Section 8 **Demersal Shelf Rockfish Assessment for 2002**

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Executive Summary

Relative to the December 2000 Stock Assessment and Fishery Evaluation report (SAFE), the following substantive changes have been made:

Input Data

New density data from the NSEO management area was included in the analysis. Yelloweye average weight and standard error data were updated using 2000 port samples. New age data from the 2000 fishery are included and a discussion on halibut bycatch was updated.

Assessment Results

The exploitable biomass estimate for yelloweye rockfish for 2002 is 15,616 mt. This is a 6% increase over the 2001 estimate due to an increase in density estimate for NSEO and an increase in average weight of fish in all areas.

Scientific and Statistical Committee Concerns Regarding Consistency in Allowable Biological Catch Recommendations

The SSC has requested the authors compare their biomass estimate (based on the sum of estimates from the four management areas) to one derived for the Southeast Outside Section (SEO) as a whole. As requested, the alternative estimate is provided

ABC and Overfishing Levels

The ABC for Demersal Shelf Rockfish (DSR) is set using Tier IV definitions with F=M=0.02 and adjusting for the 10% of other species landed in the assemblage. The ABC was set at 350 mt. The overfishing level was set using $F_{35\%}$=0.0279=484 mt.

8.1 INTRODUCTION

Rockfishes of the genus *Sebastes* are found in temperate waters of the continental shelf off North America. At least thirty-two species of *Sebastes* occur in the Gulf of Alaska (GOA). In 1988, the North Pacific Fisheries Management Council (NPFMC) divided the rockfish complex into three components for management purposes in the eastern Gulf: Demersal Shelf Rockfish (DSR), Pelagic Shelf Rockfish, and Slope Rockfish. These assemblages were based on species distribution and habitat, as well as commercial catch composition data. The species composition within each assemblage has changed over time, as new information becomes available. The DSR assemblage is now comprised of the seven species of nearshore, bottom-dwelling rockfishes listed in Table 1. These fishes all occur on the continental shelf, reside on or near bottom, and are generally associated with rugged, rocky habitat. For purposes of this report, emphasis is placed on yelloweye rockfish *Sebastes ruberrimus*, as it is the dominant species in the DSR fishery.

All DSR are considered highly K selective, exhibiting slow growth and extreme longevity (Adams 1980, Gunderson 1980, Archibald et al. 1981). Estimates of natural mortality are very low (see Fishery Data section). These types of fishes 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 (Dorn 1999).

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).

Rockfishes have a closed swim bladder that makes them susceptible to embolism mortality when brought to the surface from depth. Therefore all DSR caught, including discarded bycatch in other fisheries, are usually fatally injured and should be counted against the TAC.

Prior to 1992 DSR was recognized as a Fishery Management Plan (FMP) assemblage only in the waters east of 137^{o} W. longitude. In 1992 DSR was recognized in the East Yakutat Section (EYKT) and management of DSR extended westward to 140^{o} W. longitude. This area is referred to as the Southeast Outside (SEO) Subdistrict and is comprised of four management sections: East Yakutat (EYKT), Northern Southeast Outside (NSEO), Central Southeast Outside (CSEO) and Southern Southeast Outside (SSEO). In SEO, DSR are managed jointly by the State of Alaska and the National Marine Fisheries Service. The two internal state water subdistricts, NSEI and SSEI are managed entirely by ADF&G and are not included in this stock assessment (Figure 1).

8.2 FISHERY

8.2.1 Description of Fishery

The directed fishery for DSR began in 1979 as a small, shore-based, hook and line fishery in Southeast Alaska. This fishery targeted on the nearshore, bottom-dwelling component of the rockfish complex, with fishing occurring primarily inside the 110 m contour. The early directed fishery targeted the entire DSR complex. The current fishery targets yelloweye rockfish, and fishes primarily between the 150 m and the 75 m contours. Yelloweye rockfish accounted for an average of 90% (by weight) of the total DSR catch over the past five years. Quillback rockfish accounted for 8% of the landed catch. The directed fishery is prosecuted almost exclusively by longline gear. Although snap-on longline gear was originally used in this fishery, most vessels now use conventional longline gear. Markets for this product are domestic fresh markets and fish are generally brought in whole, bled, and iced. Processors will not accept fish delivered more than three days after landed.

The directed fishery is managed with seasonal allocations: 67 percent of the directed fishery quota is allocated between January 1 and March 15 and 33 percent is allocated between November 16 and December 31. A winter fishery was requested by the directed fleet, as the ex-vessel price is highest at that time. The directed season is closed during the halibut IFQ season to prevent over-harvest of DSR. Directed fishery quotas are set by management area and are based on the remaining ABC after subtracting the estimated DSR bycatch (landed and discard) in other fisheries.

8.2.2 Bycatch and Discards

DSR have been taken as bycatch in domestic longline fisheries, particularly the halibut fishery, since the turn of the century. Some bycatch was also landed by foreign longline and trawl vessels targeting on slope rockfish in the eastern Gulf from the late 1960s through the mid-1970s. DSR mortality during the halibut longline fishery continues to account for a significant portion of the total allowable catch (TAC). In recent years reported DSR bycatch in the halibut fishery has accounted for over 30% of the total DSR landings in Southeast.

The allowable bycatch limit of DSR during halibut fishing is 10% of the halibut weight. Current federal regulations prevent fishermen from bringing in DSR above the bycatch limit of 10% of the target species (round pounds). In 1998 the NPFMC passed an amendment to require full retention of DSR. This amendment would require fishermen to retain all DSR caught, forfeiting without penalty, the amount above the directed fishing standard. This amendment is still under review at the Regional Office. In July of 2000 the State of Alaska enacted a regulation requiring all DSR landed in state waters of Southeast Alaska to be retained and reported on fish tickets. Proceeds from the sale of DSR in excess of legal sale limits are forfeited to the State of Alaska fishery fund. The amount of yelloweye landed has significantly increased with this management action: in 2001 (as of 9/1) 40,066 pounds of yelloweye were forfeited in southeast Alaska compared to 13,767 in 2000.

Reported bycatch does not reflect true mortality rates as most rockfish suffer embolism mortality when caught and do not generally survive when released. Estimated total mortality has ranged between 130 mt to 355 mt annually. Before the implementation of the IFQ fishery, we estimated unreported mortality of DSR during the halibut fishery based on International Pacific Halibut Commission (IPHC) interview data. For example, the 1993 interview data indicates a total mortality of DSR of 13% of the June halibut landings (by weight) and 18% of the September halibut landings. This data has been more difficult to collect under the halibut IFQ fishery and appears to be less reliable than previous data.

In recent years we have used IPHC catch statistics to determine the percent of the halibut catch taken in each of the 4 DSR management areas in the Southeast Outside district. Based on the 2000 landing data, it is estimated that approximately 40% of the 2C (IPHC Regulatory Area) halibut quota and 10% of the 3A halibut quota are taken in SEO (IPHC web page). Total bycatch mortality of DSR in the halibut fishery is estimated using a 10% bycatch mortality for DSR in 2C and IPHC statistical area 190 (Fairweather Ground) and a 7% bycatch mortality in the remaining portions of 3A east of 140^{o}. Estimated unreported mortality is the difference between the total and the reported bycatch. Based on the 2001 halibut quotas, the estimated total DSR mortality for the 2002 SEO halibut fishery is anticipated to be 250 mt.

The IPHC has provided us with data from their 2000 longline survey. Bycatch is estimated based on sampling the first 20 hooks of each skate of gear. Bycatch of DSR, expressed as the percent of DSR weight to halibut weight (for legal sized halibut) ranged from 0% to well over 100%, with area estimate means ranging from 3% in EYKT (removing Fairweather stations) to 23% in Fairweather Ground. The overall rate ranged from 3% in EYKT and 16% in Fairweather Ground (Figure 2).

There is an inherent problem in estimating a rate of bycatch for DSR. DSR are habitat specific, and although their distribution overlaps with halibut, the distributions are not correlated. IPHC longline survey data indicates that bycatch of DSR is highly variable both interannually and within year by area. There is no linear relationship between the catch of halibut and the catch of DSR (Figure 3). Until full retention of DSR is implemented in federal waters it will be difficult to discern whether the TAC has been met or the ABC surpassed.

8.2.3 Catch History

The history of domestic landings of DSR from SEO are shown in Table 2. The directed DSR catch in SEO increased from 106 mt in 1982 to a peak of 803 mt in 1987. Total landings exceeded 900 mt in 1993. Directed fishery landings have often been constrained by other fishery management actions. In 1992 the directed DSR fishery was allotted a separate halibut PSC and is therefore no longer effected when the PSC is met for other longline fisheries in the GOA. In 1993 the fall directed fishery was cancelled due to an unanticipated increase in DSR bycatch during the fall halibut fishery.

Directed fishery landings from SEO totaled 183 mt in 2000, bycatch landings totaled 94 mt, all of which were landed in the halibut fishery.

8.3 DATA

8.3.1 Fishery Data

In addition to catch data listed in Table 2, catch per unit effort data is collected through a mandatory logbook program and biological information is collected through port sampling of the commercial catch. Species composition and length, weight, sex, and stage-of-maturity data are recorded and otoliths taken for aging. Yelloweye rockfish is the primary target of the directed fishery and accounted for 92%, by weight, of all DSR landed in the directed fishery during 2001. The following biological information is reported for yelloweye rockfish only.

Commercial fishery catch per unit effort (CPUE) expressed as round pounds of yelloweye rockfish per hook shows a slightly declining trend in all areas but SSEO, with overall CPUE generally higher for snap-on gear (Figure 4) than for conventional longline gear (Figure 5).

8.3.2 Mortality Estimates

An estimate of Z=0.0174 (± 0.0053) from a 1984 "lightly-exploited" stock in SSEO is used to estimate M=0.02 (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. This may be due to increased natural mortality in the older ages, perhaps senescence. The M=0.02 is based on a catch curve analysis of age data grouped into two-year intervals (to avoid zero counts) between the ages of 36 and 96.

8.3.3 Growth Parameters

Von Bertalanffy growth parameters for yelloweye are listed in Table 4 and length-weight parameters are listed in Table 5. These parameters were calculated using 1995 and 1996 port sample data. Because there are so few young fish in the commercial fisheries samples, we supplemented this data set with fish younger than 20 years from all years of port sampling data. A more detailed review of yelloweye age and growth is available in O'Connell and Funk (1986). A recent study by researchers at Moss Landing Marine Laboratory has validated break-and-burn ages for yelloweye using radiometric dating (Mounaix and Cailliet unpublished data). 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.

8.3.4 Fishery Age Compositions

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 Beamish 1983). Researchers at Moss Landing Marine Laboratory (Mounaix and Cailliet, unpublished data), have recently validated this technique for yelloweye rockfish.

Maximum published age for yelloweye is 118 years, but one specimen from the SSEO 2000 samples was aged at 121 years (O'Connell and Funk 1986).

Age frequency data from the commercial catch differs somewhat by management area (Figures 6a-c). In EYAK, the 2000 age distribution is somewhat bimodal, the largest mode at 33 years, with a second, smaller mode at 43 years. Mean age of the 2000 samples 41 years. There appears to be some recruitment in the 15-22 year age classes. In CSEO, the area with the longest catch history, a bimodal pattern has been present in the age distribution since 1992 and the older ages have declined in frequency over time. The 2000 age data shows a spike at 31 years and a smaller mode at 23 years and a mean age of 35 years. There is no sign of an incoming recruitment in these data. In SSEO the 2000 age data has a weak bimodal distribution with modes at 22 and 43 years and an average age of 42 years. Year classes are more evenly distributed than in other areas, particularly between 17 and 60 years. SSEO had the oldest fish, with an estimated age of 121 years.

8.3.5 Survey Data

Traditional abundance estimation methods (e.g., area-swept trawl surveys, mark recapture) are not considered useful for these fishes given their distribution, life history, and physiology. ADF&G uses direct observation to collect density estimates and is continuing research to develop and improve a stock assessment approach for these fishes. As part of that research, a manned submersible, *Delta*, has been used to conduct line transects to estimate rockfish density (Buckland et al. 1993, Burnham et al. 1980). We have surveyed the Fairweather Ground in the EYKT section in 1990, 1994, 1995, 1997, and 1999; the CSEO section during 1990, 1994, 1995, and1997; the NSEO section in 1994 and 2001; and the SSEO section in 1994 and 1999. A total of 452 line transects have been run since 1989, 6 of which were run in 2001 (Figure 7a-b). Although line transect data is collected for four of the eight DSR species (yelloweye, quillback, tiger, rosethorn), and for juvenile as well as adult yelloweye, included here are density estimates for adult yelloweye rockfish only. Density estimates are limited to adult yelloweye because it is the principal species targeted and caught in the fishery, and our ABC recommendations for the entire assemblage are keyed to adult yelloweye abundance. Biomass of adult yelloweye rockfish is derived as the product of estimated density, the estimate of rocky habitat within the 200 m contour, and average weight of fish for each management area. Variance estimates can be calculated for the density and weight parameters but not for area. This is an in-situ method for stock assessment and we have made some changes in techniques each year in an attempt to improve the survey. Estimation of both line length for the transects and total area of rocky habitat are difficult and result in some uncertainty in the biomass estimates.

In a typical submersible dive, two transects were run per dive with each transect lasting 30 minutes. During each transect, the submersible's pilot attempted to maintain a constant speed of 0.5 kn and to remain within 1 m of the bottom, terrain permitting. A predetermined compass heading was used to orient each transect line.

The usual procedure for line transect sampling entails counting objects on both sides of a transect line. Due to the configuration of the submersible, with primary view ports and imaging equipment on the starboard side, we only counted fish on the right side of the line. Horizontal visibility was usually good, 5-15 m. All fish observed from the starboard port were individually counted and their perpendicular distance from the transect recorded (Buckland 1985). An externally mounted video camera was used on the starboard side to record both habitat and audio observations. In 1995, a second video camera was mounted in a forward-facing position. This camera was used to "guard" the transect line promoting 100% detectability of yelloweye on the transect line, a critical assumption when employing line transects. The forward camera also enabled counts of fish that avoided the sub as the sub approached. Yelloweye rockfish have distinct coloration differences between juveniles and adults, so observations of the two were recorded separately.

A PISCES data logger overlaid depth of the submersible and its distance from the bottom, time of day, and temperature onto the videotape at 1 second intervals. In addition to the video system, we used a Photosea 35-mm camera with strobe to photograph habitat and fish.

Hand-held sonar guns were used to calibrate observer estimates of perpendicular distances. It was not practical, and can be deleterious to accurate counts and distance estimates to make a sonar gun confirmation to every fish. We therefore calibrated observer distance estimates using the sonar gun at the beginning of each dive prior to running the transect. The sonar gun was also used during the transect when necessary to reconfirm distances. To verify the accuracy of this method, we confirmed sonar readings by positioning a scuba diver at intervals along a marked transect line.

Beginning in 1997, we positioned the support ship directly over the submersible at five-minute time intervals and used the corresponding Differential Global Positioning (DPGS) fixes to determine line length.

8.4 ANALYTIC APPROACH

For each area yelloweye density was estimated as:

$$\hat{D}_{YE} = \frac{nf(0)}{L}, \qquad (1)$$

where:

n = total number yelloweye rockfish adults observed,
f (0) = probability density function of distance from a transect line, evaluated at zero distance,
L = total line length in meters.

A line transect estimator (Buckland et al. 1993) was calculated and the best fit model selected from several detection functions using Version 3.5 Release 6 of the software program DISTANCE (Laake et al. 1993, Thomas et al 1999) (Appendix 1). A principal function of the DISTANCE software is to estimate f(0). The program can either be run with default and best fit settings or can be used with set sighting intervals and truncation of a portion of the right limb of the sighting data. Estimated probability detection functions (pdf) generally exhibited the "shoulder" (i.e., an inflection and asymptote in the pdf for perpendicular distances near 0) that Burnham et al. (1980) advocate as a desirable attribute of the pdf for estimation of f(0). Final models for the stock assessment were picked, by area, based on goodness of fit of model to data (judged by visual examination of plot and X^2 goodness of fit test (Appendix 1)). The sample size for the 2001 survey data is quite small (six transects, 30 yelloweye) and there is substantial variance around this estimate.

For the 1993 SAFE (based on 1990 and 1991 data), to estimate the variance in biomass, we assumed a Poisson 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. Beginning in 1994 we substantially increased the numbers of transects conducted and now use an actual empirical estimate of the variance of n (see p. 88, Buckland et al. 1993).

Total yelloweye rockfish biomass is estimated for each management subdistrict as the product of density, mean weight, 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 tends to be positively skewed and we assume density is log-normally distributed (Buckland et al. 1993).

In 1997, biomass was estimated for the EYKT area by separating the Fairweather and non-Fairweather areas of EYKT. Biomass was then calculated for the Fairweather section using the Fairweather density and weight data and added to the non-Fairweather biomass estimate which had been estimated using data from CSEO. This was done because the Fairweather area had exceedingly high density estimates, not typical of surrounding areas. However, in 1999, given the decline in density in the Fairweather area and the large reduction in estimated area of rock habitat in non-Fairweather portions of EYKT, we used Fairweather data for the entire EYKT area.

8.4.1 2001 Density Estimates

The NSEO section was the only area surveyed during 2001. The weather was poor during the survey period and only six line transects were run, with a total of 30 yelloweye seen on these transects. Consequently, the distance sampling model did not fit the data well (Appendix 1). The best-fit model was a half-normal model. The density estimate for these data was 1,420 adult yelloweye/km^2 with a CV of 31%. This increases the density estimate for this area 40% over the 199 survey data (1995 assessment) and brings the area estimate more in line with density estimates from the rest of Southeast Outside. The NSEO area is a small area and has only been surveyed twice: in 1994 and 2001. Survey techniques were substantially changed in 1995 (see 8.3.5 above) and it is reasonable to expect that new density estimates would higher than those from 1994.

8.4.2 Habitat Area Estimates

Area estimates of DSR habitat are based on the known distribution of rocky habitat inshore of the 100-fathom edge. Information used to map this area include NOS data, sidescan and multibeam data, direct observation from the submersible, and commercial logbook data from the directed DSR fishery.

8.4.2.1 Sidescan Sonar

In 1996 we conducted a side-scan sonar/bathymetric survey for a 536 km^2 area in the CSEO section. The National Ocean Services (NOS) data from the area covered by the sidescan indicated that 216 km^2 of this area was rocky. Interpretation of the sidescan data, combined with direct observation from the submersible to groundtruth the interpretation, reveals that in fact, approximately 304 km^2 of the seafloor is rocky in this area, a 29% increase over the previous estimate (Figure 8).

Area estimates for the Fairweather portion of the East Yakutat Subdistrict were redefined during the 1997 survey. The support ship transected the bank in several sections using a paper-recording fathometer to determine gross bottom type. The "Delta" submersible was then used to groundtruth habitat characterization in several areas. Based on this survey the estimate of total area of rocky habitat on the Fairweather Ground was reduced from 1132 km^2 to 448 km^2 (Figure 9). Because of this great discrepancy, we conducted a sidescan sonar survey on the Fairweather Ground in August of 1998. The area surveyed was 780 km^2 of seafloor, primarily on the western bank of Fairweather. In the area sidescanned, 452 km^2 was rocky. Although the area surveyed did not cover the entire Fairweather Ground, it is possible to compare techniques by evaluating the difference between the west bank polygon we thought was rock in 1998 (279 km^2 in this polygon) to the sidescan data that documents 218 km^2 of rock habitat within that polygon (Figure 9). The sidescan data in conjunction with NOS data, submersible dives, and logbook data were used to re-estimate rock habitat for the EYKT area, now estimated at 617 km^2. Multibeam bathymetric and backscatter data were collected for a portion of the CSEO and SSEO sections in the summer of 2001. These data have not yet been analyzed.

8.4.2.2 Area Estimates

Area estimates of DSR rock habitat for the SEO were revised in 1999. Originally, 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 available National Ocean Services (NOS) database or logbook information. Grids squares covered approximately 18 km^2. The new estimates were based on sidescan sonar data, submersible dive observations, NOS data, and commercial logbook information. Areas of rock habitat were outlined and digitized for input into a GIS (Appendix 2). Changes were significant, and varied by area, with some areas showing an increase and some a decrease in estimated area of rock habitat. The overall change was down 46%, with 3,095 km^2 compared to 5,758 km^2 used in previous assessments (Table 7). Area estimates will most likely change in the future as we collect more information on habitat.

8.4.5 Exploitable Biomass Estimates

Estimates of exploitable biomass (adult yelloweye), with associated standard error, by year and area, are listed in Table 8. New information added this year included new estimates of density for NSEO and updated average weight and standard error of the average weight data for all areas. The total exploitable biomass for 2001 is estimated to be 15,616 mt (based on the sum of the lower 90% confidence limits of biomass estimates from each management area), up slightly (6%) over the 2000 estimate.

The SSC has requested the authors compare their biomass estimate (based on the sum of estimates from the four management areas) to one derived for the Southeast Outside Section (SEO) as a whole. We have calculated a lower 90% confidence limit for the SEO using the sum of the biomass and the sum of the variances. This estimate is 18,548 mt, 3,000 mt larger than the author's recommendation. We do not think this is the appropriate number to use for deriving ABC and TAC. By state regulation, the DSR fishery in the SEO is managed based on 4 management areas. Density estimates and biological data (and associated variances) are collected independent of other management areas and we do not have surveys in each area every year. Although a combined estimate can be made apportionment of this larger number could result in over-harvest within a management area.

8.5 PROJECTIONS AND HARVEST ALTERNATIVES

8.5.1 ABC Recommendation

Demersal shelf rockfish are particularly vulnerable to overfishing given their longevity, late maturation, and sedentary and habitat-specific residency. We continue to advocate using the sum of the area-specific lower 90% confidence limits of biomass as the reference number for setting ABC. This results in a biomass estimate of 15,616 mt.

By applying F=M=0.02 to this biomass and adjusting for the 10% of other DSR species, the recommended 2001 ABC is 350 mt. This rate is more conservative than would be obtained by using Tier 4 under the new definitions for setting ABC, as F_{40}=0.025. Continued conservatism in managing this fishery is warranted given the life history of the species and the uncertainty of the biomass estimates.

8.6 OVERFISHING DEFINITION

The overfishing level for DSR is 480 mt. This was derived by applying a fishing rate of $F_{35\%}$=0.0279 against the biomass estimate for yelloweye rockfish.

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

Under tier 4 projections of harvest scenarios for future years is not possible. Yields for 2002 are computed for scenarios 1-5 as follows:

Scenario 1: F equals the maximum permissible F_{ABC} as specified in the ABC/OFL definitions. For tier 4 species, the maximum permissible F_{ABC} is $F_{40\%}$. $F_{40\%}$ equals 0.025, corresponding to a yield of 434 mt (including the 10% other DSR).

Scenario 2: F equals the stock assessment author's recommended F_{ABC}. In this assessment, the recommended F_{ABC} is F=M=0.02, and the corresponding yield is 347 mt.

Scenario 3: F equals the 5-year average F from 1995 to 1999. The true past catch is not known for this species assemblage so the 5 year average is estimated at F=0.02 (the proposed F in all 5 years), and the corresponding yield is 347mt.

Scenario 4: F equals 50% of the maximum permissible F_{ABC} as specified in the ABC/OFL definitions. 50% of $F_{40\%}$ is 0.0125, and the corresponding yield is 217 mt.

Scenario 5: F equals 0. The corresponding yield is 0 mt.

8.8 OTHER CONSIDERATIONS

Although management of this stock has been conservative, the decline in the density estimates in the Fairweather Ground may be an indication that localized overfishing may be occurring. Harvest limits are set by management area based on density and habitat. Our harvest strategy suggests we are taking 2% of the exploitable biomass per year and this level is sustainable. However fishing effort tends to be concentrated in areas of best habitat and high density and it may be that local overfishing occurs. Anecdotal evidence also suggests that prime rockfish habitat in the Fairweather Ground has been fished more heavily by halibut fishermen since the implementation of IFQ. Yelloweye tend to be resident and tag return information would suggest that adult fish stay in the same area over years (O'Connell 1991). Under the scenario outlined above, although our harvest policy is for a 2% annual rate of exploitation, on the Fairweather Ground the yelloweye occurring in prime habitat may actually be being harvested locally at a rate well in excess of the overfishing level for the population.

This year, for the first time, the directed fishery may well be pre-empted by the halibut fishery in the EYKT area. IPHC catch data indicates that 10% of the 3A quota was taken in EYKT. If the 2002 halibut quota for 3A is similar to the 2001 quota the associated DSR mortality is estimated to be 90 mt which is equal to the area specific ABC for this management area. The Fairweather Ground is a portion of the EYKT section and has supported an important directed fishery for DSR in past years.

The Pacific Fishery Management Council has recently recommended a harvest rate policy of $F_{50\%}$ for rockfishes (Ralston et al. 2000). This recommendation is based largely on work presented by Ralston (1998) and Dorn (2000). The $F_{50\%}$ for yelloweye is F=0.016. This corresponds to an ABC of 280 mt. This ABC would preclude a directed fishery for DSR because halibut bycatch is estimated at 280 mt for the 2002 fishery.

SUMMARY

M	0.02
2001 Biomass Estimate	15,616
F_{ofl} ($F_{35\%}$)	0.0279
Max F ($F_{40\%}$)	0.025
F_{abc}	0.02
F ($_{avg\ 94\text{-}98}$)	0.02
F ($_{50\%\ F\ max}$)	0.0125
Overfishing Level	480 mt
Recommended ABC Includes 10% for other DSR	350 mt

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Table 1. Species included in the Demersal Shelf Rockfish assemblage.

Common name	Scientific Name
canary rockfish	*Sebastes pinniger*
China rockfish	*S. nebulosus*
copper rockfish	*S. caurinus*
quillback rockfish	*S. maliger*
rosethorn rockfish	*S. helvomaculatus*
tiger rockfish	*S. nigrocinctus*
yelloweye rockfish	*S. ruberrimus*

Table 2. Reported landings of demersal shelf rockfish (mt round weight from domestic fisheries in the Southeast Outside Subdistrict (SEO), 1982-1997[a].

	Research	Directed Landings		Bycatch Landings		Total	
YEAR	Catch	AREA 65	AREA 68	AREA 65	AREA 68	SEO[b]	ABC[c]
1982		106		14		120	
1983		161		15		176	
1984		543		20		563	
1985		388	7	100	4	499	
1986		449	2	41	2	494	
1987		726	77	47	5	855	
1988		471	44	29	8	552	660
1989		312	44	101	18	475	420
1990		190	17	100	36	379	470
1991		199	187	83	36	889	425
1992		307	57	145	44	503	550
1993	13	246	99	254	18	901	800
1994	4	174	109	128	26	441	960
1995	13	110	67	90	22	282	580
1996	6	248	97	62	23	436	945
1997	13	202	65	62	25	381	945
1998		176	65	83	34	363	560
1999		169	66	74	38	348	560
2000	5	126	57	70	24	282	340
2001[a]	5	82	42	98	32	259	330

[a] Landings from ADF&G Southeast Region fishticket database and NMFS weekly catch reports through November 6, 2001.

[b] Estimated unreported DSR mortality associated with halibut fishery not reflected in totals. In 2000 unreported mortality estimated to be 90 mt, in 2001 unreported mortality estimated to be 70 mt.

[c] No ABC prior to 1987, 1988-1993 ABC for FMP area 65 only.

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 from 1996 port samples (1996 data set supplemented with all years data for fish less than 20 years old).

Sex	L	K	t_0	N
Male	64.399	0.0512	-5.440	1112
Female	65.929	0.0372	-11.646	1091
Combined	64.403	0.0459	-7.565	2203

Table 5. Length-weight relationships (cm-kg) for yelloweye rockfish in Southeast Alaska ($W=aL^b$), from 1995 and 1996 port samples.

Sex	a	b	n
Male	.00013589	2.52061	2045
Female	.000064544	2.71707	2424

Table 6. Sample size (transects), number of yelloweye observed, meters surveyed, and fish/line length for line transect surveys in EYKT, CSEO, SSEO, NSEO.

Area	Year	# transects (k)	# yelloweye	Meters surveyed	YE/M	Density
EYKT	1997	18	256	17238	.01485	4176
	1999	20	206	25646	.00803	2323
CSEO	1995	24	235	39368	.00597	2929
	1997	32	166	29176	.0057	2534
SSEO	1994	13	99	18991	.005213	1173
	1999	45	288	49663	.00579	1879
NSEO	1994	9	39	9535	.00409	839
	2001	9	30	4474	.006	1420

Table 7. Estimated area of rocky habitat.

Area	Total habitat inside 200 m 1999 estimate	Rock Habitat inside 200 m 1999 estimate	Previous estimate of rock habitat	Percent Change
EYKT	16,240	703	716	+ 2%
Fairweather	3,000	617	448	+27%
Other EYKT	13,200	86	268	-68%
NSEO	1,848	357	896	-60%
CSEO	4,141	1,184	1,997	-41%
SSEO	6,066	851	2,149	-60%
SEO total	28,255	3095	5,758	-46%

Table 8. Adult yelloweye rockfish density, weight, habitat, and associated biomass estimates by year and management area.

Year	Mgt Area	Survey Year	Density (adults/km^2)	CV(D)	avg wt (kg.)	Habitat (km^2)	Point Est (mt)	**Biomass L 90% CL (mt)**
2002	EYKT	1999	2323	.3084	4.04	703	6596	4208
	CSEO	1997	2534	.2009	3.3	1184	9690	6981
	NSEO	2001	1420	.3144	3.76	357	1511	411
	SSEO	1999	1879	.1711	3.48	851	5564	4015
	Total SEO					3095	23362	**15616**
2001	EYKT	1999	2323	0.3084	3.76	703	6645	3737
	CSEO	1997	2534	.2009	3.05	1184	9432	6592
	NSEO	Revised 1994	834	.2778	3.76	357	892	892
	SSEO	1999	1879	.1711	2.98	851	4858	3797
	TOTAL SEO					3095	21827	**14693**
2000	EYKT	1999	2323	0.3084	4.07	703	6645	4045
	CSEO	1997	2534	.2009	3.144	1184	9432	6701
	NSEO	Revised 1994	834	.2778	2.98	357	892	568
	SSEO	1999	1879	.1711	3.04	851	4858	3673
	TOTAL SEO					3095	21827	**15067**
1998/ 1999	Fairweather	1997	4176	0.18	3.87	448	7369	5443
	Other EYKT	CSEO '97	2534	0.20	3.87	268	2669	1921
	Total EYKT	1997			3.87	716	10039	7899
	CSEO	1997	2534	0.20	2.87	1997	14520	10453
	NSEO	Revised '94	834	0.28	2.98	896	2239	1428
	SSEO	Revised '94, '96 avg wt	1173	0.28	3.27	2149	8243	5253
	TOTAL SEO					5757	35041	**25031**
1996/ 1997	Fairweather	95 with 97 habitat	4805	0.16	3.74	448	8046	5759
	Other EYKT	CSEO 95	2929	0.19	3.74	268	2689	2158
	EYKT total	1995				716	11014	8492
	CSEO	1995	2929	0.19	3.10	1997	18117	13168
	NSEO	Revised 1994	834	0.28	2.98	896	2239	1426
	SSEO	Revised 1994	1173	0.28	3.88	2149	9781	6222
	TOTAL SEO					5757	41151	**29285**
1995	Fairweather	90 D, 97 habitat	2283	0.10	4.05	448	4143	2947
	Other EYKT	CSEO revised 1994	1683	0.10	4.05	268	1686	1414
	EYKT total				4.05	716	5829	4957
	CSEO	Revised 1994	1683	0.10	2.70	1997	9076	7583
	NSEO	Revised 1994	834	0.28	2.98	896	2239	1426
	SSEO	Revised 1994	1173	0.29	3.88	2149	9781	6222
	TOTAL SEO					5757	26925	**20188**
1994	Fairweather	90 D, 97 habitat	2283	0.10	4.05	448	4143	2947
	Other EYKT	1991 CSEO	2030	0.09	4.05	268	2199	1564
	EYKT total					716	6342	4924
	CSEO	1991	2030	0.09	2.93	1997	11892	15608
	NSEO	1991 CSEO	2030		3.73	896	6779	5124
	SSEO	1991 CSEO	2030		3.43	2149	14964	11344
	TOTAL SEO					5757	39976	**30453**

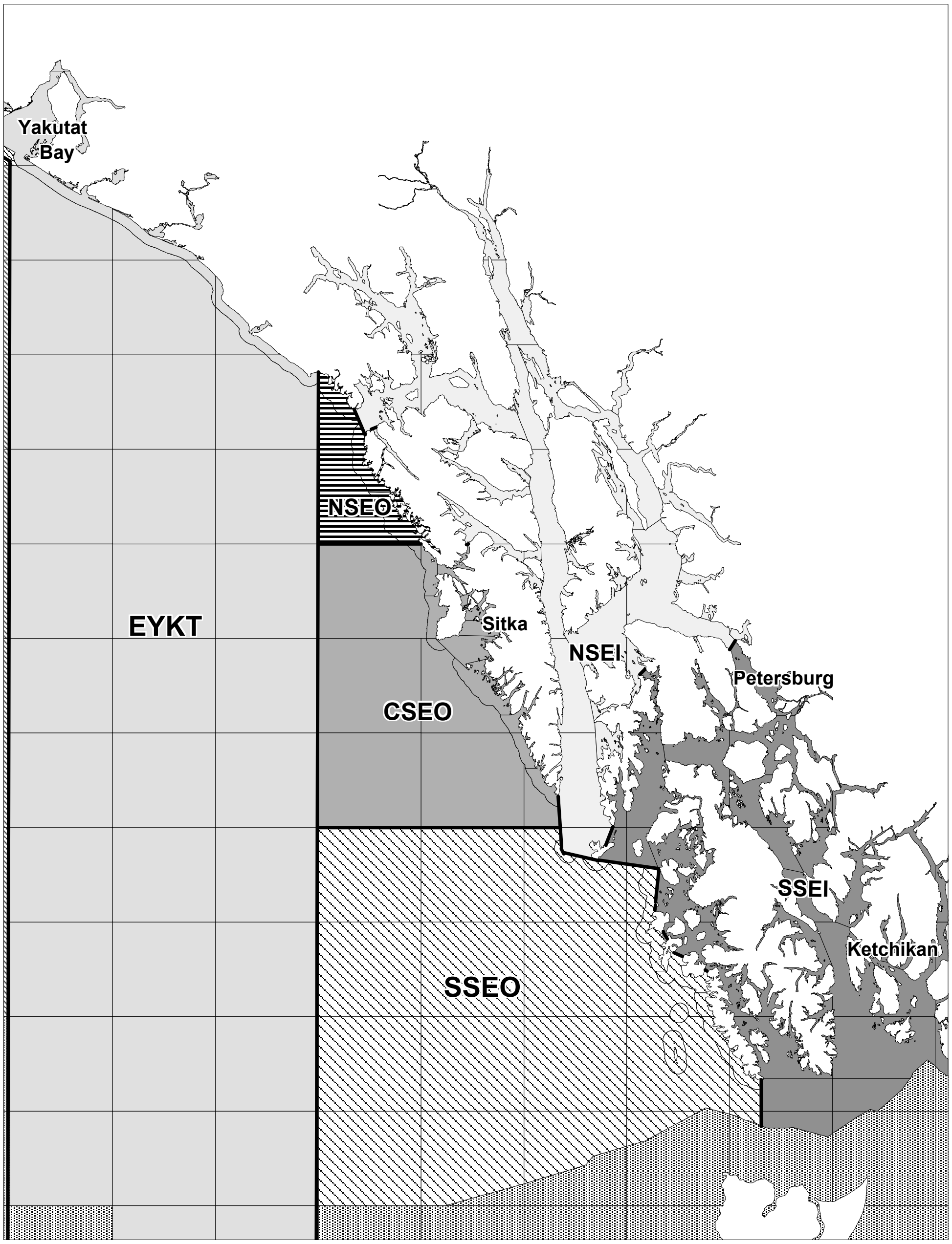


Figure 1. The Eastern Gulf of Alaska with Alaska Department of Fish and Game groundfish management areas: the EYKT, NSEO, CSEO, and SSEO sections comprise the Southeast Outside (SEO) Subdistrict.

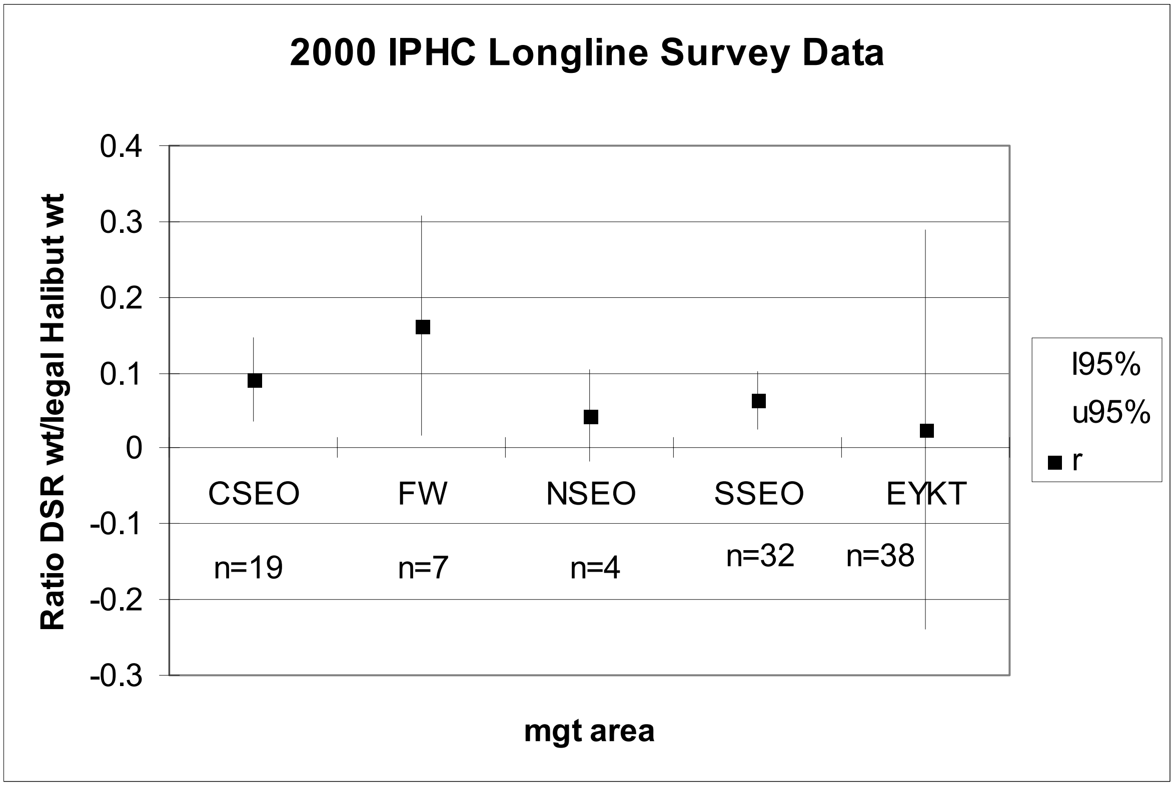


Figure 2. IPHC longline survey data, ratio of yelloweye (rd weight)/halibut (legal fish, rd weight).

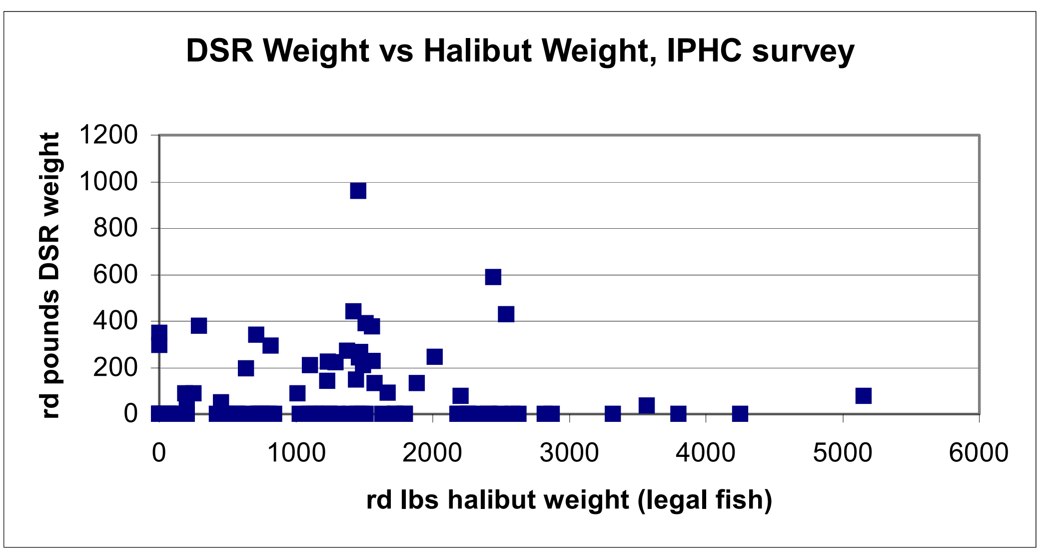


Figure 3. Catch of DSR (rd weight) versus halibut rd weight, legal fish) for 2000 IPHC longline survey.

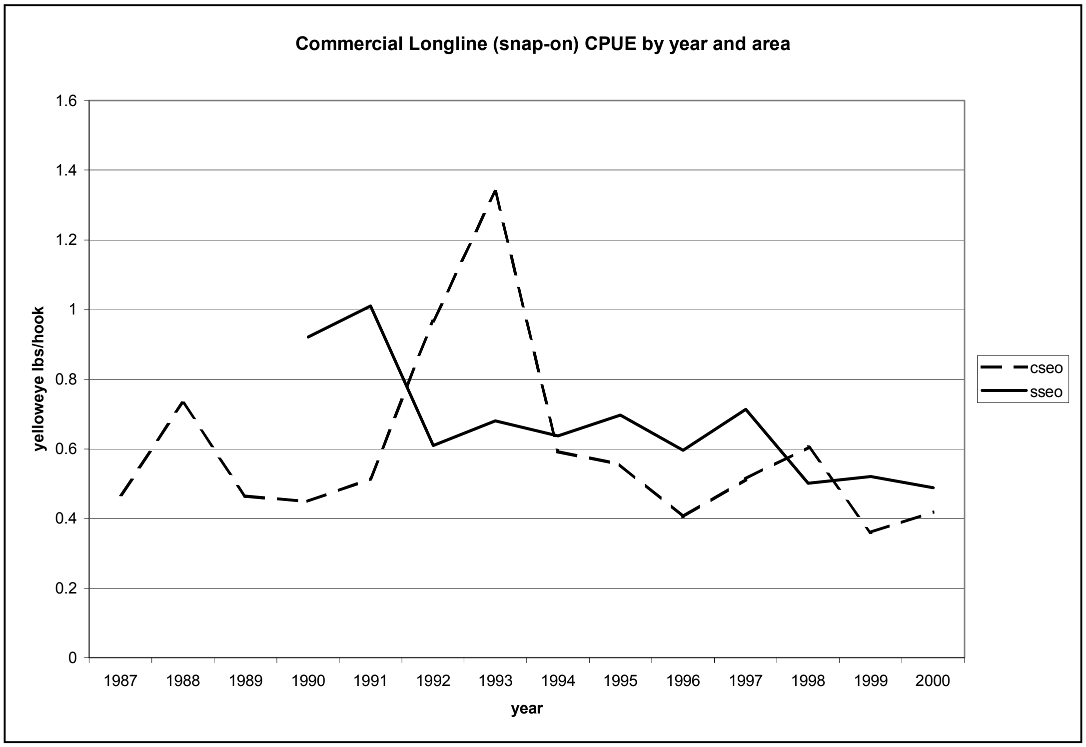


Figure 4. Commercial fishery catch per unit effort data, snap on longline gear for CSEO and SSEO, by year.

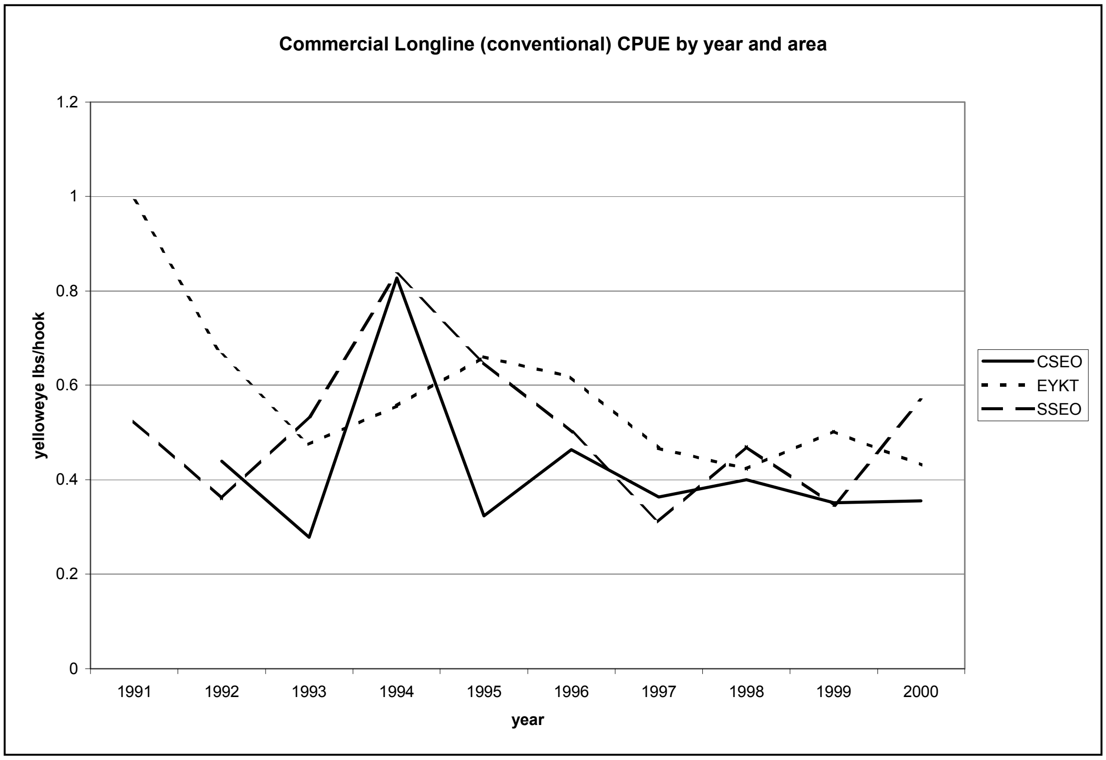


Figure 5. Commercial fishery catch per unit effort data, conventional longline gear, by area, and year.

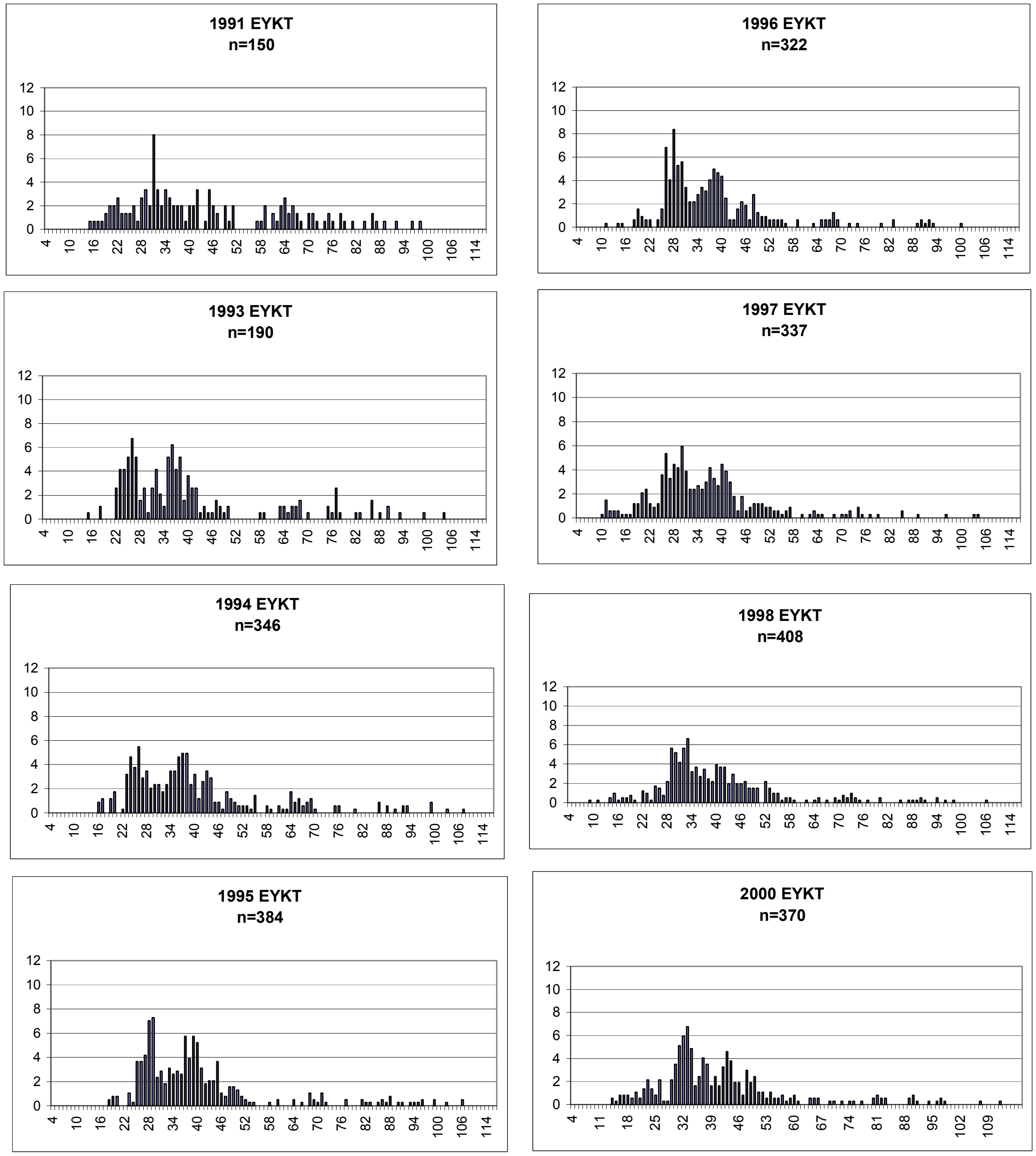


Figure 6a. Yelloweye rockfish age frequency distributions from EYKT commercial port samples.

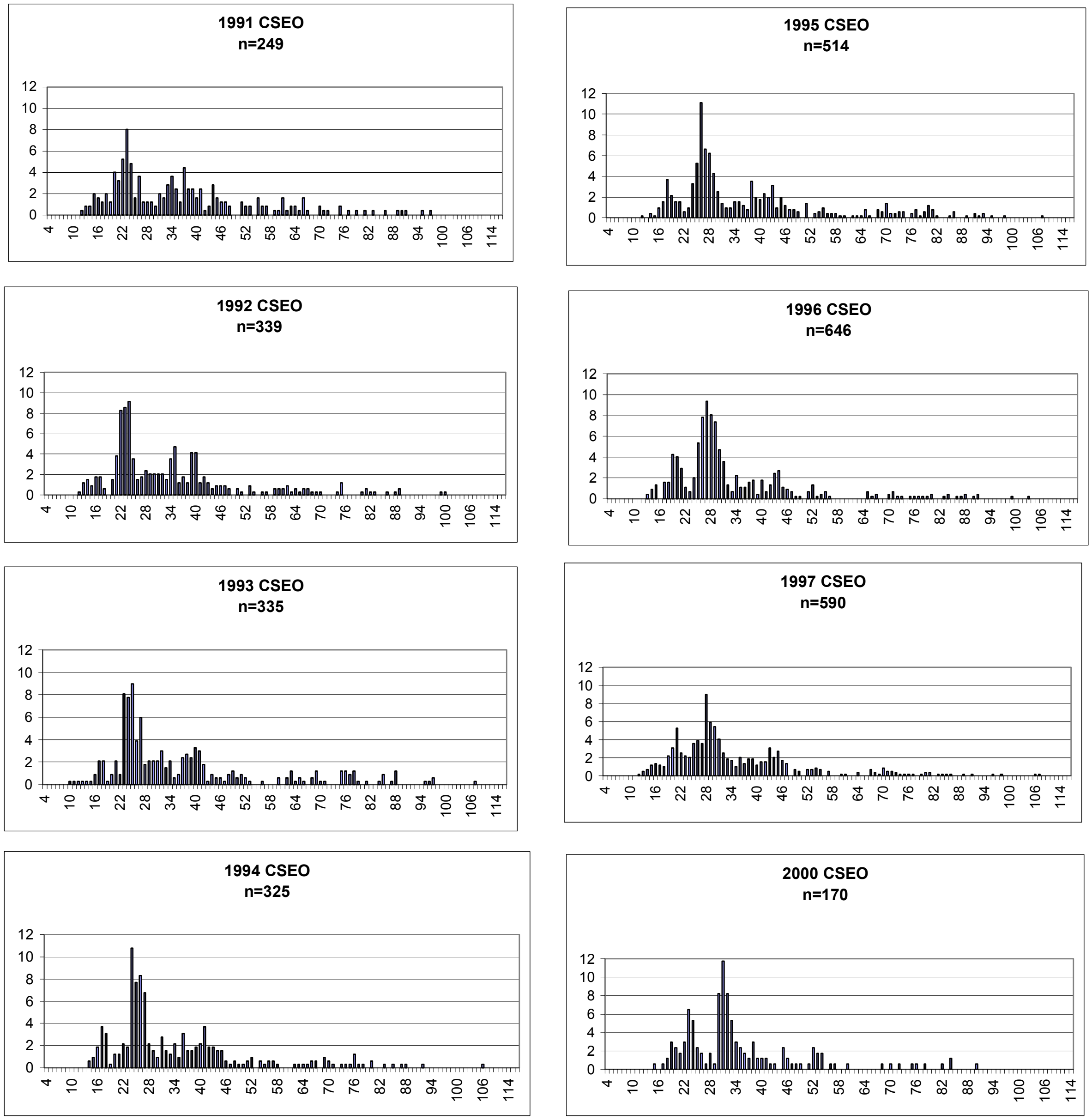


Figure 6b. Yelloweye rockfish age frequency distributions from CSEO port samples.

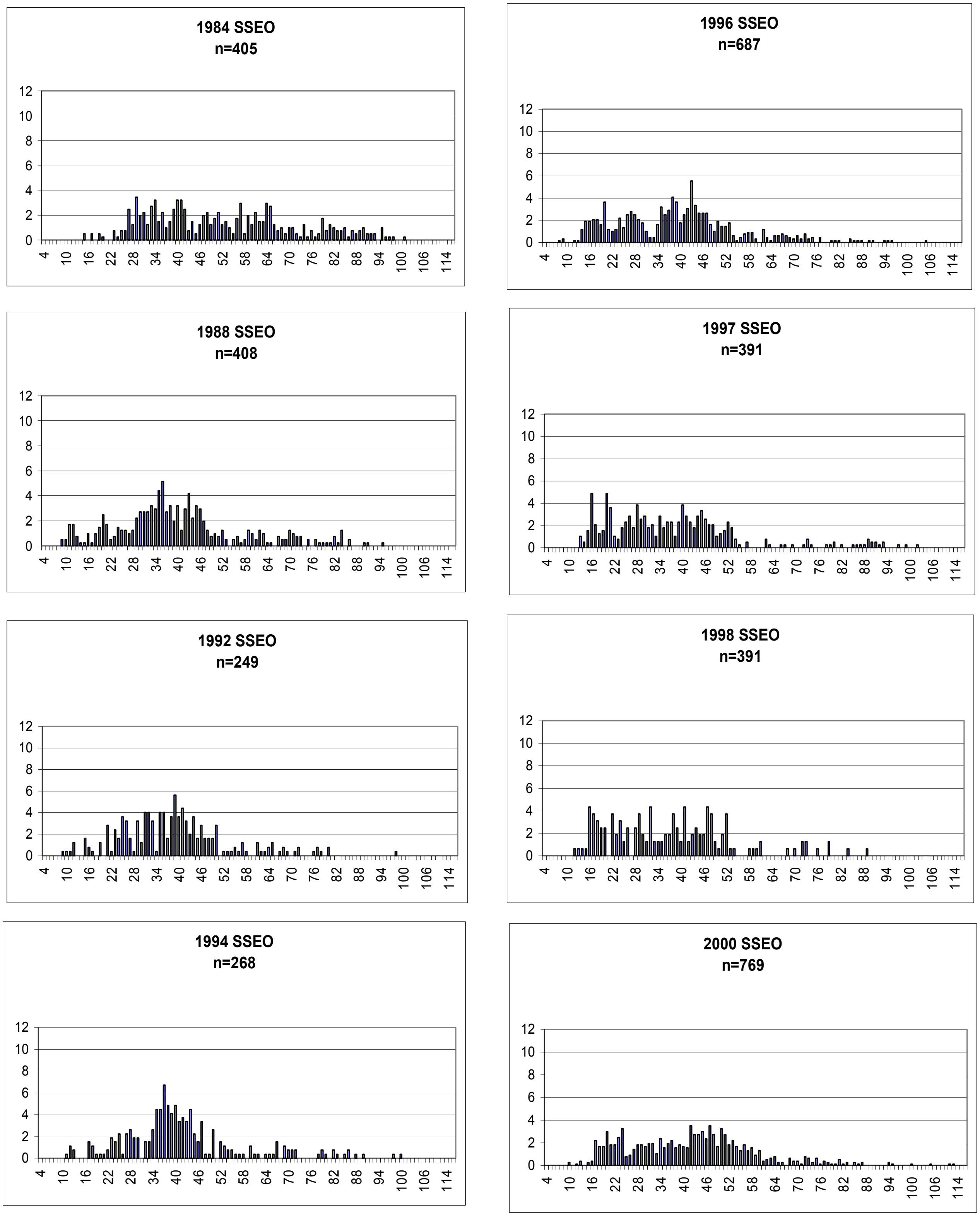


Figure 6c. Yelloweye rockfish age frequency distributons from SSEO commercial port samples.

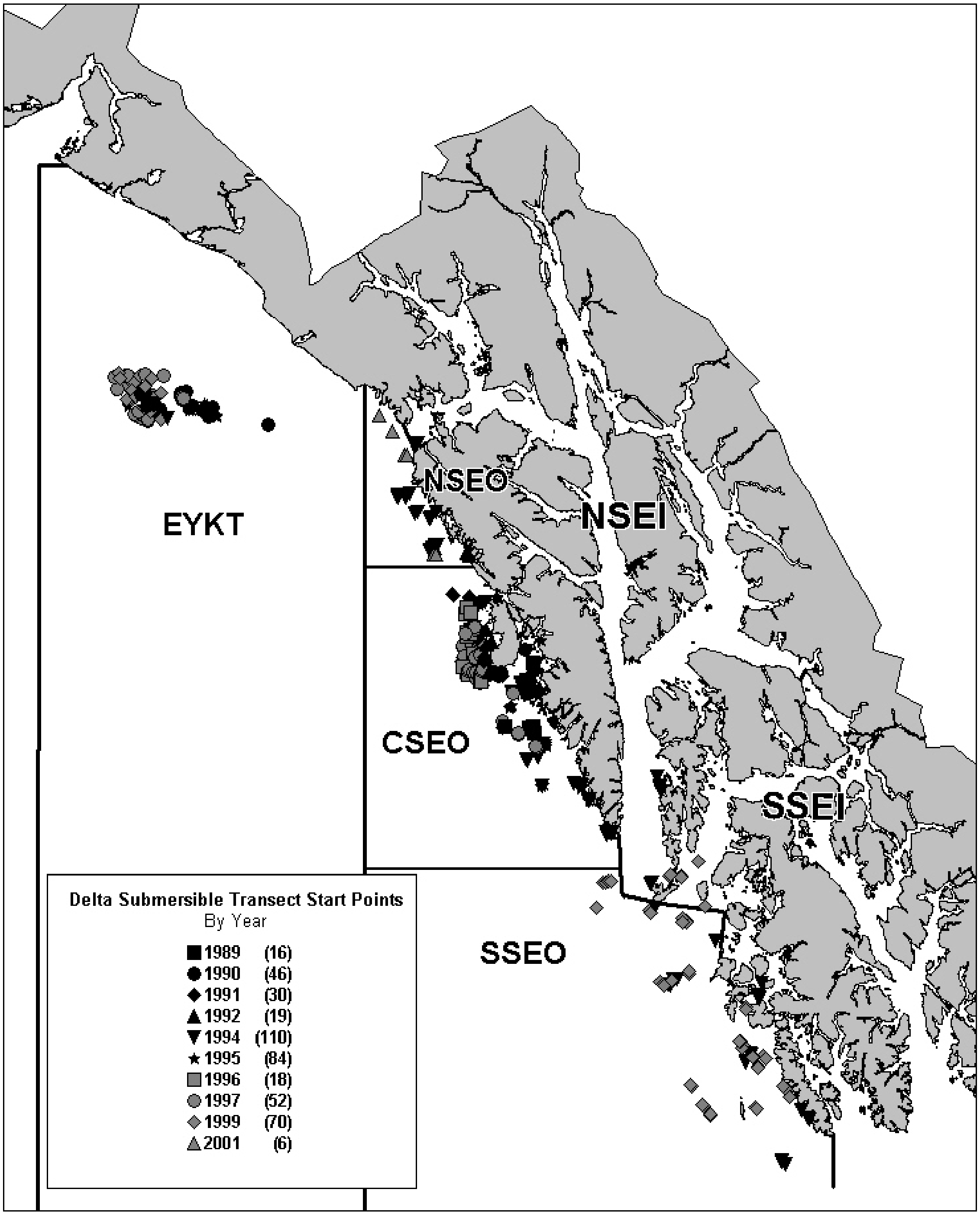


Figure 7a. Location of submersible live transects dives, Southeast Alaska 1990-1999.

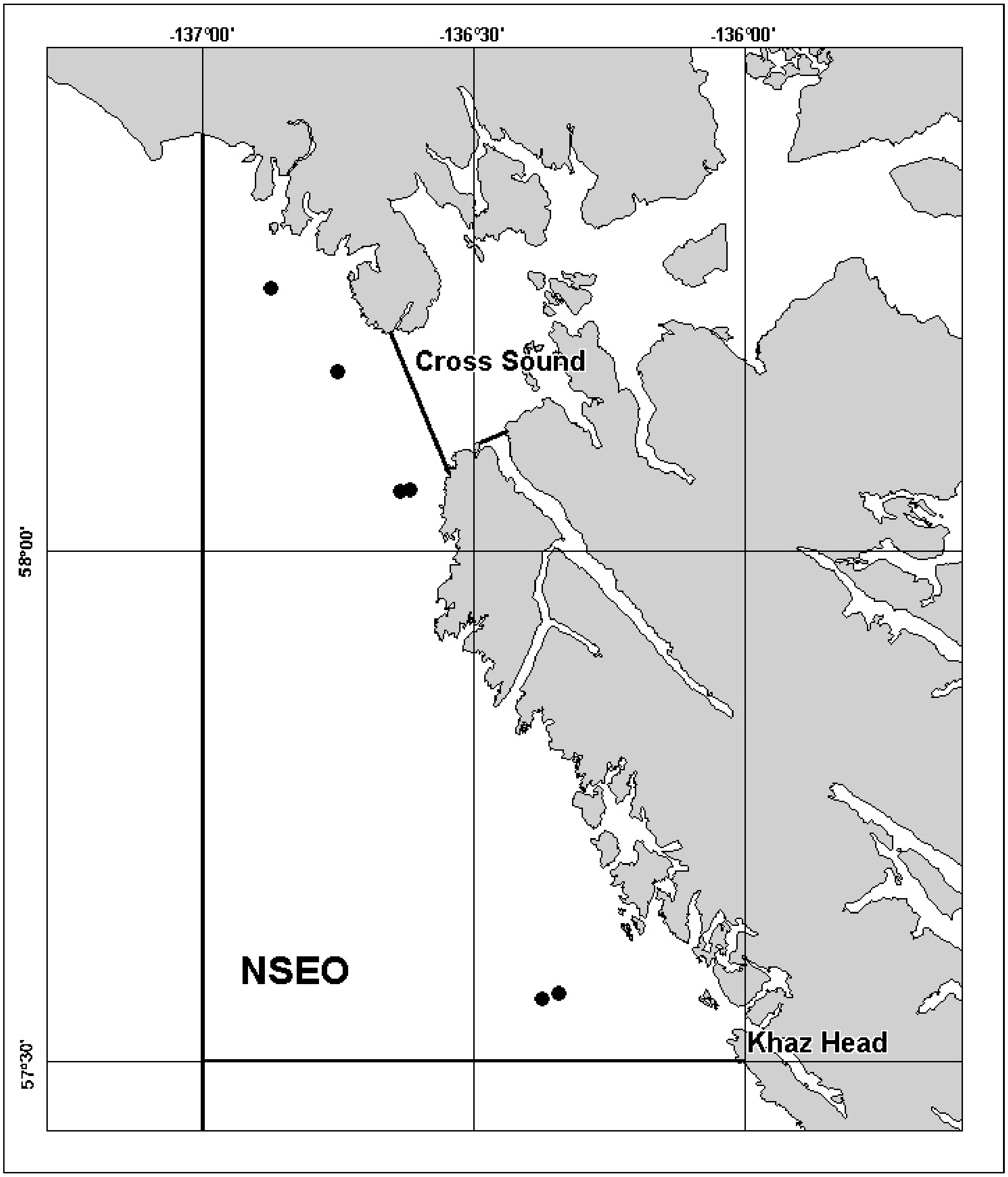


Figure 7b. Location of submersible transect dives, NSEO, 2000 survey.

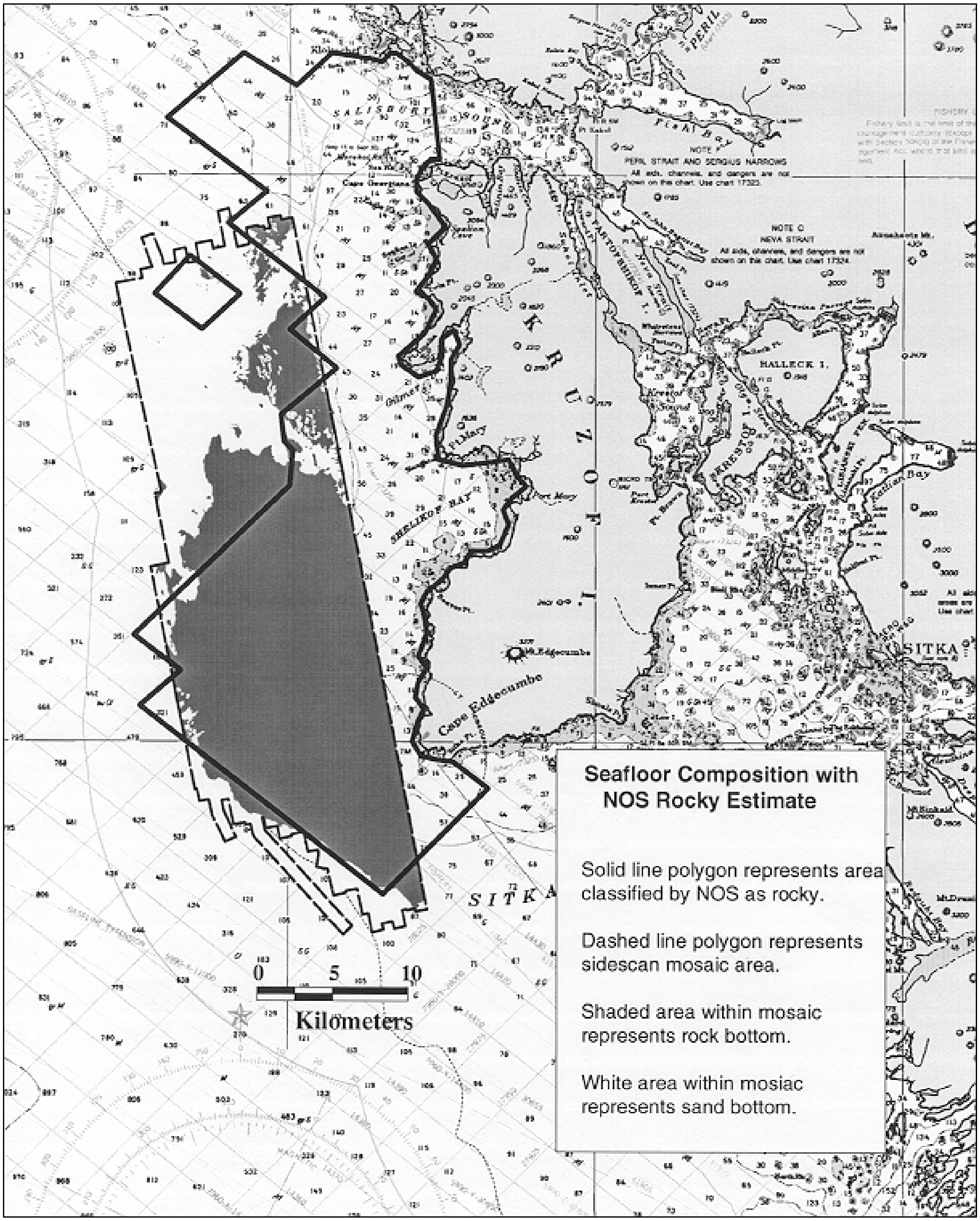


Figure 8. Comparison of area of rock habitat using NOS data versus geological interpretation using sidescan sonar data for a 536 sq. km are of seafloor off Kruzof Island.

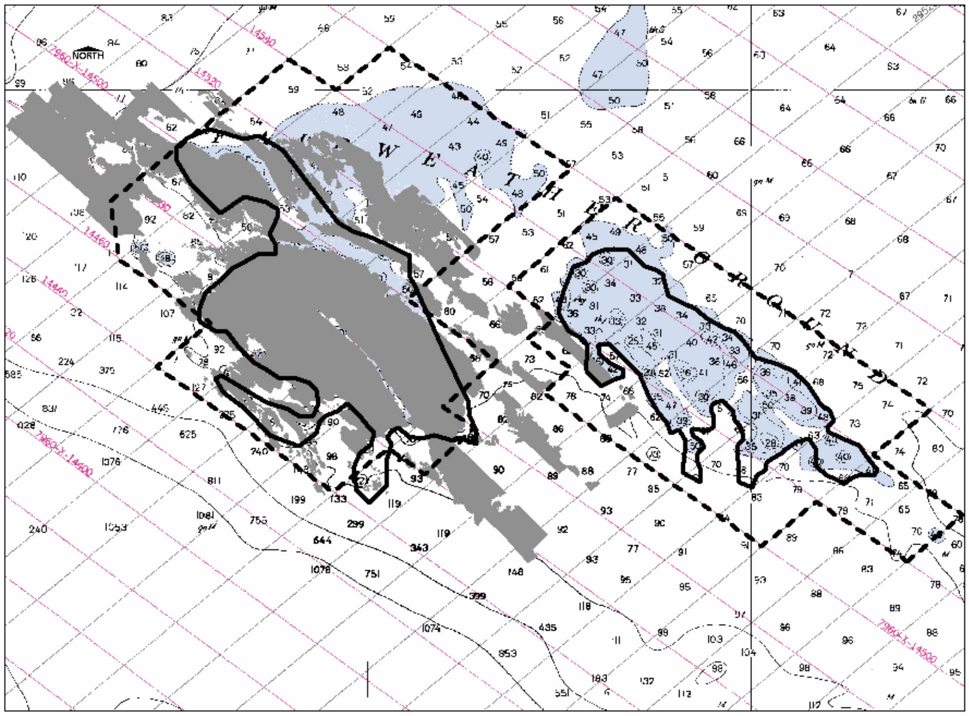
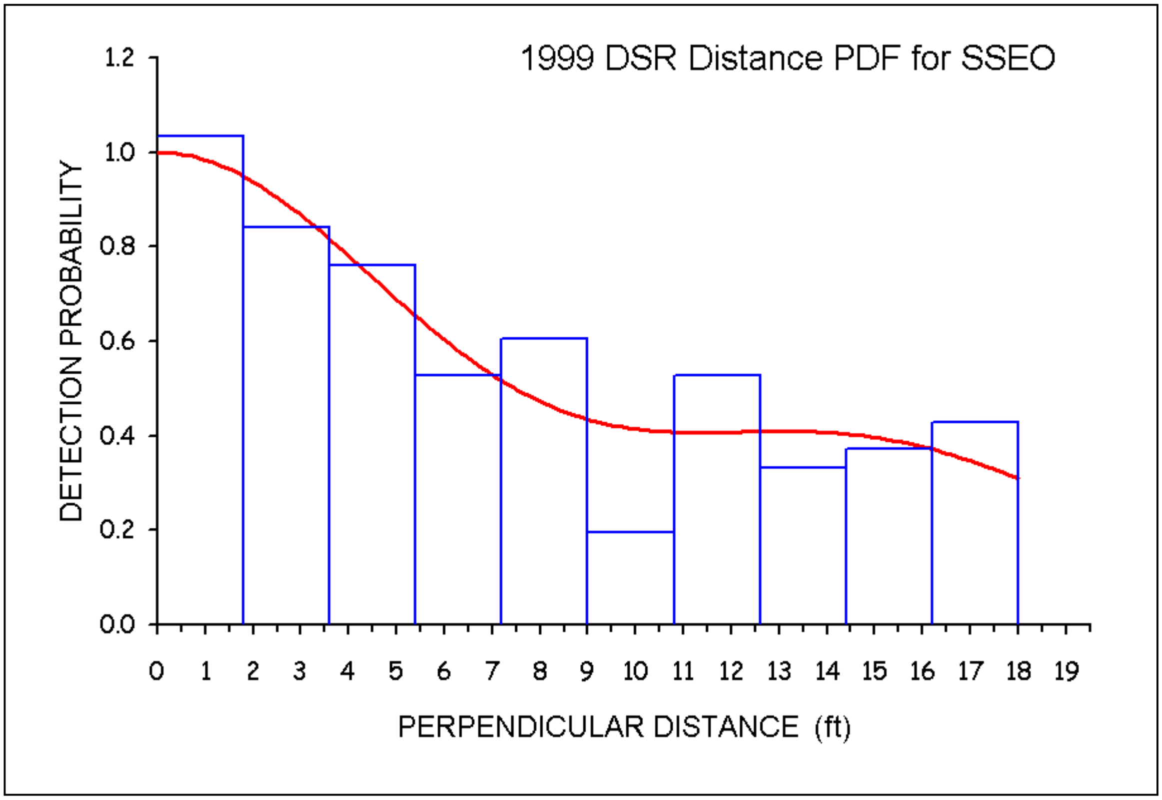
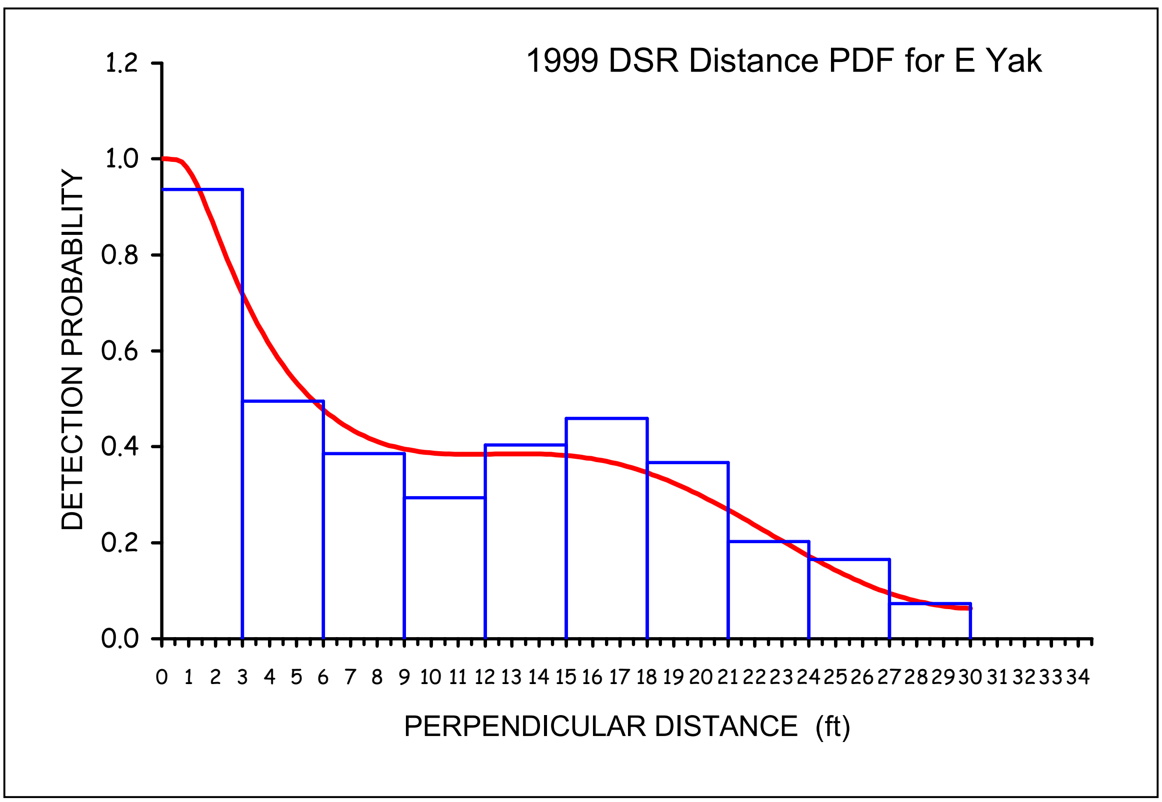
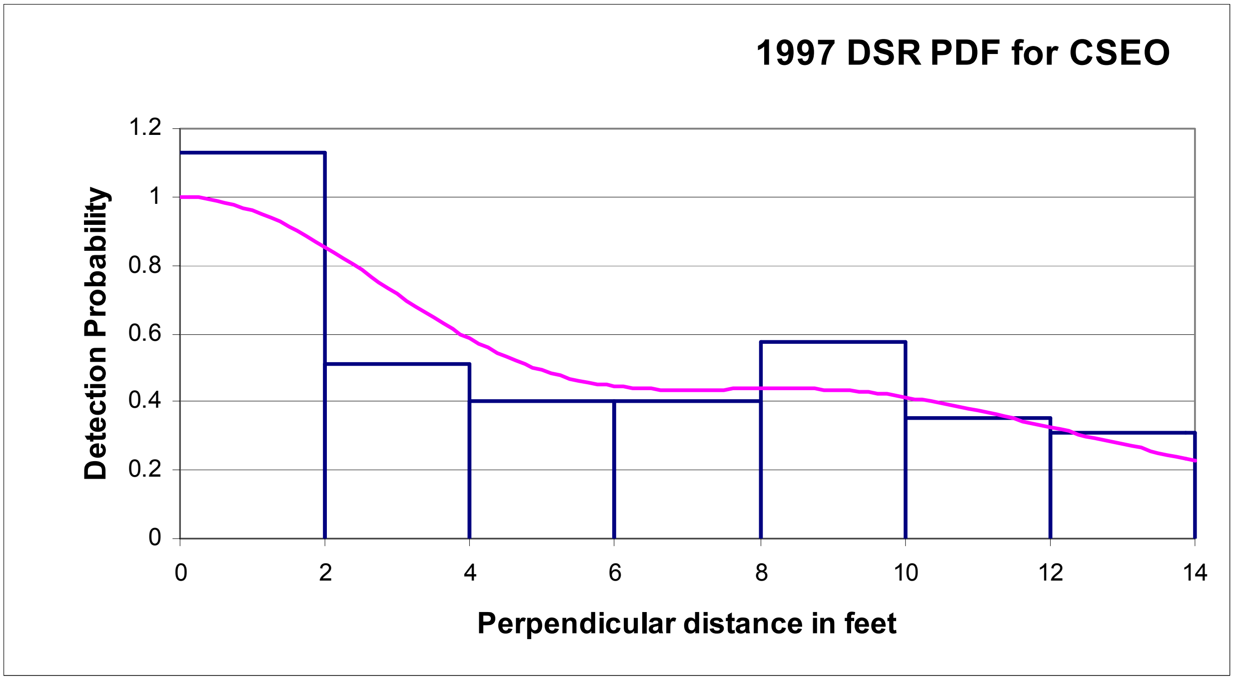


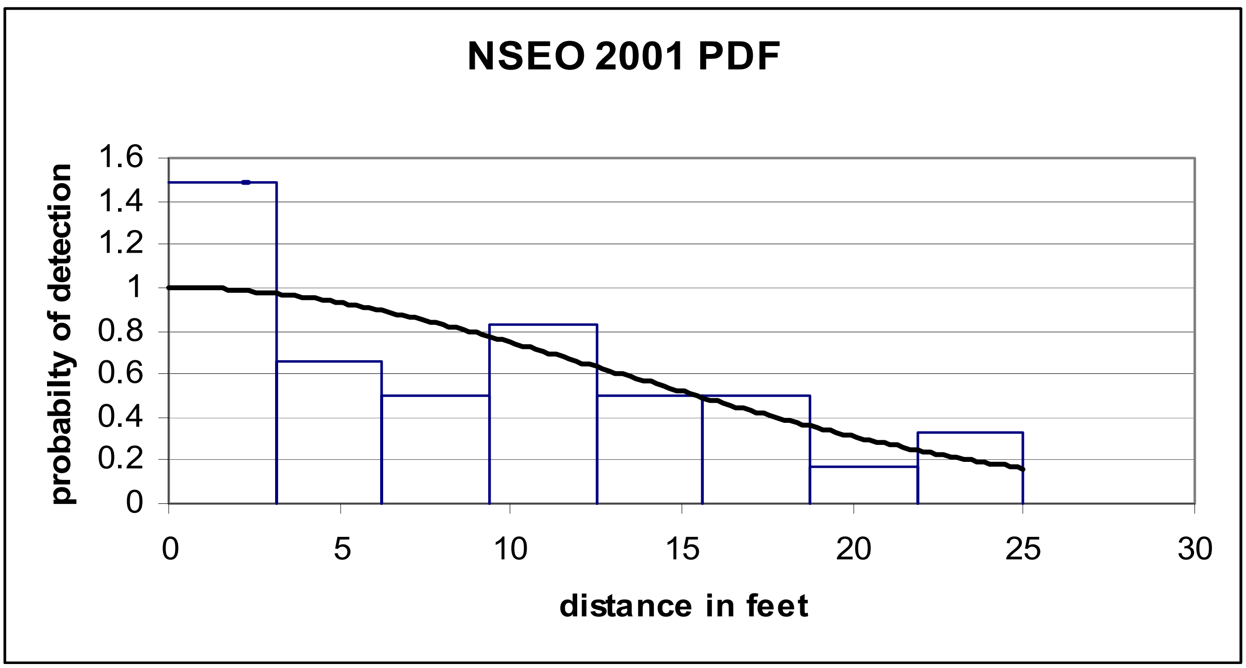
Figure 9. Comparison of delineation of rock habitat based on NOS data (dashed line) versus bottom recorder and submersible direct observation data (solid line) versus sidescan data (gray shaded area) for Fairweather Ground.

APPENDIX I. DISTANCE OUTPUT FOR 2002 ASSESSMENT


1999 DSR Distance PDF for SSEO
DETECTION PROBABILITY
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
PERPENDICULAR DISTANCE (ft)


1999 DSR Distance PDF for E Yak
DETECTION PROBABILITY
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
PERPENDICULAR DISTANCE (ft)


1997 DSR PDF for CSEO
Detection Probability
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
14
Perpendicular distance in feet


NSEO 2001 PDF
probabilty of detection
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
distance in feet

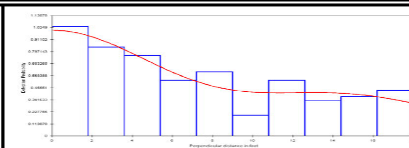
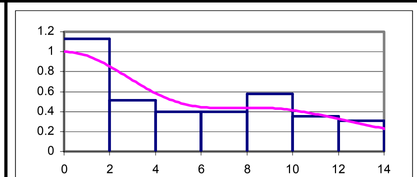
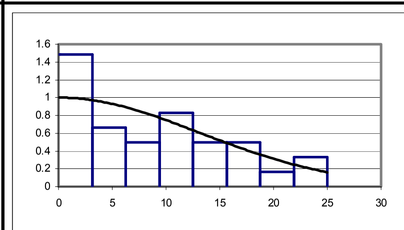
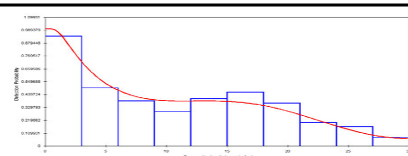
November 2001: Distance Output for Yelloweye Rockfish *(From Program DISTANCE).*

October 2001: Distance Output for Yelloweye Rockfish -new weight data and new density data for NSEO

From Program DISTANCE

Area	Detection Function Description	Density [D] (no./km^2)	s.e. [D]	CV(D)	AIC	Chi-square	k	L	n/L	s.e. n/L	f(0)
SSEO	1999: Intervals 0, 1.8, 3.6 to 18 & half norm/cosine vs. haz/cos vs. haz/herm models	**1878.9**	321.48	0.1711	1290.2	0.08992	45	49663	0.005799	0.00086537	0.098757
CSEO	1997: Intervals, 0,2,4,...,14; (Dave's run). 99 weights	**2533.9**	509.07	0.2009	625.5	0.05	32	29176	0.0057	880.0E-6	0.13574
NSEO 2001	2001	**1420**	446.4	0.3144	188.59	0.6874	6	4474	0.0067054	1.8E-3	0.0645
EYKT (All)	1999:Intervals 0, 3, 6 to 30 & Half Norm/Cosine, Haz/Cos, Haz/Herm	**2322.5**	716.17	0.3084	891.92	0.4625	20	25646	0.0080323	0.0012185	0.088131

Results chosen as best estimates, based on goodness of fit of model to data (judged by visual examination of plot and X2 goodness of fit test);NSEO data from 2001 is not well fit given small sample sizes
visual examination of goodness of fit near the origin; the shape of the detection function [a regular shape with a shoulder is best];
and the CV of density, with a lower CV being better.

n	var(n)	cv[f(0)]	cv(n)	df (Buckland et al p 90)	Detection Function	95% Lower	95% Upper	90% Lower	90% Upper	
						Log-based Confidence Intervals based on Replicate Transects				
288	1847.011382	0.0837	0.149225244	74.9		1339.40	2635.72	1415.86	2493.37	
166	659.199463	0.1288	0.1547	81.00	 Irregular, small shoulder, MARGINAL FIT @ ORIGIN	1705.69	3764.25	1819.90	3528.03	
30	65.7941935	0.1604	0.2704	9.00		709.07	2843.73	808.89	2492.79	
206	976.5406876	0.2685	0.151697335	170.4		1281.08	4210.52	1410.85	3823.23	

Area	2000 Mean Wt. (kg) [w]	2000 Std. Error Mean Wt. [s.e.(w)]	CV[w]	Area of Rocky Habitat (km^2) [A] (1999 estimate)	Biomass (kg) for Area [bk]	*Biomass (mt) for Area [bm]*	Var(biomass) for Area [Var(bk)]	CV(bk)	Lower 90% CL (kg) [l90]
Area	Formulae to the right indicate how parameters are estimated -->				= w*D*A	*=bk/1000*	=bk^2*(CV(d)^2 +CV(wt)^2)	=sqrt[Var(bk)]/bk	=bk/(exp(1.645*(ln(1+CV(bk)))^0.5))
SSEO	3.48	*0.0697*	*0.0200*	*851.00*	*5564324.77*	*5564.32*	*906410567135.91*	*0.1711*	*4207817.28*
CSEO	3.230	0.0423	0.0131	1184.00	9,690,444.45	9690.44	3806175390976.60	0.2013	6981351.68
NSEO	*2.98*	*0.0953*	*0.8778*	*357.0000*	1,510,681.20	1510.68	1984079117120.18	0.9324	411246.99
EYKT (All)	4.04	0.0573	*0.0142*	*703.00*	6,596,178.70	6596.18	4146972379739.22	0.3087	4015452.64

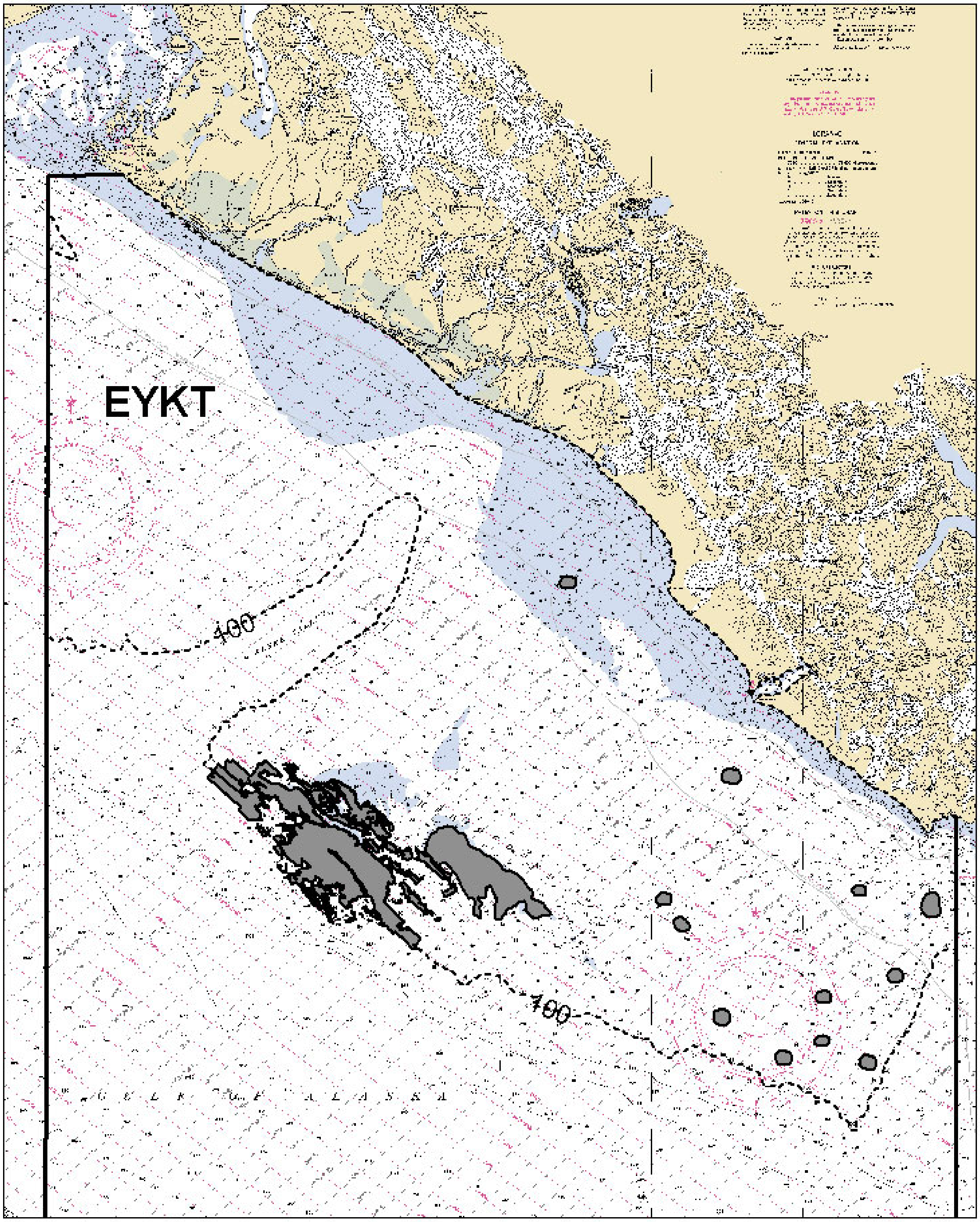
Approximations for variance of a product

of independent variables used. (Goodman, L.A. 1960. On the exact variance of products. J. Amer. Stat. Assoc. 55:708-713.)

SEO overall	23361629.12	*23361.63*	10843637454971.90	0.1410	18547988.88

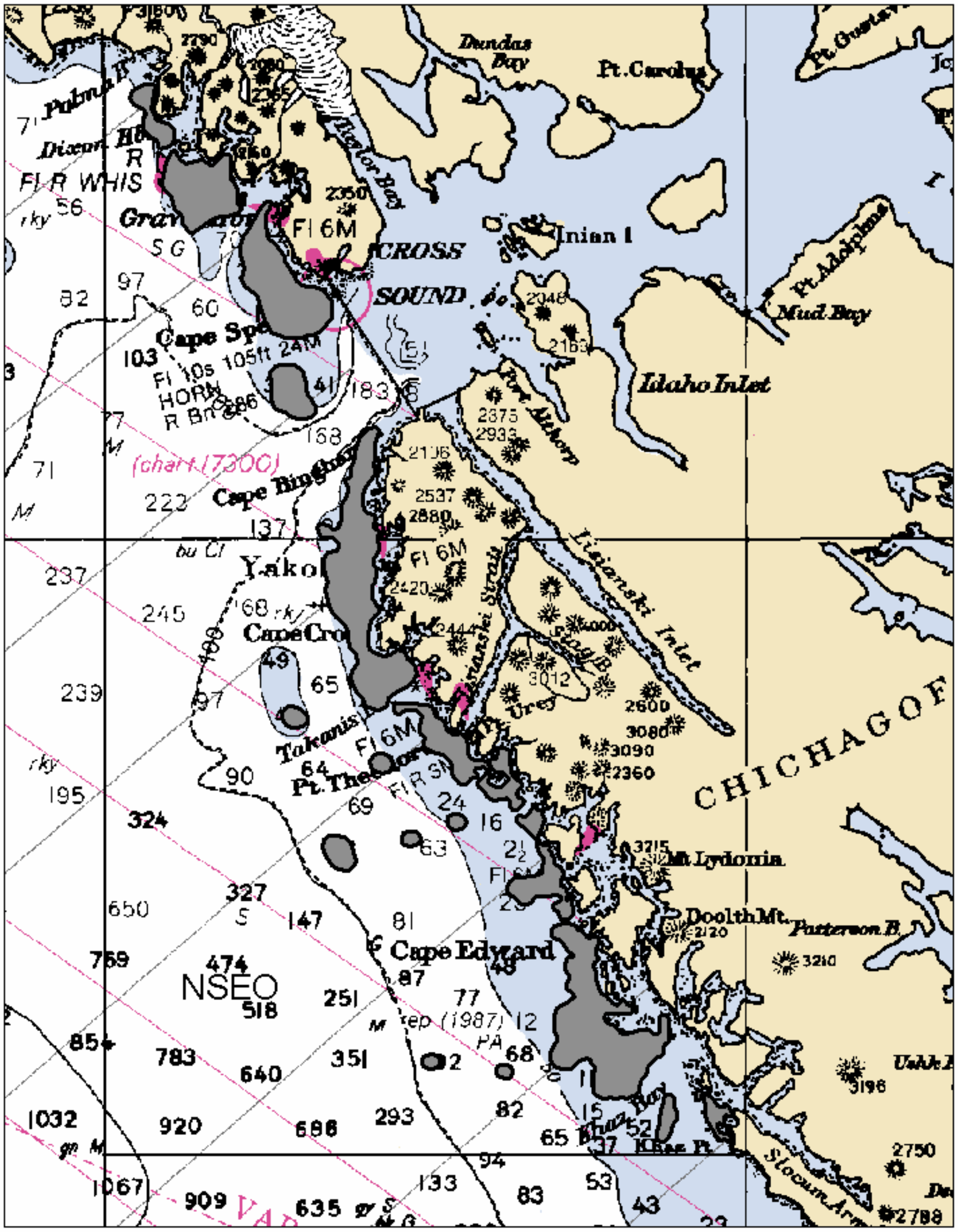
	Upper 90% CL (kg) [u90]	*Lower 90% CL (mt)*	*Upper 90% CL (mt)*		
Area	=bk*(exp(1.645*(ln(1+CV(bk)))^0.5))	*=l90/1000*	*=u90/1000*	yelloweye F=.02, mt	DSR TAC (ye/.9), mt
SSEO	*7358140.35*	*4207.82*	*7358.14*	84	94
CSEO	13450792.62	6,981.35	13,450.79	140	155
NSEO	5549360.27	411.25	5,549.36	8	9
EYKT (All)	10835533.97	4,015.45	10,835.53	80	89
	Totals, mt:	15615.87		312	347
Overall SEO	29424522.45	18,547.99	29,424.52	371	412

APPENDIX II. CHARTS DELINEATING AREA OF ROCK HABITAT INSIDE THE 200 M CONTOUR, 1999 ESTIMATES



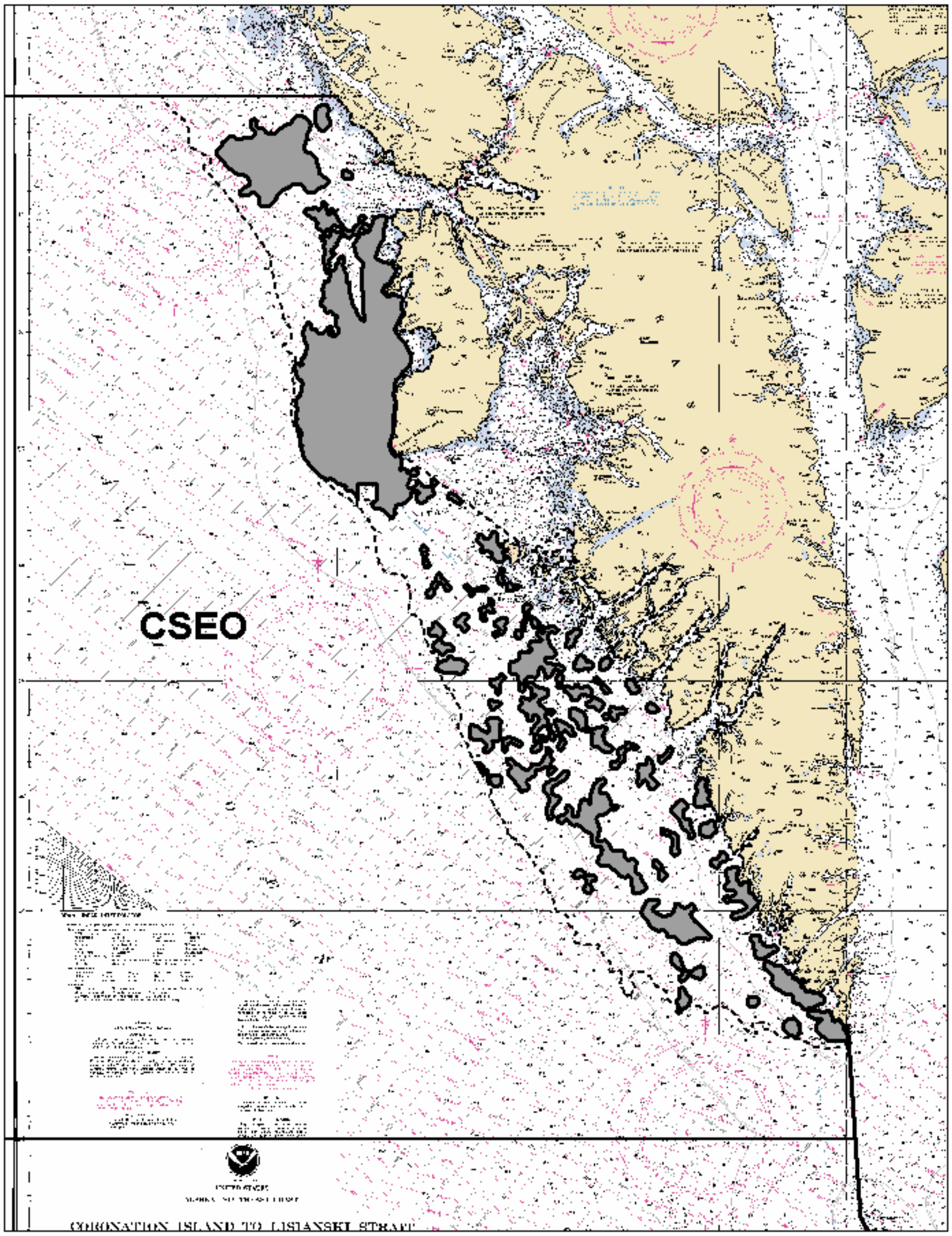
EYKT total area inside 100 fathoms: 15,100 sq. km. Rocky area: 702.5 sq. km.

Appendix II, Figure 1. Shaded area represents rock habitat.



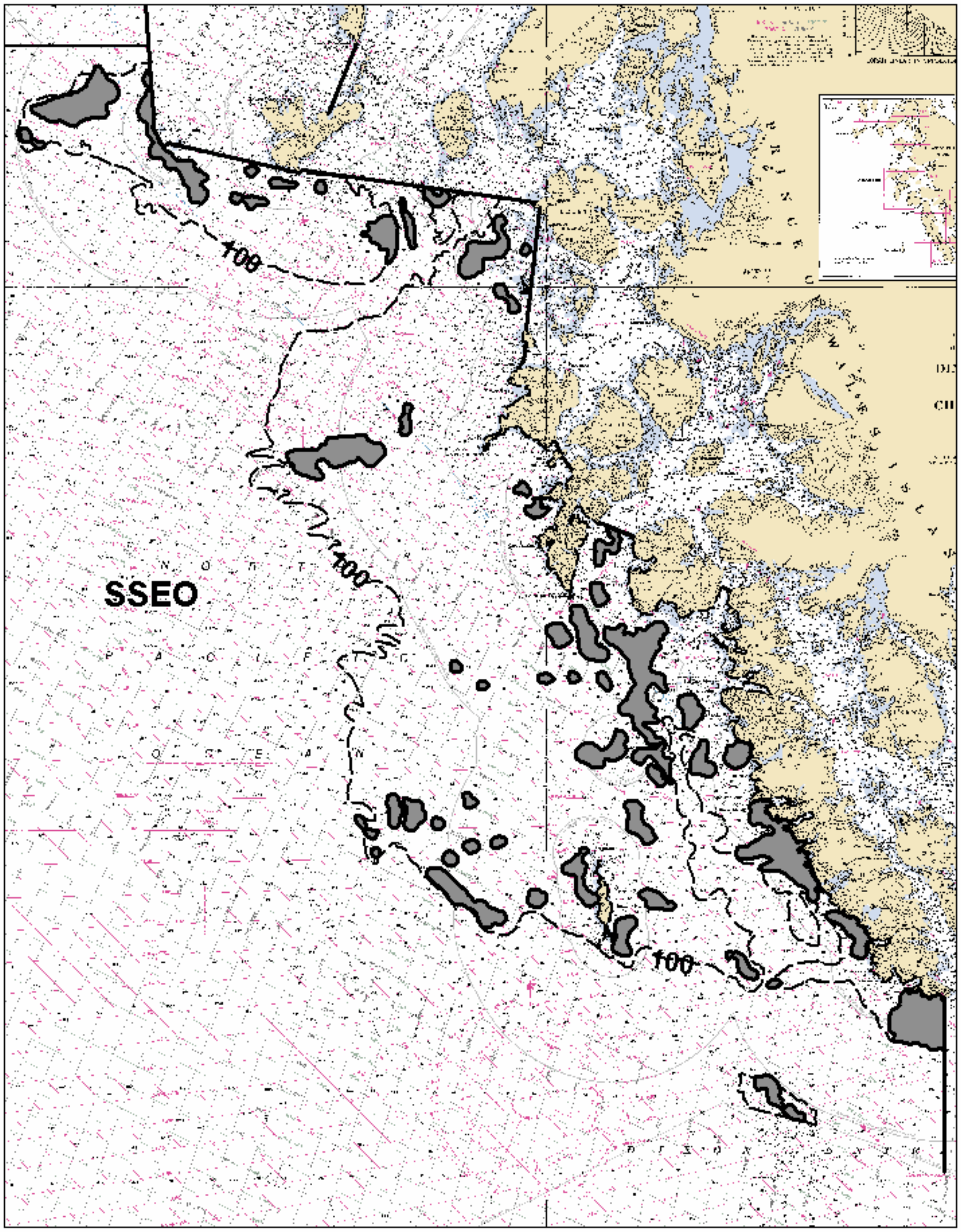
Total area inside 100 Fa = 1,848 Sq. Km. Total rock inside 100Fa = 356.7 Sq. Km. (19.3%)

Appendix II, Figure 2. Shaded area represents rock habitat.



Total area inside 100 fa = 4,141 Sq. Km. Area of rock inside 100 fa = 1,184 Sq. Km. (28.6 %)

Appendix II, Figure 3.   Shaded area represents rock habitat.



Total area inside 100 fathoms = 6,066 Sq. Km. Area of rocky habitat is 851.4 Sq. Km.

Appendix II, Figure 4. Shaded area represents rock habitat.

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