1995 STOCK ASSESSMENT AND FISHERY EVALUATION REPORT

FOR DEMERSAL SHELF ROCKFISH

IN THE EASTERN GULF OF ALASKA

By

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ABSTRACT

This document details the annual stock assessment and fishery evaluation report (SAFE) submitted to the Gulf of Alaska Plan Team of the North Pacific Fishery Management Council for 1995. Several changes from the 1994 SAFE were made. New survey data from 1994 was included in the analysis. The CSEO, NSEO, and SSEO sections were surveyed for density. The 1994 survey covered more area than past surveys and employed improved navigational techniques. The new data results in a significantly lower estimate of demersal shelf rockfish biomass than previous assessments. The estimated biomass of adult yelloweye rockfish in the Eastern Gulf of Alaska is 26,090 mt, which results in a total allowable catch limit of 580 mt. Additionally, the redbanded rockfish has been removed from this assemblage and placed in the "other slope" assemblage.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Rockfishes of the genus *Sebastes* are found in temperate waters of the continental shelf off North America. At least 32 species of *Sebastes* occur in the Gulf of Alaska (GOA). For management purposes seven of these species are included in the demersal shelf rockfish (DSR) assemblage (Table 1).

Prior to 1987, DSR were in the “other slope” assemblage in the GOA Fishery Management Plan (FMP). In 1987, the other slope category was split into three components based on commercial catch composition data and species behavior and distribution. In 1990, as a result of additional information from commercial fisheries, the composition of the DSR assemblage was modified to form a grouping of eight species, including redbanded rockfish *Sebastes babcocki*. In 1994, redbanded rockfish were removed from the demersal shelf rockfish assemblage and returned to the "other slope" assemblage. Redbanded rockfish are a transition species, occurring on the interface between the continental shelf and slope. Previously, they were landed as a trace bycatch in the DSR fishery. However, due to a change in fishing patterns by bottom trawlers, they are now landed as bycatch in the "other slope" trawl fishery, often in significant numbers.

Through 1991, DSR were recognized as a FMP species group only in the waters east of 137^{o} W longitude. In 1992, DSR were recognized as an FMP species in the East Yakutat section (EYAK) and management of DSR expanded westward to 140^{o} W longitude. Emphasis is placed on the target species, yelloweye rockfish (*Sebastes ruberrimus*).

CATCH HISTORY

Prior to 1992, the Alaska Department of Fish and Game (ADF&G) divided Southeast Alaska into five areas for DSR management (Figure 1). These areas represent the original geographic separation of the fleets from the various Southeast Alaska ports, although port ranges now overlap. ADF&G has established harvest guidelines for the directed fishery within each of these management areas. Two inside subdistricts are managed entirely by the state. The Southeast Outside Subdistrict (SEO) is comprised of the Central Southeast Outside (CSEO), Southern Southeast Outside (SSEO), and Northern Southeast Outside (NSEO) sections, and since 1992, has included the EYAK section. In SEO, DSR are managed jointly by the state and federal governments.

Rockfishes, including DSR, have been landed incidental to other groundfish and halibut fisheries in Southeast Alaska since the turn of the century. Some bycatch was also landed by foreign trawlers targeting on slope rockfish in the eastern Gulf of Alaska from the 1960s through the mid 1970s. In 1979, a small shore-based rockfish fishery began in Southeast Alaska. This fishery targeted primarily on the nearshore bottom-dwelling component of the rockfish complex. The directed DSR catch in SEO increased from 106

mt in 1982 to a peak of 726 mt in 1987 (Table 2). Landed bycatch and at-sea discards (unreported) in the halibut fishery continue to account for a significant portion of the total allowable catch (TAC) for this species group.

The history of domestic catches of DSR from SEO are shown in Table 2. Landings are listed by calendar year; however, prior to 1993 ADF&G managed the directed DSR fishery based on an October 1 - September 30 season.

The total directed fishery allocations have not always been reached due to other fishery management actions. In 1991, the Gulf was closed to all longlining on July 8 when the prohibited species cap of halibut was reached. Since 1992, there has been a separate PSC for the DSR fishery and the directed DSR fishery has not been constrained because of halibut PSC limits. However, in 1993 the fall season for the directed DSR fishery was canceled because of an unanticipated increase in DSR bycatch during the fall halibut fishery.

The directed fishery for DSR in EYAK increased substantially in 1991 when 187 mt of DSR was landed by the directed fishery (Table 2). The decline in directed harvest since 1992 is a consequence of in-season management. When EYAK was included in the SEO in 1991, the directed fishery was limited to 50 mt to ensure that enough TAC remained for bycatch during the halibut fishery. In 1992, the directed harvest limit for EYAK was set at 100 mt.

BIOLOGICAL PARAMETERS

Biological information is collected through port sampling and from resource assessment surveys. Species composition and length, sex, and stage of maturity data are recorded, and otoliths are taken for aging when possible. Species composition varies, and within-species size and age distributions change with depth (Rosenthal et al 1982). Analysis of species characteristics by depth from commercial landings is not possible because gear is commonly set in a variety of depths within a trip.

Yelloweye rockfish is the primary target species of this fishery, accounting for 90%, by weight, of all DSR landed. The following biological information is reported for yelloweye rockfish only.

Mortality Estimates

An estimate of Z=0.0174 (± 0.0053) from a 1984 "lightly-exploited" stock in SSEO is used to estimate M=.02 (Table 3). This number is similar to the estimate of Z from a small sample from CSEO in 1981 and also with Hoenig's geometric mean method for calculating Z (Hoenig 1983). There is a distinct decline in the log frequency of fish after age 95 (Figure 2). This may be due to increased natural mortality in the older ages. The M=0.02 is based on a catch curve analysis of age data grouped in 2-year intervals (to avoid zero counts) between the ages of 36 and 96.

Growth Parameters

Von Bertalanffy growth parameters for yelloweye are listed in Table 4, and length-weight parameters are listed in Table 5. A more detailed review of yelloweye age and growth is available in O'Connell and Funk (1986). Estimated length and age at 50% maturity for yelloweye collected in CSEO in 1988 are 45 cm and 21 years for females, and 50 cm and 23 years for males. Rosenthal et al (1982) estimated length at 50% sexual maturity for yelloweye from this area to be 52 cm for females and 57 cm for males.

DSR are classified as ovoviviparous although some species of *Sebastes* are viviparous (Boehlert and Yoklavich 1984, Boehlert et al. 1986). Rockfishes have internal fertilization with several months separating copulation, fertilization, and parturition. Within this species complex, parturition occurs from February through September with the majority of species extruding larvae in late winter and spring. Yelloweye rockfish extrude larvae over an extended time period, with the peak period of parturition occurring in April and May (O'Connell 1987). Although some species of *Sebastes* have been reported to spawn more than once per year in other areas (Love et al. 1990), no incidence of multiple brooding has been noted in Southeast Alaska (O'Connell 1987).

ASSESSMENT METHODOLOGY

Traditional population estimation methods (e.g., area-swept trawl surveys, mark/recapture) are not considered useful for these fishes given their distribution, life history, and physiology. However, ADF&G is continuing research to develop and improve a stock assessment approach for these fishes. As part of that research a manned submersible, *Delta*, was used to conduct line transects (Buckland et al. 1993, Burnham et al. 1980) on the Fairweather Ground in the East Yakutat section and in CSEO during 1990 and 1991[2], and

[2] The submersible *Delta* and the support ship were funded by the West Coast National Undersea Research Center, Fairbanks, Alaska.

throughout SEO in 1994. Although we collected line transect data for four of the eight DSR species (yelloweye, quillback, tiger, rosethorn), we include here only density estimates for yelloweye rockfish. Density estimates are limited to yelloweye because it is the principal species targeted and caught in the fishery, and therefore our ABC/TAC recommendations for the entire assemblage are keyed to yelloweye abundance (ABC RECOMMENDATIONS below).

For each area, yelloweye density was estimated as

$$\hat{D}_{YE} = \frac{n\hat{f}(0)}{L}, \quad (1)$$

where: n = total number yelloweye rockfish adults observed

$\hat{f}(0)$ = probability density function of distance from a transect line, evaluated at zero distance

L = total line length in meters

In 1994, we used a refined approach for measuring *L*, relying on an automated system for regularly recording the GPS-determined location of the submersible along the transect lines. The automatic system recorded the location of the submersible each minute. In contrast, we manually recorded submersible locations approximately every 10 minutes during the 1990 and 1991 sampling. The automated method has yielded a more accurate measure of *L* for the 1994 estimates.

We used a line transect estimator (Buckland et al 1993) and the best fit model selected from several detection functions using version 2.01 of the software program DISTANCE (Laake et al 1993). A principal function of the DISTANCE software is to estimate f(0). For the 1993 SAFE (based on 1990 and 1991 data), to estimate the variance in biomass we assumed a Poison distribution for the sample size, *n*. The variance of *n* provides one component of the overall variance estimate of density. We used this approach because of the relatively small number of transects conducted in 1990 and 1991. In 1994, we substantially increased the numbers of transects conducted and, therefore, used an actual empirical estimate of the variance of *n*, a better approach for variance estimation than assuming a particular distribution (see p. 88, Buckland et al. 1993).

Total species-specific biomass was estimated as the product of density estimates, mean weights and areal estimates of DSR habitat (O'Connell and Carlile 1993). For estimating variability in yelloweye biomass, we used log-based confidence limits because the distribution of density is positively skewed and we assume density is log-normally distributed (Buckland et al 1993).

Areal estimates of DSR habitat are based on the distribution of rocky habitat within the 100 fathom edge. Inclusion of areas was based on nautical charts, NOS bathymetric data, and commercial longline logbook information detailing DSR set locations. An overlay grid was placed on the nautical charts for each region

and squares within the grid were classified as either rocky or not rocky based on the above information. Although based on the best available information, the estimates of suitable habitat available for DSR in the Southeast Outside district are subject to refinement.

ABUNDANCE AND EXPLOITATION TRENDS

All DSR are considered highly k selective, exhibiting both slow growth and extreme longevity (Adams 1980; Gunderson 1980, Archibald et al. 1981). Estimates of natural mortality are very low. These fish are very susceptible to over-exploitation and are slow to recover once driven below the level of sustainable yield (Leaman and Beamish 1984, Francis 1985). An acceptable exploitation rate is assumed to be very low.

Recruitment Strengths

Information on recruitment strengths is based on sampling of commercial and research longline catches. Length frequency distributions are not particularly useful in identifying individual strong year classes because individual growth levels off at about age 30 (O'Connell and Funk 1986).

Sagittal otoliths are collected for aging. The break and burn technique is used for distinguishing annuli (Chilton and Bemish 1983). Age frequency data from the commercial catch differs somewhat by management area (Figure 3). In CSEO, the area with the longest catch history, the 1993 distribution shows a strong mode at 25 years of age, with some younger recruitment. A second mode is evident at 40 years of age. Mean age in this area is 37, several years younger than the mean age in the other areas. In SSEO, modes occur about every 10 years with the most pronounced at 36 years, 29 years, and 22 years. In EYAK, the 1993 age distribution shows two strong modes, the largest at 35 years and a second one at 25 years.

Projected Catch and Abundance

In the 1994 SAFE, the biomass estimate for the SEO subdistrict was based on a biomass estimate for EYAK combined with a biomass estimate from the remainder of the SEO subdistrict. The biomass estimate for SEO exclusive of EYAK was extrapolated from density estimates obtained in CSEO. The method used to determine the extent of rocky habitat provides only a very preliminary estimate of productive habitat in each area. Because we had no area specific density estimates for NSEO and SSEO, we assumed that the relationship between yelloweye density/km^2 found in the CSEO section holds for both the NSEO and SSEO sections. The new survey data from 1994 indicates that this assumption is faulty. Density estimates varied considerably between management sections (Table 6). We were unable to adequately sample EYAK in

1994, so no new biomass estimate is available for that area. The new estimate of exploitable biomass for yelloweye rockfish is 26,093 mt.

Based on the 1994 survey, the estimated biomass of yelloweye rockfish is well below that proposed in last year's SAFE (Table 7). The density estimates for CSEO, the only area that we have density estimates for all years surveyed, are 40% lower than previously estimated. Part of this decrease is due to the change in survey techniques. The earlier measurements for line lengths tended to underestimate line length, on average 20%, resulting in a significant overestimate in the 1994 density estimate. In past years we were time-limited and, therefore, surveyed primarily off Kruzof Island which may have higher density estimates than the rest of the area. We surveyed throughout the entire CSEO section this year which resulted in a decline in estimated density for the entire area. A decline in mean weight of CSEO yelloweye from 1993 to 1994 has also contributed to the decline in estimated biomass. The NSEO section data ($604/km^2$) indicates a substantially lower density of yelloweye than in the CSEO or EYAK sections, and the density estimates for the SSEO section fall between NSEO and CSEO.

For the past several years we have estimated unreported mortality of DSR during the halibut fishery based on IPHC interview data. For example, the 1993 interview data indicates a total of DSR mortality of 13% of the June halibut landings (by weight), and 18% of the September halibut landings. The reported landings vary seasonally and annually based on market price, halibut CPUE, and whether or not sablefish is an allowable bycatch. Because of these variables, it is difficult to apply a standard unreported mortality rate to this fishery. The reported DSR landings during the 1994 halibut fishery in the eastern Gulf totaled 214 mt.

Beginning in 1995, the halibut fishery will be managed under Individual Fishing Quotas with an open season from March to November. We have no way to estimate the unreported mortality of DSR that will be incurred during the halibut fishery under this program.

ABC RECOMMENDATIONS

Yelloweye rockfish is the predominant DSR species caught in the commercial fisheries, accounting for an average of 90% (by weight) of the total DSR catch over the past five years. Quillback rockfish accounts for 8% of the landed catch.

In the 1994 SAFE, the ABC was set by applying the estimated natural mortality rate (0.02) to the lower 90% confidence limit of the biomass estimate for yelloweye rockfish, then adding an additional 12% to account for the other DSR species in the catch. The lower 90% CI was judged to be a better estimate of biomass given the assumptions in expanding density data from CSEO to the NSEO and SSEO sections. This year we propose setting ABC using the point estimates of yelloweye biomass (1994 data) for the NSEO, CSEO, and SSEO combined, with the lower 90% CI estimate from EYAK (1990 data) as the best estimate of yelloweye rockfish biomass. We propose using the point estimates based on the improved survey design and the fact

that actual estimates rockfish density were obtained for NSEO and SSEO during 1994. The lower 90% CI should be retained as the best estimate for EYAK as we know that the line length estimates for earlier surveys were underestimated and, therefore, rockfish density for EYAK may be overestimated. This method yields an estimated biomass for yelloweye rockfish of 26,093 mt. By applying the 0.02 mortality to the biomass, and adjusting for the 10% of other DSR species, the recommend 1995 ABC is 580 mt.

OVERFISHING

The overfishing level for DSR is 1,044 mt. This was derived by applying a fishing rate of F=0.04 against the biomass estimate for yelloweye rockfish (O'Connell and Fujioka 1992).

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Table 1. Rockfishes which are included in the demersal shelf rockfish assemblage in the Gulf of Alaska.

Common Name	Scientific Name
Canary	*Sebastes pinniger*
China	*S. nebulosus*
Copper	*S. caurinus*
Quillback	*S. maliger*
Rosethorn	*S. helvomaculatus*
Tiger	*S. nigrocinctus*
Yelloweye	*S. ruberrimus*

Table 2. Reported landings of demersal shelf rockfish (MT round weight) from domestic fisheries in the Southeast Outside District (SEO), 1982-1993[1].

	DIRECTED		BYCATCH		TOTAL		TAC
YEAR	AREA 65	AREA 68	AREA 65	AREA 68	AREA 65	AREA 68	SEO
1982	106	*	14	*	120	*	*
1983	161	*	15	*	176	*	*
1984	543	*	20	*	563	*	*
1985	388	*	100	1	488	1	*
1986	449	*	41	*	491	*	*
1987	726	77	47	5	773	82	*
1988	471	44	29	8	500	52	660 ^
1989	312	44	101	18	413	62	420 ^
1990	190	17	100	36	324	55	470 ^
1991	199	187	83	36	287	223	425 ^
1992	307	57	145	44	452	101	550#
1993	246	112	254	18	698	203	800#
1994	178	109	128	26	306	135	960

[1] Landings from ADF&G Southeast Region fishticket database and NMFS weekly catch reports.

^ TAC for FMP Area 65 only.

TAC for FMP Areas 65 and 68.

[2] Fish ticket data through July 20, 1994.

Table 3. Estimates of instantaneous mortality (Z) of yelloweye rockfish in Southeast Alaska.

AREA	YEAR	SOURCE	Z	n
SSEO	1984	Commercial longline	.017*	1049
CSEO	1981	Research jig	.020*	196
CSEO	1988	Research longline	.042	600

*Z approximately equal to M

Table 4. Growth parameters for yelloweye rockfish in Southeast Alaska.

Sex	L	K	t_0	n
male	67.005	0.0563	-2.171	554
female	66.03	0.0474	-4.773	703
combined	65.85	0.0529	-3.336	1257

Table 5. Length-weight relationships (cm-kg) for yelloweye rockfish in Southeast Alaska ($W=aL^b$).

Sex	*a*	*b*	n
male	.000023827	2.93289	169
female	.000015348	3.05619	108
gravid female	.000004348	3.39621	63

Table 6. 1994 density estimates, and percent CV(D) for adult yelloweye by area.

Area	Density /km^2	CV(D)%
CSEO	1224	10.86
NSEO	604	28.57
SSEO	809	29.88

Table 7. Yelloweye density and biomass estimates by area and year.

Year	Area	Density/km^2	Avg wt.	Habitat km^2	Biomass mt	L 90%	U 90%
1990	EYAK	2283	4.05	1691	15,642	11,127	21,989
1991	CSEO	2030	2.93	1997	11,892	9,061	15,608
	NSEO	2030[1]	3.73	896	6,777	5,124	8,966
	SSEO	2030[1]	3.43	2149	14,965	11,344	19,742
1994	CSEO	1224	2.7	1997	6,601	5,479	7,953
	NSEO	604	2.98	896	1,614	1,015	2,565
	SSEO	809	3.88	2149	6,751	4,164	10,943

[1] Density based on CSEO data, no direct estimate.

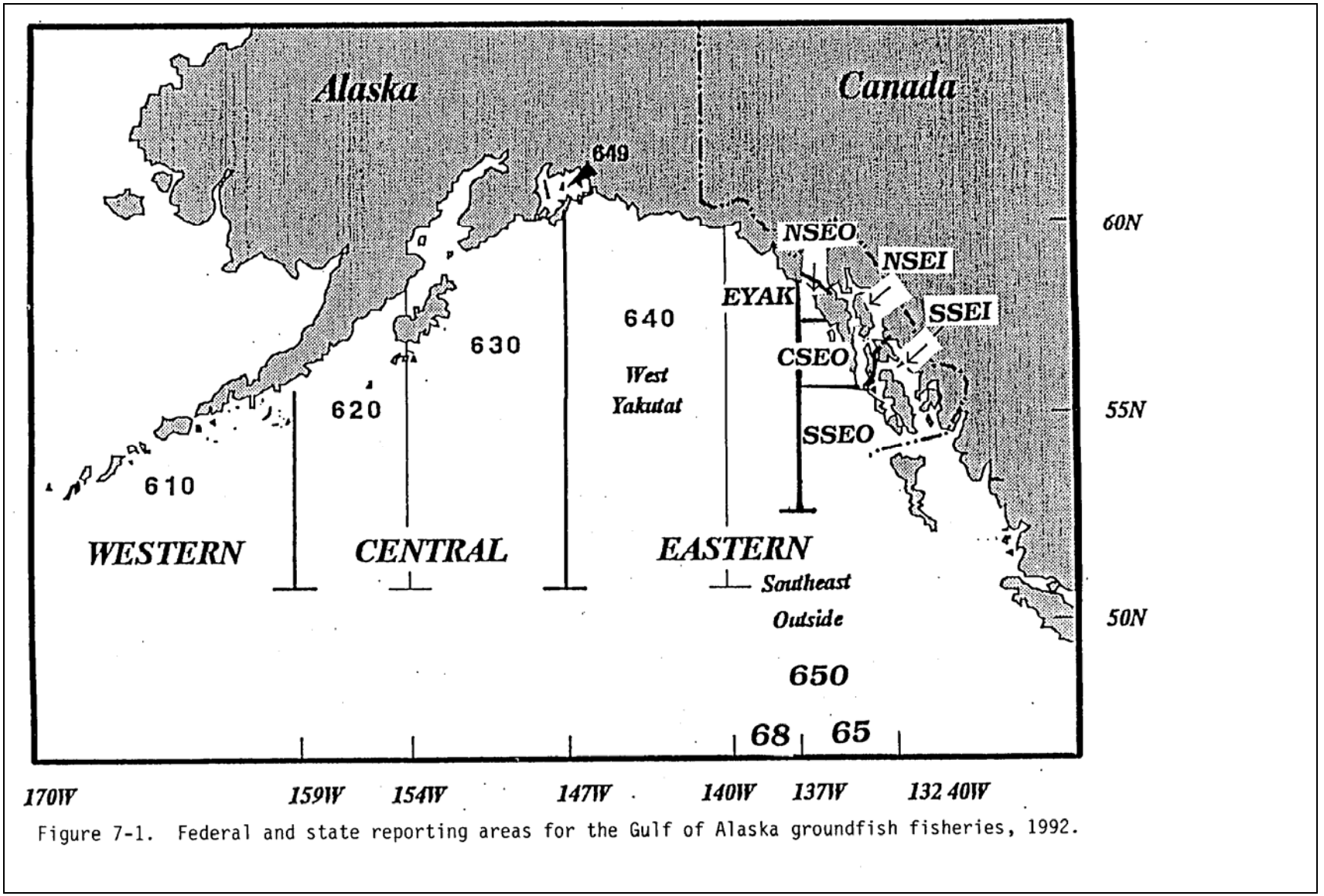

Figure 7-1. Federal and state reporting areas for the Gulf of Alaska groundfish fisheries, 1992.

Figure 1. Federal and state reporting areas for the Gulf of Alaska groundfish fisheries, 1992.

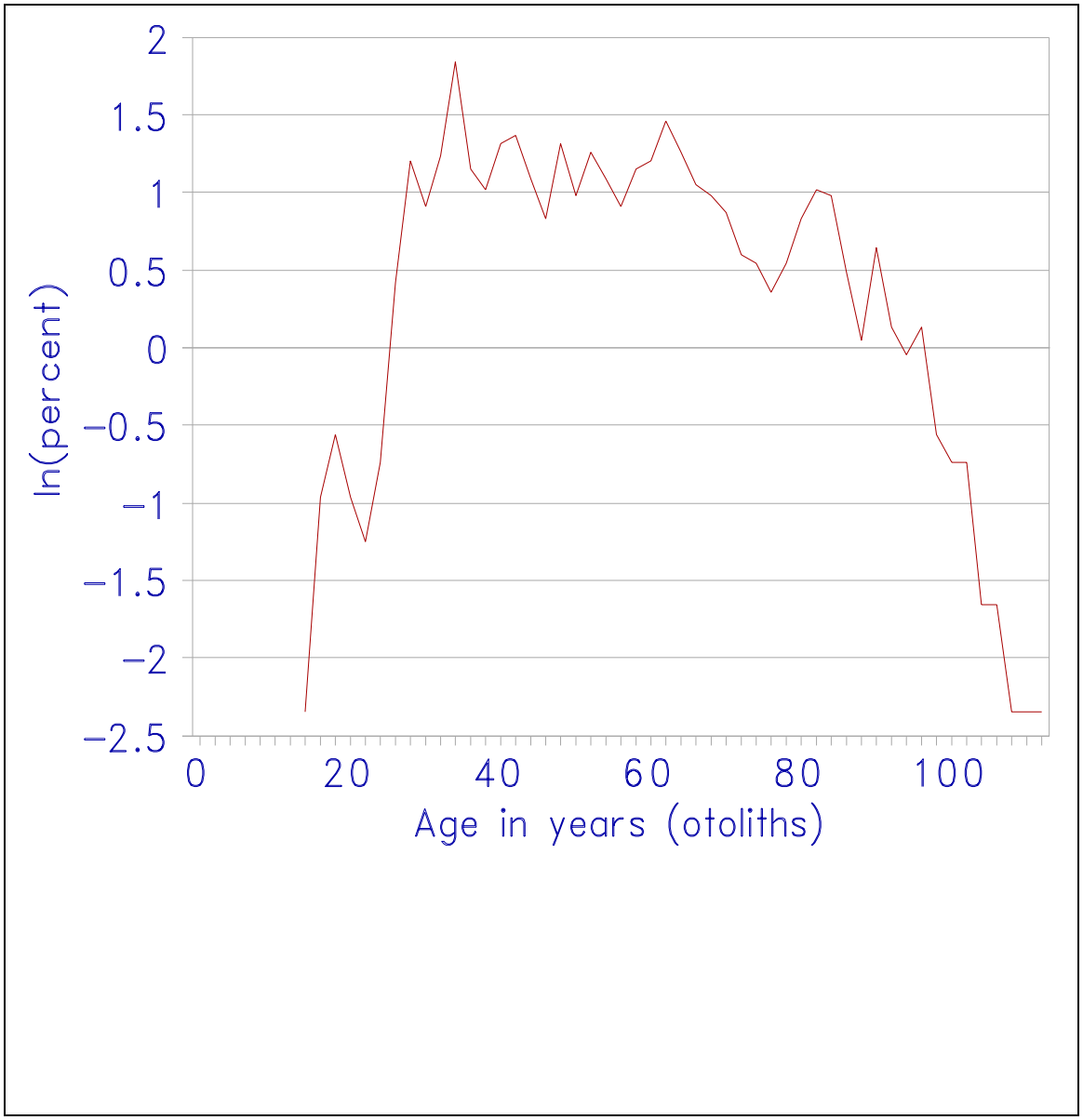

Figure 2. Catch curve for Yelloweye rockfish. 1984 SSEO samples.

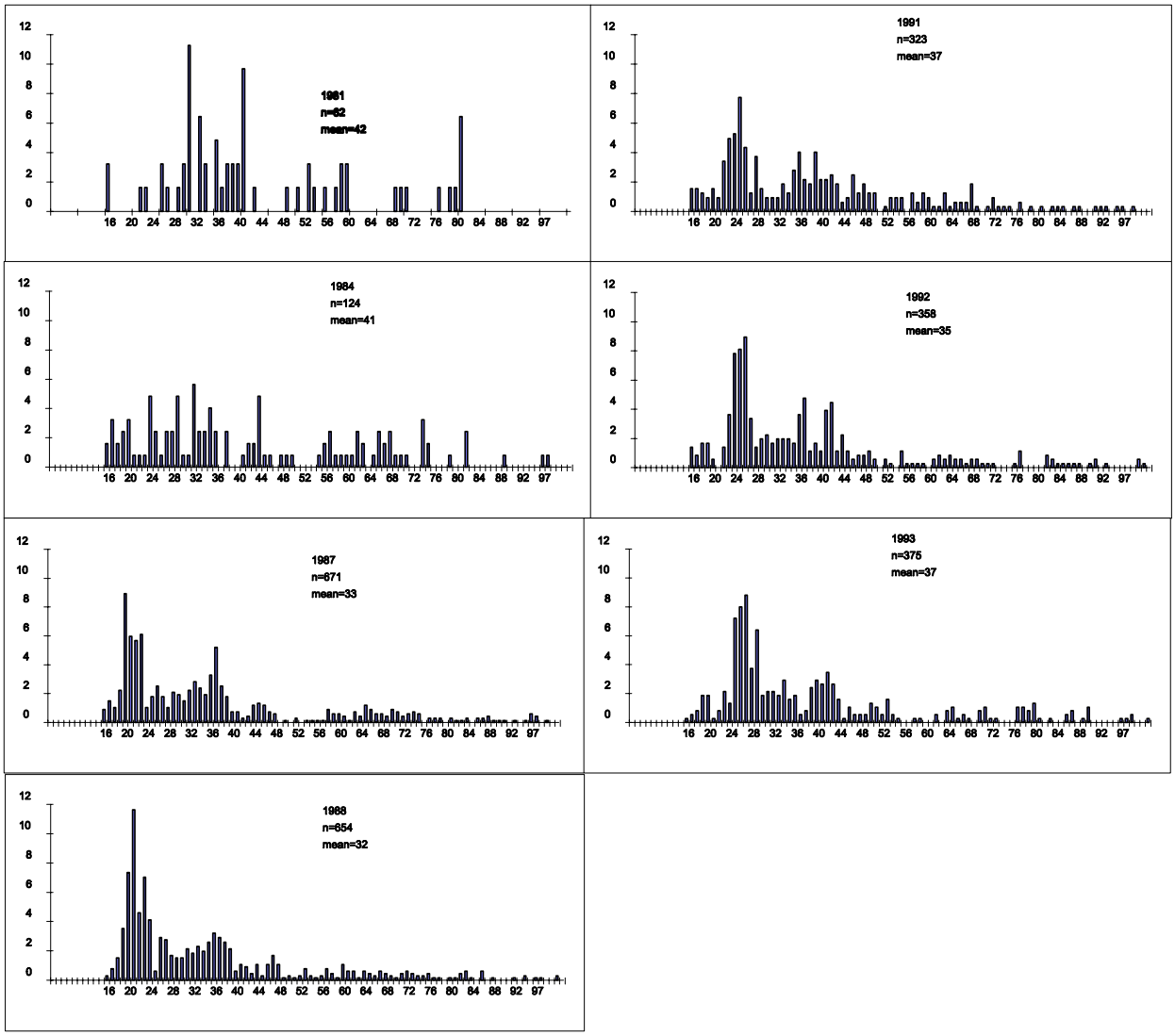

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Figure 3A. Yelloweye rockfish age distribution (% frequency) from CSEO commercial fishery.

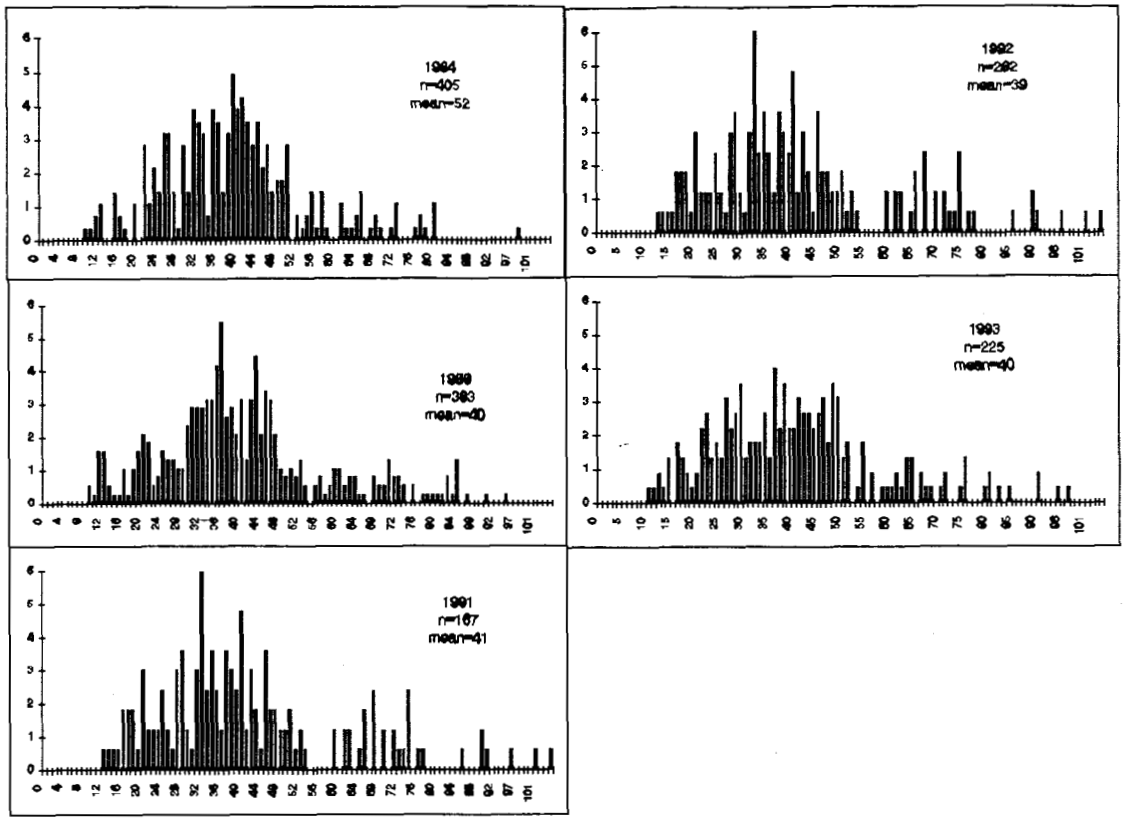

Figure 3B. Yelloweye age distribution from SSEO commercial fishery.

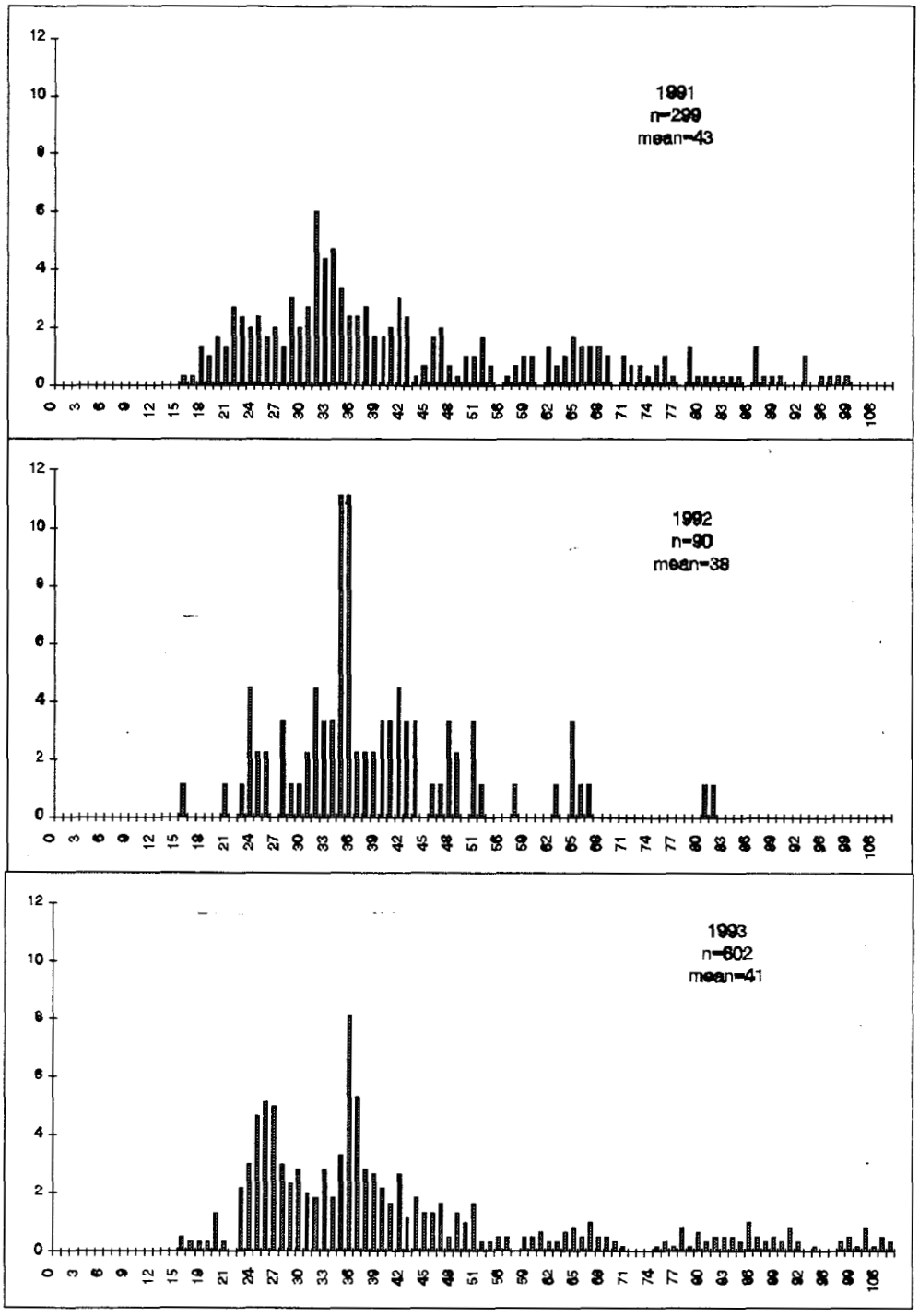

Figure 3C. Yelloweye age distribution from the EYAK area.