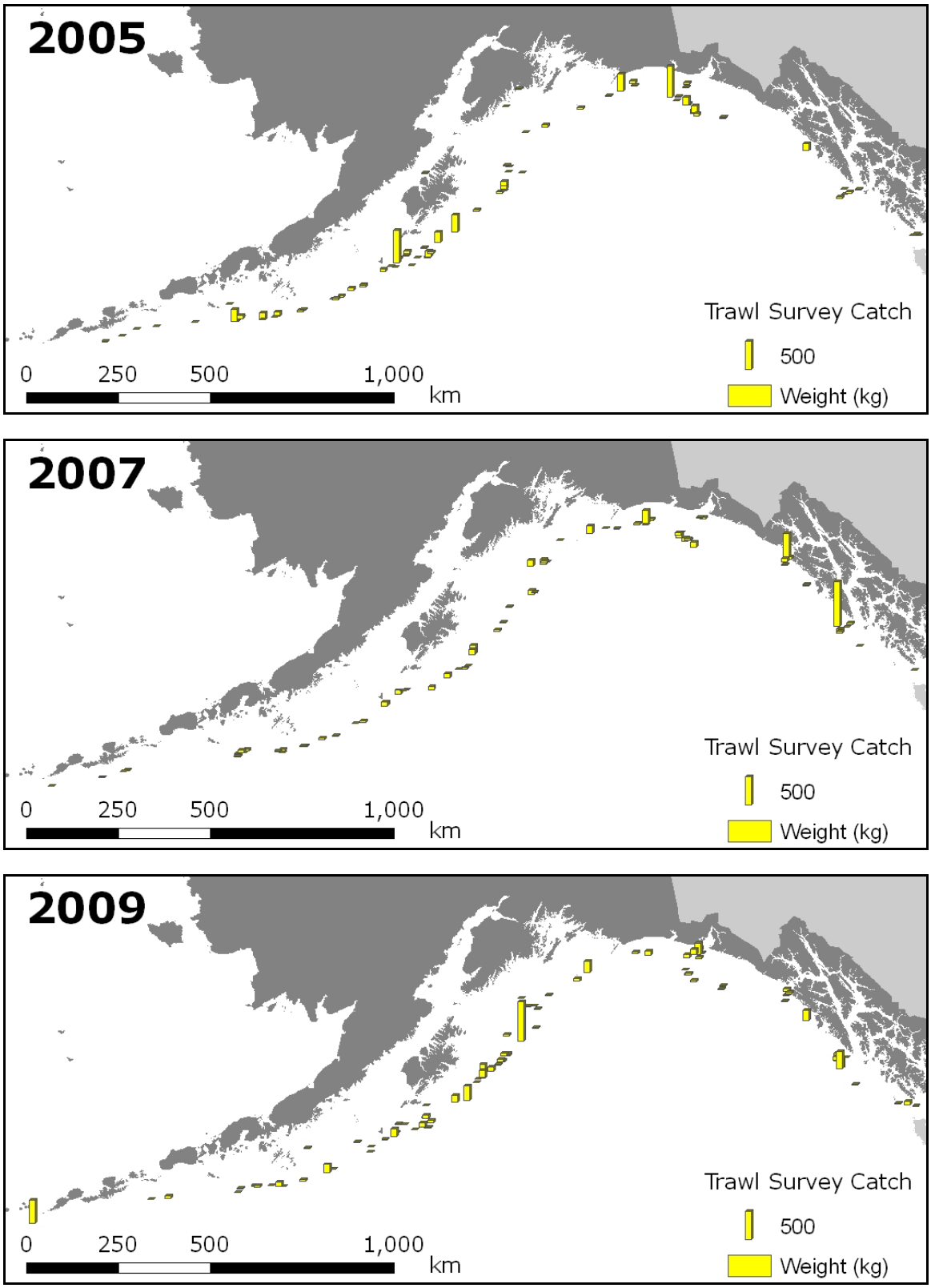

Figure 11-2.--Spatial distribution of shortraker rockfish in the Gulf of Alaska during the 2005, 2007, and 2009 NMFS bottom trawl surveys.

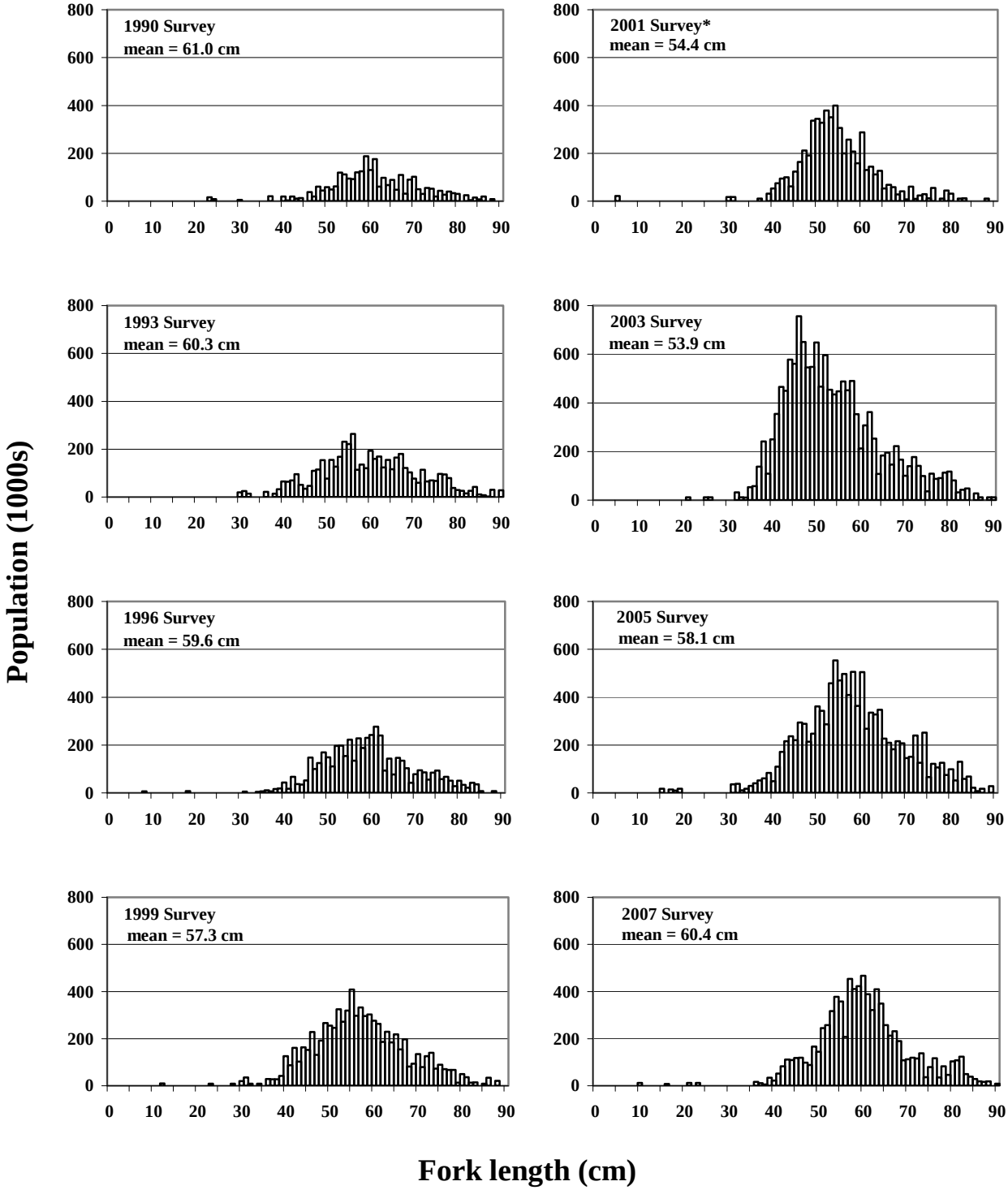

Figure 11-3.--Length frequency distribution of the estimated population of shortraker rockfish in the Gulf of Alaska, based on trawl surveys from 1990 through 2009. *2001 survey did not sample the eastern Gulf of Alaska. (Figure continued on next page.)

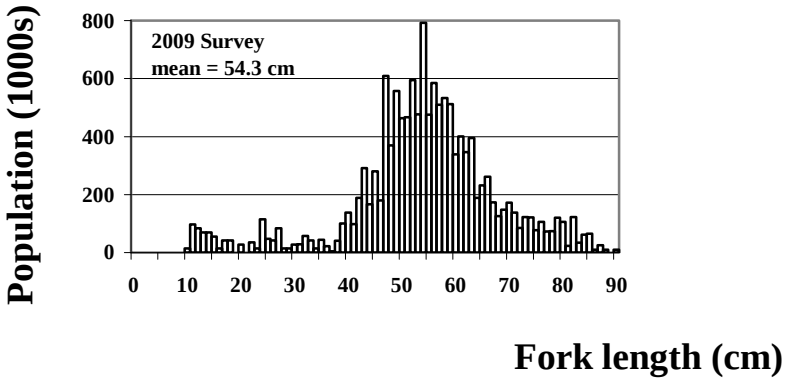

Figure 11-3.--Continued.

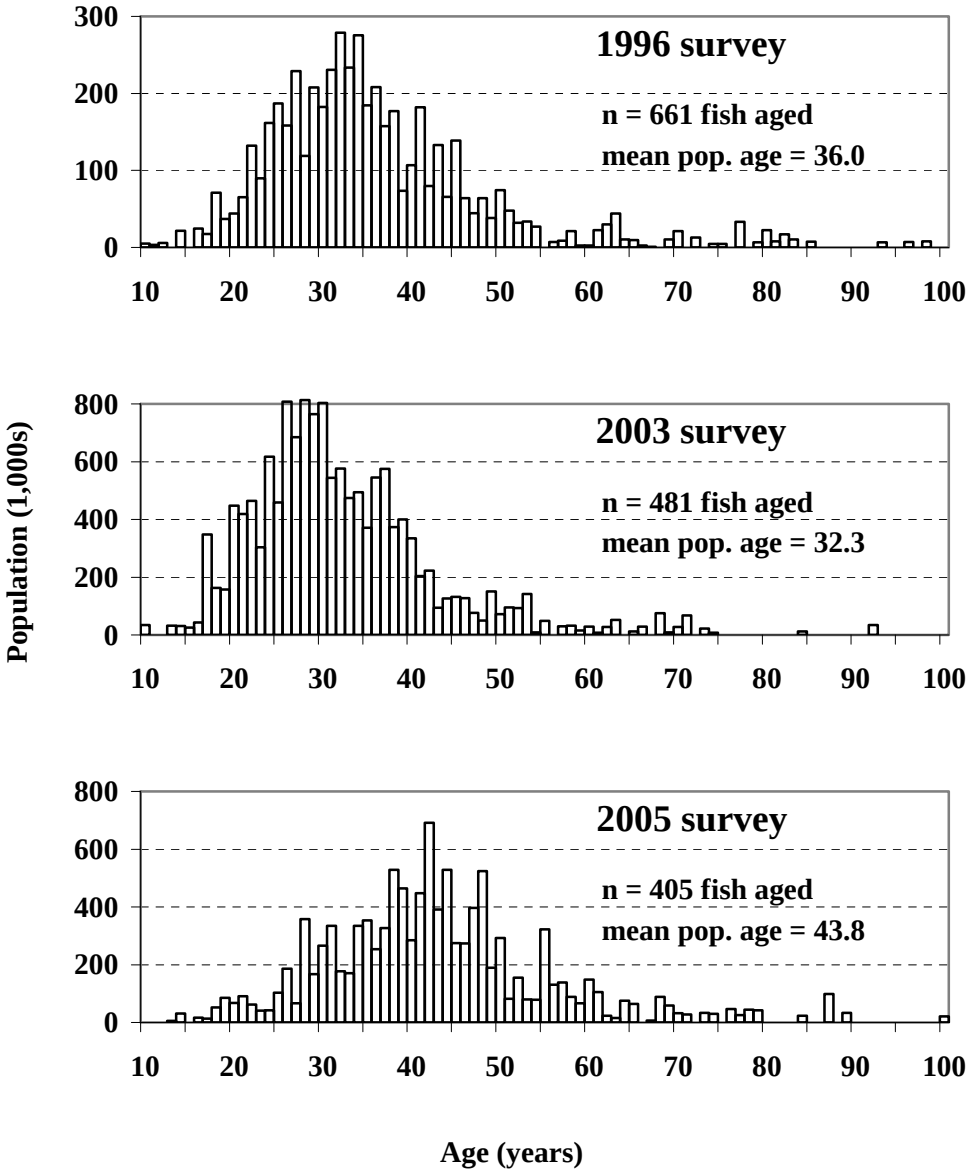

Figure 11-4.--Age composition of the estimated population of shortraker rockfish in the 1996, 2003, and 2005 Gulf of Alaska trawl surveys.

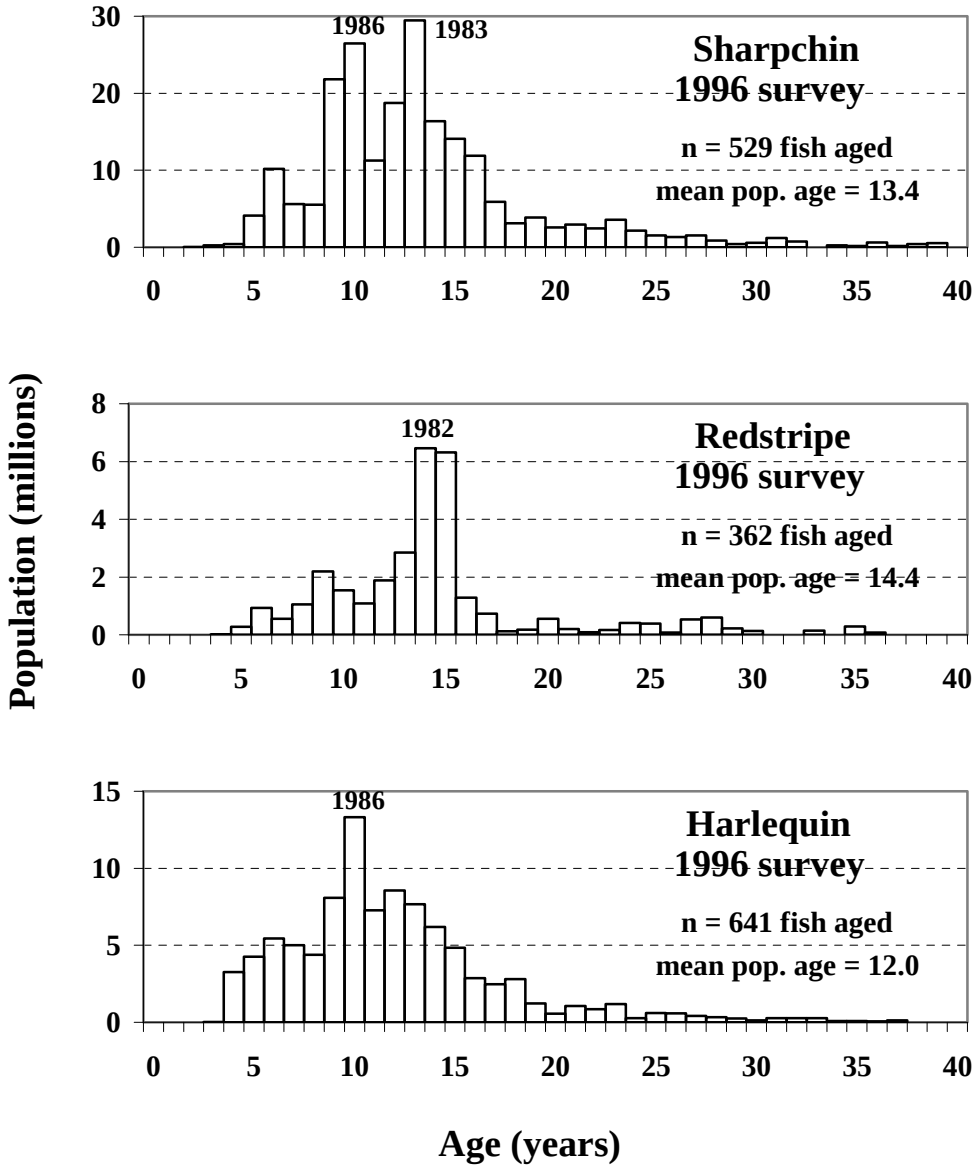

Figure 11-5.--Age compositions of the estimated population of sharpchin, redstripe, and harlequin rockfish in the 1996 Gulf of Alaska trawl survey. The numbers next to prominent bars identify apparently strong year classes.

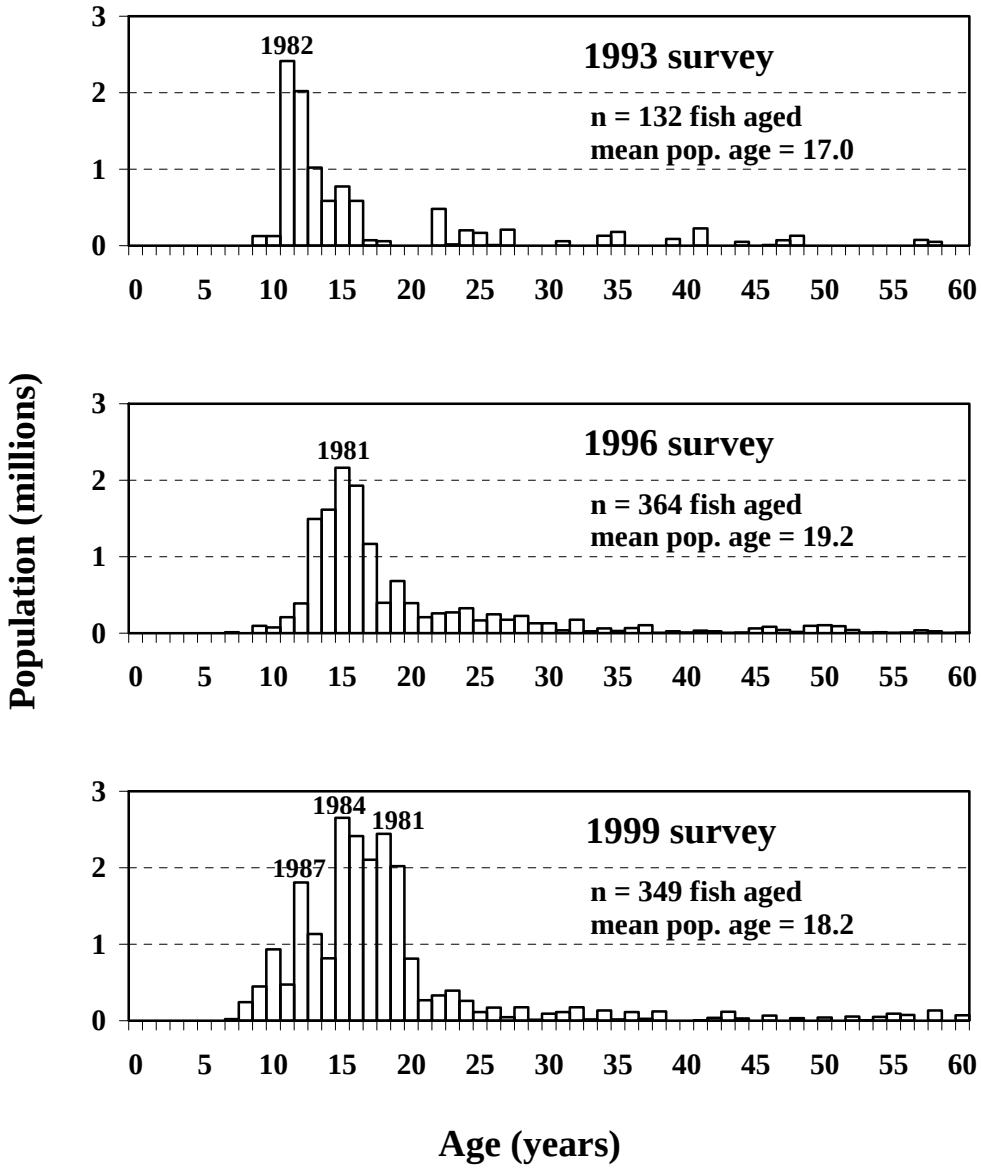

Figure 11-6.--Age compositions of the estimated population of silvergray rockfish in the 1993, 1996, and 1999 Gulf of Alaska trawl surveys. The numbers next to prominent bars identify apparently strong year classes.