NOAA Technical Memorandum NMFS-NWFSC-82


# Model-based Estimates of Abundance for 11 Species from the NMFS Slope Surveys

September 2007

**U.S. DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
National Marine Fisheries Service

**NOAA Technical Memorandum**
**NMFS-NWFSC Series**

The Northwest Fisheries Science Center of the National Marine Fisheries Service, NOAA, uses the NOAA Technical Memorandum NMFS-NWFSC series to issue scientific and technical publications. Manuscripts have been peer reviewed and edited. Documents published in this series may be cited in the scientific and technical literature.

The NMFS-NWFSC Technical Memorandum series of the Northwest Fisheries Science Center continues the NMFS-F/NWC series established in 1970 by the Northwest & Alaska Fisheries Science Center, which has since been split into the Northwest Fisheries Science Center and the Alaska Fisheries Science Center. The NMFS-AFSC Technical Memorandum series is now being used by the Alaska Fisheries Science Center.



**This document should be referenced as follows:**

Helser, T.E., I.J. Stewart, C.E. Whitmire, and B.H. Horness. 2007. Model-based estimates of abundance for 11 species from the NMFS slope surveys. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-82, 145 p.

NOAA Technical Memorandum NMFS-NWFSC-82

# Model-based Estimates of Abundance for 11 Species from the NMFS Slope Surveys

Thomas E. Helser, Ian J. Stewart, Curt E. Whitmire,
and Beth H. Horness

Northwest Fisheries Science Center
Fishery Resource Analysis and Monitoring Division
2725 Montlake Boulevard East
Seattle, Washington 98112

September 2007

**U.S. DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
National Marine Fisheries Service

**Most NOAA Technical Memorandums NMFS-NWFSC are available online at the Northwest Fisheries Science Center web site (http://www.nwfsc.noaa.gov)**

Copies are also available from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone orders (1-800-553-6847)
e-mail orders (orders@ntis.fedworld.gov)

# Table of Contents

# List of Figures

# List of Tables

# Executive Summary

Rockfish catch data in National Marine Fisheries Service (NMFS) bottom trawl surveys often consist of numerous hauls with zero catches, positive catch rate data that are highly skewed, and infrequent catches that are extreme. In such situations, expectations from design-based calculations may be biased as normality and variance homogeneity assumptions are violated.

Alternatively, model-based methods using generalized linear models (GLMs) attempt to accommodate variance heterogeneity and asymmetric, nonnormal error distributions. Generalized linear mixed models (GLMMs) represent a fundamental extension to address special random components other than residual error, such as random vessel effects.

In this analysis, we apply GLMs and GLMMs to develop population abundance indices for 11 species of groundfish caught in the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope fishery resource surveys. Full model development consisted of three steps: 1) develop a poststratification scheme based on an evaluation of basic distribution maps, average body weight relationships, and catch-weighted cumulative frequency distributions; 2) evaluate the appropriate error model for the nonzero catch rates for each species using the GLM structure (same set of fixed effects) based on Akaike Information Criterion, and fit a GLM or GLMM to the positive catch rate data; and 3) derive abundance trends based on the model's linear predictors and generate variances based on a sample-based Bayesian analysis.

Based on catch data from the NMFS (NWFSC and AFSC) slope surveys, the 11 species fell roughly into one of three categories for poststratification. The DTS species, consisting of Dover sole (*Microstomus pacificus*), sablefish (*Anoplopoma fimbria*), and shortspine (*Sebastolobus alascanus*) and longspine thornyheads (*S. altivelis*), were widely distributed from Vancouver to Conception and from depths of 183–1,280 m. These species retained the 10 original spatial strata.

Darkblotched rockfish (*Sebastes crameri*), Pacific ocean perch (*S. alutus*), splitnose rockfish (*S. diploproa*) and redbanded rockfish (*S. babcocki*) were generally distributed in the northern and shallower strata, extending from Vancouver to either Eureka or Monterey and most common between depths of 183–567 m. Each of these species, divided into two depth strata, 183–299 m and 300–567 m, showed an increasing trend in average body size with depth.

Aurora (*S. aurora*) and blackgill rockfish (*S. melanostomus*) were generally deeper slope species, distributed between 300–567 m, but whereas blackgill were limited to only Monterey and Conception, Aurora rockfish were more widely distributed between Vancouver and Monterey.

Stripetail rockfish (*S. saxicola*) ranged from Columbia to Conception but were limited to the shallow, upper slope between 183 and 300 m.

In most cases, either the log-normal or gamma model was chosen as the appropriate error distribution. Goodness of fit diagnostics, evaluated by plotting the value of the deviance residual from the appropriate device function and standardized normal Q-Q plots, indicated the GLMs and GLMMs fit the data reasonably well. Trends in population abundance for all 11 slope species along with 95% credibility intervals are reported. The results of the GLMs and GLMMs are given in detail in tables and figures for each individual species in Appendices A through K.

# Acknowledgments

We wish to thank the survey teams of the Northwest Fisheries Science Center Fishery Resource Analysis and Monitoring Division and the Alaska Fisheries Science Center Resource Assessment and Conservation Engineering Division for their tireless efforts at sea collecting the data upon which this analysis was based. We also thank John Wallace and Owen Hamel for thoughtful review of this work.

# Abbreviations and Acronyms

| | |
|---|---|
| AIC | Akaike Information Criterion |
| CV | coefficient of variation |
| DTS | Dover sole, thornyhead (shortspine and longspine), and sablefish |
| RV | research vessel |
| GLM | generalized linear model |
| GLMM | generalized linear mixed model, also referred to as Delta-GLM (appendices) |
| GPS | Global Positioning System |
| INPFC | International North Pacific Fisheries Commission |
| MCMC | Markov Chain Monte Carlo |

# Introduction

This analysis was conducted to provide statistically robust fishery independent indices of abundance in support of the 2005 stock assessments for the Dover sole (*Microstomus pacificus*), shortspine thornyhead (*Sebastolobus alascanus*), longspine thornyhead (*S. altivelis*), sablefish (*Anoplopoma fimbria*) (DTS) and other slope groundfish resources on the continental slope of the U.S. West Coast. This work is a direct extension of the analysis by Helser et al. (2004), who developed a generalized linear mixed model (GLMM) analysis of slope DTS species, and that of Dick (2004), who developed a method for discriminating among error models for generalized linear models (GLM). The Stock Assessment Modeling Workshop (NWFSC 2005), held in October of 2004 to prepare for these assessments, identified the following action items.

GLM-based survey biomass indices:

- Biomass estimates will be generated separately for Alaska Fisheries Science Center (AFSC) slope and Northwest Fisheries Science Center (NWFSC) slope surveys, and then for a combined AFSC-NWFSC slope survey. For those surveys that include "super years," such as the AFSC and the combined AFSC-NWFSC survey, density estimates by stratum will be generated for super years (if super year is used, analysts will need to account for an additional variance component).
- The GLMM analysis (Helser et al. 2004) using the delta approach will be applied to any survey that uses multiple vessels (not including the multivessel shelf survey), and various error distributions will be evaluated using the approach of Dick (2004).
- Using combined surveys—that is, the AFSC-NWFSC slope survey—implicitly assumes that survey $q$ from the separate AFSC and NWFSC surveys are equal. However, analysts may explore unequal survey $q$ in the SS2 model if separate slope surveys are used.
- If a different slope survey configuration is used from previous assessments, then sensitivity analysis should be performed to evaluate its affect on model outcome.
- The GLM approach will be fully documented for distribution to stock assessment review panels.

The analyses and results presented in this document respond directly to the above action items. Specifically this analysis applies GLMs and GLMMs to National Marine Fisheries Service (NMFS) trawl survey data, with the specific objectives of examining the AFSC and NWFSC slope survey data for meaningful poststratification scheme, and conducting a GLM based analysis of slope survey data (accounting for spatial/temporal covariates) generating biomass indices and variances for use in stock assessment.

# Methods

## Basic Data

This analysis uses raw catch data derived from bottom trawl hauls made by NMFS (NWFSC and AFSC) continental slope surveys. The AFSC slope survey began comprehensive survey coverage in 1997 of a limited spatial area, and was repeated in most years until 2001. The NWFSC slope survey overlapped with the AFSC survey in only three years, 1999, 2000, and 2001, but has been completed annually thereafter. A primary difference between these surveys is that the NWFSC slope survey is conducted using multiple vessels in an annual open bid charter system, while the AFSC slope survey was conducted by a single vessel, the NOAA research vessel (RV) *Miller Freeman*. Although several other differences exist between these surveys, only tow distance and net width (which are used to derive bottom area swept) are discussed in detail here because catches need to be standardized by appropriate measures of effort. Interested readers should see Lauth et al. (1998) for specific details of the AFSC slope survey and Turk et al. (2001) for details of the NWFSC slope survey.

In the NWFSC slope survey, operational protocols for the industry-based vessels have been standardized to include a target towing speed of 2.2 knots over ground and a nominal tow duration of 15 minutes between net set time and liftoff. Global Positioning System (GPS) navigation, a Simrad ITI net mensuration system, (Integrated Trawl Instrumentation, Kongsberg Simrad Mesotech Ltd., Port Coquitlam, BC, Canada), and a bottom contact sensor are used simultaneously to monitor trawl performance, calculate haul distance and net dimensions. While the RV *Miller Freeman* used a similar towing speed (2.3 knots), tow duration was standardized to 30 minutes, but lasted as long as 1 hour in deep water in early survey years. Net performance was monitored using a Scanmar AS catch control system (Hydra-Pro Inc., Seattle, Washington), and distances fished for hauls made by the RV *Miller Freeman* were calculated using a bottom contact sensor with GPS. Details of gear changes and survey modifications are given in Lauth et al. (1998).

## Strata Definitions

The purpose of stratifying a survey area is to account for heterogeneous density patterns of the target species in space (Gunderson 1993). In essence, this reduces within-strata variance while increasing between-strata variance. Preliminary analysis of abundance data using a GLM analysis showed a statistically significant interaction between depth and latitude. This indicated that catch rates for both Dover sole (and shortspine thornyhead, for instance) increased with depth and at lower latitudes. Studies of slope species have shown ontogenetic movements from shallow water on the continental shelf to deep water on the slope (Jacobson and Hunter 1993, Jacobson and Vetter 1996). It is likely that the rate of movement from shallow to deep water also differs from south to north due to the relative width of the continental shelf. Ten strata (or

spatial cells) were therefore selected based on specifications for both latitude and depth to account for possible gradients in abundance and life history characteristics.

Latitude boundaries were based on the five International North Pacific Fisheries Commission (INPFC) area definitions, except the Vancouver-Columbia boundary was moved to just south of the Columbia River (lat 46°00′) (Figure 1) to increase sample size in the Vancouver region. Two depth strata (183–566 m, and 567–1,280 m) were considered. These same 10 strata have been used in previous analyses of survey catch rates for slope species (Helser et al. 2004) and for many species these strata have had sufficient samples in each year. However, slope rockfish, many of which occur only within the 183–566 m depth strata and are rare by DTS standards, were reevaluated for poststratification.

In particular, the team generated cumulative frequency plots of average body weight as a function of depth and latitude as well as catch weighted cumulative frequency histograms of depth and latitude for identifying a reasonable poststratification scheme for further GLM analysis. Strata with fewer than three positive tows for a given species were combined in order to make the analysis possible. It should be emphasized that poststratification for the other rockfish was not performed to minimize variance in catch rates, but rather to account for biologically meaningful trends in body size and density.

## The Problem with "Super Years"

The RV *Miller Freeman* surveyed the entire slope from Vancouver to Monterey in 1997, 1999, 2000, and 2001. However, the vessel covered only part of the slope each year in previous years. Therefore, it was necessary to pool data into "super year" groups in order to provide coverage for a greater portion of the entire survey area. Unless data are pooled so that the biomass indices provide complete spatial coverage, they cannot be included in stock assessments. The first super year included the individual years 1990, 1991, 1992, and 1993, which collectively encompassed the Vancouver to northern Monterey INPFC areas. The 1990–1993 super year was assigned to 1992 as roughly the midpoint of the aggregate sampling effort.

The RV *Miller Freeman* surveyed a slightly greater area in 1996 than in previous years, and a second super year was assigned to 1996, representing the 1995–1996 survey years. However, the 1995–1996 super year still covered only the Vancouver to Eureka INPFC areas. Due to the absence of samples and missing survey coverage in Conception and Monterey INPFC areas, it is necessary to input biomass estimates and thus variances. In addition, variance inflation may be required to capture the inherent lack of spatial coverage pertaining to the use of super years. These technical matters are better left to analysts studying trends in abundance for a given species of interest.

## Standardization of Catch Rates

For the purposes of examining species distributions and evaluating biological poststratification, raw catches (in kilograms) were standardized by the product of distance fished and the net wingspread, or bottom area swept during the tow. Each haul's raw catch was divided by the area swept and then further standardized through multiplying by 20,000 $m^2$, or two hectares (two hectares was roughly the mean of the distribution of swept area from all vessels

and all years). This standardization accounted for both the relatively small differences in area swept among NWFSC industry vessels, and more importantly the substantial effort differences among tows made by the RV *Miller Freeman*. The bottom area swept during the NWFSC surveys (10,000 $m^2$ to 40,000 $m^2$; mean is approximately 20,000 $m^2$) is considerably less than during the RV *Miller Freeman* surveys (15,000 $m^2$ to 70,000 $m^2$; mean is approximately 40,000 $m^2$). Effort differences among hauls between the different vessels are explicitly incorporated into the GLMs using an offset (see Statistical Models subsection below). The offset was calculated as the natural logarithm of the ratio of swept area ($m^2$) of a given haul to the mean of the swept area of all hauls.

# Estimation of Biomass Indices

The primary objective of this analysis is to determine annual relative biomass indices and their coefficients of variation, that is, $B_i$ and $cv(B_i)$ where *i* denotes year. The values for these two quantities are obtained using the standard formulae

$$B_i = \sum_j A_j \cdot D_{ij} \tag{1}$$

$$cv(B_i) = \frac{1}{B_i}\sqrt{\sum_j \left(A_j\right)^2 sd\left(D_{ij}\right)^2} \tag{2}$$

where $A_j$ is the area of stratum *j* ($m^2$), $D_{ij}$ is the estimated density per unit area ($m^2$) in stratum *j* during year *i*, and $sd(X)$ denotes the standard deviation of *X*.

The delta distribution (Aitchison and Brown 1957) was used to model the survey data because there are many zero catches. This error model is based on the premise that it is possible to treat separately the question of whether a catch rate is zero, and the size of the catch given that it is nonzero (Vignaux 1994). Pennington (1983) and Stefansson (1996) have shown that this approach provides efficient estimators of abundance for fish surveys in which there are many zero catches. The expected density in stratum *j* during year *i* is obtained by multiplying the probability of a nonzero haul in stratum *j* during year *i* by the expected catch rate given that the catch is nonzero, that is,

$$D_{ij} = P_{ij} \cdot V_{ij} \tag{3}$$

where $P_{ij}$ is the expected probability that a haul in stratum *j* during year *i* leads to a nonzero catch, and $V_{ij}$ is the expected catch rate in stratum *j* during year *i* given that the catch rate is nonzero.

The information needed to apply Equation 3 is obtained from two separate GLMs or GLMMs. Whether a haul is zero or not is assumed to arise from a Bernoulli process and the data on zero/nonzero hauls are therefore modeled using a binomial error model. There is no logical choice for the distribution of nonzero catch rates based on statistical theory. However, other analyses (e.g., Dick 2005) and preliminary investigation of the data included here revealed the

exponential family may provide a reasonable approximation for the highly skewed catch distributions. Full model development consisted of a two-step process: evaluate the appropriate error model for the nonzero catch rates for each species using the generalized linear model structure (same set of fixed effects) using Akaike Information Criterion (AIC) (Akaike 1974) as specified by Dick 2005 (see Statistical Models), then fit either the GLMs or GLMMs to the positive catch data with the appropriate error distribution.

# Statistical Models

The basic form of the GLM is given as

$$\boldsymbol{y}_i = x_i'\boldsymbol{\beta} + \boldsymbol{e}_i \tag{4}$$

where $\boldsymbol{y} = (y_1, \ldots, y_N)$ is the matrix of the response variable, $\boldsymbol{x} = (\boldsymbol{x}_{11}, \ldots, \boldsymbol{x}_{1n})$ is the $N$ x $p$ design matrices of explanatory variables (fixed effects), the $p$ x 1 vector $\beta$ represents the unknown fixed effect coefficients, and $\boldsymbol{e} = (e_1, \ldots, e_N)$ is the vector of residual effects. In some cases, the generalized linear model may consist of both fixed and random effects and, as such, the notation must be expanded to handle both. The GLMM can be written as

$$\boldsymbol{y}_i = \boldsymbol{x}_i'\boldsymbol{\beta} + \boldsymbol{z}_i\mathbf{u} + \boldsymbol{e}_i \tag{5}$$

where $\boldsymbol{z} = (\boldsymbol{x}_{21}, \ldots, \boldsymbol{x}_{2n})$ is the $N$ x $k$ design matrix if random effects, $\mathbf{u}$ is the $k$ x 1 vector of unknown random effect coefficients, and all terms are as above. The residual effects, $\boldsymbol{e}_i$, account for lack of fit due to extra variation and is quite different from the random effects $\boldsymbol{Z}$ which account for some special pattern in the data; in this case random effects due to vessels. The random effect vector $\boldsymbol{Z}$ is assumed to have a multivariate normal distribution with mean 0 and variance-covariance matrix $\mathbf{G} = \sigma_v^2\boldsymbol{I}_k$. The GLM or GLMM has the following components:

- The linear component (or linear predictor) is defined just as it is for traditional linear models

$$\boldsymbol{\eta}_i = X_i'\boldsymbol{\beta} \tag{6}$$

- A monotonic differentiable link function $g$ describes how the expected value of $y_i$ is related to the linear predictor $\boldsymbol{\beta}$

$$g(\boldsymbol{\mu}_i) = X_i'\boldsymbol{\beta} \tag{7}$$

- The response variables $y_i$ are independent for $i = 1, 2, .., n$ and have a probability distribution from an exponential family. This implies that the variance of the response depends on the mean $\mu$ through a *variance function V*

$$var(y_i) = \frac{\boldsymbol{\phi} \cdot V(\boldsymbol{\mu}_i)}{w_i} \tag{8}$$

where $\phi$ is a constant and $w_i$ is a known weight for each observation. The *dispersion parameter* $\phi$ is either known (for example, for the binomial or Poisson distribution, $\phi$=1) or it must be estimated.

A GLMM with a binomial error structure was assumed for the probability of a positive haul. The probability distribution, *D*, for the binomial observations is given by

$$D \sim \binom{n}{y} \pi^{y} (1-\pi)^{n-y} \tag{9}$$

where *n* is the number of tows, *y* is the number of positive tows, the expected proportion positive is $\beta$, and the variance of $\beta$ is $\beta$ (1- $\beta$)/*n*. Using the above distribution and logit canonical link, a generalized linear model for these data is

$$\eta_{ij} = log\left[\frac{\pi_{ij}}{(1-\pi_{ij})}\right] = m + \tau_i + a_j + v_k + effort_k \tag{10}$$

where *m* is the intercept, $\tau$ is the fixed effect of the $i^{th}$ year, *a* is fixed effect of the $j^{th}$ spatial cell (stratum), and *v* is the random effect of $k^{th}$ vessel. Effort for the $k^{th}$ vessel is included in the linear model as an offset.

The GLMM for nonzero positive catch rates is given by

$$\eta_{ij} = g(\mu_{ij}) = m + \tau_i + a_j + (\tau \cdot a)_{ij} + v_k + effort_k \tag{11}$$

where $g(\mu_{ij})$ is the link function that transforms the mean into the linear predictor and the other terms are as above.

To fit the GLMM to nonzero catch rates, the appropriate error distribution was first evaluated among three different probability density functions from the exponential family (Table 1).

This was done separately for each slope species by finding the maximum likelihood estimates based on each of the three error distributions and comparing the fit to the data using AIC.

$$\text{AIC} = -2 \log L(\hat{\theta}) + 2K \tag{12}$$

where $L(\hat{\theta})$ is the likelihood function maximized over the vector of parameters, $\hat{\theta}$, and *K* the number of estimated parameters.

Table 1. Error distribution evaluation.

| **Probability density function** | ***E{Y}*** | **Var*{Y}*** |
|---|---|---|
| Gamma<br>$\frac{1}{\Gamma(\alpha)}\left(\frac{\alpha}{\mu}\right)^{\alpha} y^{\alpha-1}\exp\left(\frac{-\alpha y}{\mu}\right), \mu>0, \alpha>0$ | $\mu$ | $\frac{\mu^2}{\alpha}$ |
| Inverse Gaussian<br>$\sqrt{\frac{k}{2\pi y^3}}\exp\left\{-\frac{k}{2y}\left(\frac{y-\mu}{\mu}\right)^2\right\}, \mu>0, k>0$ | $\mu$ | $\frac{\mu^3}{k}$ |
| Lognormal<br>$\frac{1}{y\sigma\sqrt{2\pi}}\exp\left\{-0.5\left(\frac{\log y-\mu}{\sigma}\right)^2\right\}, -\infty<\mu<\infty, \sigma>0$ | $\exp\left(\mu+0.5\sigma^2\right)$ | $\exp\left(2\mu+\sigma^2\right)\left[\exp\left(\sigma^2\right)-1\right]$ |

The scaled AIC, or Δ AIC = $AIC_i$ – min AIC (Burnham and Anderson 2002), was used to choose the appropriate density function among the competing models. The models fitted to each species are identical except for the assumed error distribution: Gamma, lognormal, and inverse Gaussian. All error distributions have two parameters, *n* is the total number of observations, and *p* is the number of parameters including dispersion parameter. Both proportion positive and positive catch rate models above are extended to include the vessel as a random effect, the rationale for which is given in Helser et al. (2004) and McAllister (1995). The important distinction is GLMs are used to fit the generalized linear model to the AFSC slope survey while GLMMS are used to fit the generalized linear mixed model to the combined NWFSC-AFSC slope surveys and NWFSC slope survey.

To fit the model to the data, a sampling-based Bayesian analysis was conducted to obtain a pseudorandom sample from the joint posterior density of the variance components and other parameters in the mixed model (Tierney 1994, Wolfinger and Kass 2000). Details of the algorithm applied to variance component and mixed models, and simulations on its efficiency can be found in Wolfinger and Kass (2000). Bayesian results were also compared to restricted maximum likelihood (REML, Wolfinger and O'Connell 1993, Littell et al. 1996) estimates for parsimony. Model results of the marginal posterior of parameter estimates were evaluated relative to using both a uniform prior density equal to one everywhere for the variance components and an uninformative reference version of Jeffreys' prior (product of inverse gamma densities). In either case the resulting marginal posterior distributions were very similar, suggesting results were relatively insensitive to choice of priors.

Multiple Bayesian diagnostic procedures were performed to evaluate convergence of the Markov Chain Monte Carlo (MCMC) simulation to a stationary posterior distribution for all estimated quantities in the model (Cowles and Carlin 1996, Brooks and Gelman 1997). The MCMC chain sequence was monitored for autocorrelation at various lags, the test statistic of Heidelberger and Welch (1983) was used to assess whether adequate burn-in had been achieved. Convergence was assumed to have occurred for each chain when the criteria above were met; visual inspection of trace plots and cumulative quantiles (0.05, 0.5, 0.95) indicated stationarity in

all model parameters, and most parameters had a Geweke statistic (Geweke 1992) less than 1.96 (this statistic can be interpreted as a z-score, and will produce some significant values due to random chance).

# Results

## Distribution and Stratification

There was considerable variability in latitudinal and depth ranges for the 11 slope species examined (see Appendices A–K). The four DTS species were abundant over both the entire latitudinal range of the slope survey, from lat 32°30′N to lat 48°00′N, and depth range from roughly 100 m to greater than 1,200 m. As such these species retained the 10 original spatial strata as previously defined by Helser et al. (2004). For the other slope species, the basic rationale for poststratification of the slope survey catch data was as follows: 1) exclude spatial strata (both INPFC areas and depth regions) on extreme boundaries of the species' distribution, 2) aggregate adjacent INPFC areas until at least three positive catch samples (hauls) were present in each year to estimate the mean and variance of that stratum, and 3) identify and partition depth ranges with sample sizes (as in 2 above) and clear trends in average body size.

Based on evaluation of basic distribution maps (plotting catches from each haul approximated by standard deviations from the mean catch), average body weight, and catch weighted cumulative frequency distributions from both the NWFSC and AFSC slope surveys, the 11 species fell roughly into one of three categories for poststratification.

Darkblotched rockfish (*Sebastes crameri*), Pacific ocean perch (*S. alutus*), splitnose rockfish (*S. diploproa*) and redbanded rockfish (*S. babcocki*) were generally distributed in the northern and shallower strata, extending from Vancouver to either Eureka or Monterey and most common between 183 and 567 m. Each of these species showed an increasing trend in average body size with depth and was therefore further divided into two depth strata, 183–299 m and 300–567 m. Aurora (*S. aurora*) and blackgill rockfish (*S. melanostomus*) were generally deeper, distributed between 300–567 m, but whereas blackgill were limited to only Monterey and Conception, aurora rockfish were more widely distributed between Vancouver and Monterey. Finally, stripetail rockfish (*S. saxicola*) ranged from Columbia to Conception but were limited to the shallow, upper slope between 183–300 m.

Table 2 summarizes the poststratification scheme and gives, for each species, the latitudinal and depth range and the final spatial strata used for subsequent GLM analysis, including the total number of strata. Species specific distribution maps, trends in average body size and catch-weighted cumulative frequency distributions which assisted in evaluating poststratification schemes are provided in species specific appendices of this document. Raw haul data and summary catch statistics are also provided.

Table 2. Summarization of poststratification scheme.

| Species | Latitudinal range | Depth range (m) | Total no. of strata | Spatial strata used | |
|---|---|---|---|---|---|
| | | | | INPFC* | Depth (m) |
| Dover sole | 32°30′–> 48°00′ | < 100 m–1,200 m | 10 | V,C,E,M,CN | 183–567, 568–1,280 |
| Sablefish | 32°30′–> 48°00′ | < 100 m–1,200 m | 10 | V,C,E,M,CN | 183–567, 568–1,280 |
| Shortspine | 32°30′–> 48°00′ | 183 m–1,200 m | 10 | V,C,E,M,CN | 183–567, 568–1,280 |
| Longspine | 32°30′–> 48°00′ | 183 m–1,200 m | 10 | V,C,E,M,CN | 183–567, 568–1,280 |
| Darkblotched | 38°00′–> 48°00′ | 183 m–500 m | 4 | V,C,E,M | 183–299, 300–567 |
| Pacific Ocean perch | 40°00′–> 48°00′ | 183 m–500 m | 4 | V,C,E | 183–299, 300–567 |
| Splitnose | 34°00′–> 48°00′ | 183 m–500 m | 4 | V,C,E | 183–299, 300–567 |
| Redbanded | 36°00′–> 48°00′ | 150 m–500 m | 4 | V,C,E,M | 183–299, 300–567 |
| Aurora | 34°00′–> 48°00′ | 300 m–600 m | 4 | V,C,E,M | 300–567 |
| Blackgill | 32°30′–> 40°00′ | 300 m–600 m | 2 | M,CN | 300–567 |
| Stripetail | 32°30′–> 46°00′ | 100 m–300 m | 4 | C,E,M,CN | 183–299 |

* V = Vancouver, C = Columbia, E = Eureka, M = Monterey, CN = Conception.

# GLMs-Error Distributions

Table 3 illustrates the results of evaluating different error distributions for multiplicative delta-GLM models applied to positive catch data for 11 slope species caught in the slope survey (AFSC and NWFSC combined). Among the candidate error distributions examined for each species, the gamma or lognormal models were most often selected as the best choice based on the scaled AIC. The inverse Gaussian error distribution was identified as the best model only for darkblotched rockfish. However, due to convergence problems, the lognormal error model (which was a close second to the inverse Gaussian) was actually used to fit the data.

Table 3. Evaluation results of error distributions.

| Species | *n* | *p* | 2logLikelihood | | | Δ AIC* | | |
|---|---|---|---|---|---|---|---|---|
| | | | Gamma | Lognormal | Inverse Gaussian | Gamma | Lognormal | Inverse Gaussian |
| Dover sole | 2,473 | 71 | 24,429 | 24,813 | 27,013 | 0 | 384 | 2,584 |
| Sablefish | 2,621 | 71 | 20,659 | 20,416 | 20,972 | 243 | 0 | 556 |
| Shortspine | 2,569 | 71 | 17,269 | 17,416 | 19,344 | 0 | 147 | 2,075 |
| Longspine | 1,897 | 71 | 17,068 | 17,560 | 23,509 | 0 | 492 | 6,441 |
| Darkblotched | 371 | 25 | 2,079 | 1,965 | 1,958 | 121 | 7 | 0 |
| Pacific ocean perch | 226 | 25 | 1,425 | 1,382 | 1,451 | 43 | 0 | 69 |
| Splitnose | 353 | 25 | 5,120 | 5,320 | 5,698 | 0 | 200 | 578 |
| Redbanded | 296 | 25 | 762 | 724 | 844 | 38 | 0 | 120 |
| Aurora | 345 | 21 | 2,163 | 2,192 | 2,295 | 0 | 29 | 132 |
| Blackgill | 152 | 21 | 793 | 780 | 803 | 13 | 0 | 23 |
| Stripetail | 207 | 11 | 1,906 | 1,977 | 2,180 | 0 | 71 | 274 |

* $\Delta$ AIC = $AIC_i$ - min AIC.

Subsequent application of the GLMs and GLMMs to the positive catch data employed the selected error distributions from Table 3. It should be noted the selected error distribution is the best choice among competing models examined and not necessarily the true data generating mechanism. Although the selection process was limited to the exponential family of models, this choice can be reassessed through inspection of the residuals for each species.

# GLMs and GLMMs

The results of the GLMs and GLMMs are given in detail in tables in the appendices dealing with individual species, however a few general comments on the models are provided here. For each species, three separate GLMs or GLMMs were applied: 1) GLMMs applied to the combined NWFSC-AFSC slope surveys, 2) GLMs applied to the AFSC slope survey only (RV *Miller Freeman*), and 3) GLMMs applied to the NWFSC slope survey. Each analysis incorporated the same fixed effect design with the selected error distribution (in the case of GLMMs, vessel was used as a random effect). In each case, convergence was obtained using restricted maximum likelihood.

Although the sampling-based Bayesian algorithm was used to quantify the marginal posterior median estimates of biomass and their uncertainty, comparison with the maximum likelihood estimator revealed the two were essentially equal. The Bayesian approach provided an efficient method for propagating uncertainty and integrating the results of both the proportion positive and catch rate GLM analyses. In a purely maximum likelihood approach, this last step would require postanalysis Monte Carlo simulation where biomass is generated as the product of two multivariate normal distributions using the vector of linear predictors and variance-covariance matrices estimated from the GLMs or GLMMs.

In general the GLMMs fit the positive catch data reasonably well. Goodness of fit was evaluated by plotting the value of the deviance residual (McCulloch and Nelder 1989, p. 39) generated from the appropriate deviance function and inverse link of the linear predictor as a function of the linear predictors and standardized normal Q-Q plots from the NWFSC-AFSC GLMMs (these were the most parameterized). As in the case of traditional linear models, measures of goodness of fit are seen as uniformly distributed deviance residuals above and below a zero reference line when plotted against the linear predictors and deviance residuals which are well approximated by a standard normal distribution.

Additionally, convergence to a stationary distribution was generally achieved for each species from an MCMC sample of 20,000 draws, of which the first 10,000 were discarded and the remaining 10,000 thinned to one draw every tenth sample. In some cases longer chains were required, up to a maximum of 50,000 draws with correspondingly larger burn-in and thinning intervals. Model results are summarized in all cases based on 1,000 MCMC samples and presented in a series of tables that provide medians of the marginal posterior distributions and labeled as “predicted” quantities (coefficients of variation for each of the predicted values are given relative to the posterior median values). Full marginal posterior distributions of biomass, shown as box-whisker plots, are also given corresponding to each of the three modeling alternatives for each year.

# References


Aitchison, J., and J. A. C. Brown. 1957. The lognormal distribution. Cambridge University Press, Cambridge.

Akaike, H. 1974. A new look at the statistical model identification. IEEE transaction on automatic control, AC 19:716–723.

Brooks, S., and A. Gelman. 1997. General methods for monitoring convergence of iterative simulations. J. Comput. Graph. Stat. 7:434–455.

Burnham K. P., and D. R. Anderson. 2002. Model selection and multimodel inference, a practical information-theoretic approach. 2nd edition. Springer-Verlag, New York.

Cowels, M. K., and B. P. Carlin. 1996. Markov chain Monte Carlo convergence diagnostics: A comparative review. J. Am. Stat. Assoc. 91:883–904.

Dick, E. J. 2004. Beyond lognormal versus gamma: Discrimination among error distributions for generalized linear models. Fish. Res. 70:351–366.

Geweke, J. 1992. Evaluating the accuracy of sampling-based approaches to the calculation of posterior moments. *In* J. M. Bernardo, J. Berger, A. P. David, and A. F. M. Smith (eds.), Bayesian Statistics 4, p. 169–193. Oxford University Press, Oxford, UK.

Gunderson, D. R. 1993. Surveys of fisheries resources. Wiley, New York.

Helser, T. E, A. E. Punt, and R. D. Methot. 2004. A generalized linear mixed model analysis of a multi-vessel fishery resource survey. Fish. Res. 70:251–264.

Heidelberger, P., and P. D. Welch. 1983. Simulation run length control in the presence of an initial transient. Oper. Res. 31:1109–1144.

Jacobson, L. D., and J. R. Hunter. 1993. Bathymetric demography and management of Dover sole. N. Am. J. Fish. Manag. 13:405–420.

Jacobson, L. D., and R. D. Vetter. 1996. Bathymetric demography and niche separation of thornyhead rockfish: *Sebastolobus alascanus* and *Sebastolobus altivelis*. Can. J. Fish. Aquat. Sci. 53:600–609.

Lauth, R. R., S. E. Syrjala, and S. W. McEntire. 1998. Effects of gear modifications on the trawl performance and catching efficiency of the West Coast upper continental slope groundfish survey trawl. Mar. Fish. Rev. 60:1–26.

Littell, R. C., G. A. Milliken, W. W. Stroup, and R. D. Wolfinger. 1996. SAS system for mixed models. SAS Institute Inc., Cary, NC.

McAllister, M. 1995. Using decision analysis to choose a design of surveying fisheries resources. Doctoral dissertation. University of Washington, Seattle.

McCullaugh, P., and J. A. Nelder. 1989. Generalized linear models. 2nd edition. Chapman & Hall, New York.

Methot, R. D., J. R. Wallace, and C. W. West. 2000. Introducing a new trawl survey for the U.S. West Coast slope groundfish. ICES Document C.M. 2000/W:11.

Pennington, M. 1983. Efficient estimators of abundance for fish and plankton surveys. Biometrics 39:281–286.

Stefánsson, G. 1996. Analysis of groundfish survey abundance data: Combining the GLM and delta approaches. ICES J. Mar. Sci. 53:577–588.

Tierney, L. 1994. Markov chains for exploring posterior distributions (with discussion). Ann. Stat. 22:1701–1762.

Turk, T. A., T. Builder, C. W. West, D. J. Kamikawa, J. R. Wallace and R. D. Methot. 2001. The 1998 Northwest Fisheries Science Center Pacific West Coast upper continental slope trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-50.

Vignaux, M. 1996. Analysis of spatial structure in fish distribution using commercial catch and effort data from the New Zealand hoki fishery. Can. J. Fish. Aquat. Sci. 53:63–973.

Wolfinger, R., and M. O'Connell. 1993. Generalized linear mixed models: A pseudo-likelihood approach. J. Stat. Comput. Simul. 48:233–243.

Wolfinger, R. D., and R. E. Kass. 2000. Nonconjugate Bayesian analysis of variance component models. Biometrics 56:768–774.

# Appendix A: Dover Sole (*Microstomus pacificus*)

This appendix has tables A-1 though A-4 and figures A-1 though A-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for Dover sole. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table A-1. Basic data and statistics summary for Dover sole caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | |
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1992*** | 27 | 27 | 36 | 22 | 57 | 57 | 81 | 70 | 37 | 35 | 93 | 93 | 26 | 26 | 40 | 35 | – | – | – | – |
| **1996*** | 29 | 29 | 44 | 24 | 55 | 55 | 76 | 61 | 34 | 34 | 72 | 69 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 9 | 16 | 8 | 20 | 20 | 28 | 24 | 10 | 10 | 20 | 20 | 17 | 17 | 33 | 30 | 11 | 10 | 18 | 15 |
| **1998** | 17 | 17 | 21 | 11 | 46 | 46 | 31 | 21 | 29 | 29 | 29 | 28 | 42 | 42 | 57 | 52 | 10 | 11 | 16 | 15 |
| **1999** | 36 | 36 | 54 | 25 | 58 | 56 | 71 | 47 | 39 | 39 | 61 | 55 | 65 | 65 | 82 | 75 | 23 | 23 | 33 | 26 |
| **2000** | 35 | 34 | 47 | 25 | 59 | 58 | 70 | 46 | 37 | 37 | 60 | 55 | 72 | 72 | 94 | 88 | 27 | 26 | 36 | 30 |
| **2001** | 36 | 36 | 50 | 24 | 71 | 71 | 59 | 35 | 37 | 37 | 56 | 55 | 65 | 64 | 99 | 92 | 29 | 28 | 36 | 30 |
| **2002** | 24 | 23 | 24 | 12 | 47 | 47 | 39 | 21 | 30 | 30 | 40 | 38 | 58 | 58 | 61 | 52 | 47 | 46 | 54 | 38 |
| **2003** | 28 | 28 | 44 | 21 | 30 | 30 | 37 | 25 | 36 | 36 | 33 | 32 | 32 | 32 | 24 | 19 | 55 | 47 | 27 | 20 |
| **2004** | 13 | 13 | 14 | 8 | 46 | 46 | 19 | 14 | 14 | 14 | 23 | 21 | 17 | 16 | 21 | 21 | 50 | 45 | 49 | 37 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 71.0 | 0.12 | 8.6 | 0.27 | 55.4 | 0.14 | 20.9 | 0.15 | 41.3 | 0.18 | 44.7 | 0.10 | 76.9 | 0.24 | 38.9 | 0.15 | – | – | – | – |
| **1996*** | 74.7 | 0.21 | 4.5 | 0.30 | 50.9 | 0.14 | 10.9 | 0.15 | 57.8 | 0.15 | 31.8 | 0.11 | – | – | – | – | – | – | – | – |
| **1997** | 34.1 | 0.51 | 2.0 | 0.46 | 60.8 | 0.48 | 9.9 | 0.30 | 84.5 | 0.34 | 25.7 | 0.17 | 68.5 | 0.37 | 60.8 | 0.18 | 30.6 | 0.40 | 44.5 | 0.32 |
| **1998** | 94.0 | 0.13 | 8.6 | 0.52 | 57.3 | 0.14 | 18.9 | 0.29 | 107.8 | 0.17 | 23.6 | 0.15 | 71.4 | 0.14 | 58.6 | 0.13 | 12.9 | 0.47 | 42.1 | 0.16 |
| **1999** | 79.2 | 0.14 | 5.9 | 0.29 | 45.6 | 0.11 | 10.8 | 0.22 | 61.2 | 0.17 | 27.5 | 0.17 | 98.0 | 0.12 | 78.0 | 0.11 | 33.7 | 0.17 | 31.9 | 0.22 |
| **2000** | 69.7 | 0.12 | 10.4 | 0.34 | 63.4 | 0.11 | 12.0 | 0.24 | 57.0 | 0.13 | 28.3 | 0.21 | 85.3 | 0.13 | 69.7 | 0.11 | 55.4 | 0.16 | 33.7 | 0.18 |
| **2001** | 89.8 | 0.13 | 4.9 | 0.32 | 52.8 | 0.10 | 9.0 | 0.28 | 75.1 | 0.13 | 21.8 | 0.15 | 129.1 | 0.11 | 69.3 | 0.10 | 42.0 | 0.22 | 43.4 | 0.19 |
| **2002** | 72.2 | 0.11 | 10.9 | 0.40 | 61.6 | 0.16 | 12.5 | 0.32 | 124.3 | 0.13 | 23.7 | 0.19 | 191.4 | 0.13 | 76.4 | 0.19 | 31.2 | 0.20 | 25.6 | 0.17 |
| **2003** | 104.1 | 0.16 | 7.2 | 0.29 | 75.2 | 0.26 | 24.4 | 0.28 | 188.5 | 0.12 | 45.8 | 0.20 | 158.9 | 0.23 | 78.7 | 0.41 | 22.3 | 0.19 | 19.9 | 0.41 |
| **2004** | 115.6 | 0.27 | 4.4 | 0.39 | 59.0 | 0.14 | 14.0 | 0.35 | 140.1 | 0.18 | 70.2 | 0.30 | 103.3 | 0.22 | 97.0 | 0.21 | 25.9 | 0.21 | 26.8 | 0.26 |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 71.0 | 0.12 | 14.1 | 0.24 | 55.4 | 0.14 | 24.2 | 0.14 | 43.7 | 0.18 | 44.7 | 0.10 | 76.9 | 0.24 | 44.5 | 0.13 | – | – | – | – |
| **1996*** | 74.7 | 0.21 | 8.2 | 0.27 | 50.9 | 0.14 | 13.6 | 0.14 | 57.8 | 0.15 | 33.1 | 0.10 | – | – | – | – | – | – | – | – |
| **1997** | 34.1 | 0.51 | 4.1 | 0.39 | 60.8 | 0.48 | 11.5 | 0.29 | 84.5 | 0.34 | 25.7 | 0.17 | 68.5 | 0.37 | 66.9 | 0.17 | 33.6 | 0.39 | 53.3 | 0.30 |
| **1998** | 94.0 | 0.13 | 15.6 | 0.49 | 57.3 | 0.14 | 27.9 | 0.27 | 107.8 | 0.17 | 24.4 | 0.15 | 73.1 | 0.14 | 64.2 | 0.12 | 12.9 | 0.47 | 44.9 | 0.15 |
| **1999** | 79.2 | 0.14 | 13.0 | 0.25 | 46.4 | 0.11 | 16.3 | 0.20 | 61.2 | 0.17 | 30.0 | 0.17 | 98.0 | 0.12 | 85.3 | 0.11 | 33.7 | 0.17 | 40.5 | 0.20 |
| **2000** | 71.8 | 0.11 | 19.5 | 0.31 | 64.5 | 0.10 | 18.3 | 0.23 | 57.0 | 0.13 | 30.9 | 0.21 | 85.3 | 0.13 | 73.7 | 0.10 | 57.6 | 0.16 | 40.7 | 0.16 |
| **2001** | 89.8 | 0.13 | 10.2 | 0.28 | 52.8 | 0.10 | 15.2 | 0.25 | 77.2 | 0.13 | 23.0 | 0.14 | 131.1 | 0.11 | 74.6 | 0.10 | 43.5 | 0.22 | 50.6 | 0.17 |
| **2002** | 75.5 | 0.10 | 20.8 | 0.35 | 61.6 | 0.16 | 23.2 | 0.29 | 124.3 | 0.13 | 25.6 | 0.18 | 191.4 | 0.13 | 89.7 | 0.18 | 31.9 | 0.20 | 37.0 | 0.15 |
| **2003** | 104.1 | 0.16 | 15.1 | 0.25 | 75.2 | 0.26 | 36.2 | 0.26 | 188.5 | 0.12 | 47.2 | 0.19 | 158.9 | 0.23 | 99.3 | 0.40 | 26.1 | 0.19 | 26.9 | 0.40 |
| **2004** | 115.6 | 0.27 | 7.7 | 0.31 | 59.0 | 0.14 | 19.0 | 0.32 | 140.1 | 0.18 | 77.0 | 0.29 | 109.7 | 0.21 | 97.0 | 0.21 | 28.8 | 0.2 | 35.5 | 0.24 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table A-2. Predicted positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2ha) for Dover sole from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.97 | 0.01 | 0.52 | 0.14 | 0.98 | 0.01 | 0.70 | 0.08 | 1.00 | 0.00 | 0.95 | 0.02 | 1.00 | 0.00 | 0.91 | 0.03 | – | – | – | – |
| **1996*** | 0.96 | 0.02 | 0.48 | 0.15 | 0.98 | 0.01 | 0.67 | 0.09 | 1.00 | 0.00 | 0.94 | 0.02 | – | – | – | – | – | – | – | – |
| **1997** | 0.96 | 0.02 | 0.50 | 0.17 | 0.98 | 0.01 | 0.68 | 0.11 | 1.00 | 0.00 | 0.94 | 0.03 | 1.00 | 0.00 | 0.90 | 0.04 | 0.99 | 0.01 | 0.74 | 0.10 |
| **1998** | 0.97 | 0.01 | 0.54 | 0.14 | 0.99 | 0.01 | 0.71 | 0.09 | 1.00 | 0.00 | 0.95 | 0.02 | 1.00 | 0.00 | 0.92 | 0.03 | 0.99 | 0.00 | 0.76 | 0.08 |
| **1999** | 0.95 | 0.02 | 0.41 | 0.12 | 0.98 | 0.01 | 0.61 | 0.08 | 1.00 | 0.00 | 0.92 | 0.03 | 0.99 | 0.00 | 0.87 | 0.03 | 0.98 | 0.01 | 0.67 | 0.08 |
| **2000** | 0.96 | 0.01 | 0.46 | 0.12 | 0.98 | 0.01 | 0.65 | 0.08 | 1.00 | 0.00 | 0.93 | 0.02 | 1.00 | 0.00 | 0.89 | 0.03 | 0.98 | 0.01 | 0.71 | 0.08 |
| **2001** | 0.96 | 0.01 | 0.46 | 0.12 | 0.98 | 0.01 | 0.64 | 0.08 | 1.00 | 0.00 | 0.93 | 0.02 | 1.00 | 0.00 | 0.89 | 0.03 | 0.98 | 0.03 | 0.70 | 0.08 |
| **2002** | 0.95 | 0.02 | 0.44 | 0.14 | 0.98 | 0.01 | 0.62 | 0.09 | 1.00 | 0.00 | 0.93 | 0.03 | 0.99 | 0.00 | 0.88 | 0.03 | 0.98 | 0.01 | 0.69 | 0.08 |
| **2003** | 0.95 | 0.02 | 0.41 | 0.15 | 0.98 | 0.01 | 0.60 | 0.10 | 1.00 | 0.00 | 0.92 | 0.03 | 0.99 | 0.00 | 0.87 | 0.04 | 0.98 | 0.01 | 0.66 | 0.09 |
| **2004** | 0.96 | 0.02 | 0.48 | 0.16 | 0.98 | 0.01 | 0.67 | 0.10 | 1.00 | 0.00 | 0.94 | 0.03 | 1.00 | 0.00 | 0.90 | 0.03 | 0.99 | 0.01 | 0.73 | 0.08 |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 72.9 | 0.21 | 14.3 | 0.23 | 56.3 | 0.16 | 24.2 | 0.14 | 43.8 | 0.20 | 44.5 | 0.13 | 78.2 | 0.22 | 44.9 | 0.20 | – | – | – | – |
| **1996*** | 74.2 | 0.21 | 8.2 | 0.23 | 51.2 | 0.15 | 13.7 | 0.14 | 58.3 | 0.19 | 33.5 | 0.14 | – | – | – | – | – | – | – | – |
| **1997** | 34.7 | 0.39 | 4.2 | 0.43 | 61.7 | 0.27 | 11.6 | 0.23 | 83.9 | 0.40 | 26.2 | 0.25 | 68.5 | 0.29 | 68.7 | 0.21 | 33.9 | 0.37 | 53.6 | 0.30 |
| **1998** | 94.5 | 0.28 | 15.5 | 0.36 | 57.1 | 0.17 | 27.4 | 0.25 | 106.9 | 0.22 | 24.5 | 0.22 | 73.5 | 0.18 | 64.6 | 0.16 | 12.9 | 0.35 | 45.0 | 0.31 |
| **1999** | 80.8 | 0.19 | 13.1 | 0.23 | 46.6 | 0.15 | 16.4 | 0.16 | 61.8 | 0.18 | 30.3 | 0.16 | 98.4 | 0.14 | 85.9 | 0.13 | 33.9 | 0.24 | 40.8 | 0.23 |
| **2000** | 70.7 | 0.19 | 19.4 | 0.23 | 64.7 | 0.16 | 18.2 | 0.17 | 55.9 | 0.20 | 30.5 | 0.15 | 85.0 | 0.14 | 73.7 | 0.12 | 56.9 | 0.23 | 40.2 | 0.22 |
| **2001** | 90.0 | 0.19 | 10.2 | 0.23 | 53.0 | 0.14 | 15.2 | 0.19 | 77.3 | 0.19 | 23.1 | 0.16 | 132.0 | 0.14 | 75.0 | 0.12 | 43.3 | 0.12 | 50.8 | 0.21 |
| **2002** | 77.5 | 0.25 | 20.3 | 0.34 | 61.2 | 0.17 | 23.1 | 0.25 | 124.1 | 0.21 | 25.8 | 0.18 | 190.7 | 0.15 | 89.8 | 0.16 | 32.0 | 0.17 | 37.4 | 0.18 |
| **2003** | 103.2 | 0.22 | 15.4 | 0.25 | 76.3 | 0.20 | 35.8 | 0.23 | 187.3 | 0.20 | 46.8 | 0.21 | 159.3 | 0.20 | 98.1 | 0.26 | 26.4 | 0.17 | 26.6 | 0.26 |
| **2004** | 117.6 | 0.33 | 8.1 | 0.43 | 60.2 | 0.17 | 19.1 | 0.30 | 141.0 | 0.32 | 77.8 | 0.25 | 110.0 | 0.30 | 96.3 | 0.25 | 28.9 | 0.17 | 35.7 | 0.19 |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 10,098 | 0.24 | 2,215 | 0.43 | 19,624 | 0.17 | 4.802 | 0.27 | 5,601 | 0.21 | 13,758 | 0.15 | 14,094 | 0.24 | 17,233 | 0.23 | – | – | – | – |
| **1996*** | 10,276 | 0.23 | 1,170 | 0.42 | 17,919 | 0.16 | 2.583 | 0.27 | 7,447 | 0.22 | 10,209 | 0.17 | – | – | – | – | – | – | – | – |
| **1997** | 4,831 | 0.43 | 593 | 0.63 | 21,538 | 0.28 | 2.230 | 0.36 | 10,732 | 0.42 | 8,035 | 0.27 | 12,325 | 0.28 | 26,171 | 0.24 | 23,053 | 0.42 | 66,199 | 0.38 |
| **1998** | 13,167 | 0.29 | 2,439 | 0.46 | 19,977 | 0.18 | 5.501 | 0.35 | 13,673 | 0.22 | 7,614 | 0.24 | 13,252 | 0.18 | 24,867 | 0.19 | 8,754 | 0.35 | 57,795 | 0.39 |
| **1999** | 11,065 | 0.20 | 1,598 | 0.36 | 16,148 | 0.16 | 2.798 | 0.27 | 7,896 | 0.19 | 9,089 | 0.18 | 17,713 | 0.15 | 31,522 | 0.16 | 22,953 | 0.25 | 45,438 | 0.30 |
| **2000** | 9,807 | 0.21 | 2,672 | 0.35 | 22,543 | 0.16 | 3.311 | 0.24 | 7,139 | 0.20 | 9,231 | 0.17 | 15,304 | 0.14 | 27,663 | 0.14 | 38,649 | 0.24 | 47,484 | 0.27 |
| **2001** | 12,425 | 0.21 | 1,350 | 0.35 | 18,459 | 0.14 | 2.757 | 0.27 | 9,875 | 0.19 | 7,009 | 0.17 | 23,750 | 0.15 | 27,988 | 0.16 | 29,400 | 0.16 | 59,357 | 0.28 |
| **2002** | 10,676 | 0.26 | 2,622 | 0.48 | 21,247 | 0.17 | 4.039 | 0.31 | 15,848 | 0.23 | 7,753 | 0.20 | 34,307 | 0.16 | 33,296 | 0.18 | 21,705 | 0.18 | 42,606 | 0.25 |
| **2003** | 14,111 | 0.22 | 1,859 | 0.35 | 26,491 | 0.22 | 6.064 | 0.30 | 23,934 | 0.20 | 13,973 | 0.22 | 28,676 | 0.21 | 36,020 | 0.29 | 17,858 | 0.18 | 29,258 | 0.33 |
| **2004** | 16,316 | 0.35 | 1,122 | 0.54 | 21,016 | 0.18 | 3.560 | 0.41 | 18,029 | 0.32 | 23,763 | 0.26 | 19,804 | 0.31 | 36,205 | 0.29 | 19,595 | 0.18 | 43,127 | 0.27 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table A-3. Predicted proportion positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2ha) for Dover sole from the Delta-GLM applied to NWFSC slope survey.

| | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 0.96 | 0.02 | 0.55 | 0.15 | 0.98 | 0.01 | 0.67 | 0.11 | 1.00 | 0.00 | 0.94 | 0.03 | 1.00 | 0.00 | 0.91 | 0.04 | 0.98 | 0.01 | 0.75 | 0.09 |
| **1999** | 0.96 | 0.02 | 0.51 | 0.15 | 0.97 | 0.01 | 0.63 | 0.10 | 1.00 | 0.00 | 0.93 | 0.03 | 0.99 | 0.00 | 0.89 | 0.04 | 0.98 | 0.01 | 0.72 | 0.09 |
| **2000** | 0.97 | 0.01 | 0.58 | 0.14 | 0.98 | 0.01 | 0.69 | 0.09 | 1.00 | 0.00 | 0.94 | 0.02 | 1.00 | 0.00 | 0.91 | 0.03 | 0.99 | 0.01 | 0.77 | 0.08 |
| **2001** | 0.96 | 0.02 | 0.54 | 0.14 | 0.98 | 0.01 | 0.65 | 0.10 | 1.00 | 0.00 | 0.93 | 0.03 | 0.99 | 0.00 | 0.90 | 0.03 | 0.98 | 0.03 | 0.73 | 0.08 |
| **2002** | 0.96 | 0.02 | 0.51 | 0.15 | 0.97 | 0.01 | 0.63 | 0.10 | 1.00 | 0.00 | 0.92 | 0.03 | 0.99 | 0.00 | 0.89 | 0.04 | 0.98 | 0.01 | 0.71 | 0.08 |
| **2003** | 0.95 | 0.02 | 0.47 | 0.15 | 0.97 | 0.01 | 0.60 | 0.11 | 1.00 | 0.00 | 0.92 | 0.03 | 0.99 | 0.00 | 0.88 | 0.04 | 0.98 | 0.01 | 0.68 | 0.09 |
| **2004** | 0.96 | 0.02 | 0.54 | 0.15 | 0.98 | 0.01 | 0.66 | 0.11 | 1.00 | 0.00 | 0.93 | 0.03 | 0.99 | 0.00 | 0.90 | 0.04 | 0.98 | 0.01 | 0.74 | 0.08 |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 94.5 | 0.28 | 15.0 | 0.37 | 57.3 | 0.17 | 27.3 | 0.25 | 107.7 | 0.21 | 24.6 | 0.21 | 72.8 | 0.18 | 65.0 | 0.16 | 12.5 | 0.34 | 44.8 | 0.28 |
| **1999** | 74.6 | 0.24 | 17.2 | 0.30 | 48.2 | 0.18 | 15.2 | 0.21 | 75.3 | 0.20 | 35.9 | 0.19 | 112.9 | 0.17 | 93.7 | 0.17 | 27.7 | 0.34 | 38.0 | 0.35 |
| **2000** | 65.1 | 0.23 | 31.2 | 0.36 | 70.5 | 0.19 | 20.9 | 0.22 | 57.2 | 0.23 | 34.8 | 0.19 | 76.9 | 0.15 | 69.2 | 0.16 | 54.5 | 0.28 | 36.4 | 0.30 |
| **2001** | 69.2 | 0.22 | 10.9 | 0.34 | 47.6 | 0.15 | 15.0 | 0.30 | 63.8 | 0.21 | 26.1 | 0.20 | 111.5 | 0.17 | 61.8 | 0.15 | 36.3 | 0.15 | 46.9 | 0.29 |
| **2002** | 76.2 | 0.24 | 20.2 | 0.33 | 60.9 | 0.17 | 23.0 | 0.25 | 123.0 | 0.20 | 25.4 | 0.18 | 191.4 | 0.15 | 89.4 | 0.16 | 31.5 | 0.17 | 37.0 | 0.18 |
| **2003** | 104.9 | 0.21 | 15.6 | 0.24 | 76.0 | 0.20 | 35.9 | 0.22 | 189.1 | 0.18 | 47.1 | 0.19 | 159.2 | 0.20 | 93.6 | 0.26 | 26.4 | 0.16 | 26.7 | 0.26 |
| **2004** | 117.5 | 0.31 | 7.8 | 0.45 | 60.0 | 0.17 | 18.8 | 0.31 | 143.3 | 0.30 | 77.6 | 0.25 | 112.2 | 0.28 | 94.1 | 0.23 | 28.5 | 0.16 | 35.8 | 0.19 |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 13,165 | 0.27 | 2,441 | 0.40 | 19,928 | 0.17 | 5,102 | 0.27 | 13,744 | 0.21 | 7,494 | 0.21 | 13,122 | 0.18 | 24,872 | 0.17 | 8,478 | 0.34 | 54,932 | 0.30 |
| **1999** | 10,289 | 0.24 | 2,561 | 0.34 | 16,609 | 0.18 | 2,681 | 0.24 | 9,611 | 0.20 | 10,831 | 0.19 | 20,315 | 0.17 | 35,173 | 0.17 | 18,776 | 0.34 | 45,500 | 0.36 |
| **2000** | 9,057 | 0.23 | 5,229 | 0.41 | 24,493 | 0.19 | 4,001 | 0.24 | 7,302 | 0.23 | 10,653 | 0.19 | 13,849 | 0.16 | 26,539 | 0.16 | 37,053 | 0.28 | 46,414 | 0.31 |
| **2001** | 9,581 | 0.22 | 1,729 | 0.38 | 16,525 | 0.15 | 2,747 | 0.32 | 8,153 | 0.21 | 7,932 | 0.20 | 20,100 | 0.17 | 23,359 | 0.16 | 24,598 | 0.16 | 57,124 | 0.31 |
| **2002** | 10,519 | 0.24 | 2,956 | 0.37 | 20,961 | 0.17 | 4,001 | 0.27 | 15,728 | 0.20 | 7,636 | 0.18 | 34,408 | 0.15 | 33,311 | 0.16 | 21,247 | 0.17 | 43,742 | 0.20 |
| **2003** | 14,380 | 0.21 | 2,175 | 0.29 | 26,205 | 0.20 | 5,985 | 0.25 | 24,129 | 0.18 | 14,045 | 0.19 | 28,594 | 0.20 | 34,693 | 0.26 | 17,804 | 0.16 | 30,494 | 0.27 |
| **2004** | 16,302 | 0.31 | 1,233 | 0.51 | 20,855 | 0.17 | 3,479 | 0.33 | 18,312 | 0.30 | 23,513 | 0.25 | 20,208 | 0.28 | 35,692 | 0.24 | 19,292 | 0.16 | 44,123 | 0.21 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table A-4. Predicted proportion positive catch rate given a positive haul (kg/2Ha) and biomass (1,000s mt/2ha) of Dover sole from the Delta-GLM applied to AFSC slope survey.

| Year | Vancouver 183–567 m | | Vancouver 567–1,280 m | | Columbia 183–567 m | | Columbia 567–1,280 m | | Eureka 183–567 m | | Eureka 567–1,280 m | | Monterey 183–567 m | | Monterey 567–1,280 m | | Conception 183–567 m | | Conception 567–1,280 m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.97 | 0.03 | 0.42 | 0.22 | 0.99 | 0.01 | 0.69 | 0.12 | 1.00 | 0.00 | 0.95 | 0.04 | 1.00 | 0.00 | 0.89 | 0.07 | – | – | – | – |
| **1996*** | 0.97 | 0.04 | 0.38 | 0.23 | 0.99 | 0.02 | 0.66 | 0.12 | 1.00 | 0.00 | 0.94 | 0.05 | – | – | – | – | – | – | – | – |
| **1997** | 0.97 | 0.04 | 0.42 | 0.26 | 0.99 | 0.01 | 0.69 | 0.15 | 1.00 | 0.00 | 0.95 | 0.05 | 1.00 | 0.01 | 0.89 | 0.08 | 0.99 | 0.02 | 0.70 | 0.17 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 0.95 | 0.05 | 0.30 | 0.29 | 0.98 | 0.02 | 0.57 | 0.18 | 1.00 | 0.00 | 0.91 | 0.07 | 1.00 | 0.01 | 0.82 | 0.10 | 0.99 | 0.02 | 0.58 | 0.21 |
| **2000** | 0.96 | 0.05 | 0.34 | 0.27 | 0.99 | 0.02 | 0.61 | 0.16 | 1.00 | 0.00 | 0.93 | 0.06 | 1.00 | 0.01 | 0.85 | 0.09 | 0.99 | 0.02 | 0.63 | 0.19 |
| **2001** | 0.97 | 0.04 | 0.37 | 0.26 | 0.99 | 0.02 | 0.64 | 0.16 | 1.00 | 00.0 | 0.94 | 0.05 | 1.00 | 0.01 | 0.86 | 0.08 | 0.99 | 0.08 | 0.66 | 0.19 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 71.4 | 0.22 | 14.1 | 0.25 | 55.0 | 0.15 | 24.0 | 0.14 | 43.5 | 0.20 | 44.9 | 0.11 | 76.9 | 0.22 | 44.3 | 0.20 | – | – | – | – |
| **1996*** | 75.7 | 0.21 | 8.3 | 0.23 | 50.9 | 0.16 | 13.6 | 0.14 | 58.2 | 0.20 | 32.8 | 0.14 | – | – | – | – | – | – | – | – |
| **1997** | 33.8 | 0.41 | 4.2 | 0.42 | 59.9 | 0.27 | 11.4 | 0.23 | 84.6 | 0.39 | 26.5 | 0.26 | 69.0 | 0.29 | 67.0 | 0.22 | 33.2 | 0.38 | 53.7 | 0.29 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 89.8 | 0.36 | 7.3 | 0.41 | 44.0 | 0.27 | 18.3 | 0.27 | 22.0 | 0.40 | 21.9 | 0.25 | 71.2 | 0.28 | 75.6 | 0.21 | 41.6 | 0.39 | 44.0 | 0.30 |
| **2000** | 83.5 | 0.35 | 10.7 | 0.32 | 51.2 | 0.25 | 13.9 | 0.27 | 53.2 | 0.39 | 19.8 | 0.28 | 104.5 | 0.26 | 76.3 | 0.18 | 59.6 | 0.40 | 44.4 | 0.31 |
| **2001** | 134.8 | 0.36 | 9.4 | 0.32 | 65.4 | 0.26 | 15.1 | 0.26 | 114.4 | 0.40 | 17.6 | 0.25 | 171.3 | 0.26 | 90.6 | 0.18 | 55.2 | 0.18 | 51.6 | 0.32 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 9,971 | 0.22 | 1,748 | 0.34 | 19,252 | 0.15 | 4,619 | 0.18 | 5,561 | 0.20 | 13,745 | 0.12 | 13,860 | 0.22 | 16,565 | 0.21 | – | – | – | – |
| **1996*** | 10,452 | 0.22 | 926 | 0.34 | 17,897 | 0.16 | 2,484 | 0.19 | 7,440 | 0.20 | 9,933 | 0.15 | – | – | – | – | – | – | – | – |
| **1997** | 4,665 | 0.42 | 512 | 0.34 | 21,022 | 0.27 | 2,162 | 0.28 | 10,825 | 0.39 | 8,119 | 0.26 | 12,438 | 0.29 | 24,626 | 0.23 | 22,671 | 0.38 | 61,068 | 0.35 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 12,223 | 0.36 | 638 | 0.56 | 15,249 | 0.27 | 2,850 | 0.33 | 2,817 | 0.40 | 6,476 | 0.26 | 12,824 | 0.28 | 25,638 | 0.23 | 27,950 | 0.39 | 41,954 | 0.39 |
| **2000** | 11,353 | 0.36 | 1,064 | 0.45 | 17,889 | 0.26 | 2,374 | 0.33 | 6,805 | 0.39 | 5,876 | 0.28 | 18,821 | 0.26 | 27,207 | 0.20 | 40,405 | 0.40 | 45,348 | 0.40 |
| **2001** | 18,490 | 0.37 | 1,012 | 0.43 | 22,955 | 0.26 | 2,671 | 0.32 | 14,646 | 0.40 | 5,284 | 0.26 | 30,843 | 0.26 | 32,592 | 0.19 | 37,553 | 0.19 | 54,840 | 0.39 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

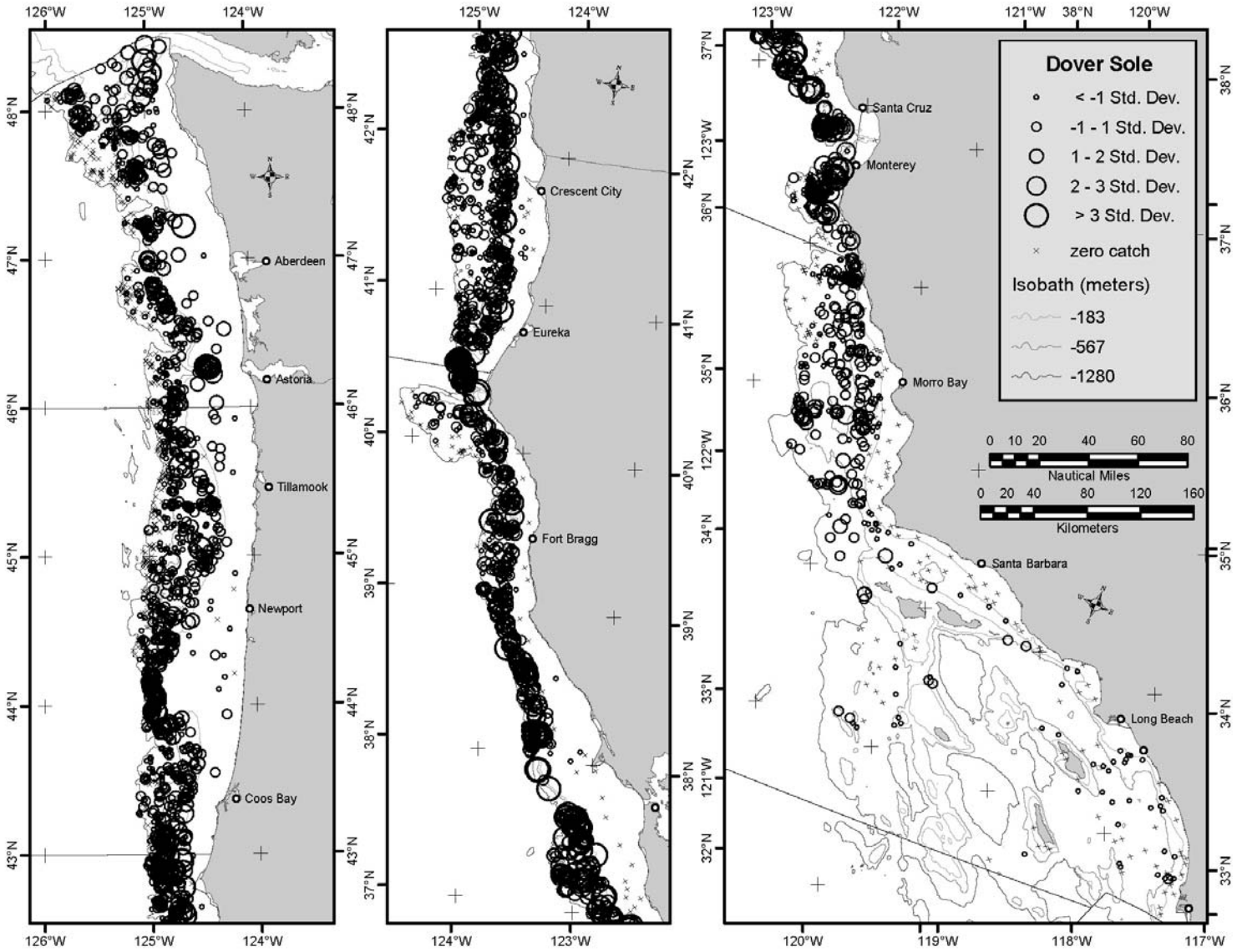



Figure A-1. Distribution of Dover sole caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

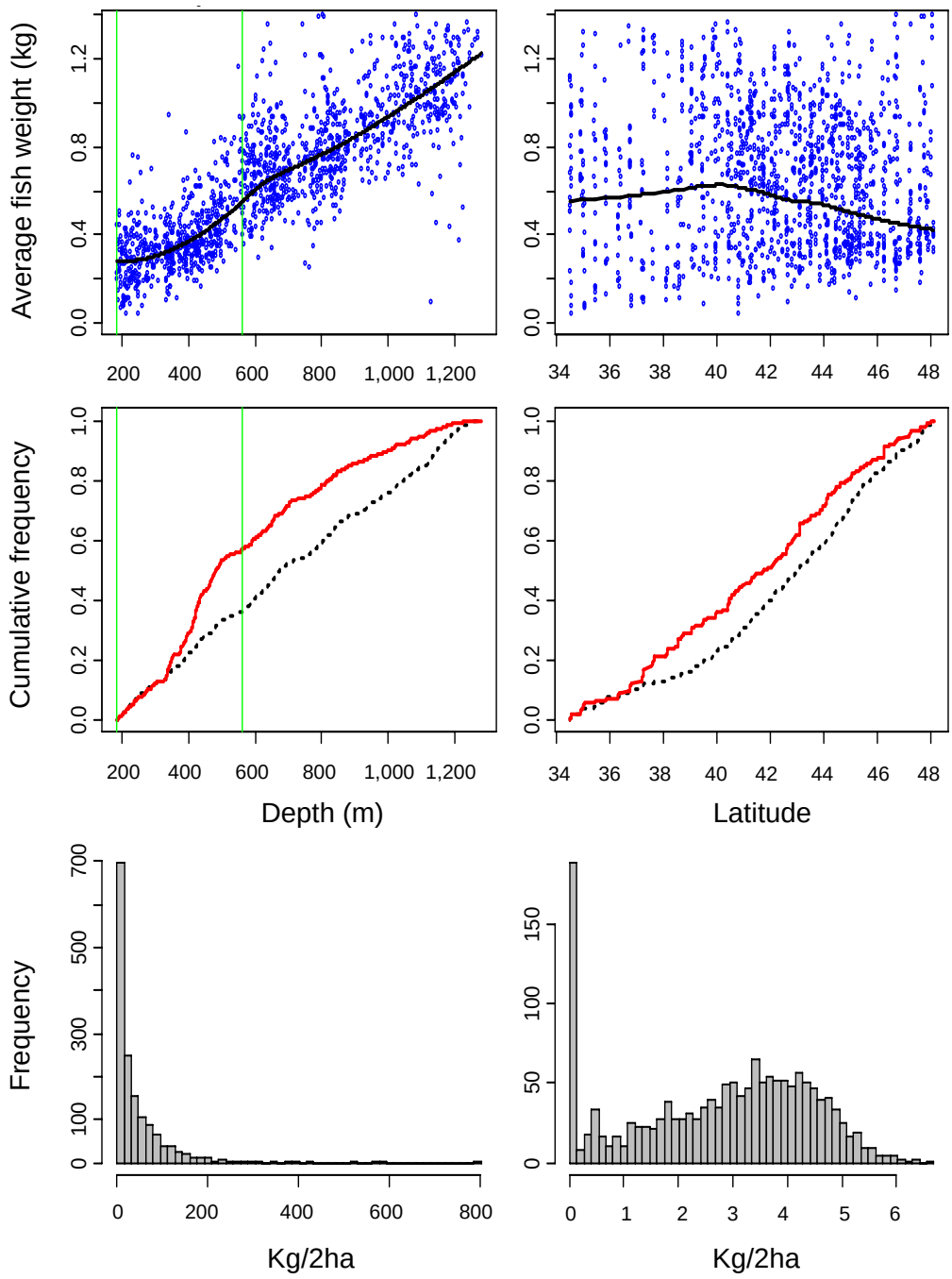



Figure A-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Dover sole caught in the AFSC slope surveys.

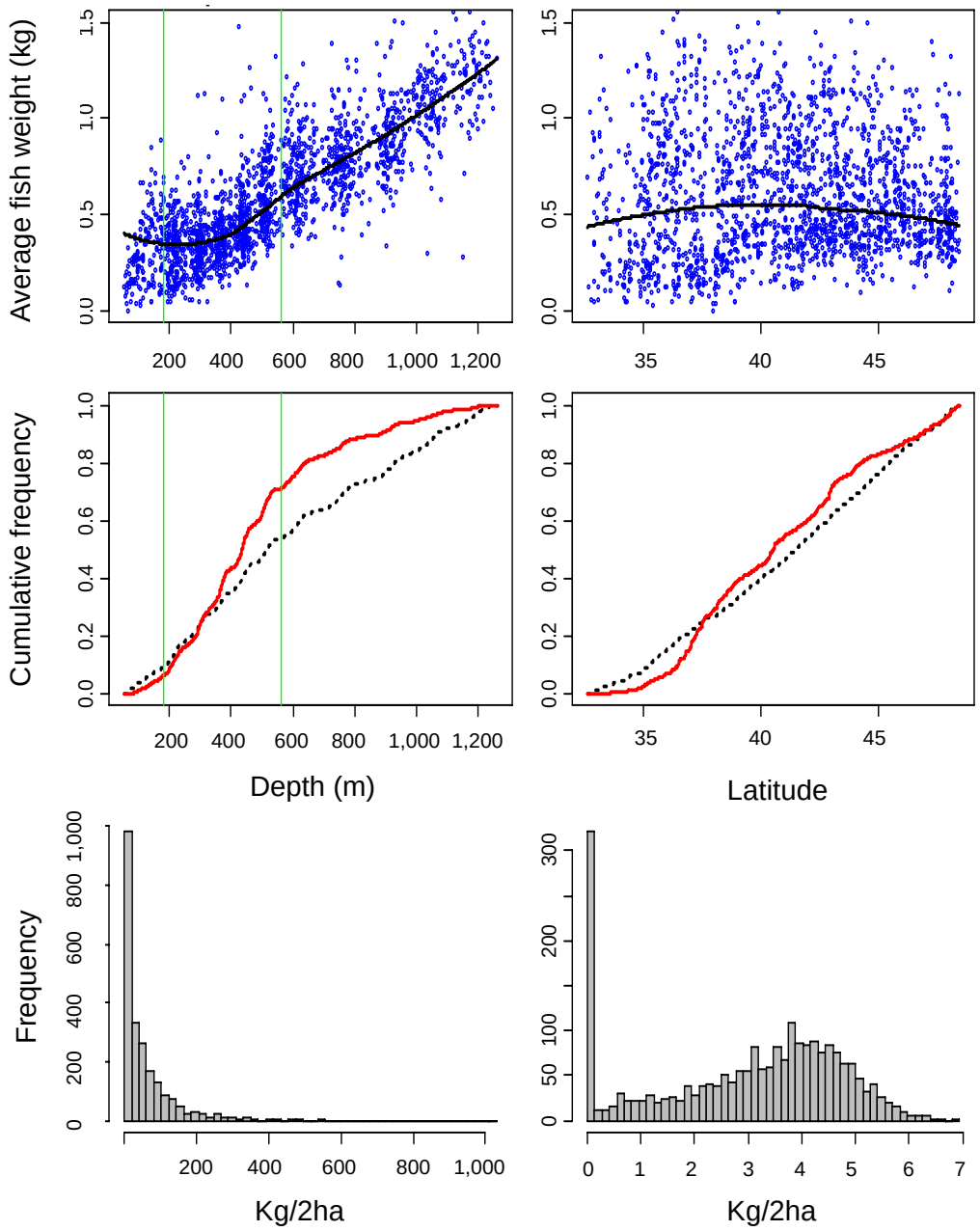
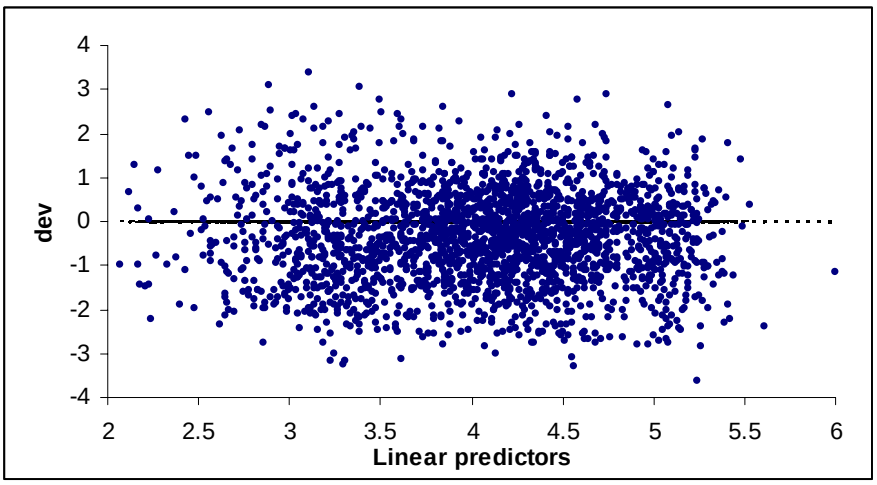
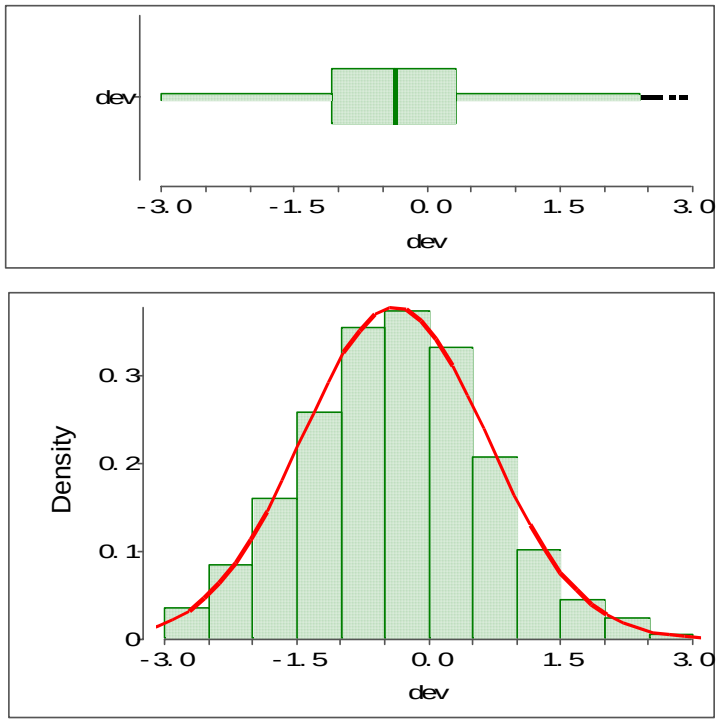



Figure A-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Dover sole caught in the NWFSC slope surveys.

A




B




C

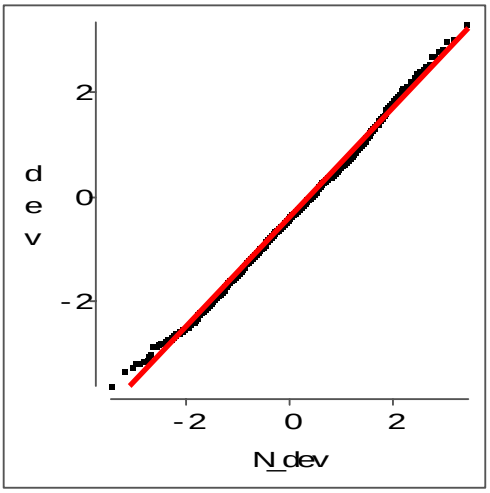



Figure A-4. Diagnostic plots from the generalized linear mixed model fit to Dover sole from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

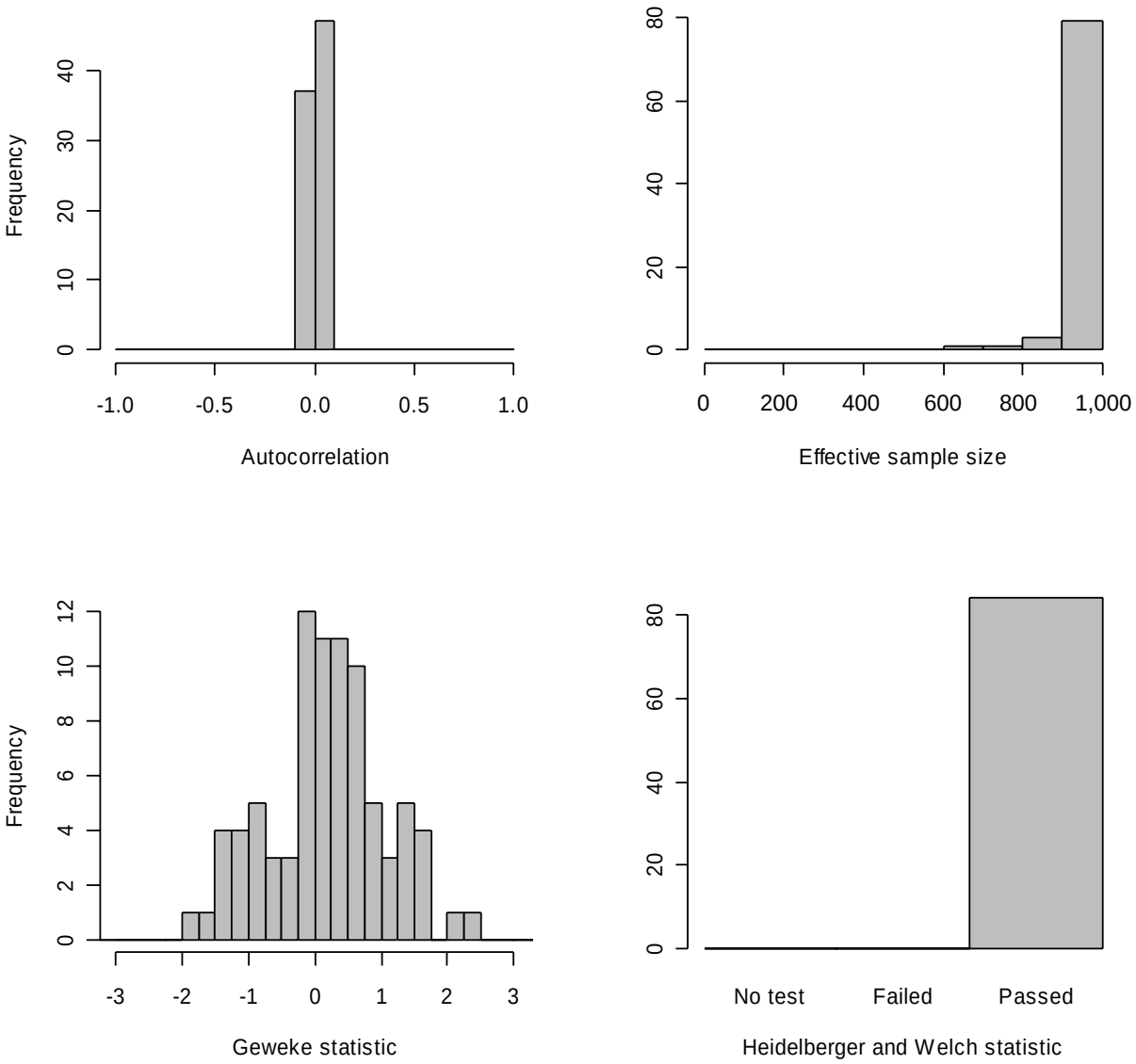
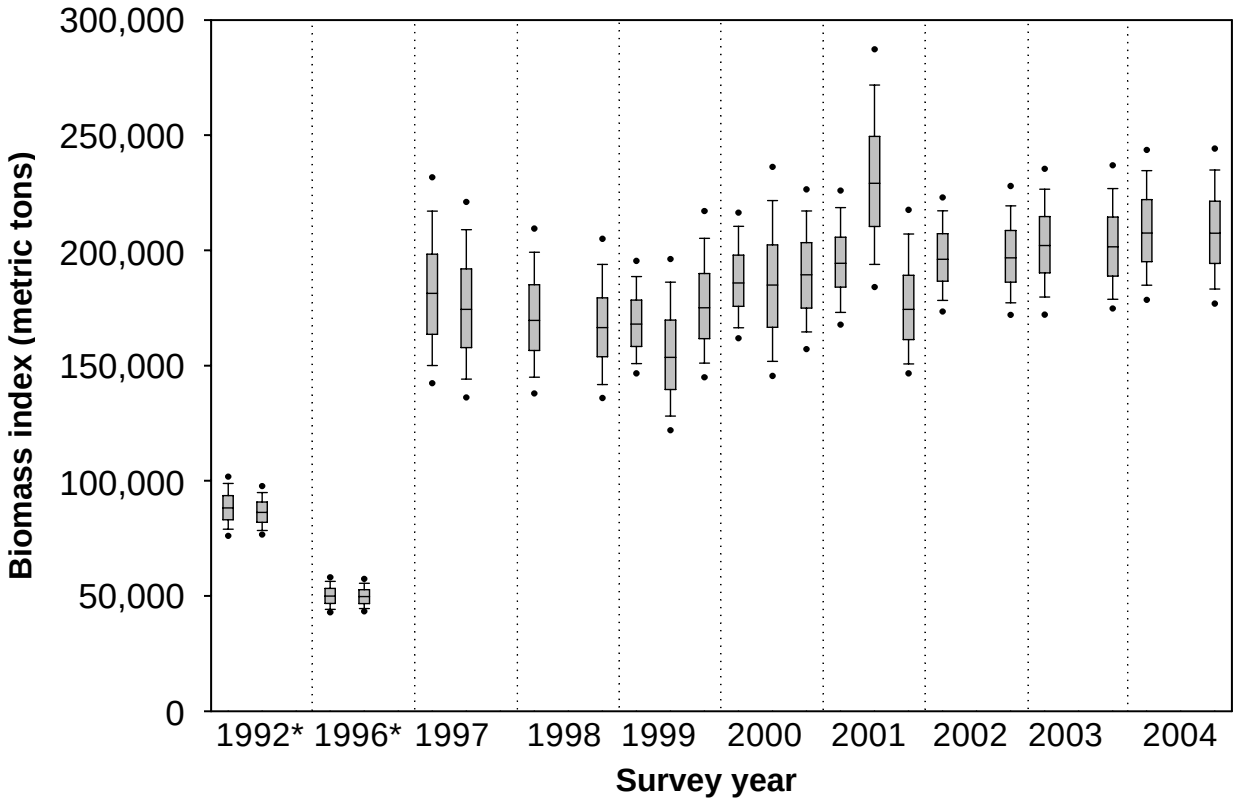



Figure A-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for Dover sole. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure A-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for Dover sole. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix B: Sablefish (*Anoplopoma fimbria*)

This appendix has tables B-1 though B-4 and figures B-1 though B-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for sablefish. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table B-1. Basic data and statistics summary for sablefish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | |
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1992*** | 27 | 26 | 36 | 36 | 57 | 54 | 81 | 79 | 37 | 36 | 93 | 92 | 26 | 24 | 40 | 40 | – | – | – | – |
| **1996*** | 29 | 28 | 44 | 43 | 55 | 53 | 76 | 76 | 34 | 34 | 72 | 67 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 7 | 16 | 16 | 20 | 19 | 28 | 28 | 10 | 10 | 20 | 19 | 17 | 12 | 33 | 33 | 11 | 9 | 18 | 18 |
| **1998** | 17 | 17 | 21 | 19 | 46 | 46 | 31 | 27 | 29 | 28 | 29 | 25 | 42 | 29 | 57 | 55 | 10 | 6 | 16 | 16 |
| **1999** | 36 | 35 | 54 | 53 | 58 | 55 | 71 | 64 | 39 | 37 | 61 | 57 | 65 | 57 | 82 | 82 | 23 | 18 | 33 | 33 |
| **2000** | 35 | 32 | 47 | 44 | 59 | 56 | 70 | 66 | 37 | 37 | 60 | 53 | 72 | 57 | 94 | 91 | 27 | 20 | 36 | 36 |
| **2001** | 36 | 34 | 50 | 48 | 71 | 68 | 59 | 48 | 37 | 36 | 56 | 49 | 65 | 53 | 99 | 99 | 29 | 22 | 36 | 36 |
| **2002** | 24 | 23 | 24 | 23 | 47 | 44 | 39 | 34 | 30 | 29 | 40 | 34 | 58 | 46 | 61 | 57 | 47 | 33 | 54 | 51 |
| **2003** | 28 | 27 | 44 | 39 | 30 | 29 | 37 | 33 | 36 | 32 | 33 | 27 | 32 | 23 | 24 | 22 | 55 | 32 | 27 | 25 |
| **2004** | 13 | 11 | 14 | 12 | 46 | 40 | 19 | 18 | 14 | 13 | 23 | 21 | 17 | 10 | 21 | 19 | 50 | 29 | 49 | 46 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **Year** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 38.0 | 0.27 | 18.7 | 0.12 | 32.7 | 0.46 | 23.4 | 0.13 | 21.0 | 0.25 | 33.7 | 0.11 | 27.9 | 0.35 | 25.2 | 0.15 | – | – | – | – |
| **1996*** | 16.6 | 0.21 | 17.2 | 0.18 | 15.4 | 0.13 | 22.9 | 0.11 | 15.0 | 0.35 | 29.2 | 0.14 | – | – | – | – | – | – | – | – |
| **1997** | 19.8 | 0.29 | 18.7 | 0.34 | 28.9 | 0.21 | 29.6 | 0.14 | 54.9 | 0.34 | 27.7 | 0.15 | 16.5 | 0.33 | 32.0 | 0.17 | 6.2 | 0.35 | 25.8 | 0.22 |
| **1998** | 7.5 | 0.22 | 12.9 | 0.23 | 9.5 | 0.15 | 17.8 | 0.14 | 10.9 | 0.25 | 13.6 | 0.19 | 4.7 | 0.26 | 14.3 | 0.16 | 8.1 | 0.54 | 19.3 | 0.21 |
| **1999** | 10.0 | 0.15 | 17.5 | 0.25 | 15.5 | 0.14 | 21.6 | 0.11 | 10.7 | 0.26 | 20.8 | 0.15 | 25.3 | 0.62 | 19.2 | 0.13 | 8.7 | 0.19 | 18.3 | 0.15 |
| **2000** | 21.5 | 0.28 | 19.9 | 0.15 | 24.5 | 0.24 | 22.9 | 0.14 | 11.9 | 0.13 | 20.8 | 0.11 | 13.2 | 0.18 | 21.3 | 0.13 | 14.2 | 0.16 | 20.6 | 0.18 |
| **2001** | 21.6 | 0.37 | 15.4 | 0.11 | 14.2 | 0.09 | 14.4 | 0.13 | 21.5 | 0.11 | 15.6 | 0.15 | 16.6 | 0.14 | 23.3 | 0.10 | 13.5 | 0.19 | 24.5 | 0.14 |
| **2002** | 13.8 | 0.23 | 16.5 | 0.21 | 23.6 | 0.13 | 11.8 | 0.14 | 22.6 | 0.15 | 17.4 | 0.15 | 18.7 | 0.17 | 18.9 | 0.13 | 10.3 | 0.25 | 11.3 | 0.15 |
| **2003** | 54.5 | 0.43 | 16.5 | 0.17 | 26.4 | 0.13 | 16.2 | 0.11 | 36.1 | 0.21 | 37.0 | 0.56 | 26.0 | 0.28 | 25.7 | 0.34 | 6.0 | 0.19 | 8.2 | 0.32 |
| **2004** | 54.9 | 0.27 | 27.5 | 0.21 | 26.9 | 0.18 | 14.0 | 0.17 | 128.8 | 0.51 | 26.3 | 0.13 | 137.6 | 0.85 | 19.9 | 0.19 | 8.8 | 0.33 | 15.4 | 0.17 |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 38.0 | 0.27 | 18.7 | 0.12 | 33.3 | 0.46 | 23.6 | 0.13 | 21.6 | 0.25 | 33.7 | 0.11 | 27.9 | 0.35 | 25.9 | 0.15 | – | – | – | – |
| **1996*** | 16.6 | 0.21 | 17.2 | 0.18 | 15.4 | 0.13 | 22.9 | 0.11 | 15.5 | 0.35 | 30.1 | 0.13 | – | – | – | – | – | – | – | – |
| **1997** | 19.8 | 0.29 | 20.0 | 0.33 | 30.5 | 0.20 | 29.6 | 0.14 | 61.1 | 0.32 | 27.7 | 0.15 | 18.7 | 0.32 | 32.0 | 0.17 | 6.8 | 0.33 | 25.8 | 0.22 |
| **1998** | 9.0 | 0.19 | 15.1 | 0.21 | 11.8 | 0.13 | 18.3 | 0.14 | 13.7 | 0.23 | 14.0 | 0.19 | 7.8 | 0.23 | 14.6 | 0.16 | 14.8 | 0.47 | 22.0 | 0.18 |
| **1999** | 11.3 | 0.14 | 17.8 | 0.25 | 17.3 | 0.13 | 21.9 | 0.11 | 13.0 | 0.25 | 21.2 | 0.15 | 30.5 | 0.62 | 19.7 | 0.12 | 9.1 | 0.18 | 18.9 | 0.14 |
| **2000** | 25.1 | 0.27 | 21.3 | 0.15 | 25.4 | 0.24 | 22.9 | 0.14 | 12.5 | 0.12 | 21.2 | 0.11 | 15.3 | 0.17 | 21.8 | 0.13 | 14.8 | 0.16 | 21.2 | 0.18 |
| **2001** | 25.2 | 0.36 | 16.0 | 0.11 | 14.8 | 0.09 | 15.5 | 0.13 | 21.5 | 0.11 | 16.7 | 0.15 | 17.1 | 0.14 | 23.8 | 0.10 | 15.0 | 0.18 | 25.3 | 0.13 |
| **2002** | 15.1 | 0.22 | 18.9 | 0.19 | 23.6 | 0.13 | 12.5 | 0.14 | 22.6 | 0.15 | 18.3 | 0.14 | 19.4 | 0.17 | 21.0 | 0.13 | 14.3 | 0.23 | 13.8 | 0.13 |
| **2003** | 61.0 | 0.43 | 17.7 | 0.17 | 29.3 | 0.12 | 16.6 | 0.11 | 36.1 | 0.21 | 37.0 | 0.56 | 26.8 | 0.28 | 25.7 | 0.34 | 8.7 | 0.16 | 12.3 | 0.29 |
| **2004** | 71.4 | 0.22 | 27.5 | 0.21 | 28.1 | 0.17 | 14.0 | 0.17 | 128.8 | 0.51 | 26.3 | 0.18 | 155.9 | 0.85 | 19.9 | 0.19 | 18.4 | 0.30 | 18.4 | 0.16 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super–year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table B-2. Predicted proportion positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2ha) for sablefish from the Delta-GLM applied to NWFSC-AFSC slope surveys combined.

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.92 | 0.06 | 0.96 | 0.03 | 0.96 | 0.03 | 0.98 | 0.02 | 0.96 | 0.04 | 0.98 | 0.02 | 0.94 | 0.05 | 0.97 | 0.03 | – | – | – | – |
| **1996*** | 0.91 | 0.07 | 0.96 | 0.04 | 0.96 | 0.04 | 0.98 | 0.02 | 0.95 | 0.04 | 0.98 | 0.02 | – | – | – | – | – | – | – | – |
| **1997** | 0.83 | 0.11 | 0.92 | 0.06 | 0.91 | 0.06 | 0.96 | 0.03 | 0.91 | 0.07 | 0.96 | 0.03 | 0.87 | 0.09 | 0.93 | 0.05 | 0.67 | 0.18 | 0.82 | 0.11 |
| **1998** | 0.75 | 0.08 | 0.87 | 0.05 | 0.87 | 0.04 | 0.94 | 0.02 | 0.86 | 0.05 | 0.93 | 0.02 | 0.80 | 0.06 | 0.90 | 0.03 | 0.57 | 0.14 | 0.75 | 0.08 |
| **1999** | 0.85 | 0.05 | 0.93 | 0.02 | 0.93 | 0.02 | 0.97 | 0.01 | 0.92 | 0.03 | 0.96 | 0.01 | 0.89 | 0.04 | 0.95 | 0.02 | 0.71 | 0.09 | 0.85 | 0.05 |
| **2000** | 0.91 | 0.03 | 0.96 | 0.02 | 0.96 | 0.02 | 0.98 | 0.01 | 0.95 | 0.02 | 0.98 | 0.01 | 0.93 | 0.02 | 0.97 | 0.01 | 0.81 | 0.06 | 0.90 | 0.03 |
| **2001** | 0.92 | 0.03 | 0.96 | 0.02 | 0.96 | 0.01 | 0.98 | 0.01 | 0.96 | 0.02 | 0.98 | 0.01 | 0.93 | 0.02 | 0.97 | 0.01 | 0.82 | 0.01 | 0.91 | 0.03 |
| **2002** | 0.91 | 0.03 | 0.96 | 0.02 | 0.95 | 0.02 | 0.98 | 0.01 | 0.95 | 0.02 | 0.98 | 0.01 | 0.93 | 0.02 | 0.97 | 0.01 | 0.81 | 0.06 | 0.90 | 0.03 |
| **2003** | 0.89 | 0.04 | 0.95 | 0.02 | 0.94 | 0.02 | 0.97 | 0.01 | 0.94 | 0.02 | 0.97 | 0.01 | 0.91 | 0.03 | 0.96 | 0.01 | 0.77 | 0.07 | 0.88 | 0.04 |
| **2004** | 0.85 | 0.05 | 0.92 | 0.03 | 0.92 | 0.03 | 0.96 | 0.01 | 0.92 | 0.03 | 0.96 | 0.01 | 0.88 | 0.04 | 0.94 | 0.02 | 0.70 | 0.09 | 0.84 | 0.05 |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 16.4 | 0.23 | 13.5 | 0.21 | 9.0 | 0.16 | 13.6 | 0.15 | 10.3 | 0.20 | 20.4 | 0.14 | 8.4 | 0.23 | 16.0 | 0.20 | – | – | – | – |
| **1996*** | 9.8 | 0.21 | 10.3 | 0.18 | 10.0 | 0.17 | 15.2 | 0.15 | 6.6 | 0.20 | 14.6 | 0.16 | – | – | – | – | – | – | – | – |
| **1997** | 12.0 | 0.41 | 8.9 | 0.31 | 13.5 | 0.27 | 21.3 | 0.22 | 36.0 | 0.40 | 18.1 | 0.26 | 7.8 | 0.31 | 19.1 | 0.20 | 3.0 | 0.37 | 15.6 | 0.27 |
| **1998** | 6.8 | 0.30 | 10.9 | 0.28 | 7.6 | 0.19 | 13.6 | 0.21 | 6.7 | 0.24 | 9.3 | 0.22 | 4.1 | 0.22 | 8.7 | 0.16 | 8.9 | 0.49 | 17.0 | 0.32 |
| **1999** | 8.2 | 0.20 | 10.8 | 0.16 | 12.1 | 0.16 | 15.8 | 0.16 | 7.3 | 0.20 | 14.6 | 0.16 | 7.9 | 0.16 | 12.5 | 0.13 | 5.7 | 0.24 | 14.0 | 0.21 |
| **2000** | 11.1 | 0.21 | 15.1 | 0.18 | 14.3 | 0.16 | 15.6 | 0.15 | 9.5 | 0.20 | 16.2 | 0.16 | 8.8 | 0.15 | 13.2 | 0.13 | 10.3 | 0.23 | 14.7 | 0.20 |
| **2001** | 9.9 | 0.20 | 13.2 | 0.17 | 11.3 | 0.15 | 10.1 | 0.16 | 15.9 | 0.19 | 12.0 | 0.15 | 8.9 | 0.14 | 15.9 | 0.13 | 9.2 | 0.13 | 19.5 | 0.19 |
| **2002** | 8.7 | 0.25 | 15.2 | 0.25 | 16.4 | 0.17 | 9.8 | 0.19 | 16.6 | 0.21 | 14.3 | 0.18 | 12.0 | 0.16 | 13.5 | 0.16 | 7.0 | 0.20 | 8.9 | 0.18 |
| **2003** | 20.6 | 0.23 | 12.3 | 0.18 | 21.9 | 0.22 | 12.9 | 0.19 | 23.4 | 0.19 | 14.3 | 0.20 | 14.3 | 0.20 | 12.7 | 0.23 | 4.8 | 0.18 | 7.6 | 0.27 |
| **2004** | 62.4 | 0.38 | 20.3 | 0.30 | 16.6 | 0.19 | 12.4 | 0.26 | 57.0 | 0.31 | 20.8 | 0.24 | 25.3 | 0.27 | 14.5 | 0.25 | 9.2 | 0.22 | 12.1 | 0.18 |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | 2,148 | 0.24 | 3,808 | 0.21 | 3,029 | 0.17 | 3,743 | 0.15 | 1,245 | 0.20 | 6,480 | 0.14 | 1,405 | 0.24 | 6,541 | 0.20 | – | – | – | – |
| **1996*** | 1,257 | 0.22 | 2,874 | 0.18 | 3,350 | 0.18 | 4,157 | 0.15 | 796 | 0.21 | 4,654 | 0.16 | – | – | – | – | – | – | – | – |
| **1997** | 1,404 | 0.43 | 2,380 | 0.32 | 4,328 | 0.27 | 5,662 | 0.22 | 4,102 | 0.40 | 5,608 | 0.27 | 1,185 | 0.32 | 7,392 | 0.21 | 1,376 | 0.42 | 21,184 | 0.30 |
| **1998** | 747 | 0.31 | 2,784 | 0.28 | 2,326 | 0.19 | 3,560 | 0.21 | 725 | 0.26 | 2,836 | 0.22 | 602 | 0.22 | 3,293 | 0.16 | 3,410 | 0.53 | 20,870 | 0.33 |
| **1999** | 1,011 | 0.20 | 2,962 | 0.16 | 3,989 | 0.17 | 4,284 | 0.16 | 851 | 0.20 | 4,605 | 0.16 | 1,250 | 0.17 | 4,975 | 0.14 | 2,796 | 0.25 | 19,855 | 0.21 |
| **2000** | 1,450 | 0.21 | 4,240 | 0.18 | 4,823 | 0.16 | 4,278 | 0.15 | 1,156 | 0.20 | 5,167 | 0.16 | 1,471 | 0.15 | 5,375 | 0.13 | 5,613 | 0.24 | 22,033 | 0.20 |
| **2001** | 1,307 | 0.20 | 3,740 | 0.17 | 3,851 | 0.15 | 2,801 | 0.15 | 1,954 | 0.18 | 3,853 | 0.15 | 1,490 | 0.15 | 6,501 | 0.13 | 5,102 | 0.13 | 29,744 | 0.19 |
| **2002** | 1,140 | 0.25 | 4,296 | 0.25 | 5,555 | 0.17 | 2,712 | 0.19 | 2,019 | 0.21 | 4,574 | 0.18 | 2,002 | 0.16 | 5,527 | 0.16 | 3,862 | 0.21 | 13,377 | 0.18 |
| **2003** | 2,641 | 0.23 | 3,447 | 0.18 | 7,320 | 0.22 | 3,535 | 0.19 | 2,810 | 0.19 | 4,521 | 0.21 | 2,342 | 0.20 | 5,137 | 0.23 | 2,510 | 0.19 | 11,128 | 0.27 |
| **2004** | 7,518 | 0.39 | 5,511 | 0.31 | 5,431 | 0.19 | 3,358 | 0.26 | 6,697 | 0.31 | 6,503 | 0.25 | 3,997 | 0.28 | 5,751 | 0.25 | 4,392 | 0.25 | 16,858 | 0.19 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table B-3. Predicted proportion positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2ha) of sablefish from the Delta-GLM applied to NWFSC slope surveys.

| | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 0.7 | 0.07 | 0.9 | 0.04 | 0.9 | 0.04 | 0.9 | 0.02 | 0.9 | 0.04 | 0.9 | 0.02 | 0.8 | 0.05 | 0.9 | 0.03 | 0.5 | 0.12 | 0.7 | 0.07 |
| **1999** | 0.8 | 0.05 | 0.9 | 0.03 | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.03 | 0.9 | 0.02 | 0.7 | 0.08 | 0.8 | 0.05 |
| **2000** | 0.9 | 0.04 | 0.9 | 0.02 | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.02 | 1.0 | 0.01 | 0.7 | 0.07 | 0.9 | 0.04 |
| **2001** | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.02 | 1.0 | 0.01 | 1.0 | 0.02 | 1.0 | 0.01 | 0.9 | 0.02 | 1.0 | 0.01 | 0.8 | 0.01 | 0.9 | 0.03 |
| **2002** | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.01 | 1.0 | 0.01 | 1.0 | 0.01 | 1.0 | 0.01 | 0.9 | 0.02 | 1.0 | 0.01 | 0.8 | 0.05 | 0.9 | 0.03 |
| **2003** | 0.9 | 0.04 | 0.9 | 0.02 | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.03 | 1.0 | 0.01 | 0.7 | 0.06 | 0.9 | 0.04 |
| **2004** | 0.8 | 0.05 | 0.9 | 0.03 | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.03 | 0.9 | 0.02 | 0.7 | 0.08 | 0.8 | 0.05 |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Man** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 7.1 | 0.30 | 10.4 | 0.26 | 7.9 | 0.18 | 12.9 | 0.19 | 7.0 | 0.23 | 9.1 | 0.20 | 4.5 | 0.21 | 8.3 | 0.15 | 9.8 | 0.52 | 16.7 | 0.29 |
| **1999** | 8.4 | 0.26 | 10.0 | 0.22 | 13.5 | 0.18 | 16.9 | 0.17 | 9.5 | 0.23 | 14.0 | 0.19 | 9.5 | 0.18 | 12.0 | 0.16 | 3.7 | 0.33 | 11.8 | 0.29 |
| **2000** | 10.1 | 0.26 | 14.8 | 0.28 | 16.6 | 0.19 | 14.8 | 0.18 | 9.6 | 0.23 | 13.3 | 0.18 | 8.0 | 0.17 | 10.3 | 0.16 | 10.3 | 0.28 | 16.1 | 0.28 |
| **2001** | 8.7 | 0.24 | 12.1 | 0.23 | 10.8 | 0.16 | 7.3 | 0.22 | 14.4 | 0.20 | 10.4 | 0.18 | 6.8 | 0.17 | 12.6 | 0.14 | 10.0 | 0.14 | 15.9 | 0.27 |
| **2002** | 8.6 | 0.24 | 13.6 | 0.24 | 16.1 | 0.15 | 8.9 | 0.18 | 16.2 | 0.20 | 13.1 | 0.19 | 11.9 | 0.15 | 12.9 | 0.15 | 7.0 | 0.18 | 8.3 | 0.16 |
| **2003** | 20.8 | 0.21 | 11.3 | 0.16 | 21.6 | 0.22 | 11.6 | 0.18 | 22.5 | 0.18 | 13.2 | 0.18 | 13.9 | 0.18 | 11.4 | 0.22 | 4.8 | 0.18 | 7.0 | 0.25 |
| **2004** | 56.7 | 0.35 | 18.8 | 0.30 | 16.0 | 0.18 | 10.8 | 0.26 | 57.0 | 0.30 | 18.8 | 0.25 | 24.0 | 0.29 | 13.4 | 0.24 | 8.8 | 0.22 | 11.2 | 0.18 |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 742 | 0.31 | 2,632 | 0.27 | 2,406 | 0.18 | 3,382 | 0.19 | 782 | 0.23 | 2,779 | 0.20 | 648 | 0.22 | 3,153 | 0.15 | 3,571 | 0.56 | 20,040 | 0.30 |
| **1999** | 998 | 0.26 | 2,697 | 0.22 | 4,391 | 0.18 | 4,581 | 0.17 | 1,129 | 0.23 | 4,401 | 0.19 | 1,511 | 0.18 | 4,759 | 0.16 | 1,715 | 0.34 | 16,164 | 0.29 |
| **2000** | 1,254 | 0.27 | 4,055 | 0.28 | 5,513 | 0.20 | 4,043 | 0.18 | 1,157 | 0.23 | 4,234 | 0.18 | 1,308 | 0.17 | 4,168 | 0.16 | 5,269 | 0.30 | 23,166 | 0.28 |
| **2001** | 1,103 | 0.24 | 3,381 | 0.23 | 3,650 | 0.16 | 2,009 | 0.22 | 1,750 | 0.20 | 3,320 | 0.18 | 1,131 | 0.17 | 5,132 | 0.15 | 5,219 | 0.15 | 23,104 | 0.27 |
| **2002** | 1,094 | 0.24 | 3,793 | 0.24 | 5,393 | 0.15 | 2,449 | 0.18 | 1,975 | 0.20 | 4,174 | 0.19 | 1,965 | 0.16 | 5,245 | 0.15 | 3,645 | 0.19 | 12,199 | 0.16 |
| **2003** | 2,575 | 0.22 | 3,114 | 0.16 | 7,219 | 0.22 | 3,179 | 0.18 | 2,732 | 0.18 | 4,210 | 0.18 | 2,276 | 0.19 | 4,590 | 0.22 | 2,396 | 0.19 | 9,967 | 0.26 |
| **2004** | 6,636 | 0.35 | 5,014 | 0.30 | 5,187 | 0.18 | 2,924 | 0.26 | 6,758 | 0.29 | 5,879 | 0.25 | 3,790 | 0.29 | 5,315 | 0.24 | 3,998 | 0.23 | 15,160 | 0.18 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table B-4. Predicted proportion positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2Ha) of sablefish from the Delta-GLM applied to AFSC slope surveys.

| Year | Vancouver 183–567 m | | Vancouver 567–1,280 m | | Columbia 183–567 m | | Columbia 567–1,280 m | | Eureka 183–567 m | | Eureka 567–1,280 m | | Monterey 183–567 m | | Monterey 567–1,280 m | | Conception 183–567 m | | Conception 567–1,280 m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.99 | 0.02 | 0.99 | 0.01 | 0.98 | 0.02 | 0.99 | 0.01 | 0.96 | 0.03 | 0.98 | 0.02 | 0.97 | 0.03 | 0.99 | 0.02 | – | – | – | – |
| **1996*** | 0.98 | 0.03 | 0.99 | 0.01 | 0.98 | 0.02 | 0.99 | 0.01 | 0.95 | 0.05 | 0.98 | 0.02 | – | – | – | – | – | – | – | – |
| **1997** | 0.96 | 0.06 | 0.98 | 0.03 | 0.95 | 0.05 | 0.98 | 0.03 | 0.87 | 0.10 | 0.94 | 0.05 | 0.89 | 0.08 | 0.95 | 0.04 | 0.92 | 0.09 | 0.96 | 0.05 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 0.96 | 0.06 | 0.98 | 0.03 | 0.95 | 0.05 | 0.98 | 0.03 | 0.87 | 0.10 | 0.94 | 0.05 | 0.89 | 0.08 | 0.95 | 0.04 | 0.92 | 0.90 | 0.97 | 0.05 |
| **2000** | 0.99 | 0.03 | 1.00 | 0.01 | 0.99 | 0.03 | 1.00 | 0.01 | 0.98 | 0.06 | 0.99 | 0.02 | 0.98 | 0.05 | 0.99 | 0.02 | 0.99 | 0.05 | 1.00 | 0.02 |
| **2001** | 0.99 | 0.03 | 1.00 | 0.01 | 0.99 | 0.03 | 1.00 | 0.01 | 0.98 | 0.05 | 0.99 | 0.02 | 0.99 | 0.04 | 0.99 | 0.02 | 0.99 | 0.02 | 1.00 | 0.03 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 18.7 | 0.22 | 13.1 | 0.18 | 10.0 | 0.15 | 13.2 | 0.12 | 11.6 | 0.18 | 20.7 | 0.11 | 10.2 | 0.21 | 16.0 | 0.17 | – | – | – | – |
| **1996*** | 10.2 | 0.21 | 10.5 | 0.16 | 10.9 | 0.15 | 15.6 | 0.13 | 7.0 | 0.19 | 15.2 | 0.13 | – | – | – | – | – | – | – | – |
| **1997** | 14.0 | 0.38 | 9.4 | 0.29 | 15.1 | 0.27 | 22.1 | 0.22 | 39.7 | 0.38 | 18.9 | 0.26 | 8.3 | 0.30 | 20.1 | 0.19 | 3.2 | 0.38 | 16.3 | 0.27 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 8.8 | 0.32 | 11.8 | 0.22 | 11.0 | 0.25 | 13.1 | 0.20 | 3.7 | 0.41 | 14.1 | 0.24 | 6.1 | 0.26 | 12.4 | 0.18 | 10.1 | 0.38 | 15.4 | 0.27 |
| **2000** | 14.6 | 0.36 | 15.5 | 0.22 | 11.5 | 0.26 | 14.8 | 0.20 | 9.4 | 0.37 | 21.2 | 0.26 | 12.1 | 0.24 | 15.9 | 0.17 | 10.0 | 0.36 | 13.4 | 0.26 |
| **2001** | 14.1 | 0.37 | 13.7 | 0.22 | 14.0 | 0.24 | 13.6 | 0.20 | 24.8 | 0.35 | 14.1 | 0.25 | 18.6 | 0.25 | 20.5 | 0.17 | 8.6 | 0.17 | 21.8 | 0.26 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | 2,656 | 0.22 | 3,845 | 0.18 | 3,510 | 0.15 | 3,689 | 0.12 | 1,417 | 0.18 | 6,624 | 0.11 | 1,764 | 0.22 | 6,640 | 0.17 | – | – | – | – |
| **1996*** | 1,437 | 0.21 | 3,061 | 0.16 | 3,773 | 0.15 | 4,335 | 0.13 | 852 | 0.20 | 4,823 | 0.13 | – | – | – | – | – | – | – | – |
| **1997** | 1,898 | 0.39 | 2,703 | 0.29 | 5,020 | 0.27 | 6,047 | 0.22 | 4,307 | 0.41 | 5,747 | 0.26 | 1,321 | 0.31 | 8,047 | 0.19 | 1,998 | 0.40 | 26,005 | 0.28 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 1,205 | 0.32 | 3,401 | 0.22 | 3,654 | 0.26 | 3,572 | 0.21 | 406 | 0.42 | 4,267 | 0.25 | 972 | 0.27 | 4,954 | 0.19 | 6,325 | 0.38 | 24,487 | 0.28 |
| **2000** | 2,067 | 0.37 | 4,553 | 0.22 | 4,034 | 0.26 | 4,146 | 0.20 | 1,151 | 0.38 | 6,832 | 0.26 | 2,129 | 0.24 | 6,660 | 0.17 | 6,663 | 0.37 | 22,047 | 0.26 |
| **2001** | 2,006 | 0.37 | 4,009 | 0.22 | 4,913 | 0.25 | 3,808 | 0.20 | 3,091 | 0.36 | 4,550 | 0.25 | 3,276 | 0.26 | 8,572 | 0.17 | 5,758 | 0.17 | 36,156 | 0.26 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

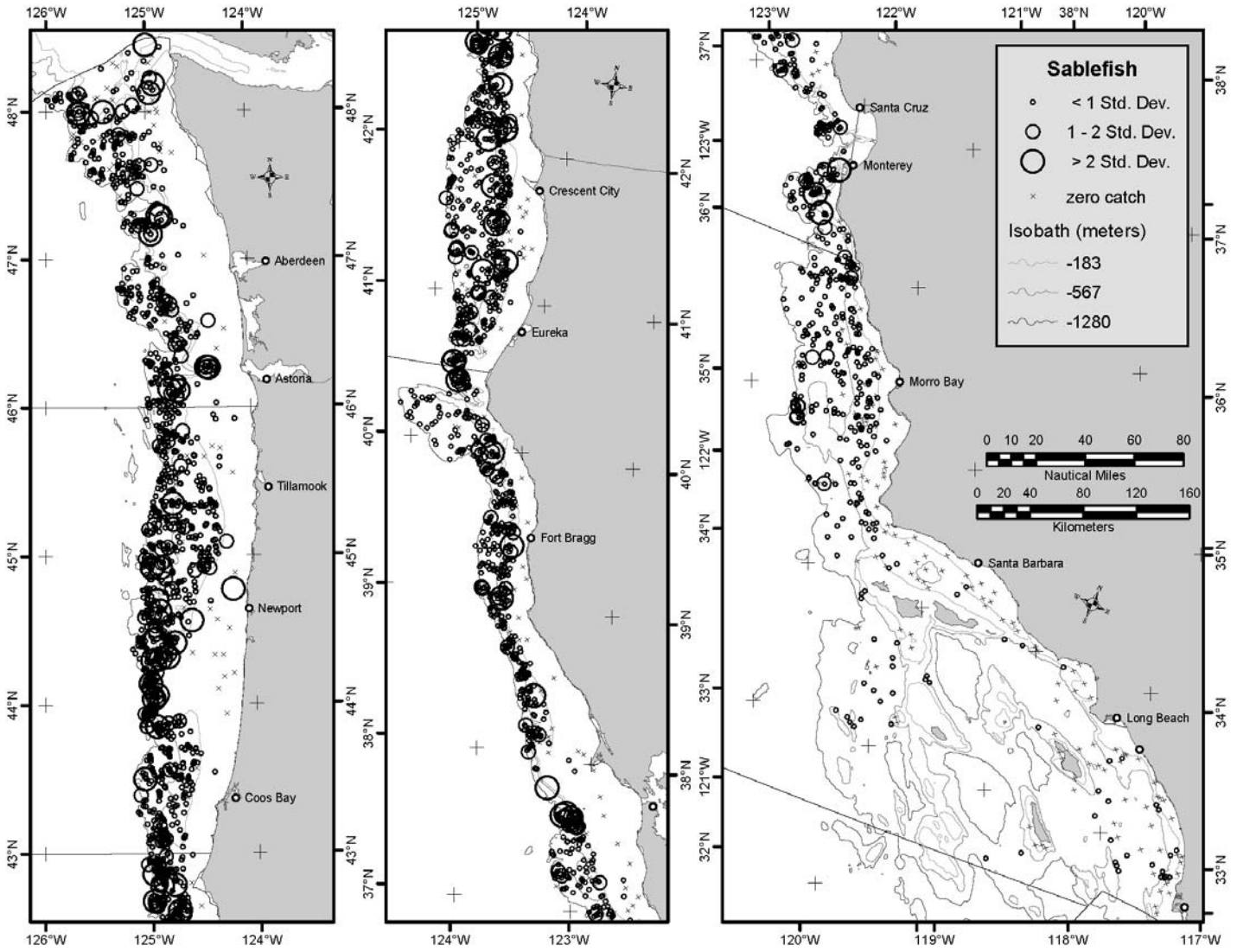



Figure B-1. Distribution of sablefish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

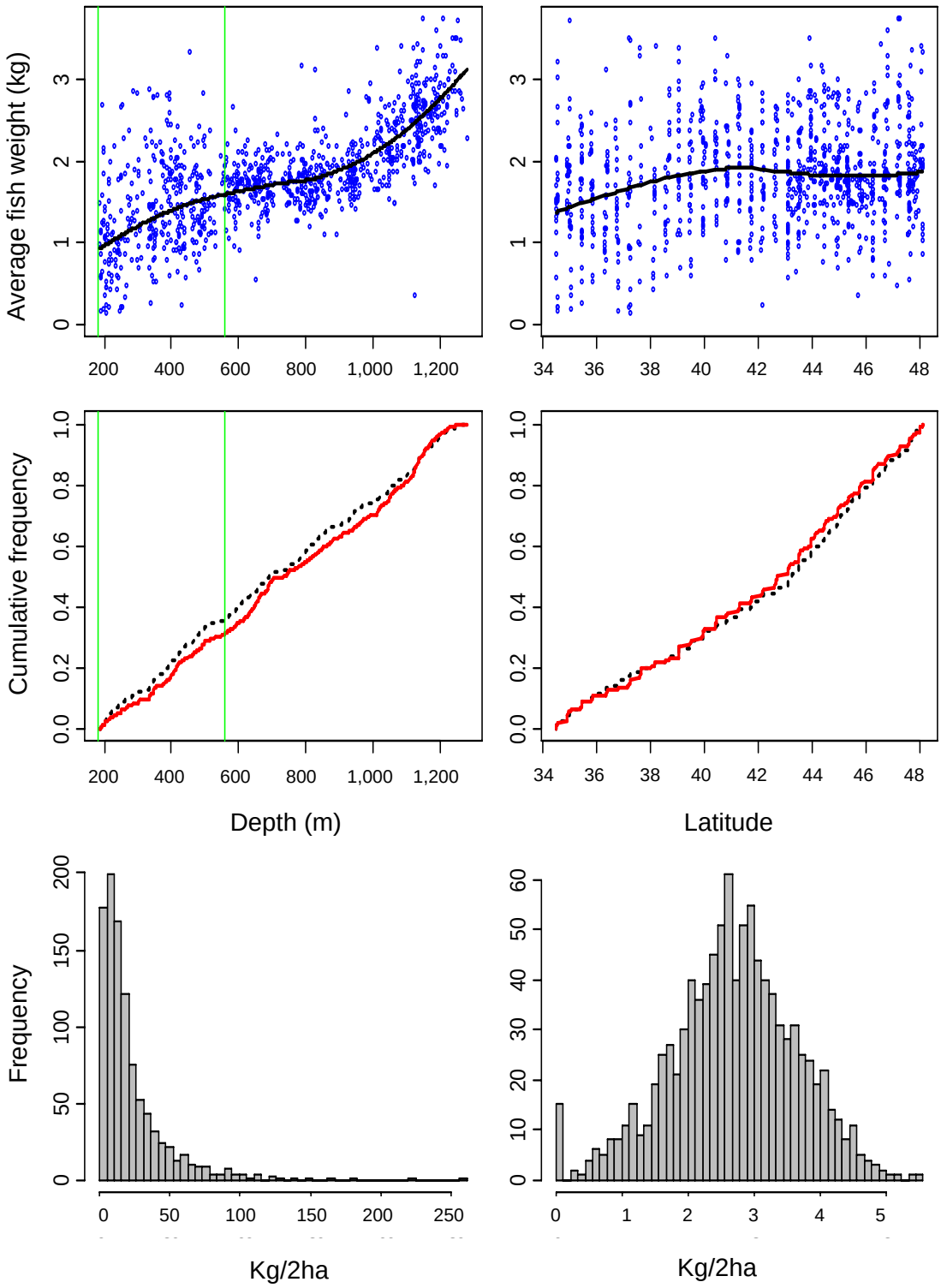



Figure B-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of sablefish caught in the AFSC slope surveys.

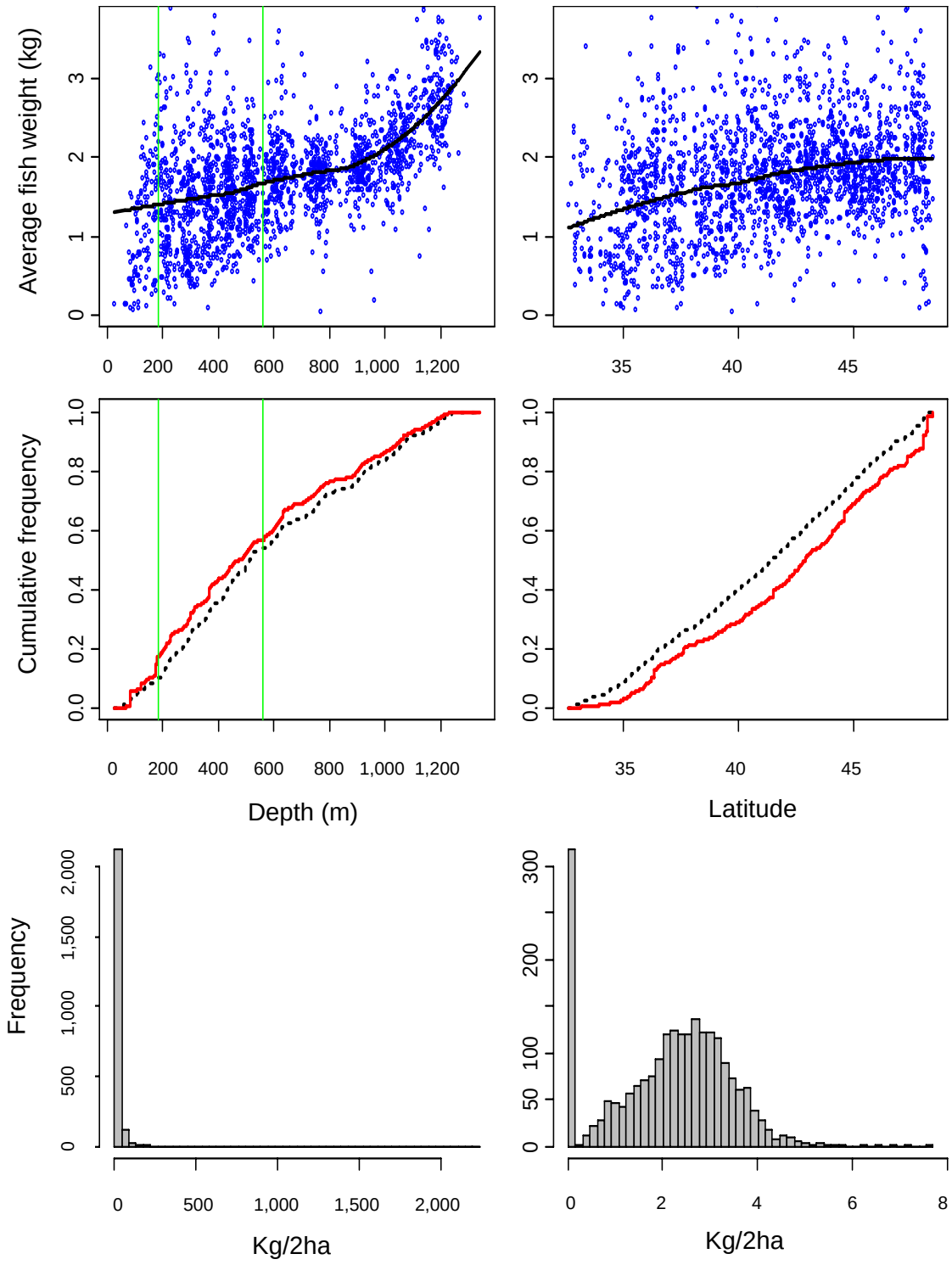



Figure B-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of sablefish caught in the NWFSC slope surveys.

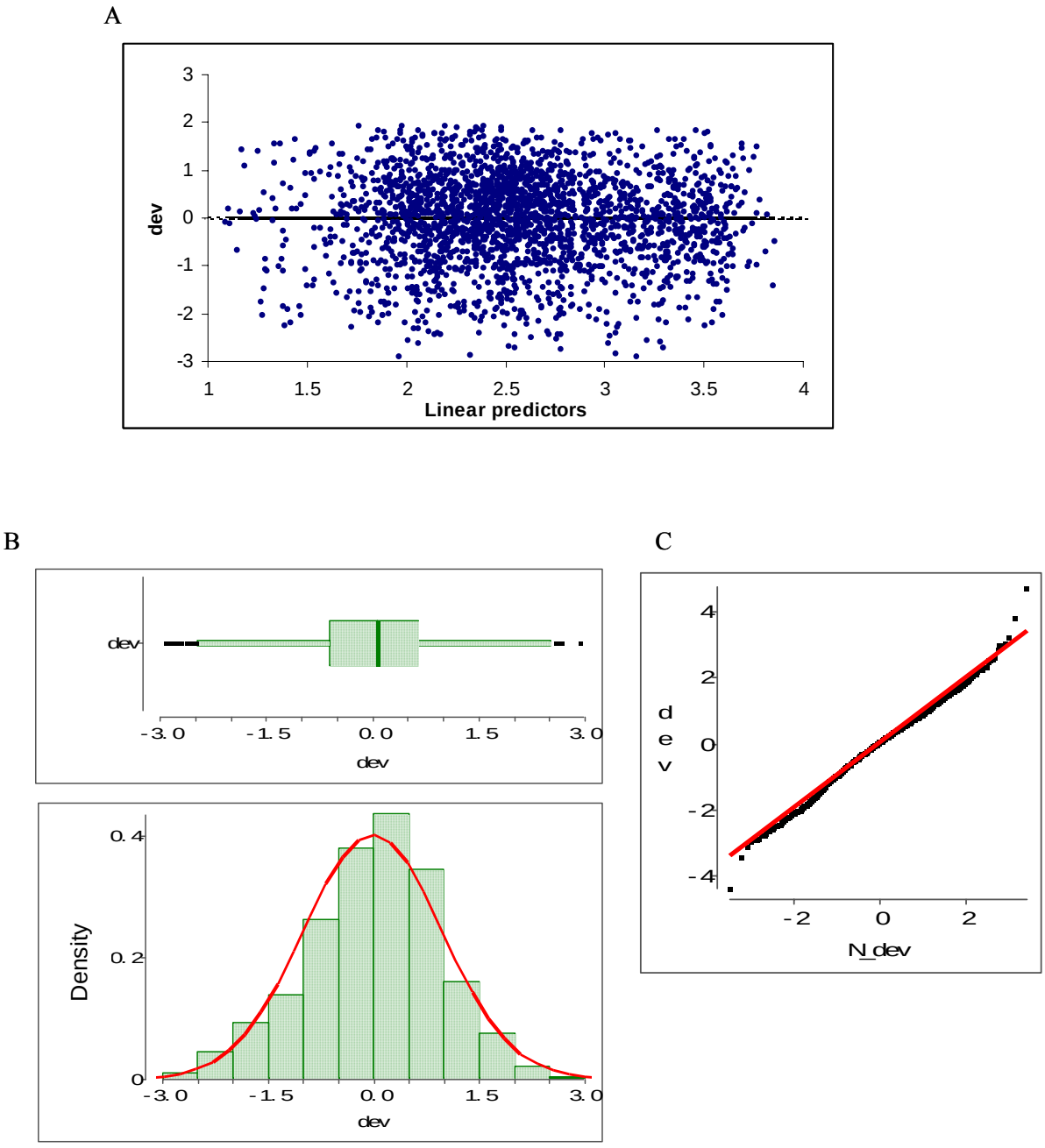



Figure B-4. Diagnostic plots from the generalized linear mixed model fit to sablefish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

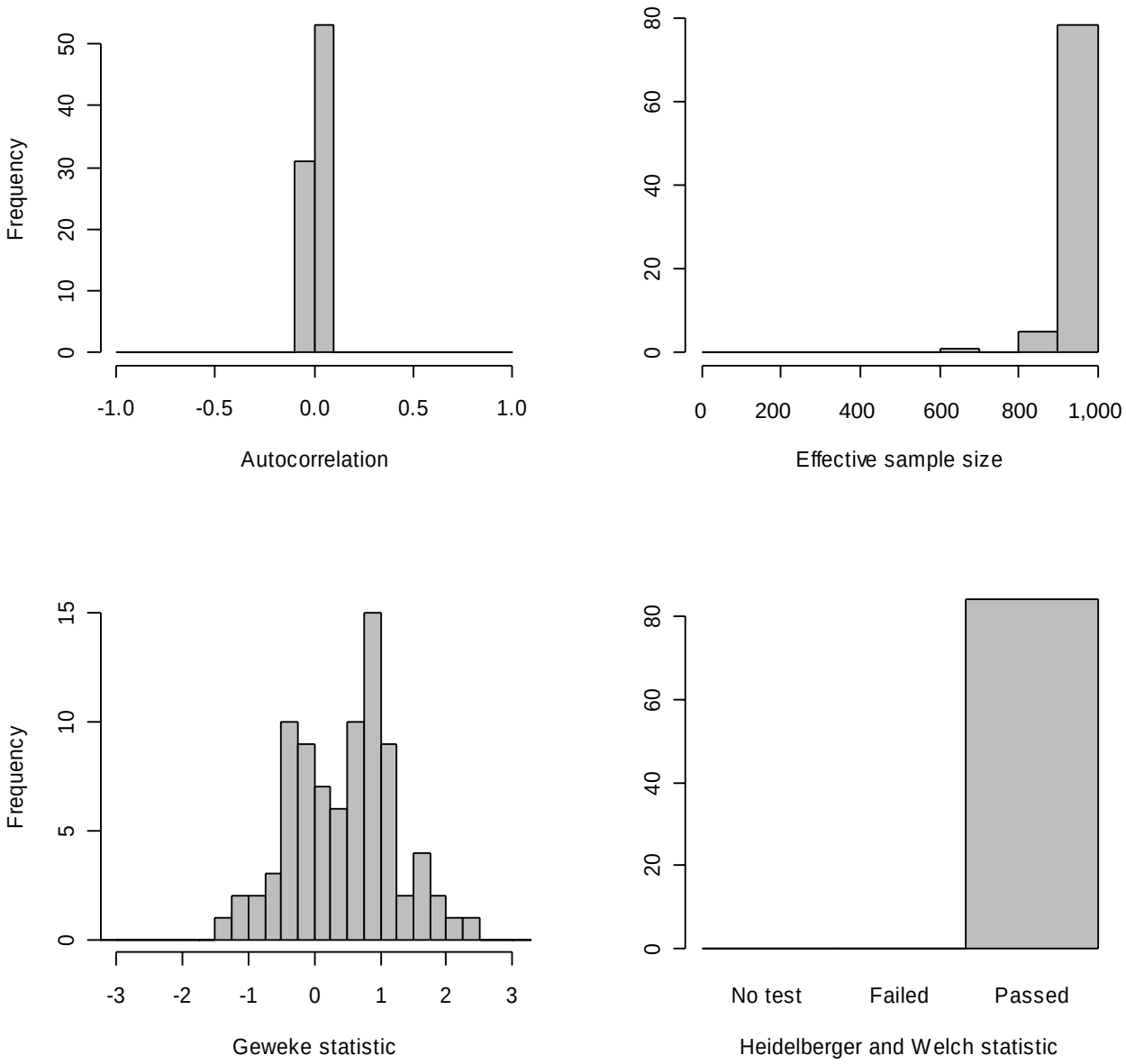
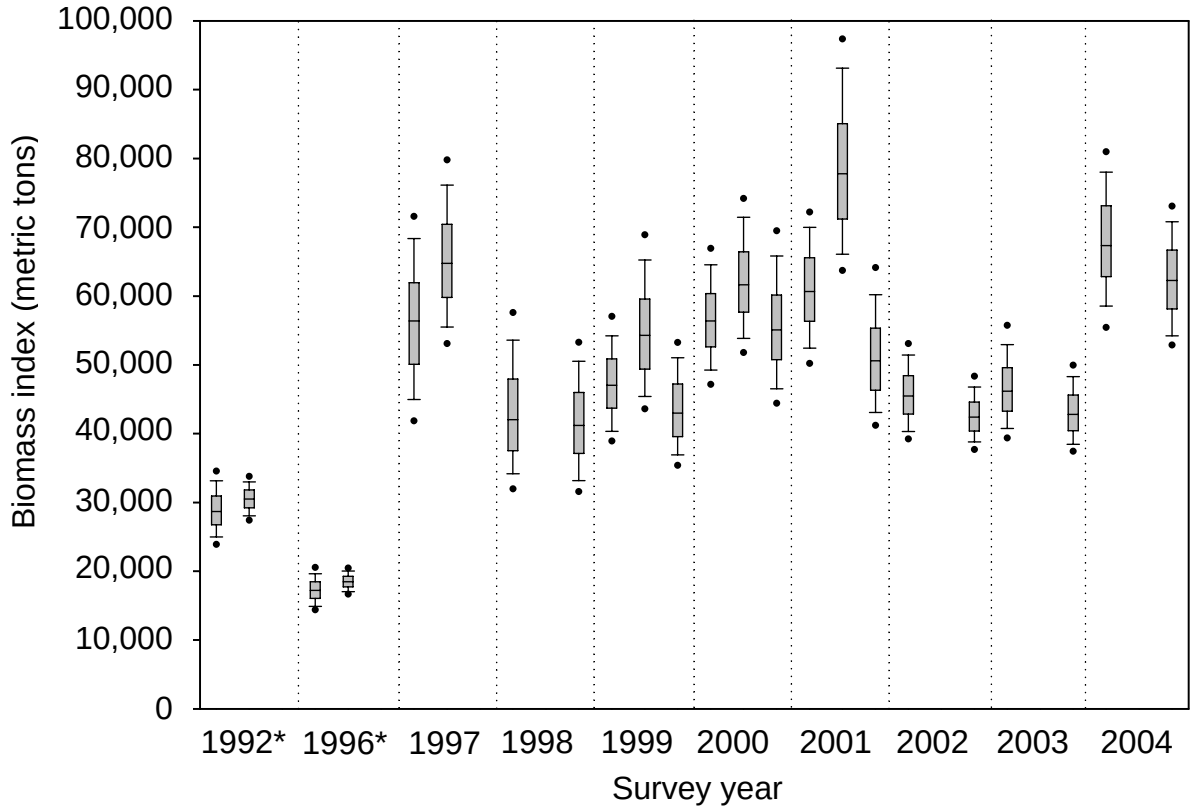



Figure B-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for sablefish. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure B-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for sablefish. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix C: Shortspine Thornyhead (*Sebastolobus alascanus*)

This appendix has tables C-1 though C-4 and figures C-1 though C-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for shortspine thornyhead. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table C-1. Basic data and statistics summary for shortspine thornyhead caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–567 m** | | **567–1280 m** | | **183–567 m** | | **567–1280 m** | | **183–567 m** | | **567–1280 m** | | **183–567 m** | | **567–1280 m** | | **183–567 m** | | **567–1280 m** | |
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1992*** | 27 | 26 | 36 | 36 | 57 | 54 | 81 | 79 | 37 | 36 | 93 | 92 | 26 | 24 | 40 | 40 | – | – | – | – |
| **1996*** | 29 | 28 | 44 | 43 | 55 | 53 | 76 | 76 | 34 | 34 | 72 | 67 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 7 | 16 | 16 | 20 | 19 | 28 | 28 | 10 | 10 | 20 | 19 | 17 | 12 | 33 | 33 | 11 | 9 | 18 | 16 |
| **1998** | 17 | 17 | 21 | 19 | 46 | 46 | 31 | 27 | 29 | 28 | 29 | 25 | 42 | 29 | 57 | 55 | 10 | 6 | 16 | 33 |
| **1999** | 36 | 35 | 54 | 53 | 58 | 55 | 71 | 64 | 39 | 37 | 61 | 57 | 65 | 57 | 82 | 82 | 23 | 18 | 33 | 36 |
| **2000** | 35 | 32 | 47 | 44 | 59 | 56 | 70 | 66 | 37 | 37 | 60 | 53 | 72 | 57 | 94 | 91 | 27 | 20 | 36 | 36 |
| **2001** | 36 | 34 | 50 | 48 | 71 | 68 | 59 | 48 | 37 | 36 | 56 | 49 | 65 | 53 | 99 | 99 | 29 | 22 | 36 | 51 |
| **2002** | 24 | 23 | 24 | 23 | 47 | 44 | 39 | 34 | 30 | 29 | 40 | 34 | 58 | 46 | 61 | 57 | 47 | 33 | 54 | 25 |
| **2003** | 28 | 27 | 44 | 39 | 30 | 29 | 37 | 33 | 36 | 32 | 33 | 27 | 32 | 23 | 24 | 22 | 55 | 32 | 27 | 25 |
| **2004** | 13 | 11 | 14 | 12 | 46 | 40 | 19 | 18 | 14 | 13 | 23 | 21 | 17 | 10 | 21 | 19 | 50 | 29 | 49 | 46 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 14.5 | 0.17 | 9.0 | 0.10 | 18.7 | 0.11 | 9.8 | 0.14 | 5.8 | 0.25 | 15.9 | 0.09 | 7.6 | 0.25 | 14.3 | 0.13 | – | – | – | – |
| **1996*** | 13.9 | 0.20 | 5.9 | 0.09 | 15.5 | 0.10 | 7.7 | 0.15 | 9.0 | 0.13 | 13.2 | 0.22 | – | – | – | – | – | – | – | – |
| **1997** | 8.4 | 0.35 | 4.2 | 0.28 | 13.2 | 0.20 | 5.1 | 0.19 | 7.6 | 0.24 | 9.0 | 0.16 | 4.2 | 0.33 | 16.8 | 0.17 | 6.4 | 0.32 | 18.5 | 0.18 |
| **1998** | 26.5 | 0.18 | 7.0 | 0.17 | 11.0 | 0.08 | 6.6 | 0.22 | 6.5 | 0.18 | 9.8 | 0.21 | 3.1 | 0.18 | 13.8 | 0.13 | 3.9 | 0.59 | 13.6 | 0.13 |
| **1999** | 14.4 | 0.11 | 7.0 | 0.13 | 9.9 | 0.12 | 5.2 | 0.11 | 6.7 | 0.18 | 7.7 | 0.13 | 7.9 | 0.28 | 15.5 | 0.11 | 9.3 | 0.25 | 15.1 | 0.15 |
| **2000** | 19.5 | 0.24 | 8.8 | 0.15 | 12.8 | 0.12 | 8.7 | 0.26 | 5.1 | 0.14 | 7.1 | 0.17 | 4.7 | 0.24 | 17.1 | 0.15 | 9.9 | 0.28 | 16.8 | 0.15 |
| **2001** | 17.6 | 0.13 | 5.3 | 0.10 | 13.0 | 0.13 | 5.6 | 0.18 | 4.7 | 0.14 | 8.7 | 0.16 | 4.3 | 0.15 | 16.8 | 0.10 | 9.0 | 0.35 | 15.8 | 0.12 |
| **2002** | 26.5 | 0.17 | 10.9 | 0.28 | 13.1 | 0.13 | 7.9 | 0.24 | 5.2 | 0.21 | 7.8 | 0.17 | 6.9 | 0.26 | 16.7 | 0.16 | 13.1 | 0.24 | 18.7 | 0.20 |
| **2003** | 18.8 | 0.18 | 6.2 | 0.12 | 20.3 | 0.14 | 6.6 | 0.25 | 7.3 | 0.21 | 10.1 | 0.34 | 10.8 | 0.36 | 12.9 | 0.22 | 4.7 | 0.24 | 13.0 | 0.23 |
| **2004** | 31.9 | 0.29 | 5.6 | 0.23 | 19.5 | 0.15 | 7.3 | 0.34 | 8.0 | 0.23 | 12.3 | 0.35 | 4.4 | 0.57 | 10.7 | 0.17 | 4.8 | 0.22 | 13.7 | 0.14 |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 15.1 | 0.16 | 9.0 | 0.10 | 19.7 | 0.11 | 10.0 | 0.14 | 5.9 | 0.25 | 16.0 | 0.09 | 8.2 | 0.24 | 14.3 | 0.13 | – | – | – | – |
| **1996*** | 14.4 | 0.20 | 6.1 | 0.09 | 16.1 | 0.10 | 7.7 | 0.15 | 9.0 | 0.13 | 14.2 | 0.21 | – | – | – | – | – | – | – | – |
| **1997** | 10.7 | 0.30 | 4.2 | 0.28 | 13.8 | 0.19 | 5.1 | 0.19 | 7.6 | 0.24 | 9.5 | 0.15 | 5.9 | 0.29 | 16.8 | 0.17 | 7.9 | 0.29 | 18.5 | 0.18 |
| **1998** | 26.5 | 0.18 | 7.8 | 0.16 | 11.0 | 0.08 | 7.6 | 0.21 | 6.7 | 0.18 | 11.4 | 0.20 | 4.5 | 0.15 | 14.3 | 0.12 | 6.5 | 0.55 | 13.6 | 0.13 |
| **1999** | 14.8 | 0.11 | 7.2 | 0.13 | 10.5 | 0.12 | 5.8 | 0.10 | 7.0 | 0.18 | 8.2 | 0.12 | 9.0 | 0.28 | 15.5 | 0.11 | 11.9 | 0.22 | 15.1 | 0.15 |
| **2000** | 21.3 | 0.24 | 9.4 | 0.14 | 13.5 | 0.11 | 9.2 | 0.26 | 5.1 | 0.14 | 8.0 | 0.16 | 6.0 | 0.23 | 17.5 | 0.15 | 12.9 | 0.25 | 16.8 | 0.15 |
| **2001** | 18.6 | 0.12 | 5.6 | 0.09 | 13.5 | 0.13 | 6.9 | 0.17 | 4.8 | 0.14 | 9.9 | 0.16 | 5.3 | 0.14 | 16.8 | 0.10 | 11.9 | 0.33 | 15.8 | 0.12 |
| **2002** | 27.8 | 0.17 | 11.3 | 0.27 | 14.0 | 0.12 | 9.0 | 0.23 | 5.4 | 0.21 | 9.2 | 0.16 | 8.7 | 0.25 | 17.9 | 0.15 | 18.6 | 0.22 | 19.8 | 0.20 |
| **2003** | 19.5 | 0.17 | 7.0 | 0.11 | 21.0 | 0.13 | 7.4 | 0.24 | 8.2 | 0.20 | 12.4 | 0.33 | 15.1 | 0.34 | 14.1 | 0.21 | 8.1 | 0.21 | 14.0 | 0.22 |
| **2004** | 37.8 | 0.26 | 6.6 | 0.20 | 22.4 | 0.14 | 7.7 | 0.34 | 8.6 | 0.22 | 13.4 | 0.35 | 7.4 | 0.55 | 11.9 | 0.16 | 8.3 | 0.19 | 14.6 | 0.13 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table C-2. Predicted proportion positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2ha) of shortspine thornyhead from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.95 | 0.02 | 0.97 | 0.01 | 0.95 | 0.02 | 0.97 | 0.01 | 0.94 | 0.03 | 0.97 | 0.02 | 0.92 | 0.03 | 0.95 | 0.02 | – | – | – | – |
| **1996*** | 0.94 | 0.03 | 0.97 | 0.02 | 0.93 | 0.03 | 0.96 | 0.02 | 0.92 | 0.04 | 0.95 | 0.02 | – | – | – | – | – | – | – | – |
| **1997** | 0.91 | 0.04 | 0.95 | 0.02 | 0.89 | 0.04 | 0.94 | 0.03 | 0.88 | 0.05 | 0.93 | 0.03 | 0.84 | 0.06 | 0.91 | 0.04 | 0.79 | 0.08 | 0.87 | 0.05 |
| **1998** | 0.92 | 0.02 | 0.95 | 0.01 | 0.90 | 0.03 | 0.95 | 0.02 | 0.89 | 0.03 | 0.94 | 0.02 | 0.86 | 0.04 | 0.91 | 0.02 | 0.81 | 0.05 | 0.88 | 0.03 |
| **1999** | 0.93 | 0.02 | 0.96 | 0.01 | 0.92 | 0.02 | 0.96 | 0.01 | 0.91 | 0.02 | 0.95 | 0.01 | 0.88 | 0.03 | 0.93 | 0.02 | 0.84 | 0.04 | 0.90 | 0.03 |
| **2000** | 0.92 | 0.02 | 0.95 | 0.01 | 0.91 | 0.02 | 0.95 | 0.01 | 0.89 | 0.03 | 0.94 | 0.02 | 0.86 | 0.03 | 0.92 | 0.02 | 0.81 | 0.05 | 0.89 | 0.03 |
| **2001** | 0.92 | 0.02 | 0.96 | 0.01 | 0.91 | 0.02 | 0.95 | 0.01 | 0.90 | 0.02 | 0.94 | 0.01 | 0.86 | 0.03 | 0.92 | 0.02 | 0.82 | 0.02 | 0.89 | 0.03 |
| **2002** | 0.92 | 0.02 | 0.95 | 0.01 | 0.90 | 0.02 | 0.94 | 0.01 | 0.89 | 0.03 | 0.94 | 0.02 | 0.85 | 0.03 | 0.91 | 0.02 | 0.81 | 0.04 | 0.88 | 0.03 |
| **2003** | 0.87 | 0.03 | 0.92 | 0.02 | 0.84 | 0.04 | 0.91 | 0.02 | 0.82 | 0.04 | 0.89 | 0.03 | 0.77 | 0.05 | 0.86 | 0.03 | 0.71 | 0.06 | 0.81 | 0.04 |
| **2004** | 0.87 | 0.04 | 0.92 | 0.02 | 0.85 | 0.04 | 0.91 | 0.02 | 0.83 | 0.04 | 0.90 | 0.03 | 0.77 | 0.05 | 0.86 | 0.03 | 0.71 | 0.07 | 0.82 | 0.04 |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 15.4 | 0.23 | 11.3 | 0.21 | 20.6 | 0.16 | 11.9 | 0.16 | 6.4 | 0.21 | 19.5 | 0.14 | 8.5 | 0.24 | 18.1 | 0.18 | – | – | – | – |
| **1996*** | 16.9 | 0.22 | 7.3 | 0.19 | 17.7 | 0.17 | 9.3 | 0.15 | 10.3 | 0.20 | 16.7 | 0.15 | – | – | – | – | – | – | – | – |
| **1997** | 11.5 | 0.50 | 4.8 | 0.30 | 15.1 | 0.28 | 5.9 | 0.22 | 8.8 | 0.39 | 11.1 | 0.27 | 6.8 | 0.36 | 19.5 | 0.22 | 9.1 | 0.40 | 21.8 | 0.28 |
| **1998** | 24.1 | 0.30 | 8.3 | 0.29 | 10.1 | 0.18 | 7.8 | 0.24 | 6.0 | 0.22 | 11.7 | 0.23 | 4.0 | 0.23 | 14.9 | 0.17 | 6.0 | 0.56 | 13.7 | 0.30 |
| **1999** | 15.5 | 0.19 | 8.2 | 0.17 | 11.6 | 0.17 | 6.9 | 0.15 | 7.4 | 0.19 | 9.7 | 0.15 | 8.9 | 0.15 | 17.7 | 0.14 | 13.4 | 0.29 | 17.4 | 0.22 |
| **2000** | 21.3 | 0.21 | 10.4 | 0.18 | 13.8 | 0.16 | 10.0 | 0.15 | 5.4 | 0.19 | 9.0 | 0.16 | 6.0 | 0.16 | 19.8 | 0.14 | 14.3 | 0.27 | 18.8 | 0.20 |
| **2001** | 19.5 | 0.20 | 6.2 | 0.17 | 13.3 | 0.14 | 7.3 | 0.17 | 4.7 | 0.20 | 10.9 | 0.18 | 5.1 | 0.17 | 18.3 | 0.13 | 12.3 | 0.13 | 17.8 | 0.20 |
| **2002** | 27.6 | 0.25 | 12.2 | 0.24 | 13.9 | 0.17 | 9.5 | 0.21 | 5.4 | 0.22 | 9.7 | 0.21 | 8.7 | 0.17 | 19.0 | 0.17 | 18.4 | 0.20 | 20.4 | 0.16 |
| **2003** | 20.3 | 0.23 | 8.0 | 0.19 | 22.2 | 0.21 | 8.1 | 0.21 | 8.4 | 0.21 | 13.6 | 0.23 | 15.4 | 0.25 | 15.9 | 0.25 | 8.1 | 0.22 | 14.8 | 0.25 |
| **2004** | 39.5 | 0.37 | 7.3 | 0.33 | 22.3 | 0.20 | 8.6 | 0.28 | 8.8 | 0.36 | 14.1 | 0.27 | 7.2 | 0.39 | 12.8 | 0.27 | 8.5 | 0.22 | 15.7 | 0.17 |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 2,134 | 0.23 | 3,267 | 0.21 | 6,920 | 0.16 | 3,240 | 0.16 | 766 | 0.21 | 6,129 | 0.14 | 1,394 | 0.25 | 7,248 | 0.18 | – | – | – | – |
| **1996*** | 2,301 | 0.22 | 2,055 | 0.19 | 5,778 | 0.18 | 2,509 | 0.15 | 1,205 | 0.21 | 5,193 | 0.15 | – | – | – | – | – | – | – | – |
| **1997** | 1,506 | 0.50 | 1,347 | 0.30 | 4,777 | 0.28 | 1,552 | 0.23 | 983 | 0.39 | 3,372 | 0.27 | 1,022 | 0.38 | 7,455 | 0.22 | 4,858 | 0.41 | 31,500 | 0.29 |
| **1998** | 3,192 | 0.30 | 2,335 | 0.29 | 3,231 | 0.18 | 2,070 | 0.24 | 696 | 0.22 | 3,570 | 0.23 | 621 | 0.23 | 5,775 | 0.17 | 3,339 | 0.55 | 20,230 | 0.30 |
| **1999** | 2,087 | 0.19 | 2,337 | 0.17 | 3,787 | 0.17 | 1,846 | 0.15 | 867 | 0.20 | 3,001 | 0.15 | 1,412 | 0.15 | 6,949 | 0.14 | 7,712 | 0.29 | 26,275 | 0.22 |
| **2000** | 2,820 | 0.21 | 2,942 | 0.18 | 4,457 | 0.16 | 2,651 | 0.15 | 616 | 0.19 | 2,761 | 0.16 | 932 | 0.16 | 7,667 | 0.14 | 8,015 | 0.28 | 27,892 | 0.20 |
| **2001** | 2,598 | 0.21 | 1,740 | 0.17 | 4,311 | 0.14 | 1,954 | 0.17 | 542 | 0.20 | 3,353 | 0.18 | 794 | 0.17 | 7,121 | 0.13 | 6,866 | 0.13 | 26,481 | 0.20 |
| **2002** | 3,648 | 0.25 | 3,434 | 0.24 | 4,434 | 0.17 | 2,511 | 0.21 | 616 | 0.22 | 2,958 | 0.21 | 1,345 | 0.17 | 7,329 | 0.17 | 10,179 | 0.21 | 30,095 | 0.17 |
| **2003** | 2,542 | 0.23 | 2,176 | 0.19 | 6,615 | 0.22 | 2,078 | 0.21 | 890 | 0.21 | 3,948 | 0.23 | 2,138 | 0.26 | 5,735 | 0.26 | 3,910 | 0.23 | 20,203 | 0.25 |
| **2004** | 4,972 | 0.37 | 1,971 | 0.34 | 6,702 | 0.20 | 2,195 | 0.28 | 929 | 0.36 | 4,090 | 0.27 | 1,011 | 0.40 | 4,661 | 0.27 | 4,142 | 0.23 | 21,580 | 0.18 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table C-3. Predicted proportion positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2ha) of shortspine thornyhead from the Delta-GLM applied to NWFSC slope surveys.

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 0.9 | 0.03 | 1.0 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.04 | 0.9 | 0.03 | 0.8 | 0.06 | 0.9 | 0.04 |
| **1999** | 0.9 | 0.02 | 1.0 | 0.01 | 0.9 | 0.02 | 1.0 | 0.02 | 0.9 | 0.03 | 1.0 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.8 | 0.05 | 0.9 | 0.03 |
| **2000** | 0.9 | 0.03 | 1.0 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.8 | 0.04 | 0.9 | 0.03 | 0.8 | 0.05 | 0.9 | 0.04 |
| **2001** | 0.9 | 0.03 | 1.0 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.04 | 0.9 | 0.03 | 0.8 | 0.03 | 0.9 | 0.04 |
| **2002** | 0.9 | 0.03 | 1.0 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.03 | 0.9 | 0.02 | 0.9 | 0.04 | 0.9 | 0.02 | 0.8 | 0.05 | 0.9 | 0.03 |
| **2003** | 0.9 | 0.04 | 0.9 | 0.03 | 0.8 | 0.04 | 0.9 | 0.03 | 0.8 | 0.05 | 0.9 | 0.03 | 0.8 | 0.06 | 0.8 | 0.04 | 0.7 | 0.07 | 0.8 | 0.05 |
| **2004** | 0.9 | 0.04 | 0.9 | 0.03 | 0.9 | 0.04 | 0.9 | 0.03 | 0.8 | 0.05 | 0.9 | 0.03 | 0.8 | 0.06 | 0.9 | 0.04 | 0.7 | 0.07 | 0.8 | 0.05 |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 25.9 | 0.31 | 7.6 | 0.30 | 10.7 | 0.19 | 7.3 | 0.24 | 6.6 | 0.24 | 11.3 | 0.25 | 4.4 | 0.23 | 13.9 | 0.18 | 6.3 | 0.62 | 13.4 | 0.30 |
| **1999** | 16.7 | 0.27 | 8.1 | 0.24 | 9.9 | 0.21 | 6.4 | 0.20 | 8.3 | 0.24 | 9.7 | 0.20 | 10.9 | 0.19 | 17.2 | 0.18 | 10.5 | 0.45 | 13.5 | 0.34 |
| **2000** | 20.9 | 0.27 | 12.0 | 0.31 | 11.7 | 0.22 | 11.3 | 0.21 | 4.6 | 0.26 | 8.3 | 0.22 | 6.6 | 0.21 | 17.8 | 0.18 | 10.1 | 0.39 | 15.6 | 0.32 |
| **2001** | 18.9 | 0.26 | 6.5 | 0.26 | 11.6 | 0.18 | 8.8 | 0.26 | 4.2 | 0.24 | 10.4 | 0.23 | 5.7 | 0.21 | 14.4 | 0.17 | 13.4 | 0.17 | 15.6 | 0.31 |
| **2002** | 28.1 | 0.28 | 11.8 | 0.26 | 14.4 | 0.19 | 9.1 | 0.22 | 5.5 | 0.24 | 9.3 | 0.22 | 9.0 | 0.19 | 18.5 | 0.18 | 19.3 | 0.21 | 20.7 | 0.18 |
| **2003** | 20.6 | 0.24 | 7.3 | 0.19 | 22.1 | 0.23 | 7.8 | 0.21 | 8.5 | 0.24 | 13.1 | 0.24 | 15.8 | 0.25 | 14.7 | 0.27 | 8.5 | 0.22 | 14.5 | 0.25 |
| **2004** | 38.5 | 0.40 | 6.6 | 0.40 | 22.3 | 0.19 | 7.7 | 0.30 | 8.5 | 0.36 | 13.4 | 0.27 | 7.6 | 0.43 | 12.0 | 0.28 | 8.4 | 0.24 | 14.8 | 0.19 |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 3,435 | 0.31 | 2,140 | 0.30 | 3,462 | 0.19 | 1,928 | 0.24 | 751 | 0.25 | 3,438 | 0.26 | 670 | 0.23 | 5,328 | 0.18 | 3,459 | 0.62 | 19,487 | 0.31 |
| **1999** | 2,260 | 0.27 | 2,316 | 0.24 | 3,278 | 0.21 | 1,722 | 0.20 | 968 | 0.24 | 3,000 | 0.20 | 1,744 | 0.20 | 6,732 | 0.19 | 6,130 | 0.45 | 20,374 | 0.34 |
| **2000** | 2,792 | 0.27 | 3,345 | 0.31 | 3,801 | 0.22 | 2,996 | 0.21 | 527 | 0.26 | 2,520 | 0.22 | 1,016 | 0.21 | 6,830 | 0.18 | 5,612 | 0.39 | 22,551 | 0.32 |
| **2001** | 2,528 | 0.27 | 1,824 | 0.26 | 3,725 | 0.18 | 2,346 | 0.26 | 480 | 0.24 | 3,152 | 0.24 | 877 | 0.22 | 5,544 | 0.17 | 7,469 | 0.17 | 22,753 | 0.31 |
| **2002** | 3,740 | 0.28 | 3,304 | 0.26 | 4,619 | 0.19 | 2,419 | 0.22 | 631 | 0.24 | 2,849 | 0.22 | 1,389 | 0.19 | 7,066 | 0.18 | 10,685 | 0.22 | 30,102 | 0.19 |
| **2003** | 2,560 | 0.25 | 1,971 | 0.19 | 6,604 | 0.24 | 1,972 | 0.21 | 897 | 0.24 | 3,782 | 0.24 | 2,174 | 0.26 | 5,250 | 0.27 | 4,054 | 0.24 | 19,264 | 0.26 |
| **2004** | 4,843 | 0.40 | 1,786 | 0.40 | 6,720 | 0.20 | 1,961 | 0.30 | 899 | 0.36 | 3,905 | 0.28 | 1,057 | 0.44 | 4,283 | 0.28 | 4,034 | 0.25 | 19,731 | 0.20 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table C-4. Predicted proportion positive catch rate given a positive haul (kg/2Ha) and biomass (1,000s mt/2ha) of shortspine thornyhead from the Delta-GLM applied to AFSC slope surveys.

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.95 | 0.03 | 0.98 | 0.01 | 0.94 | 0.03 | 0.98 | 0.01 | 0.93 | 0.04 | 0.97 | 0.02 | 0.92 | 0.04 | 0.97 | 0.02 | – | – | – | – |
| **1996*** | 0.93 | 0.04 | 0.97 | 0.02 | 0.92 | 0.03 | 0.97 | 0.02 | 0.90 | 0.05 | 0.96 | 0.02 | – | – | – | – | – | – | – | – |
| **1997** | 0.89 | 0.06 | 0.96 | 0.03 | 0.88 | 0.06 | 0.95 | 0.03 | 0.85 | 0.07 | 0.93 | 0.03 | 0.85 | 0.07 | 0.93 | 0.03 | 0.80 | 0.10 | 0.91 | 0.05 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 0.90 | 0.05 | 0.96 | 0.03 | 0.89 | 0.05 | 0.95 | 0.03 | 0.86 | 0.07 | 0.94 | 0.03 | 0.86 | 0.06 | 0.94 | 0.03 | 0.82 | 0.10 | 0.92 | 0.05 |
| **2000** | 0.91 | 0.05 | 0.96 | 0.02 | 0.90 | 0.05 | 0.96 | 0.02 | 0.87 | 0.06 | 0.95 | 0.03 | 0.87 | 0.06 | 0.94 | 0.03 | 0.83 | 0.08 | 0.93 | 0.04 |
| **2001** | 0.92 | 0.05 | 0.97 | 0.02 | 0.91 | 0.04 | 0.96 | 0.02 | 0.89 | 0.06 | 0.95 | 0.03 | 0.88 | 0.06 | 0.95 | 0.02 | 0.85 | 0.02 | 0.93 | 0.04 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 15.1 | 0.21 | 9.0 | 0.17 | 19.9 | 0.14 | 10.1 | 0.11 | 5.9 | 0.17 | 16.1 | 0.10 | 8.2 | 0.22 | 14.3 | 0.17 | – | – | – | – |
| **1996*** | 14.5 | 0.21 | 6.1 | 0.16 | 16.1 | 0.14 | 7.8 | 0.11 | 9.0 | 0.17 | 14.2 | 0.12 | – | – | – | – | – | – | – | – |
| **1997** | 10.9 | 0.45 | 4.3 | 0.26 | 13.7 | 0.24 | 5.0 | 0.20 | 7.7 | 0.33 | 9.6 | 0.24 | 6.0 | 0.30 | 16.7 | 0.18 | 7.9 | 0.36 | 18.8 | 0.24 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 12.9 | 0.30 | 6.7 | 0.22 | 12.7 | 0.24 | 5.4 | 0.20 | 4.3 | 0.39 | 6.4 | 0.23 | 5.6 | 0.27 | 14.7 | 0.18 | 14.2 | 0.39 | 16.4 | 0.25 |
| **2000** | 23.3 | 0.34 | 7.8 | 0.21 | 17.2 | 0.25 | 6.7 | 0.19 | 6.7 | 0.36 | 8.2 | 0.25 | 5.1 | 0.26 | 17.6 | 0.16 | 17.1 | 0.40 | 18.3 | 0.24 |
| **2001** | 19.0 | 0.33 | 5.0 | 0.21 | 18.4 | 0.24 | 5.2 | 0.22 | 6.7 | 0.36 | 9.8 | 0.24 | 4.5 | 0.27 | 20.6 | 0.16 | 10.3 | 0.16 | 16.6 | 0.24 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | 2,047 | 0.21 | 2,600 | 0.17 | 6,616 | 0.15 | 2,767 | 0.11 | 699 | 0.18 | 5,102 | 0.10 | 1,361 | 0.22 | 5,872 | 0.17 | – | – | – | – |
| **1996*** | 1,950 | 0.21 | 1,738 | 0.16 | 5,255 | 0.15 | 2,103 | 0.11 | 1,033 | 0.18 | 4,452 | 0.12 | – | – | – | – | – | – | – | – |
| **1997** | 1,390 | 0.46 | 1,190 | 0.27 | 4,220 | 0.25 | 1,337 | 0.20 | 820 | 0.34 | 2,907 | 0.24 | 899 | 0.30 | 6,568 | 0.19 | 4,317 | 0.38 | 28,355 | 0.25 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 1,676 | 0.30 | 1,884 | 0.22 | 3,989 | 0.25 | 1,435 | 0.20 | 472 | 0.40 | 1,957 | 0.23 | 859 | 0.27 | 5,796 | 0.18 | 7,859 | 0.40 | 24,832 | 0.25 |
| **2000** | 3,054 | 0.34 | 2,232 | 0.21 | 5,413 | 0.26 | 1,780 | 0.19 | 744 | 0.37 | 2,530 | 0.25 | 799 | 0.27 | 7,025 | 0.16 | 9,706 | 0.40 | 27,864 | 0.25 |
| **2001** | 2,489 | 0.34 | 1,405 | 0.21 | 5,923 | 0.24 | 1,399 | 0.22 | 751 | 0.37 | 3,019 | 0.24 | 715 | 0.27 | 8,199 | 0.16 | 5,890 | 0.16 | 25,729 | 0.24 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | | – | – | – | – | – |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

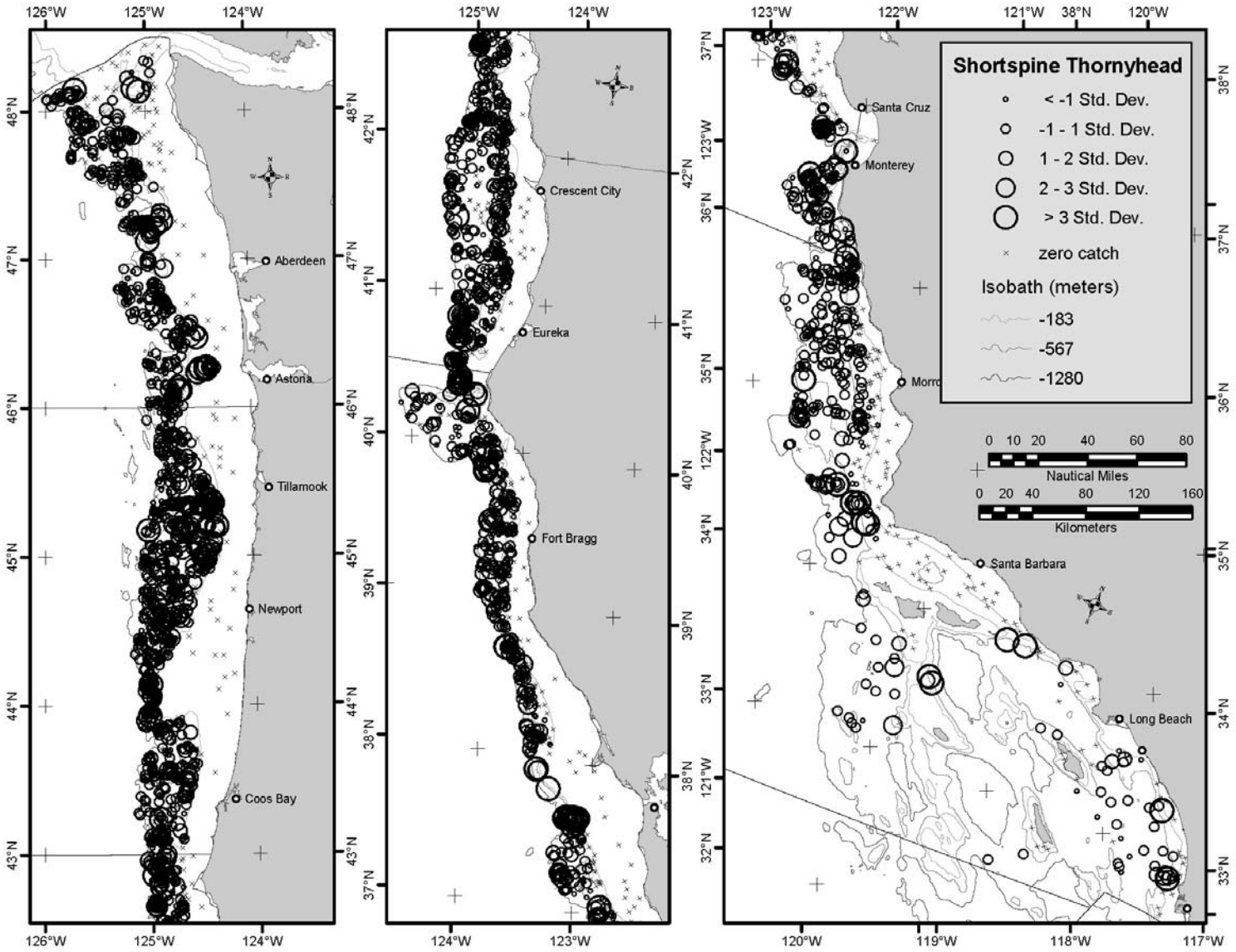



Figure C-1. Distribution of shortspine thornyhead caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

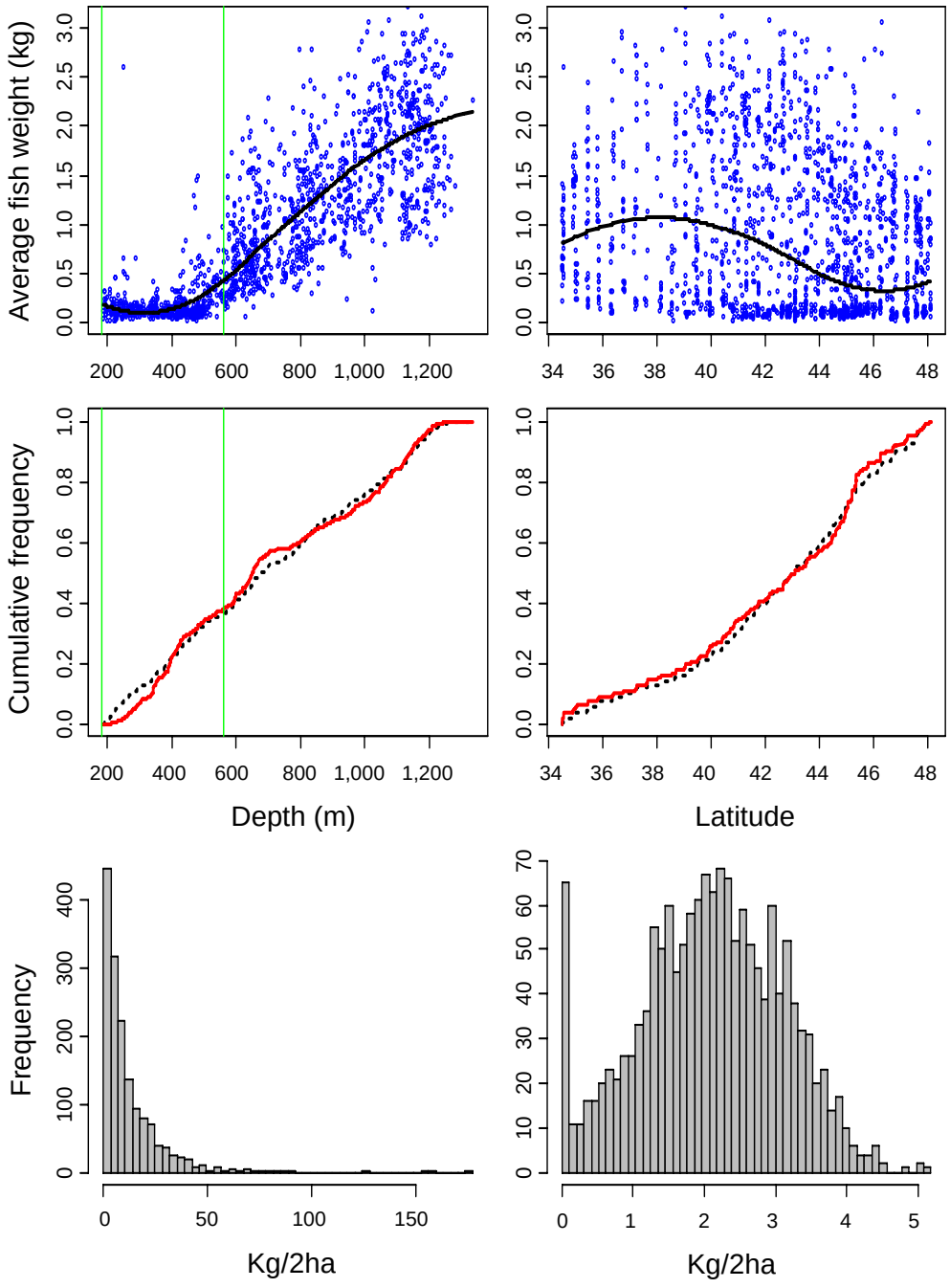



Figure C-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of shortspine thornyhead caught in the AFSC slope surveys.

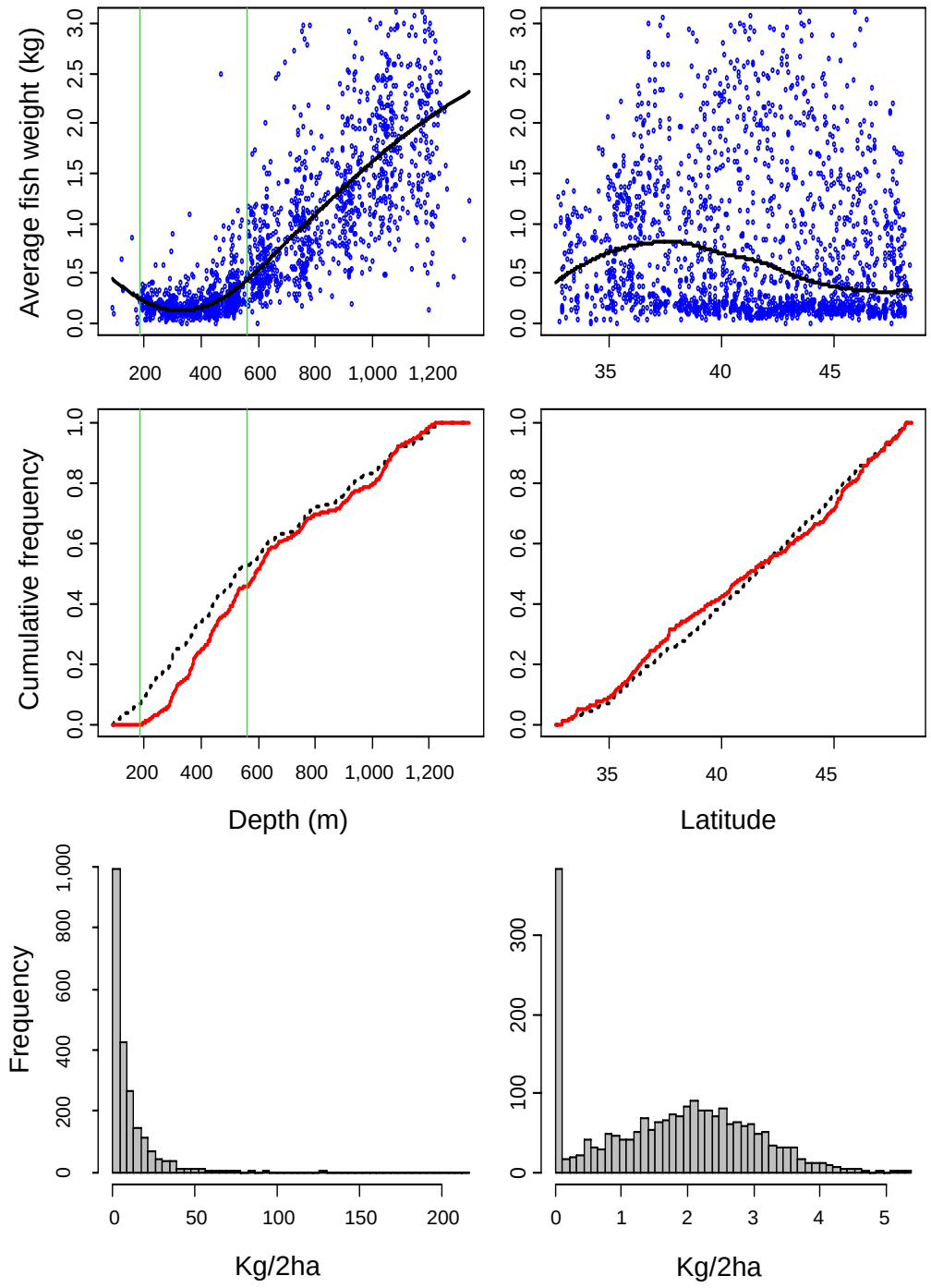



Figure C-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of shortspine thornyhead caught in the NWFSC slope surveys.

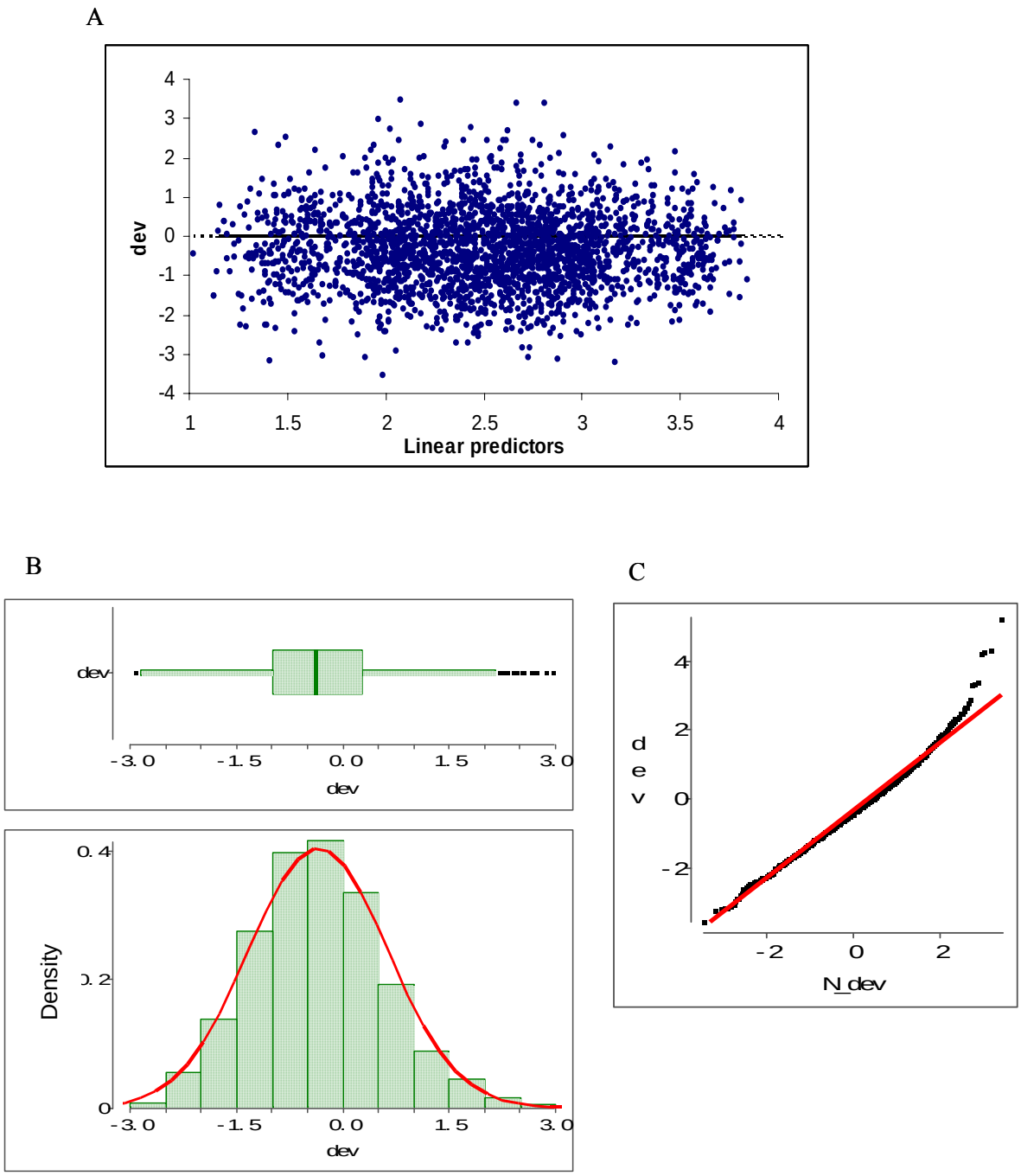



Figure C-4. Diagnostic plots from the generalized linear mixed model fit to shortspine thornyhead from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

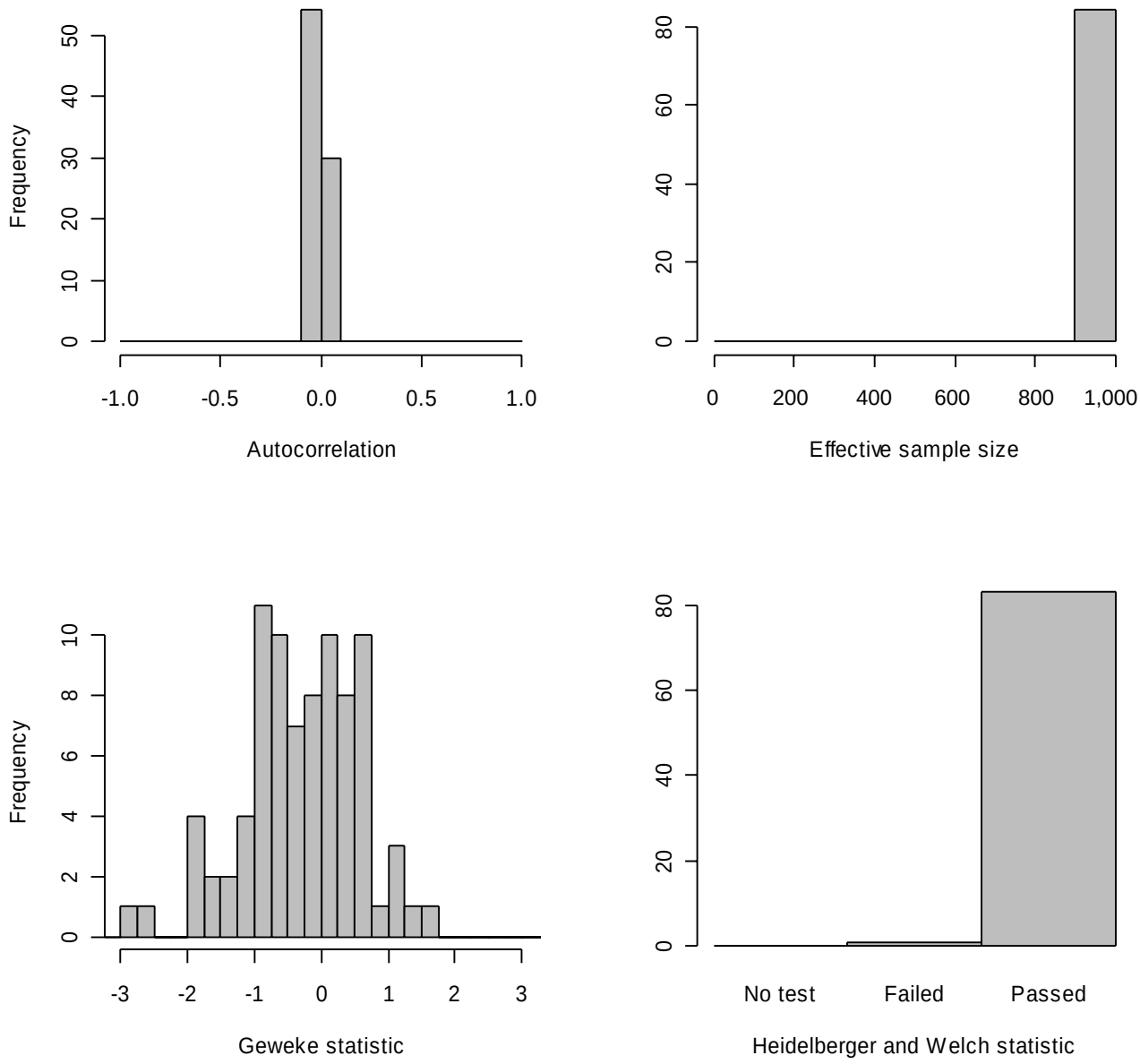
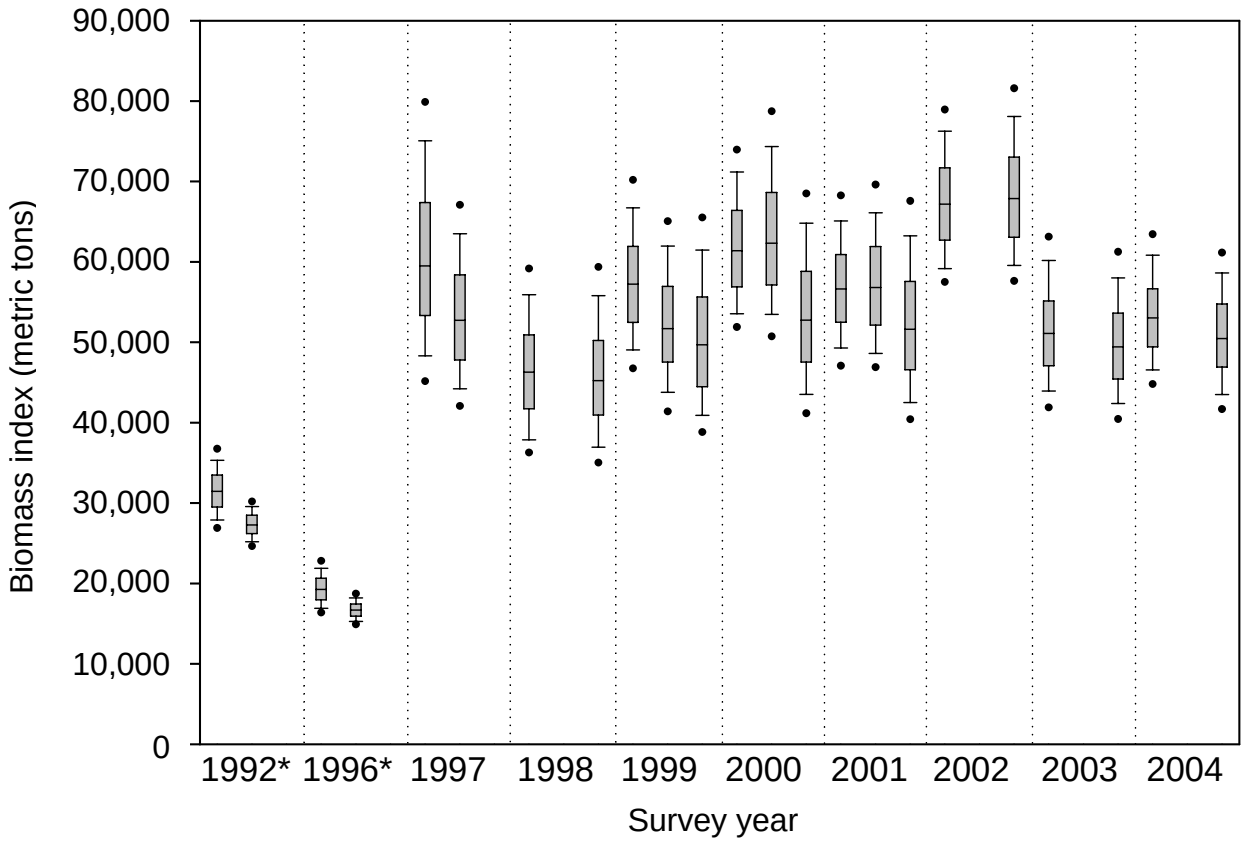



Figure C-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for shortspine thornyhead. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure C-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for shortspine thornyhead. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix D: Longspine Thornyhead (*Sebastolobus altivelis*)

This appendix has tables D-1 though D-4 and figures D-1 though D-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for longspine thornyhead. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table D-1. Basic data and statistics summary for longspine thornyhead caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 |
| **1992*** | 27 | 6 | 36 | 36 | 57 | 15 | 81 | 81 | 37 | 10 | 93 | 93 | 26 | 8 | 40 | 39 | – | – | – | – |
| **1996*** | 29 | 10 | 44 | 44 | 55 | 14 | 76 | 76 | 34 | 10 | 72 | 72 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 1 | 16 | 16 | 20 | 5 | 28 | 28 | 10 | 2 | 20 | 20 | 17 | 5 | 33 | 33 | 11 | 6 | 18 | 18 |
| **1998** | 17 | 6 | 21 | 21 | 46 | 12 | 31 | 32 | 29 | 8 | 29 | 29 | 42 | 6 | 57 | 57 | 11 | 4 | 16 | 16 |
| **1999** | 36 | 6 | 54 | 54 | 58 | 18 | 71 | 71 | 39 | 6 | 61 | 61 | 65 | 16 | 82 | 82 | 23 | 9 | 33 | 33 |
| **2000** | 35 | 7 | 47 | 47 | 59 | 15 | 70 | 70 | 37 | 6 | 60 | 60 | 72 | 20 | 94 | 94 | 27 | 8 | 36 | 36 |
| **2001** | 36 | 9 | 50 | 50 | 71 | 26 | 59 | 58 | 37 | 9 | 56 | 58 | 65 | 21 | 99 | 98 | 29 | 10 | 36 | 36 |
| **2002** | 24 | 7 | 24 | 24 | 47 | 17 | 39 | 39 | 30 | 8 | 40 | 41 | 58 | 17 | 61 | 60 | 46 | 16 | 55 | 53 |
| **2003** | 28 | 6 | 44 | 44 | 30 | 7 | 37 | 37 | 36 | 9 | 33 | 33 | 32 | 7 | 24 | 24 | 55 | 11 | 27 | 25 |
| **2004** | 13 | 3 | 14 | 4 | 46 | 16 | 19 | 19 | 14 | 3 | 23 | 23 | 17 | 2 | 21 | 21 | 50 | 14 | 49 | 47 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 4.2 | 0.42 | 68.1 | 0.10 | 2.4 | 0.42 | 43.7 | 0.06 | 0.9 | 0.77 | 69.1 | 0.06 | 5.1 | 0.45 | 65.4 | 0.13 | – | – | – | – |
| **1996*** | 3.5 | 0.38 | 46.5 | 0.07 | 1.0 | 0.49 | 50.0 | 0.07 | 2.3 | 0.59 | 61.2 | 0.06 | – | – | – | – | – | – | – | – |
| **1997** | 0.0 | 1.00 | 44.9 | 0.07 | 0.9 | 0.71 | 49.1 | 0.10 | 0.3 | 0.90 | 69.7 | 0.09 | 2.6 | 0.51 | 66.1 | 0.15 | 10.0 | 0.37 | 52.8 | 0.18 |
| **1998** | 1.1 | 0.54 | 38.0 | 0.13 | 1.6 | 0.38 | 32.1 | 0.10 | 0.8 | 0.39 | 50.5 | 0.11 | 0.6 | 0.60 | 44.3 | 0.09 | 3.4 | 0.56 | 39.0 | 0.17 |
| **1999** | 0.8 | 0.64 | 44.4 | 0.07 | 1.4 | 0.42 | 41.9 | 0.07 | 0.2 | 0.48 | 58.2 | 0.07 | 2.0 | 0.37 | 56.8 | 0.10 | 6.4 | 0.31 | 48.0 | 0.15 |
| **2000** | 0.9 | 0.44 | 50.2 | 0.09 | 1.0 | 0.64 | 43.4 | 0.06 | 0.4 | 0.46 | 63.4 | 0.06 | 1.5 | 0.29 | 54.6 | 0.09 | 6.7 | 0.39 | 49.0 | 0.14 |
| **2001** | 1.3 | 0.50 | 44.7 | 0.08 | 2.0 | 0.26 | 40.5 | 0.07 | 0.9 | 0.46 | 59.3 | 0.07 | 2.3 | 0.38 | 58.6 | 0.07 | 5.9 | 0.33 | 53.6 | 0.11 |
| **2002** | 3.3 | 0.49 | 43.0 | 0.13 | 1.9 | 0.34 | 40.6 | 0.08 | 1.0 | 0.46 | 68.3 | 0.10 | 2.3 | 0.37 | 52.6 | 0.09 | 3.6 | 0.31 | 36.1 | 0.12 |
| **2003** | 1.3 | 0.60 | 59.2 | 0.10 | 2.6 | 0.42 | 45.6 | 0.07 | 1.1 | 0.46 | 71.4 | 0.10 | 4.1 | 0.53 | 59.3 | 0.13 | 5.2 | 0.31 | 32.2 | 0.19 |
| **2004** | 0.5 | 0.75 | 41.7 | 0.15 | 2.8 | 0.31 | 46.3 | 0.10 | 1.9 | 0.73 | 68.3 | 0.13 | 0.2 | 0.87 | 78.2 | 0.13 | 4.5 | 0.34 | 39.5 | 0.13 |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 18.9 | 0.22 | 68.1 | 0.10 | 9.1 | 0.36 | 43.7 | 0.06 | 3.2 | 0.74 | 69.1 | 0.06 | 16.7 | 0.35 | 67.1 | 0.12 | – | – | – | – |
| **1996*** | 10.1 | 0.28 | 46.5 | 0.07 | 4.0 | 0.45 | 50.0 | 0.07 | 7.8 | 0.54 | 61.2 | 0.06 | – | – | – | – | – | – | – | – |
| **1997** | 0.3 | 0.00 | 44.9 | 0.07 | 3.4 | 0.64 | 49.1 | 0.10 | 1.7 | 0.81 | 69.7 | 0.09 | 8.9 | 0.36 | 66.1 | 0.15 | 18.4 | 0.24 | 52.8 | 0.18 |
| **1998** | 3.0 | 0.44 | 39.9 | 0.12 | 6.1 | 0.29 | 32.1 | 0.10 | 3.1 | 0.25 | 50.5 | 0.11 | 3.9 | 0.50 | 44.3 | 0.09 | 9.4 | 0.41 | 39.0 | 0.17 |
| **1999** | 4.5 | 0.56 | 45.2 | 0.07 | 4.5 | 0.38 | 41.9 | 0.07 | 1.2 | 0.31 | 58.2 | 0.07 | 8.0 | 0.31 | 56.8 | 0.10 | 16.5 | 0.16 | 48.0 | 0.15 |
| **2000** | 4.6 | 0.29 | 50.2 | 0.09 | 3.7 | 0.61 | 43.4 | 0.06 | 2.4 | 0.28 | 63.4 | 0.06 | 5.3 | 0.23 | 54.6 | 0.09 | 21.8 | 0.26 | 49.0 | 0.14 |
| **2001** | 5.1 | 0.43 | 44.7 | 0.08 | 5.3 | 0.21 | 41.2 | 0.07 | 3.9 | 0.37 | 59.3 | 0.07 | 7.1 | 0.34 | 58.6 | 0.07 | 17.0 | 0.21 | 53.6 | 0.11 |
| **2002** | 10.8 | 0.39 | 43.0 | 0.13 | 5.3 | 0.29 | 40.6 | 0.08 | 3.8 | 0.37 | 68.3 | 0.10 | 7.8 | 0.31 | 53.5 | 0.09 | 10.3 | 0.24 | 37.4 | 0.12 |
| **2003** | 6.2 | 0.51 | 59.2 | 0.10 | 11.1 | 0.27 | 45.6 | 0.07 | 4.6 | 0.38 | 71.4 | 0.10 | 19.0 | 0.44 | 59.3 | 0.13 | 26.0 | 0.16 | 34.8 | 0.19 |
| **2004** | 2.1 | 0.63 | 41.7 | 0.15 | 8.0 | 0.24 | 46.3 | 0.10 | 8.7 | 0.59 | 68.3 | 0.13 | 1.4 | 0.73 | 78.2 | 0.13 | 16.1 | 0.26 | 41.2 | 0.12 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table D-2. Predicted proportion positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2ha) of longspine thornyhead from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.19 | 0.24 | 0.99 | 0.00 | 0.24 | 0.20 | 0.99 | 0.00 | 0.19 | 0.22 | 0.99 | 0.00 | 0.22 | 0.21 | 0.99 | 0.00 | – | – | – | – |
| **1996*** | 0.19 | 0.24 | 0.99 | 0.00 | 0.24 | 0.21 | 0.99 | 0.00 | 0.19 | 0.22 | 0.99 | 0.00 | – | – | – | – | – | – | – | – |
| **1997** | 0.19 | 0.28 | 0.99 | 0.00 | 0.24 | 0.25 | 0.99 | 0.00 | 0.19 | 0.28 | 0.99 | 0.00 | 0.22 | 0.26 | 0.99 | 0.00 | 0.24 | 0.26 | 0.99 | 0.00 |
| **1998** | 0.25 | 0.20 | 0.99 | 0.00 | 0.31 | 0.17 | 0.99 | 0.00 | 0.25 | 0.19 | 0.99 | 0.00 | 0.29 | 0.17 | 0.99 | 0.00 | 0.31 | 0.19 | 0.99 | 0.00 |
| **1999** | 0.20 | 0.19 | 0.99 | 0.00 | 0.26 | 0.15 | 0.99 | 0.00 | 0.21 | 0.18 | 0.99 | 0.00 | 0.23 | 0.16 | 0.99 | 0.00 | 0.26 | 0.17 | 0.99 | 0.00 |
| **2000** | 0.22 | 0.19 | 0.99 | 0.00 | 0.27 | 0.16 | 0.99 | 0.00 | 0.22 | 0.18 | 0.99 | 0.00 | 0.25 | 0.16 | 0.99 | 0.00 | 0.27 | 0.17 | 0.99 | 0.00 |
| **2001** | 0.29 | 0.16 | 0.99 | 0.00 | 0.35 | 0.12 | 1.00 | 0.00 | 0.30 | 0.15 | 0.99 | 0.00 | 0.33 | 0.13 | 1.00 | 0.00 | 0.36 | 0.00 | 1.00 | 0.00 |
| **2002** | 0.30 | 0.17 | 0.99 | 0.00 | 0.36 | 0.14 | 1.00 | 0.00 | 0.30 | 0.16 | 0.99 | 0.00 | 0.34 | 0.15 | 1.00 | 0.00 | 0.37 | 0.14 | 1.00 | 0.00 |
| **2003** | 0.19 | 0.21 | 0.99 | 0.00 | 0.24 | 0.18 | 0.99 | 0.00 | 0.20 | 0.20 | 0.99 | 0.00 | 0.22 | 0.19 | 0.99 | 0.00 | 0.24 | 0.19 | 0.99 | 0.00 |
| **2004** | 0.21 | 0.22 | 0.99 | 0.00 | 0.26 | 0.19 | 0.99 | 0.00 | 0.21 | 0.21 | 0.99 | 0.00 | 0.24 | 0.20 | 0.99 | 0.00 | 0.26 | 0.18 | 0.99 | 0.00 |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 17.8 | 0.36 | 55.3 | 0.15 | 8.6 | 0.21 | 35.3 | 0.12 | 2.9 | 0.26 | 58.6 | 0.11 | 15.9 | 0.30 | 56.0 | 0.15 | – | – | – | – |
| **1996*** | 8.6 | 0.26 | 40.1 | 0.13 | 3.4 | 0.23 | 42.6 | 0.11 | 6.9 | 0.26 | 52.5 | 0.11 | – | – | – | – | – | – | – | – |
| **1997** | 0.3 | 1.25 | 39.5 | 0.23 | 3.0 | 0.39 | 42.6 | 0.16 | 1.5 | 0.71 | 60.7 | 0.19 | 7.8 | 0.38 | 57.4 | 0.15 | 15.9 | 0.38 | 45.6 | 0.20 |
| **1998** | 2.9 | 0.33 | 36.3 | 0.20 | 6.0 | 0.24 | 29.0 | 0.15 | 3.0 | 0.30 | 47.2 | 0.16 | 3.6 | 0.36 | 40.7 | 0.12 | 8.7 | 0.44 | 35.6 | 0.21 |
| **1999** | 4.6 | 0.37 | 43.0 | 0.12 | 4.3 | 0.19 | 38.8 | 0.11 | 1.2 | 0.33 | 54.8 | 0.12 | 7.6 | 0.21 | 54.2 | 0.10 | 15.0 | 0.27 | 43.4 | 0.16 |
| **2000** | 4.9 | 0.33 | 47.6 | 0.13 | 3.3 | 0.21 | 40.5 | 0.11 | 2.2 | 0.33 | 60.7 | 0.12 | 5.1 | 0.19 | 50.4 | 0.10 | 20.1 | 0.29 | 46.0 | 0.15 |
| **2001** | 5.4 | 0.27 | 42.2 | 0.13 | 5.6 | 0.17 | 39.0 | 0.12 | 4.0 | 0.28 | 58.1 | 0.11 | 7.4 | 0.19 | 56.4 | 0.10 | 16.4 | 0.10 | 51.2 | 0.14 |
| **2002** | 10.9 | 0.31 | 42.6 | 0.17 | 5.7 | 0.20 | 40.9 | 0.14 | 4.0 | 0.28 | 69.2 | 0.13 | 7.8 | 0.20 | 55.0 | 0.11 | 11.6 | 0.21 | 38.6 | 0.12 |
| **2003** | 6.3 | 0.36 | 57.6 | 0.13 | 11.1 | 0.32 | 44.9 | 0.14 | 4.6 | 0.28 | 70.6 | 0.15 | 18.8 | 0.31 | 57.3 | 0.16 | 26.8 | 0.24 | 34.1 | 0.17 |
| **2004** | 1.9 | 0.52 | 39.1 | 0.23 | 7.7 | 0.22 | 43.7 | 0.19 | 8.5 | 0.53 | 64.5 | 0.18 | 1.5 | 0.68 | 76.8 | 0.18 | 15.5 | 0.22 | 39.8 | 0.13 |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | 489 | 0.45 | 16,190 | 0.15 | 734 | 0.30 | 9, 856 | 0.12 | 72 | 0.34 | 18,945 | 0.11 | 632 | 0.40 | 23,469 | 0.15 | – | – | – | – |
| **1996*** | 236 | 0.37 | 11,707 | 0.13 | 284 | 0.31 | 11,880 | 0.11 | 166 | 0.36 | 16,998 | 0.11 | – | – | – | – | – | – | – | – |
| **1997** | 7 | 1.54 | 11,536 | 0.23 | 257 | 0.49 | 11,896 | 0.16 | 36 | 0.82 | 19,623 | 0.19 | 307 | 0.50 | 24,109 | 0.15 | 2,651 | 0.50 | 75,829 | 0.20 |
| **1998** | 101 | 0.40 | 10,636 | 0.20 | 653 | 0.30 | 8,135 | 0.15 | 96 | 0.36 | 15,319 | 0.16 | 186 | 0.40 | 17,123 | 0.12 | 1,854 | 0.49 | 59,167 | 0.21 |
| **1999** | 135 | 0.45 | 12,591 | 0.12 | 396 | 0.25 | 10,865 | 0.11 | 31 | 0.38 | 17,719 | 0.12 | 319 | 0.27 | 22,814 | 0.10 | 2,676 | 0.34 | 72,096 | 0.16 |
| **2000** | 154 | 0.41 | 13,944 | 0.13 | 322 | 0.27 | 11,350 | 0.11 | 61 | 0.40 | 19,667 | 0.12 | 230 | 0.26 | 21,208 | 0.10 | 3,731 | 0.36 | 76,412 | 0.15 |
| **2001** | 226 | 0.33 | 12,386 | 0.13 | 706 | 0.21 | 10,940 | 0.12 | 150 | 0.33 | 18,888 | 0.11 | 435 | 0.24 | 23,761 | 0.10 | 4,010 | 0.10 | 85,494 | 0.14 |
| **2002** | 473 | 0.37 | 12,519 | 0.17 | 726 | 0.25 | 11,490 | 0.14 | 153 | 0.33 | 22,488 | 0.13 | 472 | 0.26 | 23,130 | 0.11 | 2,902 | 0.26 | 64,364 | 0.12 |
| **2003** | 176 | 0.42 | 16,841 | 0.13 | 959 | 0.38 | 12,565 | 0.14 | 114 | 0.35 | 22,788 | 0.15 | 738 | 0.38 | 24,051 | 0.16 | 4,484 | 0.32 | 56,628 | 0.17 |
| **2004** | 58 | 0.60 | 11,425 | 0.23 | 722 | 0.29 | 12,212 | 0.19 | 228 | 0.61 | 20,860 | 0.18 | 65 | 0.74 | 32,273 | 0.18 | 2,787 | 0.30 | 66,178 | 0.13 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993, and 1996 = 1995, 1996. For the 1992 super year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super year as far south as Eureka.

Table D-3. Predicted proportion positive catch rate given a positive haul (kg/2ha) and biomass (1,000s mt/2ha) of longspine thornyhead from the Delta-GLM applied to NWFSC slope surveys.

| | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | | **183–567 m** | | **567–1,280 m** | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 0.27 | 0.22 | 0.99 | 0.00 | 0.35 | 0.16 | 0.99 | 0.00 | 0.26 | 0.20 | 0.99 | 0.00 | 0.25 | 0.19 | 0.99 | 0.00 | 0.27 | 0.21 | 0.99 | 0.00 |
| **1999** | 0.25 | 0.22 | 0.99 | 0.00 | 0.32 | 0.17 | 0.99 | 0.00 | 0.24 | 0.21 | 0.99 | 0.01 | 0.23 | 0.19 | 0.99 | 0.00 | 0.25 | 0.21 | 0.99 | 0.00 |
| **2000** | 0.23 | 0.23 | 0.99 | 0.01 | 0.30 | 0.18 | 0.99 | 0.00 | 0.22 | 0.22 | 0.99 | 0.01 | 0.21 | 0.21 | 0.99 | 0.01 | 0.23 | 0.23 | 0.99 | 0.01 |
| **2001** | 0.32 | 0.19 | 0.99 | 0.00 | 0.40 | 0.13 | 0.99 | 0.00 | 0.31 | 0.17 | 0.99 | 0.00 | 0.30 | 0.17 | 0.99 | 0.00 | 0.32 | 0.00 | 0.99 | 0.00 |
| **2002** | 0.33 | 0.18 | 0.99 | 0.00 | 0.41 | 0.13 | 1.00 | 0.00 | 0.32 | 0.17 | 0.99 | 0.00 | 0.31 | 0.16 | 0.99 | 0.00 | 0.33 | 0.16 | 0.99 | 0.00 |
| **2003** | 0.22 | 0.22 | 0.99 | 0.01 | 0.29 | 0.17 | 0.99 | 0.00 | 0.21 | 0.21 | 0.99 | 0.01 | 0.20 | 0.21 | 0.99 | 0.01 | 0.22 | 0.20 | 0.99 | 0.01 |
| **2004** | 0.23 | 0.24 | 0.99 | 0.01 | 0.30 | 0.18 | 0.99 | 0.00 | 0.22 | 0.23 | 0.99 | 0.01 | 0.21 | 0.23 | 0.99 | 0.01 | 0.23 | 0.22 | 0.99 | 0.01 |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 2.7 | 0.35 | 37.7 | 0.19 | 5.7 | 0.24 | 30.3 | 0.15 | 2.9 | 0.29 | 48.3 | 0.16 | 3.5 | 0.33 | 42.3 | 0.11 | 8.5 | 0.43 | 36.1 | 0.20 |
| **1999** | 3.2 | 0.44 | 44.6 | 0.15 | 3.8 | 0.22 | 38.3 | 0.13 | 1.0 | 0.37 | 57.5 | 0.14 | 5.1 | 0.26 | 59.4 | 0.12 | 10.7 | 0.42 | 45.4 | 0.21 |
| **2000** | 5.6 | 0.37 | 53.5 | 0.18 | 1.0 | 0.26 | 43.0 | 0.13 | 2.9 | 0.51 | 63.3 | 0.14 | 3.8 | 0.24 | 49.0 | 0.12 | 16.2 | 0.51 | 61.9 | 0.21 |
| **2001** | 6.0 | 0.29 | 51.9 | 0.17 | 6.0 | 0.18 | 37.0 | 0.15 | 4.2 | 0.29 | 57.7 | 0.15 | 12.0 | 0.26 | 55.2 | 0.12 | 16.1 | 0.12 | 67.9 | 0.20 |
| **2002** | 10.8 | 0.32 | 44.6 | 0.17 | 5.6 | 0.20 | 41.9 | 0.14 | 3.9 | 0.30 | 70.8 | 0.13 | 7.8 | 0.20 | 55.5 | 0.11 | 11.2 | 0.20 | 39.3 | 0.12 |
| **2003** | 6.0 | 0.34 | 59.6 | 0.14 | 10.9 | 0.32 | 46.3 | 0.13 | 4.6 | 0.29 | 72.6 | 0.14 | 18.4 | 0.32 | 60.0 | 0.17 | 26.2 | 0.24 | 34.5 | 0.16 |
| **2004** | 2.0 | 0.51 | 41.2 | 0.22 | 8.0 | 0.20 | 45.7 | 0.19 | 8.7 | 0.53 | 67.8 | 0.17 | 1.5 | 0.67 | 79.8 | 0.17 | 15.6 | 0.23 | 41.0 | 0.13 |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1998** | 107 | 0.42 | 11,012 | 0.19 | 704 | 0.30 | 8,481 | 0.15 | 98 | 0.36 | 15,640 | 0.16 | 159 | 0.38 | 17,736 | 0.11 | 1,564 | 0.52 | 59,980 | 0.20 |
| **1999** | 116 | 0.53 | 13,039 | 0.15 | 432 | 0.29 | 10,695 | 0.13 | 30 | 0.43 | 18,574 | 0.14 | 216 | 0.34 | 24,825 | 0.12 | 1,810 | 0.50 | 75,308 | 0.21 |
| **2000** | 188 | 0.45 | 15,585 | 0.18 | 108 | 0.32 | 12,009 | 0.13 | 81 | 0.61 | 20,401 | 0.14 | 148 | 0.34 | 20,522 | 0.12 | 2,509 | 0.65 | 102,318 | 0.21 |
| **2001** | 276 | 0.37 | 15,225 | 0.17 | 871 | 0.22 | 10,392 | 0.15 | 168 | 0.35 | 18,669 | 0.15 | 648 | 0.32 | 23,154 | 0.12 | 3,579 | 0.12 | 112,790 | 0.20 |
| **2002** | 511 | 0.39 | 13,091 | 0.17 | 821 | 0.24 | 11,758 | 0.14 | 156 | 0.35 | 22,994 | 0.13 | 429 | 0.26 | 23,306 | 0.11 | 2,495 | 0.26 | 65,270 | 0.12 |
| **2003** | 193 | 0.43 | 17,382 | 0.14 | 1,080 | 0.38 | 12,938 | 0.13 | 124 | 0.36 | 23,386 | 0.14 | 675 | 0.40 | 24,990 | 0.17 | 3,962 | 0.33 | 56,993 | 0.16 |
| **2004** | 67 | 0.60 | 12,014 | 0.22 | 848 | 0.27 | 12,776 | 0.19 | 247 | 0.64 | 21,854 | 0.17 | 56 | 0.78 | 33,345 | 0.17 | 2,463 | 0.33 | 67,838 | 0.13 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

Table D-4. Predicted proportion positive catch rate given a positive haul (kg/2Ha) and biomass (1,000s mt/2ha) of longspine thornyhead from the Delta-GLM applied to AFSC slope surveys.

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Predicted proportion positive based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.15 | 0.30 | 1.00 | 0.01 | 0.18 | 0.22 | 1.00 | 0.01 | 0.17 | 0.27 | 1.00 | 0.01 | 0.31 | 0.22 | 1.00 | 0.00 | – | – | – | – |
| **1996*** | 0.17 | 0.29 | 1.00 | 0.01 | 0.20 | 0.22 | 1.00 | 0.01 | 0.18 | 0.27 | 1.00 | 0.01 | – | – | – | – | – | – | – | – |
| **1997** | 0.12 | 0.40 | 1.00 | 0.01 | 0.14 | 0.33 | 1.00 | 0.01 | 0.13 | 0.37 | 1.00 | 0.01 | 0.25 | 0.28 | 1.00 | 0.01 | 0.38 | 0.27 | 1.00 | 0.00 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 0.11 | 0.41 | 1.00 | 0.01 | 0.13 | 0.35 | 1.00 | 0.01 | 0.12 | 0.41 | 1.00 | 0.02 | 0.23 | 0.29 | 1.00 | 0.01 | 0.35 | 0.29 | 1.00 | 0.00 |
| **2000** | 0.16 | 0.35 | 1.00 | 0.01 | 0.18 | 0.31 | 1.00 | 0.01 | 0.17 | 0.34 | 1.00 | 0.01 | 0.31 | 0.25 | 1.00 | 0.00 | 0.44 | 0.24 | 1.00 | 0.00 |
| **2001** | 0.19 | 0.36 | 1.00 | 0.01 | 0.22 | 0.28 | 1.00 | 0.01 | 0.20 | 0.33 | 1.00 | 0.01 | 0.36 | 0.23 | 1.00 | 0.00 | 0.49 | 0.00 | 1.00 | 0.00 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2ha) given positive haul based on results from the Delta-GLM model | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 19.1 | 0.32 | 67.9 | 0.13 | 9.2 | 0.20 | 43.7 | 0.08 | 3.3 | 0.25 | 69.2 | 0.08 | 16.8 | 0.27 | 67.2 | 0.12 | – | – | – | – |
| **1996*** | 10.1 | 0.25 | 46.6 | 0.11 | 3.9 | 0.20 | 50.0 | 0.09 | 7.8 | 0.24 | 61.0 | 0.09 | – | – | – | – | – | – | – | – |
| **1997** | 0.3 | 1.16 | 44.5 | 0.19 | 3.4 | 0.37 | 48.9 | 0.15 | 1.6 | 0.65 | 69.7 | 0.17 | 8.9 | 0.37 | 65.9 | 0.14 | 18.4 | 0.32 | 52.8 | 0.18 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 7.9 | 0.64 | 49.2 | 0.15 | 6.7 | 0.37 | 49.8 | 0.15 | 2.8 | 1.13 | 65.6 | 0.17 | 13.2 | 0.33 | 56.3 | 0.13 | 21.3 | 0.36 | 51.4 | 0.17 |
| **2000** | 3.4 | 0.62 | 49.8 | 0.14 | 9.1 | 0.35 | 44.6 | 0.15 | 1.7 | 0.53 | 68.1 | 0.17 | 7.6 | 0.29 | 62.8 | 0.12 | 25.7 | 0.37 | 39.4 | 0.18 |
| **2001** | 0.2 | 1.22 | 40.2 | 0.15 | 3.7 | 0.36 | 47.6 | 0.14 | 2.7 | 1.18 | 68.4 | 0.17 | 3.2 | 0.24 | 67.6 | 0.12 | 18.4 | 0.12 | 45.2 | 0.17 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | | | | | | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | 420 | 0.50 | 19,978 | 0.13 | 592 | 0.33 | 12,252 | 0.08 | 68 | 0.38 | 22,477 | 0.08 | 918 | 0.37 | 28,404 | 0.12 | – | – | – | – |
| **1996*** | 246 | 0.40 | 13,725 | 0.11 | 280 | 0.30 | 14,008 | 0.09 | 185 | 0.37 | 19,863 | 0.09 | – | – | – | – | – | – | – | – |
| **1997** | 5 | 1.51 | 13,053 | 0.20 | 169 | 0.57 | 13,677 | 0.15 | 27 | 0.91 | 22,657 | 0.17 | 408 | 0.47 | 27,844 | 0.14 | 4,716 | 0.44 | 88,241 | 0.18 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 129 | 0.83 | 14,419 | 0.15 | 306 | 0.57 | 13,937 | 0.15 | 43 | 1.26 | 21,290 | 0.17 | 544 | 0.48 | 23,751 | 0.13 | 5,090 | 0.48 | 85,948 | 0.17 |
| **2000** | 75 | 0.81 | 14,591 | 0.14 | 601 | 0.50 | 12,513 | 0.15 | 37 | 0.66 | 22,134 | 0.17 | 426 | 0.39 | 26,518 | 0.12 | 7,717 | 0.47 | 65,957 | 0.18 |
| **2001** | 4 | 1.49 | 11,842 | 0.15 | 287 | 0.48 | 13,370 | 0.14 | 66 | 1.34 | 22,264 | 0.17 | 204 | 0.34 | 28,556 | 0.12 | 6,172 | 0.12 | 75,599 | 0.17 |
| **2002** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka.

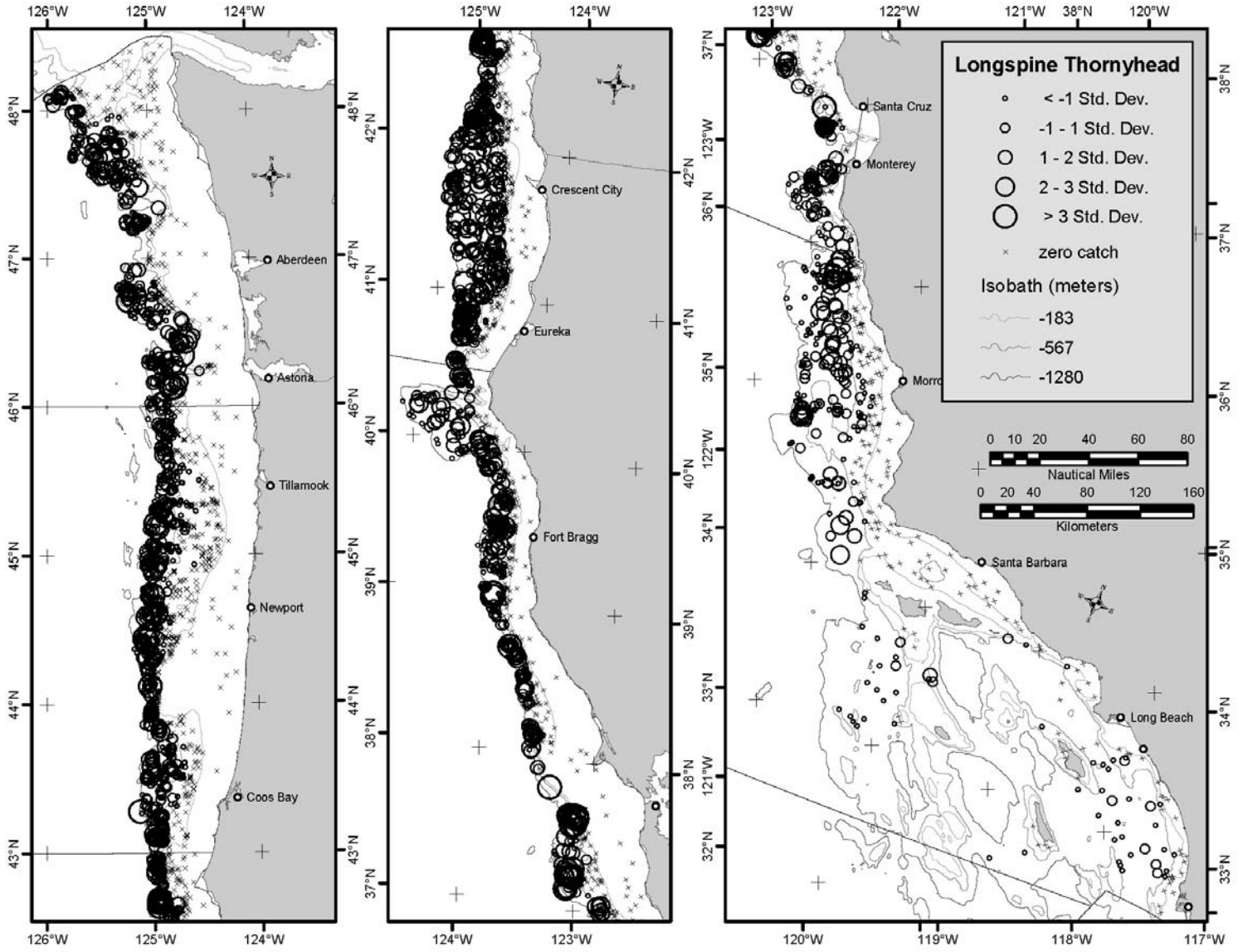



Figure D-1. Distribution of longspine thornyhead caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

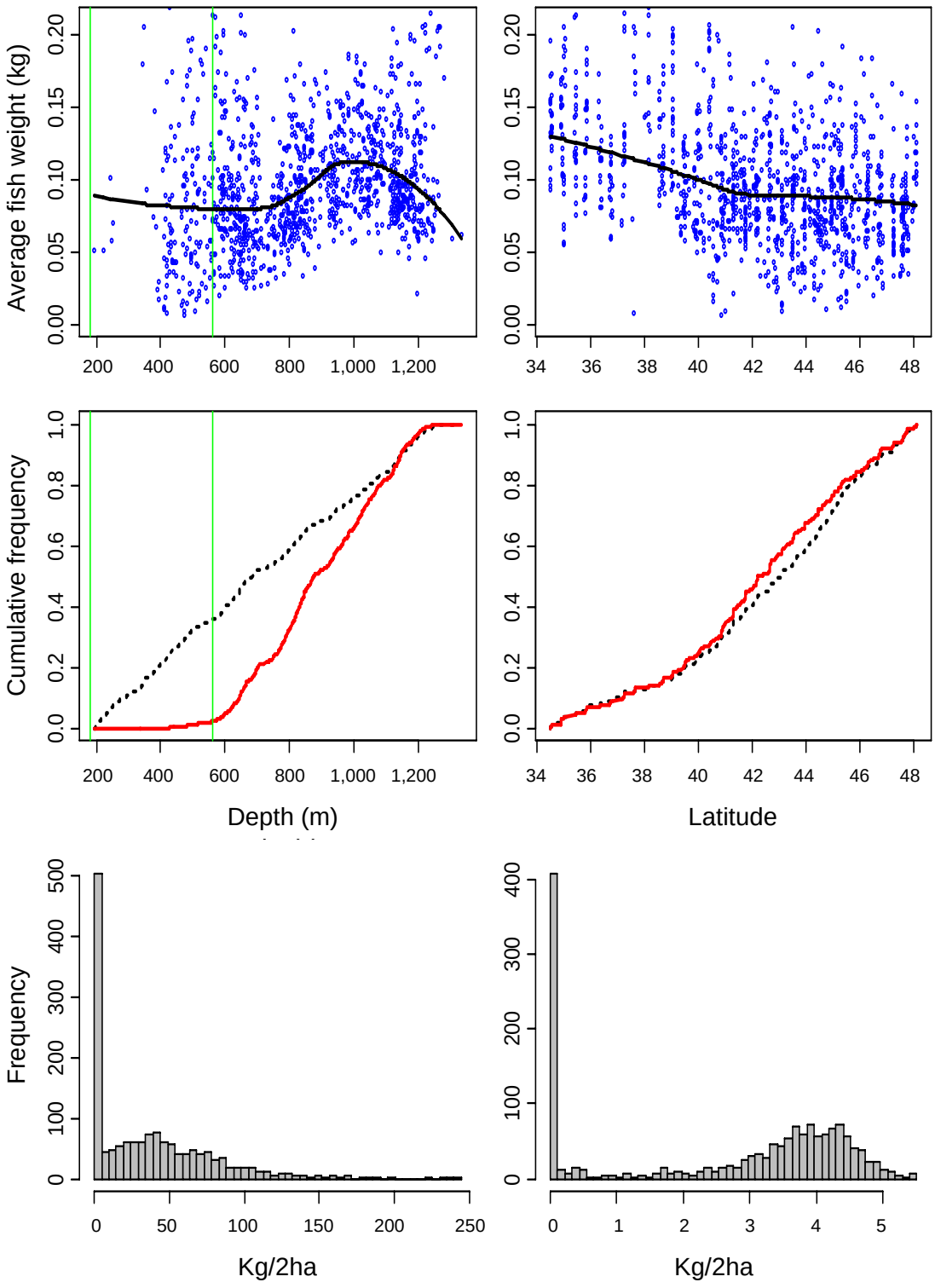



Figure D-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of longspine thornyhead caught in the AFSC slope surveys.

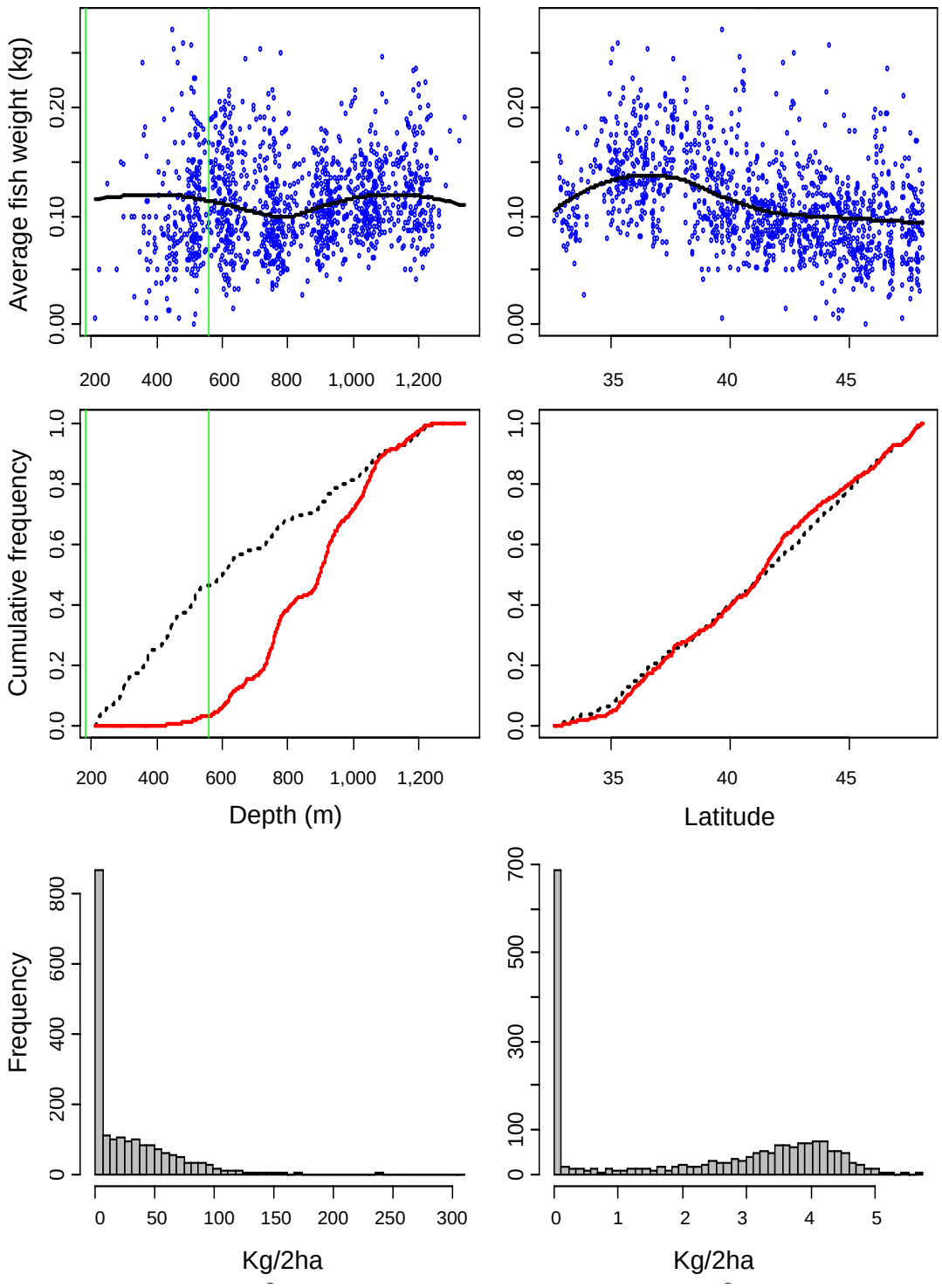



Figure D-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of longspine thornyhead caught in the NWFSC slope surveys.

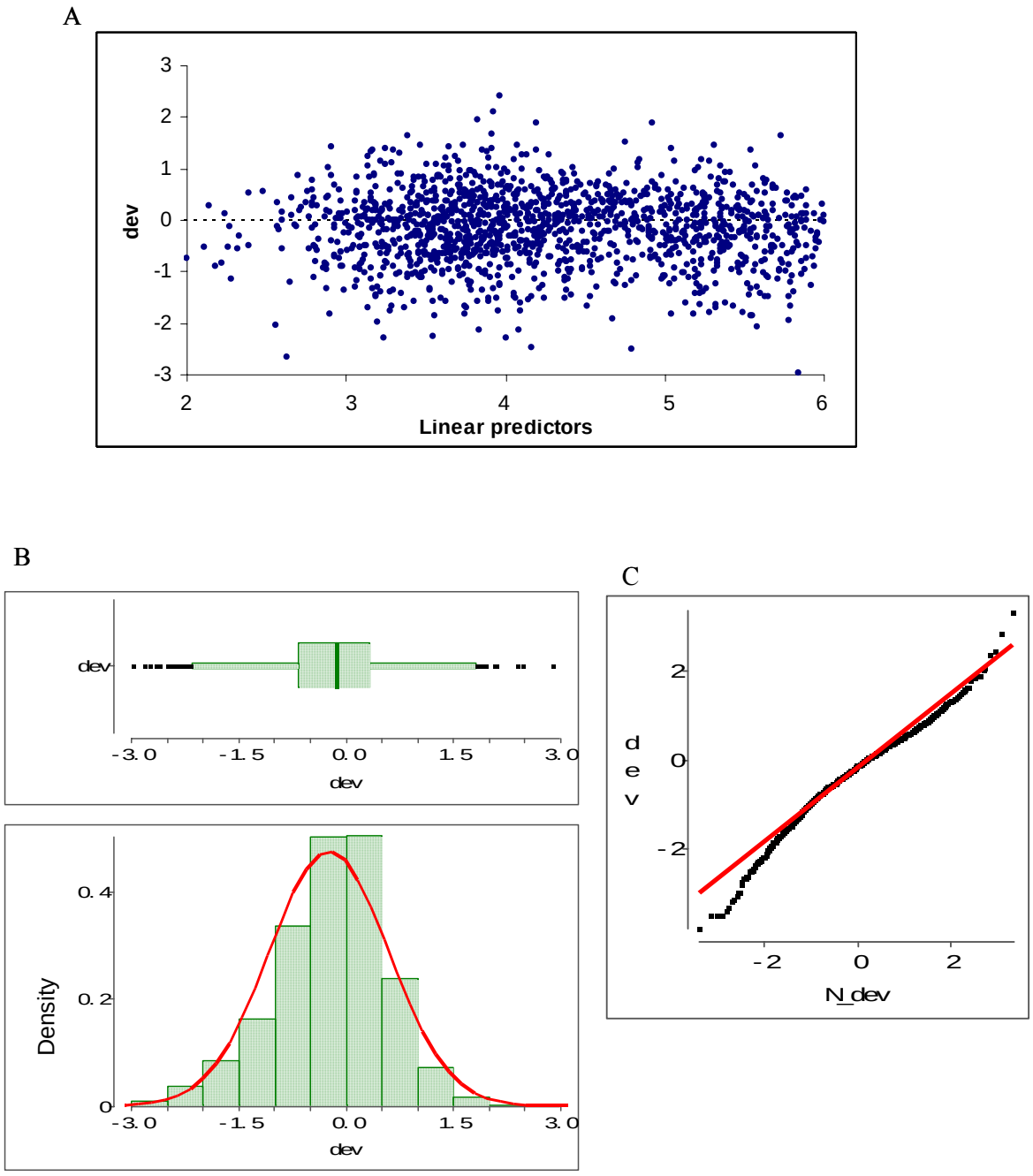



Figure D-4. Diagnostic plots from the generalized linear mixed model fit to longspine thornyhead from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

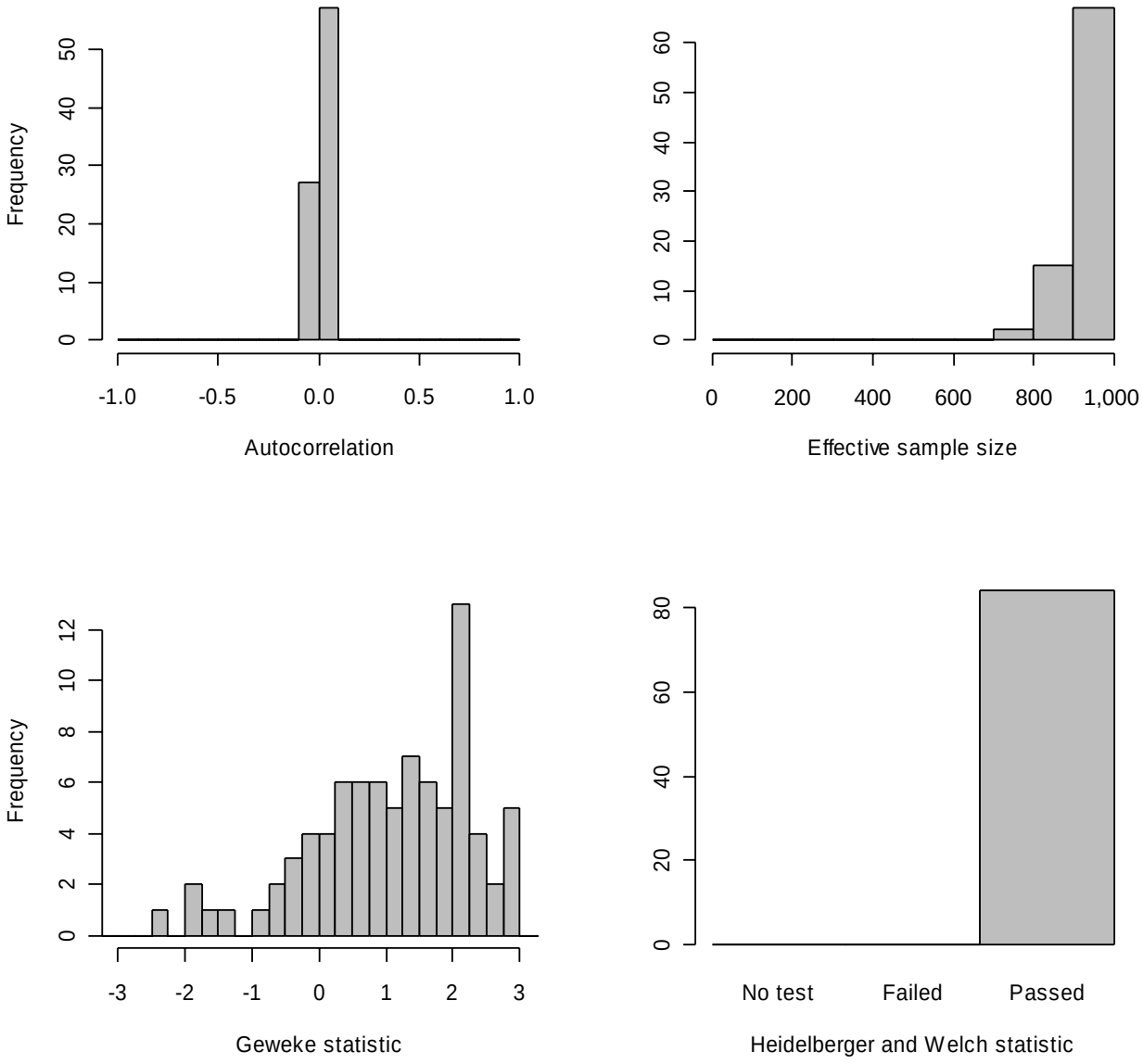
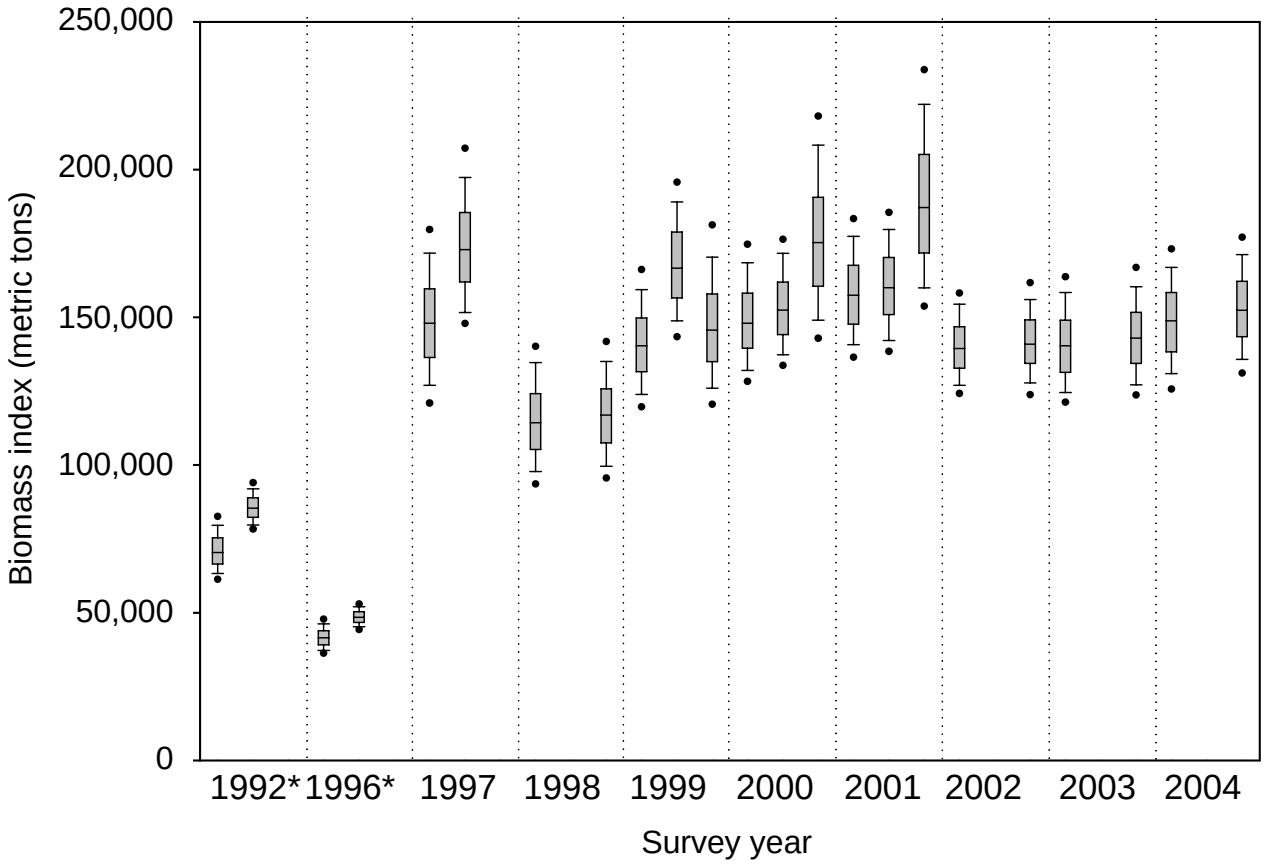



Figure D-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for longspine thornyhead. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure D-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for longspine thornyheads. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix E: Darkblotched Rockfish (*Sebastes crameri*)

This appendix has tables E-1 though E-5 and figures E-1 though E-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for darkblotched rockfish. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table E-1. Basic data and statistics summary for darkblotched rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 |
| **1992*** | 27 | 12 | 36 | 0 | 57 | 34 | 81 | 0 | 37 | 19 | 93 | 1 | 26 | 10 | 40 | 0 | – | – | – | – |
| **1996*** | 29 | 13 | 44 | 0 | 55 | 23 | 76 | 0 | 34 | 12 | 72 | 0 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 5 | 16 | 0 | 20 | 10 | 28 | 0 | 10 | 6 | 20 | 0 | 17 | 5 | 33 | 1 | 11 | 0 | 18 | 0 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 36 | 11 | 55 | 0 | 58 | 30 | 71 | 0 | 39 | 25 | 61 | 0 | 65 | 19 | 82 | 0 | 23 | 0 | 33 | 0 |
| **2000** | 34 | 13 | 47 | 0 | 59 | 25 | 70 | 0 | 37 | 19 | 60 | 0 | 73 | 21 | 94 | 0 | 27 | 2 | 36 | 0 |
| **2001** | 36 | 12 | 50 | 0 | 71 | 22 | 59 | 0 | 38 | 13 | 58 | 0 | 65 | 25 | 99 | 0 | 29 | 4 | 36 | 0 |
| **2002** | 24 | 5 | 24 | 0 | 47 | 13 | 39 | 0 | 30 | 18 | 41 | 0 | 58 | 16 | 61 | 0 | 47 | 3 | 55 | 0 |
| **2003** | 28 | 11 | 44 | 0 | 30 | 16 | 37 | 0 | 36 | 22 | 33 | 0 | 32 | 11 | 24 | 0 | 55 | 4 | 27 | 0 |
| **2004** | 13 | 2 | 14 | 0 | 46 | 28 | 19 | 0 | 14 | 9 | 23 | 0 | 17 | 7 | 21 | 0 | 50 | 8 | 49 | 0 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 18.6 | 0.65 | 0.0 | N/A | 2.6 | 0.44 | 0.0 | N/A | 4.2 | 0.36 | 0.0 | 1.00 | 3.9 | 0.83 | 0.0 | N/A | – | – | – | – |
| **1996*** | 3.3 | 0.72 | 0.0 | N/A | 3.4 | 0.77 | 0.0 | N/A | 0.7 | 0.40 | 0.0 | N/A | – | – | – | – | – | – | – | – |
| **1997** | 1.9 | 0.67 | 0.0 | N/A | 1.1 | 0.48 | 0.0 | N/A | 5.5 | 0.95 | 0.0 | N/A | 0.2 | 0.45 | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 7.0 | 0.49 | 0.0 | N/A | 1.1 | 0.27 | 0.0 | N/A | 3.0 | 0.35 | 0.0 | N/A | 1.3 | 0.70 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| **2000** | 14.1 | 0.80 | 0.0 | N/A | 17.5 | 0.78 | 0.0 | N/A | 1.2 | 0.30 | 0.0 | N/A | 1.8 | 0.75 | 0.0 | N/A | 0.0 | 0.92 | 0.0 | N/A |
| **2001** | 5.9 | 0.41 | 0.0 | N/A | 2.0 | 0.70 | 0.0 | N/A | 1.4 | 0.49 | 0.0 | N/A | 1.0 | 0.52 | 0.0 | N/A | 0.1 | 0.56 | 0.0 | N/A |
| **2002** | 2.3 | 0.82 | 0.0 | N/A | 2.5 | 0.50 | 0.0 | N/A | 10.4 | 0.40 | 0.0 | N/A | 0.9 | 0.42 | 0.0 | N/A | 0.0 | 0.62 | 0.0 | N/A |
| **2003** | 64.8 | 0.67 | 0.0 | N/A | 16.1 | 0.58 | 0.0 | N/A | 7.3 | 0.51 | 0.0 | N/A | 23.4 | 0.92 | 0.0 | N/A | 0.0 | 0.56 | 0.0 | N/A |
| **2004** | 0.7 | 0.68 | 0.0 | N/A | 2.5 | 0.35 | 0.0 | N/A | 9.0 | 0.35 | 0.0 | N/A | 5.6 | 0.70 | 0.0 | N/A | 0.1 | 0.43 | 0.0 | N/A |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 41.8 | 0.63 | N/A | N/A | 4.4 | 0.43 | N/A | N/A | 8.2 | 0.33 | 0.8 | 0.00 | 10.1 | 0.82 | 0.0 | 0.00 | – | – | – | – |
| **1996*** | 7.5 | 0.70 | N/A | N/A | 8.2 | 0.76 | N/A | N/A | 1.9 | 0.34 | N/A | N/A | – | – | – | – | – | – | – | – |
| **1997** | 3.5 | 0.62 | N/A | N/A | 2.3 | 0.43 | N/A | N/A | 9.2 | 0.94 | N/A | N/A | 0.6 | 0.24 | 1.0 | 0.00 | N/A | 0.00 | N/A | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 23.0 | 0.43 | N/A | N/A | 2.2 | 0.23 | N/A | N/A | 4.6 | 0.33 | N/A | N/A | 4.4 | 0.69 | N/A | N/A | N/A | 0.00 | N/A | N/A |
| **2000** | 36.8 | 0.79 | N/A | N/A | 41.5 | 0.78 | N/A | N/A | 2.3 | 0.26 | N/A | N/A | 6.2 | 0.73 | N/A | N/A | 0.2 | 0.85 | N/A | N/A |
| **2001** | 17.7 | 0.34 | N/A | N/A | 6.5 | 0.69 | N/A | N/A | 4.0 | 0.44 | N/A | N/A | 2.5 | 0.50 | N/A | N/A | 0.4 | 0.34 | N/A | N/A |
| **2002** | 13.4 | 0.76 | N/A | N/A | 9.1 | 0.46 | N/A | N/A | 17.4 | 0.37 | N/A | N/A | 3.4 | 0.37 | N/A | N/A | 0.4 | 0.30 | N/A | N/A |
| **2003** | 164.9 | 0.65 | N/A | N/A | 30.2 | 0.57 | N/A | N/A | 12.0 | 0.49 | N/A | N/A | 68.0 | 0.91 | N/A | N/A | 0.5 | 0.31 | N/A | N/A |
| **2004** | 4.3 | 0.10 | N/A | N/A | 4.1 | 0.33 | N/A | N/A | 14.0 | 0.28 | N/A | N/A | 13.5 | 0.66 | N/A | N/A | 0.8 | 0.29 | N/A | N/A |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table E-2. Poststratified data and statistics summary for darkblotched rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| | Vancouver-Columbia | | | | Eureka-Monterey | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| | Total number and number positive tows by year and spatial strata | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1992*** | 24 | 19 | 61 | 27 | 25 | 18 | 38 | 11 |
| **1996*** | 26 | 19 | 58 | 17 | 17 | 9 | 17 | 3 |
| **1997** | 10 | 5 | 19 | 10 | 11 | 8 | 16 | 3 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 31 | 21 | 63 | 20 | 35 | 24 | 69 | 20 |
| **2000** | 35 | 25 | 59 | 13 | 44 | 28 | 66 | 12 |
| **2001** | 24 | 16 | 83 | 18 | 37 | 25 | 67 | 13 |
| **2002** | 19 | 12 | 52 | 6 | 29 | 20 | 59 | 14 |
| **2003** | 24 | 14 | 34 | 13 | 28 | 21 | 40 | 12 |
| **2004** | 26 | 19 | 33 | 11 | 16 | 11 | 15 | 5 |
| | Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 22.4 | 0.60 | 1.7 | 0.55 | 9.9 | 0.38 | 0.2 | 0.36 |
| **1996*** | 4.3 | 0.62 | 2.8 | 0.83 | 1.2 | 0.41 | 0.1 | 0.57 |
| **1997** | 2.8 | 0.52 | 0.6 | 0.31 | 5.2 | 0.91 | 0.1 | 0.55 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 4.8 | 0.40 | 2.6 | 0.66 | 2.4 | 0.34 | 1.5 | 0.58 |
| **2000** | 41.7 | 0.60 | 0.9 | 0.37 | 1.4 | 0.27 | 1.5 | 0.88 |
| **2001** | 7.0 | 0.44 | 2.1 | 0.59 | 2.7 | 0.39 | 0.2 | 0.33 |
| **2002** | 8.6 | 0.42 | 0.2 | 0.62 | 11.2 | 0.38 | 0.6 | 0.47 |
| **2003** | 76.4 | 0.66 | 11.0 | 0.62 | 7.3 | 0.46 | 17.2 | 0.86 |
| **2004** | 2.2 | 0.20 | 2.0 | 0.60 | 10.2 | 0.42 | 3.9 | 0.65 |
| | Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | |
| **1992*** | 28.3 | 0.60 | 4.2 | 0.54 | 13.7 | 0.36 | 0.9 | 0.26 |
| **1996*** | 5.9 | 0.61 | 10.2 | 0.83 | 2.3 | 0.34 | 0.5 | 0.20 |
| **1997** | 5.6 | 0.43 | 1.2 | 0.21 | 7.1 | 0.91 | 0.5 | 0.11 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 7.1 | 0.39 | 8.4 | 0.65 | 3.5 | 0.32 | 5.7 | 0.55 |
| **2000** | 59.1 | 0.59 | 4.2 | 0.29 | 2.3 | 0.24 | 9.1 | 0.87 |
| **2001** | 10.5 | 0.42 | 10.5 | 0.56 | 4.0 | 0.38 | 1.1 | 0.21 |
| **2002** | 13.6 | 0.38 | 1.8 | 0.50 | 16.2 | 0.37 | 3.1 | 0.41 |
| **2003** | 131.0 | 0.65 | 35.6 | 0.59 | 9.7 | 0.45 | 67.2 | 0.85 |
| **2004** | 3.0 | 0.15 | 6.0 | 0.56 | 14.8 | 0.39 | 11.8 | 0.57 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table E-3. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of darkblotched rockfish from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| | Vancouver-Columbia | | | | Eureka-Monterey | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.76 | 0.07 | 0.32 | 0.19 | 0.73 | 0.08 | 0.30 | 0.21 |
| **1996*** | 0.59 | 0.12 | 0.19 | 0.25 | 0.57 | 0.13 | 0.17 | 0.28 |
| **1997** | 0.70 | 0.11 | 0.26 | 0.27 | 0.67 | 0.12 | 0.23 | 0.28 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.73 | 0.07 | 0.29 | 0.17 | 0.70 | 0.08 | 0.26 | 0.19 |
| **2000** | 0.67 | 0.08 | 0.24 | 0.19 | 0.64 | 0.08 | 0.22 | 0.19 |
| **2001** | 0.67 | 0.08 | 0.24 | 0.18 | 0.64 | 0.09 | 0.21 | 0.19 |
| **2002** | 0.67 | 0.09 | 0.24 | 0.20 | 0.64 | 0.09 | 0.22 | 0.21 |
| **2003** | 0.75 | 0.07 | 0.31 | 0.19 | 0.72 | 0.08 | 0.29 | 0.20 |
| **2004** | 0.76 | 0.07 | 0.33 | 0.21 | 0.73 | 0.08 | 0.30 | 0.22 |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 3.3 | 0.54 | 1.8 | 0.46 | 4.3 | 0.55 | 0.8 | 0.71 |
| **1996*** | 2.1 | 0.55 | 1.8 | 0.52 | 1.7 | 0.76 | 0.6 | 2.55 |
| **1997** | 4.7 | 1.23 | 1.3 | 0.71 | 1.2 | 0.82 | 0.6 | 1.91 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 2.0 | 0.45 | 2.1 | 0.46 | 1.4 | 0.42 | 1.3 | 0.45 |
| **2000** | 4.5 | 0.40 | 2.8 | 0.55 | 0.8 | 0.37 | 1.6 | 0.57 |
| **2001** | 2.3 | 0.52 | 2.1 | 0.48 | 1.1 | 0.39 | 0.9 | 0.55 |
| **2002** | 3.3 | 0.61 | 1.2 | 1.16 | 3.6 | 0.44 | 1.4 | 0.52 |
| **2003** | 19.2 | 0.52 | 6.7 | 0.56 | 2.4 | 0.45 | 2.4 | 0.63 |
| **2004** | 2.3 | 0.49 | 2.5 | 0.65 | 4.7 | 0.59 | 3.0 | 1.18 |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 480 | 0.54 | 176 | 0.52 | 313 | 0.56 | 53 | 0.80 |
| **1996*** | 245 | 0.58 | 101 | 0.59 | 93 | 0.81 | 22 | 2.57 |
| **1997** | 629 | 1.26 | 101 | 0.80 | 78 | 0.84 | 31 | 2.05 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 289 | 0.45 | 184 | 0.52 | 99 | 0.43 | 74 | 0.50 |
| **2000** | 589 | 0.41 | 202 | 0.59 | 52 | 0.37 | 71 | 0.61 |
| **2001** | 298 | 0.53 | 149 | 0.53 | 69 | 0.41 | 41 | 0.62 |
| **2002** | 433 | 0.62 | 89 | 1.18 | 227 | 0.46 | 65 | 0.62 |
| **2003** | 2,763 | 0.53 | 637 | 0.61 | 172 | 0.46 | 145 | 0.74 |
| **2004** | 331 | 0.50 | 256 | 0.69 | 339 | 0.62 | 192 | 1.24 |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998, the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table E-4. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of darkblotched rockfish from the Delta-GLM applied to NWFSC slope surveys.

| | Vancouver-Columbia | | | | Eureka-Monterey | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| | Predicted proportion positive based on Delta-GLM model | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.71 | 0.07 | 0.26 | 0.18 | 0.73 | 0.07 | 0.28 | 0.17 |
| **2000** | 0.65 | 0.08 | 0.21 | 0.19 | 0.67 | 0.08 | 0.22 | 0.18 |
| **2001** | 0.66 | 0.09 | 0.22 | 0.19 | 0.67 | 0.08 | 0.23 | 0.19 |
| **2002** | 0.66 | 0.09 | 0.22 | 0.20 | 0.67 | 0.09 | 0.23 | 0.20 |
| **2003** | 0.74 | 0.07 | 0.29 | 0.19 | 0.75 | 0.07 | 0.30 | 0.19 |
| **2004** | 0.76 | 0.07 | 0.31 | 0.20 | 0.77 | 0.07 | 0.32 | 0.22 |
| | Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 2.1 | 0.42 | 2.0 | 0.46 | 1.5 | 0.40 | 1.3 | 0.44 |
| **2000** | 4.4 | 0.41 | 2.9 | 0.63 | 0.8 | 0.40 | 1.6 | 0.62 |
| **2001** | 2.4 | 0.50 | 2.2 | 0.46 | 1.1 | 0.39 | 0.9 | 0.54 |
| **2002** | 3.4 | 0.61 | 1.3 | 1.14 | 3.7 | 0.45 | 1.4 | 0.50 |
| **2003** | 19.5 | 0.54 | 6.6 | 0.53 | 2.4 | 0.42 | 2.5 | 0.58 |
| **2004** | 2.3 | 0.47 | 2.4 | 0.68 | 4.7 | 0.68 | 3.2 | 1.06 |
| | Predicted biomass (mt) by strata | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 287 | 0.42 | 165 | 0.50 | 104 | 0.41 | 75 | 0.50 |
| **2000** | 553 | 0.43 | 185 | 0.68 | 54 | 0.42 | 75 | 0.66 |
| **2001** | 298 | 0.52 | 142 | 0.53 | 73 | 0.41 | 45 | 0.62 |
| **2002** | 424 | 0.65 | 88 | 1.19 | 242 | 0.46 | 68 | 0.57 |
| **2003** | 2,749 | 0.56 | 588 | 0.60 | 178 | 0.43 | 156 | 0.62 |
| **2004** | 331 | 0.49 | 225 | 0.77 | 359 | 0.69 | 214 | 1.16 |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table E-5. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of darkblotched rockfish from the Delta-GLM applied to AFSC slope surveys.

| | Vancouver-Columbia | | | | Eureka-Monterey | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| | Predicted proportion positive based on Delta-GLM model | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.73 | 0.07 | 0.34 | 0.14 | 0.63 | 0.10 | 0.24 | 0.18 |
| **1996*** | 0.56 | 0.11 | 0.19 | 0.18 | 0.44 | 0.15 | 0.13 | 0.24 |
| **1997** | 0.67 | 0.11 | 0.28 | 0.22 | 0.56 | 0.15 | 0.19 | 0.27 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.72 | 0.09 | 0.32 | 0.20 | 0.62 | 0.13 | 0.23 | 0.24 |
| **2000** | 0.66 | 0.11 | 0.27 | 0.24 | 0.55 | 0.14 | 0.19 | 0.27 |
| **2001** | 0.57 | 0.15 | 0.20 | 0.26 | 0.45 | 0.19 | 0.14 | 0.29 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| | Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 2.4 | 0.40 | 1.3 | 0.32 | 3.3 | 0.41 | 0.6 | 0.56 |
| **1996*** | 1.6 | 0.39 | 1.4 | 0.41 | 1.3 | 0.65 | 0.5 | 1.93 |
| **1997** | 3.4 | 1.06 | 1.0 | 0.58 | 0.9 | 0.73 | 0.4 | 1.89 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 1.2 | 0.79 | 1.4 | 0.52 | 0.7 | 0.74 | 0.8 | 0.92 |
| **2000** | 2.3 | 0.89 | 1.9 | 0.72 | 0.3 | 0.66 | 0.9 | 1.21 |
| **2001** | 5.0 | 1.10 | 0.8 | 1.25 | 1.3 | 0.78 | 1.1 | 1.26 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| | Predicted biomass (mt) by strata | | | | | | | |
| **1992*** | 341 | 0.41 | 138 | 0.35 | 200 | 0.43 | 31 | 0.62 |
| **1996*** | 175 | 0.40 | 80 | 0.46 | 55 | 0.71 | 12 | 2.05 |
| **1997** | 433 | 1.10 | 79 | 0.68 | 49 | 0.78 | 18 | 2.50 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 160 | 0.82 | 138 | 0.59 | 43 | 0.77 | 39 | 1.01 |
| **2000** | 293 | 0.89 | 152 | 0.82 | 14 | 0.70 | 35 | 1.47 |
| **2001** | 559 | 1.16 | 50 | 1.42 | 56 | 0.88 | 32 | 1.44 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

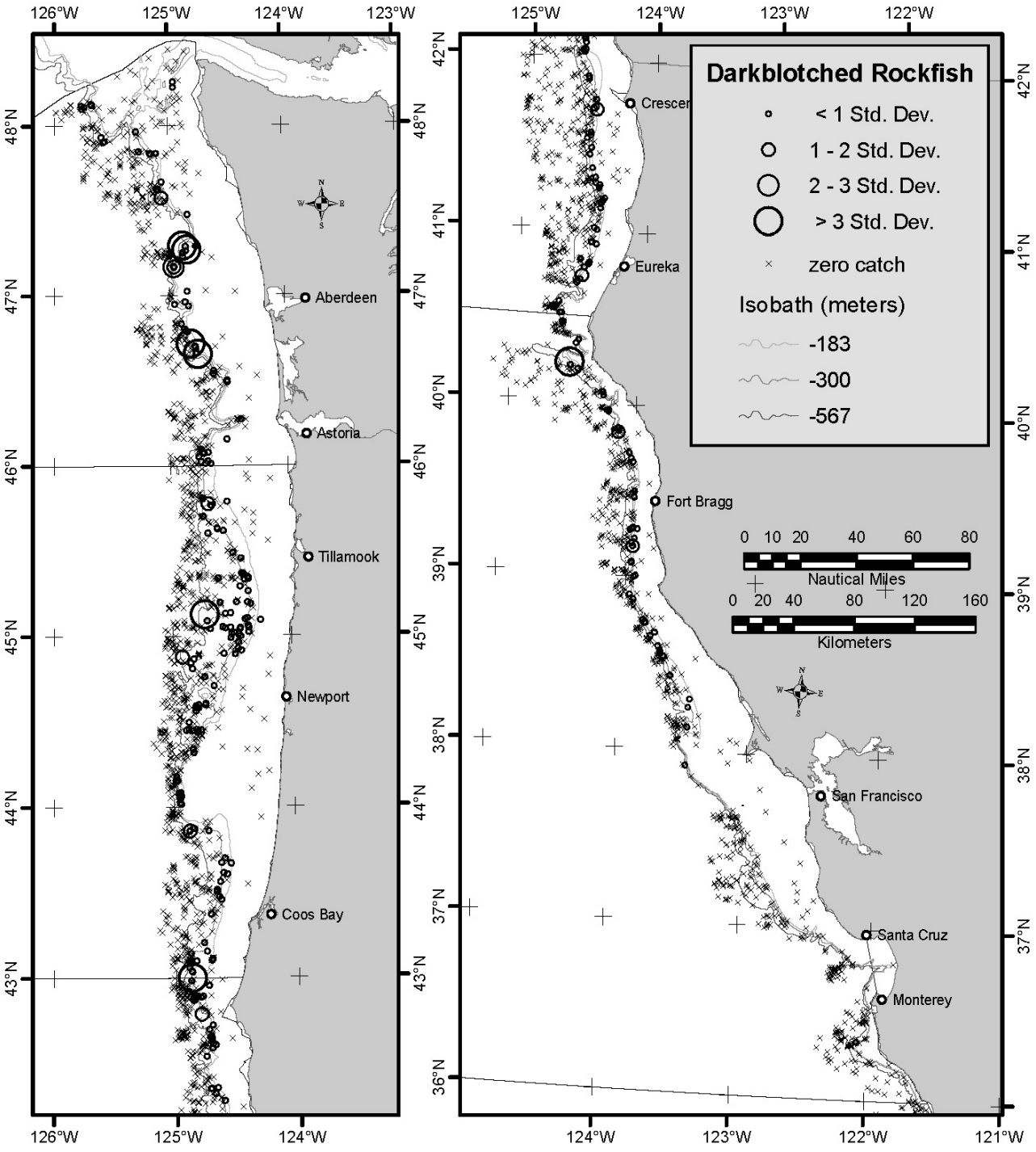



Figure E-1. Distribution of darkblotched rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

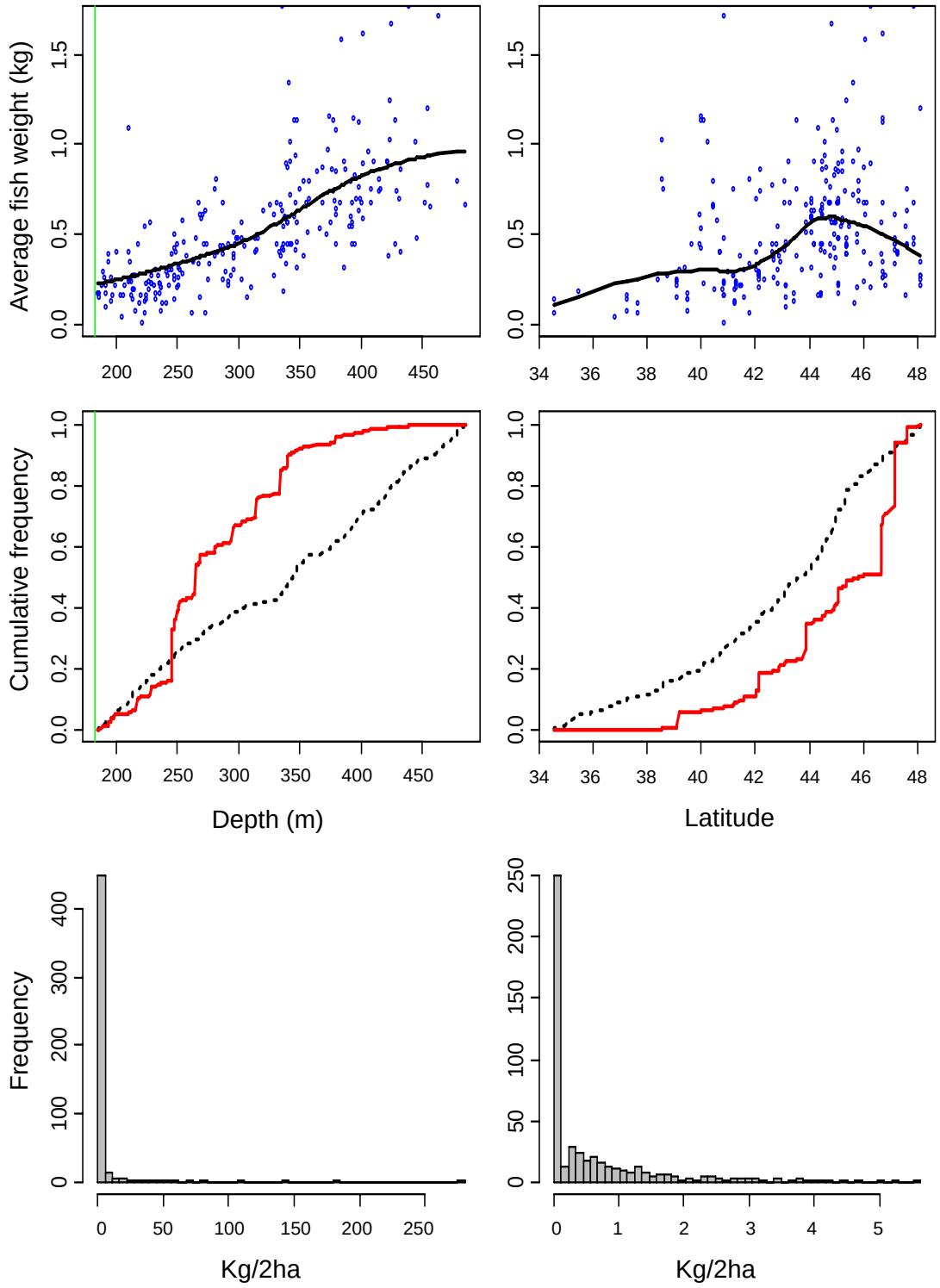



Figure E-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of darkblotched rockfish caught in the AFSC slope surveys.

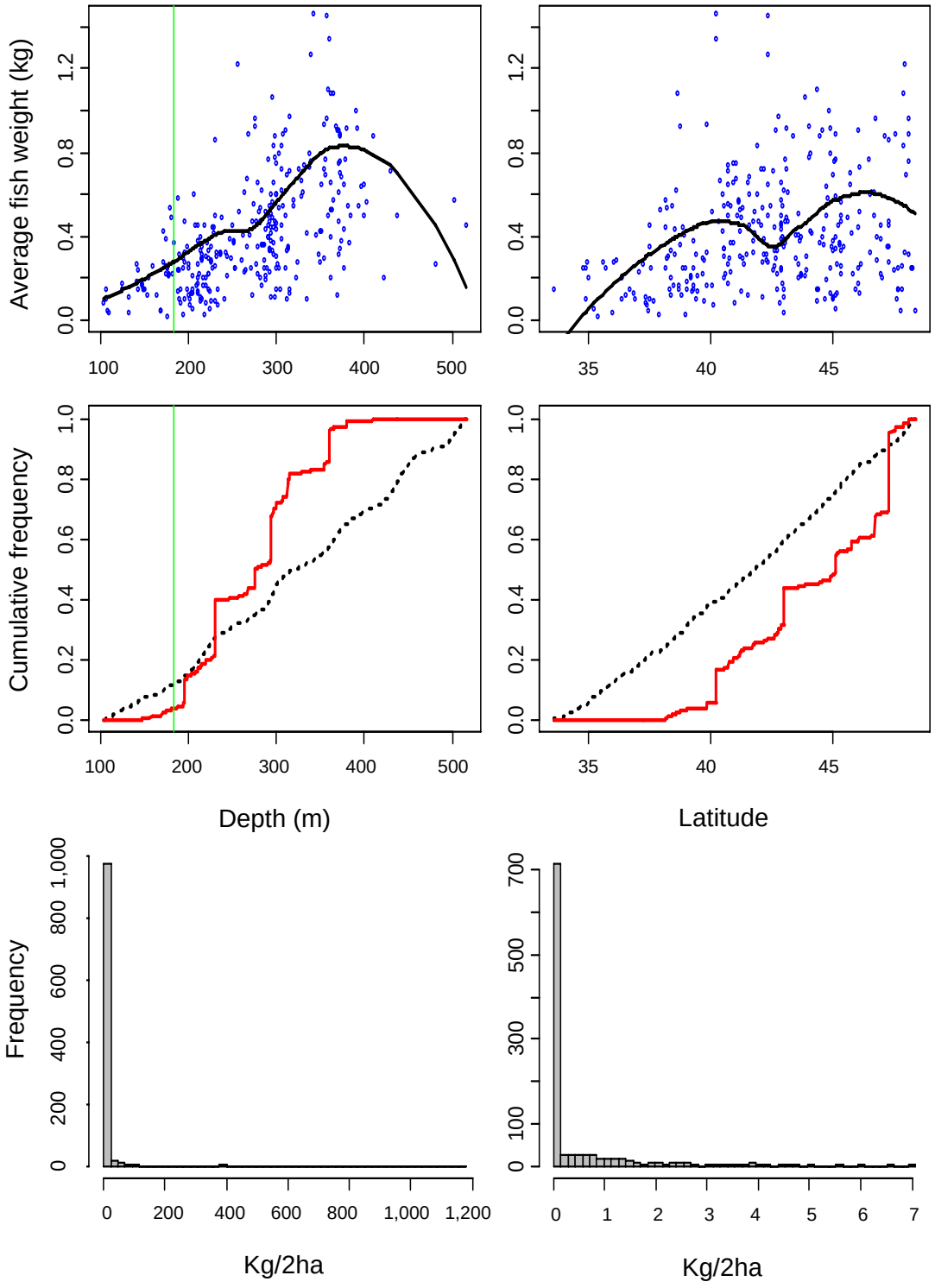



Figure E-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of darkblotched rockfish caught in the NWFSC slope surveys.

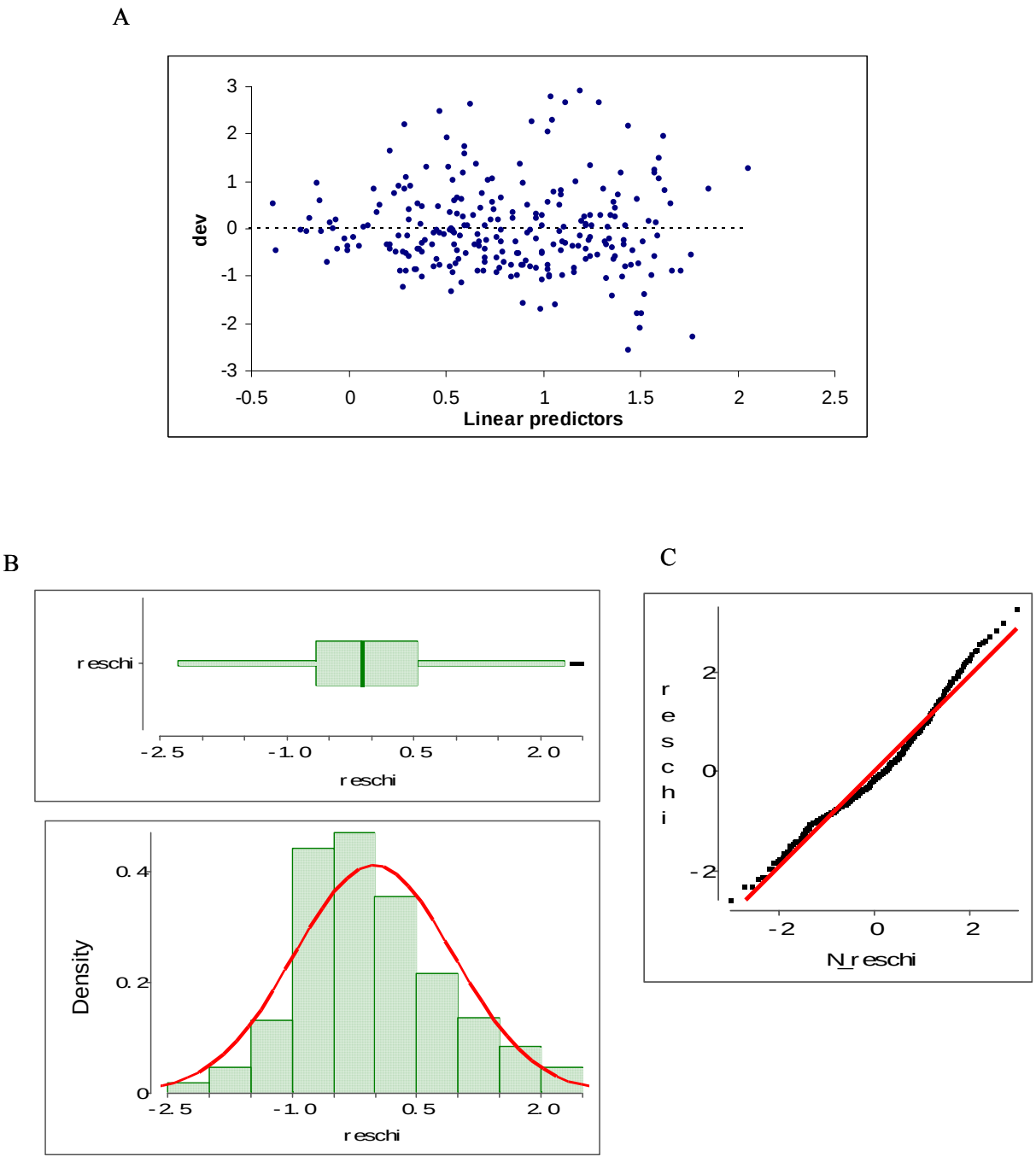



Figure E-4. Diagnostic plots from the generalized linear mixed model fit to darkblotched rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

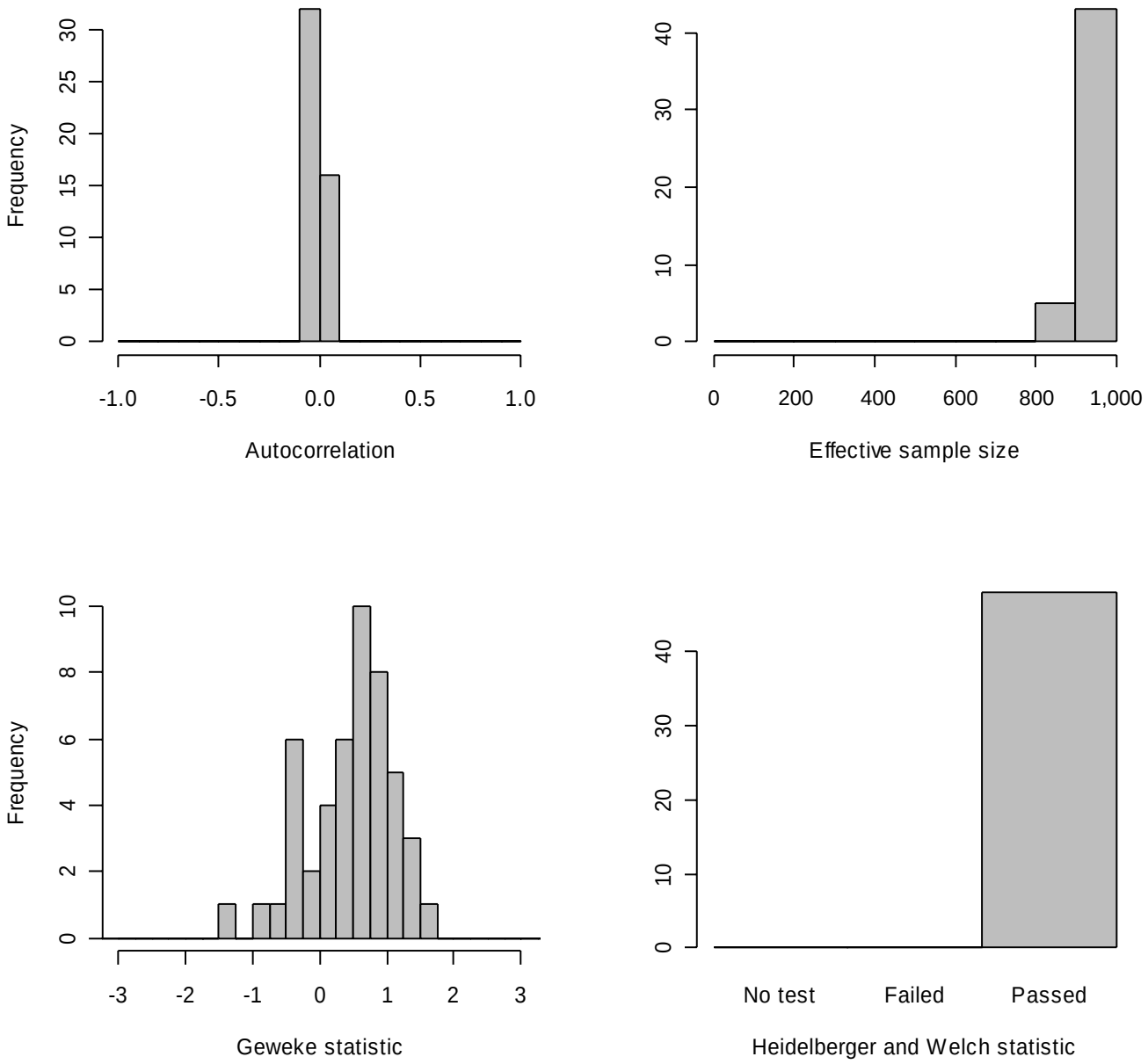
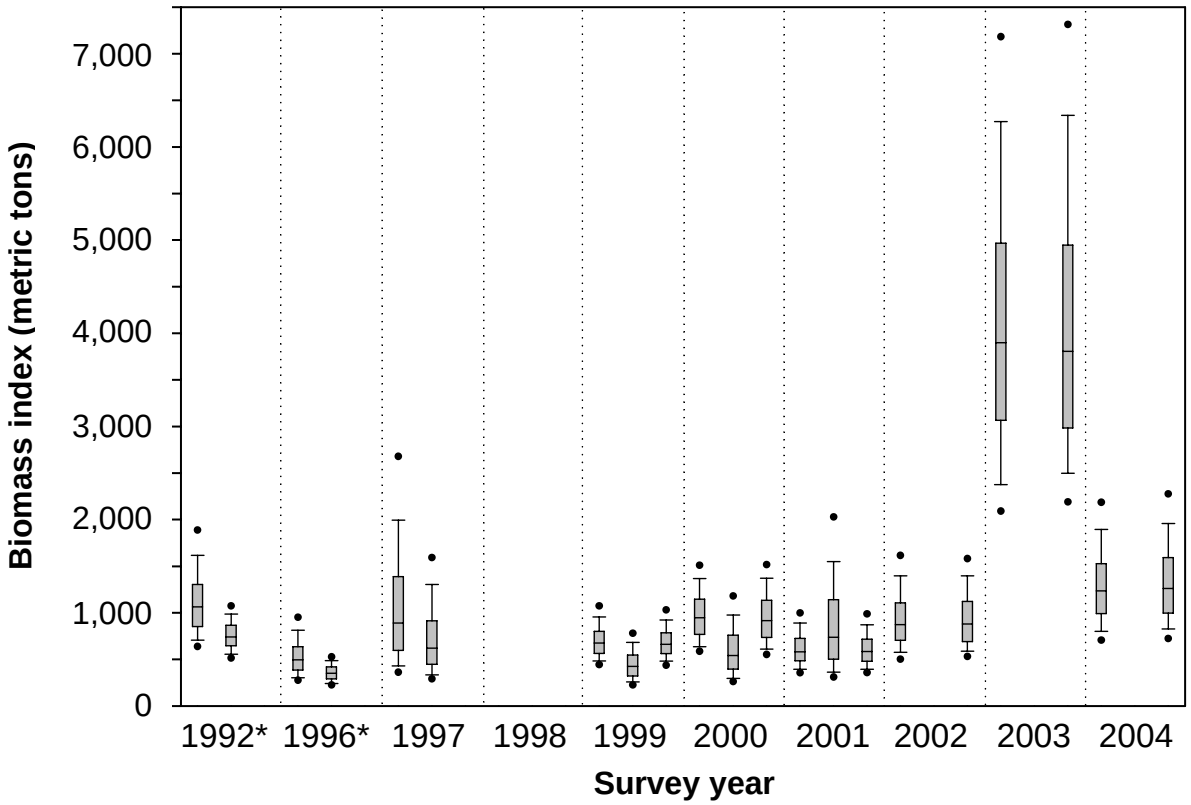



Figure E-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for darkblotched rockfish. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure E-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for darkblotched rockfish. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix F: Pacific Ocean Perch (*Sebastes alutus*)

This appendix has tables F-1 though F-5 and figures F-1 though F-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for Pacific ocean perch. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table F-1. Basic data and statistics summary for Pacific ocean perch caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 |
| **1992*** | 27 | 19 | 36 | 0 | 57 | 37 | 81 | 0 | 37 | 17 | 93 | 1 | 26 | 0 | 40 | 0 | – | – | – | – |
| **1996*** | 29 | 21 | 44 | 0 | 55 | 27 | 76 | 0 | 34 | 6 | 72 | 0 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 7 | 16 | 0 | 20 | 13 | 28 | 0 | 10 | 0 | 20 | 0 | 17 | 1 | 33 | 0 | 11 | 0 | 18 | 0 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 36 | 24 | 55 | 1 | 58 | 21 | 71 | 0 | 39 | 10 | 61 | 0 | 65 | 4 | 82 | 0 | 23 | 0 | 33 | 0 |
| **2000** | 35 | 22 | 47 | 0 | 59 | 19 | 70 | 0 | 37 | 6 | 60 | 0 | 73 | 1 | 94 | 0 | 27 | 0 | 36 | 0 |
| **2001** | 36 | 22 | 50 | 0 | 71 | 17 | 59 | 0 | 38 | 6 | 58 | 1 | 65 | 1 | 99 | 0 | 29 | 0 | 36 | 0 |
| **2002** | 24 | 12 | 24 | 0 | 47 | 7 | 39 | 0 | 30 | 4 | 41 | 0 | 58 | 1 | 61 | 0 | 47 | 0 | 55 | 0 |
| **2003** | 28 | 18 | 44 | 0 | 30 | 13 | 37 | 0 | 36 | 6 | 33 | 0 | 32 | 2 | 24 | 0 | 55 | 0 | 27 | 0 |
| **2004** | 13 | 4 | 14 | 0 | 46 | 24 | 19 | 0 | 14 | 2 | 23 | 0 | 17 | 0 | 21 | 0 | 50 | 0 | 49 | 0 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 28.9 | 0.50 | 0.0 | N/A | 2.7 | 0.33 | 0.0 | N/A | 0.4 | 0.26 | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A | – | – | – | – |
| **1996*** | 19.2 | 0.34 | 0.0 | N/A | 1.1 | 0.34 | 0.0 | N/A | 0.1 | 0.60 | 0.0 | N/A | – | – | – | – | – | – | – | – |
| **1997** | 7.3 | 0.61 | 0.0 | N/A | 1.2 | 0.33 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 15.0 | 0.38 | 0.0 | 1.00 | 7.9 | 0.66 | 0.0 | N/A | 0.2 | 0.38 | 0.0 | N/A | 0.0 | 0.53 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| **2000** | 13.8 | 0.46 | 0.0 | N/A | 1.6 | 0.59 | 0.0 | N/A | 0.1 | 0.46 | 0.0 | N/A | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| **2001** | 18.7 | 0.39 | 0.0 | N/A | 7.5 | 0.90 | 0.0 | N/A | 0.1 | 0.56 | 0.0 | 1.00 | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| **2002** | 12.2 | 0.45 | 0.0 | N/A | 0.2 | 0.40 | 0.0 | N/A | 1.4 | 0.94 | 0.0 | N/A | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| **2003** | 95.0 | 0.45 | 0.0 | N/A | 20.8 | 0.65 | 0.0 | N/A | 0.2 | 0.47 | 0.0 | N/A | 0.1 | 0.87 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| **2004** | 36.1 | 1.00 | 0.0 | N/A | 5.3 | 0.45 | 0.0 | N/A | 0.1 | 0.20 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 41.0 | 0.49 | N/A | N/A | 4.2 | 0.32 | N/A | N/A | 0.8 | 0.18 | 0.3 | 0.00 | N/A | N/A | N/A | N/A | – | – | – | – |
| **1996*** | 26.5 | 0.32 | N/A | N/A | 2.3 | 0.32 | N/A | N/A | 0.7 | 0.50 | N/A | N/A | – | – | – | – | – | – | – | – |
| **1997** | 9.4 | 0.60 | N/A | N/A | 1.8 | 0.29 | N/A | N/A | 0.0 | N/A | N/A | N/A | 0.7 | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 22.4 | 0.36 | 2.1 | N/A | 21.8 | 0.64 | N/A | N/A | 0.8 | 0.27 | N/A | N/A | 0.5 | 0.25 | N/A | N/A | N/A | N/A | N/A | N/A |
| **2000** | 22.0 | 0.44 | N/A | N/A | 4.9 | 0.56 | N/A | N/A | 0.8 | 0.27 | N/A | N/A | 0.0 | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A |
| **2001** | 30.5 | 0.37 | N/A | N/A | 31.5 | 0.90 | N/A | N/A | 0.6 | 0.45 | 0.7 | N/A | 0.0 | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A |
| **2002** | 25.4 | 0.40 | N/A | N/A | 1.0 | 0.19 | N/A | N/A | 10.6 | 0.93 | N/A | N/A | 0.9 | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A |
| **2003** | 147.7 | 0.43 | N/A | N/A | 48.0 | 0.63 | N/A | N/A | 1.4 | 0.30 | N/A | N/A | 2.2 | 0.73 | N/A | N/A | N/A | N/A | N/A | N/A |
| **2004** | 117.2 | 1.00 | N/A | N/A | 10.2 | 0.43 | N/A | N/A | 1.4 | 0.46 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table F-2. Poststratified data and statistics summary for Pacific ocean perch caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| | Vancouver | | | | Columbia-Eureka | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| | Total number and number positive tows by year and spatial strata | | | | | | | |
| | **Total# tows** | **# tows> 0** | **Total# tows** | **# tows > 0** | **Total# tows** | **# tows> 0** | **Total# tows** | **# tows > 0** |
| **1992*** | 10 | 10 | 19 | 9 | 31 | 20 | 71 | 34 |
| **1996*** | 12 | 12 | 18 | 9 | 31 | 13 | 63 | 20 |
| **1997** | 4 | 4 | 5 | 3 | 11 | 3 | 23 | 11 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 8 | 6 | 28 | 18 | 39 | 15 | 64 | 16 |
| **2000** | 12 | 10 | 25 | 12 | 37 | 10 | 64 | 15 |
| **2001** | 9 | 8 | 30 | 14 | 27 | 10 | 92 | 13 |
| **2002** | 4 | 4 | 21 | 8 | 27 | 5 | 55 | 6 |
| **2003** | 16 | 15 | 13 | 3 | 25 | 7 | 54 | 12 |
| **2004** | 7 | 3 | 6 | 3 | 26 | 12 | 34 | 14 |
| | Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 74.5 | 0.48 | 1.8 | 0.35 | 0.8 | 0.31 | 2.0 | 0.36 |
| **1996*** | 44.2 | 0.29 | 1.4 | 0.46 | 0.3 | 0.34 | 0.9 | 0.37 |
| **1997** | 16.0 | 0.55 | 0.4 | 0.53 | 0.7 | 0.75 | 0.7 | 0.41 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 25.5 | 0.53 | 11.9 | 0.52 | 11.1 | 0.69 | 0.5 | 0.43 |
| **2000** | 24.4 | 0.66 | 7.7 | 0.57 | 1.7 | 0.88 | 0.6 | 0.39 |
| **2001** | 32.7 | 0.36 | 12.6 | 0.62 | 18.2 | 0.99 | 0.5 | 0.68 |
| **2002** | 30.4 | 0.58 | 7.9 | 0.65 | 1.6 | 0.92 | 0.1 | 0.42 |
| **2003** | 162.3 | 0.44 | 4.7 | 0.95 | 7.5 | 0.78 | 8.3 | 0.86 |
| **2004** | 66.9 | 0.99 | 0.1 | 1.00 | 3.6 | 0.87 | 4.6 | 0.50 |
| | Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | |
| **1992*** | 74.5 | 0.48 | 3.8 | 0.26 | 1.3 | 0.28 | 4.2 | 0.34 |
| **1996*** | 44.2 | 0.29 | 2.8 | 0.40 | 0.6 | 0.27 | 2.9 | 0.33 |
| **1997** | 16.0 | 0.55 | 0.6 | 0.37 | 3.6 | 0.47 | 1.4 | 0.35 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 34.0 | 0.49 | 18.6 | 0.51 | 28.9 | 0.67 | 2.0 | 0.38 |
| **2000** | 29.2 | 0.65 | 16.0 | 0.54 | 6.0 | 0.87 | 2.5 | 0.32 |
| **2001** | 36.8 | 0.34 | 27.0 | 0.60 | 49.0 | 0.98 | 3.8 | 0.65 |
| **2002** | 30.4 | 0.58 | 22.6 | 0.60 | 8.7 | 0.91 | 1.1 | 0.19 |
| **2003** | 173.2 | 0.43 | 20.5 | 0.93 | 26.7 | 0.75 | 37.2 | 0.85 |
| **2004** | 156.2 | 1.00 | 0.4 | 1.00 | 7.7 | 0.87 | 11.0 | 0.45 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table F-3. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of Pacific ocean perch from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| | Vancouver | | | | Columbia-Eureka | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| | Predicted proportion positive based on Delta-GLM model | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.82 | 0.07 | 0.68 | 0.11 | 0.54 | 0.15 | 0.36 | 0.21 |
| **1996*** | 0.66 | 0.12 | 0.48 | 0.18 | 0.33 | 0.22 | 0.20 | 0.27 |
| **1997** | 0.74 | 0.12 | 0.58 | 0.18 | 0.43 | 0.24 | 0.26 | 0.32 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.71 | 0.09 | 0.55 | 0.13 | 0.40 | 0.17 | 0.24 | 0.21 |
| **2000** | 0.70 | 0.10 | 0.52 | 0.14 | 0.37 | 0.19 | 0.22 | 0.23 |
| **2001** | 0.69 | 0.10 | 0.51 | 0.14 | 0.36 | 0.18 | 0.21 | 0.23 |
| **2002** | 0.58 | 0.14 | 0.40 | 0.20 | 0.26 | 0.25 | 0.14 | 0.29 |
| **2003** | 0.69 | 0.10 | 0.51 | 0.16 | 0.37 | 0.20 | 0.22 | 0.25 |
| **2004** | 0.74 | 0.11 | 0.57 | 0.16 | 0.42 | 0.20 | 0.26 | 0.27 |
| | Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 28.9 | 0.80 | 2.5 | 0.92 | 0.8 | 0.64 | 1.1 | 0.55 |
| **1996*** | 17.6 | 0.78 | 1.9 | 0.90 | 0.4 | 0.80 | 1.3 | 0.65 |
| **1997** | 5.4 | 1.97 | 0.5 | 2.63 | 3.3 | 5.76 | 1.0 | 0.87 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 11.6 | 1.13 | 3.9 | 0.63 | 1.4 | 0.73 | 1.0 | 0.66 |
| **2000** | 4.0 | 0.82 | 3.3 | 0.74 | 0.7 | 0.83 | 1.2 | 0.64 |
| **2001** | 15.2 | 0.90 | 2.3 | 0.66 | 0.8 | 0.89 | 1.0 | 0.75 |
| **2002** | 3.6 | 1.90 | 5.9 | 1.16 | 1.4 | 1.33 | 0.9 | 1.25 |
| **2003** | 16.0 | 0.63 | 4.2 | 2.81 | 2.1 | 1.17 | 3.0 | 0.69 |
| **2004** | 11.2 | 3.40 | 0.6 | 19.31 | 1.1 | 0.90 | 3.1 | 0.80 |
| | Predicted biomass (mt) by strata | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 1,684.8 | 0.81 | 123.4 | 0.94 | 66.8 | 0.69 | 123.9 | 0.63 |
| **1996*** | 832.6 | 0.80 | 65.1 | 0.91 | 22.8 | 0.89 | 83.6 | 0.75 |
| **1997** | 284.5 | 1.99 | 23.0 | 2.43 | 228.3 | 6.61 | 82.7 | 1.10 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 590.0 | 1.17 | 152.0 | 0.65 | 89.7 | 0.82 | 77.2 | 0.70 |
| **2000** | 197.0 | 0.85 | 124.8 | 0.77 | 44.7 | 0.87 | 79.9 | 0.76 |
| **2001** | 753.1 | 0.91 | 85.5 | 0.66 | 44.7 | 0.91 | 69.2 | 0.80 |
| **2002** | 150.7 | 1.84 | 167.8 | 1.23 | 59.0 | 1.47 | 42.5 | 1.40 |
| **2003** | 794.1 | 0.65 | 150.1 | 2.97 | 125.4 | 1.24 | 203.1 | 0.76 |
| **2004** | 579.0 | 3.69 | 23.5 | 21.32 | 71.6 | 0.94 | 255.6 | 0.86 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table F-4. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of Pacific ocean perch from the Delta-GLM applied to NWFSC slope surveys.

| | Vancouver | | | | Columbia-Eureka | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.73 | 0.09 | 0.56 | 0.13 | 0.39 | 0.18 | 0.23 | 0.22 |
| **2000** | 0.72 | 0.09 | 0.53 | 0.14 | 0.37 | 0.19 | 0.21 | 0.24 |
| **2001** | 0.71 | 0.10 | 0.53 | 0.14 | 0.36 | 0.19 | 0.20 | 0.22 |
| **2002** | 0.59 | 0.15 | 0.40 | 0.21 | 0.25 | 0.26 | 0.13 | 0.30 |
| **2003** | 0.70 | 0.10 | 0.52 | 0.16 | 0.36 | 0.21 | 0.20 | 0.27 |
| **2004** | 0.75 | 0.10 | 0.58 | 0.15 | 0.42 | 0.21 | 0.25 | 0.26 |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 11.55 | 1.46 | 3.80 | 0.69 | 1.4 | 0.80 | 1.0 | 0.68 |
| **2000** | 3.71 | 1.10 | 3.39 | 0.90 | 0.7 | 0.98 | 1.1 | 0.70 |
| **2001** | 16.06 | 1.17 | 2.30 | 0.77 | 0.8 | 1.06 | 1.0 | 0.85 |
| **2002** | 3.44 | 2.06 | 6.45 | 1.11 | 1.4 | 1.52 | 0.9 | 1.38 |
| **2003** | 16.62 | 0.79 | 4.19 | 4.45 | 2.2 | 1.35 | 3.1 | 0.79 |
| **2004** | 10.94 | 3.29 | 0.45 | 46.19 | 1.1 | 0.98 | 3.0 | 0.80 |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 617.0 | 1.46 | 152.9 | 0.72 | 88.4 | 0.90 | 73.6 | 0.77 |
| **2000** | 195.5 | 1.10 | 129.5 | 0.92 | 44.6 | 1.00 | 75.0 | 0.82 |
| **2001** | 831.4 | 1.16 | 86.0 | 0.80 | 44.3 | 1.19 | 65.7 | 0.95 |
| **2002** | 146.7 | 2.06 | 181.5 | 1.18 | 59.4 | 1.63 | 40.1 | 1.52 |
| **2003** | 824.6 | 0.81 | 159.5 | 4.13 | 128.9 | 1.49 | 198.7 | 0.93 |
| **2004** | 584.1 | 3.30 | 18.9 | 40.44 | 71.0 | 1.07 | 238.3 | 0.91 |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table F-5. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of Pacific ocean perch from the Delta-GLM applied to AFSC slope surveys.

| | Vancouver | | | | Columbia-Eureka | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.79 | 0.07 | 0.66 | 0.10 | 0.56 | 0.11 | 0.39 | 0.13 |
| **1996*** | 0.62 | 0.11 | 0.46 | 0.16 | 0.36 | 0.16 | 0.22 | 0.18 |
| **1997** | 0.71 | 0.12 | 0.55 | 0.17 | 0.45 | 0.19 | 0.29 | 0.25 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.61 | 0.15 | 0.44 | 0.20 | 0.34 | 0.23 | 0.21 | 0.27 |
| **2000** | 0.66 | 0.14 | 0.50 | 0.18 | 0.40 | 0.22 | 0.25 | 0.25 |
| **2001** | 0.76 | 0.10 | 0.62 | 0.15 | 0.52 | 0.17 | 0.35 | 0.21 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2 Ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 27.1 | 0.62 | 2.4 | 0.65 | 0.7 | 0.42 | 1.0 | 0.29 |
| **1996*** | 17.1 | 0.56 | 1.8 | 0.67 | 0.4 | 0.53 | 1.3 | 0.39 |
| **1997** | 5.0 | 1.61 | 0.5 | 2.05 | 3.1 | 3.19 | 0.9 | 0.60 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 36.5 | 3.65 | 5.5 | 1.11 | 1.8 | 1.22 | 1.0 | 0.70 |
| **2000** | 1.3 | 1.34 | 3.5 | 1.40 | 1.0 | 1.88 | 1.2 | 0.76 |
| **2001** | 9.4 | 1.37 | 0.6 | 1.52 | 1.4 | 0.91 | 0.8 | 0.65 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 1,536.0 | 0.64 | 115.0 | 0.67 | 66.4 | 0.45 | 130.4 | 0.32 |
| **1996*** | 769.1 | 0.58 | 58.0 | 0.70 | 23.0 | 0.57 | 92.8 | 0.43 |
| **1997** | 249.4 | 1.56 | 21.2 | 2.21 | 219.3 | 3.31 | 85.8 | 0.67 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 1,564.0 | 3.71 | 167.4 | 1.21 | 98.5 | 1.35 | 67.1 | 0.74 |
| **2000** | 61.6 | 1.36 | 122.9 | 1.59 | 60.4 | 2.17 | 99.2 | 0.81 |
| **2001** | 503.6 | 1.40 | 24.9 | 1.62 | 112.0 | 0.98 | 89.8 | 0.75 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

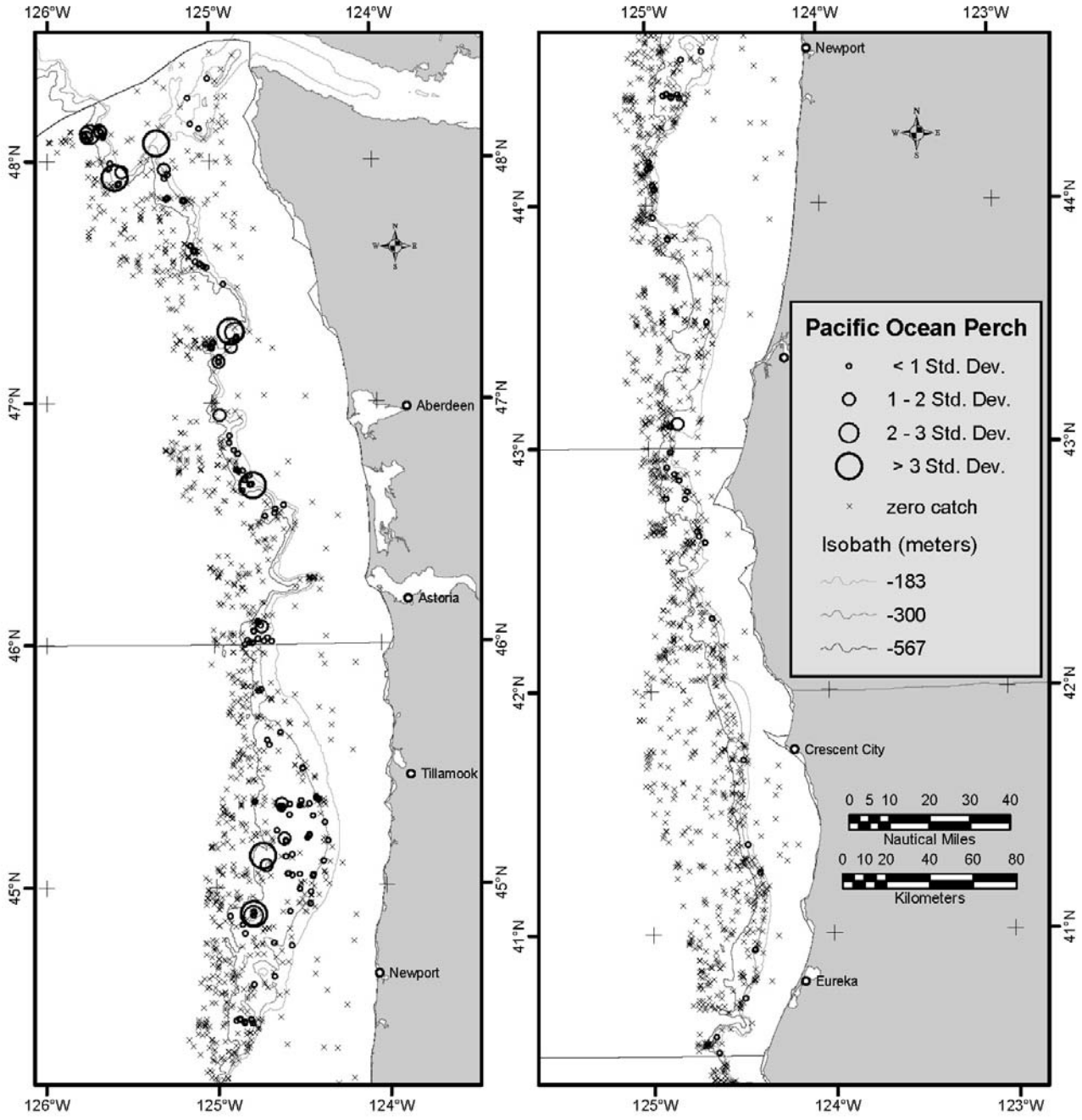



Figure F-1. Distribution of Pacific ocean perch caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

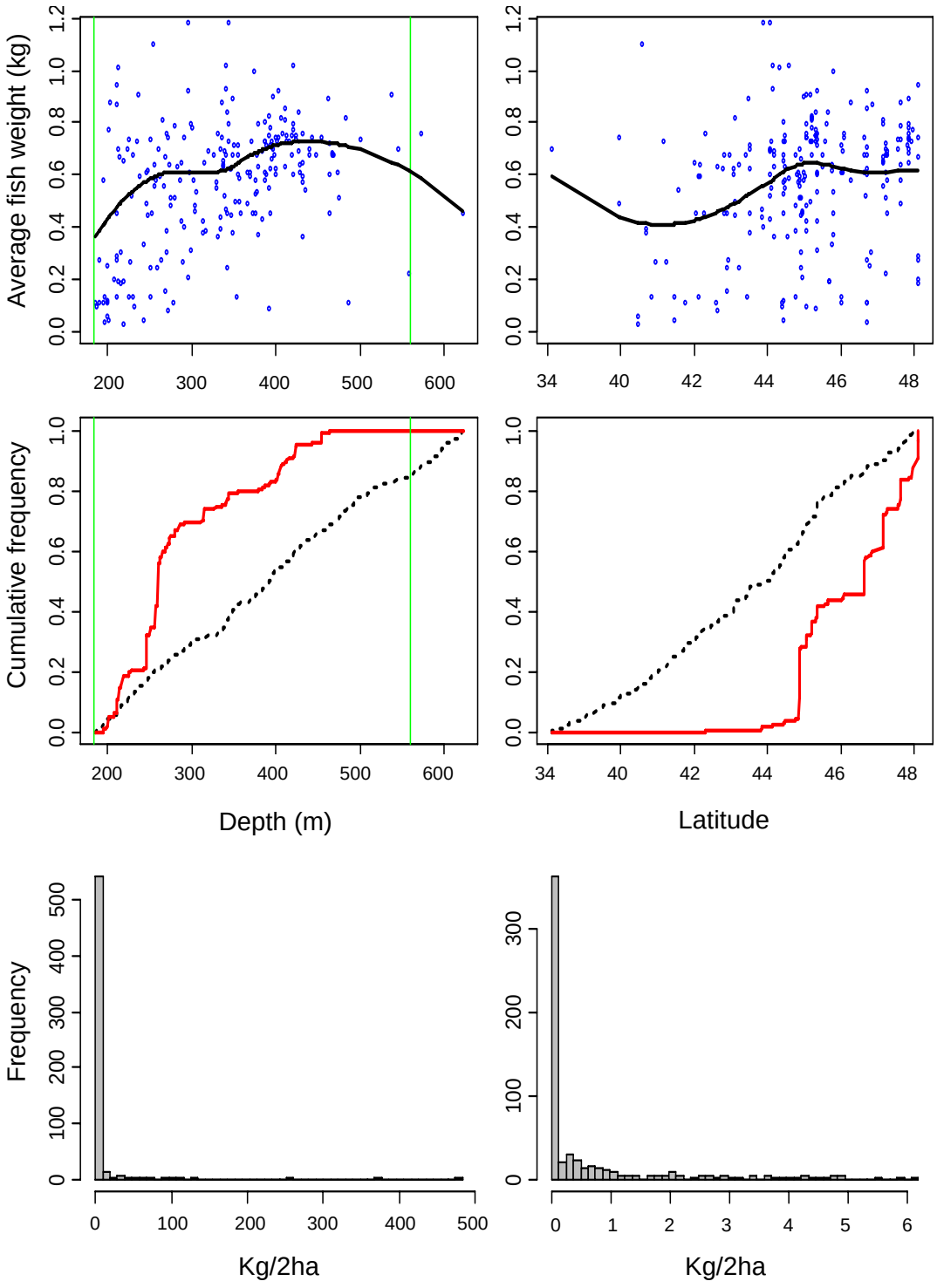



Figure F-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Pacific ocean perch caught in the AFSC slope surveys.

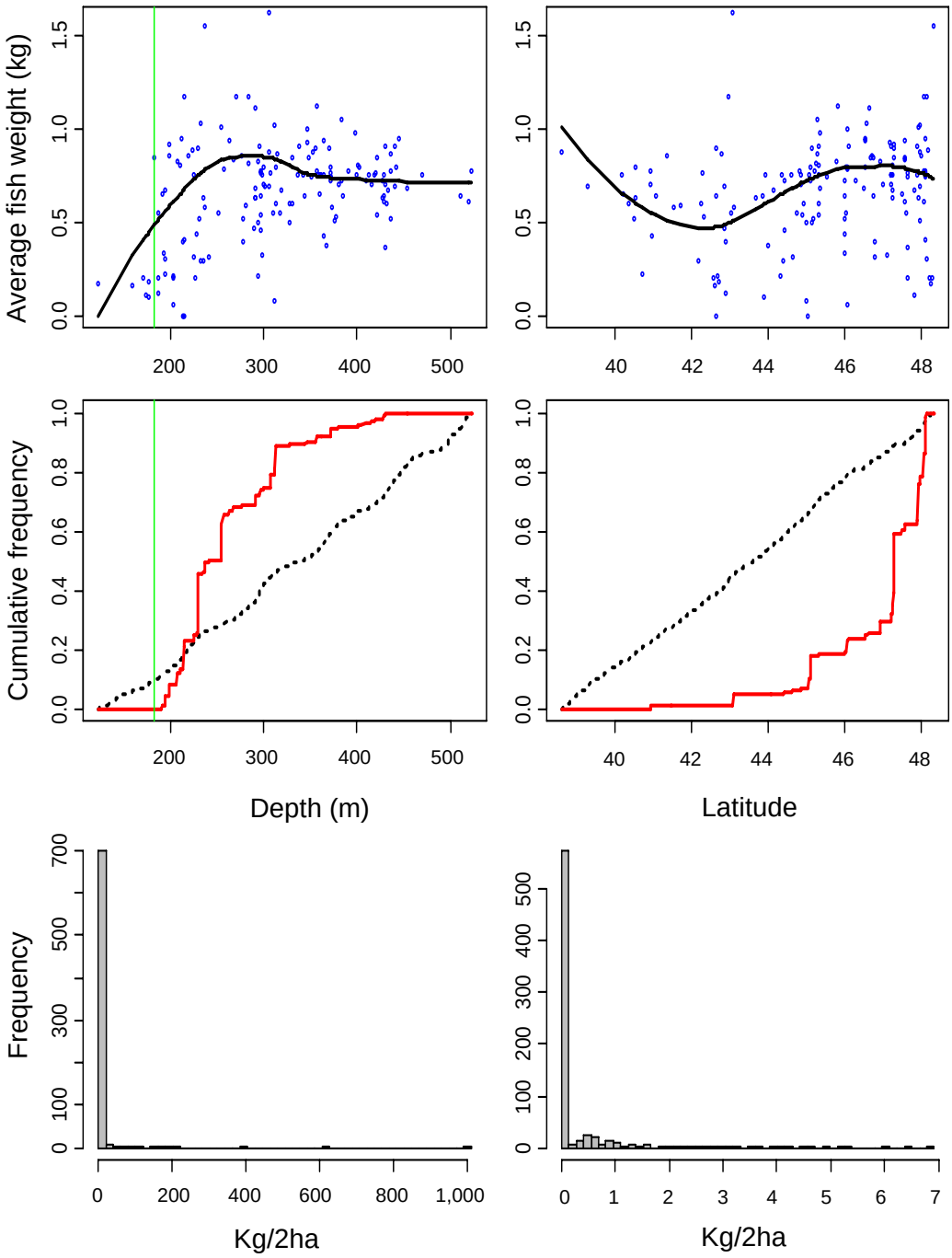



Figure F-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Pacific ocean perch caught in the NWFSC slope surveys.

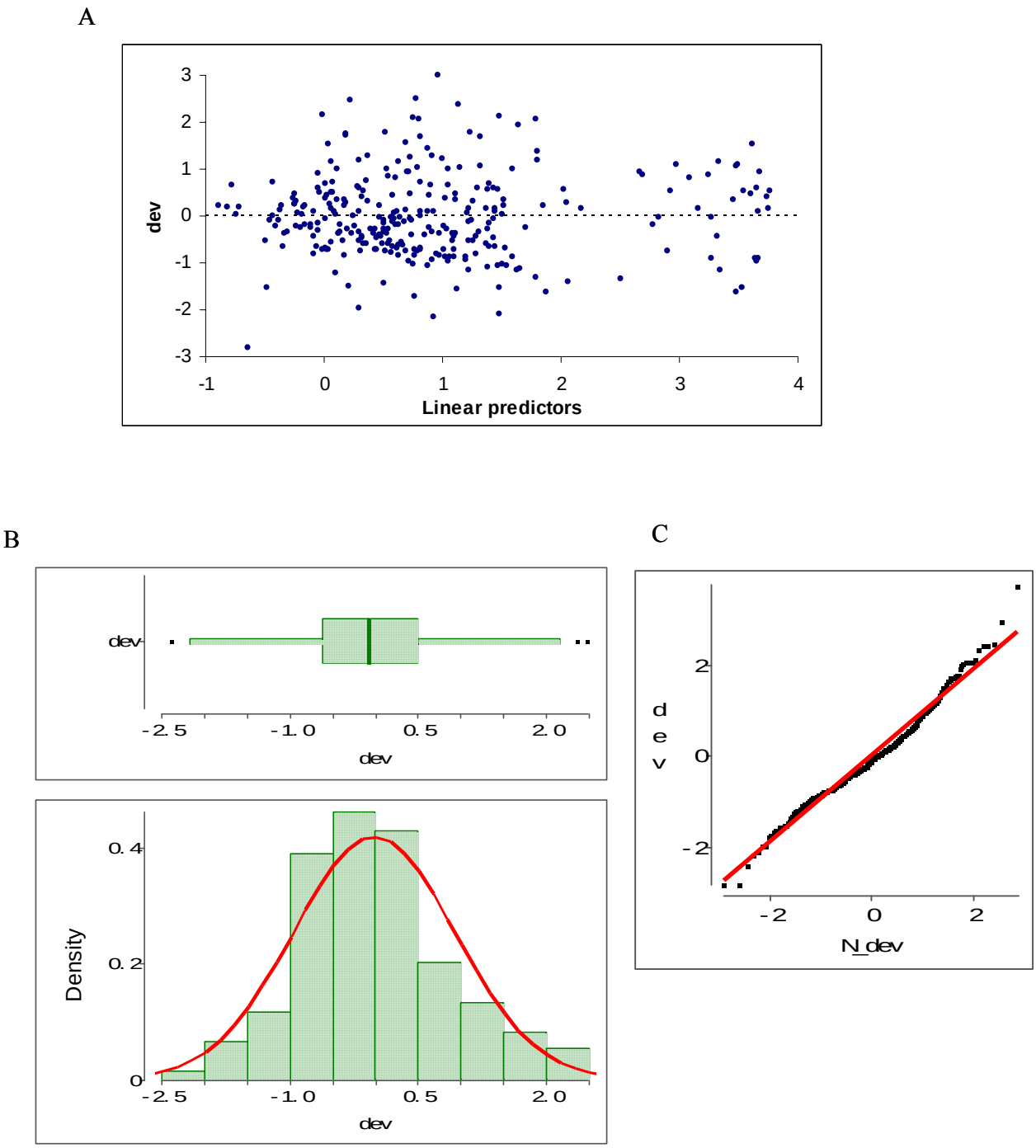



Figure F-4. Diagnostic plots from the generalized linear mixed model fit to Pacific ocean perch from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

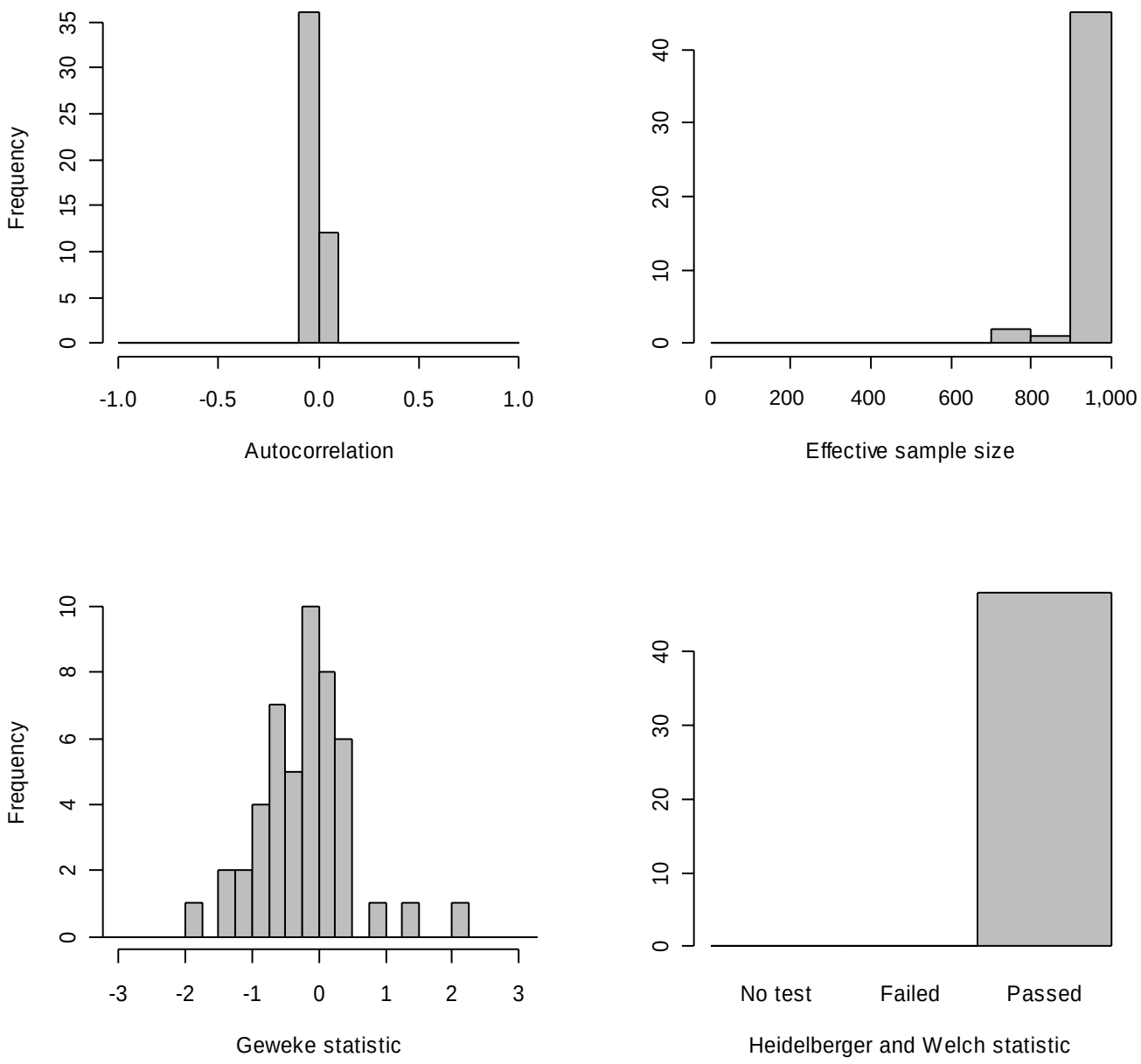
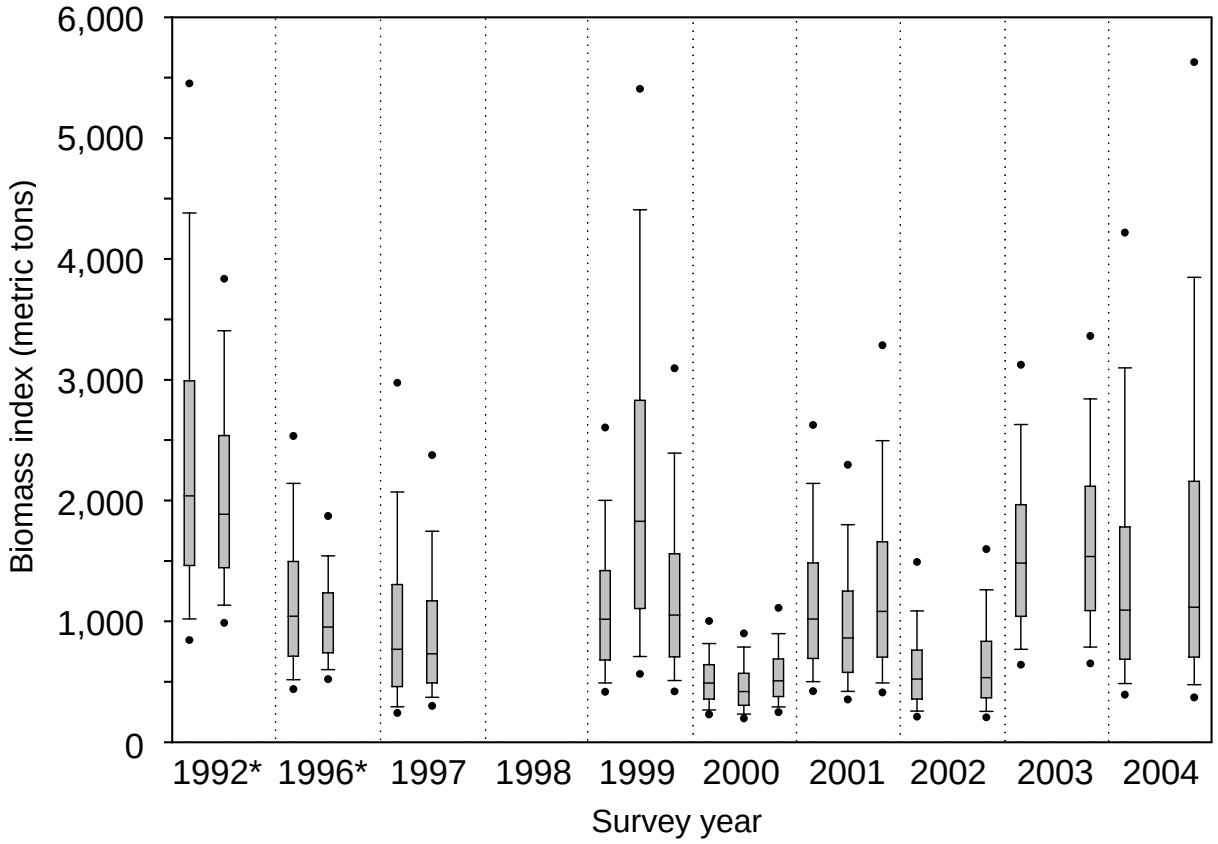



Figure F-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for Pacific ocean perch. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure F-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for Pacific ocean perch. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix G: Splitnose Rockfish (*Sebastes diploproa*)

This appendix has tables G-1 though G-5 and figures G-1 though G-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for splitnose rockfish. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table G-1. Basic data and statistics summary for splitnose rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 |
| **1992*** | 27 | 12 | 36 | 0 | 57 | 37 | 81 | 0 | 37 | 22 | 93 | 1 | 26 | 16 | 40 | 0 | – | – | – | – |
| **1996*** | 29 | 13 | 44 | 0 | 55 | 29 | 76 | 0 | 34 | 19 | 72 | 0 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 7 | 16 | 0 | 20 | 16 | 28 | 0 | 10 | 6 | 20 | 0 | 17 | 10 | 33 | 1 | 11 | 9 | 18 | 0 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 36 | 13 | 55 | 0 | 58 | 33 | 71 | 0 | 39 | 28 | 61 | 1 | 65 | 42 | 82 | 0 | 23 | 15 | 33 | 0 |
| **2000** | 35 | 19 | 47 | 0 | 59 | 36 | 70 | 0 | 37 | 22 | 60 | 0 | 73 | 47 | 94 | 2 | 27 | 20 | 36 | 0 |
| **2001** | 36 | 17 | 50 | 0 | 71 | 30 | 59 | 0 | 38 | 23 | 58 | 0 | 65 | 43 | 99 | 0 | 29 | 21 | 36 | 0 |
| **2002** | 24 | 7 | 24 | 0 | 47 | 21 | 39 | 0 | 30 | 19 | 41 | 0 | 58 | 32 | 61 | 1 | 47 | 31 | 55 | 0 |
| **2003** | 28 | 13 | 44 | 0 | 30 | 20 | 37 | 0 | 36 | 24 | 33 | 0 | 32 | 22 | 24 | 0 | 55 | 30 | 27 | 0 |
| **2004** | 13 | 3 | 14 | 0 | 46 | 27 | 19 | 0 | 14 | 11 | 23 | 0 | 17 | 13 | 21 | 0 | 50 | 33 | 49 | 0 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 1.2 | 0.53 | 0.0 | N/A | 3.6 | 0.43 | 0.0 | N/A | 22.9 | 0.69 | 0.0 | 1.00 | 16.6 | 0.57 | 0.0 | N/A | – | – | – | – |
| **1996*** | 4.1 | 0.66 | 0.0 | N/A | 4.2 | 0.40 | 0.0 | N/A | 10.2 | 0.39 | 0.0 | N/A | – | – | – | – | – | – | – | – |
| **1997** | 1.9 | 0.61 | 0.0 | N/A | 6.3 | 0.55 | 0.0 | N/A | 8.4 | 0.50 | 0.0 | N/A | 32.5 | 0.80 | 0.1 | 1.00 | 28.4 | 0.60 | 0.0 | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 4.1 | 0.57 | 0.0 | N/A | 5.8 | 0.56 | 0.0 | N/A | 16.0 | 0.50 | 0.0 | 1.00 | 33.9 | 0.21 | 0.0 | N/A | 21.4 | 0.29 | 0.0 | N/A |
| **2000** | 3.1 | 0.69 | 0.0 | N/A | 14.4 | 0.50 | 0.0 | N/A | 6.1 | 0.40 | 0.0 | N/A | 80.1 | 0.50 | 0.0 | 0.85 | 66.2 | 0.64 | 0.0 | N/A |
| **2001** | 7.8 | 0.50 | 0.0 | N/A | 4.1 | 0.38 | 0.0 | N/A | 6.4 | 0.44 | 0.0 | N/A | 20.8 | 0.25 | 0.0 | N/A | 30.7 | 0.28 | 0.0 | N/A |
| **2002** | 5.7 | 0.79 | 0.0 | N/A | 3.2 | 0.48 | 0.0 | N/A | 3.2 | 0.30 | 0.0 | N/A | 20.7 | 0.25 | 0.0 | 1.00 | 30.9 | 0.29 | 0.0 | N/A |
| **2003** | 9.3 | 0.61 | 0.0 | N/A | 15.1 | 0.43 | 0.0 | N/A | 18.0 | 0.45 | 0.0 | N/A | 36.6 | 0.34 | 0.0 | N/A | 21.1 | 0.27 | 0.0 | N/A |
| **2004** | 5.2 | 0.66 | 0.0 | N/A | 18.0 | 0.32 | 0.0 | N/A | 56.5 | 0.49 | 0.0 | N/A | 129.4 | 0.32 | 0.0 | N/A | 31.6 | 0.42 | 0.0 | N/A |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 2.6 | 0.49 | N/A | N/A | 5.6 | 0.43 | N/A | N/A | 38.5 | 0.68 | 0.5 | 0.00 | 27.0 | 0.55 | N/A | N/A | – | – | – | – |
| **1996*** | 9.2 | 0.64 | N/A | N/A | 7.9 | 0.38 | N/A | N/A | 18.3 | 0.37 | N/A | N/A | – | – | – | – | – | – | – | – |
| **1997** | 2.4 | 0.59 | N/A | N/A | 7.9 | 0.54 | N/A | N/A | 14.1 | 0.43 | N/A | N/A | 55.2 | 0.79 | 2.6 | 0.00 | 34.7 | 0.59 | N/A | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 11.4 | 0.54 | N/A | N/A | 10.2 | 0.55 | N/A | N/A | 22.3 | 0.50 | 1.7 | N/A | 52.5 | 0.19 | N/A | N/A | 32.8 | 0.25 | N/A | N/A |
| **2000** | 5.8 | 0.68 | N/A | N/A | 23.4 | 0.49 | N/A | N/A | 10.3 | 0.38 | N/A | N/A | 124.3 | 0.49 | 1.8 | 0.68 | 86.1 | 0.64 | N/A | N/A |
| **2001** | 16.5 | 0.47 | N/A | N/A | 9.7 | 0.35 | N/A | N/A | 10.6 | 0.42 | N/A | N/A | 31.4 | 0.23 | N/A | N/A | 42.4 | 0.26 | N/A | N/A |
| **2002** | 18.8 | 0.76 | N/A | N/A | 7.1 | 0.45 | N/A | N/A | 5.1 | 0.27 | N/A | N/A | 37.6 | 0.22 | 0.6 | N/A | 46.8 | 0.28 | N/A | N/A |
| **2003** | 20.1 | 0.59 | N/A | N/A | 22.7 | 0.41 | N/A | N/A | 27.0 | 0.43 | N/A | N/A | 53.2 | 0.32 | N/A | N/A | 38.6 | 0.25 | N/A | N/A |
| **2004** | 22.6 | 0.51 | N/A | N/A | 30.7 | 0.30 | N/A | N/A | 71.9 | 0.47 | N/A | N/A | 169.3 | 0.30 | N/A | N/A | 47.9 | 0.41 | N/A | N/A |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table G-2. Poststratified data and statistics summary for splitnose rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| | Vancouver | | | | | Columbia-Eureka | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | | **183–299 m** | | **300–567 m** | |
| | Total number and number positive tows by year and spatial strata | | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total# tows** | **# tows > 0** | | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1992*** | 8 | 6 | 19 | 6 | | 24 | 22 | 71 | 37 |
| **1996*** | 9 | 8 | 20 | 5 | | 24 | 20 | 65 | 28 |
| **1997** | 4 | 4 | 5 | 3 | | 9 | 9 | 21 | 13 |
| **1998** | – | – | – | – | – | – | – | – | – |
| **1999** | 8 | 6 | 28 | 7 | | 25 | 23 | 72 | 38 |
| **2000** | 8 | 7 | 28 | 12 | | 24 | 22 | 72 | 36 |
| **2001** | 8 | 6 | 28 | 11 | | 18 | 15 | 91 | 38 |
| **2002** | 3 | 3 | 21 | 5 | | 17 | 16 | 60 | 24 |
| **2003** | 13 | 7 | 15 | 6 | | 20 | 18 | 46 | 28 |
| **2004** | 5 | 3 | 8 | 3 | | 18 | 16 | 42 | 22 |
| | Summary statistics (mean, CV) for all tows in Kg/2h. | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 7.3 | 0.49 | 1.0 | 0.37 | | 49.1 | 0.50 | 1.1 | 0.69 |
| **1996*** | 12.6 | 0.33 | 0.3 | 0.40 | | 20.1 | 0.37 | 0.3 | 0.94 |
| **1997** | 10.6 | 0.64 | 1.8 | 0.33 | | 7.5 | 0.43 | 27.5 | 0.56 |
| **1998** | – | – | – | – | – | – | – | – | – |
| **1999** | 14.0 | 0.45 | 0.7 | 0.40 | | 46.4 | 0.24 | 14.4 | 0.23 |
| **2000** | 26.0 | 0.45 | 0.7 | 0.31 | | 90.9 | 0.65 | 35.1 | 0.37 |
| **2001** | 18.5 | 0.34 | 1.4 | 0.48 | | 18.2 | 0.24 | 15.6 | 0.24 |
| **2002** | 13.9 | 0.44 | 0.3 | 0.46 | | 35.0 | 0.27 | 10.4 | 0.23 |
| **2003** | 18.3 | 0.42 | 6.6 | 0.62 | | 26.9 | 0.26 | 20.1 | 0.28 |
| **2004** | 26.3 | 0.45 | 0.3 | 0.75 | | 71.0 | 0.32 | 2.7 | 0.50 |
| | Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | |
| **1992*** | 8.7 | 0.49 | 2.2 | 0.34 | | 51.1 | 0.50 | 3.5 | 0.67 |
| **1996*** | 14.9 | 0.32 | 1.0 | 0.36 | | 21.4 | 0.36 | 2.1 | 0.91 |
| **1997** | 10.6 | 0.64 | 2.8 | 0.29 | | 8.9 | 0.42 | 56.9 | 0.53 |
| **1998** | – | – | – | – | – | – | – | – | – |
| **1999** | 16.1 | 0.45 | 2.5 | 0.35 | | 51.5 | 0.23 | 28.3 | 0.21 |
| **2000** | 28.6 | 0.45 | 1.9 | 0.26 | | 101.2 | 0.65 | 74.2 | 0.35 |
| **2001** | 23.3 | 0.33 | 4.6 | 0.46 | | 19.6 | 0.24 | 36.2 | 0.21 |
| **2002** | 16.5 | 0.43 | 1.3 | 0.40 | | 41.8 | 0.26 | 25.3 | 0.20 |
| **2003** | 25.8 | 0.40 | 17.2 | 0.60 | | 32.8 | 0.25 | 45.3 | 0.26 |
| **2004** | 42.0 | 0.41 | 1.6 | 0.60 | | 71.0 | 0.32 | 5.0 | 0.46 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table G-3. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of splitnose rockfish from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| | Vancouver | | | | Columbia-Eureka | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.79 | 0.08 | 0.31 | 0.24 | 0.89 | 0.04 | 0.50 | 0.16 |
| **1996*** | 0.70 | 0.11 | 0.22 | 0.28 | 0.84 | 0.06 | 0.39 | 0.20 |
| **1997** | 0.88 | 0.06 | 0.47 | 0.24 | 0.94 | 0.03 | 0.66 | 0.15 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.78 | 0.07 | 0.31 | 0.20 | 0.89 | 0.04 | 0.49 | 0.13 |
| **2000** | 0.83 | 0.06 | 0.36 | 0.18 | 0.91 | 0.03 | 0.55 | 0.11 |
| **2001** | 0.77 | 0.07 | 0.29 | 0.19 | 0.88 | 0.04 | 0.47 | 0.13 |
| **2002** | 0.75 | 0.08 | 0.27 | 0.22 | 0.87 | 0.04 | 0.45 | 0.14 |
| **2003** | 0.80 | 0.07 | 0.33 | 0.21 | 0.90 | 0.04 | 0.52 | 0.14 |
| **2004** | 0.75 | 0.10 | 0.27 | 0.27 | 0.87 | 0.05 | 0.44 | 0.18 |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 3.9 | 1.74 | 1.4 | 1.93 | 38.9 | 0.64 | 5.2 | 0.52 |
| **1996*** | 14.6 | 1.29 | 0.8 | 2.33 | 24.8 | 0.70 | 3.4 | 0.59 |
| **1997** | 4.0 | 2.14 | 0.5 | 4.93 | 15.2 | 1.20 | 6.0 | 0.90 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 21.8 | 1.61 | 2.1 | 1.30 | 14.9 | 0.53 | 17.9 | 0.44 |
| **2000** | 14.2 | 1.38 | 1.2 | 0.90 | 31.6 | 0.60 | 10.9 | 0.46 |
| **2001** | 32.5 | 1.55 | 8.8 | 0.98 | 24.6 | 0.80 | 4.9 | 0.44 |
| **2002** | 54.0 | 14.84 | 6.4 | 2.42 | 12.1 | 0.71 | 2.9 | 0.57 |
| **2003** | 38.5 | 1.50 | 1.1 | 1.88 | 33.4 | 0.75 | 21.2 | 0.56 |
| **2004** | 15.9 | 10.98 | 46.3 | 45.85 | 81.1 | 0.66 | 13.2 | 0.60 |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 218.7 | 1.75 | 32.1 | 2.10 | 5,617.0 | 0.65 | 829.0 | 0.56 |
| **1996*** | 733.6 | 1.35 | 13.2 | 2.92 | 3,349.2 | 0.72 | 414.0 | 0.66 |
| **1997** | 253.1 | 2.14 | 18.4 | 4.33 | 2,314.9 | 1.21 | 1,230.4 | 0.97 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 1,248.4 | 1.61 | 48.0 | 1.39 | 2,156.0 | 0.53 | 2,816.6 | 0.48 |
| **2000** | 846.8 | 1.37 | 30.3 | 0.97 | 4,699.6 | 0.60 | 1,938.2 | 0.48 |
| **2001** | 1,775.8 | 1.60 | 187.3 | 1.08 | 3,530.0 | 0.80 | 763.0 | 0.45 |
| **2002** | 2,976.9 | 14.80 | 117.2 | 2.86 | 1,716.2 | 0.71 | 421.3 | 0.60 |
| **2003** | 2,230.8 | 1.51 | 26.8 | 1.92 | 4,858.9 | 0.75 | 3,453.7 | 0.59 |
| **2004** | 849.6 | 11.45 | 826.2 | 57.64 | 11,365.6 | 0.67 | 1,858.0 | 0.67 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table G-4. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of splitnose rockfish from the Delta-GLM applied to NWFSC slope surveys.

| | Vancouver | | | | Columbia-Eureka | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| | Predicted proportion positive based on Delta-GLM model | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.76 | 0.08 | 0.30 | 0.20 | 0.88 | 0.04 | 0.50 | 0.12 |
| **2000** | 0.80 | 0.07 | 0.36 | 0.19 | 0.90 | 0.03 | 0.56 | 0.11 |
| **2001** | 0.75 | 0.08 | 0.29 | 0.22 | 0.87 | 0.04 | 0.48 | 0.13 |
| **2002** | 0.73 | 0.09 | 0.27 | 0.23 | 0.86 | 0.05 | 0.46 | 0.14 |
| **2003** | 0.79 | 0.08 | 0.33 | 0.21 | 0.89 | 0.04 | 0.53 | 0.13 |
| **2004** | 0.73 | 0.11 | 0.27 | 0.28 | 0.86 | 0.06 | 0.45 | 0.18 |
| | Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 22.41 | 1.54 | 2.25 | 1.62 | 14.3 | 0.59 | 17.4 | 0.43 |
| **2000** | 13.67 | 1.41 | 1.18 | 0.81 | 31.5 | 0.65 | 10.5 | 0.44 |
| **2001** | 33.44 | 1.48 | 8.88 | 0.98 | 24.2 | 0.76 | 5.0 | 0.42 |
| **2002** | 57.13 | 12.86 | 6.28 | 1.84 | 12.3 | 0.73 | 2.9 | 0.55 |
| **2003** | 38.60 | 1.49 | 1.18 | 1.61 | 33.6 | 0.65 | 21.0 | 0.52 |
| **2004** | 14.86 | 8.80 | 41.66 | 163.63 | 78.9 | 0.71 | 12.7 | 0.64 |
| | Predicted biomass (mt) by strata | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 1,210.1 | 1.59 | 50.7 | 1.74 | 2,027.7 | 0.60 | 2,787.0 | 0.46 |
| **2000** | 789.5 | 1.43 | 30.9 | 0.81 | 4,606.2 | 0.64 | 1,909.3 | 0.45 |
| **2001** | 1,832.6 | 1.50 | 184.3 | 1.03 | 3,440.8 | 0.76 | 767.1 | 0.46 |
| **2002** | 2,923.5 | 13.35 | 121.1 | 1.93 | 1,731.0 | 0.73 | 418.0 | 0.60 |
| **2003** | 2,203.5 | 1.45 | 28.0 | 1.68 | 4,837.9 | 0.66 | 3,515.8 | 0.53 |
| **2004** | 764.7 | 9.40 | 758.5 | 169.17 | 11,082.4 | 0.71 | 1,823.1 | 0.70 |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table G-5. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of splitnose rockfish from the Delta-GLM applied to AFSC slope surveys.

| | Vancouver | | | | Columbia-Eureka | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.80 | 0.08 | 0.28 | 0.22 | 0.87 | 0.05 | 0.40 | 0.13 |
| **1996*** | 0.70 | 0.11 | 0.19 | 0.26 | 0.80 | 0.07 | 0.29 | 0.16 |
| **1997** | 0.89 | 0.06 | 0.43 | 0.25 | 0.93 | 0.04 | 0.57 | 0.17 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.79 | 0.10 | 0.26 | 0.29 | 0.87 | 0.07 | 0.38 | 0.22 |
| **2000** | 0.77 | 0.11 | 0.25 | 0.31 | 0.86 | 0.07 | 0.36 | 0.22 |
| **2001** | 0.77 | 0.11 | 0.24 | 0.30 | 0.85 | 0.07 | 0.36 | 0.23 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 3.9 | 1.41 | 1.4 | 1.15 | 38.3 | 0.50 | 5.2 | 0.36 |
| **1996*** | 14.3 | 1.00 | 0.8 | 1.67 | 24.5 | 0.53 | 3.4 | 0.43 |
| **1997** | 3.6 | 2.10 | 0.5 | 3.08 | 14.7 | 0.95 | 5.8 | 0.69 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 3.7 | 2.82 | 2.9 | 1.71 | 34.3 | 1.24 | 3.2 | 0.83 |
| **2000** | 4.4 | 5.90 | 2.7 | 4.95 | 33.3 | 1.17 | 2.4 | 0.76 |
| **2001** | 43.8 | 4.26 | 0.6 | 3.25 | 43.8 | 1.36 | 5.3 | 0.86 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 219.5 | 1.45 | 28.0 | 1.22 | 5,445.3 | 0.50 | 668.1 | 0.39 |
| **1996*** | 727.0 | 1.02 | 10.7 | 1.77 | 3,202.2 | 0.54 | 302.4 | 0.51 |
| **1997** | 224.6 | 2.09 | 15.4 | 3.52 | 2,225.4 | 0.95 | 1,040.8 | 0.75 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 207.3 | 2.81 | 54.7 | 1.87 | 4,787.2 | 1.25 | 391.1 | 0.90 |
| **2000** | 241.7 | 6.27 | 46.3 | 6.00 | 4,585.2 | 1.18 | 274.3 | 0.81 |
| **2001** | 2,398.8 | 3.93 | 10.2 | 3.55 | 6,101.3 | 1.35 | 603.9 | 0.95 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super–year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super–year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

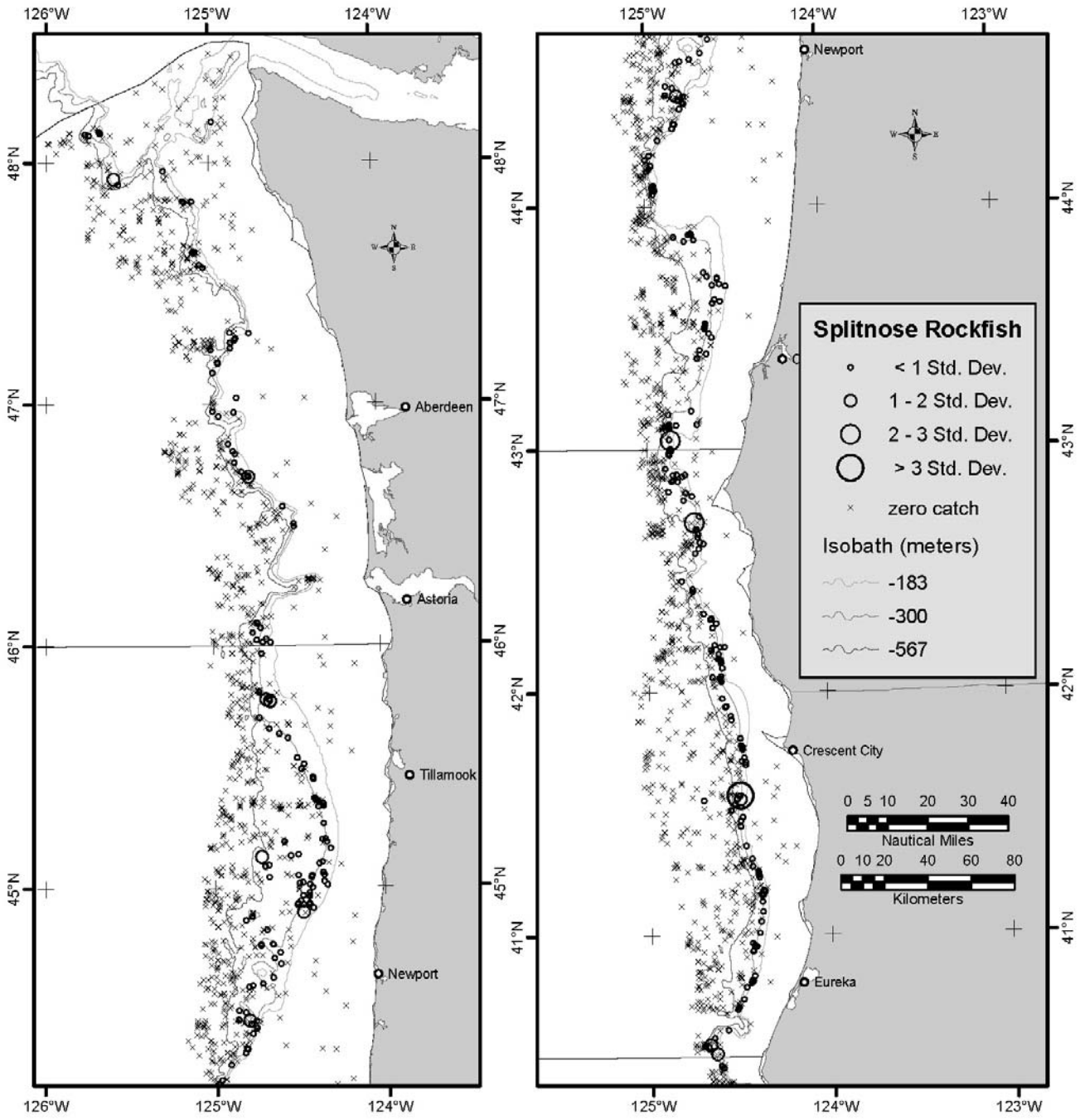



Figure G-1. Distribution of splitnose rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

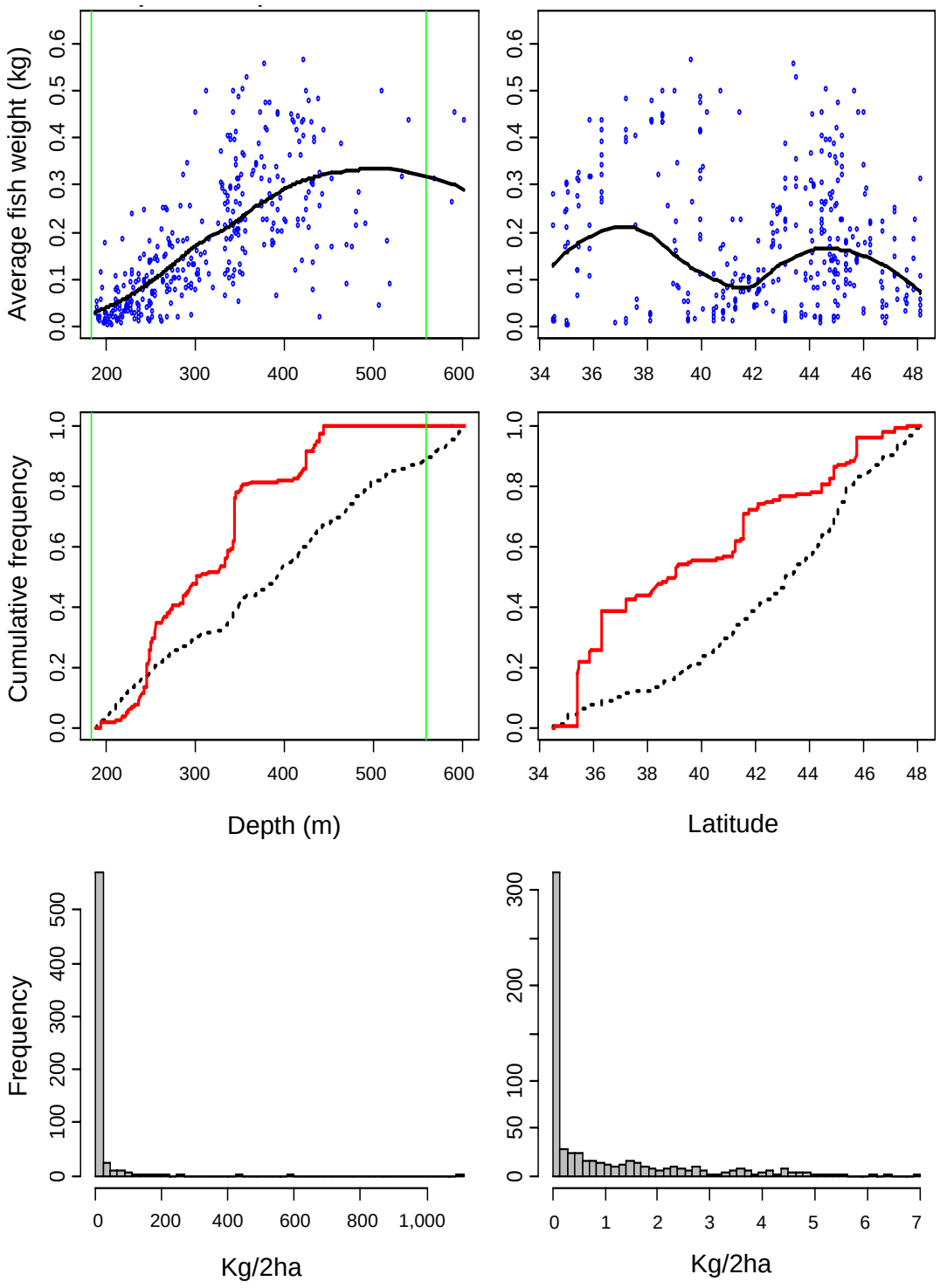



Figure G-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of splitnose rockfish caught in the AFSC slope surveys.

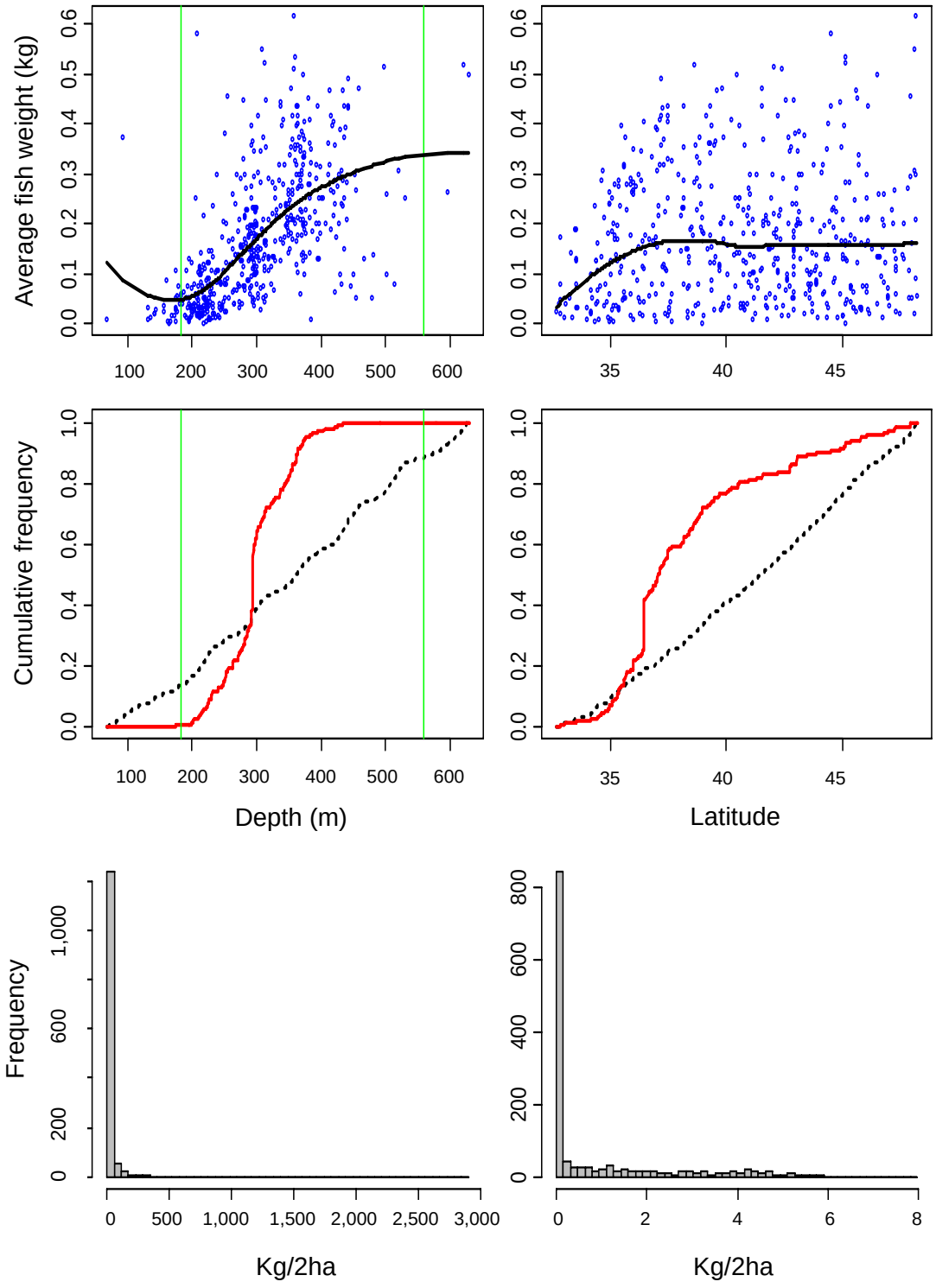



Figure G-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of splitnose rockfish caught in the NWFSC slope surveys.

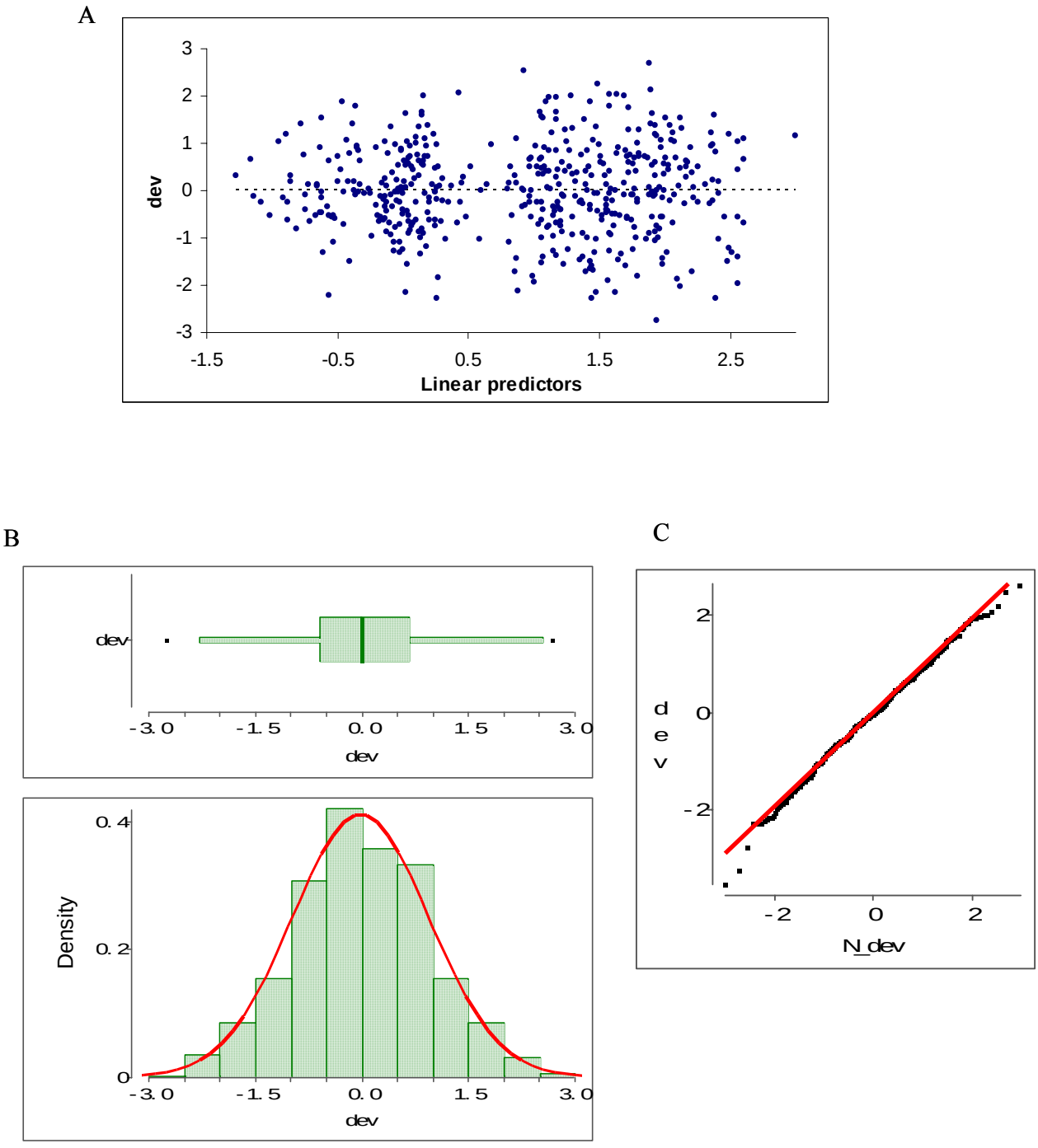



Figure G-4. Diagnostic plots from the generalized linear mixed model fit to splitnose rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

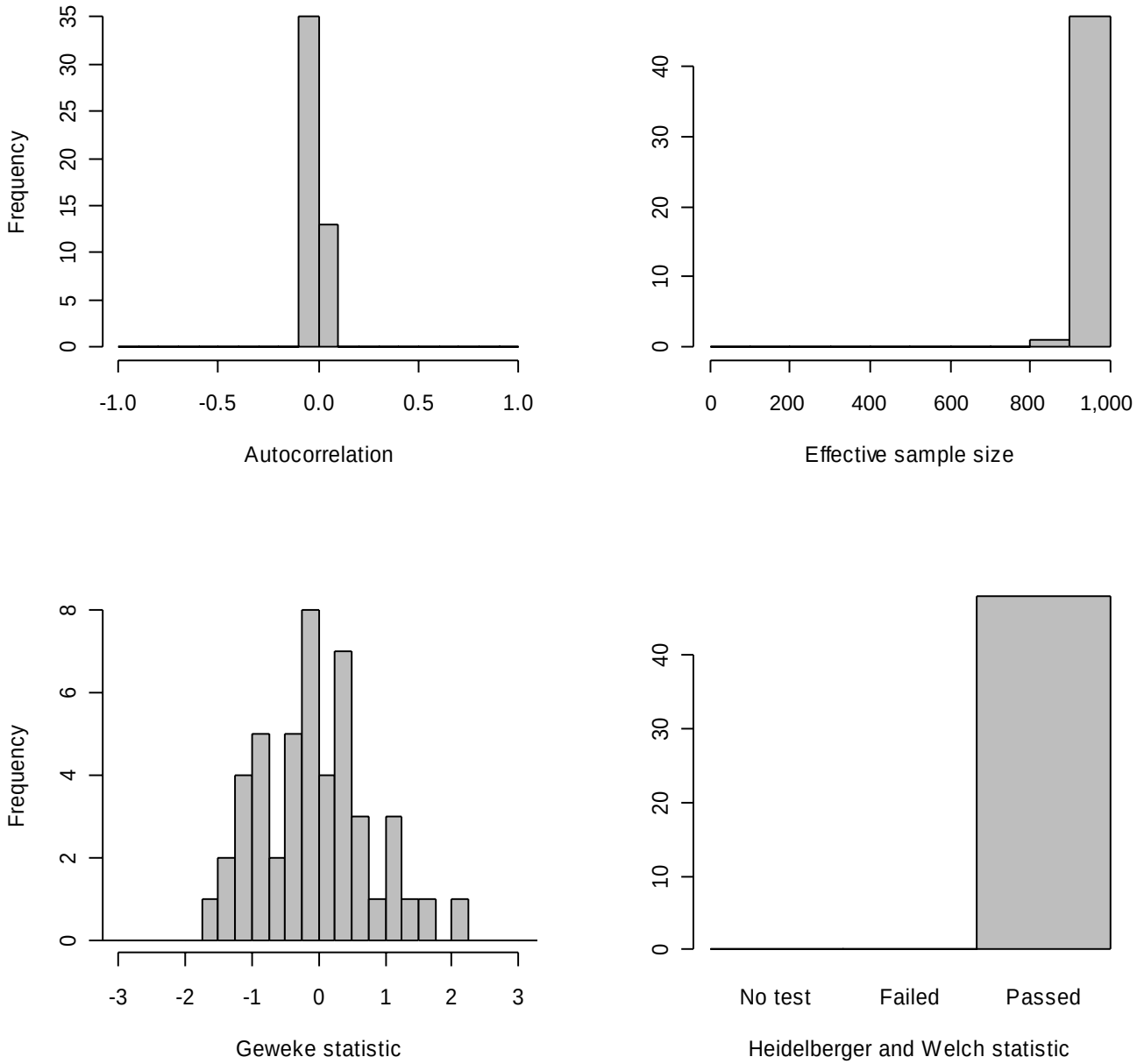
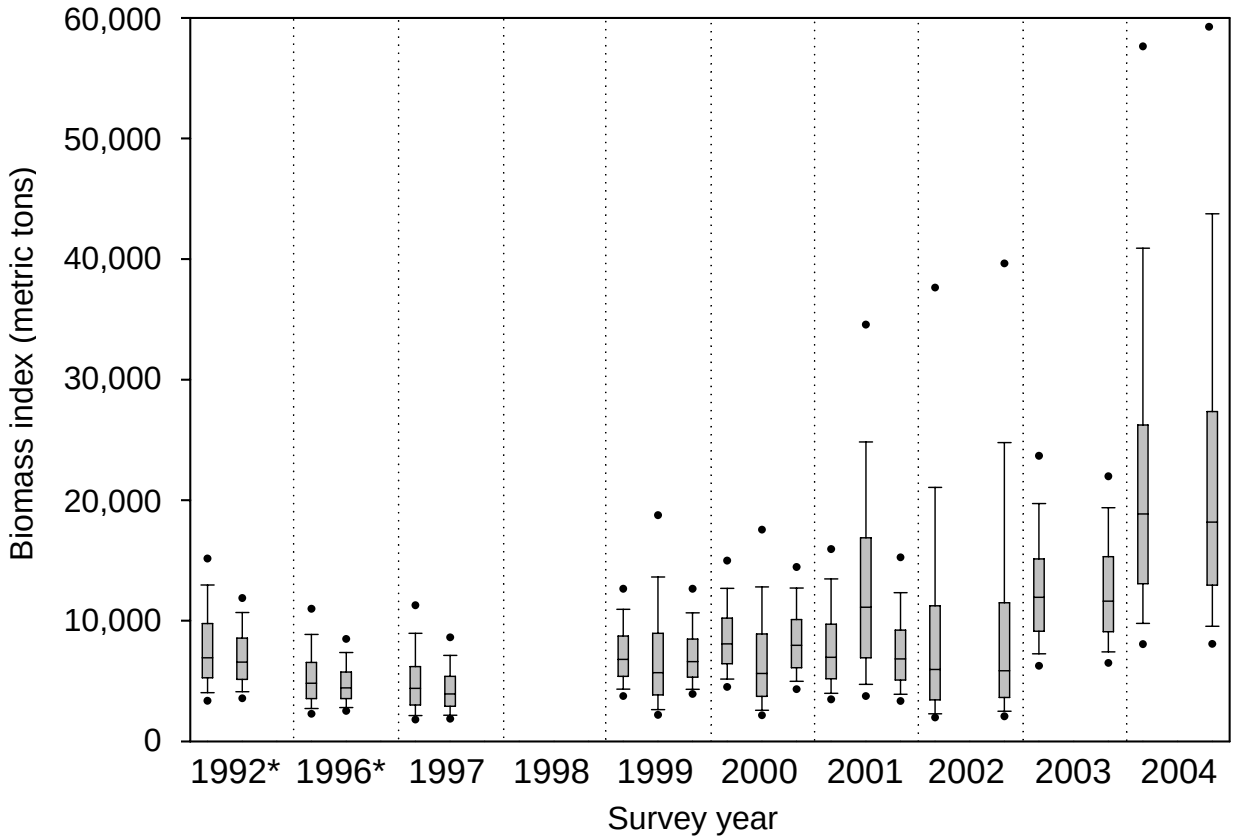



Figure G-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution of splitnose rockfish. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure G-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for splitnose rockfish. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix H: Redbanded Rockfish (*Sebastes babcocki*)

This appendix has tables H-1 though H-5 and figures H-1 though H-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for redbanded rockfish. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table H-1. Basic data and statistics summary for redbanded rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Vancouver 183–567 m | | Vancouver 567–1,280 m | | Columbia 183–567 m | | Columbia 567–1,280 m | | Eureka 183–567 m | | Eureka 567–1,280 m | | Monterey 183–567 m | | Monterey 567–1,280 m | | Conception 183–567 m | | Conception 567–1,280 m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 |
| **1992*** | 27 | 13 | 36 | 0 | 57 | 23 | 81 | 0 | 37 | 16 | 93 | 0 | 26 | 11 | 40 | 0 | – | – | – | – |
| **1996*** | 29 | 11 | 44 | 0 | 55 | 18 | 76 | 0 | 34 | 13 | 72 | 0 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 4 | 16 | 0 | 20 | 6 | 28 | 0 | 10 | 3 | 20 | 0 | 17 | 5 | 33 | 0 | 11 | 0 | 18 | 0 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 36 | 13 | 55 | 1 | 58 | 19 | 71 | 1 | 39 | 19 | 61 | 0 | 65 | 17 | 82 | 0 | 23 | 3 | 33 | 0 |
| **2000** | 35 | 14 | 47 | 0 | 58 | 25 | 70 | 0 | 37 | 13 | 60 | 0 | 73 | 18 | 94 | 0 | 27 | 3 | 36 | 0 |
| **2001** | 36 | 13 | 50 | 0 | 70 | 15 | 59 | 1 | 38 | 10 | 58 | 0 | 65 | 16 | 99 | 0 | 29 | 2 | 36 | 0 |
| **2002** | 24 | 5 | 24 | 0 | 47 | 10 | 39 | 0 | 30 | 12 | 41 | 0 | 58 | 11 | 61 | 0 | 47 | 3 | 55 | 0 |
| **2003** | 28 | 13 | 44 | 0 | 30 | 14 | 37 | 0 | 36 | 14 | 33 | 0 | 32 | 9 | 24 | 0 | 55 | 3 | 27 | 0 |
| **2004** | 7 | 3 | 14 | 0 | 19 | 10 | 19 | 0 | 7 | 5 | 23 | 0 | 9 | 1 | 21 | 0 | 15 | 1 | 49 | 0 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 1.2 | 0.61 | 0.0 | N/A | 0.3 | 0.26 | 0.0 | N/A | 1.6 | 0.45 | 0.0 | N/A | 0.4 | 0.40 | 0.0 | N/A | – | – | – | – |
| **1996*** | 0.3 | 0.34 | 0.0 | N/A | 0.2 | 0.29 | 0.0 | N/A | 0.4 | 0.45 | 0.0 | N/A | – | – | – | – | – | – | – | – |
| **1997** | 0.8 | 0.75 | 0.0 | N/A | 0.1 | 0.39 | 0.0 | N/A | 0.2 | 0.98 | 0.0 | N/A | 0.1 | 0.62 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 3.7 | 0.90 | 0.0 | 1.00 | 0.1 | 0.26 | 0.0 | 1.00 | 0.5 | 0.30 | 0.0 | N/A | 0.1 | 0.35 | 0.0 | N/A | 0.2 | 0.81 | 0.0 | N/A |
| **2000** | 0.6 | 0.40 | 0.0 | N/A | 0.5 | 0.35 | 0.0 | N/A | 0.5 | 0.37 | 0.0 | N/A | 0.3 | 0.49 | 0.0 | N/A | 0.8 | 0.72 | 0.0 | N/A |
| **2001** | 1.1 | 0.47 | 0.0 | N/A | 0.2 | 0.30 | 0.0 | 1.00 | 0.4 | 0.53 | 0.0 | N/A | 0.1 | 0.48 | 0.0 | N/A | 0.1 | 0.78 | 0.0 | N/A |
| **2002** | 0.4 | 0.61 | 0.0 | N/A | 1.0 | 0.66 | 0.0 | N/A | 0.7 | 0.38 | 0.0 | N/A | 0.3 | 0.50 | 0.0 | N/A | 0.0 | 0.70 | 0.0 | N/A |
| **2003** | 2.2 | 0.29 | 0.0 | N/A | 0.8 | 0.30 | 0.0 | N/A | 0.6 | 0.38 | 0.0 | N/A | 0.5 | 0.47 | 0.0 | N/A | 0.1 | 0.78 | 0.0 | N/A |
| **2004** | 16.7 | 0.95 | 0.0 | N/A | 0.9 | 0.34 | 0.0 | N/A | 0.3 | 0.47 | 0.0 | N/A | 0.2 | 1.00 | 0.0 | N/A | 0.1 | 1.00 | 0.0 | N/A |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 2.4 | 0.59 | N/A | N/A | 0.6 | 0.21 | N/A | N/A | 3.8 | 0.41 | N/A | N/A | 0.8 | 0.34 | N/A | N/A | – | – | – | – |
| **1996*** | 0.8 | 0.25 | N/A | N/A | 0.6 | 0.22 | N/A | N/A | 1.1 | 0.40 | N/A | N/A | – | – | – | – | – | – | – | – |
| **1997** | 1.9 | 0.70 | N/A | N/A | 0.4 | 0.19 | N/A | N/A | 0.7 | 0.98 | N/A | N/A | 0.4 | 0.53 | N/A | N/A | N/A | N/A | N/A | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 10.2 | 0.89 | 0.8 | N/A | 0.5 | 0.19 | 0.1 | N/A | 1.0 | 0.26 | N/A | N/A | 0.5 | 0.28 | N/A | N/A | 1.3 | 0.71 | N/A | N/A |
| **2000** | 1.4 | 0.35 | N/A | N/A | 1.1 | 0.31 | N/A | N/A | 1.3 | 0.30 | N/A | N/A | 1.1 | 0.45 | N/A | N/A | 7.0 | 0.55 | N/A | N/A |
| **2001** | 3.0 | 0.42 | N/A | N/A | 0.9 | 0.20 | 2.1 | N/A | 1.4 | 0.47 | N/A | N/A | 0.4 | 0.43 | N/A | N/A | 1.0 | 0.50 | N/A | N/A |
| **2002** | 2.3 | 0.45 | N/A | N/A | 4.6 | 0.62 | N/A | N/A | 1.7 | 0.32 | N/A | N/A | 1.6 | 0.44 | N/A | N/A | 0.7 | 0.50 | N/A | N/A |
| **2003** | 4.8 | 0.21 | N/A | N/A | 1.7 | 0.23 | N/A | N/A | 1.6 | 0.32 | N/A | N/A | 1.7 | 0.39 | N/A | N/A | 1.1 | 0.65 | N/A | N/A |
| **2004** | 39.1 | 0.94 | N/A | N/A | 1.6 | 0.25 | N/A | N/A | 0.5 | 0.40 | N/A | N/A | 2.0 | – | N/A | N/A | 0.3 | – | N/A | N/A |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993, and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* extended only as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table H-2. Poststratified data and statistics summary for redbanded rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| | Vancouver-Columbia | | | | Eureka-Monterey | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| | Total number and number positive tows by year and spatial strata | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1992*** | 24 | 19 | 61 | 17 | 25 | 20 | 38 | 7 |
| **1996*** | 26 | 14 | 58 | 15 | 17 | 11 | 17 | 3 |
| **1997** | 10 | 6 | 19 | 4 | 11 | 5 | 16 | 3 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 31 | 17 | 63 | 15 | 35 | 13 | 69 | 23 |
| **2000** | 34 | 23 | 60 | 16 | 44 | 18 | 66 | 13 |
| **2001** | 23 | 17 | 83 | 11 | 37 | 12 | 67 | 14 |
| **2002** | 19 | 11 | 52 | 4 | 29 | 10 | 59 | 13 |
| **2003** | 24 | 17 | 34 | 10 | 28 | 11 | 40 | 12 |
| **2004** | 26 | 13 | 33 | 6 | 16 | 6 | 15 | 6 |
| | Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 0.6 | 0.34 | 0.5 | 0.60 | 2.5 | 0.41 | 0.1 | 0.52 |
| **1996*** | 0.3 | 0.31 | 0.2 | 0.31 | 0.5 | 0.58 | 0.3 | 0.75 |
| **1997** | 0.3 | 0.35 | 0.3 | 0.79 | 0.3 | 0.66 | 0.0 | 0.69 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 4.3 | 0.90 | 0.1 | 0.29 | 0.4 | 0.39 | 0.2 | 0.29 |
| **2000** | 1.0 | 0.35 | 0.2 | 0.30 | 0.3 | 0.35 | 0.3 | 0.46 |
| **2001** | 1.3 | 0.45 | 0.3 | 0.55 | 0.4 | 0.56 | 0.1 | 0.41 |
| **2002** | 2.9 | 0.55 | 0.0 | 0.73 | 0.7 | 0.44 | 0.2 | 0.43 |
| **2003** | 2.8 | 0.26 | 0.5 | 0.38 | 0.4 | 0.40 | 0.6 | 0.38 |
| **2004** | 5.2 | 0.84 | 0.1 | 0.45 | 0.3 | 0.51 | 0.6 | 0.56 |
| | Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | |
| **1992*** | 0.7 | 0.32 | 1.9 | 0.58 | 3.2 | 0.40 | 0.9 | 0.40 |
| **1996*** | 0.6 | 0.25 | 0.8 | 0.22 | 0.7 | 0.56 | 2.9 | 0.40 |
| **1997** | 0.4 | 0.24 | 1.8 | 0.72 | 0.7 | 0.60 | 0.3 | 0.51 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 7.8 | 0.89 | 0.6 | 0.19 | 1.0 | 0.32 | 0.6 | 0.24 |
| **2000** | 1.4 | 0.33 | 1.0 | 0.20 | 0.8 | 0.30 | 1.8 | 0.39 |
| **2001** | 1.7 | 0.44 | 2.3 | 0.49 | 1.1 | 0.52 | 0.5 | 0.34 |
| **2002** | 5.0 | 0.52 | 0.4 | 0.57 | 2.0 | 0.37 | 1.3 | 0.36 |
| **2003** | 3.9 | 0.22 | 2.0 | 0.27 | 0.9 | 0.33 | 2.2 | 0.29 |
| **2004** | 10.3 | 0.82 | 0.5 | 0.28 | 0.7 | 0.40 | 1.5 | 0.48 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table H-3. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of redbanded rockfish from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| | Vancouver-Columbia | | | | Eureka-Monterey | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| | Predicted proportion positive based on Delta-GLM model | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.63 | 0.10 | 0.29 | 0.19 | 0.59 | 0.12 | 0.25 | 0.21 |
| **1996*** | 0.49 | 0.15 | 0.18 | 0.25 | 0.44 | 0.17 | 0.16 | 0.27 |
| **1997** | 0.48 | 0.19 | 0.18 | 0.31 | 0.43 | 0.20 | 0.15 | 0.33 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.57 | 0.10 | 0.24 | 0.17 | 0.53 | 0.11 | 0.21 | 0.18 |
| **2000** | 0.57 | 0.10 | 0.24 | 0.17 | 0.52 | 0.11 | 0.21 | 0.18 |
| **2001** | 0.51 | 0.12 | 0.20 | 0.19 | 0.46 | 0.13 | 0.17 | 0.20 |
| **2002** | 0.49 | 0.14 | 0.18 | 0.22 | 0.44 | 0.14 | 0.16 | 0.22 |
| **2003** | 0.63 | 0.09 | 0.29 | 0.18 | 0.59 | 0.10 | 0.24 | 0.19 |
| **2004** | 0.54 | 0.13 | 0.22 | 0.25 | 0.49 | 0.15 | 0.19 | 0.27 |
| | Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 0.4 | 0.43 | 0.7 | 0.42 | 0.9 | 0.41 | 0.6 | 0.70 |
| **1996*** | 0.4 | 0.46 | 0.5 | 0.45 | 0.2 | 0.52 | 3.1 | 2.11 |
| **1997** | 0.4 | 0.78 | 0.9 | 1.05 | 0.1 | 0.88 | 0.2 | 1.27 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.5 | 0.39 | 0.5 | 0.39 | 0.5 | 0.46 | 0.4 | 0.33 |
| **2000** | 0.6 | 0.34 | 0.6 | 0.43 | 0.4 | 0.37 | 0.7 | 0.44 |
| **2001** | 0.7 | 0.42 | 1.0 | 0.54 | 0.3 | 0.47 | 0.3 | 0.45 |
| **2002** | 1.9 | 0.47 | 0.2 | 1.31 | 0.9 | 0.52 | 0.8 | 0.49 |
| **2003** | 1.9 | 0.41 | 1.3 | 0.58 | 0.4 | 0.51 | 1.5 | 0.48 |
| **2004** | 2.1 | 0.47 | 0.3 | 0.72 | 0.5 | 0.73 | 1.0 | 0.72 |
| | Predicted biomass (mt) by strata | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 98.7 | 0.45 | 128.0 | 0.47 | 109.4 | 0.43 | 60.3 | 0.77 |
| **1996*** | 71.2 | 0.50 | 54.5 | 0.53 | 19.7 | 0.55 | 205.6 | 2.22 |
| **1997** | 71.9 | 0.84 | 105.8 | 1.23 | 11.2 | 0.92 | 14.7 | 1.54 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 116.8 | 0.41 | 69.5 | 0.43 | 47.1 | 0.49 | 32.8 | 0.38 |
| **2000** | 130.1 | 0.37 | 91.6 | 0.50 | 38.7 | 0.40 | 61.2 | 0.49 |
| **2001** | 130.3 | 0.43 | 116.0 | 0.61 | 26.1 | 0.51 | 20.7 | 0.52 |
| **2002** | 368.7 | 0.49 | 27.1 | 1.34 | 75.1 | 0.56 | 54.2 | 0.58 |
| **2003** | 468.9 | 0.42 | 229.6 | 0.62 | 45.2 | 0.53 | 158.9 | 0.53 |
| **2004** | 435.0 | 0.50 | 42.5 | 0.80 | 43.5 | 0.81 | 81.0 | 0.85 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table H-4. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of redbanded rockfish from the Delta-GLM applied to NWFSC slope surveys.

| | Vancouver-Columbia | | | | Eureka-Monterey | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.54 | 0.11 | 0.25 | 0.17 | 0.50 | 0.11 | 0.22 | 0.18 |
| **2000** | 0.55 | 0.10 | 0.25 | 0.17 | 0.51 | 0.11 | 0.22 | 0.18 |
| **2001** | 0.48 | 0.12 | 0.21 | 0.18 | 0.44 | 0.13 | 0.18 | 0.19 |
| **2002** | 0.46 | 0.14 | 0.19 | 0.21 | 0.42 | 0.15 | 0.17 | 0.21 |
| **2003** | 0.61 | 0.10 | 0.30 | 0.18 | 0.57 | 0.11 | 0.27 | 0.19 |
| **2004** | 0.53 | 0.14 | 0.24 | 0.23 | 0.48 | 0.15 | 0.21 | 0.25 |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.51 | 0.41 | 0.45 | 0.42 | 0.5 | 0.46 | 0.4 | 0.33 |
| **2000** | 0.57 | 0.35 | 0.64 | 0.41 | 0.4 | 0.37 | 0.7 | 0.44 |
| **2001** | 0.66 | 0.39 | 0.99 | 0.48 | 0.3 | 0.45 | 0.3 | 0.41 |
| **2002** | 1.84 | 0.50 | 0.23 | 1.25 | 0.8 | 0.52 | 0.8 | 0.45 |
| **2003** | 1.90 | 0.41 | 1.27 | 0.51 | 0.4 | 0.49 | 1.5 | 0.46 |
| **2004** | 2.04 | 0.47 | 0.31 | 0.75 | 0.4 | 0.73 | 1.0 | 0.70 |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 106.4 | 0.42 | 67.5 | 0.47 | 44.3 | 0.49 | 33.6 | 0.39 |
| **2000** | 119.8 | 0.37 | 97.6 | 0.47 | 37.5 | 0.39 | 67.9 | 0.50 |
| **2001** | 123.1 | 0.42 | 124.8 | 0.54 | 24.7 | 0.47 | 22.4 | 0.47 |
| **2002** | 325.0 | 0.53 | 27.6 | 1.31 | 68.6 | 0.56 | 56.6 | 0.54 |
| **2003** | 447.5 | 0.42 | 235.6 | 0.55 | 44.4 | 0.52 | 170.1 | 0.54 |
| **2004** | 413.9 | 0.51 | 46.4 | 0.78 | 43.3 | 0.76 | 88.6 | 0.82 |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table H-5. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of redbanded rockfish from the Delta-GLM applied to AFSC slope surveys.

| | Vancouver-Columbia | | | | Eureka-Monterey | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **183–299 m** | | **300–567 m** | | **183–299 m** | | **300–567 m** | |
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.69 | 0.08 | 0.25 | 0.16 | 0.56 | 0.12 | 0.16 | 0.23 |
| **1996*** | 0.53 | 0.12 | 0.15 | 0.21 | 0.39 | 0.17 | 0.09 | 0.29 |
| **1997** | 0.55 | 0.16 | 0.15 | 0.31 | 0.40 | 0.21 | 0.09 | 0.36 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.55 | 0.16 | 0.15 | 0.30 | 0.41 | 0.20 | 0.09 | 0.34 |
| **2000** | 0.66 | 0.12 | 0.22 | 0.25 | 0.52 | 0.16 | 0.14 | 0.30 |
| **2001** | 0.58 | 0.15 | 0.17 | 0.30 | 0.43 | 0.19 | 0.10 | 0.34 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 0.4 | 0.36 | 0.7 | 0.41 | 0.9 | 0.35 | 0.6 | 0.66 |
| **1996*** | 0.4 | 0.43 | 0.5 | 0.44 | 0.2 | 0.49 | 2.7 | 1.98 |
| **1997** | 0.4 | 0.79 | 1.0 | 1.05 | 0.1 | 0.76 | 0.2 | 1.52 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.4 | 0.87 | 0.5 | 0.58 | 0.3 | 0.95 | 0.4 | 1.35 |
| **2000** | 0.5 | 0.81 | 0.6 | 0.56 | 0.5 | 0.89 | 0.2 | 1.40 |
| **2001** | 0.7 | 0.64 | 2.0 | 0.98 | 0.4 | 1.19 | 0.1 | 1.21 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 104.7 | 0.38 | 105.7 | 0.47 | 95.1 | 0.38 | 37.6 | 0.74 |
| **1996*** | 75.7 | 0.44 | 41.5 | 0.52 | 16.8 | 0.53 | 100.6 | 2.02 |
| **1997** | 75.6 | 0.83 | 87.4 | 1.19 | 10.0 | 0.86 | 8.0 | 1.70 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 82.9 | 0.90 | 47.4 | 0.67 | 22.7 | 0.93 | 15.8 | 1.65 |
| **2000** | 133.0 | 0.83 | 76.1 | 0.65 | 54.5 | 0.90 | 11.7 | 1.42 |
| **2001** | 158.0 | 0.70 | 202.2 | 1.10 | 31.4 | 1.33 | 4.7 | 1.46 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

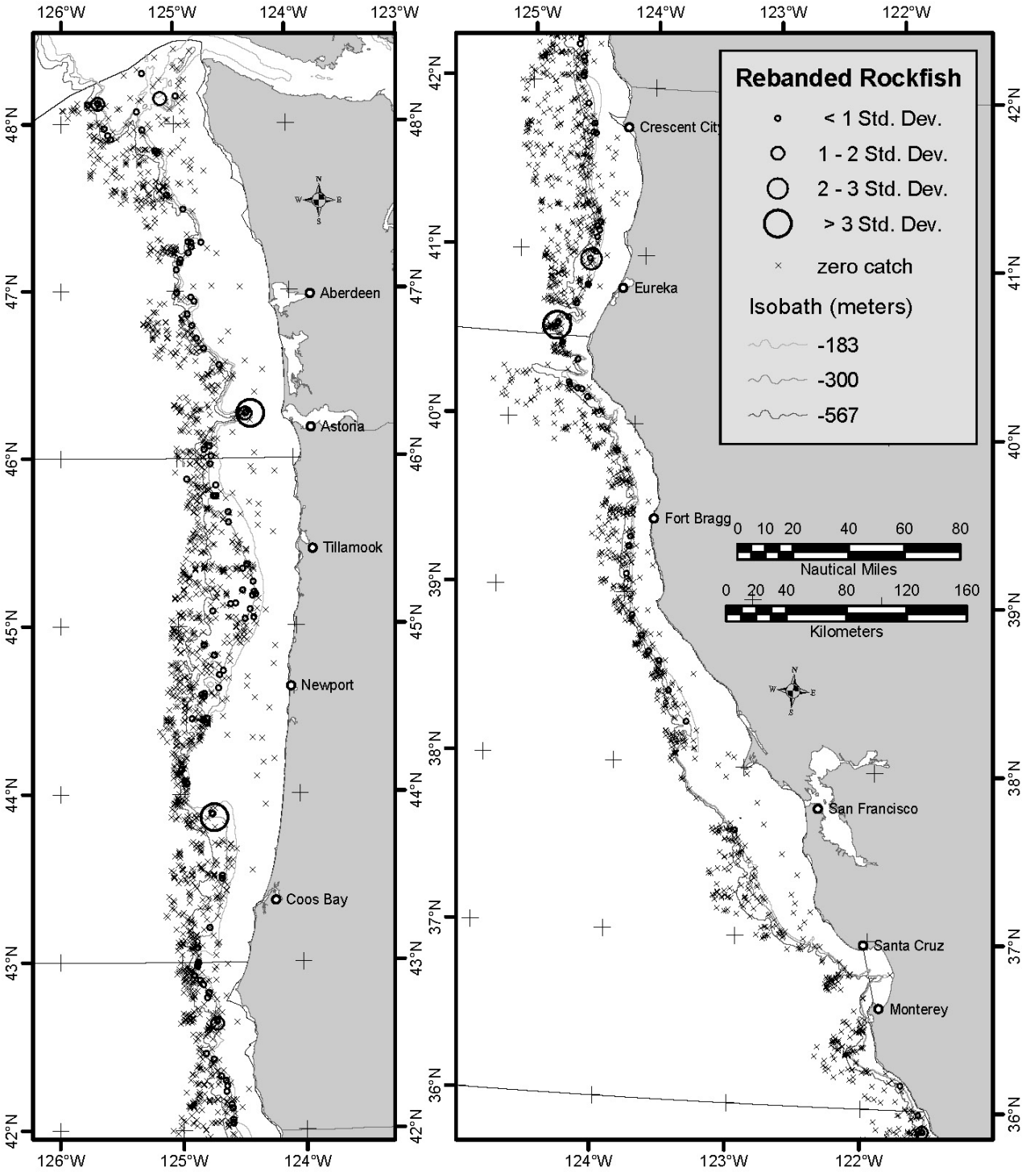



Figure H-1. Distribution of redbanded rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

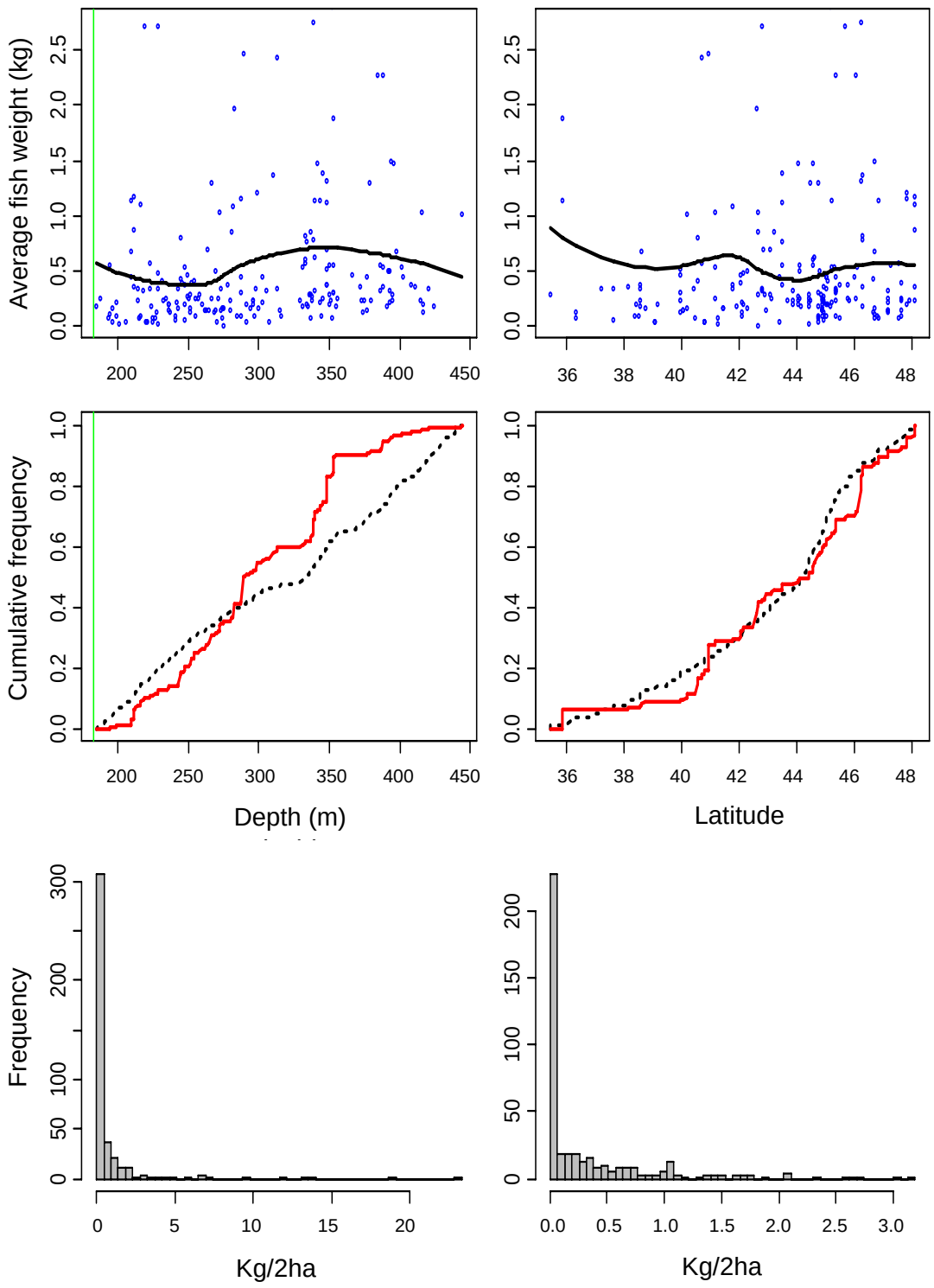



Figure H-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of redbanded rockfish caught in the AFSC slope surveys.

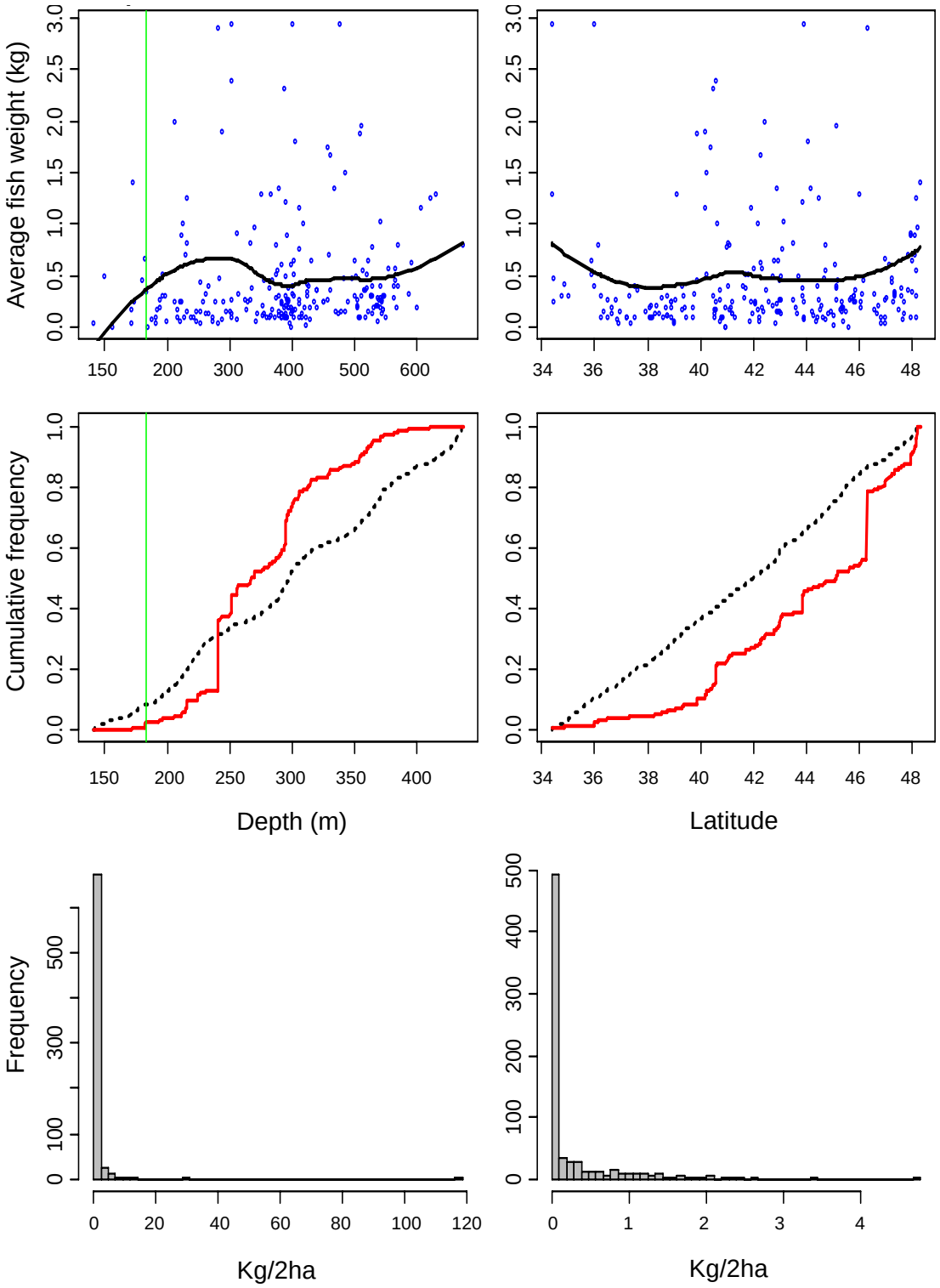



Figure H-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of redbanded rockfish caught in the NWFSC slope surveys.

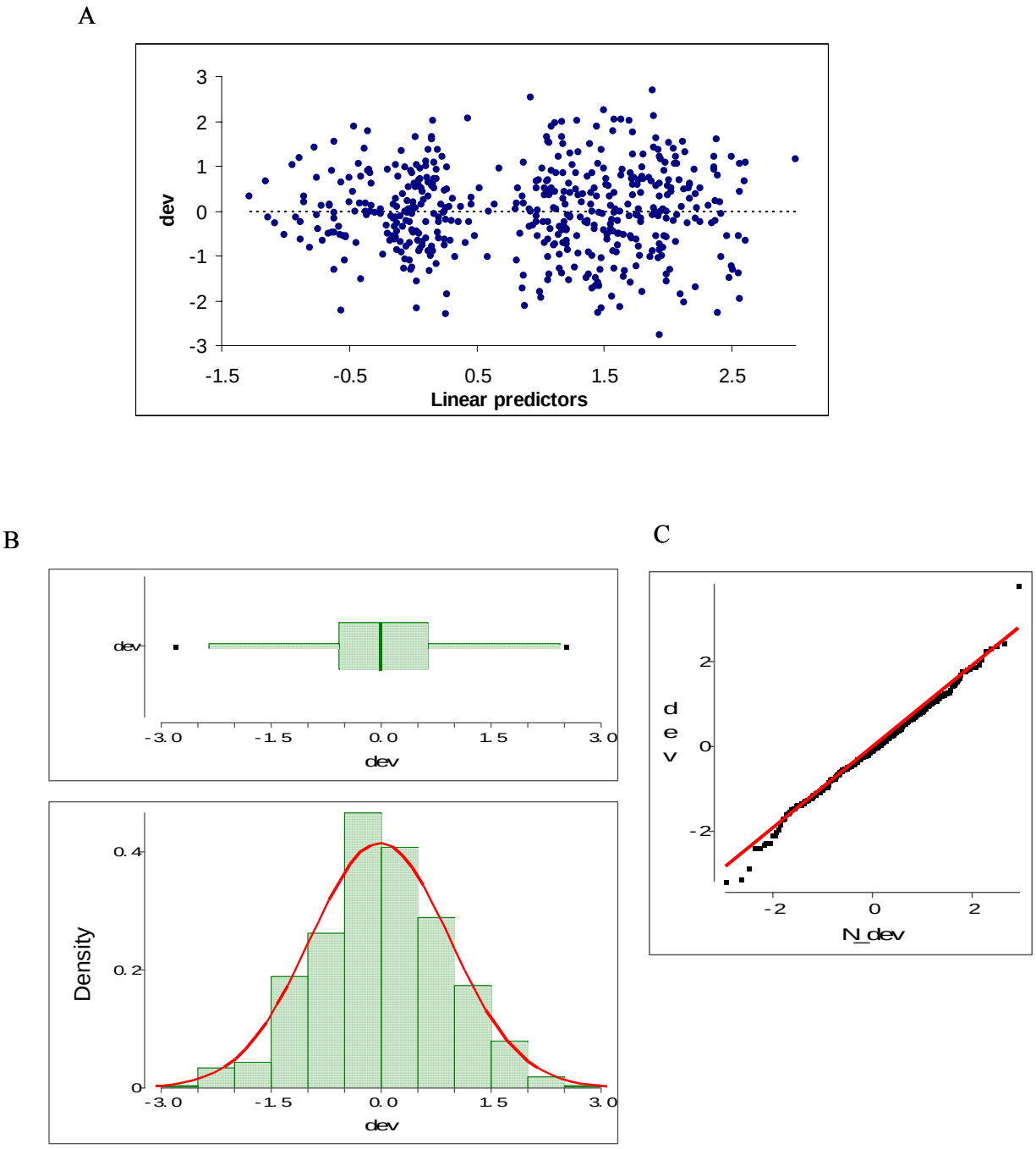



Figure H-4. Diagnostic plots from the generalized linear mixed model fit to redbanded rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

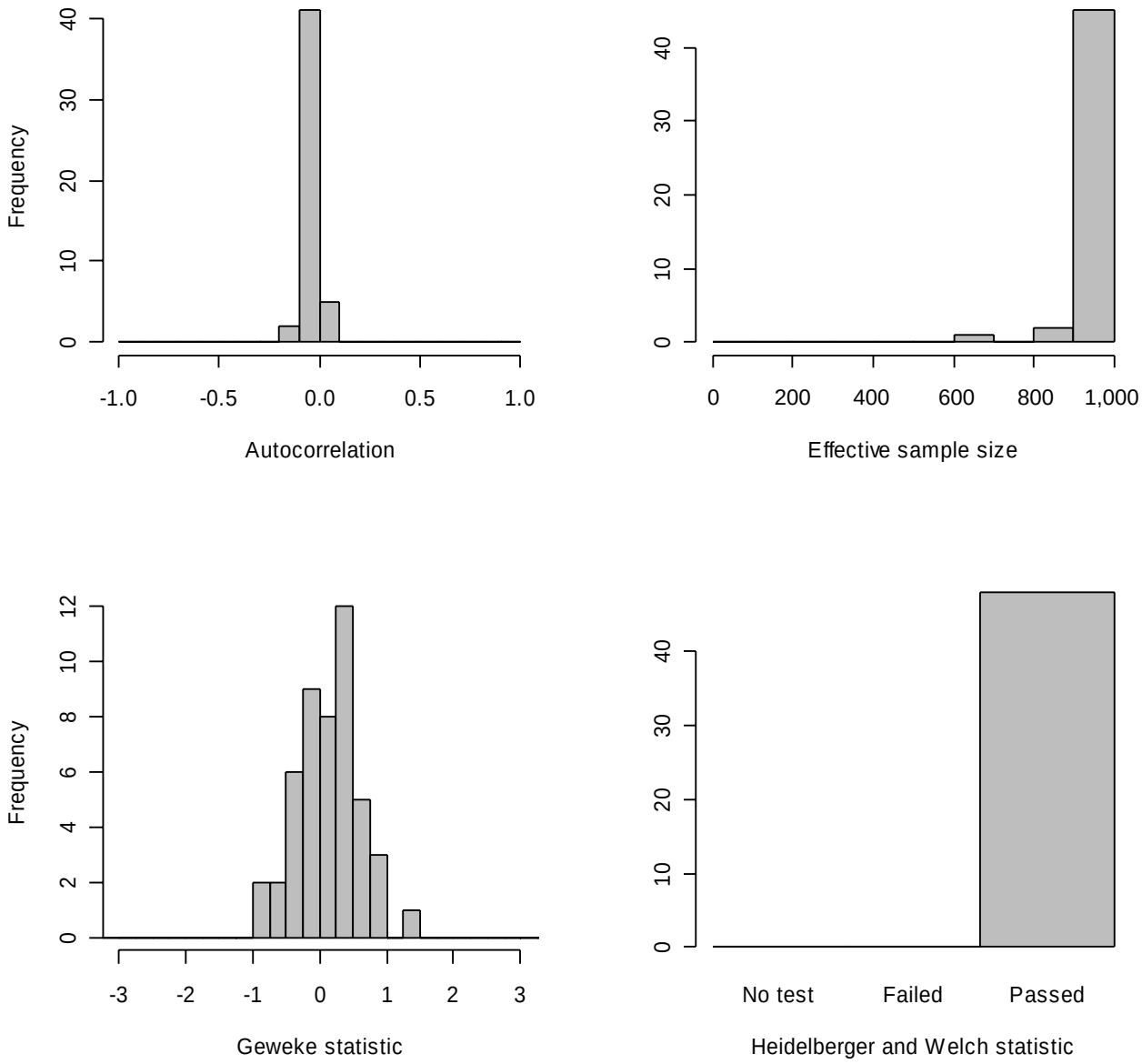
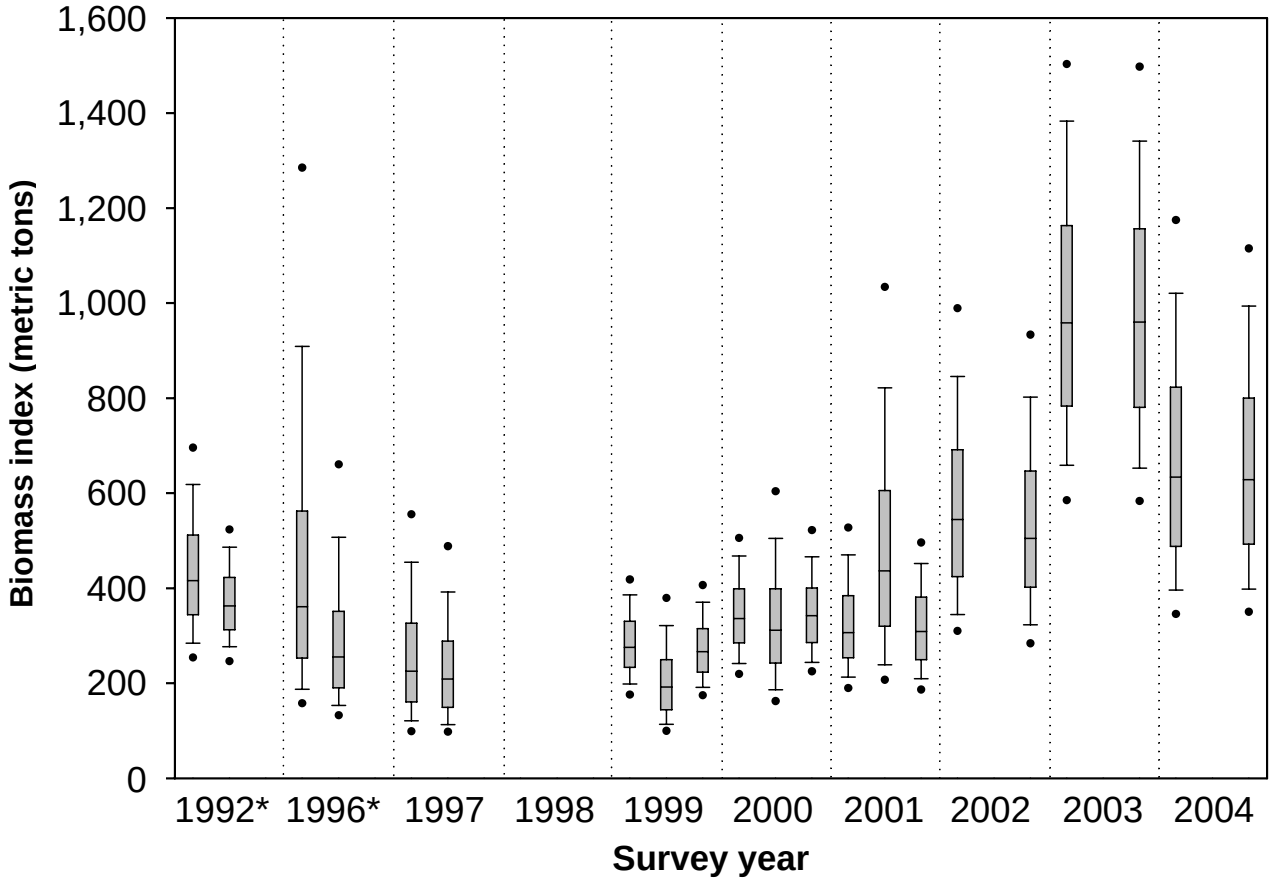



Figure H-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for redbanded rockfish. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure H-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for redbanded rockfish. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix I: Aurora Rockfish (*Sebastes aurora*)

This appendix has tables I-1 though I-5 and figures I-1 though I-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for Aurora rockfish. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table I-1. Basic data and statistics summary for aurora rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Vancouver | | | | Columbia | | | | Eureka | | | | Monterey | | | | Conception | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | | 183–567 m | | 567–1,280 m | |
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 |
| **1992*** | 27 | 6 | 36 | 0 | 57 | 22 | 81 | 0 | 37 | 19 | 93 | 2 | 26 | 15 | 40 | 2 | – | – | – | – |
| **1996*** | 29 | 6 | 44 | 0 | 55 | 24 | 76 | 0 | 34 | 18 | 72 | 1 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 1 | 16 | 0 | 20 | 8 | 28 | 0 | 10 | 5 | 20 | 0 | 17 | 10 | 33 | 2 | 11 | 8 | 18 | 0 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 36 | 6 | 55 | 0 | 58 | 23 | 71 | 0 | 39 | 16 | 61 | 0 | 65 | 38 | 82 | 6 | 23 | 18 | 33 | 0 |
| **2000** | 35 | 2 | 47 | 1 | 59 | 13 | 70 | 0 | 37 | 20 | 60 | 0 | 73 | 33 | 94 | 3 | 27 | 17 | 36 | 2 |
| **2001** | 36 | 8 | 50 | 0 | 71 | 33 | 59 | 0 | 38 | 15 | 58 | 1 | 65 | 30 | 99 | 5 | 29 | 19 | 36 | 4 |
| **2002** | 4 | 0 | 24 | 0 | 15 | 3 | 39 | 1 | 12 | 0 | 41 | 0 | 17 | 0 | 61 | 1 | 20 | 1 | 55 | 4 |
| **2003** | 16 | 1 | 44 | 0 | 8 | 0 | 37 | 1 | 17 | 0 | 33 | 0 | 11 | 1 | 24 | 1 | 17 | 0 | 27 | 2 |
| **2004** | 7 | 0 | 14 | 0 | 19 | 0 | 19 | 1 | 7 | 0 | 23 | 0 | 9 | 0 | 21 | 3 | 15 | 0 | 49 | 6 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 0.2 | 0.53 | 0.0 | N/A | 0.7 | 0.46 | 0.0 | N/A | 2.6 | 0.27 | 0.0 | 0.73 | 4.6 | 0.37 | 0.1 | 0.89 | – | – | – | – |
| **1996*** | 0.2 | 0.47 | 0.0 | N/A | 0.8 | 0.32 | 0.0 | N/A | 3.6 | 0.33 | 0.0 | 1.00 | – | – | – | – | – | – | – | – |
| **1997** | 0.1 | 1.00 | 0.0 | N/A | 0.3 | 0.50 | 0.0 | N/A | 3.0 | 0.57 | 0.0 | N/A | 5.4 | 0.72 | 0.0 | 0.72 | 8.9 | 0.42 | 0.1 | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 0.1 | 0.56 | 0.0 | N/A | 0.6 | 0.28 | 0.0 | N/A | 1.4 | 0.36 | 0.0 | N/A | 3.3 | 0.21 | 0.1 | 0.54 | 9.1 | 0.29 | 0.1 | N/A |
| **2000** | 0.1 | 0.88 | 0.0 | 1.00 | 0.6 | 0.38 | 0.0 | N/A | 1.6 | 0.27 | 0.0 | N/A | 3.1 | 0.25 | 0.1 | 0.70 | 10.5 | 0.23 | 0.0 | 0.73 |
| **2001** | 0.6 | 0.44 | 0.0 | N/A | 1.0 | 0.22 | 0.0 | N/A | 2.0 | 0.35 | 0.0 | 1.00 | 4.3 | 0.33 | 0.0 | 0.50 | 9.2 | 0.27 | 0.0 | 0.80 |
| **2002** | 0.8 | 0.38 | 0.0 | N/A | 0.9 | 0.32 | 0.0 | 1.00 | 1.8 | 0.47 | 0.0 | N/A | 3.9 | 0.22 | 0.2 | 1.00 | 3.8 | 0.33 | 0.1 | 0.63 |
| **2003** | 0.1 | 0.72 | 0.0 | N/A | 0.7 | 0.41 | 0.1 | 1.00 | 2.2 | 0.47 | 0.0 | N/A | 3.5 | 0.49 | 0.0 | 1.00 | 4.2 | 0.31 | 0.7 | 0.71 |
| **2004** | 0.0 | 0.00 | 0.0 | N/A | 0.0 | 0.00 | 0.0 | 1.00 | 0.0 | 0.00 | 0.0 | N/A | 0.0 | 0.00 | 0.9 | 0.89 | 0.0 | 0.00 | 0.2 | 0.57 |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 0.7 | 0.41 | N/A | N/A | 1.9 | 0.44 | N/A | N/A | 5.0 | 0.22 | 1.3 | 0.28 | 8.1 | 0.33 | 2.4 | 0.76 | – | – | – | – |
| **1996*** | 1.0 | 0.31 | N/A | N/A | 1.8 | 0.28 | N/A | N/A | 6.7 | 0.28 | 0.7 | N/A | – | – | – | – | – | – | – | – |
| **1997** | 0.9 | 0.00 | N/A | N/A | 0.7 | 0.44 | N/A | N/A | 6.1 | 0.48 | N/A | N/A | 9.2 | 0.70 | 0.3 | 0.28 | 12.2 | 0.37 | N/A | N/A |
| **1998** | – | – | N/A | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 0.6 | 0.45 | N/A | N/A | 1.5 | 0.24 | N/A | N/A | 3.4 | 0.31 | N/A | N/A | 5.7 | 0.18 | 0.9 | 0.40 | 11.6 | 0.27 | N/A | N/A |
| **2000** | 1.4 | 0.76 | N/A | N/A | 2.5 | 0.30 | N/A | N/A | 3.0 | 0.22 | N/A | N/A | 6.8 | 0.22 | 2.5 | 0.49 | 16.0 | 0.18 | 0.0 | 0.00 |
| **2001** | 2.8 | 0.32 | N/A | N/A | 2.1 | 0.19 | N/A | N/A | 5.2 | 0.30 | 0.4 | N/A | 9.3 | 0.30 | 0.8 | 0.26 | 14.1 | 0.23 | 0.6 | 0.55 |
| **2002** | 2.1 | 0.28 | N/A | N/A | 2.7 | 0.26 | 1.0 | N/A | 4.1 | 0.42 | N/A | N/A | 7.4 | 0.18 | 12.3 | N/A | 8.2 | 0.30 | 2.0 | 0.46 |
| **2003** | 1.0 | 0.55 | N/A | N/A | 2.8 | 0.25 | 1.9 | N/A | 6.0 | 0.42 | N/A | N/A | 8.0 | 0.45 | 1.1 | N/A | 8.8 | 0.28 | 9.1 | 0.22 |
| **2004** | 0.0 | 0.00 | N/A | N/A | 0.0 | 0.00 | 0.5 | N/A | 0.0 | 0.0 | N/A | N/A | 0.0 | 0.00 | 6.3 | 0.84 | 0.0 | 0.00 | 1.0 | 0.47 |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993, and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* extended only as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table I-2. Poststratified data and statistics summary for aurora rockfish caught between 300 and 567 m in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Columbia | | Eureka | | Monterey | | Conception | |
|---|---|---|---|---|---|---|---|---|
| | Total number and number positive tows by year and spatial strata | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1992*** | 44 | 22 | 20 | 18 | 18 | 15 | – | – |
| **1996*** | 41 | 23 | 17 | 16 | – | – | – | – |
| **1997** | 14 | 7 | 5 | 5 | 11 | 10 | 9 | 8 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 36 | 19 | 23 | 15 | 47 | 34 | 17 | 16 |
| **2000** | 36 | 13 | 24 | 19 | 43 | 31 | 21 | 17 |
| **2001** | 56 | 31 | 27 | 14 | 41 | 29 | 23 | 19 |
| **2002** | 32 | 13 | 18 | 13 | 41 | 31 | 27 | 21 |
| **2003** | 22 | 7 | 19 | 13 | 22 | 13 | 38 | 26 |
| **2004** | 27 | 15 | 7 | 4 | 8 | 6 | 35 | 19 |
| | Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 0.9 | 0.46 | 4.7 | 0.23 | 6.7 | 0.35 | – | – |
| **1996*** | 1.0 | 0.31 | 7.1 | 0.28 | – | – | – | – |
| **1997** | 0.4 | 0.53 | 6.1 | 0.48 | 8.3 | 0.71 | 10.8 | 0.39 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.9 | 0.29 | 2.3 | 0.35 | 4.5 | 0.20 | 12.3 | 0.27 |
| **2000** | 0.9 | 0.37 | 2.4 | 0.24 | 5.2 | 0.23 | 12.9 | 0.21 |
| **2001** | 1.2 | 0.22 | 2.8 | 0.35 | 6.7 | 0.32 | 11.7 | 0.25 |
| **2002** | 1.2 | 0.34 | 3.0 | 0.45 | 5.6 | 0.20 | 6.6 | 0.31 |
| **2003** | 0.9 | 0.40 | 4.1 | 0.44 | 5.1 | 0.48 | 6.0 | 0.30 |
| **2004** | 5.0 | 0.33 | 2.6 | 0.73 | 8.3 | 0.50 | 4.7 | 0.40 |
| | Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | |
| **1992*** | 1.9 | 0.44 | 5.3 | 0.21 | 8.1 | 0.33 | – | – |
| **1996*** | 1.8 | 0.28 | 7.5 | 0.28 | – | – | – | – |
| **1997** | 0.8 | 0.47 | 6.1 | 0.48 | 9.2 | 0.70 | 12.2 | 0.37 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 1.6 | 0.25 | 3.6 | 0.31 | 6.2 | 0.18 | 13.0 | 0.26 |
| **2000** | 2.5 | 0.30 | 3.1 | 0.22 | 7.3 | 0.21 | 16.0 | 0.18 |
| **2001** | 2.2 | 0.19 | 5.4 | 0.30 | 9.5 | 0.31 | 14.1 | 0.23 |
| **2002** | 3.0 | 0.27 | 4.1 | 0.42 | 7.4 | 0.18 | 8.5 | 0.29 |
| **2003** | 2.8 | 0.25 | 6.0 | 0.42 | 8.6 | 0.45 | 8.8 | 0.28 |
| **2004** | 9.1 | 0.28 | 4.5 | 0.68 | 11.0 | 0.46 | 8.7 | 0.37 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table I-3. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of aurora rockfish from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| Year | Columbia | | Eureka | | Monterey | | Conception | |
|---|---|---|---|---|---|---|---|---|
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.43 | 0.19 | 0.72 | 0.11 | 0.73 | 0.10 | – | – |
| **1996*** | 0.45 | 0.20 | 0.73 | 0.11 | – | – | – | – |
| **1997** | 0.46 | 0.25 | 0.74 | 0.13 | 0.76 | 0.12 | 0.79 | 0.11 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.44 | 0.16 | 0.73 | 0.08 | 0.74 | 0.08 | 0.77 | 0.08 |
| **2000** | 0.42 | 0.17 | 0.71 | 0.09 | 0.72 | 0.08 | 0.76 | 0.08 |
| **2001** | 0.48 | 0.14 | 0.75 | 0.08 | 0.77 | 0.07 | 0.79 | 0.07 |
| **2002** | 0.48 | 0.15 | 0.75 | 0.08 | 0.77 | 0.07 | 0.80 | 0.07 |
| **2003** | 0.35 | 0.20 | 0.64 | 0.12 | 0.66 | 0.11 | 0.70 | 0.10 |
| **2004** | 0.37 | 0.21 | 0.66 | 0.12 | 0.68 | 0.11 | 0.72 | 0.09 |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 1.7 | 0.32 | 4.6 | 0.37 | 7.1 | 0.41 | – | – |
| **1996*** | 1.6 | 0.33 | 6.8 | 0.39 | – | – | – | – |
| **1997** | 0.7 | 0.59 | 5.4 | 0.78 | 8.1 | 0.48 | 11.0 | 0.55 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 1.6 | 0.33 | 3.3 | 0.39 | 6.0 | 0.26 | 12.1 | 0.39 |
| **2000** | 2.5 | 0.42 | 3.1 | 0.34 | 7.3 | 0.36 | 15.8 | 0.36 |
| **2001** | 2.2 | 0.28 | 5.4 | 0.39 | 9.3 | 0.27 | 13.7 | 0.34 |
| **2002** | 3.3 | 0.43 | 4.6 | 0.43 | 8.2 | 0.28 | 9.6 | 0.34 |
| **2003** | 2.8 | 0.56 | 6.5 | 0.40 | 9.2 | 0.41 | 9.1 | 0.29 |
| **2004** | 9.2 | 0.39 | 4.2 | 0.86 | 11.7 | 0.63 | 9.0 | 0.35 |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 170.7 | 0.39 | 286.4 | 0.39 | 632.9 | 0.43 | – | – |
| **1996*** | 163.6 | 0.40 | 422.3 | 0.40 | – | – | – | – |
| **1997** | 76.7 | 0.68 | 347.2 | 0.79 | 759.0 | 0.49 | 4,470.3 | 0.56 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 163.2 | 0.37 | 212.8 | 0.39 | 555.1 | 0.27 | 4,814.3 | 0.40 |
| **2000** | 244.5 | 0.45 | 187.9 | 0.34 | 659.7 | 0.37 | 6,221.9 | 0.37 |
| **2001** | 247.2 | 0.31 | 349.5 | 0.40 | 869.6 | 0.27 | 5,658.5 | 0.35 |
| **2002** | 378.9 | 0.46 | 302.6 | 0.44 | 775.6 | 0.30 | 3,949.5 | 0.36 |
| **2003** | 227.1 | 0.61 | 359.3 | 0.41 | 752.3 | 0.43 | 3,182.9 | 0.43 |
| **2004** | 799.3 | 0.45 | 242.3 | 0.89 | 986.3 | 0.64 | 4,172.8 | 0.64 |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table I-4. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of aurora rockfish between 183 and 300 m from the Delta-GLM applied to NWFSC slope surveys.

| Year | Columbia | | Eureka | | Monterey | | Conception | |
|---|---|---|---|---|---|---|---|---|
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.48 | 0.18 | 0.66 | 0.13 | 0.73 | 0.09 | 0.75 | 0.09 |
| **2000** | 0.47 | 0.17 | 0.66 | 0.12 | 0.73 | 0.09 | 0.74 | 0.09 |
| **2001** | 0.52 | 0.15 | 0.70 | 0.11 | 0.76 | 0.08 | 0.78 | 0.08 |
| **2002** | 0.52 | 0.15 | 0.70 | 0.11 | 0.76 | 0.08 | 0.78 | 0.07 |
| **2003** | 0.40 | 0.21 | 0.58 | 0.15 | 0.67 | 0.11 | 0.69 | 0.10 |
| **2004** | 0.41 | 0.22 | 0.60 | 0.16 | 0.68 | 0.13 | 0.70 | 0.11 |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 1.8 | 0.52 | 2.5 | 0.48 | 6.4 | 0.31 | 10.6 | 0.56 |
| **2000** | 2.8 | 0.70 | 2.7 | 0.43 | 6.8 | 0.54 | 16.1 | 0.54 |
| **2001** | 2.6 | 0.35 | 4.8 | 0.49 | 8.9 | 0.37 | 11.9 | 0.46 |
| **2002** | 3.5 | 0.44 | 4.6 | 0.44 | 8.4 | 0.30 | 9.5 | 0.34 |
| **2003** | 2.8 | 0.64 | 6.6 | 0.45 | 8.7 | 0.44 | 9.0 | 0.32 |
| **2004** | 8.9 | 0.42 | 4.6 | 0.89 | 11.4 | 0.73 | 9.3 | 0.38 |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 194.1 | 0.58 | 138.9 | 0.51 | 571.2 | 0.33 | 4,057.9 | 0.58 |
| **2000** | 306.5 | 0.75 | 156.1 | 0.44 | 610.5 | 0.56 | 6,218.3 | 0.56 |
| **2001** | 310.2 | 0.39 | 289.6 | 0.50 | 822.8 | 0.39 | 4,806.7 | 0.48 |
| **2002** | 419.7 | 0.48 | 279.0 | 0.47 | 784.9 | 0.32 | 3,873.6 | 0.35 |
| **2003** | 254.5 | 0.71 | 329.6 | 0.49 | 718.7 | 0.47 | 3,040.7 | 0.47 |
| **2004** | 869.7 | 0.50 | 237.4 | 0.94 | 953.0 | 0.73 | 4,031.9 | 0.73 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table I-5. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of aurora rockfish from the Delta-GLM applied to AFSC slope surveys.

| Year | Columbia | | Eureka | | Monterey | | Conception | |
|---|---|---|---|---|---|---|---|---|
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.40 | 0.16 | 0.88 | 0.07 | 0.75 | 0.10 | – | – |
| **1996*** | 0.43 | 0.18 | 0.89 | 0.07 | – | – | – | – |
| **1997** | 0.43 | 0.25 | 0.89 | 0.08 | 0.77 | 0.12 | 0.86 | 0.11 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.46 | 0.23 | 0.90 | 0.08 | 0.79 | 0.11 | 0.87 | 0.10 |
| **2000** | 0.39 | 0.25 | 0.88 | 0.09 | 0.74 | 0.12 | 0.83 | 0.12 |
| **2001** | 0.43 | 0.23 | 0.89 | 0.08 | 0.78 | 0.11 | 0.86 | 0.11 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 1.9 | 0.33 | 5.2 | 0.32 | 8.2 | 0.37 | – | – |
| **1996*** | 1.8 | 0.29 | 7.6 | 0.34 | – | – | – | – |
| **1997** | 0.8 | 0.67 | 6.0 | 0.81 | 9.2 | 0.47 | 12.4 | 0.52 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 1.5 | 0.50 | 6.1 | 0.77 | 6.1 | 0.51 | 15.9 | 0.61 |
| **2000** | 2.6 | 0.63 | 4.9 | 0.78 | 9.5 | 0.62 | 18.6 | 0.62 |
| **2001** | 1.8 | 0.51 | 7.4 | 0.88 | 11.6 | 0.47 | 19.2 | 0.61 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | 174.6 | 0.37 | 389.9 | 0.34 | 747.0 | 0.39 | – | – |
| **1996*** | 181.3 | 0.36 | 578.5 | 0.36 | – | – | – | – |
| **1997** | 78.5 | 0.81 | 462.6 | 0.79 | 880.2 | 0.47 | 5,479.1 | 0.54 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 158.6 | 0.59 | 471.1 | 0.79 | 582.0 | 0.53 | 7,038.2 | 0.62 |
| **2000** | 227.5 | 0.72 | 366.0 | 0.78 | 846.1 | 0.62 | 7,949.7 | 0.62 |
| **2001** | 180.0 | 0.57 | 560.6 | 0.89 | 1,093.7 | 0.47 | 8,406.8 | 0.64 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

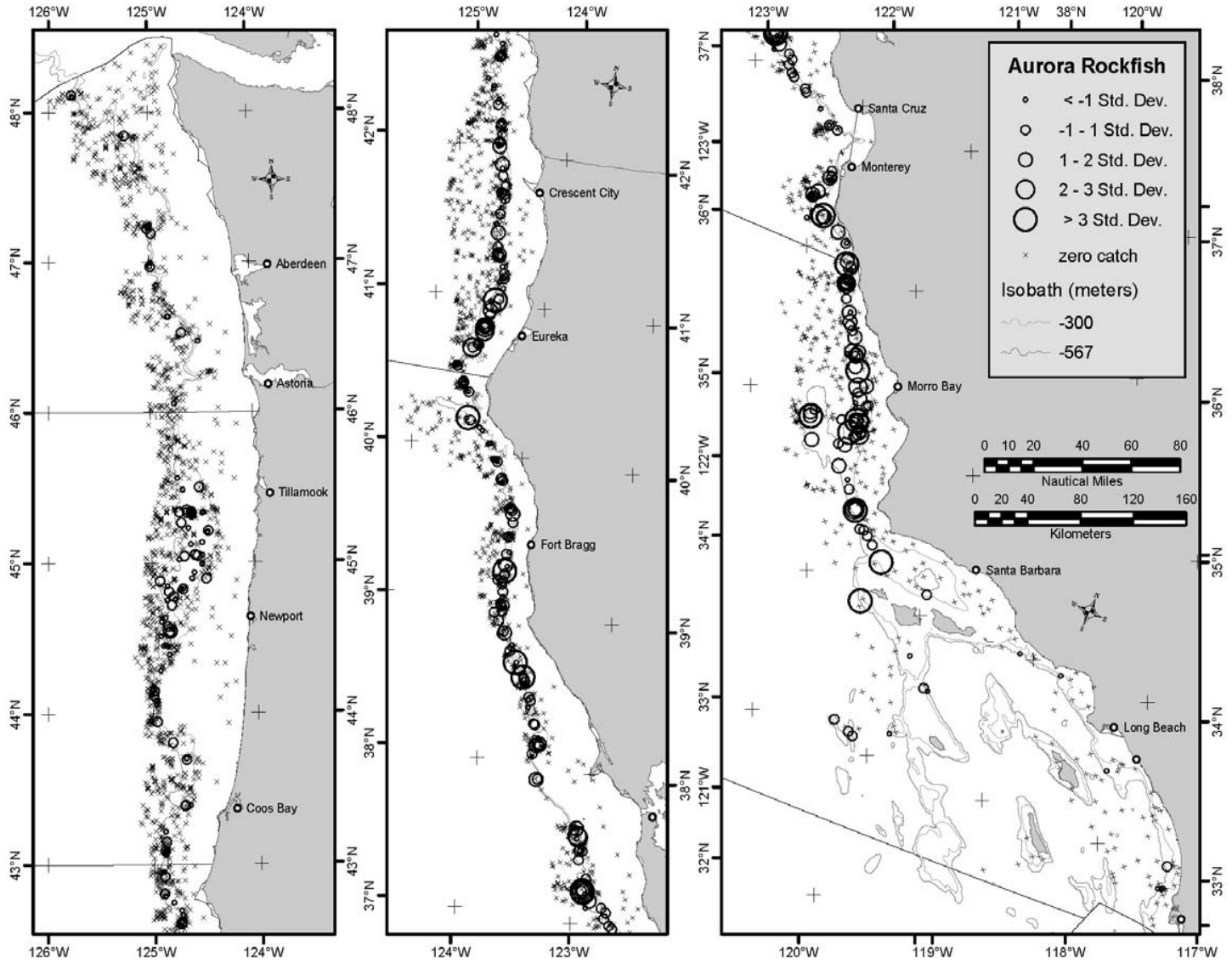



Figure I-1. Distribution of aurora rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

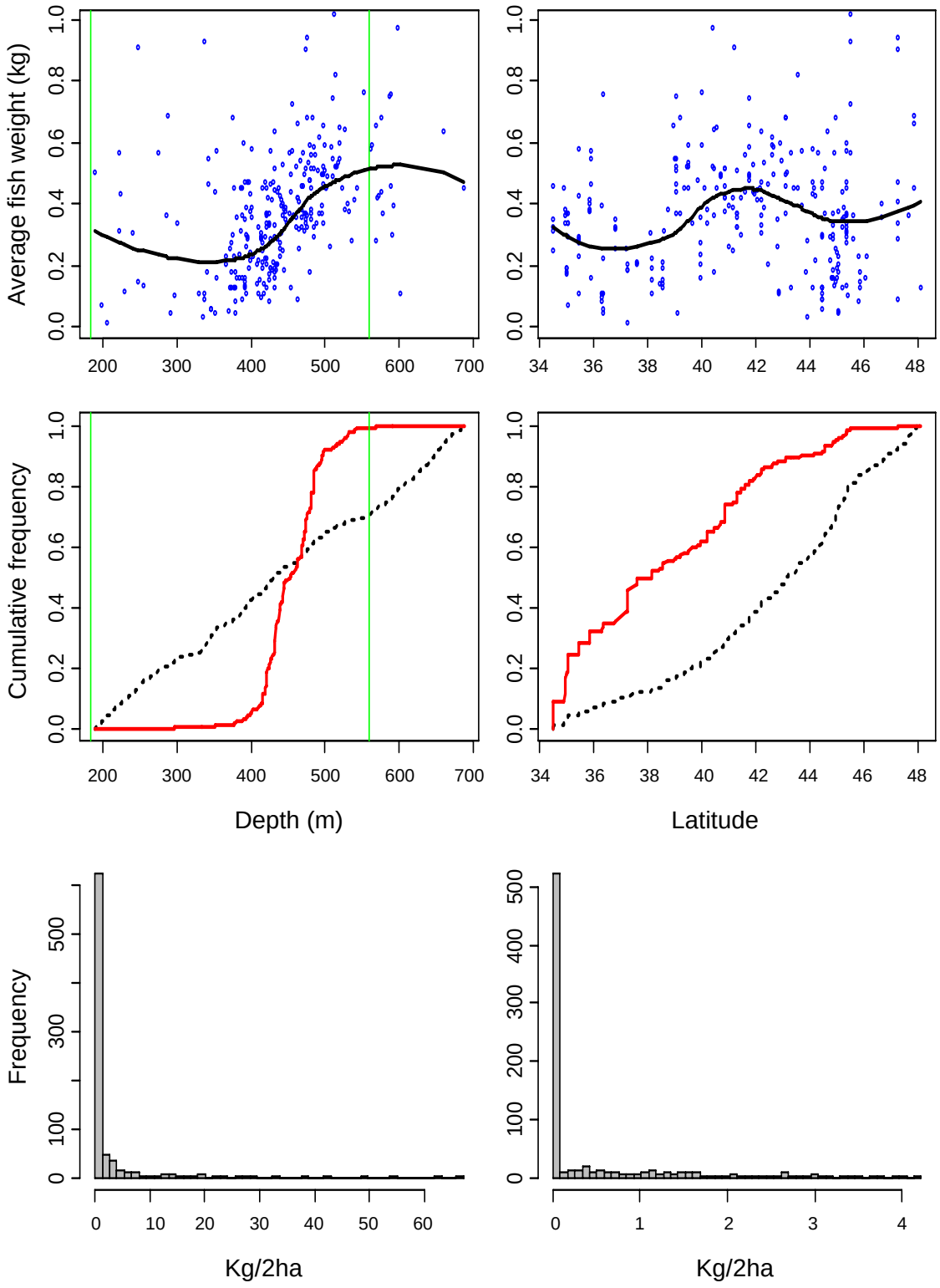



Figure I-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of aurora rockfish caught in the AFSC slope surveys.

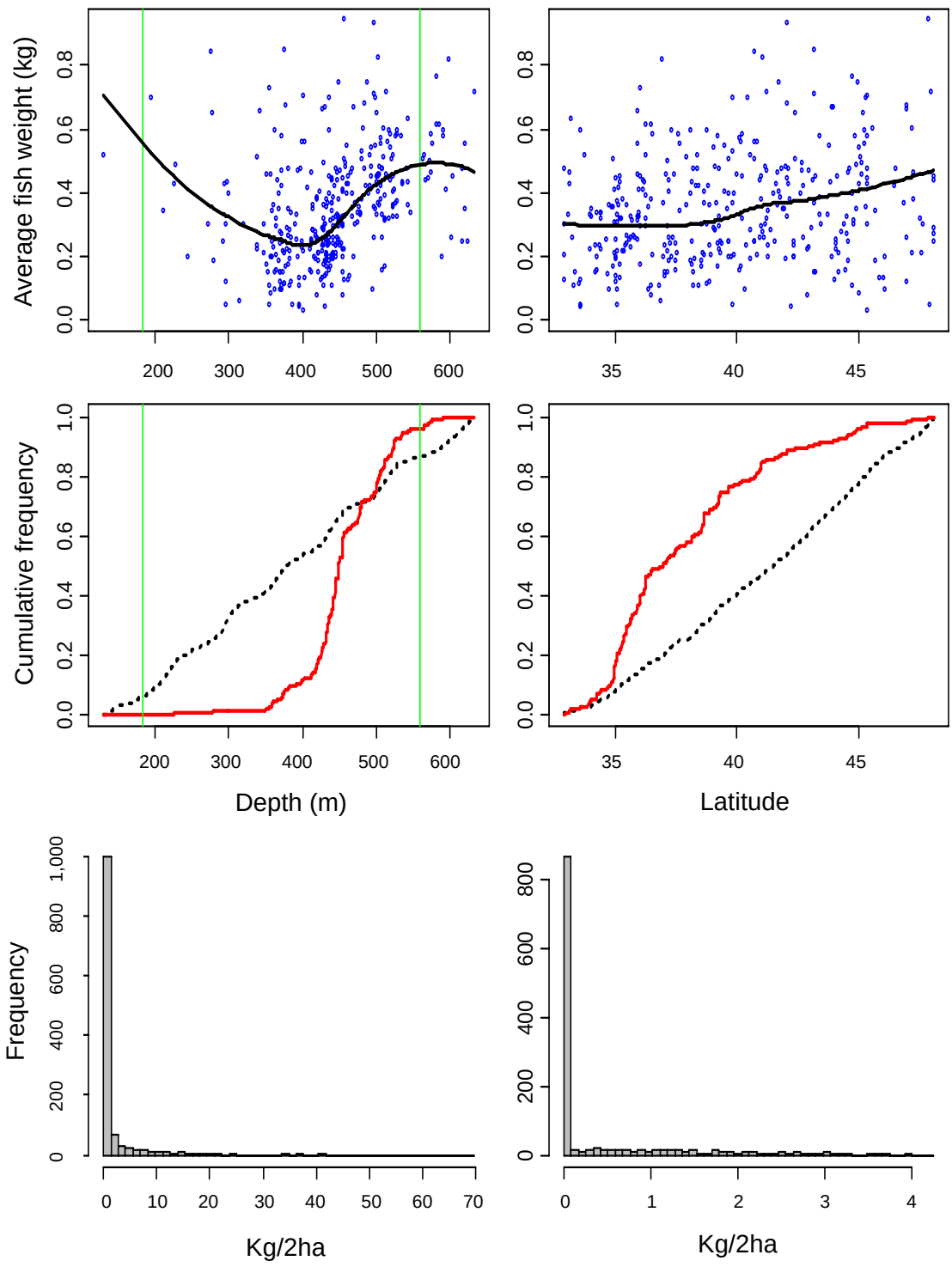



Figure I-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of aurora rockfish caught in the NWFSC slope surveys.

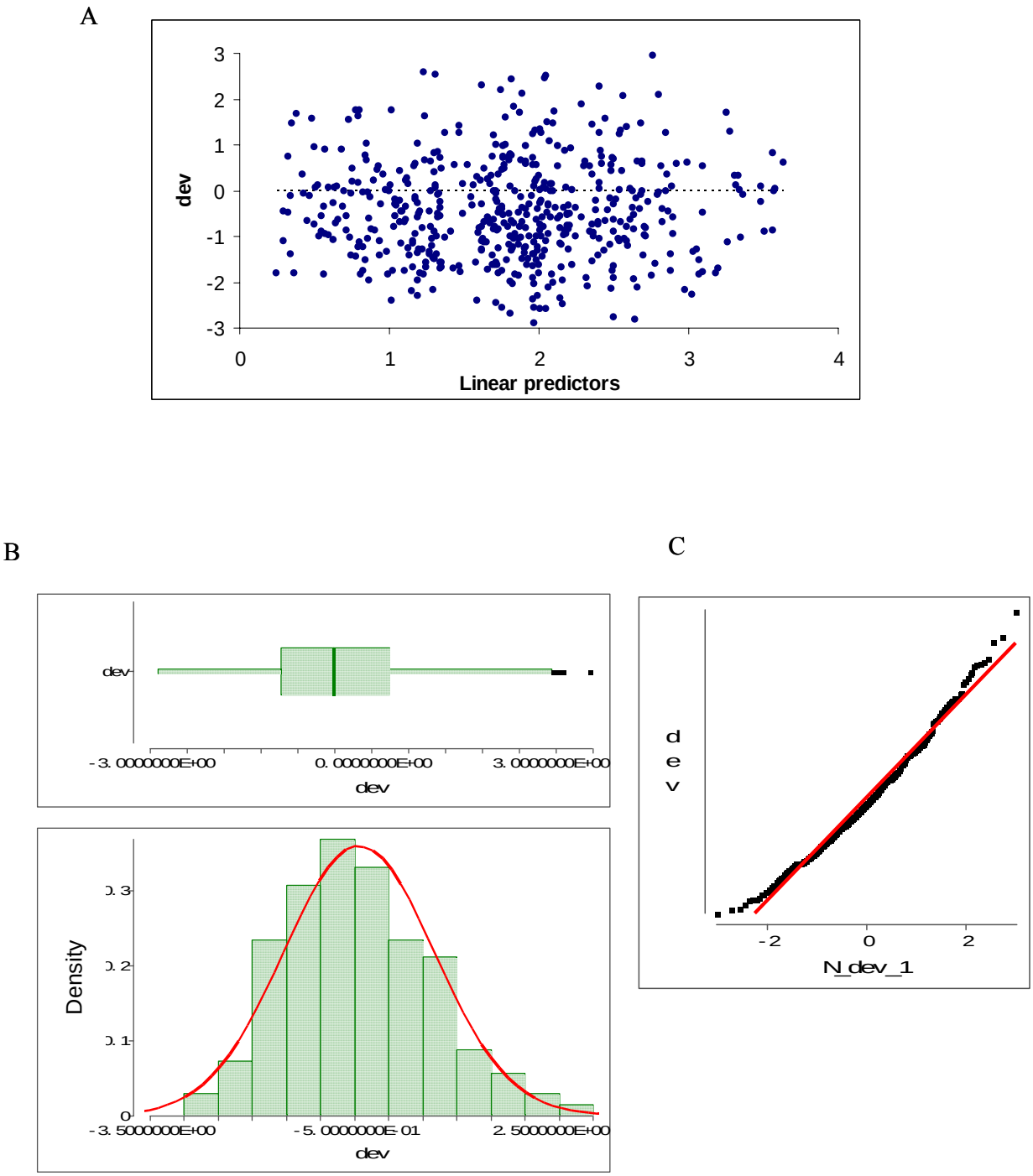



Figure I-4. Diagnostic plots from the generalized linear mixed model fit to aurora rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

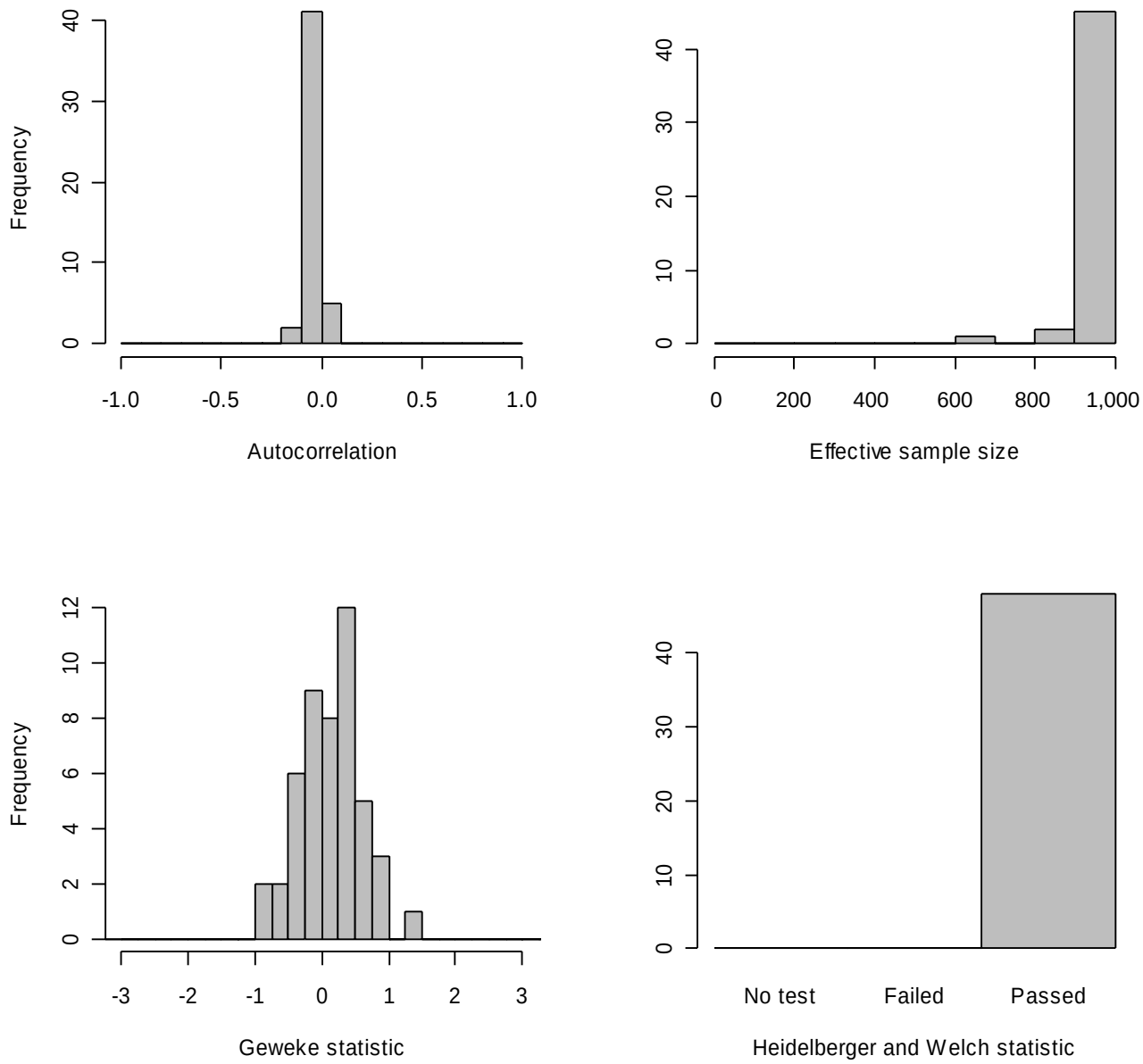
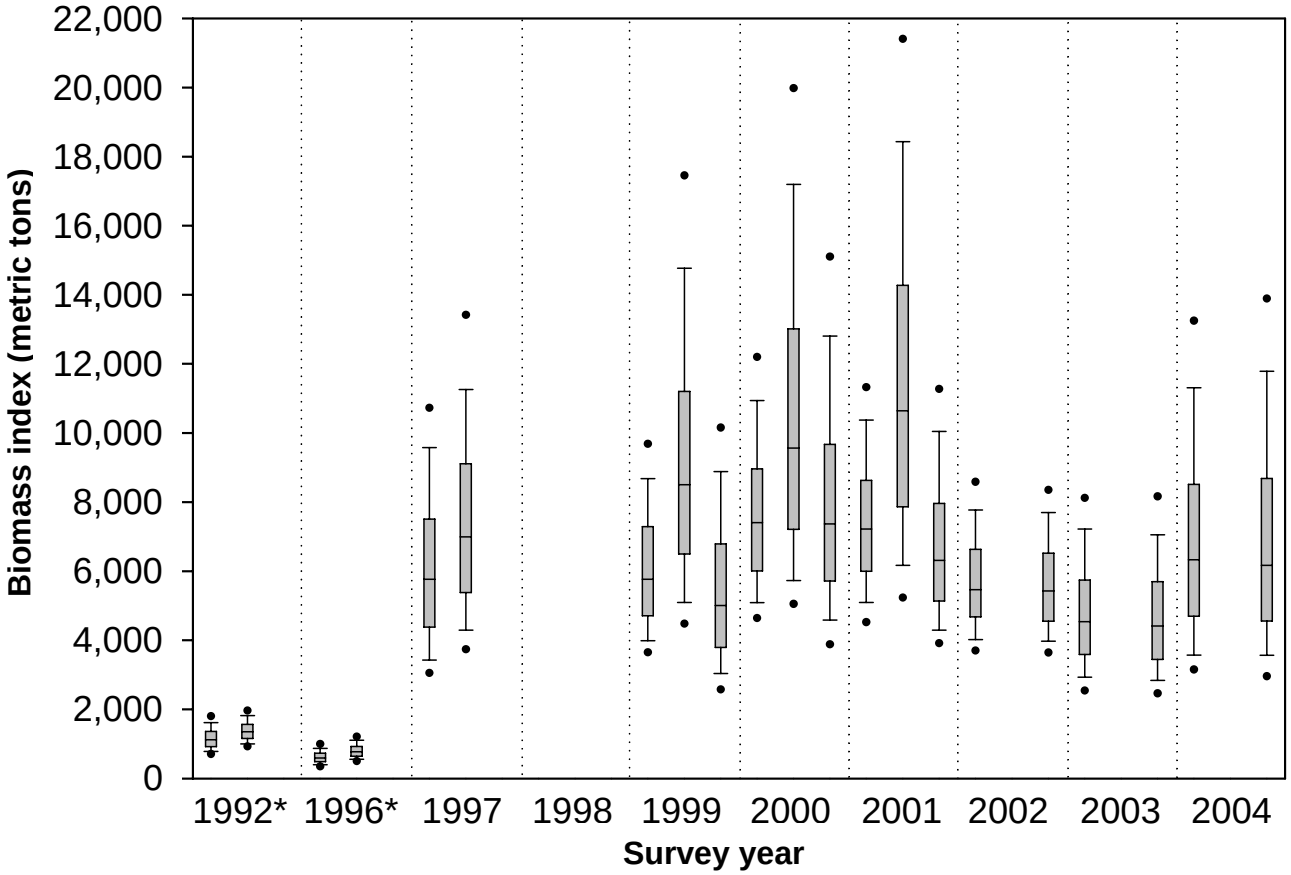



Figure I-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution of aurora rockfish. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure I-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for aurora rockfish. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix J: Stripetail Rockfish (*Sebastes saxicola*)

This appendix has tables J-1 though J-5 and figures J-1 though J-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for stripetail rockfish. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table J-1. Basic data and statistics summary for stripetail rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Vancouver 183–567 m | | Vancouver 567–1,280 m | | Columbia 183–567 m | | Columbia 567–1,280 | | Eureka 183–567 m | | Eureka 567–1,280 m | | Monterey 183–567 m | | Monterey 567–1,280 m | | Conception 183–567 m | | Conception 567–1,280 m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | |
| | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 |
| **1992*** | 27 | 2 | 36 | 0 | 57 | 6 | 81 | 0 | 37 | 16 | 93 | 0 | 26 | 11 | 40 | 0 | – | – | – | – |
| **1996*** | 29 | 3 | 44 | 0 | 55 | 8 | 76 | 0 | 34 | 15 | 72 | 0 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 2 | 16 | 0 | 20 | 3 | 28 | 0 | 10 | 5 | 20 | 0 | 17 | 6 | 33 | 0 | 11 | 4 | 18 | 0 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 36 | 1 | 55 | 0 | 58 | 17 | 71 | 0 | 38 | 14 | 61 | 0 | 65 | 28 | 82 | 0 | 23 | 6 | 33 | 0 |
| **2000** | 35 | 6 | 47 | 0 | 59 | 9 | 70 | 0 | 37 | 9 | 60 | 0 | 73 | 31 | 94 | 0 | 27 | 10 | 36 | 0 |
| **2001** | 36 | 4 | 50 | 0 | 71 | 3 | 59 | 0 | 38 | 8 | 58 | 0 | 65 | 31 | 99 | 0 | 29 | 13 | 36 | 0 |
| **2002** | 24 | 3 | 24 | 0 | 47 | 6 | 39 | 0 | 30 | 9 | 41 | 0 | 58 | 20 | 61 | 0 | 47 | 22 | 55 | 0 |
| **2003** | 28 | 3 | 44 | 0 | 30 | 3 | 37 | 0 | 36 | 10 | 33 | 0 | 32 | 13 | 24 | 0 | 55 | 23 | 27 | 0 |
| **2004** | 7 | 1 | 14 | 0 | 19 | 10 | 19 | 0 | 7 | 5 | 23 | 0 | 9 | 9 | 21 | 0 | 15 | 15 | 49 | 0 |
| | Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 0.7 | 0.86 | 0.0 | N/A | 0.4 | 0.67 | 0.0 | N/A | 8.2 | 0.40 | 0.0 | N/A | 6.5 | 0.43 | 0.0 | N/A | – | – | – | – |
| **1996*** | 0.7 | 0.78 | 0.0 | N/A | 0.3 | 0.60 | 0.0 | N/A | 9.0 | 0.41 | 0.0 | N/A | – | – | – | – | – | – | – | – |
| **1997** | 0.3 | 0.97 | 0.0 | N/A | 0.4 | 0.67 | 0.0 | N/A | 14.9 | 0.81 | 0.0 | N/A | 45.1 | 0.47 | 0.0 | N/A | 19.4 | 0.59 | 0.0 | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 0.2 | 1.00 | 0.0 | N/A | 11.6 | 0.63 | 0.0 | N/A | 6.6 | 0.35 | 0.0 | N/A | 16.8 | 0.30 | 0.0 | N/A | 5.5 | 0.47 | 0.0 | N/A |
| **2000** | 1.5 | 0.95 | 0.0 | N/A | 1.0 | 0.65 | 0.0 | N/A | 10.8 | 0.51 | 0.0 | N/A | 22.6 | 0.25 | 0.0 | N/A | 8.7 | 0.52 | 0.0 | N/A |
| **2001** | 2.4 | 0.80 | 0.0 | N/A | 0.0 | 0.72 | 0.0 | N/A | 3.2 | 0.46 | 0.0 | N/A | 23.6 | 0.24 | 0.0 | N/A | 7.6 | 0.43 | 0.0 | N/A |
| **2002** | 0.1 | 0.71 | 0.0 | N/A | 0.6 | 0.89 | 0.0 | N/A | 5.9 | 0.43 | 0.0 | N/A | 10.2 | 0.28 | 0.0 | N/A | 9.4 | 0.35 | 0.0 | N/A |
| **2003** | 0.7 | 0.98 | 0.0 | N/A | 0.6 | 0.96 | 0.0 | N/A | 21.0 | 0.57 | 0.0 | N/A | 21.2 | 0.38 | 0.0 | N/A | 5.4 | 0.56 | 0.0 | N/A |
| **2004** | 0.0 | 1.00 | 0.0 | N/A | 12.9 | 0.72 | 0.0 | N/A | 6.3 | 0.76 | 0.0 | N/A | 129.3 | 0.28 | 0.0 | N/A | 19.2 | 0.28 | 0.0 | N/A |
| | Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | |
| **1992*** | 9.4 | 0.70 | N/A | N/A | 4.3 | 0.60 | N/A | N/A | 18.9 | 0.36 | N/A | N/A | 15.5 | 0.38 | N/A | N/A | – | – | – | – |
| **1996*** | 6.4 | 0.66 | N/A | N/A | 1.8 | 0.53 | N/A | N/A | 20.5 | 0.36 | N/A | N/A | – | – | – | – | – | – | – | – |
| **1997** | 1.5 | 0.95 | N/A | N/A | 2.9 | 0.47 | N/A | N/A | 29.9 | 0.78 | N/A | N/A | 127.9 | 0.35 | N/A | N/A | 53.3 | 0.45 | N/A | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 7.3 | N/A | N/A | N/A | 39.5 | 0.61 | N/A | N/A | 17.9 | 0.28 | N/A | N/A | 39.0 | 0.27 | N/A | N/A | 20.9 | 0.33 | N/A | N/A |
| **2000** | 8.8 | 0.95 | N/A | N/A | 6.9 | 0.59 | N/A | N/A | 44.3 | 0.44 | N/A | N/A | 53.3 | 0.21 | N/A | N/A | 25.2 | 0.46 | N/A | N/A |
| **2001** | 21.9 | 0.72 | N/A | N/A | 0.4 | 0.53 | N/A | N/A | 15.0 | 0.35 | N/A | N/A | 49.5 | 0.20 | N/A | N/A | 17.0 | 0.38 | N/A | N/A |
| **2002** | 0.6 | 0.53 | N/A | N/A | 4.6 | 0.87 | N/A | N/A | 19.6 | 0.34 | N/A | N/A | 29.6 | 0.21 | N/A | N/A | 20.0 | 0.32 | N/A | N/A |
| **2003** | 6.5 | 0.97 | N/A | N/A | 5.6 | 0.94 | N/A | N/A | 75.6 | 0.52 | N/A | N/A | 52.2 | 0.32 | N/A | N/A | 13.0 | 0.55 | N/A | N/A |
| **2004** | 0.2 | N/A | N/A | N/A | 24.5 | 0.70 | N/A | N/A | 8.9 | 0.70 | N/A | N/A | 129.3 | 0.28 | N/A | N/A | 19.2 | 0.28 | N/A | N/A |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993, and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table J-2. Poststratified data and statistics summary for stripetail rockfish caught between 300 and 567 m in the slope surveys (AFSC and NWFSC slope surveys combined).

| Year | Columbia | | Eureka | | Monterey | | Conception | |
|---|---|---|---|---|---|---|---|---|
| | Total number and number positive tows by year and spatial strata | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1992*** | 14 | 6 | 17 | 14 | 9 | 8 | – | – |
| **1996*** | 14 | 8 | 17 | 14 | – | – | – | – |
| **1997** | 6 | 3 | 5 | 5 | 6 | 6 | 4 | 3 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 23 | 14 | 15 | 13 | 19 | 19 | 6 | 5 |
| **2000** | 23 | 8 | 14 | 9 | 30 | 26 | 6 | 6 |
| **2001** | 15 | 3 | 12 | 8 | 25 | 23 | 6 | 6 |
| **2002** | 15 | 6 | 12 | 9 | 17 | 15 | 20 | 19 |
| **2003** | 8 | 3 | 17 | 10 | 11 | 10 | 17 | 17 |
| **2004** | 19 | 10 | 7 | 5 | 9 | 9 | 15 | 15 |
| | Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 1.8 | 0.65 | 17.6 | 0.37 | 18.8 | 0.35 | – | – |
| **1996*** | 1.0 | 0.57 | 18.0 | 0.37 | – | – | – | – |
| **1997** | 1.5 | 0.61 | 29.9 | 0.78 | 127.9 | 0.35 | 14.8 | 1.00 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 29.1 | 0.62 | 16.7 | 0.29 | 54.2 | 0.26 | 19.8 | 0.38 |
| **2000** | 2.4 | 0.66 | 28.5 | 0.47 | 53.3 | 0.22 | 13.9 | 0.51 |
| **2001** | 0.1 | 0.70 | 10.0 | 0.40 | 55.7 | 0.22 | 17.9 | 0.55 |
| **2002** | 1.8 | 0.88 | 14.7 | 0.38 | 28.6 | 0.21 | 19.4 | 0.35 |
| **2003** | 2.1 | 0.95 | 44.5 | 0.55 | 61.4 | 0.30 | 17.4 | 0.54 |
| **2004** | 12.9 | 0.72 | 6.3 | 0.76 | 129.3 | 0.28 | 19.2 | 0.28 |
| | Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | |
| **1992*** | 4.3 | 0.60 | 21.4 | 0.35 | 21.2 | 0.33 | – | – |
| **1996*** | 1.8 | 0.53 | 21.9 | 0.36 | – | – | – | – |
| **1997** | 2.9 | 0.47 | 29.9 | 0.78 | 127.9 | 0.35 | 14.8 | 1.00 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 47.8 | 0.60 | 19.3 | 0.27 | 54.2 | 0.26 | 23.7 | 0.33 |
| **2000** | 7.6 | 0.60 | 44.3 | 0.44 | 61.6 | 0.21 | 13.9 | 0.51 |
| **2001** | 0.4 | 0.53 | 15.0 | 0.35 | 60.5 | 0.21 | 17.9 | 0.55 |
| **2002** | 4.6 | 0.87 | 19.6 | 0.34 | 32.4 | 0.19 | 20.4 | 0.35 |
| **2003** | 5.6 | 0.94 | 75.6 | 0.52 | 67.5 | 0.28 | 17.4 | 0.54 |
| **2004** | 24.5 | 0.70 | 8.9 | 0.74 | 129.3 | 0.28 | 19.2 | 0.28 |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table J-3. Predicted portion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of stripetail rockfish between 183 and 300 m from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| Year | Columbia | | Eureka | | Monterey | | Conception | |
|---|---|---|---|---|---|---|---|---|
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.34 | 0.35 | 0.70 | 0.16 | 0.93 | 0.06 | – | – |
| **1996*** | 0.43 | 0.31 | 0.77 | 0.14 | – | – | – | – |
| **1997** | 0.56 | 0.34 | 0.85 | 0.15 | 0.97 | 0.05 | 0.99 | 0.03 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.60 | 0.18 | 0.87 | 0.07 | 0.97 | 0.02 | 0.99 | 0.02 |
| **2000** | 0.31 | 0.30 | 0.66 | 0.16 | 0.91 | 0.05 | 0.96 | 0.05 |
| **2001** | 0.29 | 0.32 | 0.65 | 0.17 | 0.91 | 0.05 | 0.96 | 0.05 |
| **2002** | 0.40 | 0.27 | 0.74 | 0.13 | 0.94 | 0.04 | 0.97 | 0.03 |
| **2003** | 0.30 | 0.35 | 0.65 | 0.17 | 0.91 | 0.06 | 0.96 | 0.04 |
| **2004** | 0.51 | 0.24 | 0.82 | 0.11 | 0.96 | 0.03 | 0.98 | 0.02 |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 4.29 | 0.84 | 21.04 | 0.48 | 20.4 | 0.70 | – | – |
| **1996*** | 1.82 | 0.70 | 20.78 | 0.51 | – | – | – | – |
| **1997** | 2.77 | 1.47 | 29.85 | 0.92 | 128.2 | 0.77 | 15.2 | 2.03 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 47.33 | 0.46 | 20.12 | 0.51 | 57.1 | 0.40 | 23.8 | 0.91 |
| **2000** | 6.97 | 0.70 | 42.16 | 0.55 | 55.7 | 0.81 | 13.5 | 0.81 |
| **2001** | 0.34 | 1.35 | 15.53 | 0.67 | 60.2 | 0.35 | 18.3 | 0.73 |
| **2002** | 4.32 | 0.78 | 17.66 | 0.57 | 28.8 | 0.46 | 20.2 | 0.37 |
| **2003** | 5.31 | 1.40 | 70.83 | 0.54 | 63.1 | 0.53 | 14.9 | 0.41 |
| **2004** | 21.61 | 0.59 | 7.11 | 0.90 | 110.4 | 0.56 | 15.4 | 0.45 |
| Predicted biomass (mt) by strata | | | | | | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 176.5 | 1.05 | 597.8 | 0.52 | 1,089.5 | 0.69 | – | – |
| **1996*** | 92.3 | 0.87 | 660.4 | 0.54 | – | – | – | – |
| **1997** | 176.0 | 1.60 | 975.2 | 1.02 | 6,997.8 | 0.78 | 2,496.2 | 2.04 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 3,421.7 | 0.50 | 708.3 | 0.52 | 3,169.5 | 0.40 | 3,895.1 | 0.92 |
| **2000** | 261.3 | 0.88 | 1,121.2 | 0.61 | 2,918.3 | 0.82 | 2,149.3 | 0.82 |
| **2001** | 11.8 | 1.46 | 416.2 | 0.71 | 3,105.6 | 0.36 | 2,934.3 | 0.74 |
| **2002** | 205.9 | 0.90 | 541.3 | 0.58 | 1,553.1 | 0.46 | 3,263.2 | 0.38 |
| **2003** | 188.4 | 1.55 | 1,885.7 | 0.59 | 3,276.1 | 0.54 | 9,563.2 | 0.54 |
| **2004** | 1,345.6 | 0.67 | 233.9 | 0.91 | 6,058.8 | 0.57 | 17,686.4 | 0.57 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table J-4. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of stripetail rockfish between 183 and 300 m from the Delta-GLM applied to NWFSC slope surveys.

| Year | Columbia | | Eureka | | Monterey | | Conception | |
|---|---|---|---|---|---|---|---|---|
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.67 | 0.16 | 0.88 | 0.08 | 0.98 | 0.02 | 1.00 | 0.02 |
| **2000** | 0.35 | 0.31 | 0.66 | 0.17 | 0.92 | 0.04 | 0.98 | 0.04 |
| **2001** | 0.24 | 0.40 | 0.54 | 0.24 | 0.86 | 0.08 | 0.97 | 0.06 |
| **2002** | 0.40 | 0.26 | 0.70 | 0.14 | 0.93 | 0.04 | 0.99 | 0.04 |
| **2003** | 0.32 | 0.34 | 0.63 | 0.17 | 0.90 | 0.07 | 0.98 | 0.04 |
| **2004** | 0.51 | 0.24 | 0.79 | 0.12 | 0.95 | 0.04 | 0.99 | 0.03 |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 60.2 | 0.64 | 14.8 | 0.70 | 52.1 | 0.53 | 16.2 | 1.11 |
| **2000** | 8.1 | 0.85 | 40.1 | 0.79 | 58.5 | 1.32 | 17.9 | 1.32 |
| **2001** | 0.1 | 7.80 | 19.3 | 1.09 | 49.7 | 0.50 | 14.9 | 1.09 |
| **2002** | 4.2 | 0.83 | 17.1 | 0.63 | 28.9 | 0.46 | 19.2 | 0.47 |
| **2003** | 5.1 | 1.38 | 69.8 | 0.63 | 64.8 | 0.57 | 15.3 | 0.46 |
| **2004** | 19.7 | 0.69 | 7.1 | 0.95 | 108.3 | 0.62 | 14.7 | 0.49 |
| Predicted biomass (mt) by strata | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | – | – | – | – | – | – | – | – |
| **1996*** | – | – | – | – | – | – | – | – |
| **1997** | – | – | – | – | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 4,790.1 | 0.69 | 527.7 | 0.71 | 2,908.4 | 0.53 | 2,689.7 | 1.11 |
| **2000** | 346.9 | 1.10 | 1,091.4 | 0.83 | 3,036.7 | 1.33 | 2,898.7 | 1.33 |
| **2001** | 2.8 | 8.24 | 412.6 | 1.21 | 2,421.1 | 0.52 | 2,381.2 | 1.07 |
| **2002** | 199.9 | 0.90 | 492.0 | 0.66 | 1,512.6 | 0.47 | 3,147.6 | 0.48 |
| **2003** | 194.1 | 1.48 | 1,761.3 | 0.71 | 3,282.4 | 0.58 | 9,581.6 | 0.58 |
| **2004** | 1,216.3 | 0.75 | 229.7 | 0.97 | 5,856.7 | 0.63 | 17,096.3 | 0.63 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table J-5. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of stripetail rockfish between 183 and 300 m from the Delta-GLM applied to AFSC slope surveys.

| Year | Columbia | | Eureka | | Monterey | | Conception | |
|---|---|---|---|---|---|---|---|---|
| Predicted proportion positive based on Delta-GLM model | | | | | | | | |
| | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.31 | 0.29 | 0.72 | 0.13 | 0.97 | 0.06 | – | – |
| **1996*** | 0.42 | 0.26 | 0.81 | 0.10 | – | – | – | – |
| **1997** | 0.54 | 0.30 | 0.87 | 0.12 | 0.99 | 0.04 | 0.90 | 0.17 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.38 | 0.40 | 0.78 | 0.16 | 0.98 | 0.06 | 0.83 | 0.22 |
| **2000** | 0.23 | 0.55 | 0.63 | 0.24 | 0.95 | 0.31 | 0.71 | 0.31 |
| **2001** | 0.49 | 0.34 | 0.85 | 0.13 | 0.98 | 0.05 | 0.89 | 0.18 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 4.3 | 0.59 | 21.1 | 0.38 | 20.5 | 0.50 | – | – |
| **1996*** | 1.9 | 0.51 | 22.0 | 0.38 | – | – | – | – |
| **1997** | 3.0 | 1.17 | 30.3 | 0.72 | 128.9 | 0.63 | 15.1 | 1.86 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 0.2 | 0.94 | 29.2 | 0.72 | 64.6 | 0.55 | 50.2 | 4.90 |
| **2000** | 0.1 | 5.01 | 38.5 | 1.15 | 47.8 | 1.61 | 5.4 | 1.61 |
| **2001** | 0.5 | 2.03 | 13.2 | 0.81 | 82.9 | 0.56 | 23.8 | 1.55 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |
| Predicted biomass (mt) by strata | | | | | | | | |
| | Bio. | CV | Bio. | CV | Bio. | CV | Bio. | CV |
| **1992*** | 155.0 | 0.76 | 631.5 | 0.40 | 1,112.5 | 0.51 | – | – |
| **1996*** | 92.9 | 0.61 | 738.1 | 0.39 | – | – | – | – |
| **1997** | 180.6 | 1.38 | 1,051.5 | 0.75 | 7,229.4 | 0.63 | 2,056.6 | 2.05 |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 6.7 | 1.33 | 944.4 | 0.75 | 3,598.6 | 0.55 | 6,050.7 | 4.44 |
| **2000** | 1.5 | 9.10 | 978.1 | 1.19 | 2,528.7 | 1.95 | 575.5 | 1.95 |
| **2001** | 24.8 | 2.08 | 454.9 | 0.84 | 4,623.9 | 0.55 | 3,236.2 | 1.70 |
| **2002** | – | – | – | – | – | – | – | – |
| **2003** | – | – | – | – | – | – | – | – |
| **2004** | – | – | – | – | – | – | – | – |

***** Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

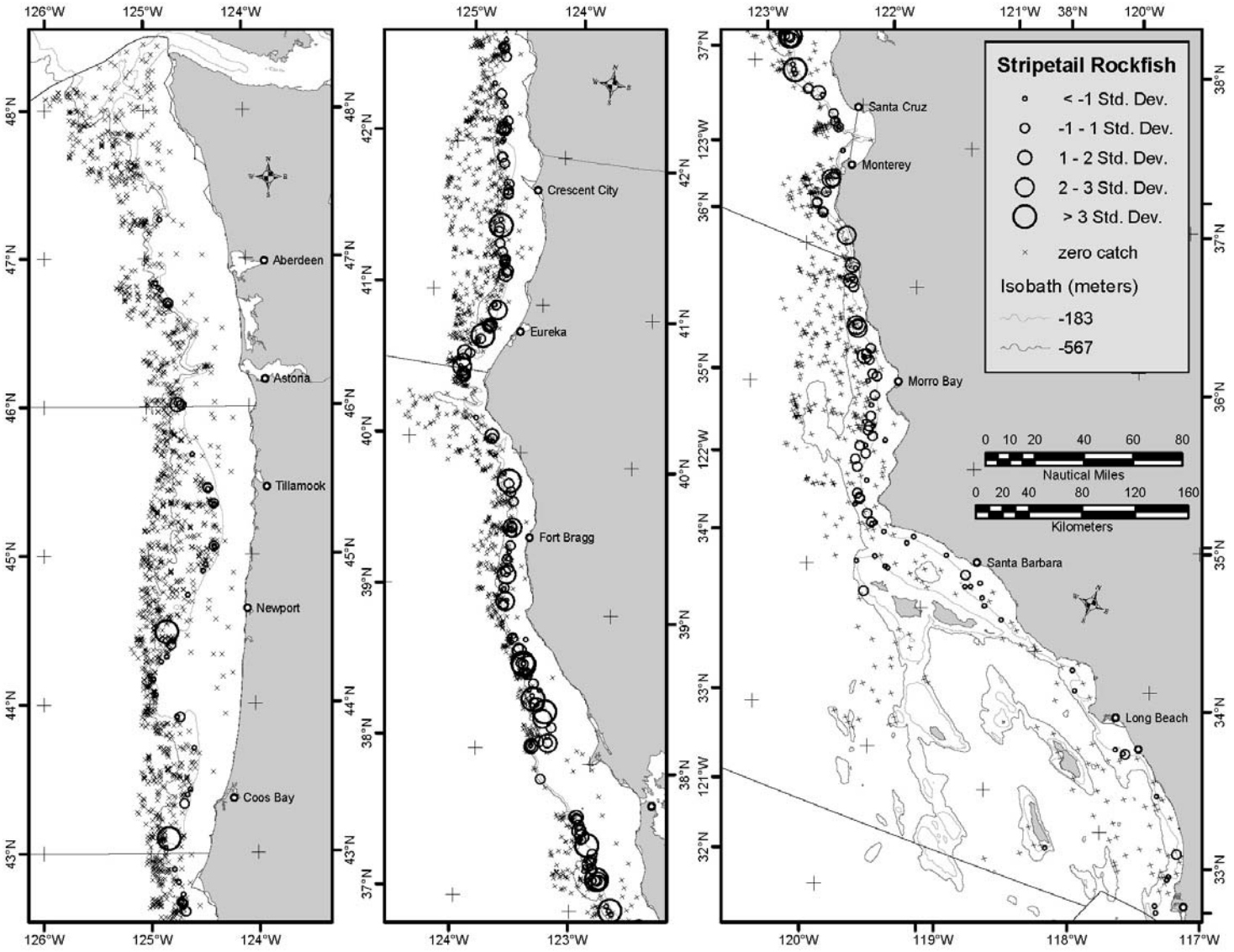



Figure J-1. Distribution of stripetail rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

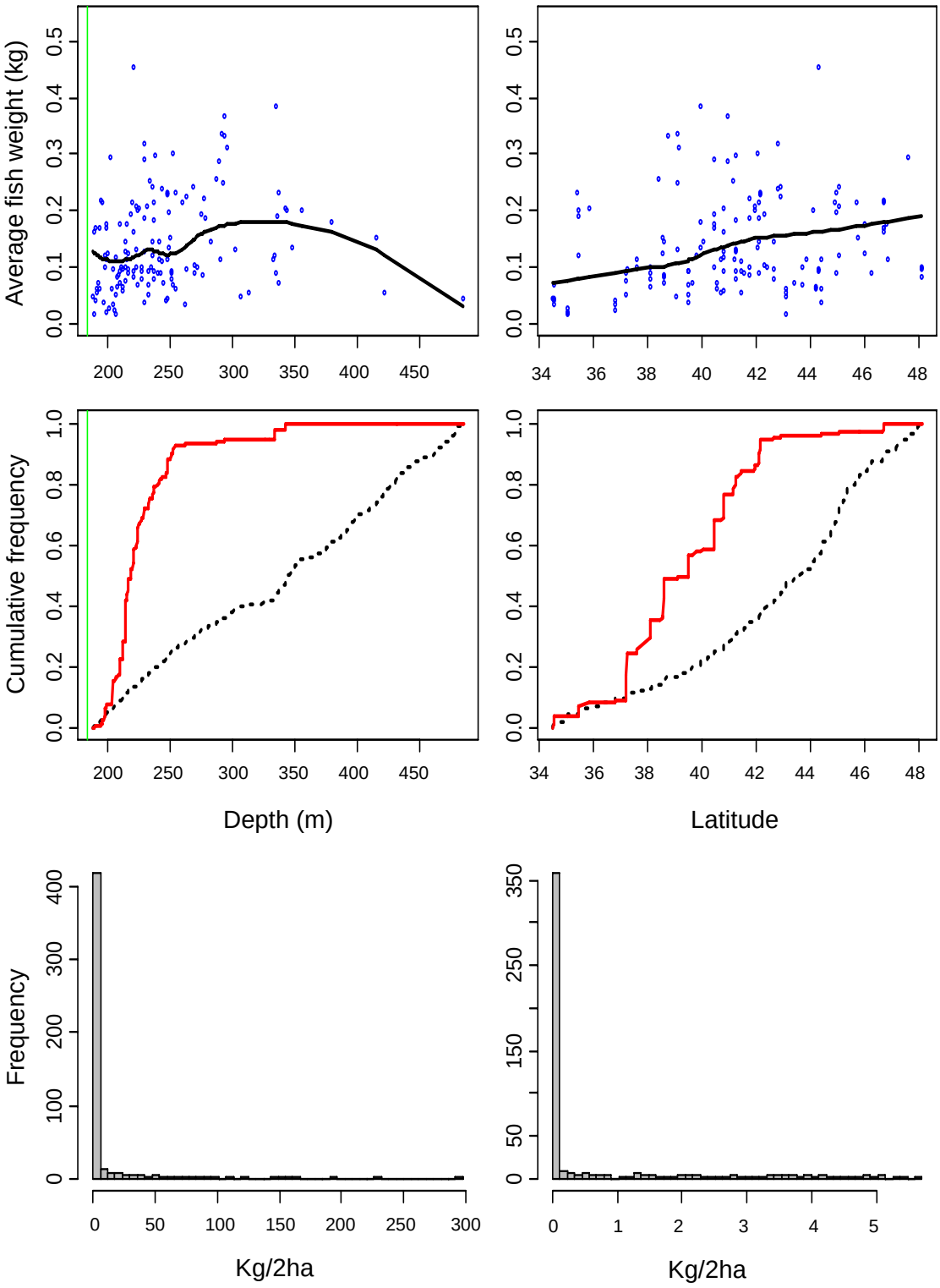



Figure J-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of stripetail rockfish caught in the AFSC slope surveys.

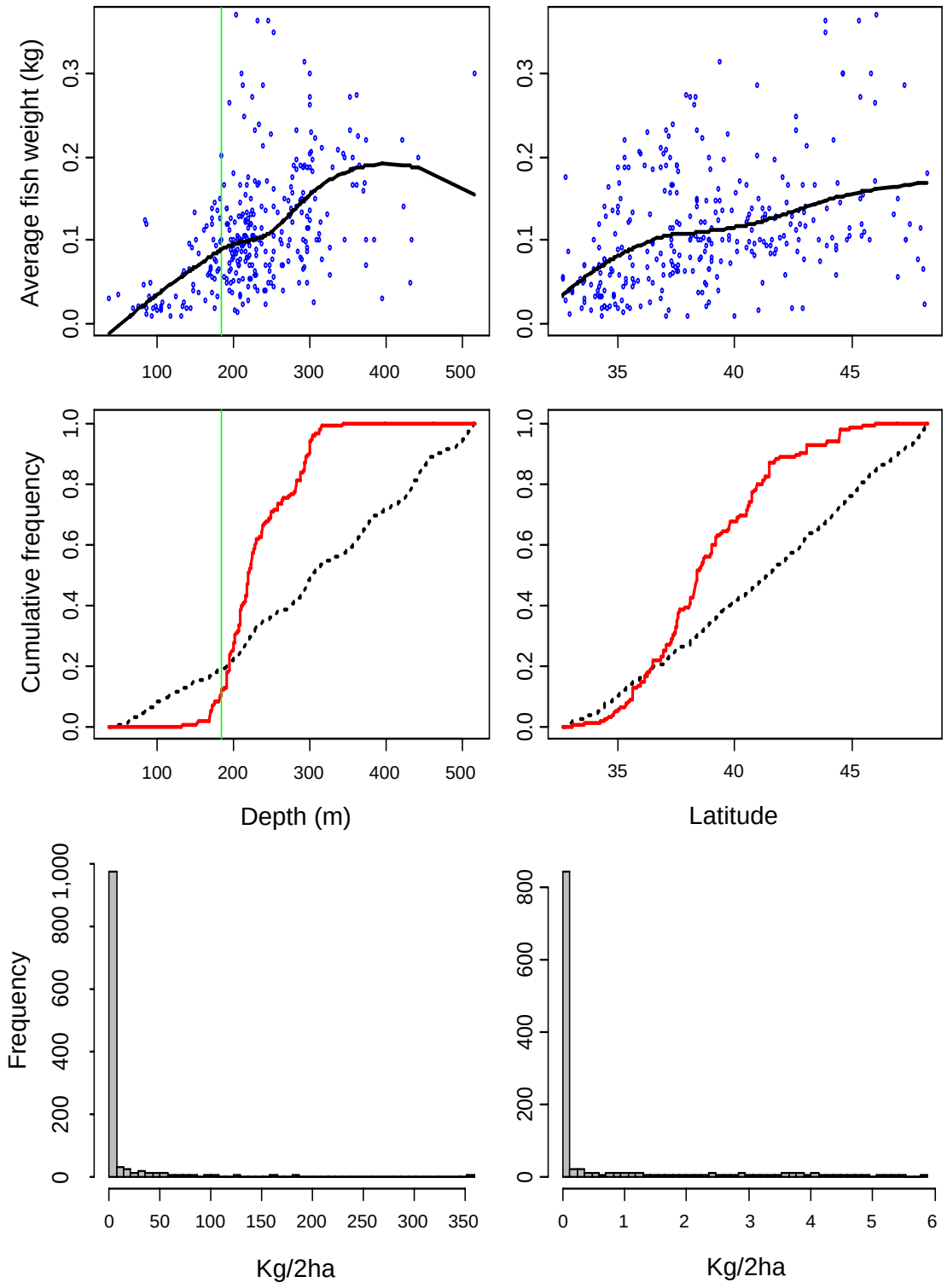



Figure J-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of stripetail rockfish caught in the NWFSC slope surveys.

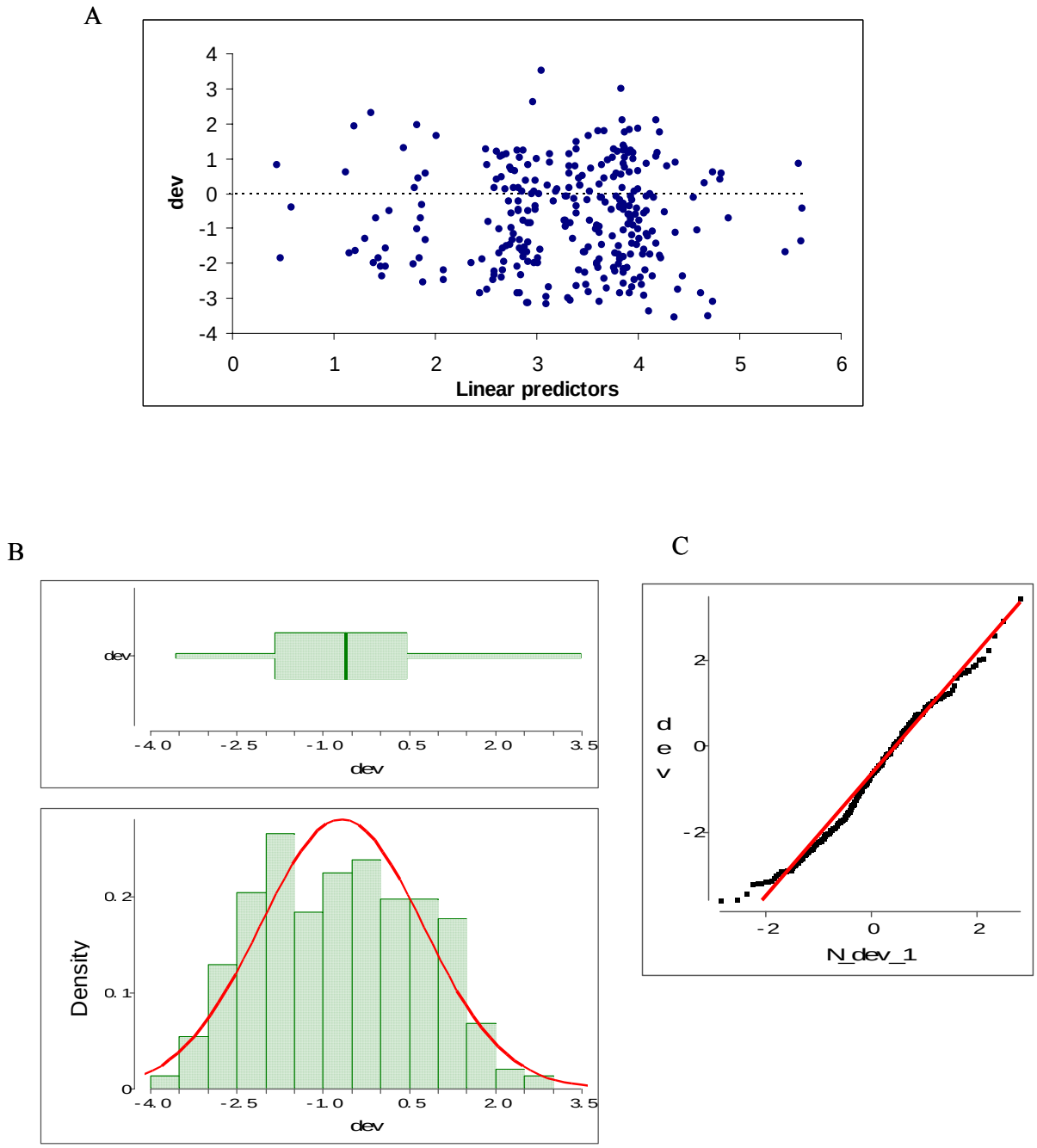



Figure J-4. Diagnostic plots from the generalized linear mixed model fit to stripetail rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

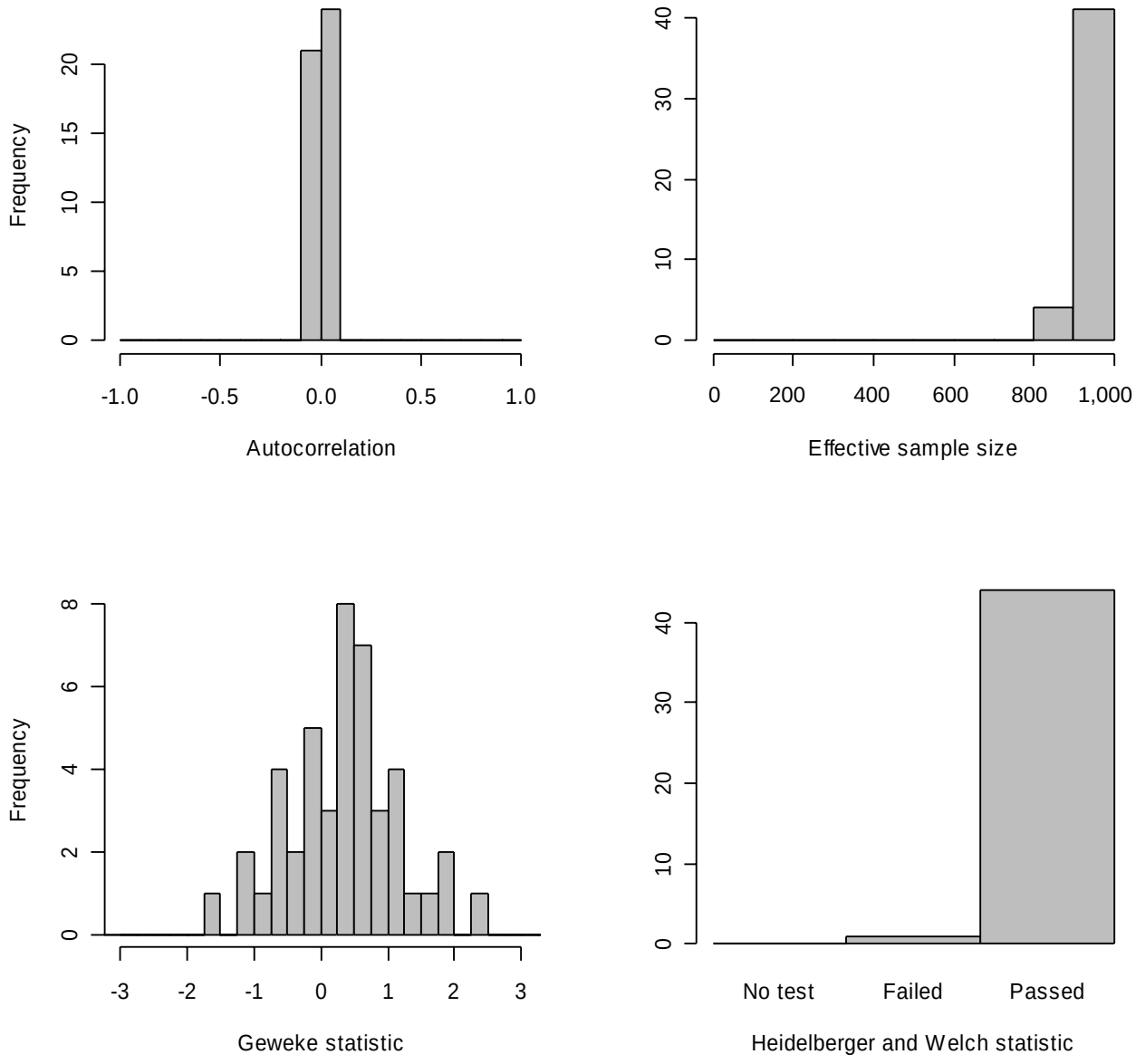
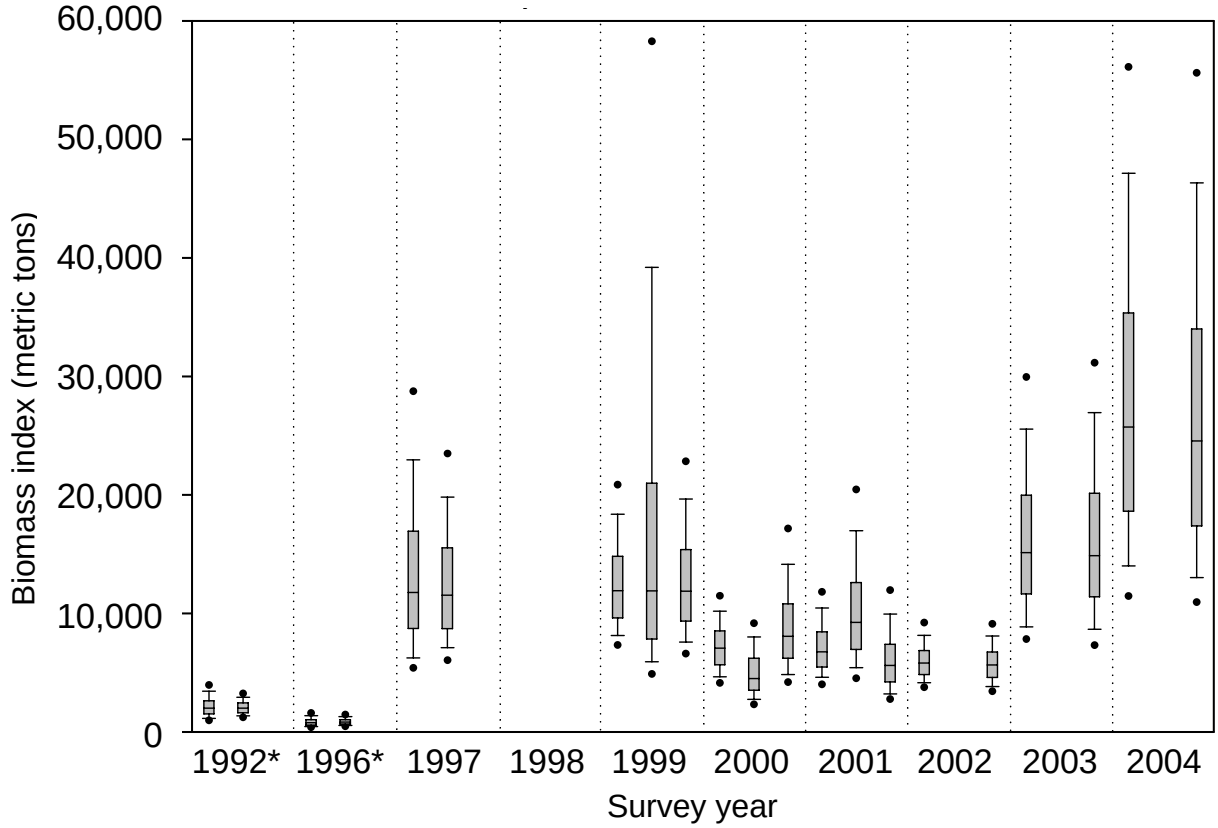



Figure J-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution of stripetail rockfish. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure J-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for stripetail rockfish. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5$^{th}$–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Appendix K: Blackgill Rockfish (*Sebastes melanostomus*)

This appendix has tables K-1 though K-5 and figures K-1 though K-6. The tables provide basic data and statistics summaries and model predictions by stratum from the generalized linear mixed model (Delta-GLM) applied to the Northwest Fisheries Science Center (NWFSC) and Alaska Fisheries Science Center (AFSC) continental slope bottom trawl surveys for blackgill rockfish. The figures show the coastwide distribution of abundance, trends in average weight and catch by depth and latitude, Delta-GLM model diagnostics, and long term trends in biomass (including confidence intervals).

Table K-1. Basic data and statistics summary for blackgill rockfish caught in the slope surveys (AFSC and NWFSC slope surveys combines).

| Year | Vancouver 183–567 m | | Vancouver 567–1,280 m | | Columbia 183–567 m | | Columbia 567–1,280 m | | Eureka 183–567 m | | Eureka 567–1,280 m | | Monterey 183–567 m | | Monterey 567–1,280 m | | Conception 183–567 m | | Conception 567–1,280 m | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total number and number positive tows by year and spatial strata | | | | | | | | | | | | | | | | | | | | |
| | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 | Total # tows | # tows > 0 |
| **1992*** | 27 | 1 | 36 | 0 | 57 | 0 | 81 | 0 | 37 | 5 | 93 | 0 | 26 | 4 | 40 | 0 | – | – | – | – |
| **1996*** | 29 | 1 | 44 | 0 | 55 | 0 | 76 | 0 | 34 | 0 | 72 | 0 | – | – | – | – | – | – | – | – |
| **1997** | 9 | 0 | 16 | 0 | 20 | 1 | 28 | 0 | 10 | 0 | 20 | 0 | 17 | 6 | 33 | 0 | 11 | 6 | 18 | 0 |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 36 | 0 | 55 | 0 | 58 | 2 | 71 | 0 | 39 | 3 | 61 | 0 | 65 | 27 | 82 | 2 | 23 | 7 | 33 | 1 |
| **2000** | 35 | 2 | 47 | 0 | 59 | 0 | 70 | 0 | 37 | 1 | 60 | 0 | 73 | 24 | 94 | 0 | 27 | 10 | 36 | 0 |
| **2001** | 36 | 4 | 50 | 0 | 71 | 2 | 59 | 0 | 38 | 0 | 58 | 0 | 65 | 20 | 99 | 0 | 29 | 14 | 36 | 0 |
| **2002** | 24 | 2 | 24 | 0 | 47 | 0 | 39 | 0 | 30 | 2 | 41 | 0 | 58 | 17 | 61 | 0 | 47 | 15 | 55 | 0 |
| **2003** | 28 | 0 | 44 | 0 | 30 | 2 | 37 | 0 | 36 | 0 | 33 | 0 | 32 | 6 | 24 | 0 | 55 | 15 | 27 | 0 |
| **2004** | 13 | 0 | 14 | 0 | 46 | 6 | 19 | 0 | 14 | 0 | 23 | 0 | 17 | 1 | 21 | 1 | 50 | 12 | 49 | 0 |
| Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | | | | | | | | | | | | | | |
| | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV | Mean | CV |
| **1992*** | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.4 | 0.67 | 0.0 | N/A | 1.5 | 0.85 | 0.0 | N/A | – | – | – | – |
| **1996*** | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | – | – | – | – | – | – | – | – |
| **1997** | 0.0 | N/A | 0.0 | N/A | 0.0 | 1.00 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 1.1 | 0.46 | 0.0 | N/A | 2.0 | 0.61 | 0.0 | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | 0.0 | N/A | 0.0 | N/A | 0.0 | 0.70 | 0.0 | N/A | 0.1 | 0.82 | 0.0 | N/A | 2.4 | 0.44 | 0.0 | 0.83 | 2.0 | 0.56 | 0.0 | N/A |
| **2000** | 0.3 | 0.71 | 0.0 | N/A | 0.0 | 0.00 | 0.0 | N/A | 0.0 | 1.00 | 0.0 | N/A | 1.6 | 0.24 | 0.0 | N/A | 3.3 | 0.65 | 0.0 | 1.00 |
| **2001** | 0.3 | 0.64 | 0.0 | N/A | 0.0 | 0.96 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 3.0 | 0.41 | 0.0 | N/A | 1.8 | 0.44 | 0.0 | N/A |
| **2002** | 0.3 | 0.86 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.2 | 0.72 | 0.0 | N/A | 1.4 | 0.31 | 0.0 | N/A | 3.5 | 0.54 | 0.0 | N/A |
| **2003** | 0.0 | N/A | 0.0 | N/A | 0.4 | 0.87 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.8 | 0.90 | 0.0 | N/A | 1.3 | 0.41 | 0.0 | N/A |
| **2004** | 0.0 | N/A | 0.0 | N/A | 1.8 | 0.56 | 0.0 | N/A | 0.0 | N/A | 0.0 | N/A | 0.5 | 1.00 | 0.1 | 1.00 | 5.1 | 0.50 | 0.0 | N/A |
| Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | | | | | | | | | | | | | | |
| **1992*** | 1.0 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 3.0 | 0.57 | N/A | N/A | 9.9 | 0.80 | N/A | N/A | – | – | – | – |
| **1996*** | 0.8 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | – | – | – | – | – | – | – | – |
| **1997** | N/A | N/A | N/A | N/A | 0.9 | 0.00 | N/A | N/A | N/A | N/A | N/A | N/A | 3.1 | 0.33 | N/A | N/A | 3.6 | 0.56 | N/A | N/A |
| **1998** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| **1999** | N/A | N/A | N/A | N/A | 0.7 | 0.09 | N/A | N/A | 1.0 | 0.72 | N/A | N/A | 5.8 | 0.42 | 0.7 | 0.62 | 6.4 | 0.49 | N/A | N/A |
| **2000** | 5.2 | 0.16 | N/A | N/A | N/A | N/A | N/A | N/A | 0.1 | 0.00 | N/A | N/A | 5.0 | 0.17 | N/A | N/A | 8.7 | 0.62 | 1.3 | N/A |
| **2001** | 2.9 | 0.48 | N/A | N/A | 1.4 | 0.91 | N/A | N/A | N/A | N/A | N/A | N/A | 9.7 | 0.37 | N/A | N/A | 3.7 | 0.40 | N/A | N/A |
| **2002** | 4.0 | 0.70 | N/A | N/A | N/A | N/A | N/A | N/A | 2.7 | 0.27 | N/A | N/A | 4.6 | 0.24 | N/A | N/A | 11.0 | 0.50 | N/A | N/A |
| **2003** | N/A | N/A | N/A | N/A | 5.8 | 0.72 | N/A | N/A | N/A | N/A | N/A | N/A | 4.2 | 0.88 | N/A | N/A | 4.9 | 0.36 | N/A | N/A |
| **2004** | N/A | N/A | N/A | N/A | 13.7 | 0.43 | N/A | N/A | N/A | N/A | N/A | N/A | 8.0 | N/A | 1.8 | N/A | 21.1 | 0.44 | N/A | N/A |

***** Year designation for a composite of years with differential spatial coverage referred to as super year. Super year 1992 = 1990, 1991, 1992, 1993, and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table K-2. Poststratified data and statistics summary for blackgill rockfish caught at depths between 300 and 567 m in the slope surveys (AFSC and NWFSC slope surveys combined).

| | AFSC Slope | | | | NWFSC Slope | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **Monterey** | | **Conception** | | **Monterey** | | **Conception** | |
| | Total number and number positive tows by year and spatial strata | | | | | | | |
| | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** | **Total # tows** | **# tows > 0** |
| **1997** | 11 | 5 | 9 | 6 | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 12 | 6 | 8 | 6 | 34 | 18 | 9 | 1 |
| **2000** | 13 | 8 | 8 | 3 | 30 | 13 | 13 | 7 |
| **2001** | 14 | 7 | 8 | 5 | 27 | 10 | 15 | 8 |
| **2002** | – | – | – | – | 41 | 17 | 27 | 13 |
| **2003** | – | – | – | – | 22 | 6 | 38 | 13 |
| **2004** | – | – | – | – | 8 | 1 | 35 | 12 |
| | Summary statistics (mean, CV) for all tows in Kg/2ha | | | | | | | |
| | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** | **Mean** | **CV** |
| **1997** | 1.6 | 0.46 | 2.4 | 0.59 | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 7.9 | 0.68 | 5.5 | 0.52 | 1.7 | 0.29 | 0.1 | 0.85 |
| **2000** | 3.2 | 0.39 | 8.2 | 0.85 | 2.3 | 0.31 | 1.7 | 0.45 |
| **2001** | 4.4 | 0.44 | 4.2 | 0.61 | 4.9 | 0.55 | 1.2 | 0.43 |
| **2002** | – | – | – | – | 1.9 | 0.30 | 6.1 | 0.53 |
| **2003** | – | – | – | – | 1.2 | 0.90 | 1.9 | 0.40 |
| **2004** | – | – | – | – | 1.0 | 1.00 | 8.0 | 0.50 |
| | Summary statistics (mean, CV) for all positive tows in kg/2ha | | | | | | | |
| **1997** | 3.5 | 0.33 | 3.6 | 0.56 | – | – | – | – |
| **1998** | – | – | – | – | – | – | – | – |
| **1999** | 15.9 | 0.64 | 7.4 | 0.48 | 3.6 | 0.25 | 0.8 | – |
| **2000** | 5.2 | 0.33 | 21.6 | 0.79 | 5.4 | 0.22 | 3.1 | 0.39 |
| **2001** | 8.8 | 0.35 | 6.7 | 0.55 | 13.0 | 0.52 | 2.1 | 0.35 |
| **2002** | – | – | – | – | 4.6 | 0.24 | 12.6 | 0.50 |
| **2003** | – | – | – | – | 4.2 | 0.88 | 5.7 | 0.34 |
| **2004** | – | – | – | – | 7.2 | 0.50 | 21.1 | 0.44 |

In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table K-3. Predicted portion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of blackgill rockfish between 300 and 567 m from the Delta-GLM applied to NWFSC-AFSC slope surveys.

| Year | Monterey | | Conception | |
|---|---|---|---|---|
| | Predicted proportion positive based on Delta-GLM model | | | |
| | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | 0.19 | 0.55 | 0.22 | 0.54 |
| **1996*** | – | – | – | – |
| **1997** | 0.39 | 0.30 | 0.45 | 0.28 |
| **1998** | – | – | – | – |
| **1999** | 0.44 | 0.17 | 0.49 | 0.17 |
| **2000** | 0.45 | 0.16 | 0.51 | 0.16 |
| **2001** | 0.46 | 0.16 | 0.51 | 0.16 |
| **2002** | 0.47 | 0.16 | 0.52 | 0.16 |
| **2003** | 0.30 | 0.25 | 0.34 | 0.22 |
| **2004** | 0.27 | 0.32 | 0.31 | 0.26 |
| | Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | |
| | Mean | CV | Mean | CV |
| **1992*** | 5.88 | 1.21 | 5.84 | 1.14 |
| **1996*** | – | – | – | – |
| **1997** | 2.04 | 1.11 | 2.08 | 1.01 |
| **1998** | – | – | – | – |
| **1999** | 5.67 | 0.49 | 3.84 | 0.90 |
| **2000** | 5.37 | 0.46 | 6.25 | 0.69 |
| **2001** | 7.98 | 0.51 | 3.23 | 0.58 |
| **2002** | 4.30 | 0.54 | 10.90 | 0.55 |
| **2003** | 4.37 | 0.90 | 6.11 | 0.60 |
| **2004** | 5.54 | 6.92 | 22.48 | 0.59 |
| | Predicted biomass (mt) by strata | | | |
| | Bio. | CV | Bio. | CV |
| **1992*** | 133.7 | 1.57 | 684.05 | 1.57 |
| **1996*** | – | – | – | – |
| **1997** | 96.8 | 1.26 | 475.80 | 1.19 |
| **1998** | – | – | – | – |
| **1999** | 301.4 | 0.55 | 980.66 | 0.90 |
| **2000** | 301.0 | 0.51 | 1,632.55 | 0.72 |
| **2001** | 452.7 | 0.54 | 860.94 | 0.61 |
| **2002** | 244.3 | 0.58 | 2,920.33 | 0.60 |
| **2003** | 161.5 | 1.00 | 1,074.12 | 0.67 |
| **2004** | 176.7 | 7.73 | 3,682.92 | 0.65 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super–year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table K-4. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of blackgill rockfish between 300 and 567 m from the Delta-GLM applied to NWFSC slope surveys.

| Year | Monterey | | Conception | |
|---|---|---|---|---|
| | Predicted proportion positive based on Delta-GLM model | | | |
| | Fract. pos. | CV | Fract. pos. | CV |
| **1992*** | – | – | – | – |
| **1996*** | – | – | – | – |
| **1997** | – | – | – | – |
| **1998** | – | – | – | – |
| **1999** | 0.43 | 0.21 | 0.48 | 0.21 |
| **2000** | 0.50 | 0.19 | 0.55 | 0.19 |
| **2001** | 0.46 | 0.21 | 0.52 | 0.20 |
| **2002** | 0.47 | 0.18 | 0.52 | 0.17 |
| **2003** | 0.29 | 0.29 | 0.34 | 0.24 |
| **2004** | 0.26 | 0.34 | 0.31 | 0.28 |
| | Predicted catch rate (kg/2ha) given positive haul based on Delta-GLM model | | | |
| | Mean | CV | Mean | CV |
| **1992*** | – | – | – | – |
| **1996*** | – | – | – | – |
| **1997** | – | – | – | – |
| **1998** | – | – | – | – |
| **1999** | 3.4 | 0.66 | 1.0 | 7.49 |
| **2000** | 6.6 | 0.59 | 3.1 | 0.91 |
| **2001** | 11.8 | 0.67 | 2.7 | 0.79 |
| **2002** | 4.0 | 0.53 | 10.8 | 0.52 |
| **2003** | 4.5 | 0.77 | 5.2 | 0.55 |
| **2004** | 5.7 | 5.50 | 21.3 | 0.63 |
| | Predicted biomass (mt) by strata | | | |
| | Bio. | CV | Bio. | CV |
| **1992*** | – | – | – | – |
| **1996*** | – | – | – | – |
| **1997** | – | – | – | – |
| **1998** | – | – | – | – |
| **1999** | 180.91 | 0.69 | 236.22 | 9.01 |
| **2000** | 390.71 | 0.66 | 863.84 | 1.00 |
| **2001** | 659.74 | 0.68 | 704.10 | 0.82 |
| **2002** | 229.76 | 0.59 | 2,881.06 | 0.57 |
| **2003** | 158.64 | 0.95 | 925.08 | 0.66 |
| **2004** | 186.67 | 4.66 | 3,436.27 | 0.72 |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

Table K-5. Predicted proportion positive, catch rate given positive haul (kg/2ha) and biomass (mt) of blackgill rockfish between 300 and 567 m from the Delta-GLM applied to AFSC slope surveys.

| Year | Monterey | | Conception | |
|---|---|---|---|---|
| | Predicted portion positive based on Delta-GLM model | | | |
| | **Fract. pos.** | **CV** | **Fract. pos.** | **CV** |
| **1992*** | 0.17 | 0.57 | 0.21 | 0.65 |
| **1996*** | – | – | – | – |
| **1997** | 0.37 | 0.31 | 0.45 | 0.27 |
| **1998** | – | – | – | – |
| **1999** | 0.43 | 0.29 | 0.50 | 0.27 |
| **2000** | 0.38 | 0.30 | 0.45 | 0.29 |
| **2001** | 0.44 | 0.26 | 0.51 | 0.26 |
| **2002** | – | – | – | – |
| **2003** | – | – | – | – |
| **2004** | – | – | – | – |
| | Predicted catch rate (kg/2ha) given positive haul based on Delta–GLM model | | | |
| | **Mean** | **CV** | **Mean** | **CV** |
| **1992*** | 10.0 | 0.85 | 9.7 | 0.85 |
| **1996*** | – | – | – | – |
| **1997** | 3.6 | 0.69 | 3.6 | 0.63 |
| **1998** | – | – | – | – |
| **1999** | 16.0 | 0.63 | 7.4 | 0.64 |
| **2000** | 5.3 | 0.50 | 20.9 | 1.67 |
| **2001** | 8.9 | 0.61 | 6.8 | 0.70 |
| **2002** | – | – | – | – |
| **2003** | – | – | – | – |
| **2004** | – | – | – | – |
| | Predicted biomass (mt) by strata | | | |
| | **Bio.** | **CV** | **Bio.** | **CV** |
| **1992*** | 226.1 | 1.14 | 864.3 | 1.27 |
| **1996*** | – | – | – | – |
| **1997** | 162.2 | 0.82 | 833.6 | 0.75 |
| **1998** | – | – | – | – |
| **1999** | 828.1 | 0.79 | 1,920.3 | 0.74 |
| **2000** | 244.8 | 0.65 | 4,856.8 | 1.76 |
| **2001** | 481.3 | 0.72 | 1,771.2 | 0.79 |
| **2002** | – | – | – | – |
| **2003** | – | – | – | – |
| **2004** | – | – | – | – |

* Year designation for a composite of years with differential spatial coverage referred to as super years. Super year 1992 = 1990, 1991, 1992, 1993; and 1996 = 1995, 1996. For the 1992 super-year category, the RV *Miller Freeman* only extended as far south as Monterey, and for the 1996 super-year as far south as Eureka. In 1998 the NWFSC slope survey focused primarily on DTS species; therefore, catch information is not available for slope rockfish.

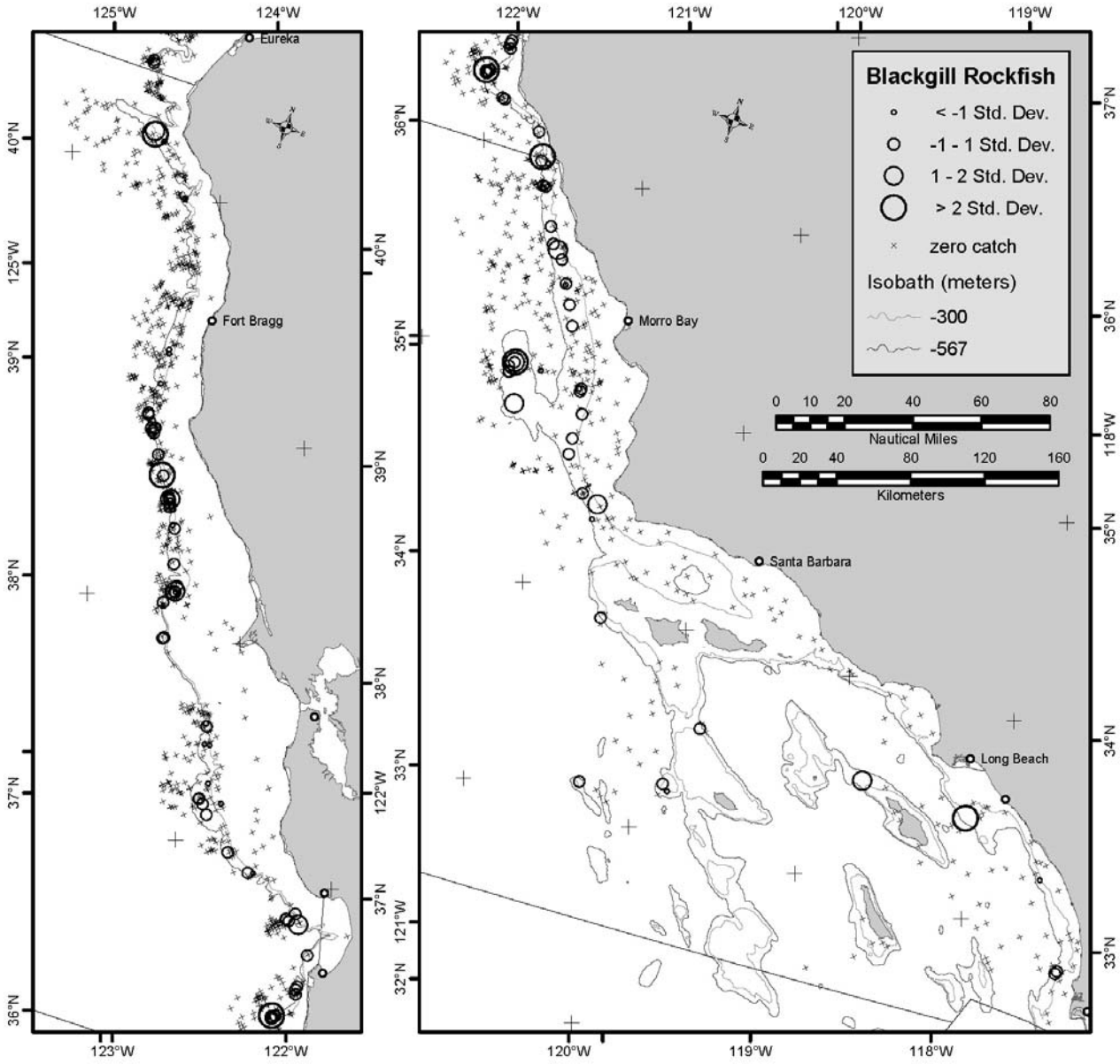



Figure K-1. Distribution of blackgill rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

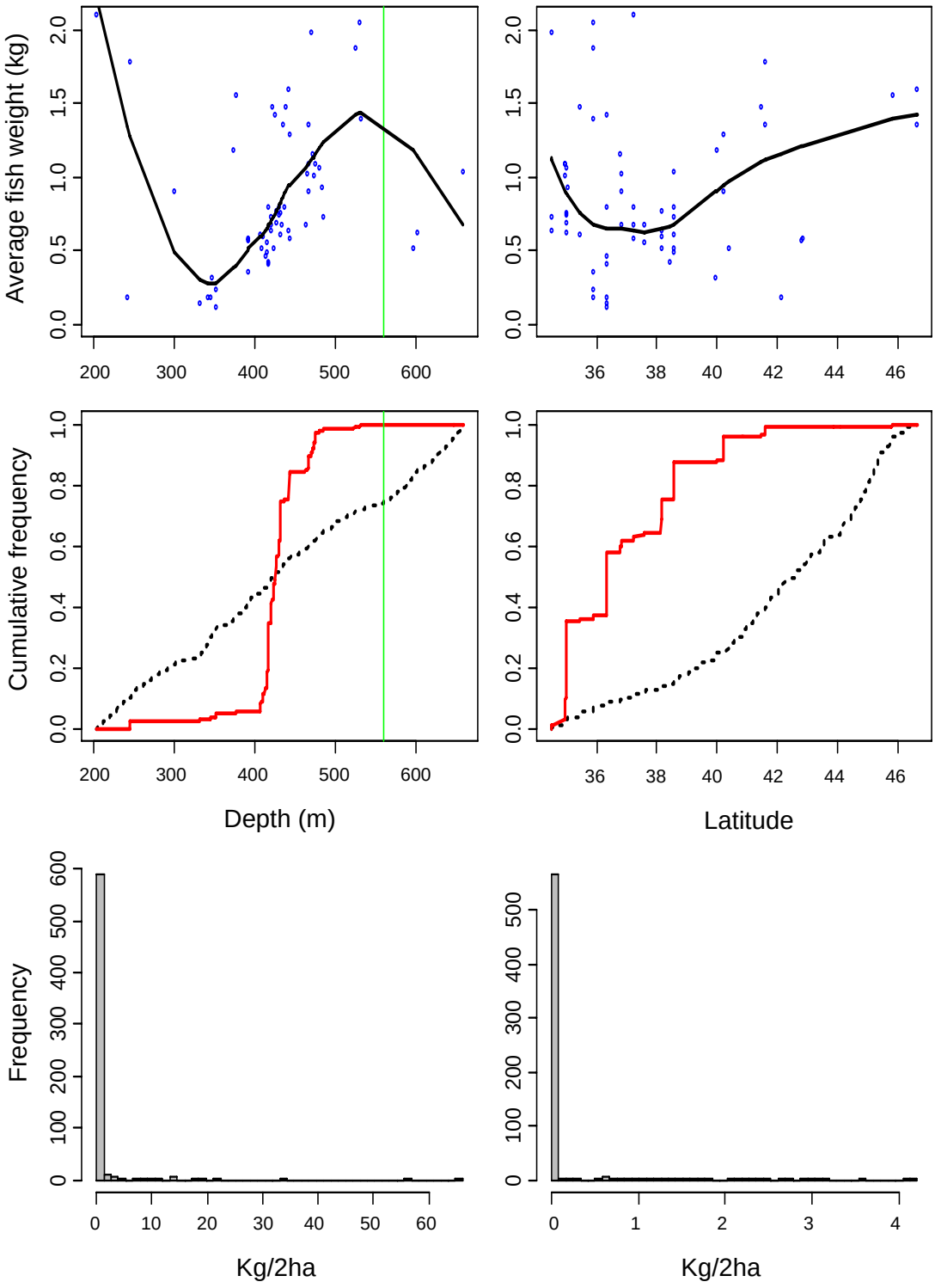



Figure K-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of blackgill rockfish caught in the AFSC slope surveys.

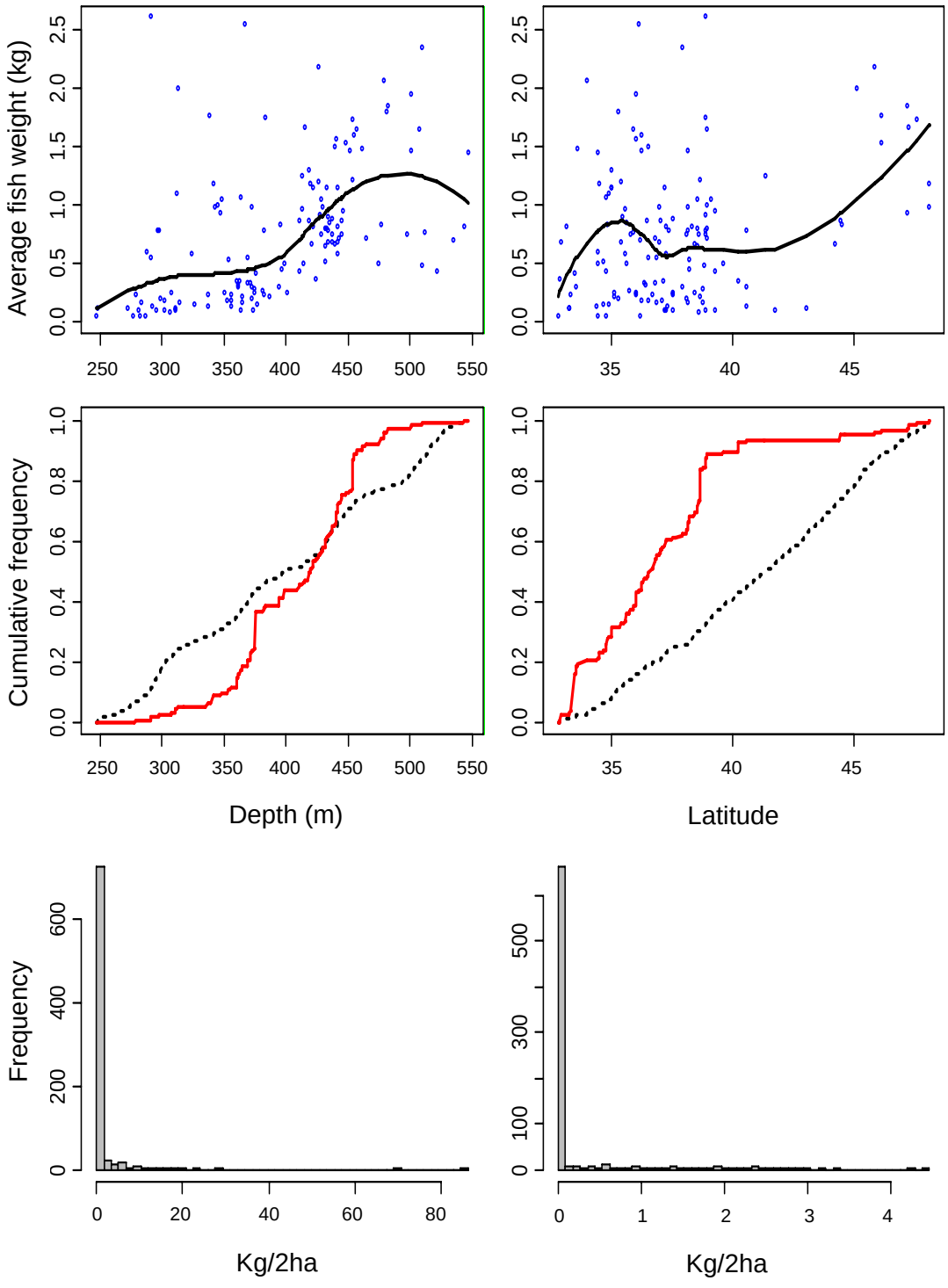



Figure K-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of blackgill rockfish caught in the NWFSC slope surveys.

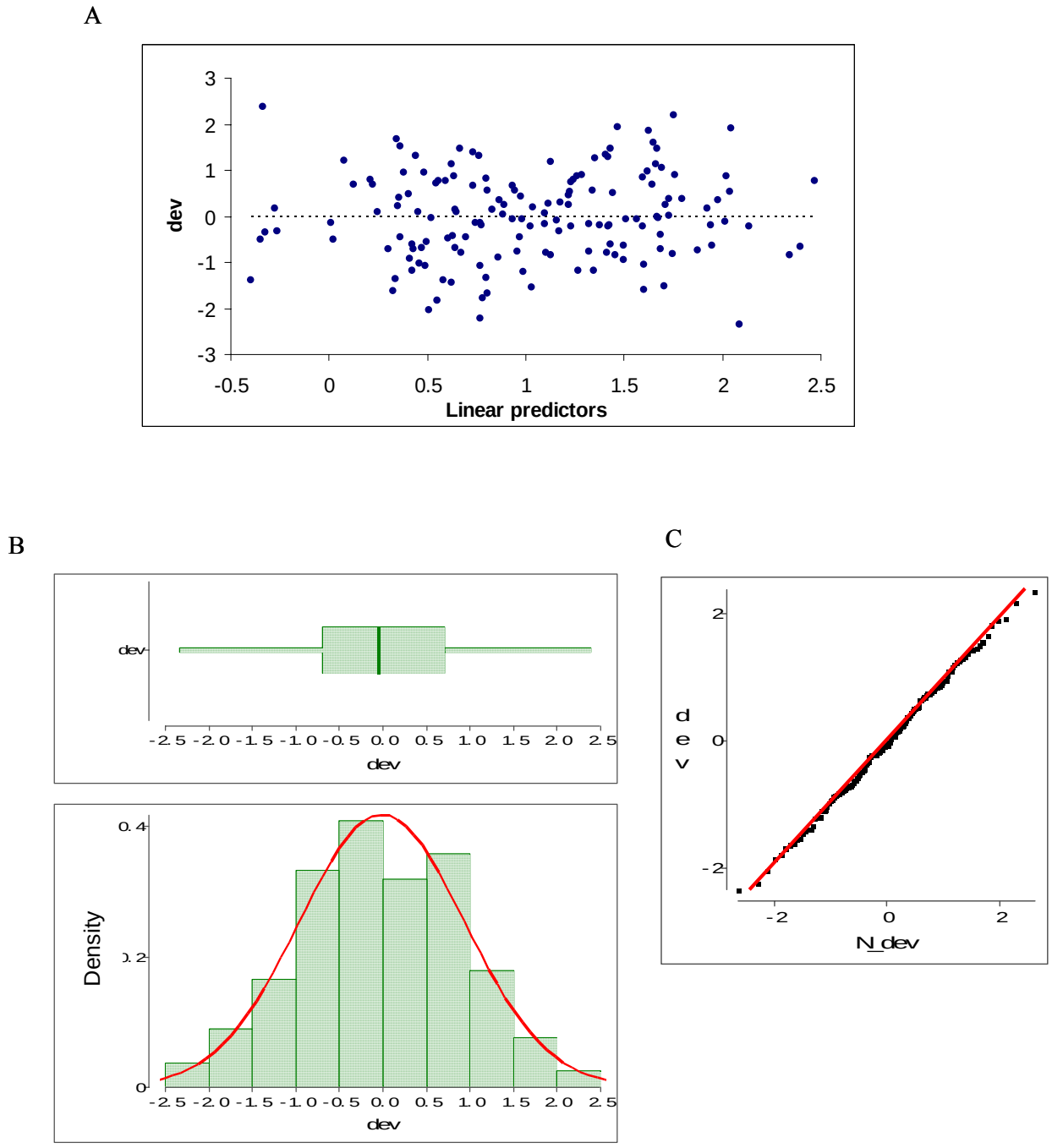



Figure K-4. Diagnostic plots from the generalized linear mixed model fit to blackgill rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C) Standardized deviance residual plotted as a function of standard normal deviates, normal Q-Q plot.

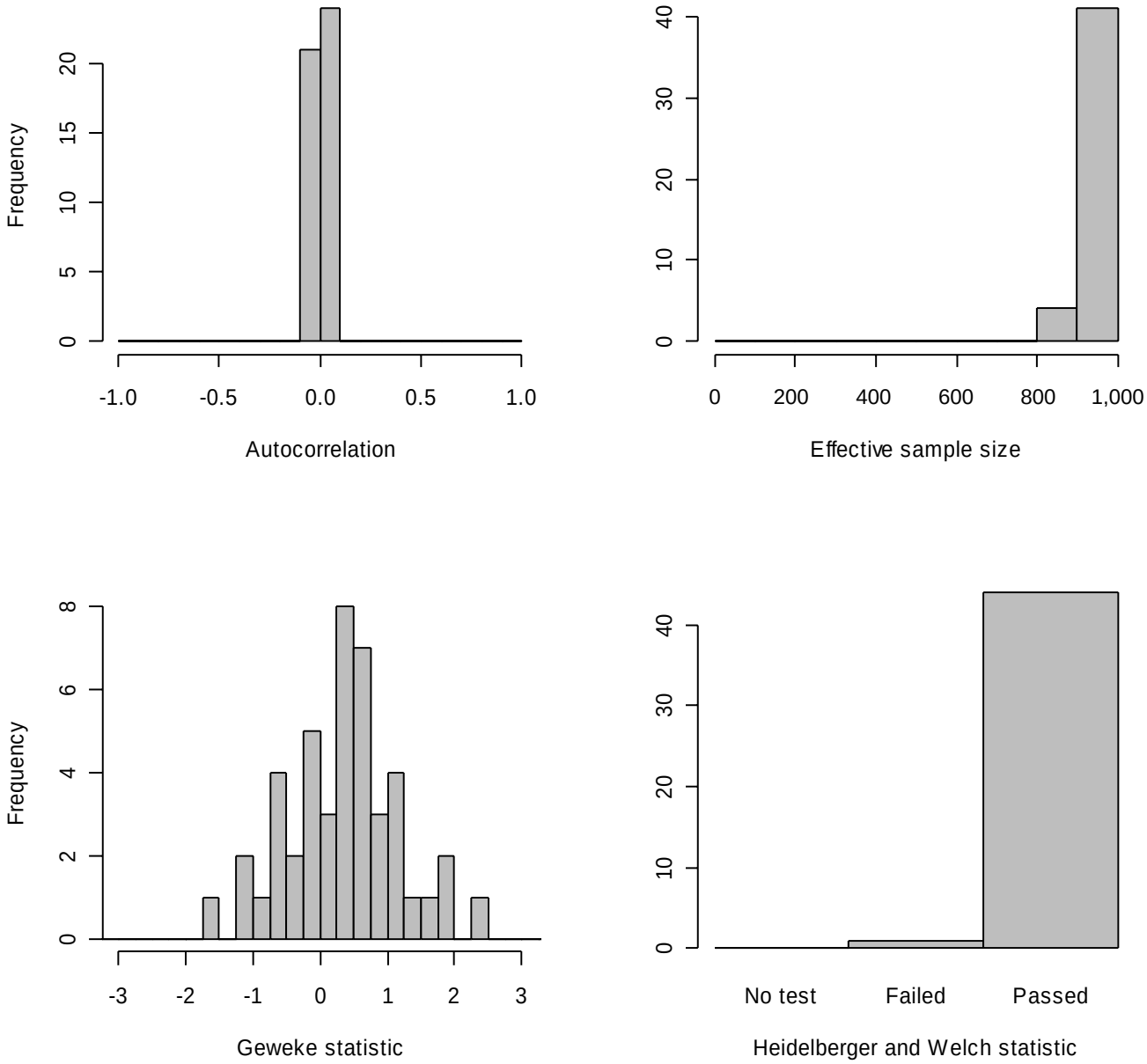
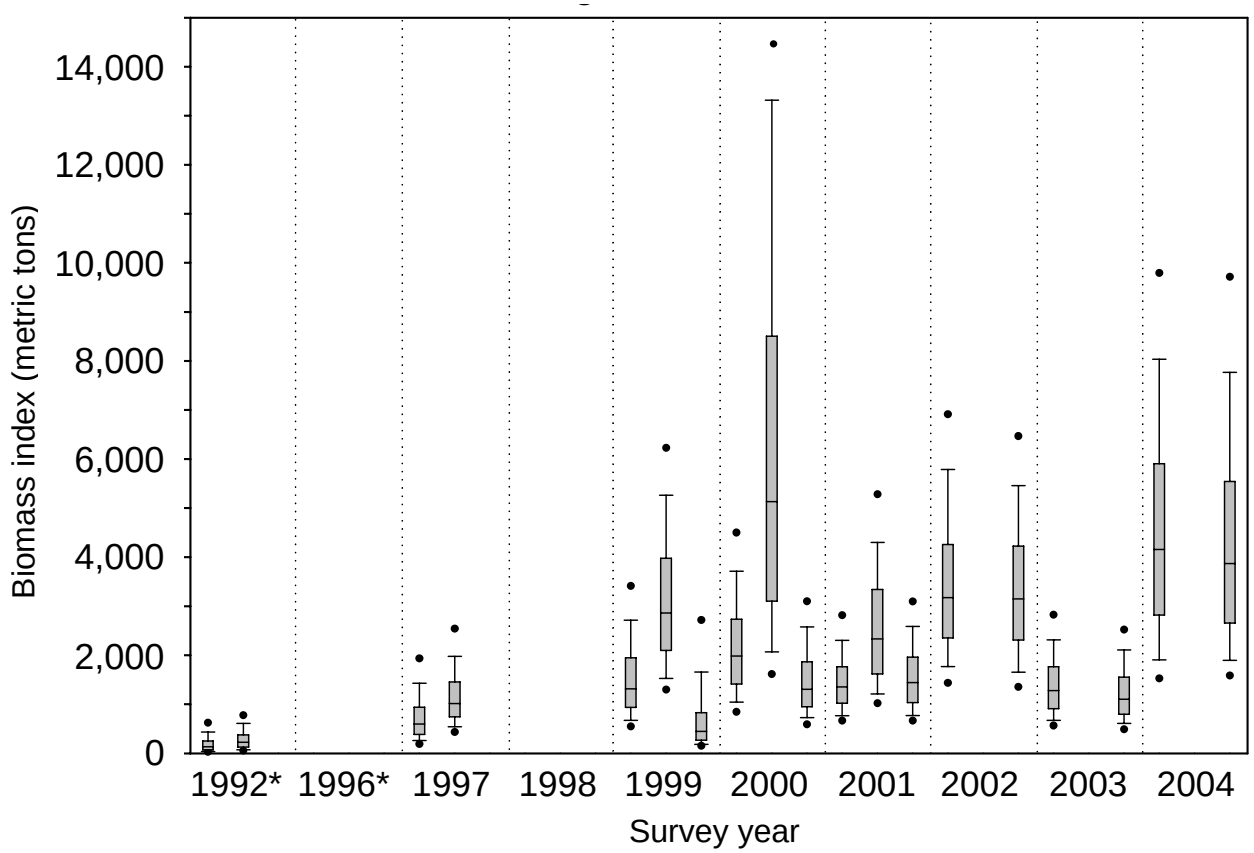



Figure K-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for blackgill rockfish. Plots shown are autocorrelation, effective sample size, Geweke statistics of convergence of the mean (should be < |2|), and Heidelberger and Welch statistic.




* Super year 1992 excludes Conception biomass. Super year 1996 excludes Monterey and Conception biomass.

Figure K-6. Marginal posterior distributions of biomass indices from the generalized linear and generalized linear mixed models fit to AFSC and NWFSC slope surveys for blackgill rockfish. Box-whisker plots shown give the 50th (cross bar), 25th–75th (shaded box), 10th–90th (whisker), and 5th–95th (dot) percentiles. Posterior distribution of model fits are given in order for each year; AFSC-NWFSC combined, AFSC only, and NWFSC only.

# Recent NOAA Technical Memorandums

**published by the**
**Northwest Fisheries Science Center**

**NOAA Technical Memorandum NMFS-NWFSC-**

**81** **Hard, J.J., J.M. Myers, M.J. Ford, R.G. Cope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams. P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007.** Status review of Puget Sound steelhead *(Oncorhynchus mykiss)*. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-81, 117 p. NTIS number pending.

**80** **Berntson, E.A., P.S. Levin, and P.C. Moran (editors). 2007.** Conservation of North Pacific rockfishes: Ecological genetics and stock structure. Proceedings of the workshop, March 2-3, 2004, Seattle, Washington. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-80, 80 p. NTIS number 2007-111137.

**79** **Lawson, P.W., E.P. Bjorkstedt, M.W. Chilcote, C.W. Huntington, J.S. Mills, K.M.S. Moore, T.E. Nickelson, G.H. Reeves, H.A. Stout, T.C. Wainwright, and L.A. Weitkamp. 2007.** Identification of historical populations of coho salmon *(Oncorhynchus kisutch)* in the Oregon coast evolutionarily significant unit. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-79, 129 p. NTIS number PB2007-111607.

**78** **Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J.B. Scott. 2006.** Independent populations of Chinook salmon in Puget Sound. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-78, 125 p. NTIS number PB2007-104920.

**77** **Sloan, C.A., D.W. Brown, G.M. Ylitalo, J. Buzitis, D.P. Herman, D.G. Burrows, G. Yanagida, R.W. Pearce, J.L. Bolton, R.H. Boyer, and M.M. Krahn. 2006.** Quality assurance plan for analyses of environmental samples for polycyclic aromatic compounds, persistent organic pollutants, fatty acids, stable isotope ratios, lipid classes, and metabolites of polycyclic aromatic compounds. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-77, 30 p. NTIS number PB2007-104919.

**76** **Gustafson R.G., J. Drake, M.J. Ford, J.M. Myers, E.E. Holmes, and R.S. Waples. 2006.** Status review of Cherry Point Pacific herring *(Clupea pallasii)* and updated status review of the Georgia Basin Pacific herring distinct population segment under the Endangered Species Act. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-76, 182 p. NTIS number PB2007-104918.

**75** **Keller, A.A., B.H. Horness, V.J. Tuttle, J.R. Wallace, V.H. Simon, E.L. Fruh, K.L. Bosley, and D.J. Kamikawa. 2006.** The 2002 U.S. West Coast upper continental slope trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-75, 189 p. NTIS PB2006-111432.

**74** **Pool, S.S., and R.D. Brodeur. 2006.** Neustonic mesozooplankton abundance and distribution in the northern California Current, 2000 and 2002. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-74, 76 p. NTIS PB2006-109275.

**Most NOAA Technical Memorandums NMFS-NWFSC are available online at the Northwest Fisheries Science Center web site (http://www.nwfsc.noaa.gov)**