Section 11 Demersal Shelf Rockfish Assessment for 2004

By
Victoria O'Connell, Cleo Brylinsky and David Carlile
November 2003

Executive Summary

Relative to the December 2002 Stock Assessment and Fishery Evaluation report (SAFE), the following substantive changes have been made:

Input Data

New estimates of yelloweye density for the Central Southeast Outside area (CSEO) and East Yakutat area (EYKT) from the 2003 survey were used. Yelloweye average weight and standard error data were updated using 2002 and winter 2003 port samples. New age data from the 2002 fishery are included.

Assessment Results

The exploitable biomass estimate for yelloweye rockfish for 2004 is 20,168 mt.

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

The SSC had no specific comments regarding the Demersal Shelf Rockfish (DSR) stock assessment.

ABC and Overfishing Levels

The ABC for 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 450 mt. The overfishing level (690 mt) was set using $F_{35\%}$=0.031 and adjusting for the 10% of other species landed.

11.1 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 (O'Connell and Brylinsky 2003) (Figure 1).

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. 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).

Rockfishes are considered viviparous although different species have different maternal contribution (Boehlert and Yoklavich 1984, Boehlert et al. 1986, Love et al 2002, Yoklavich and Boehlert 1995). 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, the State of Alaska and the National Marine Fisheries Service manage DSR jointly. The two internal state water subdistricts, NSEI and SSEI are managed entirely by ADF&G and are not included in this stock assessment (Figure 2).

11.2 FISHERY

11.2.1 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 200 m and the 90 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 being caught. Price per pound (round) has increased significantly over time, with a maximum price paid of $2.60 in 2003.

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. The directed fleet requested a winter fishery, 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 at sea discard) in other fisheries.

11.2.2 Bycatch

Landed bycatch in the DSR fishery includes lingcod, Pacific cod, and other rockfishes. For example, in the 2002 directed DSR fishery landed weight included 413,055 round pounds of DSR, 48,000 lbs of lingcod, 20,500 lbs of Pacific cod, 9,000 lbs of dusky rockfish, 7,500 lbs of redbanded rockfish, 6,000 lbs of silvergrey rockfish, and 3,000 lbs of black rockfish. The magnitude of at-sea discard in the directed DSR fishery is difficult to quantify as this is an unobserved fleet. However, logbook data indicates primary discarded bycatch includes dogfish, skates, and halibut.

11.2.3 Discards

DSR have been taken as bycatch in domestic longline fisheries, particularly the halibut fishery, for over 100 years. 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 2002, reported DSR bycatch in the halibut fishery accounted for over 40% of the total reported DSR landings in the SEO subdistrict.

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 49,344 pounds of yelloweye were forfeited in southeast Alaska compared to 13,767 in 2000. Of this 49,344 pounds, permit holders retained 8,944 pounds for personal use.

Landed bycatch of DSR does not reflect the true mortality of bycatch as most rockfish suffer embolism mortality when caught and do not generally survive when released. Only a portion of bycatch is landed and reported on fishtickets. 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. International Pacific Halibut Commission (IPHC) longline survey data indicates that bycatch of DSR is highly variable both inter-annually 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 exceeded.

The IPHC has provided us with data from recent longline surveys. Bycatch is estimated based on sampling the first 20 hooks of each skate of gear. There are obviously some problems in estimating total bycatch using this sampling approach. DSR tend to be contagiously distributed because they are habitat specific in their distribution. The 2003 IPHC survey bycatch of yelloweye, expressed as the percent of yelloweye weight to legal-sized halibut weight ranged from 0% to 83%, with area estimate means ranging from 3% in EYKT to 12% in CSEO. The overall rate ranged from 4% in EYKT and 18% in NSEO (Figure 4).

Estimated total mortality of DSR in the halibut fishery has ranged between 130 mt to 355 mt annually. Before the implementation of the halibut Individual Fishery Quota (IFQ) fishery, we estimated unreported mortality of DSR during the halibut fishery based on 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. For 2003, it was estimated that a total of 275 mt of DSR would be caught in the SEO halibut fishery; 145 mt have been landed and reported as of October 10, 2003. Based on the 2002 halibut landing data, it is estimated that approximately 47% of the 2C (IPHC Regulatory Area) halibut quota and 11% of the 3A halibut quota are taken in SEO (IPHC web page). Total bycatch mortality of DSR in the halibut fishery is estimated using 10% bycatch mortality in 2C and IPHC statistical area 190 (Fairweather Ground) and a 5% bycatch mortality in the remaining portions of 3A east of 140^o. Based on the 2003 halibut quotas and the distribution of commercial halibut harvest in 2002, the estimated total DSR mortality for the 2004 SEO halibut fishery is anticipated to be 288 mt. If the 2004 halibut quota is different from the 2003 quota the estimate will be revised. There is some indication in the yelloweye biological data that we may be underestimating bycatch mortality, and consequently harvesting at a higher rate than intended.

11.2.3 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 726 mt in 1987. Total landings exceeded 900 mt in 1993. Directed commercial fishery landings have often been constrained by other fishery management actions. In 1992 the directed DSR fishery was allotted a separate halibut prohibited species cap (PSC) and is therefore no longer affected 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 136 mt in 2002, bycatch landings totaled 153 mt, 96% of which were landed in the halibut fishery.

Sport catch of yelloweye in Southeast is difficult to determine. Preliminary estimates of landed catch of yelloweye from Southeast in 2001 (the last year data is available for) indicate over 26,000 fish were landed[1]. Total catch likely exceeds landed catch, as there is a bag limit of 2 or 1 per day depending on area.

11.3 DATA

11.3.1 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 96%, by weight, of DSR landed in all commercial fisheries in SEO during 2002. Biological information detailed below is reported for yelloweye rockfish only.

Commercial fishery catch per unit effort (CPUE) expressed as round pounds of yelloweye rockfish per hook for vessels using conventional gear has been fairly stable in CSEO and shows a slow decline in SSEO for the past two years after increasing in between 1998 and 2001 (Figure 5). Overall CPUE is generally higher for snap-on gear than for conventional longline gear.

11.3.2 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). 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. This number is similar to the estimate of Z from a small sample from CSEO in 1981 and to the 0.0196 estimated for a lightly exploited stock of yelloweye on Bowie Seamount (Lynne Yamanaka, Department of Fisheries and Oceans Canada, Pacific Biological Station, pers. comm). Hoenig’s geometric mean method for calculating Z yields estimates of 0.033 when using his fish parameters, and 0.038 when using his combined parameters, and a maximum age of 121 year (Hoenig 1983). Wallace (2001) set natural mortality

[1] Unpublished data, Mike Jaenicke, Alaska Department of Fish and Game, Sport Fish Division, Douglas, AK.

equal to 0.04 in his stock assessment of west coast yelloweye. For the Northern California and Oregon data the model performed better when M was set constant until 50% maturity then increased linearly until age 70 (Wallace 2001).

Catch curve analysis of recent age data was run for each management area in SEO. The port sampling data from 2000-2002 were used and a line fit to the data between the majority of the ages (approximately 20-60 years). The estimate of Z is 0.03 for SSEO, 0.04 for EYKT, and 0.056 for CSEO (Table 3). Catch curves are problematic for fish with variable recruitment however, given a natural mortality estimate of 0.02, the catch curve results indicate that we may be exceeding our harvest policy of 2 percent in the CSEO area.

11.3.3 Growth Parameters

Von Bertalanffy growth parameters and length weight parameters for yelloweye are listed in Table 4. These parameters were calculated using 2000 to 2002 port sample data. Males attain a larger maximum size than females and there appears to be a slight trend in the data for increasing growth with increasing latitude (Table 4). Estimated length and age at 50% maturity for yelloweye collected in CSEO are 42 cm and 22 years for females and 43 cm and 18 years for males (Table 5). 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.

11.3.4 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 1987). Sagittal otoliths are collected for aging. The break and burn technique is used for distinguishing annuli (Chilton and Beamish 1983). Radiometric age validation has been conducted for yelloweye rockfish otoliths collected in Southeast Alaska (Andrews et al 2002). Radiometry of the disequilibrium of ^{210}Pb and ^{226}Ra was used as the validation technique. Although there is not a tight relationship between growth-zone-derived ages and radiometric ages, Andrews et al conclude support for age that exceeds 100 years from their observation that as aged derived from growth zones approached and exceeded 100 years, the sample ratios measured approached equilibrium. Maximum published age for yelloweye is 118 years (O'Connell and Funk 1987), but one specimen from the SSEO 2000 samples was aged at 121 years.

In CSEO, the area with the longest directed fishery harvest history, a bimodal pattern has been present in the age distribution since 1992 and the oldest ages have declined in frequency over time (Figures 6a-b.). Maximum age for fish sampled from CSEO in 2002 is 109 years and the average age is 36. There is a strong mode at 26 years and a secondary mode around 33 years. Very few fish are represented in the 60 and older ages. In 2000 and 2001 it appears that 31 year olds and 33 year olds respectively contributed significantly, accounting for 11% of the samples in each year. The corresponding year classes do not appear strong in prior years nor do they appear particularly strong in 2002. In the SSEO samples the 2002 age data has a bimodal distribution with a strong mode at 24/25 years and smaller modes at 34 and 44 years (Figures 6c-d). Maximum age is 116, with very few fish older than 60. The SSEO samples had an average age of 40 years. No new samples were available for EYKT as there are currently no directed fisheries in this area (Figure 6e-f) and no age data is available for NSEO.

11.3.5 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, 1999, and 2003; the CSEO section during 1990, 1994, 1995, 1997, and 2003; the NSEO section in 1994 and 2001; and the SSEO section in 1994 and 1999. A total of 573 line transects have been run since 1989 (Figures 7, 8 and 9). 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 based on adult yelloweye biomass. 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 transect line length 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.

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.

Beginning in 1997, we positioned the support ship directly over the submersible at five-minute time intervals and used the corresponding Differential Global Positioning (DGPS) fixes to determine line length. In 2003 the submersible tracking system was equipped with a gyro compass, enabling more accurate tracking of the submersible.

11.4 ANALYTIC APPROACH

For each area yelloweye density was estimated as:

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

(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. 1998, 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, AIC value, and X^2 goodness of fit test (Appendix 1)). The sample size for the 2001 NSEO survey data is quite small (six transects, 30 yelloweye) and there is substantial variance around this estimate. Sample size, number of yelloweye observed, and meters surveyed is shown by area and year in Table 6.

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 fish weight, and area 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).

Beginning 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 that 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 large reduction in estimated area of rock habitat in non-Fairweather portions of EYKT, we used Fairweather data for the entire EYKT area.

11.4.1 2003 Density Estimates

New density surveys were conducted during 2003 in CSEO and EYKT (Figures 8 and 9). There were no new surveys of NSEO and SSEO. Yelloweye rockfish density for this stock assessment is based on the last best estimate. The SSEO area was last surveyed in 1999, and NSEO was surveyed in 2001. Density estimates by area range from 1,420 to 3,557 adult yelloweye per km^2 (Table 7).

The density estimates for CSEO in 2003 were 1,864 adult yelloweye/km^2 (CV=11.22%). This is significantly lower than the previous estimate obtained in 1997 of 2,534 adult yelloweye/km^2 (CV=16.6%). In 1997 there were only 32 transects run compared to 102 in 2003. The PDF has a better fit to the data in 2003 compared to 1997 (Figures A1 and A2, appendix).

The density estimates for EYKT in 2003 were 3,557 adult yelloweye/km^2 (CV=17.2%). This is higher than the 1999 estimate of 2,322 adult yelloweye/km^2 (CV=30.8%). The sample sizes were equal in both survey years (20 transects run) however the PDF has a better fit to the 2003 data compared to the 1999 data set (Figures A3 and A4, appendix).

11.4.2 Habitat

Area estimates of yelloweye habitat are based on the known distribution of rocky habitat inshore of 110 fathoms. Information used to identify these areas includes NOS data, sidescan and multibeam data, direct observation from the submersible, and commercial logbook data from the directed DSR fishery. Beginning in 2002, we revised estimates of area of yelloweye habitat using the following protocol: In areas with multibeam and/or sidescan sonar data area of yelloweye habitat is delineated based on defined habitat types within the mapped area. For areas without these data sets we use the position data from 1993-2000 commercial logbooks, buffered to 0.5 mi from the start position. Longline sets must have at least a 0.04 yelloweye/hook catch rate to be included in the data. Prior to the 2002 assessment the commercial logbook data was not buffered and our estimate of yelloweye habitat was based on hand drawing polygons encompassing set start locations as well as NOS habitat data. Because these new estimates are based on confidential logbook information, maps are not available.

11.4.2.1 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.

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. 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, 403 km^2 was rocky.

11.4.2.2 Multibeam Sonar

In 2001 we conducted a multibeam survey for two area in Southeast: a portion of CSEO off of Larch Bay and a portion of SSEO off of Hazy Islands. National Marine Fisheries Service Auke Bay Lab surveyed an adjacent area offshore of the Larch Bay site. Of the 293.7 km^2 surveyed offshore of Larch Bay, 112 km^2 were identified as yelloweye habitat based on interpretation of the multibeam data. A total of 385 km^2 were surveyed off Hazy Island, 105.5 km^2 of which was identified as yelloweye habitat.

In 2002 we conducted a multibeam survey for a portion of the east bank of Fairweather Ground. Of the 219 km^2 area surveyed, 75 km^2 was identified as yelloweye habitat (Figure 10). Based on this information the estimated yelloweye habitat area for the EYKT area was reduced from 757 km^2 to 742 km^2.

114.2.3 Area Estimates

Total area of yelloweye habitat for the SEO is estimated to be 3,360 km^2 (Table 7). The estimates of yelloweye habitat are highly subjective. Although a defined protocol allows for a standard interpretation there is no way to estimate variance of this data. The buffered fishing log data most likely does not represent the true placement of habitat because fishermen often start their sets outside of productive habitat to ensure the majority of hooks land in the correct habitat. Beginning in 2003 both start and end positions are required to be reported in logbooks. This will allow us to use the middle of the set as our buffered area.

11.4.5 Exploitable Biomass Estimates

Estimates of exploitable biomass (adult yelloweye), with associated standard error, by year and area, are listed in Table 7. New information added this year includes new density estimates for EYKT and CSEO, 2002/winter 2003 average weight data and standard error of the average weight data for CSEO and SSEO, and revised estimates of the area of yelloweye habitat in EYKT. The total exploitable biomass for 2003 is estimated to be 20,168 mt (based on the sum of the lower 90% confidence limits of biomass estimates from each management area).

11.5 PROJECTIONS AND HARVEST ALTERNATIVES

11.5.1 ABC Recommendation

Demersal shelf rockfish are particularly vulnerable to overfishing given their longevity, late maturation, and sedentary and habitat-specific residency. We recommend a harvest rate lower than the maximum allowed under Tier 4. By applying F=M=0.02 to this biomass and adjusting for the 10% of other DSR species, the recommended 2004 ABC is 450 mt. This rate is more conservative than would be obtained by using Tier 4 definitions for setting ABC, as $F_{40\%}$=0.023.

Continued conservatism in managing this fishery is warranted given the life history of the species and the uncertainty of the biomass estimates.

11.6 OVERFISHING DEFINITION

The overfishing level for DSR is 690 mt. This was derived by applying a fishing rate of $F_{35\%}$=0.031 against the biomass estimate for yelloweye rockfish and accounting for 10% of the other species in the assemblage.

11.7 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 2003 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 560 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 450 mt (including the 10% other DSR).

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 450 mt (including the 10% other DSR).

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 280 mt (including the 10% other DSR).

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

11.8 OTHER CONSIDERATIONS

Although management of this stock has been conservative, the decline in the density estimates in the CSEO 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. Yelloweye tend to be resident and tag return information would suggest that adult fish stay in the same area over years (O'Connell 1991). Catch curve analysis of age data from CSEO suggests that total mortality is approaching 6% (natural mortality is estimated at 2% annually). Catch curves are problematic for fish with variable recruitment, however, catch curves from the SSEO and EYKT areas suggest harvest rate more in line with the harvest policy with Z estimated at less than 4%. It is possible that mortality associated with the halibut fishery has been underestimated. However, recent review of available sport fish catches indicates that fishery may be the source of the increased harvest. Sport fish harvest is not currently accounted for in total catch statistics or TAC setting.

Sport catch of yelloweye in Southeast is difficult to determine. Preliminary estimates of landed catch of yelloweye from Southeast in 2001 (the last year data is available for) indicate over 26,000 fish were landed. Total catch likely exceeds landed catch, as there is a bag limit of 2 or 1 per day depending on area. In the CSEO area landed sport catch of yelloweye in 2001 exceeded 11,000 fish[2]. Weight data is not available from the sport catch, but if the average weight is similar to that of the commercial fishery (3.12 kg) the landed sport fish catch of yelloweye in CSEO was over 35 mt in 2001. Future stock assessment will need to address sport fish removals in evaluating harvest.

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=0.015. This corresponds to an ABC of 340 mt (including 10% for other DSR species).

11.9 ECOSYSTEM CONSIDERATIONS

The following table consolidates information regarding ecosystem effects on the stock and the stocks effect on the ecosystem. Specific data to evaluate these effects is mostly lacking. Yelloweye rockfish consume rockfishes, herring, sandlance, shrimps, and crabs and seasonally lingcod eggs. Many predators, including other rockfishes consume larval and juvenile yelloweye. Adult yelloweye have been found in the stomachs of longline caught lingcod and halibut but this may be opportunistic feeding as the yelloweye were caught on gear. A yelloweye was also found in the stomach of an orca whale (Love et al).

Ecosystem effects on Demersal Shelf Rockfish

Indicator	Observation	Interpretation	Evaluation
Prey availability or abundance trends			
Zooplankton	Stomach contents, ichthyoplankton surveys, changes mean wt-at-age	Stable, data limited	Unknown
Predator population trends			
Marine mammals	Fur seals declining, Steller sea lions increasing slightly	Possibly lower mortality on pollock	No concern
Birds	Stable, some increasing some decreasing	Affects young-of-year mortality	Probably no concern
Fish (Pollock, Pacific cod, halibut)	Stable to increasing	Possible increases to mortality	Unknown
Changes in habitat quality			
Temperature regime			
Winter-spring envir. Production	Variable	Variable recruitment	Possible concern

Table continued on next page

[2] Unpublished data, Mike Jaenicke, Alaska Department of Fish and Game, Division of Sport Fish, Douglas, AK.

Demersal Shelf Rockfish effects on ecosystem			
Indicator	Observation	Interpretation	Evaluation
Fishery contribution to bycatch			
Prohibited species	Halibut are taken as bycatch but released	Minor contribution to mortality, soak times are short for DSR gear, separate PSC cap for DSR	Little concern
Forage (including herring, Atka mackerel, cod, and pollock)	A small amount of cod bycatch is taken in this fishery	Bycatch levels small relative to forage biomass	No concern
HAPC biota	Low bycatch levels of *Primnoa* coral, hard coral, and sponges.	Longline gear has some bycatch but levels small relative to HAPC biota	Little concern
Marine mammals and birds	Very minor direct-take	Safe	No concern
Sensitive non-target species	Likely minor impact	Data limited, likely to be safe	No concern
Fishery concentration in space and time	Half the catch is taken through the IFQ season, the directed fishery is concentrated during the winter and fall	Fishery does not hinder reproduction	Little concern
Fishery effects on amount of large size target fish	Fishery is catching primarily adults but difficult to target largest individuals over others	Large and small fish both occur in population	Little concern
Fishery contribution to discards and offal production	Discard rates low for DSR fishery but includes dogfish and skates	Data limited	Possible concern
Fishery effects on age-at-maturity and fecundity	Fishery is catching some immature fish but small proportion of total catch	If increased could reduce spawning potential and yield	Possible concern

SUMMARY

M	0.020
2004 Biomass Estimate	20,168
F_{ofl} ($F_{35\%}$)	0.031
Max F ($F_{40\%}$)	0.025
F_{abc}	0.020
F ($_{avg\ 94-98}$)	0.020
F ($_{50\%\ F\ max}$)	0.0125
Overfishing Level Includes 10% for other DSR	690 mt
Maximum Allowable ABC	560 mt
Recommended ABC Includes 10% for other DSR	450 mt

REFERENCES

Adams, P. B. 1980. Life history patterns in marine fishes and their consequences for fisheries management. Fish Bull. 78(1):1-12.

Archibald, C. P., W. Shaw, and B. M. Leaman. 1981. Growth and mortality estimates of rockfish (Scorpaenidae) from B. C. coastal waters. 1977-1979. Can. Tech. Rep. Fish. Aquat. Sc. No. 1048. 57p.

Andrews, A. H., G.M. Cailliet, K.H. Coale, K.M. Munk, M.M. Mahoney, and V.M. O'Connell. 2002. Radiometric age validation of the yelloweye rockfish (*sebastes ruberrimus*) from southeastern Alaska. Mar. Freshwater Res.,53:139-146.

Boehlert, G. W. and M. M. Yoklavich. 1984. Reproduction, embryonic energetics, and the maternal-fetal relationship in the viviparous genus Sebastes. Biol. Bull. 167:354-370.

Boehlert, G. W., M. Kusakari, M. Shimizu, and J. Yamada. 1986. Energetics during embryonic development in kurosoi, *Sebastes schlegeli* Hilgendorf. J. Exp. Mar. Biol. Ecol. 101:239-256.

Buckland, S. T., D. R. Anderson, K. P Burnham, and J. L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman & Hall. London. 446 p.

Burnham, K. P., D. R. Anderson, and J. L. Laake. 1980. Estimation of density from line transect sampling of biological populations. Wildlife Monographs. Vol. 72. 202 p.

Chilton, D. E. and R. J. Beamish. 1983. Age determination methods for fishes studied by the groundfish program in the pacific biological station. Can. Spec. Publ. Fish. Aquat. Sci. 60. 102 pp.

Dorn, M. 2000. Advice on west coast rockfish harvest rates from Bayesian meta-analysis of *Sebastes* stock-recruit relationships. Proceedings of the 11th Western Groundfish Conference, Alaska Department of Fish and Game, Sitka, Alaska

Francis, R. C. 1985. Fisheries research and its application to west coast groundfish management. In T. Frady (ed.). Proceedings of the Conference on Fisheries Management: Issues and Options. p. 285-304. Alaska Sea Grant Report 85-2.

Gunderson, D. R. 1980. Using r-K selection theory to predict natural mortality. Can J. Fish. Aquat. Sci. 37:1522-1530.

Hayes, R. J. and S. T. Buckland. 1983. Radial distance models for the line transect method. Biometrics 39:29-42.

Hoenig, J. M. 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 82:898-903.

Leaman, B. M. 1991. Reproductive styles and life history variables relative to exploitation and management of Sebastes stocks. Env. Biol. Fishes. 30:253-271.

Leaman, B. M. and R. J. Beamish. 1984. Ecological and management implications of longevity in some northeast Pacific groundfishes. Int. North Pac. Fish. Comm., Bull. 42:85-97.

Love, M. S., P. Morris, M. McCrae, and R. Collins. 1990. Life History Aspects of 19 rockfish species (Scorpaenidae: Sebastes) from the southern California Bight. NOAA Tech. Rpt. NMFS 87: 38pp.

O'Connell, V. M. 1987. Reproductive seasons for some Sebastes species in Southeastern Alaska. Alaska Department of Fish and Game Information Leaflet 263: 21 p.

O'Connell, V. M. 1991. A preliminary examination of breakaway tagging for demersal rockfishes. Alaska Department of Fish and Game, Commercial Fisheries Division, Fisheries Research Bulletin 91-06, 8 p.

O'Connell, V. M. and D. W. Carlile. 1993. Habitat-specific density of adult yelloweye rockfish Sebastes ruberrimus in the eastern Gulf of Alaska. Fish Bull 91:304-309.

O'Connell, V. M. and J. T. Fujioka. 1991. Demersal shelf rockfishes (Gulf of Alaska) IN Loh-Lee Low (ed.). Status of living marine resources off Alaska as assessed in 1991. NOAA Tech. Memo. NMFS F/NWC-211, 95 p.

O'Connell, V. M. and F. C. Funk. 1987. Age and growth of yelloweye rockfish (Sebastes ruberrimus) landed in Southeastern Alaska. In B. R. Melteff (editor). Proceedings of the International Rockfish Symposium. p 171-185. Alaska Sea Grant Report No. 87-2.

Ralston, S. 1998. The status of federally managed rockfish on the U.S. west coast, pp 6-16. IN: M. Yoklavich (ed.), Marine Harvest Refugia for West Coast Rockfish: a Workshop. NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFCS-225.

Ralston, S., J. Bence, W. Clark, R. Conser, T. Jagielo, and T. Quinn II. 2000. West Coast Groundfish Harvest Rate Policy Workshop AFSC, Seattle, Washington: March 20-23, 2000. Panel Report to the Scientific and Statistical Committee of the Pacific Fishery Management Council.

Rosenthal, R. J., L. Haldorson. L. J. Field, V. M. O'Connell, M. LaRiviere, J. Underwood, and M. C. Murphy. 1982. Inshore and shallow offshore bottomfish resources in the Southeastern Gulf of Alaska (1981-1982). Alaska Department of Fish & Game, Juneau, Alaska. 166 pp.

Thomas, L., Laake, J.L., Derry, J.F., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Strindberg, S., Hedley, S.L., Burt, M.L., Marques, F., Pollard, J.H. And Fewster, R.M. 1998. Distance 3.5. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK.

Wallace, Farron R. 2001. Status of the yelloweye rockfish resource in 2001 for Northern California and Oregon waters. 86 pp. Appendix to Status of the Pacific Coast Groundfish Fishery through 2001 and Recommended Acceptable Catches for 2002. Pacific Fishery Management Council, Portland, OR.

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), 1982-2003[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	6	122	50	110	37	326	330
2002	2	136	0	115	38	292	350
2003	7	81	0	105	48	241	360

[a] Landings from ADF&G Southeast Region fishticket database and NMFS weekly catch reports through November 14, 2003 (do not include fall directed fishery catch).
[b] Estimated unreported DSR mortality associated with halibut fishery not reflected in totals.
[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
EYKT	2000-2002	Commercial Longline ages 24-62	.04	295
CSEO	2000-2002	Commercial Longline Ages 20-60	0.056	514
SSEO	2000-2002	Commercial Longline (ages 24-67)	0.03	602
SE		Hoenigs equation max age 121 (parameters combined taxa)	0.038	
SE		Hoenig's equation max age 121 (fish parameters)	0.033	

*Z approximately equal to M as there was very little directed fishing pressure in these areas at that time (1981 for CSEO, 1984 for SSEO).

Table 4. Growth parameters (cm and kg) for yelloweye rockfish in Southeast Alaska from 2000-2002 port samples, by sex and area and combined for both sexes and outside areas (EYKT, CSEO, and SSEO).

		Wt. Vs Length		**von B**		
Sex	**Area**	**a**	**b**	L_{inf}	**K**	t_0
Female	EYKT	0.000008876	3.2113	71.0496	0.0327	-14.8832
	CSEO	0.000012	3.1346	65.8733	0.0342	-14.7556
	SSEO	0.000023	2.9689	67.4639	0.0236	-28.7107
	NSEI	0.000018	3.0248	68.5183	0.0314	-13.5622
	SSEI	0.000017	3.011	68.674	0.0196	-36.7438
Male	EYKT	0.000055	2.7441	72.0703	0.03	-18.9701
	CSEO	0.000037	2.8348	65.9722	0.05	-4.2473
	SSEO	0.000016	3.0397	63.112	0.0573	-4.4311
	NSEI	0.000008792	3.1884	63.3418	0.0367	-17.7907
	SSEI	0.000008189	3.1716	62.3299	0.0727	1.0032
Combined	Outside Areas Only	0.000014	3.0869	65.9619	0.0369	-13.0505

Table 5. Length and age at 50% sexual maturity for yelloweye rockfish, Southeast Alaska.

	m_∞	κ	γ	50%
Female length	0.98142	1.0813	41.79	41.8
Female age	0.97801	0.283363	21.814	22.0
Male length	1.004079	0.55547	43.128	43.1
Male age	0.9942	0.3645	18.23	18.3

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 (YE)	Meters surveyed (m)	YE/m	Density
EYKT	1997	18	256	17238	.01485	4176
	1999	20	206	25646	.00803	2323
	2003	20	323	18503	.017456	3360
CSEO	1995	24	235	39368	.00597	2929
	1997	32	166	29176	.0057	2534
	2003	102	706	90275	.00782	1865
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. Adult yelloweye rockfish density, weight, habitat, and associated biomass estimates by year and management area.

Fishery 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)
2004	EYKT	2003	3557	0.1720	4.30	742	11350	8558
	CSEO	2003	1865	0.1122	3.12	1414	8226	6834
	NSEO	2001	1420	0.3144	2.98	472	1997	1202
	SSEO	1999	1879	0.1711	3.47	732	4772	3574
	Total SEO					3360		**20168**
2003	EYKT	1999	2323	0.3084	4.30	757	7560	4601
	CSEO	1997	2534	0.2009	3.14	1414	11250	8093
	NSEO	2001	1420	0.3144	2.98	472	1997	1205
	SSEO	1999	1879	0.1711	3.47	732	4772	3609
	Total SEO					3375	24762	**17509**
2002	EYKT	1999	2323	0.3084	4.04	703	6596	4208
	CSEO	1997	2534	0.2009	3.3	1184	9690	6981
	NSEO	2001	1420	0.3144	3.76	357	1511	411
	SSEO	1999	1879	0.1711	3.48	851	5564	4015
	Total SEO					3095	23362	**15616**
2001	EYKT	1999	2323	0.3084	3.76	703	6645	3737
	CSEO	1997	2534	0.2009	3.05	1184	9432	6592
	NSEO	Revised 1994	834	0.2778	3.76	357	892	892
	SSEO	1999	1879	0.1711	2.98	851	4858	3797
	TOTAL SEO					3095	21827	**14693**
2000	EYKT	1999	2323	0.3084	4.07	703	6645	4045
	CSEO	1997	2534	0.2009	3.14	1184	9432	6701
	NSEO	Revised 1994	834	0.2778	2.98	357	892	568
	SSEO	1999	1879	0.1711	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. Adult yelloweye rockfish (top panel) and juvenile yelloweye rockfish (lower panel), southeast Alaska.

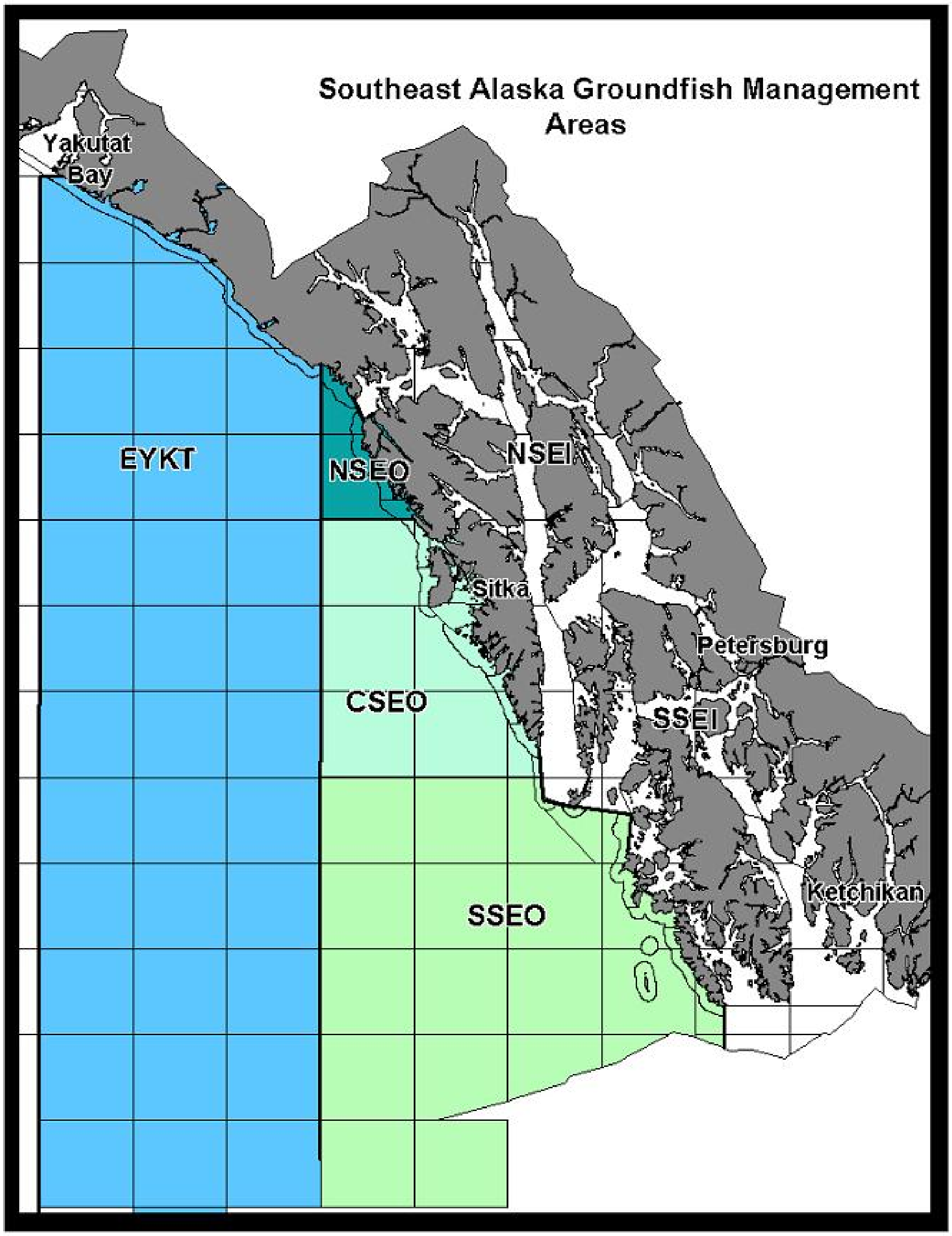


Figure 2. The Eastern Gulf of Alaska with Alaska Department of Fish and Game groundfish management areas: the EYKT, NSEO, CSEO, and SSEO sections comprise the Southeast Outside (SEO) Subdistrict.

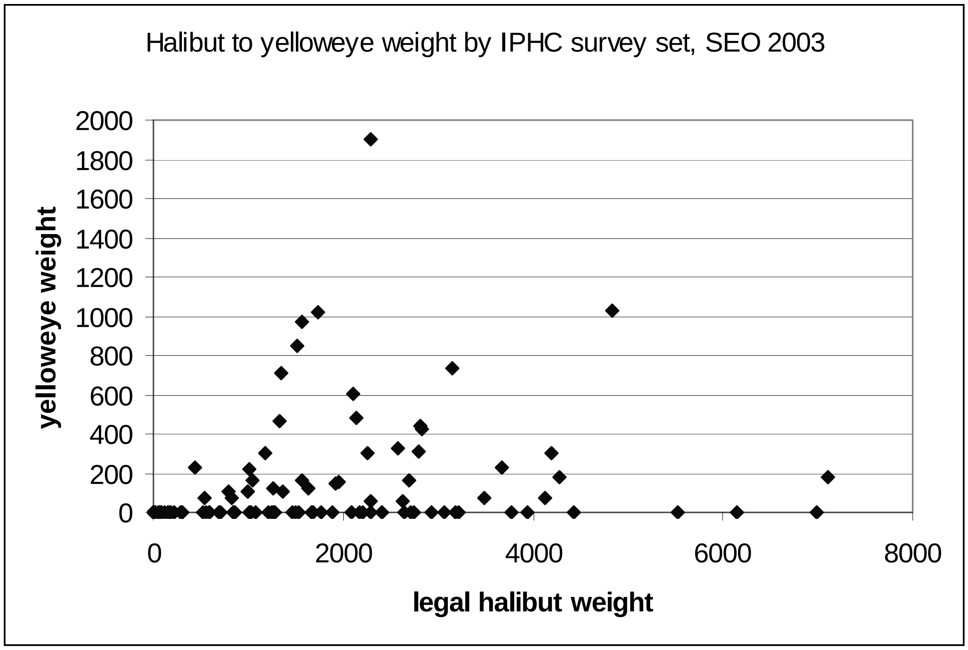


Figure 3. Catch of yelloweye (rd weight) versus halibut rd weight, legal fish) for 2003 IPHC longline survey in SEO survey stations.

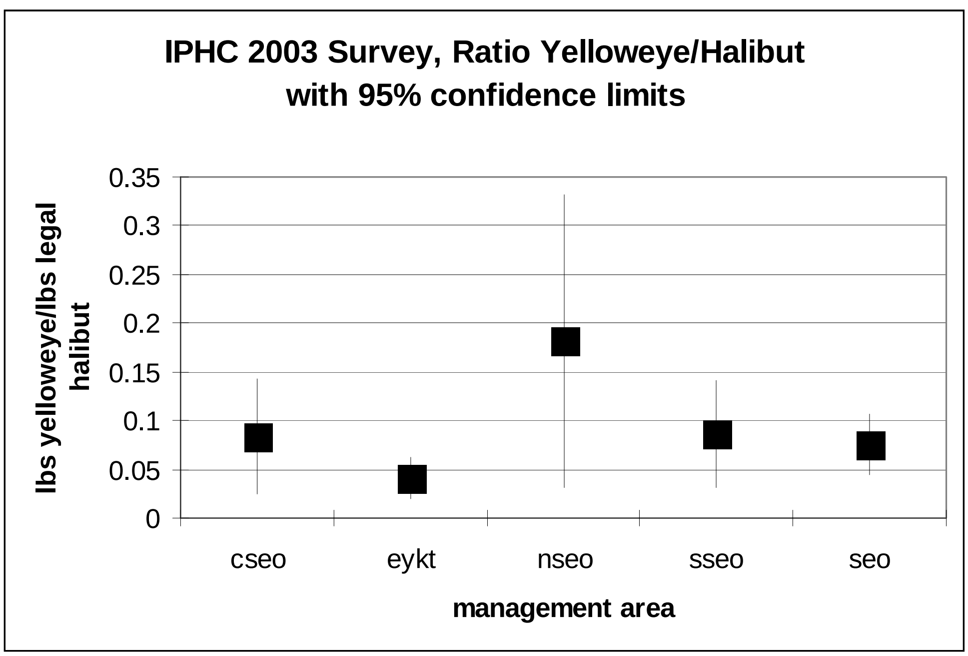
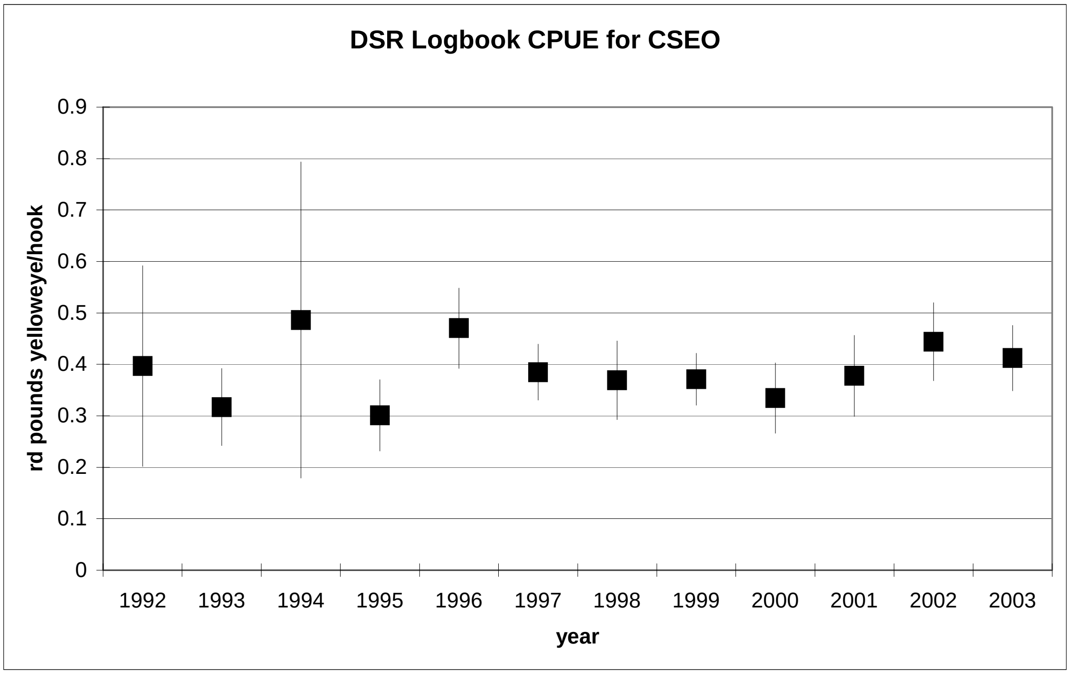


Figure 4. 2003 IPHC longline survey data, ratio of yelloweye to legal halibut by management area and for SEO combined.



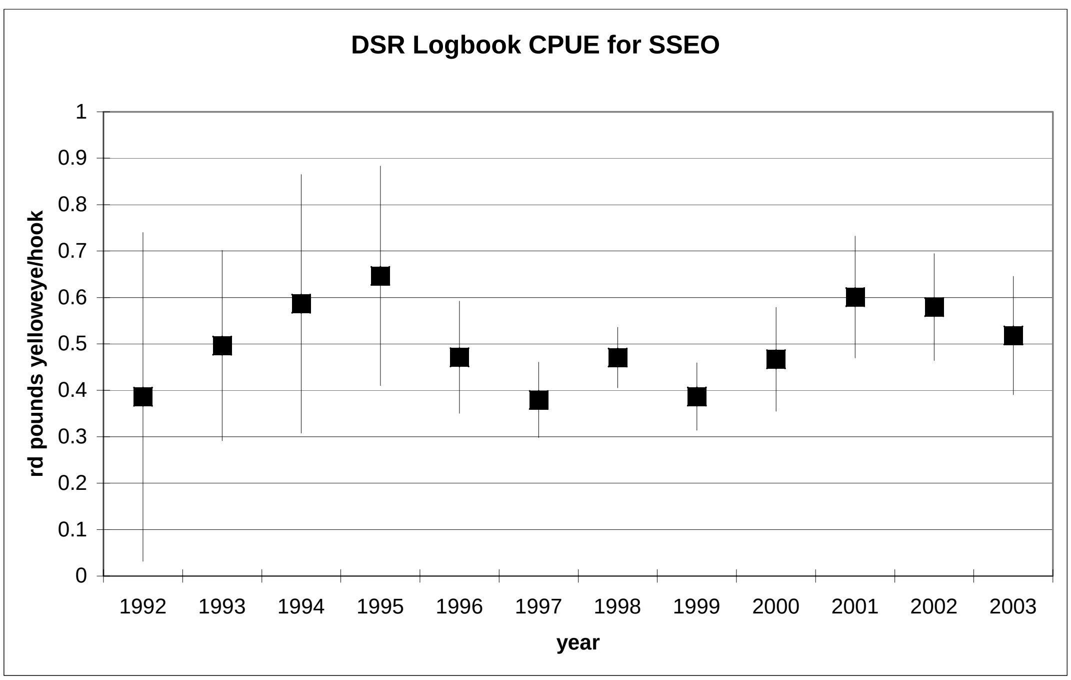


Figure 5. Commercial fishery catch per unit effort data, conventional longline gear, by area, and year.

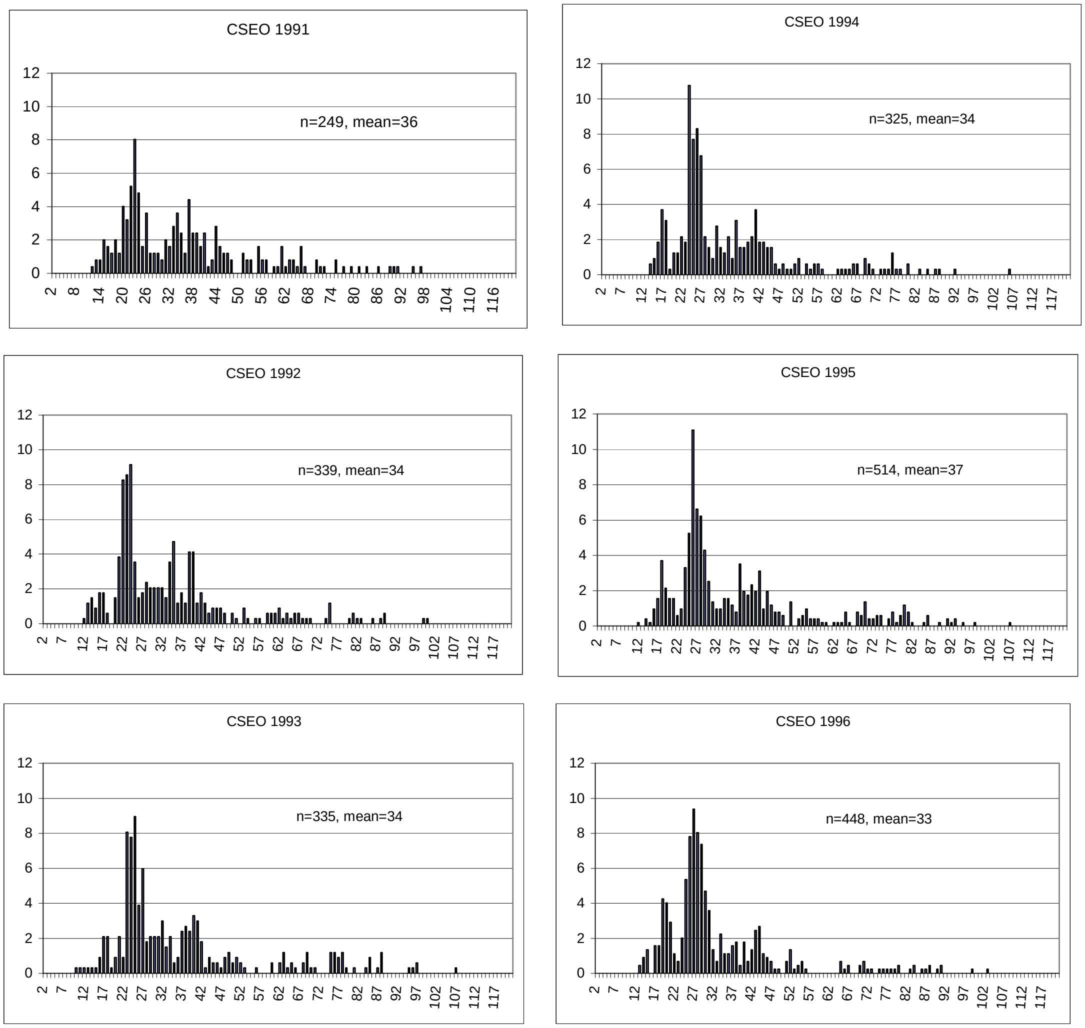


Figure 6a. Yelloweye rockfish age frequency distributions from CSEO port samples, 1991-1996.

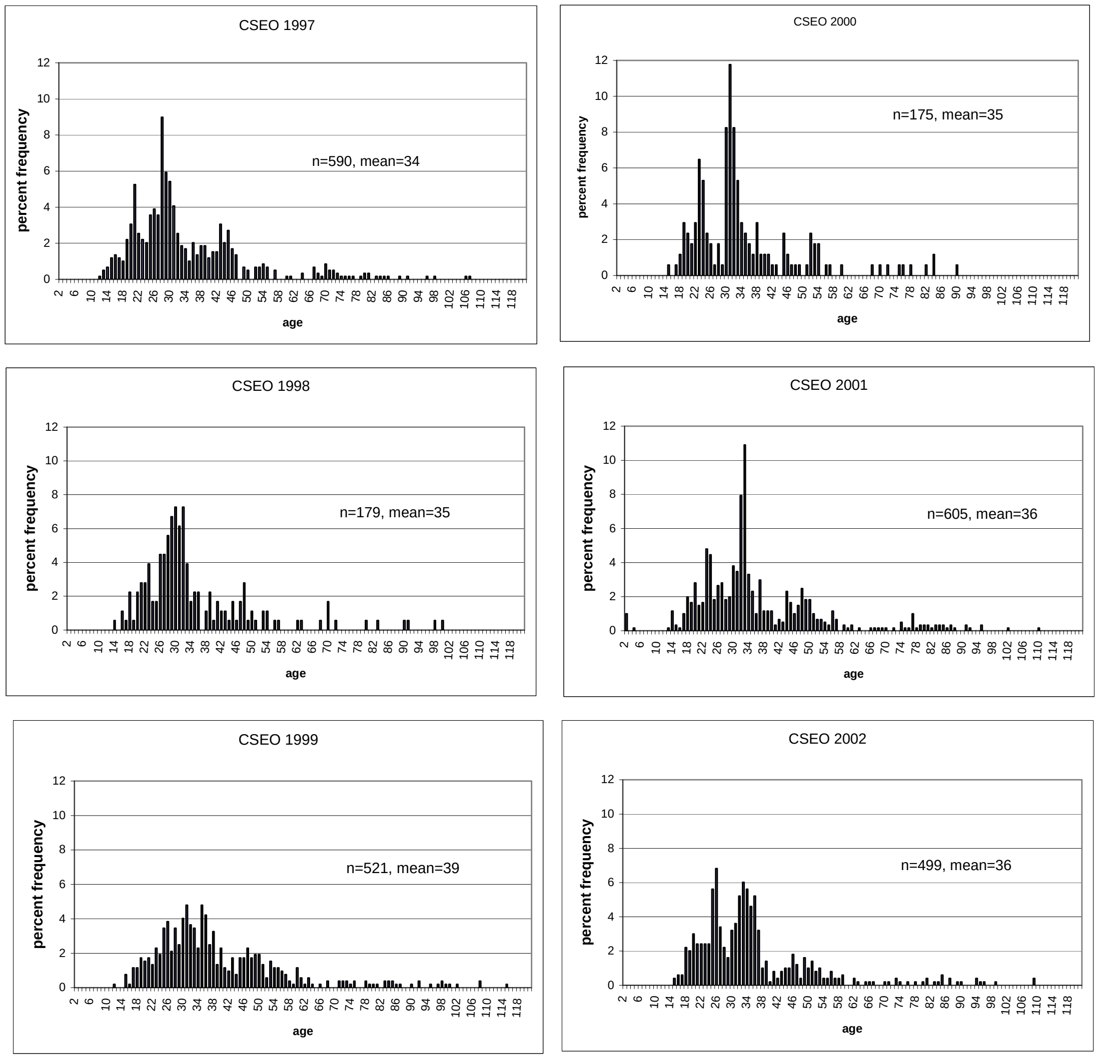


Figure 6b. Yelloweye rockfish age frequency distributions from CSEO port samples, 1997-2002.

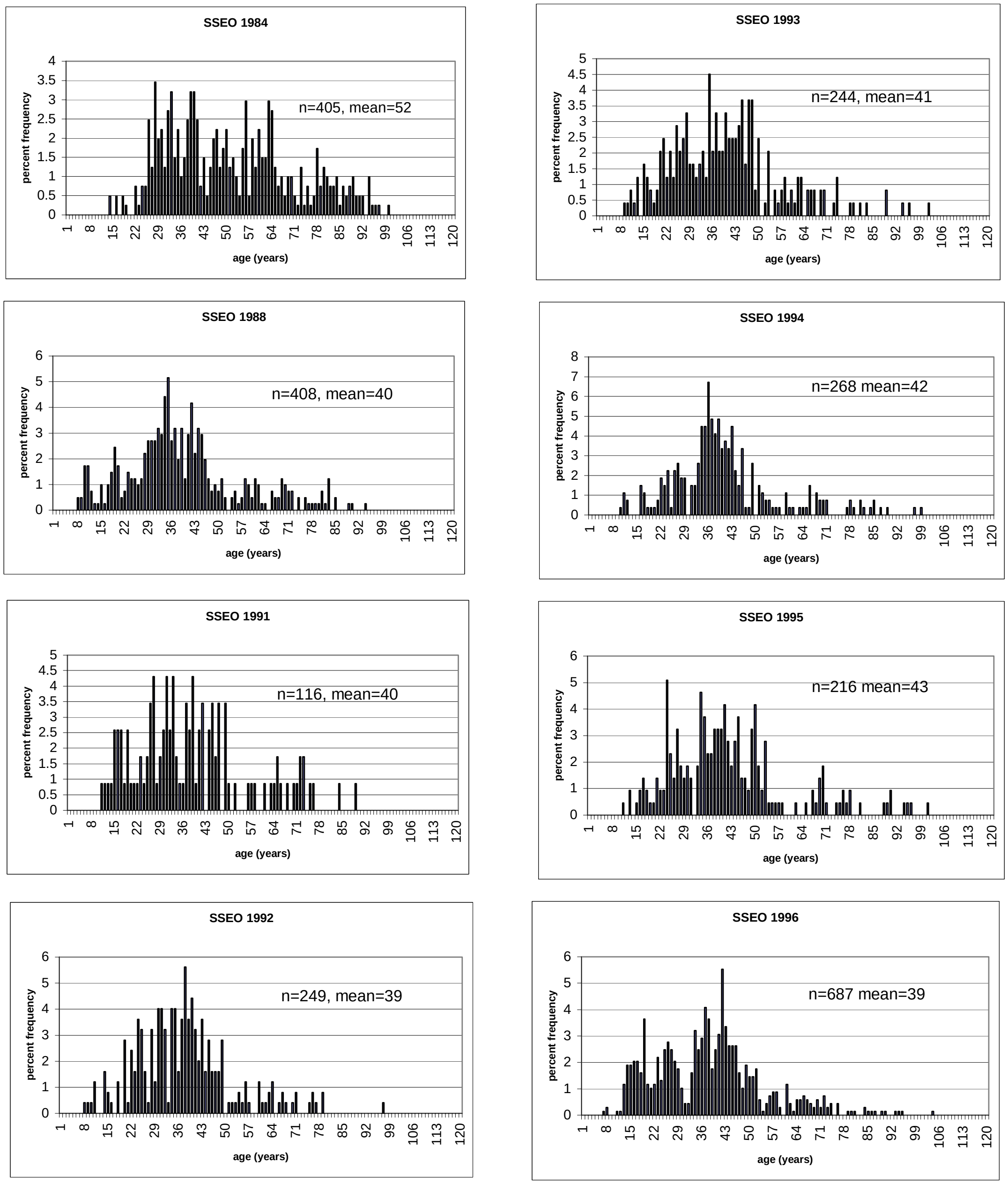


Figure 6c. Yelloweye age frequency distributions from SSEO port samples, 1984-1996.

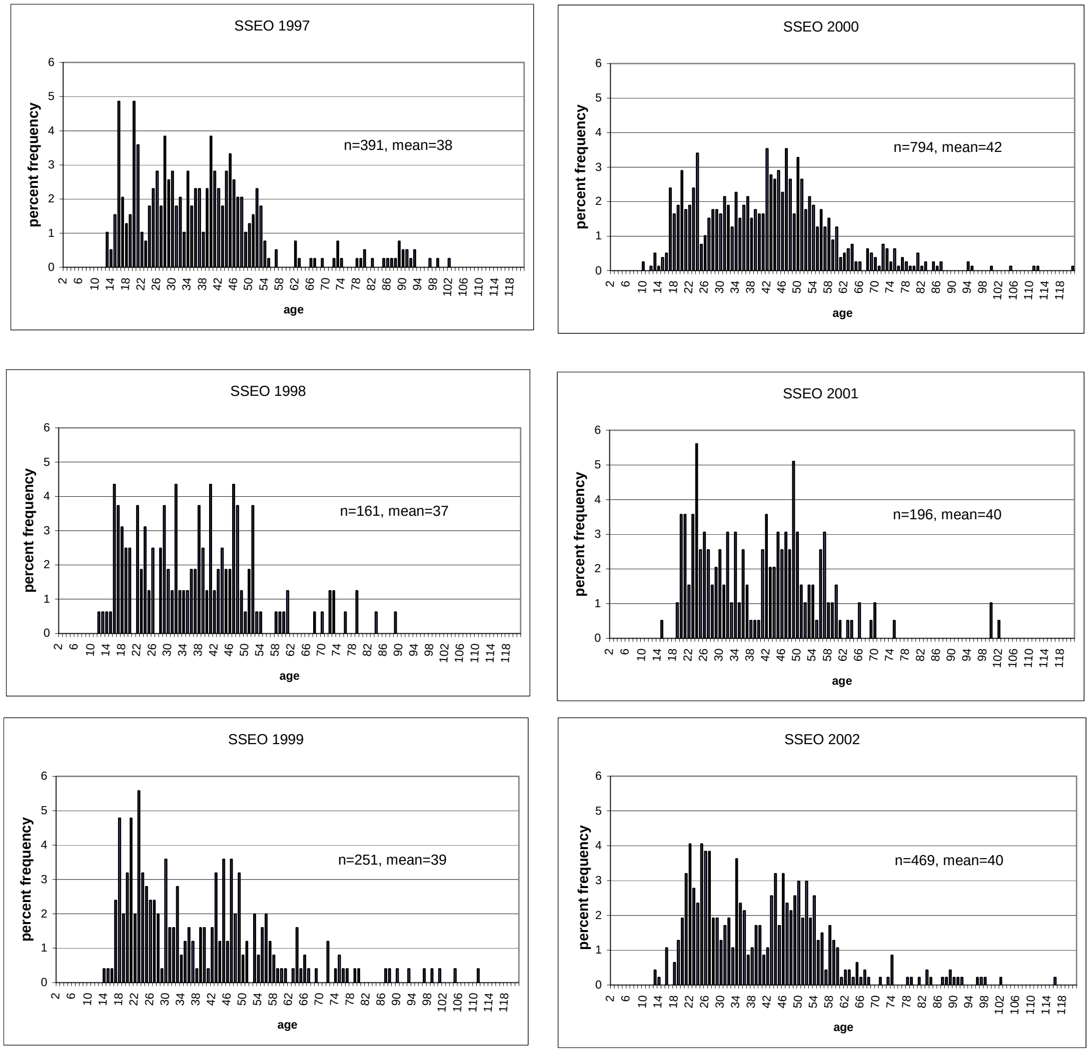


Figure 6d. Yelloweye age frequency distributions from port samples, 1997-2002.

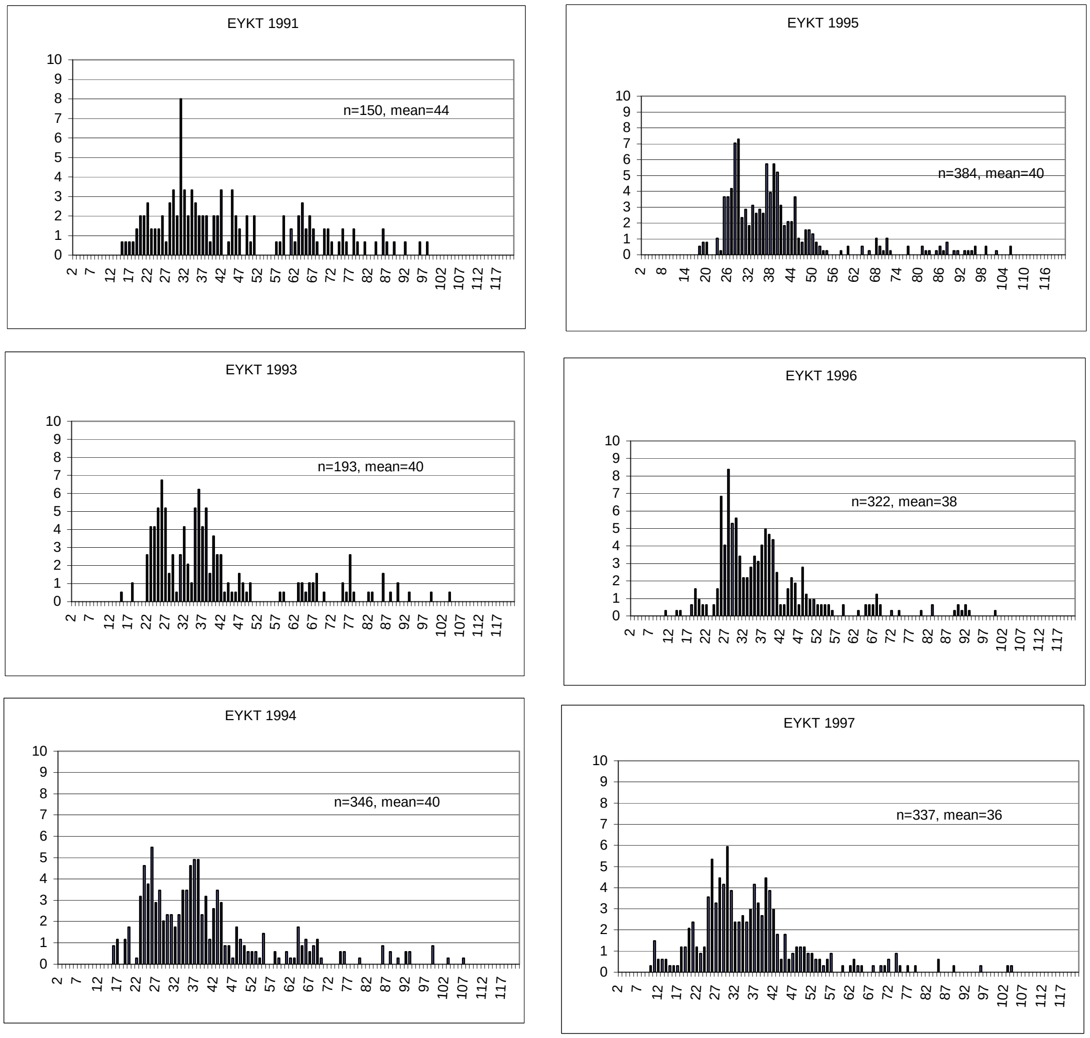


Figure 6e. Yelloweye rockfish age frequency distributions from EYKT commercial port samples, 1991-1997.

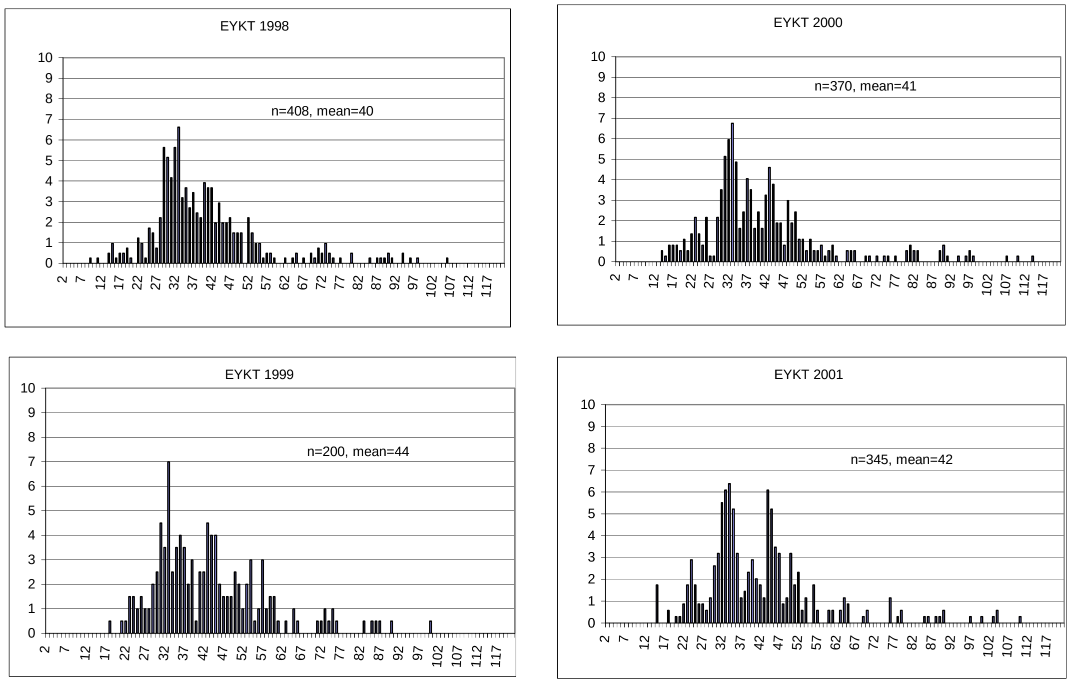


Figure 6f. Yelloweye rockfish age frequency distributions from EYKT commercial port samples, 1998-2001.

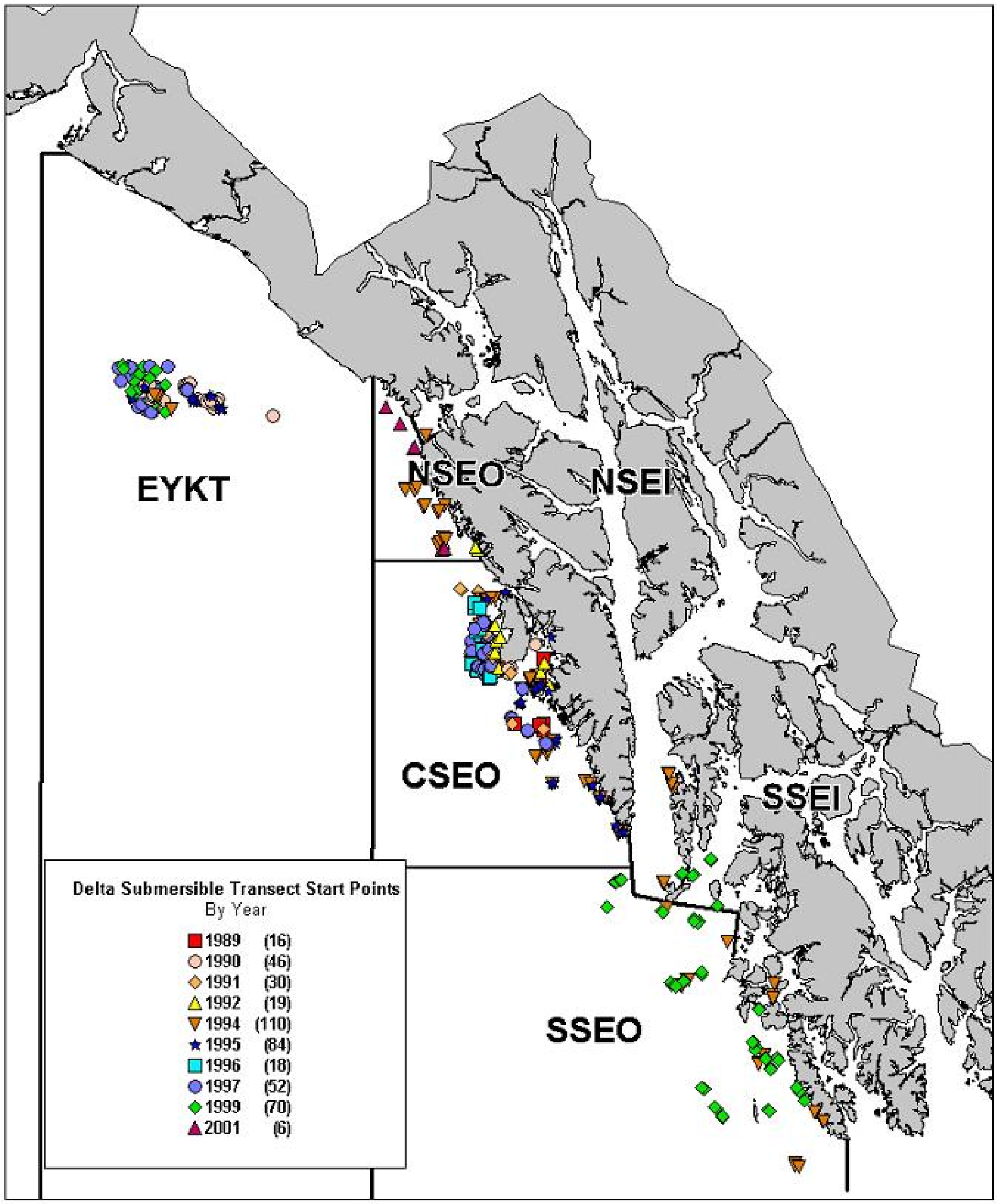


Figure 7. Location of submersible live transects dives, Southeast Alaska 1990-2001.

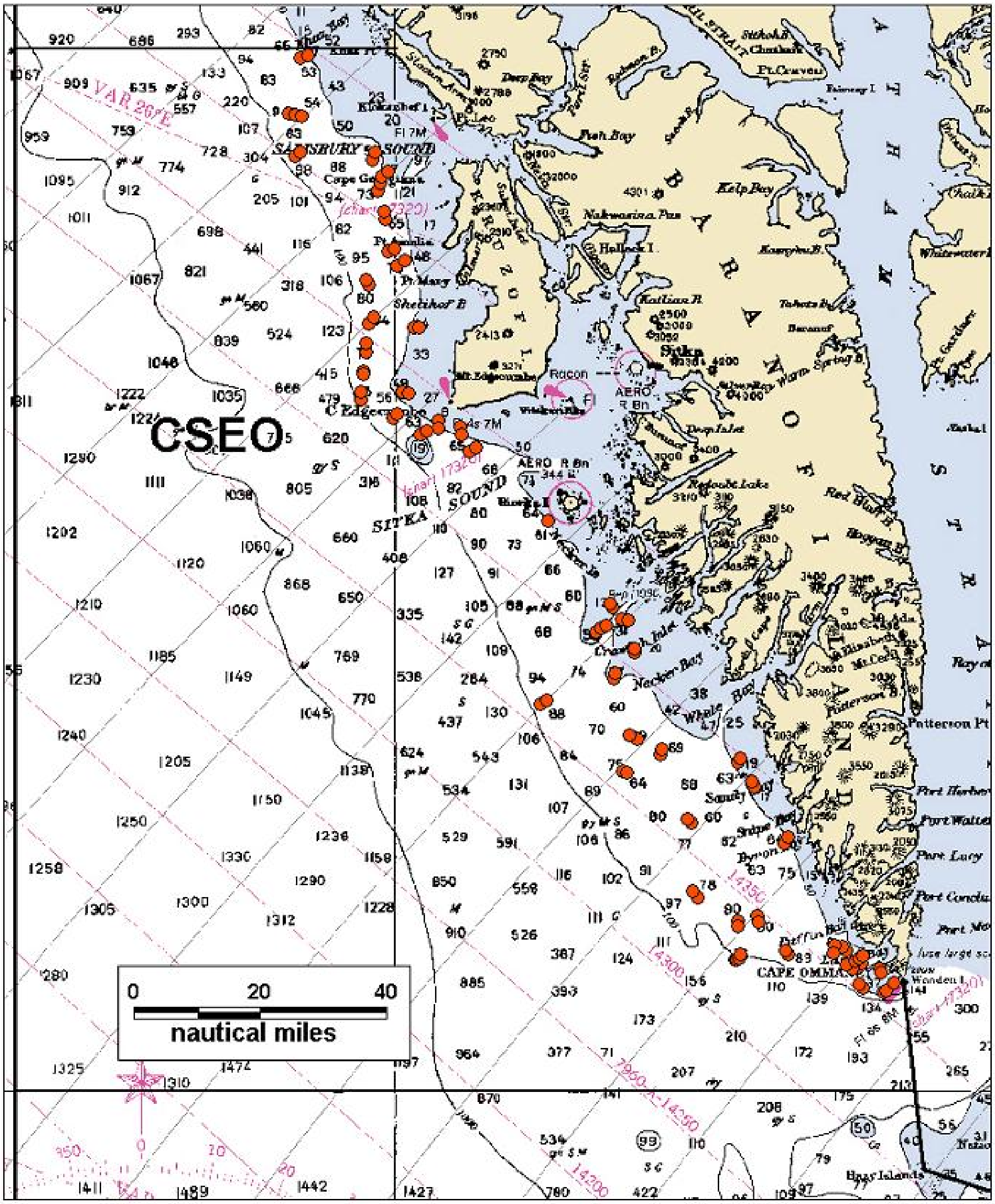


Figure 8. Start location for line transect submersible dives in CSEO during 2003.

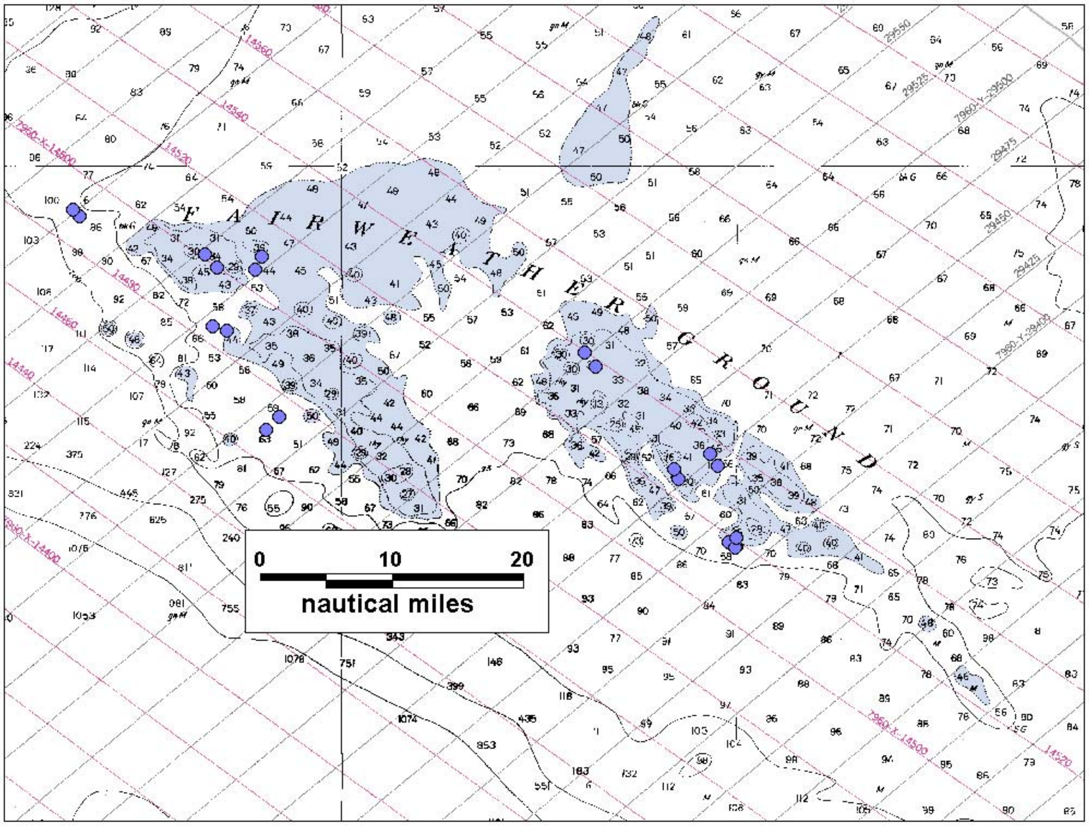


Figure 9. Start location for line transect submersible dives in EYKT during 2003.

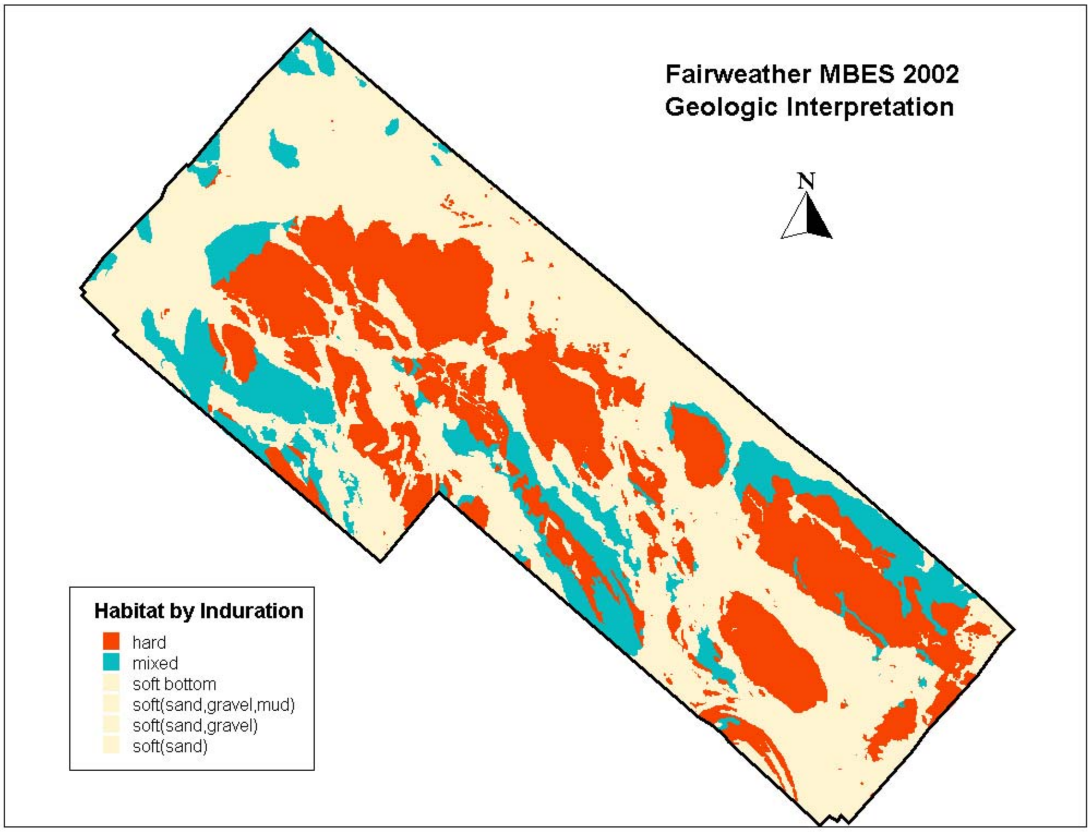


Figure 10. Habitat interpretation of 2002 multibeam data, east bank of Fairweather Ground.

APPENDIX I. DISTANCE OUTPUT FOR 2003 ASSESSMENT

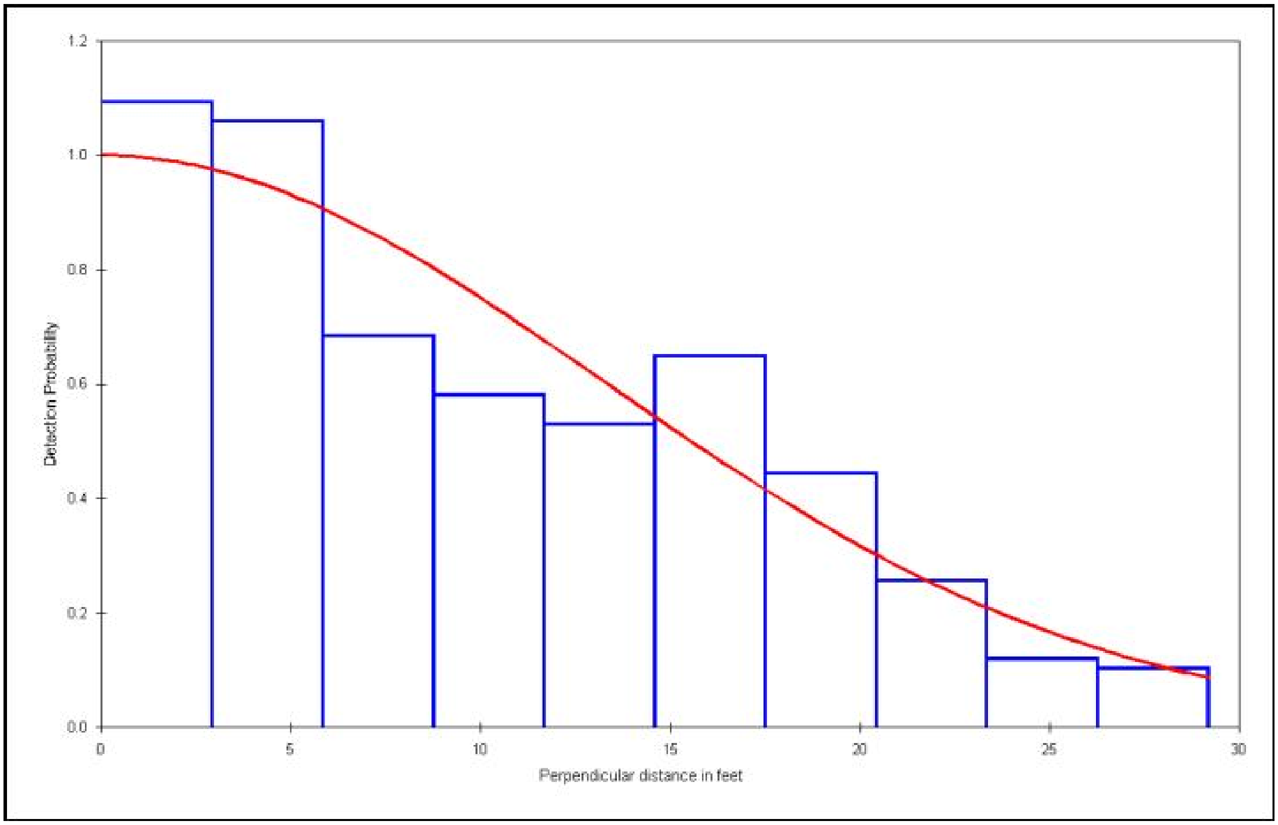


Figure A1. 2003 EYKT Probability Detection Function, best fit.

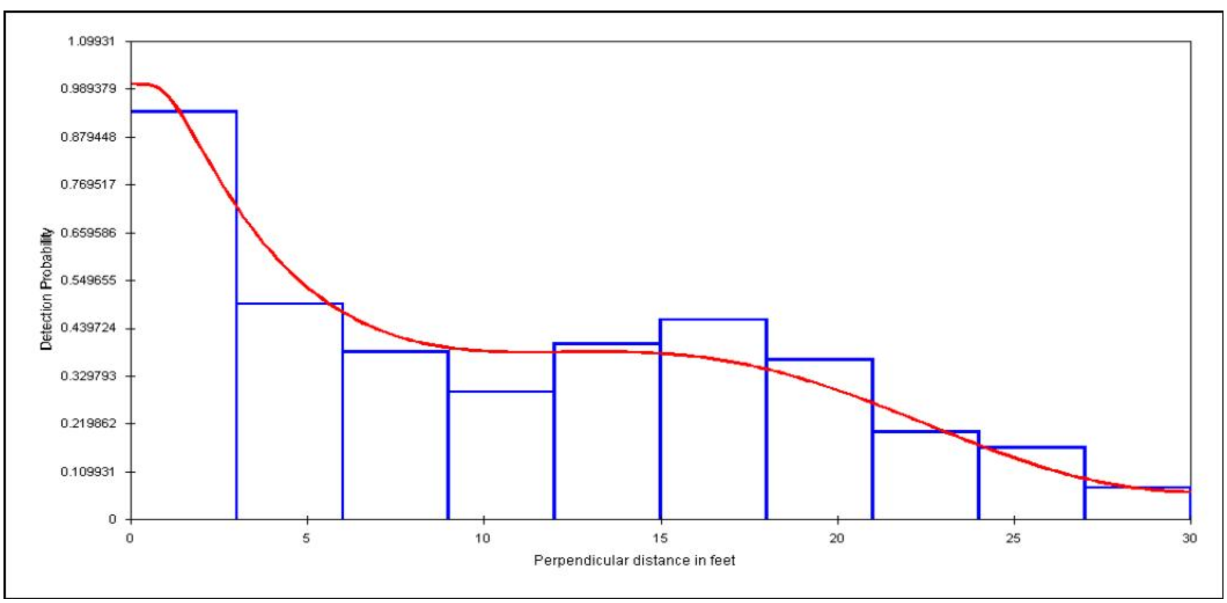


Figure A2. 1999 EYKT Probability Detection Function.

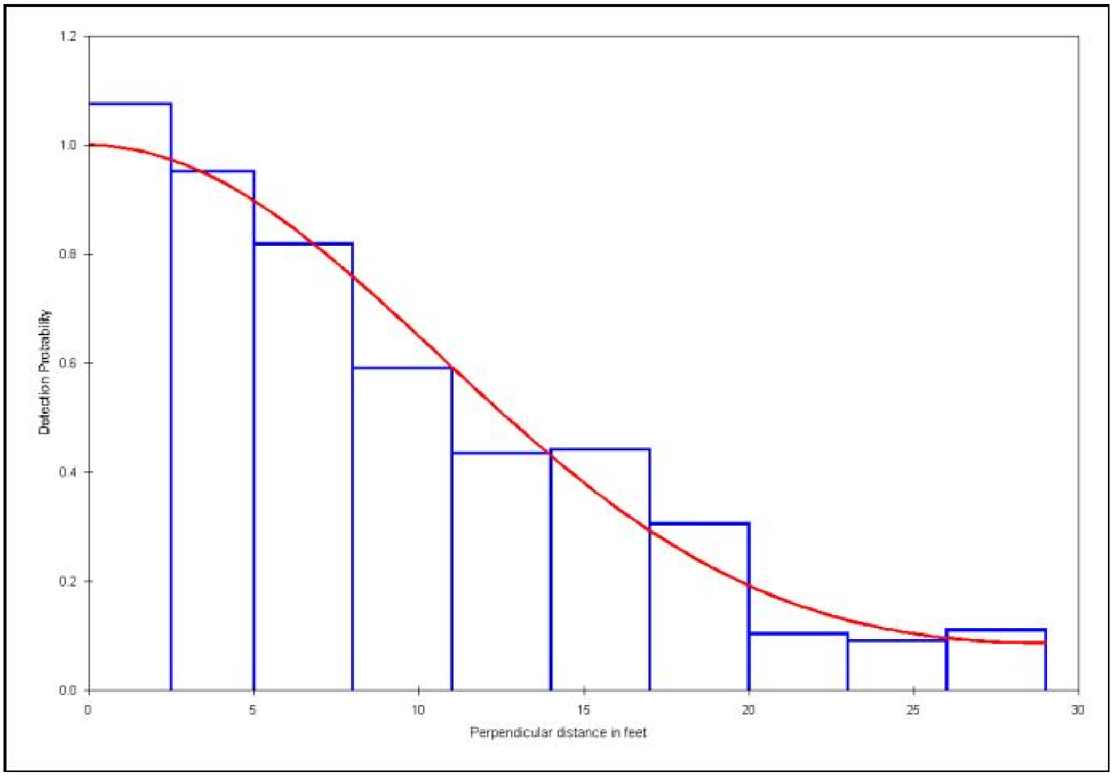


Figure A3. 2003 CSEO Probability Detection Function, best fit.

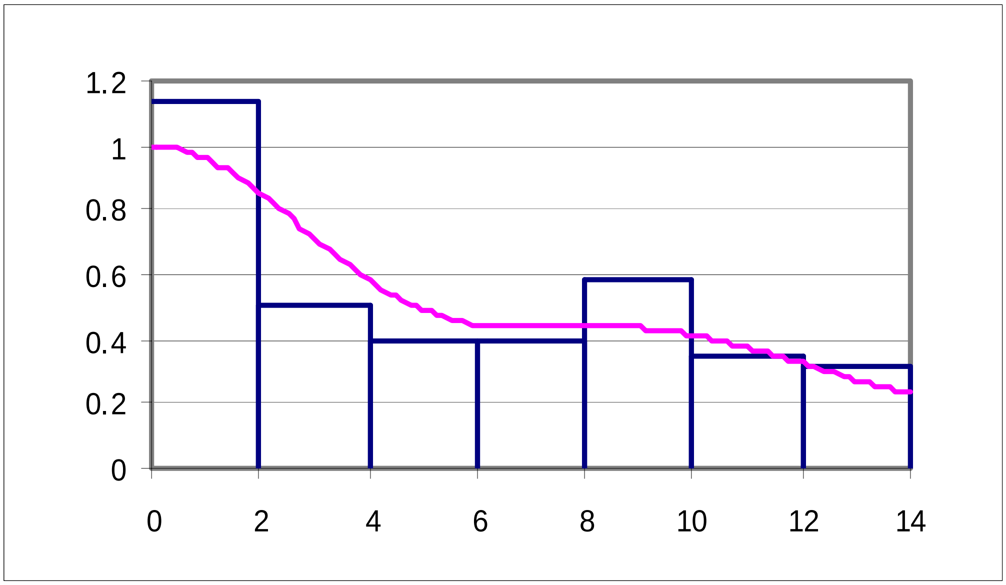


Figure A4. 1997 CSEO Probability Detection Function.

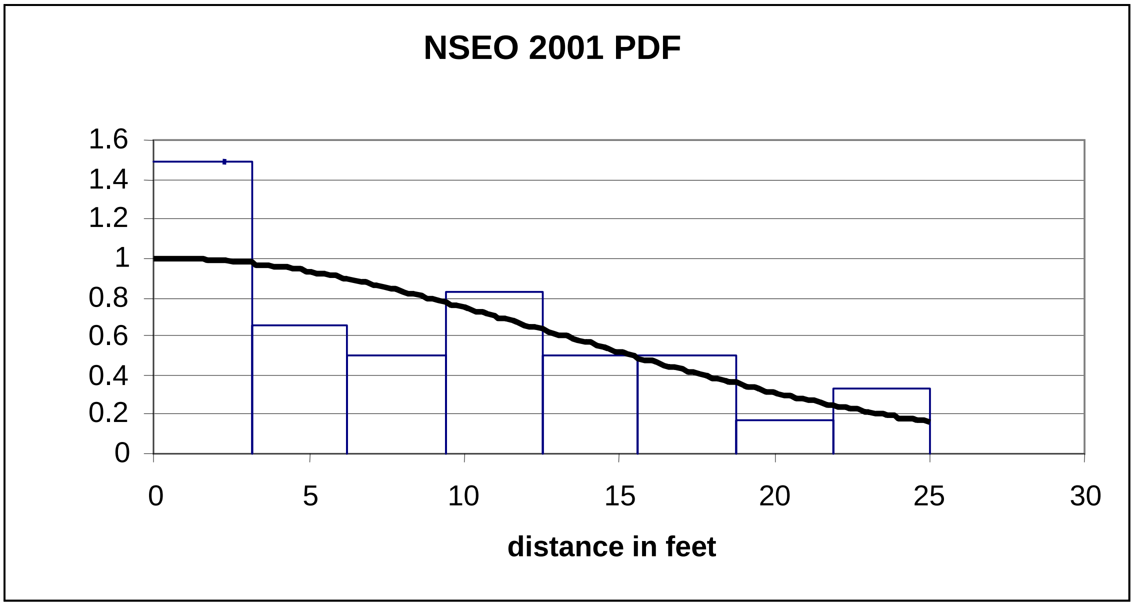


Figure A5. 2001 NSEO Probability Detection Function.

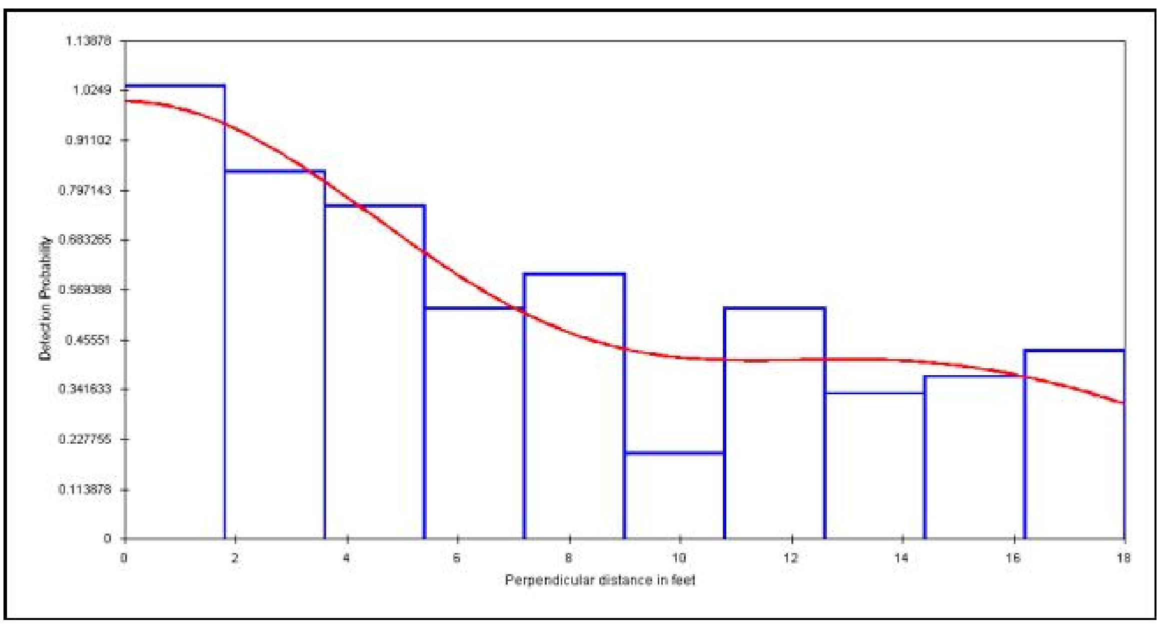


Figure A6. 1999 SSEO Probability Detection Function.

BLANK PAGE

November 2003
SAFE

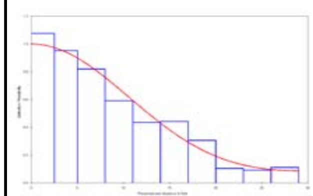
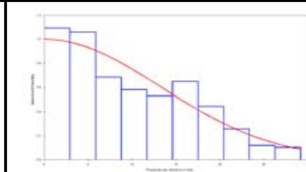
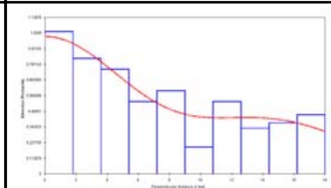
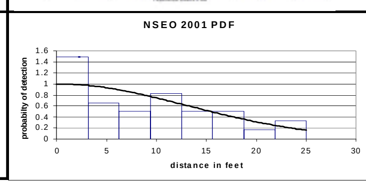
From Program DISTANCE

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)
CSEO 2003 LT with 2002/3 wt update	CSEO 2003 all observers: 0,2.5,5.8.11.14.17.20.23.26.29, uniform cosine	1864.7	209.21	0.1122	2950.5	0.048015	102	90275	0.0078205	0.0008291	0.072675
EYKT 2003 lt habitat updated from 2002 mb	2003, half normal cosine, 10 cutpoints, end 29	3557.2	611.84	0.172	1378.5	0.15468	20	18503	0.017456	0.002863	0.062111
SSEO 1999 with 2002/3 wt update	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	0.0008654	0.098757
NSEO 2001 LT	2001	1420	446.4	0.3144	188.59	0.69	6	4474	0.0067054	1.8E-3	0.0645

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); 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.

1. Densities estimated using Version 4.0 of Program DISTANCE.
2. Log-based confidence intervals are used because the distribution of D is positively skewed & an interval with better coverage is obtained by assuming that D is log-normally distributed. (Buckland et al. 1993. Distance sampling: Estimating abundance of biological populations. Chapman & Hall)
3. Note, under 'Detection Function Description', that different detection functions were investigated with differing truncations, etc. The function judged to provide the best fit to the DSR data was used in estimating biomass. This differs from the 1993 S.A.F.E. work, when hazard functions were used for all density estimates.
4. AIC (from Program DISTANCE output) is Akaike's Information Criterion. A lower AIC is better, indicating a better fit of the function to the data and fewer parameters in the function.
5. Weight data was updated for CSEO and SSEO using 2002 and winter 2003 port samples, no new weight data for NSEO and EYKT (no fishery there)
6. 2003 line transects for CSEO and EYKT, 2001 for NSEO, and 1999 for SSEO

Log-based Confidence Intervals based on Replicate Transects

n	var(n)	cv[f(0)]	cv(n)	df (Buckland et al p 90)	**Detection Function**	95% Lower	95% Upper	90% Lower	90% Upper	Area
706	5602.6143	0.0367	0.1060207	126.4		1494.46	2326.67	1549.25	2244.38	CSEO
323	2806.2541	0.0461	0.1640065	23		2498.66	5064.18	2654.70	4766.51	EYKT
288	1847.0114	0.0837	0.1492252	74.9		1339.40	2635.72	1415.86	2493.37	SSEO
30	65.79419	0.1604	0.2704	9.00		709.07	2843.73	808.89	2492.79	NSEO

	02 and winter 03 for sseo and cseo,	Std. Error Mean Wt. [s.e.(w)]	CV[w]	Area of Rocky Habitat (km^2) [A] (2003 estimate)	Biomass (kg) for Area [bk]	*Biomass (mt) for Area [bm]*	Var(biomass) for Area [Var(bk)]	CV(bk)	Lower 90% CL (kg) [l90]		Upper 90% CL (kg) [u90]	*Lower 90% CL (mt)*	*Upper 90% CL (mt)*		
Area	Formulae to the right indicate how parameters a				= w*D*A	*=bk/1000*	k^2*(CV(d)^2 +CV(wt)	=sqrt[Var(l	=bk/(exp(1.645*(ln(1+CV(bk)))^0.5))	Area	=bk*(exp(1.645*(ln(1+CV(bk)))^0.5))	*=l90/1000*	*=u90/1000*	yelloweye F=.02, mt	DSR TAC (ye/.9), mt
CSEO	3.12	0.044921	0.0144	1414.00	8,226,459.70	8226.46	865973844752.00	0.1131	6833688.27	CSEO	9903091.35	6,833.69	9,903.09	136.67377	151.85974
EYKT (All)	4.30	0.08	0.0178	742.00	11,349,602.32	11349.60	3851695053123.11	0.1729	8557617.98	EYKT (All)	15052491.61	8,557.62	15,052.49	171.15236	190.16929
SSEO	3.44	0.0491	0.0143	732.00	4731220.51	*4731.22*	*659875824436.16*	*0.1717*	*3574386.95*	SSEO	*6262457.83*	*3574.39*	*6262.46*	71.487739	79.430821
NSEO	2.980	0.0953	0.0320	472.00	1,997,315.20	1997.32	398411051516.20	0.3160	1202336.82	NSEO	3317928.83	1,202.34	3,317.93	24.046736	26.718596
				3360.00							Totals, mt:	20168.03		403.3606002	448.1784447

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.)