Chapter 12

SHORTRAKER ROCKFISH AND OTHER SLOPE ROCKFISH

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12.0 EXECUTIVE SUMMARY

12.0.1 Summary of Major Changes

Major new information in this assessment includes biomass estimates from the 2007 trawl survey, the first-ever survey age results in Alaska for shortraker, sharpchin, redstripe, harlequin, and silvergray rockfish, and new information on age-and-growth and natural mortality rates for several "other slope rockfish" species. Assessment methodology in this report is generally similar to that used in past assessments for shortraker rockfish and "other slope rockfish", but changes were made to the way that exploitable biomass is calculated and to the natural mortality rate used for silvergray rockfish.

Previously, exploitable biomass for shortraker rockfish and "other slope rockfish" was estimated by the unweighted average biomass of the most recent three Gulf of Alaska trawl surveys, excluding the biomass in the 1-100 m depth stratum. The removal of the 1-100 m stratum from the estimate was a holdover from many years ago when the assessment included Pacific ocean perch; the rationale was that small-sized Pacific ocean perch predominated in this stratum, and these fish should be considered unexploitable. However, an analysis presented in the current assessment shows that the biomass of shortraker rockfish and "other slope rockfish" in this stratum is negligible; hence, the exclusion of the 1-100 m stratum from the exploitable biomass computations for these groups appears unnecessary. Including this shallow stratum, and averaging the biomass estimates in the last three Gulf of Alaska trawl surveys (2003, 2005, and 2007), results in an exploitable biomass of 39,905 mt for shortraker rockfish and 90,283 mt for "other slope rockfish".

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 several years. Now that age results are available for shortraker, redstripe, harlequin, and silvergray rockfish, these species could potentially be moved into tier 4 also. However, for the present assessment it was decided to keep these species in tier 5 until better verification of the new ages is available, along with additional age results. The tier 5 definitions state that $F_{\mathrm{ABC}} \leq 0.75M$. Applying this definition to the exploitable biomass of shortraker rockfish results in a recommended ABC of 898 mt in 2008. For "other slope rockfish", applying an $F_{\mathrm{ABC}} \leq F_{40\%}$ rate to the exploitable biomass of sharpchin rockfish (tier 4) and an $F_{\mathrm{ABC}} \leq 0.75M$ rate to that of the other species (tier 5) results in ABC's of 836 mt and 3,461 mt, respectively, or a combined recommended ABC of 4,297 mt for the "other slope rockfish" management group in 2008.

In the ABC computations for silvergray rockfish, an updated estimate of natural mortality M was used for the first time. Previously, an M of 0.04 was used for silvergray rockfish based on the midpoint of the range of instantaneous mortality Z (0.01-0.07) for British Columbia stocks. For the present assessment, two new estimates are available that are direct measures of M for silvergray rockfish: a range of M values for the Gulf of Alaska of 0.041-0.057, and an M of 0.06 in British Columbia. Thus, both new values indicate that M is likely higher than 0.04. Consequently, an M of 0.05, which is the approximate midpoint

of the 0.041-0.057 range, was used as a new value of *M* for the ABC computations of silvergray rockfish in this assessment.

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 (2003, 2005, and 2007). 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, 13.37%; Central area, 35.07%; and Eastern area, 51.56%. Applying these percentages to the recommended ABC of 898 mt yields the following apportionments for the Gulf in 2008: Western area, 120 mt; Central area, 315 mt; and Eastern area, 463 mt. Apportionment values for "other slope rockfish" are: Western area, 8.31%; Central area, 13.24%; and Eastern area, 78.46%. Applying these percentages to the recommended ABC of 4,297 mt yields the following apportionments for the Gulf in 2008: Western area, 357 mt; Central area, 569 mt; and Eastern area, 3,371 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, 17.93%; and East Yakutat/Southeast Outside, 82.07%. This translates into an ABC of 604 mt for West Yakutat and 2,767 mt for East Yakutat/Southeast Outside in 2008.

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 (39,905 mt) yields an overfishing catch limit of 1,197 mt for 2008. 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 5,624 mt for the "other slope rockfish" group in 2008.

12.0.2 Summary of ABCs and Overfishing Levels for 2008

Shortraker rockfish ABC: Gulfwide, 898; Western Area, 120; Central Area; 315; Eastern Area, 463.

Shortraker rockfish overfishing level: Gulfwide, 1,197.

"Other slope rockfish" ABC: Gulfwide, 4,297; Western Area, 357; Central Area, 569; West Yakutat, 604; East Yakutat/Southeast Outside, 2,767.

"Other slope rockfish" overfishing level: Gulfwide, 5,624

12.0.3 Summaries for Plan Team

All values are in metric tons.

Stock Assemblage	Year	Biomass	OFL	ABC	TAC	Catch[1]
Shortraker Rockfish	2006	37,461	1,124	843	843	664
	2007		1,124	843	843	622
	2008	39,905	1,197	898		
	2009		1,197	898		

Stock Assemblage	Area	2007 OFL	2007 ABC	2007 TAC	2007 Catch[1]	2008 OFL	2008 ABC	2009 OFL	2009 ABC
Shortraker Rockfish	W		153	153	191		120		120
	C		353	353	194		315		315
	E		337	337	237		463		463
	Total	1,124	843	843	622	1,197	898	1,197	898

[1]Current as of September 22, 2007 (http://www.fakr.noaa.gov/2006/car110_goa.pdf).

Stock Assemblage	Year	Biomass	OFL	ABC	TAC	Catch[1]
Other Slope Rockfish	2006	93,552	5,394	4,152	1,480	931
	2007		5,394	4,154	1,482	646
	2008	90,283	5,624	4,297		
	2009		5,624	4,297		

Stock Assemblage	Area	2007 OFL	2007 ABC	2007 TAC	2007 Catch[1]	2008 OFL	2008 ABC	2009 OFL	2009 ABC
Other Slope Rockfish	W		577	577	247		357		357
	C		386	386	310		569		569
	WYAK		319	319	46		604		604
	EYAK/SEO		2,872	200	43		2,767		2,767
	Total	5,394	4,154	1,482	646	5,624	4,297	5,624	4,297

[1]Current as of September 22, 2007 (http://www.fakr.noaa.gov/2006/car110_goa.pdf).
Note: all values for "other slope rockfish" include northern rockfish in the eastern Gulf of Alaska.

12.0.4 Responses to SSC Comments

There were no SSC comments specific to this assessment in their Dec. 2006 minutes, nor were there SSC comments in general that needed to be addressed in this assessment.

12.1 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 12-1.

Shortraker rockfish ranges from southeastern Kamchatka, north into 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. (Whether this is true viviparity is still subject to some debate.) There have been no fecundity studies on shortraker rockfish. One study on reproductive biology of the fish indicated they had a protracted reproductive period, and that parturition (larval release) may take place from early spring through summer (McDermott 1994). Genetic techniques have been used recently to identify a few post-larval shortraker rockfish from samples collected in epipelagic waters far offshore in the Gulf of Alaska, which is the only documentation of habitat preference for this life stage. There is no information on when juvenile fish become demersal; in fact, only a few specimens of juvenile shortraker rockfish <35 cm fork length have ever been caught in the Gulf of Alaska, so information on this life stage is virtually unknown. Orlov (2001) has 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). Within this habitat, shortraker rockfish tend to have a relatively even distribution when compared with the highly aggregated and patchy distribution of 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. 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. Recently, however, a study was completed on the biological characteristics of silvergray rockfish 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 limited 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. Amendment 58 to the Gulf of Alaska Groundfish Plan, which took effect in 1998, prohibited trawling in the Eastern area east of 140 degrees W. longitude. Since most species of "other slope rockfish" are caught exclusively with trawl gear, this amendment 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.

12.2 FISHERY

12.2.1 Catch History

Official fishery catch statistics for shortraker rockfish are only available for 2005-2007, when the species was first reported separately for management purposes (Table 12-2). 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 12-2. Catch data for "other slope rockfish" are available for the complete period 1991-2007 (Table 12-3). 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 12-4. The estimates are based on a combination of observer program and NMFS Alaska regional office data, 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 12-2, the total Gulfwide catch of shortraker/rougheye for a given year was generally very similar to the corresponding TAC. The 2005-2007 shortraker rockfish official catches have been much lower than any of the unofficial estimates in previous years. These low catches in the last three years correspond to the years when shortraker rockfish has been in its own management category. This suggests that the separation of shortraker rockfish from the shortraker/rougheye group may have caused a reduction in catch of shortraker rockfish.

With the exception of 1993, Gulfwide catches of "other slope rockfish" have always been <1,700 mt (Table 12-3). 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/rougheye, shortraker rockfish, and "other slope rockfish" are shown in Table 12-5.

12.2.2 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 and rougheye rockfish can both be caught with either bottom trawls or longlines. The percent caught in each gear type is listed in the following tables for the years 1993-2007[1]:

[1] National Marine Fisheries Service, Alaska Region, Sustainable Fisheries Division, P.O. Box 21668, Juneau, AK 99802. Catches updated through 29 September 2007.

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
Trawl	48.9	51.8	50.6
Longline	51.1	48.2	49.4

Thus, in all years except 2001, 2004, and 2005, the majority of the catch has been taken by trawlers. 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 species of *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 1993-2007 (updated through 29 September 2007):

Gear	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
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	84.7	78.6	77.6
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	15.3	21.4	22.4

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. 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. Effects of this program to catches of shortraker rockfish and "other slope rockfish" in the Central area are uncertain, but likely will include: 1) improved at-sea and plant observer coverage for vessels participating in the rockfish fishery; and 2) extending the season when most of these fish 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, which should spread out the catches over this period.

12.2.3 Species Composition of the "Other Slope Rockfish Catch"

Species composition data for the commercial catch of "other slope rockfish" in the 1992-2006 commercial fishery can be estimated from information collected by the domestic observer program (Table 12-6). 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 12-3 for each area/year combination and then summed over areas to yield the Gulfwide estimated values for each year in Table 12-6. 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.

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 three most recent years calculated, 2004-2006.

12.2.4 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 targeted on shortraker/rougheye, the major bycatch was arrowtooth flounder, sablefish, and shortspine thornyhead, in descending order by percent.

12.2.5 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 1991-2007 (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 September 22, 2007.

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	20.9	38.9

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 probably have less incentive to retain these fish. However, it should be noted that in two of the last three years, discard rates for "other slope rockfish" have been much lower than previously, which suggests that fishermen are starting to find ways to market these fish.

12.3 DATA

12.3.1 Fishery Data

12.3.1.1 Catch

Detailed catch information for shortraker/rougheye, shortraker rockfish, and "other slope rockfish" is listed in Tables 12-2 through 12-6.

12.3.1.2 Size and Age Composition

The number 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.

12.3.2 Survey Data

12.3.2.1 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 results for both surveys concerning rockfish, however, should be viewed with some caution, as the analyses do not take into account possible effects of competition for hooks with other species caught on the longline. Scientists at the NMFS ASFC Auke Bay Laboratories are in the process of examining the longline survey catches to determine associations between species, including shortraker rockfish. This analysis will likely be available by 2009, when the next full assessment for shortraker rockfish is required, and it should provide information as to how the longline survey results can be used in the assessment of this species.

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 12-7). 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. It should be noted, however, that the four highest annual Gulfwide RPNs and RPWs for shortraker rockfish were in the years 1998-2001. The abundance values decreased substantially from 2001 to 2005, followed by large increases in both 2006 and 2007.

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.

12.3.2.2 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, and 2007. 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. Also, the 1984 and 1987 survey results should be treated with some caution. A different 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 often shown somewhat large fluctuations between surveys but the confidence intervals have all overlapped and differences in the estimates do not appear significant, with two exceptions: the 2003 and 2005 estimates (42,023 and 42,568 mt, respectively) appear to be significantly greater than the 1990 estimate (12,681 mt) (Tables 12-8 and 12-9; Figure 12.1). Compared with other species of *Sebastes*, the estimates for shortraker rockfish show relatively tight confidence intervals and low coefficients of variations (cv's; compare Table 12-9 vs. Table 12-10). The low cv's are an indication of the rather even distribution of shortraker rockfish that was noted in the introduction (Section 12.1).

Despite this precision, however, the trawl surveys are believed to do a relatively poor job of 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. Most of this area is not trawlable by the survey's gear because of its steep and rocky bottom, except for gully entrances where the bottom is not so steep. 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 12-7 vs Table 12-9). 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 12-8). Geographically, most of the biomass for these species is found in the eastern Gulf of Alaska, especially the Southeastern statistical area (Table 12-10). 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 cv's for the estimates are generally much higher than those for shortraker rockfish. For example, cv's 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 12-8). Again, its biomass increased nearly ten-fold from 2003 to 2005, followed by a large decline in 2007 to nearly the 2003 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 very 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.

12.3.2.3 Trawl Survey Size Compositions

Size compositions for shortraker rockfish from the trawl surveys have all been unimodal, with almost no fish <35 cm in length (Figure 12-2). Mean length of shortraker rockfish progressively declined from 61.0 cm in 1990 to 53.9 cm in 2003 and then increased to 58.1 cm in 2005 and 60.4 cm in 2007. The small mean length in 2003 can be attributed mostly to an increase in the numbers of fish in the 35-50 cm range. 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). Previous Gulfwide trawl surveys (e.g., Martin and Clausen 1995; Martin 1997) 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.

12.3.2.4 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. He partially validated his methodology by comparing his results with those of a previous radiometric study of shortraker rockfish ages (Kastelle et al. 2000). This new aging methodology was used to determine the age composition of shortraker rockfish in the 2005 Gulf of Alaska trawl survey (Figure 12-3). The data in this figure represent the first-ever production aging of shortraker rockfish for stock assessment. Ages ranged from 5 to 116 years, and the results indicate that the shortraker rockfish population in the Gulf of Alaska is very old (mean age of ~44). Further verification of the aging methodology is tentatively planned that would be based on carbon-14 aging of individual otoliths[3]. If successful, carbon-14 aging would provide a more certain verification of the aging technique.

Future production aging is expected for shortraker rockfish otoliths that have been collected in surveys before 2005. With the inclusion of additional age samples, combined with further verification of the aging methodology, it may be possible to apply an age-structured model to Gulf of Alaska shortraker rockfish in upcoming assessments.

Age compositions have also become available for sharpchin, redstripe, harlequin, and silvergray rockfish in the Gulf of Alaska (Figures 12-4 and 12-5). These are the first "other slope rockfish" samples in Alaska that have been aged. 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 all for the 1996 trawl survey. Sharpchin ages ranged from 2 to 44, redstripe from 4 to 36,

[3] C. Hutchinson, National Marine Fisheries Service, Alaska Fisheries Science Center, REFM Division, 7600 Sand Point Way NE, Seattle WA 98115. Pers. commun. Mar. 2007.
[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.

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.

12.4 ASSESSMENT PARAMETERS

12.4.1 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 12-11. 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*). New mortality rate information added to this table since the last full assessment report (Clausen 2005) includes the first Gulf of Alaska estimates for sharpchin, harlequin, and silvergray rockfish, and a new estimate for silvergray rockfish in British Columbia. However, the mortality rate for harlequin rockfish (0.127-0.157) is likely 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 12-11. New maximum age information includes 116 years for Gulf of Alaska shortraker, 47 for Gulf of Alaska harlequin, 36 for Gulf of Alaska redstripe, and 82 for British Columbia silvergray. One researcher has reported an extremely old maximum age for shortraker rockfish in the Gulf of Alaska of 157 years (Munk 2001). If true, this would make shortraker rockfish one of the longest-lived of all fishes. Age and size of maturity information for females is only available for shortraker, sharpchin, and silvergray rockfish. The age of maturity of 9 years for silvergray rockfish in British Columbia is a new addition to the table. 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.

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

12.4.2 Length and Weight at Age

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

12.5 ANALYTIC APPROACH

Due to the lack of biological information for shortraker rockfish and "other slope rockfish" (especially an absence of age data), past assessments for these two categories have all used a biomass-based approach based on trawl survey data to calculate ABCs. We continue to use this approach in the present assessment. As previously mentioned, the first production age results for Gulf of Alaska shortraker rockfish have just become available. As more age results for shortraker rockfish become available, we expect to begin development of an age-structured model for this species.

12.5.1 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, excluding the biomass in the 1-100 m depth stratum. However, in the comments by the NPFMC's Scientific and Statistical Committee (SSC) concerning the 2005 shortraker rockfish and "other slope rockfish" assessment, it was suggested that the SAFE author should examine the appropriateness of excluding this stratum. The original rationale for this exclusion dates to the 1988 assessment (Clausen and Heifetz 1989) when all slope rockfish were grouped together as a single management category. There was concern that Pacific ocean perch (POP) were being overexploited within this category, and it was noted that according to the trawl survey results, most POP in the 1-100 m stratum were small juvenile fish less than the age of recruitment. Therefore, to help constrain the POP catch, it was decided to exclude the 1-100 m stratum from the calculations of exploitable biomass for slope rockfish. For consistency, this exclusion has been retained in the years since 1988 for all the slope rockfish species that are still assessed with a biomass-based approach.

To evaluate whether excluding the 1-100 m stratum is still justifiable in the calculation of exploitable biomass, the percent of the Gulfwide biomass found in the 1-100 stratum was determined for shortraker rockfish and "other slope rockfish" in the six trawl surveys between 1993 and 2005 (Table 12-14). For shortraker rockfish, the mean biomass in the 1-100 m stratum was extremely low, i.e., only 0.1%. Thus, excluding this shallow stratum in the exploitable biomass computations for shortraker rockfish appears to be an inconsequential and unnecessary step, and it is recommended that this procedure be dropped starting with the present assessment. For "other slope rockfish", the percent biomass in 1-100 m was also very low (3%). Only one survey, 2005, had much biomass in this stratum, and this was mostly due to just a single haul with a relatively large catch of redstripe and harlequin rockfish. If this survey is removed from the computation of mean percent biomass in the 1-100 m stratum, the stratum only comprises 1% of the "other slope rockfish" biomass. Hence, there does not appear to be a convincing argument for excluding the shallow stratum as part of the exploitable biomass; rather, to simplify the assessment of "other slope rockfish", it seems reasonable to include the 1-100 m stratum in the calculations of exploitable biomass.

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 2003, 2005, and 2007 (Table 12-15). These averages yield the following values of current exploitable biomass: 39,905 mt for shortraker rockfish and 90,283 mt for "other slope rockfish". It should be noted that the exploitable biomass for "other slope rockfish" is based on the values in Table 12-15, instead of those in Table 12-8, because Table 12-15 includes northern rockfish in the Eastern area, where northern rockfish are a member of this management category.

12.6 ABC RECOMMENDATIONS AND OVERFISHING LEVELS

12.6.1 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 data are available for shortraker rockfish, theoretically they could be moved into tier 4, where $F_{ABC} \leq F_{40\%}$. However, because age data is only available for one survey and also because the new aging method is still somewhat uncertain and could benefit from additional verification, 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 39,905 mt for shortraker rockfish results in an ABC of 898 mt for 2008. This is a small increase compared to the 2006 and 2007 ABCs of 843 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 2003, 2005, and 2007 trawl surveys, the percent distribution of exploitable biomass for shortraker rockfish biomass in the Gulf of Alaska is: Western area, 13.37%; Central area, 35.07%, and Eastern area, 51.56% (Table 12-16). Applying these percentages to the recommended ABC of 898 mt yields the following apportionments for the Gulf in 2008: Western area, 120 mt; Central area, 315 mt; and Eastern area, 463 mt.

12.6.2 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 several years. Age data have now become available for redstripe, harlequin, and silvergray rockfish so that, similar to the case for shortraker rockfish, these three species could be moved up to tier 4. However, there has been no validation for the aging of these species, and until such validation takes place, it seems prudent to keep them in tier 5. For tier 5, F_{ABC} is defined to be $\leq 0.75M$. Values of M in the computations are based on the mortality rates listed in Table 12-11. An estimate of M for redstripe rockfish of 0.10 can be obtained directly from the table. Previously, an M of 0.04 was used for silvergray rockfish based on the midpoint of the range of Z (0.01-0.07) for British Columbia stocks. However, for the present assessment, two new estimates are available that are direct measures of M for silvergray rockfish: a range of M values for the Gulf of Alaska of 0.041-0.057, and an M of 0.06 in British Columbia. Thus, the new values indicate that the old M of 0.04 was likely too low. I suggest that an M of 0.05, which is the approximate midpoint of the 0.041-0.057 range, be used as a new value of M for the ABC computations of silvergray rockfish in this assessment. Previously, an M of 0.06 was used for harlequin and redbanded rockfish and minor species, based on the average M for northern, sharpchin, redstripe, and silvergray rockfish. As discussed in section 12.4.1, natural mortality estimates have become available for the first time for harlequin rockfish, but the estimates 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	15,774	0.05	0.053	$F_{ABC} \leq F_{40\%}$	$F_{ABC} = F_{40\%}$	836
Redstripe	5	13,739	0.10	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	1,030
Harlequin	5	13,576	0.06	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	611
Silvergray	5	40,517	0.05	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	1,519
Redbanded	5	5,435	0.06	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	245
minor species	5	1,242	0.06	-	$F_{ABC} \leq 0.75 \times M$	$F_{ABC} = 0.75 \times M$	56
All species		90,283					4,297

Therefore, the recommended combined ABC for "other slope rockfish" in 2008 is 4,297 mt. This is a very slight increase compared to the 2007 ABCs of 4,154 mt. Geographic apportionment of the 2008 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, 8.31%; Central area, 13.24%, and Eastern area, 78.46% (Table 12-16). Applying these percentages to the recommended ABC of 4,297 mt yields the following apportionments for the Gulf in 2008: Western area, 357 mt; Central area, 569 mt; and Eastern area, 3,371 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., 2003, 2005, and 2007. The weighted average of the "other slope rockfish" biomass in these three surveys for West Yakutat is 17.93%, and that for East Yakutat/Southeast Outside is 82.07%. This translates into an ABC of 604 mt for West Yakutat

and 2,767 mt for East Yakutat/Southeast Outside in 2008. The West Yakutat ABC includes a very small amount of northern rockfish (<2 mt) that was allocated to this area because all the northern rockfish biomass in the Eastern area occurs only in West Yakutat.

12.6.3 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 (39,905 mt) yields an overfishing catch limit of 1,197 mt for 2008.

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 5,624 mt for the "other slope rockfish" group in 2008.

12.6.4 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 12-17.

12.7 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 2008 can be computed (Table 12-18).

12.8 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 12-19.

12.8.1 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 larval 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 prey on squids, shrimp, and

deepwater fish such as myctophids (Yang and Nelson 2000; Yang 2003) . 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.

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.

12.8.2 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 12-20). 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: Fishery discard rates during 2005-2007 have been 15 - 23 % for shortraker rockfish and 33 - 62% 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 fishery can move around rocks and boulders on the bottom.

12.8.3 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. Age validation studies are needed for sharpchin, redstripe, harlequin, and silvergray rockfish, and additional age validation would be beneficial for shortraker rockfish.

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Table 12-1.--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 12-2.--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), 1991-2007. Updated through September 22, 2007.

	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	191	194	237	622	843	843

Sources: Catch: National Marine Fisheries Service, Alaska Region, P.O. Box 21668, Juneau, AK 99802; ABC and TAC: 1991-2005, Clausen (2005); 2006 and 2007, North Pacific Fishery Management Council News and Notes, Vol. 5-05 (Dec. 2005) and Vol. 5-06 (Dec. 2006). North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252.

Table 12-3.--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), 1991-2007. Updated through September 22, 2007.

	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	247	310	89	646	4,154	1,482

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: 1991-2005, Clausen (2005); 2006 and 2007, North Pacific Fishery Management Council News and Notes, Vol. 5-05 (Dec. 2005) and Vol. 5-06 (Dec. 2006). North Pacific Fishery Management Council, 605 W. 4th. Avenue, Suite 306, Anchorage, AK 99501-2252.

Table 12-4.--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 12-5.--Catch (mt) of shortraker/rougheye rockfish, shortraker rockfish, and "other slope rockfish" taken during research cruises in the Gulf of Alaska, 1977-2007. Catch of shortraker rockfish not available for years before 2003. (Does not include catches in longline surveys before 1996; tr=trace).

Year	Shortraker/ rougheye	Shortraker rockfish	Other slope rockfish
1977	0.7	-	0.8
1978	2.8	-	9.5
1979	1.9	-	0.4
1980	1.9	-	0.4
1981	12.5	-	16.3
1982	5.4	-	2.9
1983	3.2	-	0.1
1984	23.7	-	3.4
1985	10.5	-	1.7
1986	2.6	-	0.0
1987	28.1	-	19.8
1988	0.0	-	0.7
1989	0.6	-	0.1
1990	7.6	-	11.8
1991	Tr	-	tr
1992	0.1	-	0.0
1993	12.8	-	11.3
1994	0.1	-	0.0
1995	Tr	-	0.0
1996	23.1	-	16.9
1997	26.6	-	0.0
1998	82.1	-	2.4
1999	145.4	-	51.6
2000	19.8	-	0.0
2001	16.9	-	0.7
2002	11.9	-	tr
2003	-	9.8	8.7
2004	-	4.7	tr
2005	-	8.6	11.0
2006	-	5.7	tr
2007	-	12.6	8.1

Table 12-6.--Estimated commercial catch (mt) for species in the "other slope rockfish" management category in the Gulf of Alaska, 1992-2006. 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
Sharpchin rockfish	434	1,345	330	342	278	316	319	169	274	162	276	226	119	69	89
Redstripe rockfish	261	1,222	207	198	134	291	51	107	51	44	13	42	38	20	56
Harlequin rockfish	745	1,864	789	667	403	492	443	438	186	281	365	732	674	601	716
Silvergray rockfish	130	487	219	123	8	34	8	19	19	18	52	20	17	4	8
Yellowmouth rockfish	102	498	40	15	6	63	1	2	13	8	15	10	5	0	0
Redbanded rockfish	-	-	23	22	30	15	20	21	25	36	35	38	31	21	34
Minor "other slope rockfish" species	2	16	4	31	23	6	21	32	10	11	17	9	trace	1	28
Total, all species	1,674	5,433	1,613	1,397	881	1,217	861	788	577	559	774	1,078	885	715	931

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

Table 12-7.--Relative population number (RPN) and relative population weight (RPW) for shortraker rockfish in the Gulf of Alaska domestic longline survey, 1988-2007. 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	1999	2000	2001	2002	2003	2004	2005	2006	2007
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	5,011	9,481	5,150	3,386	3,576	6,477	2,041	3,901	3,566
Chirikof	1,290	858	773	776	572	229	613	531	646	918	973	823	1,298	1,031	951	809	474	274	931	714
Kodiak	2,332	2,691	3,476	2,412	1,374	1,067	1,040	1,325	2,231	2,200	2,498	3,078	2,904	3,703	1,982	1,510	1,409	1,807	3,080	4,200
Yakutat	5,830	6,492	9,281	10,575	9,130	7,121	5,222	7,992	8,409	12,408	15,295	13,394	13,995	14,177	9,942	7,312	7,519	6,963	7,970	13,169
Southeastern	1,420	1,972	1,403	2,247	1,479	2,199	1,862	2,427	1,967	2,459	3,258	3,167	4,025	2,646	3,098	3,951	2,874	1,905	2,106	2,876
Total	15,364	15,285	17,948	19,085	14,214	12,139	11,286	18,039	17,352	20,873	26,654	25,473	31,703	26,706	19,358	17,158	18,754	12,990	17,989	24,524
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	6,954	15,050	7,314	4,978	5,874	9,678	3,458	5,830	4,944
Chirikof	2,591	1,449	1,216	1,384	914	293	1,174	812	1,007	1,471	1,422	1,165	1,607	1,682	1,324	1,420	624	378	969	1,067
Kodiak	5,043	5,833	6,787	4,874	2,802	1,912	2,649	2,554	4,657	4,273	5,201	5,562	5,553	7,413	3,305	2,908	2,496	3,144	6,086	8,003
Yakutat	13,320	13,335	19,093	20,585	17,033	14,411	11,046	15,248	17,352	26,830	30,685	26,500	28,754	28,382	18,314	14,583	14,292	12,751	14,056	22,684
Southeastern	2,474	3,384	2,214	3,546	2,053	4,124	3,102	4,034	3,377	3,970	5,818	4,569	7,099	4,574	5,598	7,455	5,045	2,946	3,203	4,914
Total	28,297	28,302	34,313	36,343	24,880	22,932	21,927	30,588	32,338	41,013	49,842	44,750	58,063	49,365	33,518	32,240	32,134	22,677	30,144	41,612

Source: C. Lunsford, National Marine Fisheries Service, Alaska Fisheries Science Center, Auke Bay Laboratories, 17109 Pt. Lena Loop Rd., Juneau AK 99801. Pers. commun. September 25, 2007.

Table 12-8.--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 2007.

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

[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 12-9.--Detailed biomass estimates (mt) for shortraker rockfish in the Gulf of Alaska, by statistical area, based on bottom trawl surveys conducted between 1984 and 2007. 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

*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 cv's listed in this table.

Table 12-10.--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 2007. 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
					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
					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

(Table continued on next page).

Table 12-10.--(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
					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

*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 cv's listed in this table.

Table 12-11.-- 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
	-	-	116	-	-	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 12-12.-- 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 12-13.--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 12-14.--Percent of biomass in the 1-100 m stratum for shortraker rockfish and “other slope rockfish” in Gulf of Alaska trawl surveys, 1993-2005.

Year	Shortraker	"Other slope rockfish"
1993	0.39%	1.84%
1996	0.00%	1.00%
1999	0.00%	0.20%
2001	0.00%	0.14%
2003	0.00%	1.62%
2005	0.32%	13.40%
mean	0.12%	3.03%

Table 12-15.--Biomass estimates (mt) for shortraker rockfish and "other slope rockfish" in the Gulf of Alaska, by NPFMC regulatory areas, in the 2003, 2005, and 2007 trawl surveys.

	Area			
Species	Western	Central	Eastern	Total
	2003			
Shortraker rockfish	11,166	17,288	13,569	42,023
Sharpchin rockfish	38	290	6,766	7,094
Redstripe rockfish	5	175	7,845	8,025
Harlequin rockfish	25	1,498	2,021	3,545
Silvergray rockfish	0	65	51,851	51,916
Redbanded rockfish	19	889	2,532	3,441
Minor species[a]	0	114	1,055	1,169
Total, "other slope rockfish"	87	3,031	72,071	75,189
	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

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

Table 12-16.-- Percentage of biomass by area for shortraker rockfish and "other slope rockfish" based on the biomass estimates shown in Table 12-15 for Gulf of Alaska trawl surveys in 2003, 2005, and 2007. Weighted averages use weights of 4:6:9 for the 2003, 2005, and 2007 surveys, respectively.

	Area		
Management group	Western	Central	Eastern
	2003		
Shortraker rockfish	26.57%	41.14%	32.29%
Other slope rockfish[a]	0.12%	4.03%	95.85%
	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%
	4:6:9 weighted average		
Shortraker rockfish	13.37%	35.07%	51.56%
Other slope rockfish[a]	8.31%	13.24%	78.46%

[a] Includes northern rockfish in the Eastern area.

Table 12-17.--Summary of computations of ABCs and overfishing levels for shortraker rockfish and "other slope rockfish" for 2008. 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	39,905	F=0.75M=0.023	898	F=M=0.030	1,197
Sharpchin rockfish	4	15,774	$F_{40\%}$=0.053	836	$F_{35\%}$=0.064	1,010
Redstripe rockfish	5	13,739	F=0.75M=0.075	1,030	F=M=0.100	1,374
Harlequin rockfish	5	13,576	F=0.75M=0.045	611	F=M=0.060	815
Silvergray rockfish	5	40,517	F=0.75M=0.038	1,519	F=M=0.050	2,026
Redbanded rockfish	5	5,435	F=0.75M=0.045	245	F=M=0.060	326
Minor species	5	1,242	F=0.75M=0.045	56	F=M=0.060	75
Total, other slope rockfish		90,283		4,297		5,624

Table 12-18.--Set of yield projections for shortraker rockfish and "other slope rockfish" for 2008 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	39,905	0.023	898	0.023	898	0.0113	449	-	-
Sharpchin	15,774	0.053	836	0.053	836	0.0265	418	-	-
Redstripe	13,739	0.075	1,030	0.075	1,030	0.0375	515	-	-
Harlequin	13,576	0.045	611	0.045	611	0.0225	305	-	-
Silvergray	40,517	0.038	1,519	0.038	1,519	0.0190	770	-	-
Redbanded	5,435	0.045	245	0.045	245	0.0225	122	-	-
Minor spp	1,242	0.045	56	0.045	56	0.0225	28	-	-
Total, other slope rockfish	90,283		4,297		4,297		2,159	0.009	808

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 2003-2007 (i.e., the most recent five years with catch data). (Scenario 4 calculations were not done for shortraker rockfish because official catch information for this management category is only available for 2005-2007).

Table 12-19.-- 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 ecosys-tem 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		
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 12-20. 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

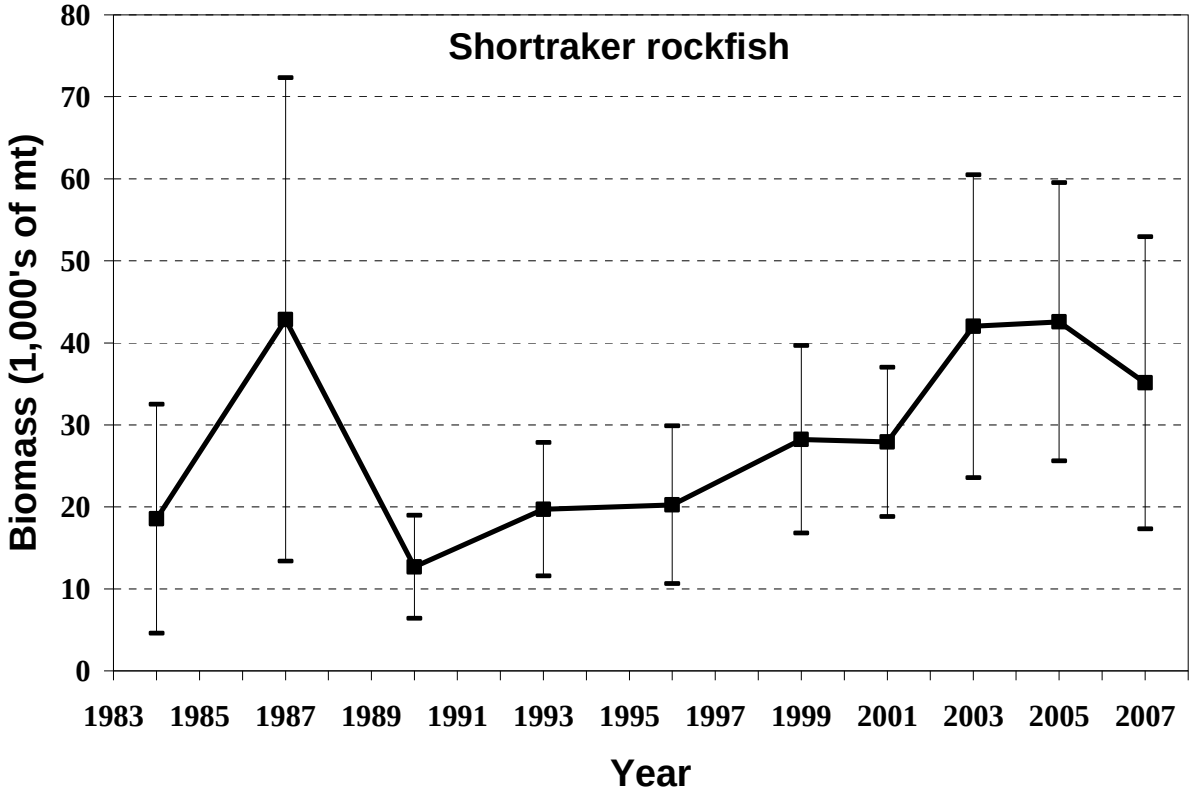

Figure 12-1.--Estimated biomass of shortraker rockfish in the Gulf of Alaska based on results of bottom trawl surveys from 1984 through 2007. The vertical bars show the 95% confidence limits associated with each estimate. The eastern Gulf of Alaska was not sampled in the 2001 survey, but substitute estimates of biomass and variance for this region in 2001 were calculated and included in the above graph.

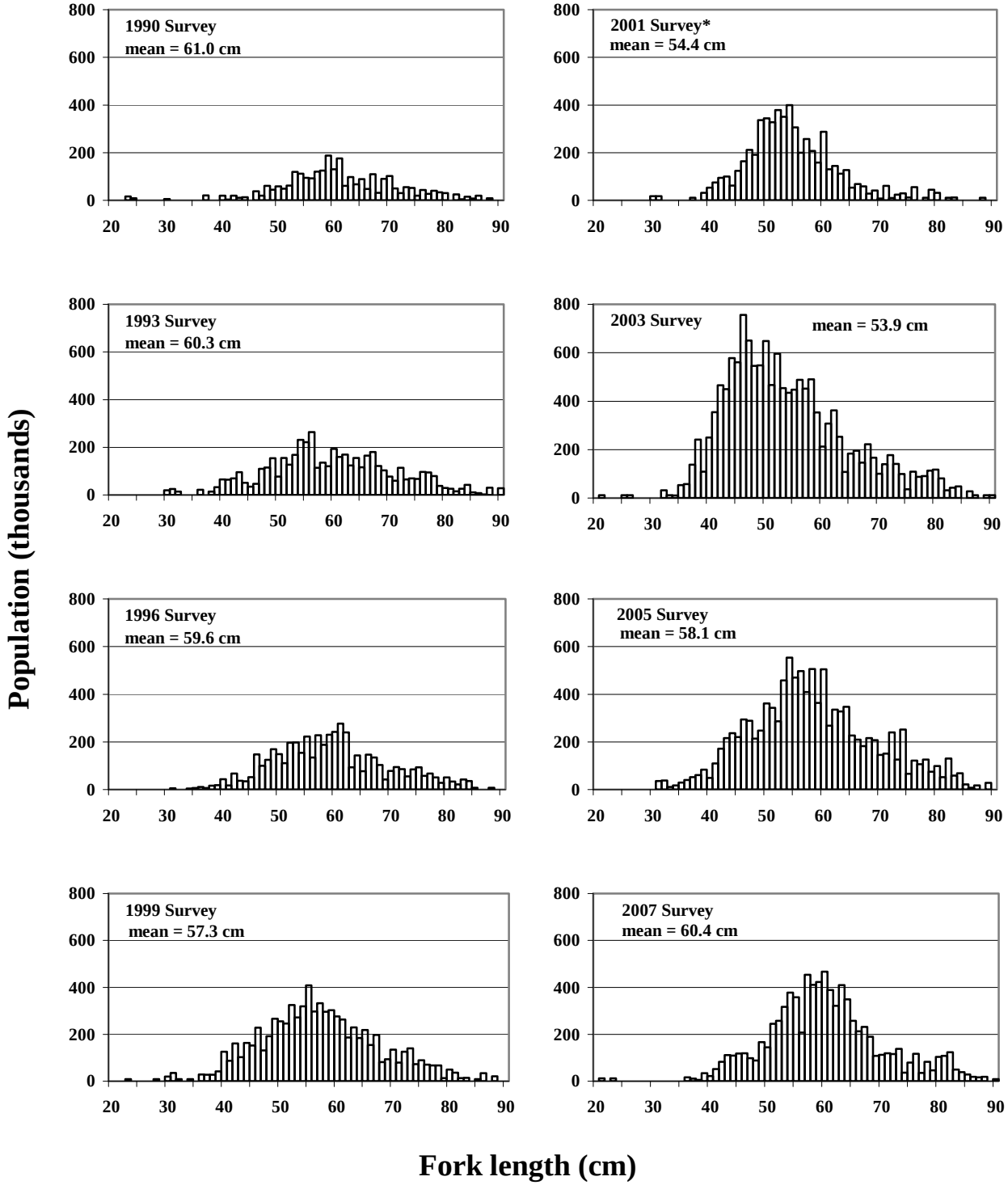

Figure 12-2.--Length frequency distribution of the estimated population of shortraker rockfish in the Gulf of Alaska, based on trawl surveys from 1990 through 2007. *2001 survey did not sample the eastern Gulf of Alaska.

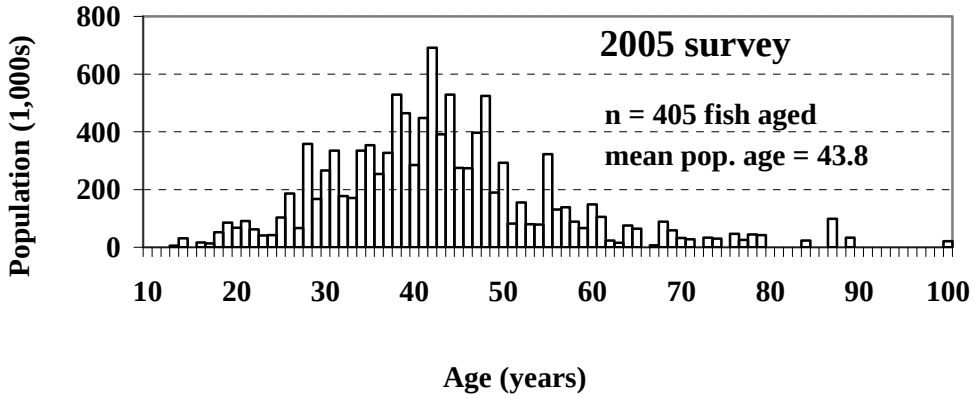

Figure 12-3.--Age composition of the estimated population of shortraker rockfish in the 2005 Gulf of Alaska trawl survey.

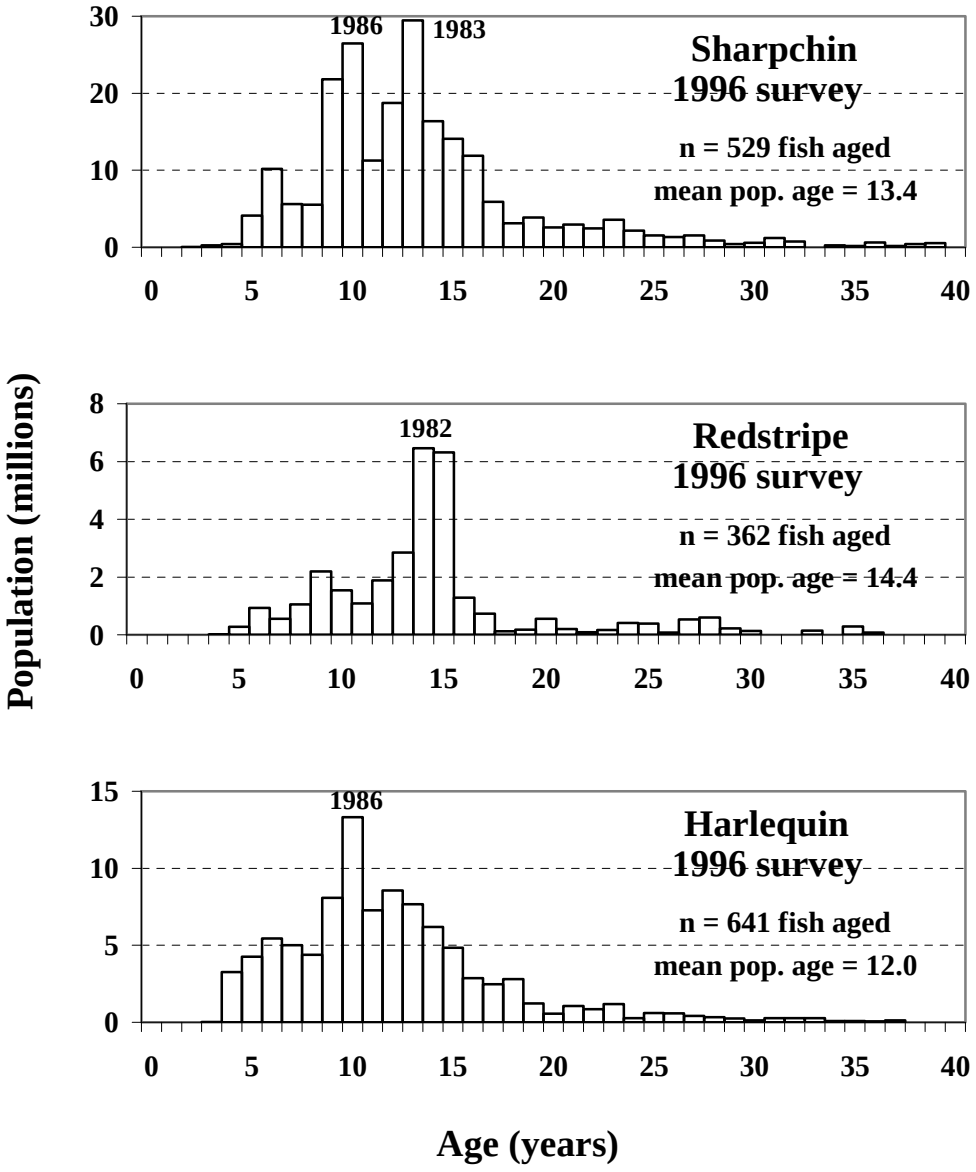

Figure 12-4.--Age compositions of the estimated population of sharpchin, redstripe, and harlequin rockfish in the 1996 Gulf of Alaska trawl survey. The numbers next to prominent bars identify apparently strong year classes.

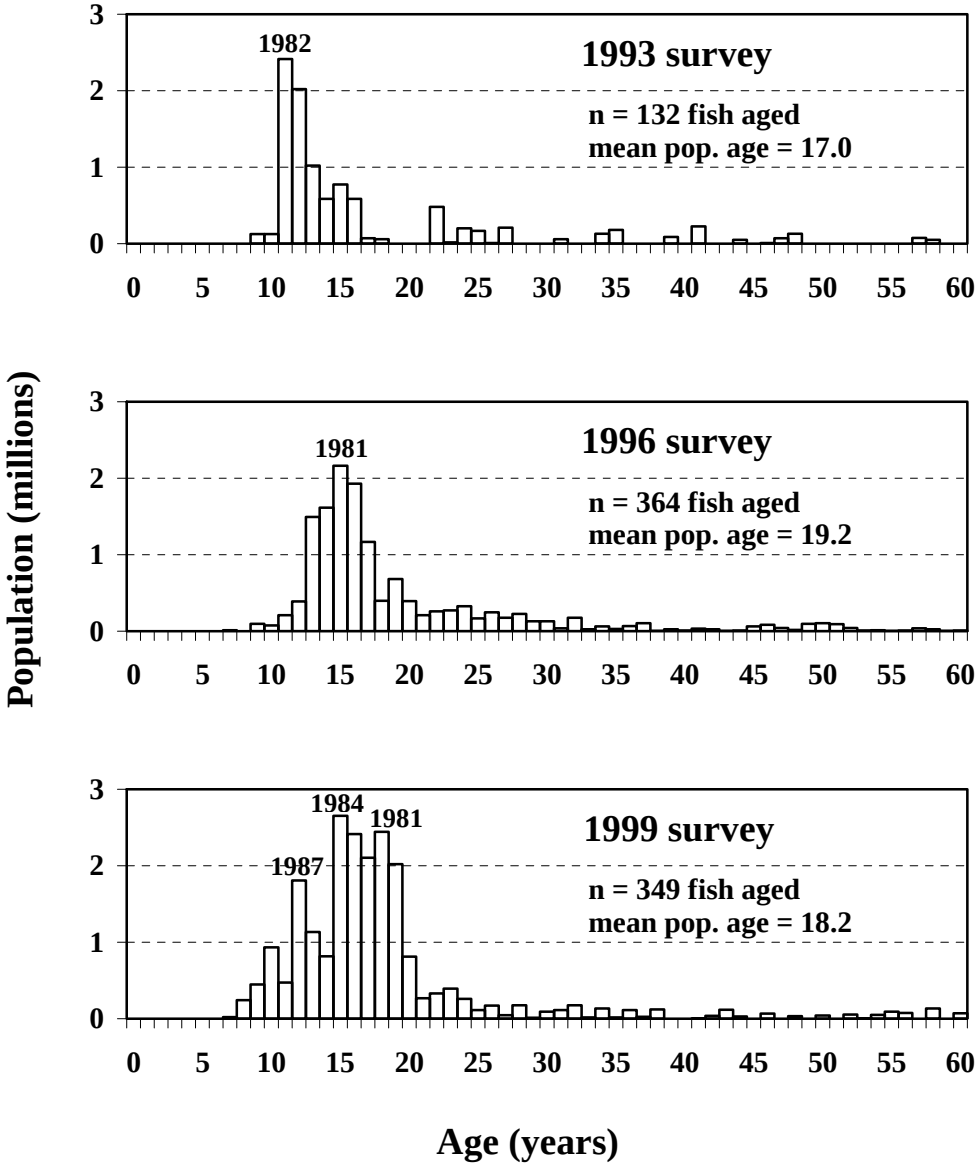

Figure 12-5.--Age compositions of the estimated population of silvergray rockfish in the 1993, 1996, and 1999 Gulf of Alaska trawl surveys. The numbers next to prominent bars identify apparently strong year classes.