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

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

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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

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

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

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 β 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

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

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 μ through a *variance function V*

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

where ϕ is a constant and w_i is a known weight for each observation. The *dispersion parameter* ϕ is either known (for example, for the binomial or Poisson distribution, ϕ=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 β, and the variance of β is β (1- β)/*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, τ is the fixed effect of the ith year, *a* is fixed effect of the jth spatial cell (stratum), and *v* is the random effect of kth vessel. Effort for the kth 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		
$\frac{1}{\Gamma(\alpha)}\left(\frac{\alpha}{\mu}\right)^{\alpha} y^{\alpha-1}\exp\left(\frac{-\alpha y}{\mu}\right), \mu>0, \alpha>0$	μ	$\frac{\mu^2}{\alpha}$
Inverse Gaussian		
$\sqrt{\frac{k}{2\pi y^3}}\exp\left\{-\frac{k}{2y}\left(\frac{y-\mu}{\mu}\right)^2\right\}, \mu>0, k>0$	μ	$\frac{\mu^3}{k}$
Lognormal		
$\frac{1}{y\sigma\sqrt{2\pi}}\exp\left\{-0.5\left(\frac{\log y-\mu}{\sigma}\right)^2\right\}, -\infty<\mu<\infty, \sigma>0$	$\exp\left(\mu+0.5\sigma^2\right)$	$\exp\left(2\mu+\sigma^2\right)\left[\exp\left(\sigma^2\right)-1\right]$

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

* Δ 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.

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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.

	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	0.03	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.

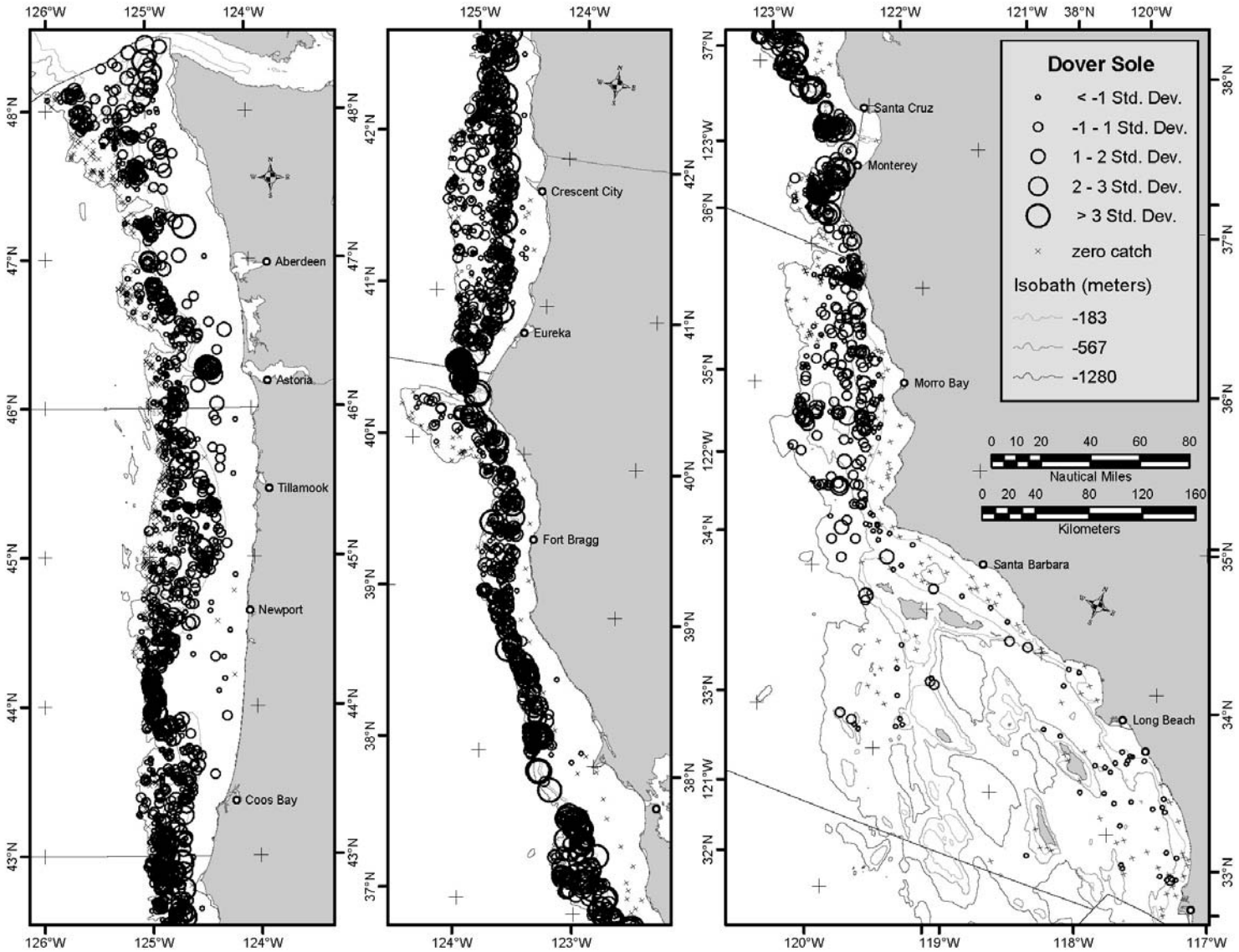


Figure A-1. Distribution of Dover sole caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

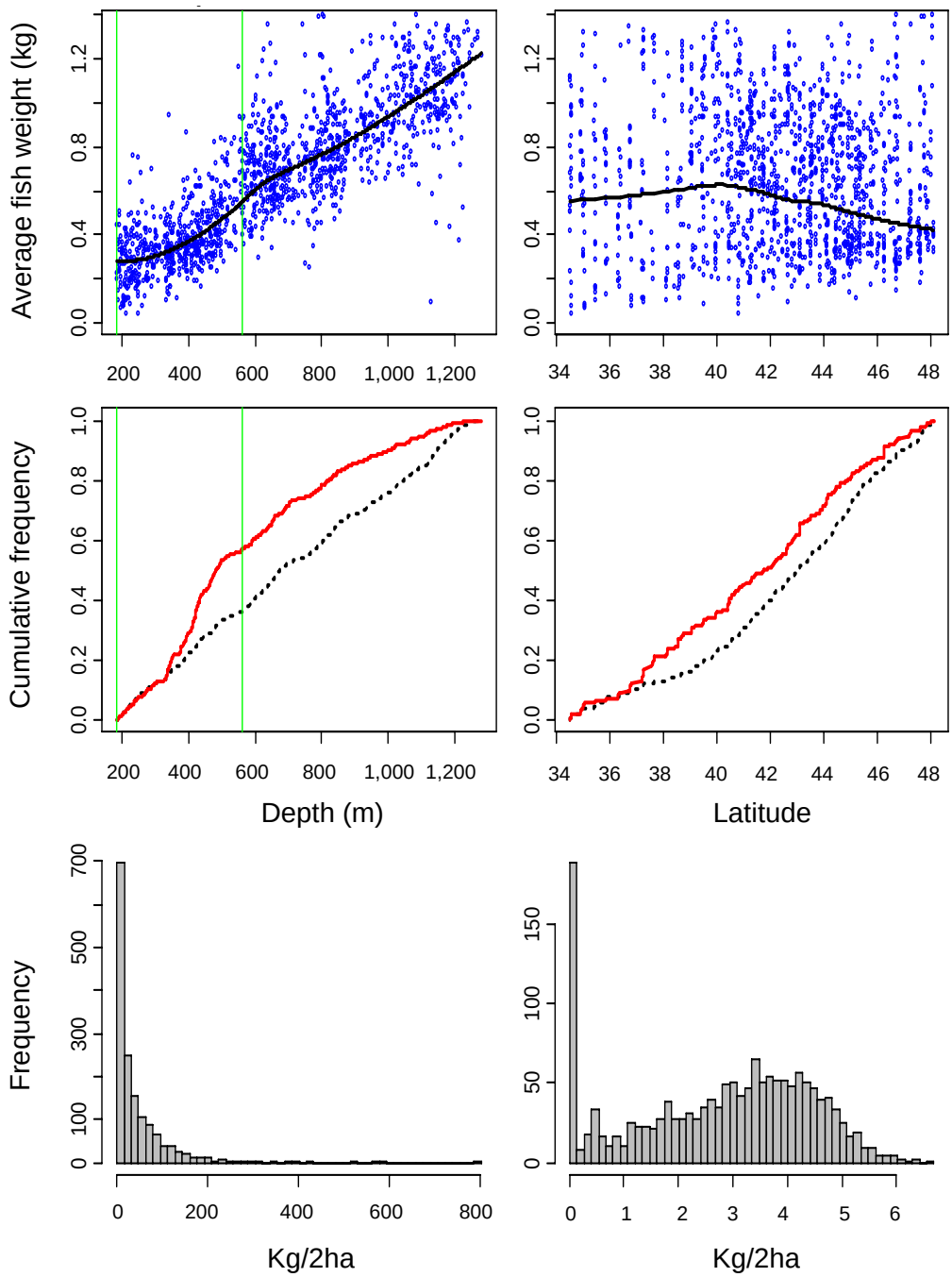


Figure A-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Dover sole caught in the AFSC slope surveys.

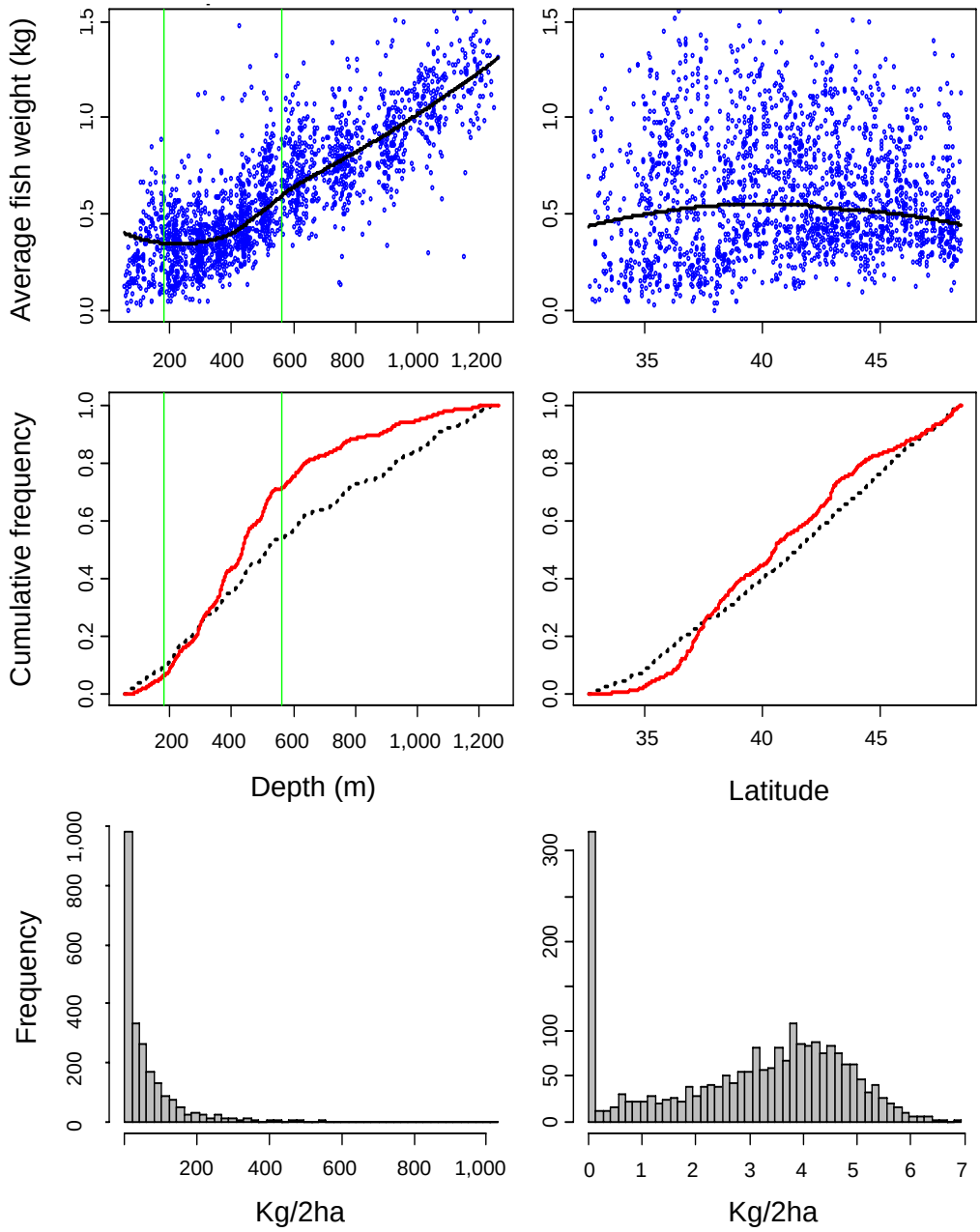
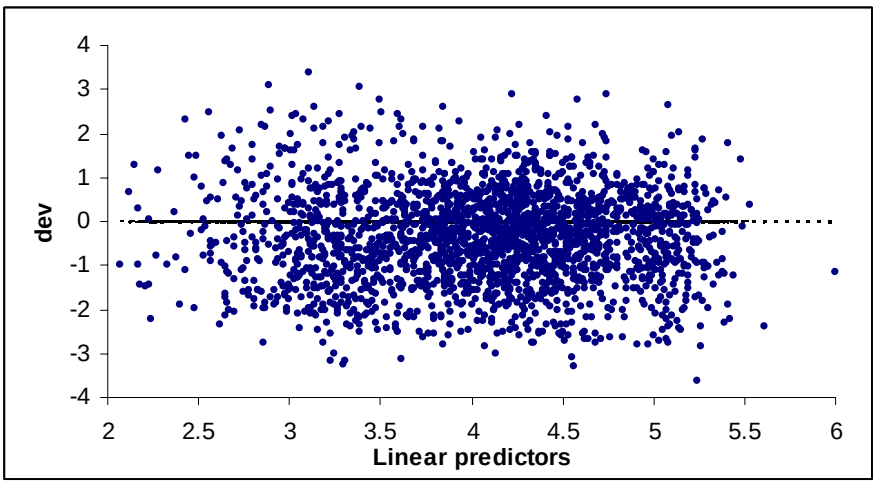
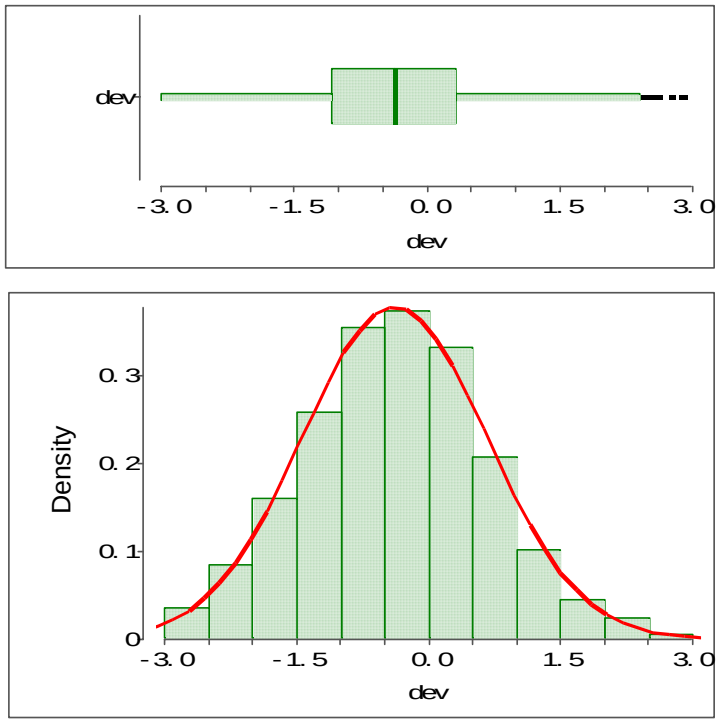


Figure A-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Dover sole caught in the NWFSC slope surveys.

A



B



C

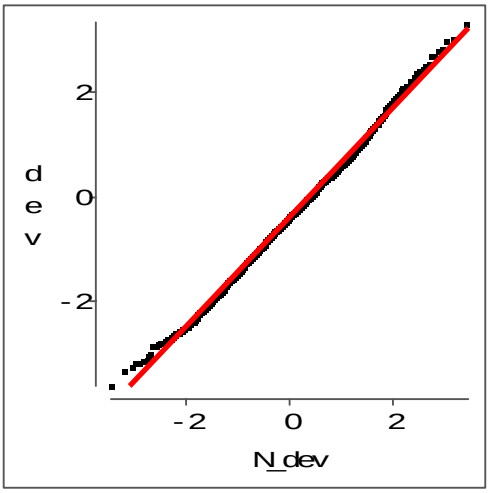


Figure A-4. Diagnostic plots from the generalized linear mixed model fit to Dover sole from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C)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

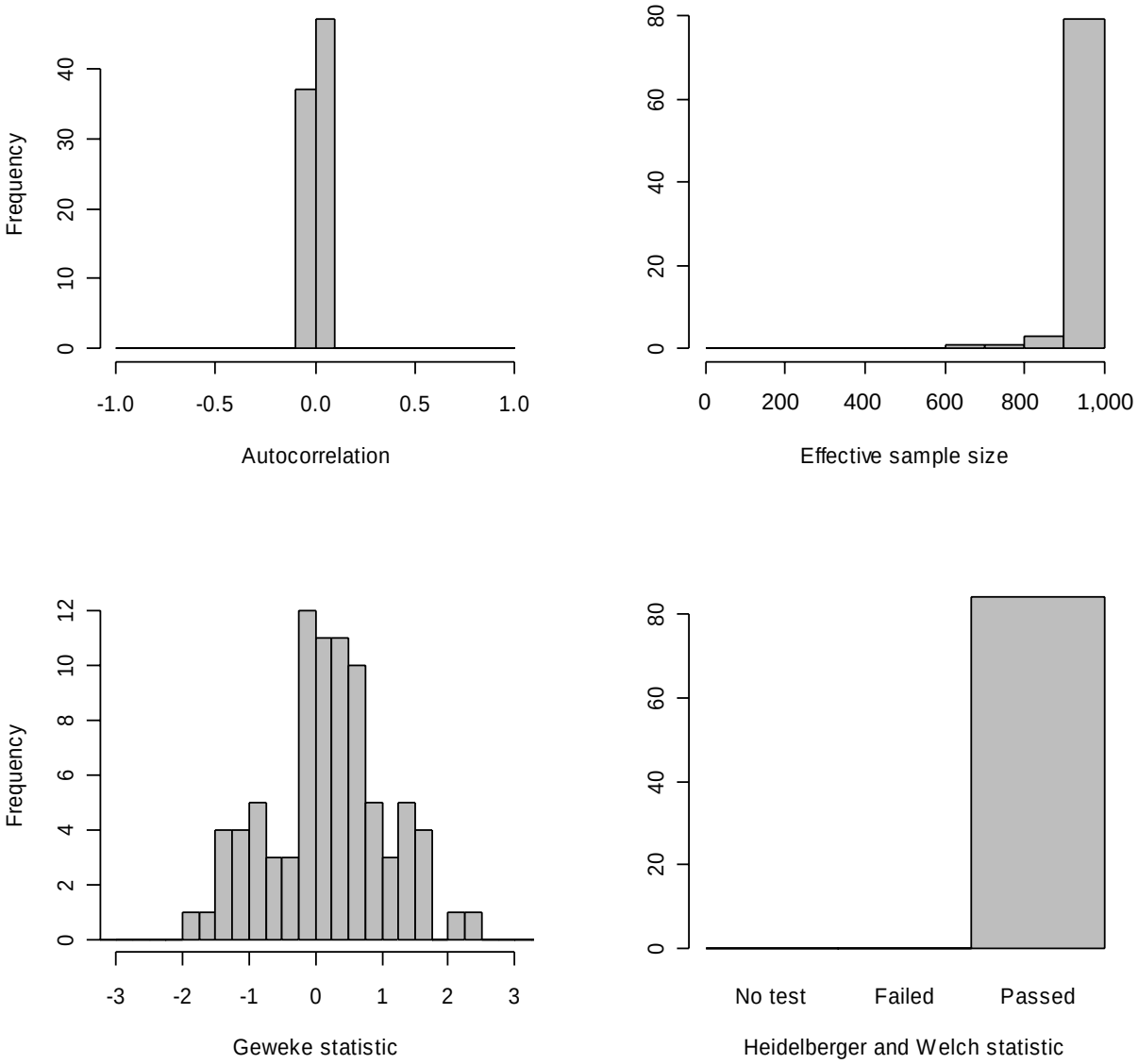
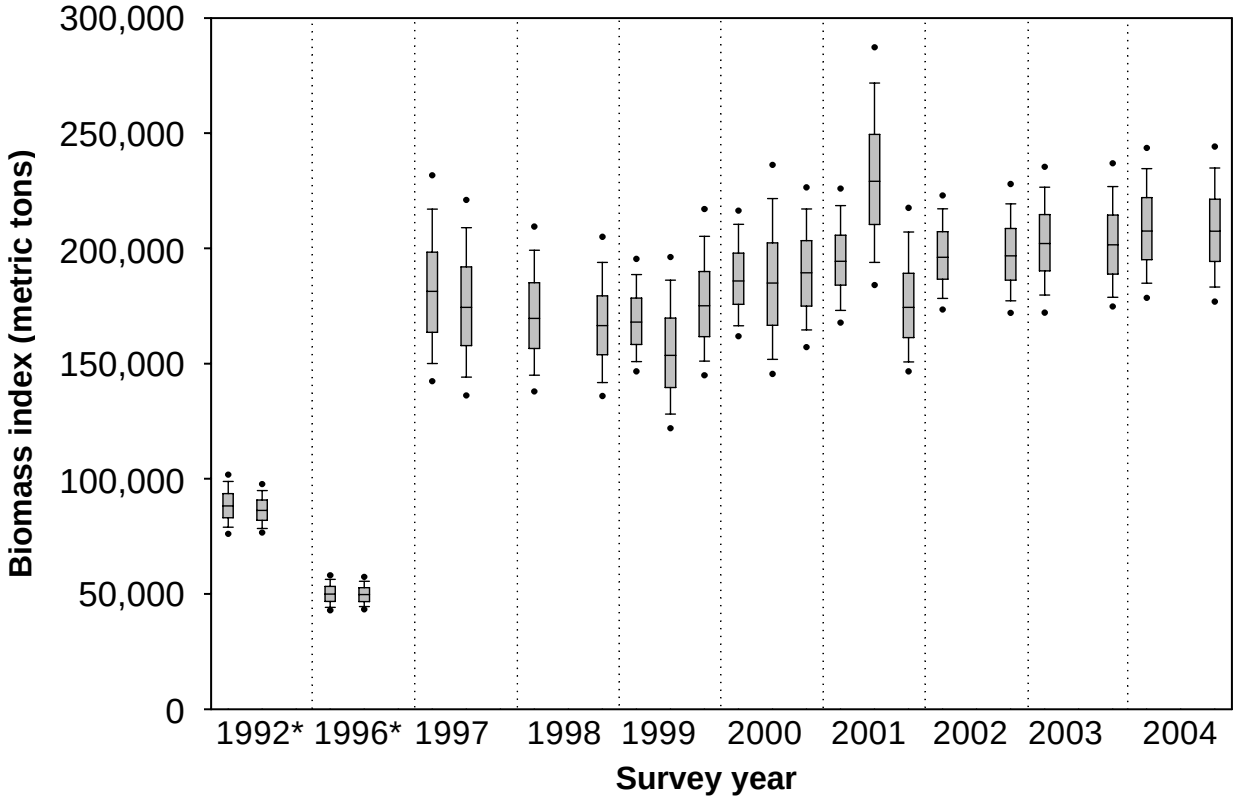


Figure A-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for Dover sole. Plots shown 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.

	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*	0.92	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.

	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*	0.99	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.

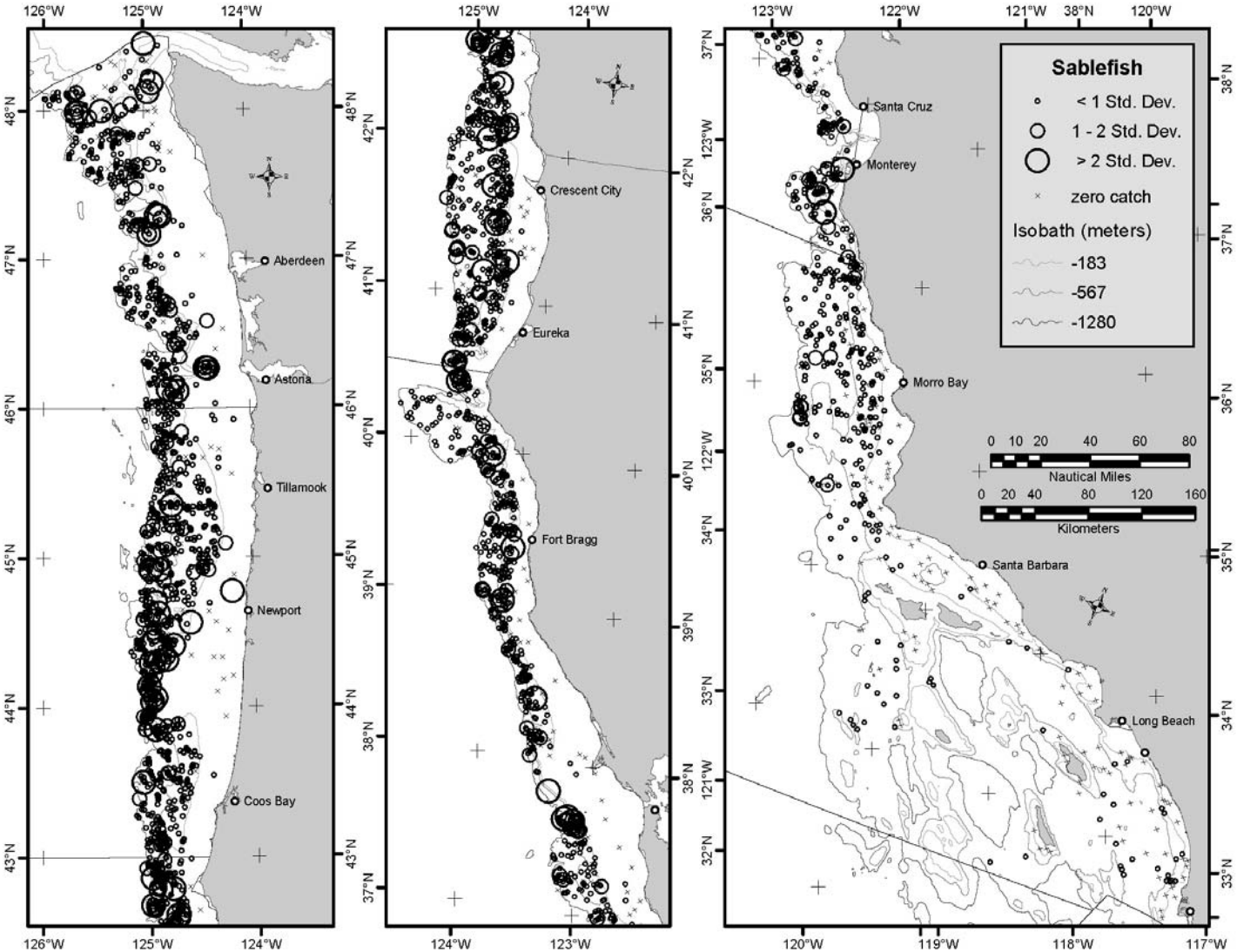


Figure B-1. Distribution of sablefish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

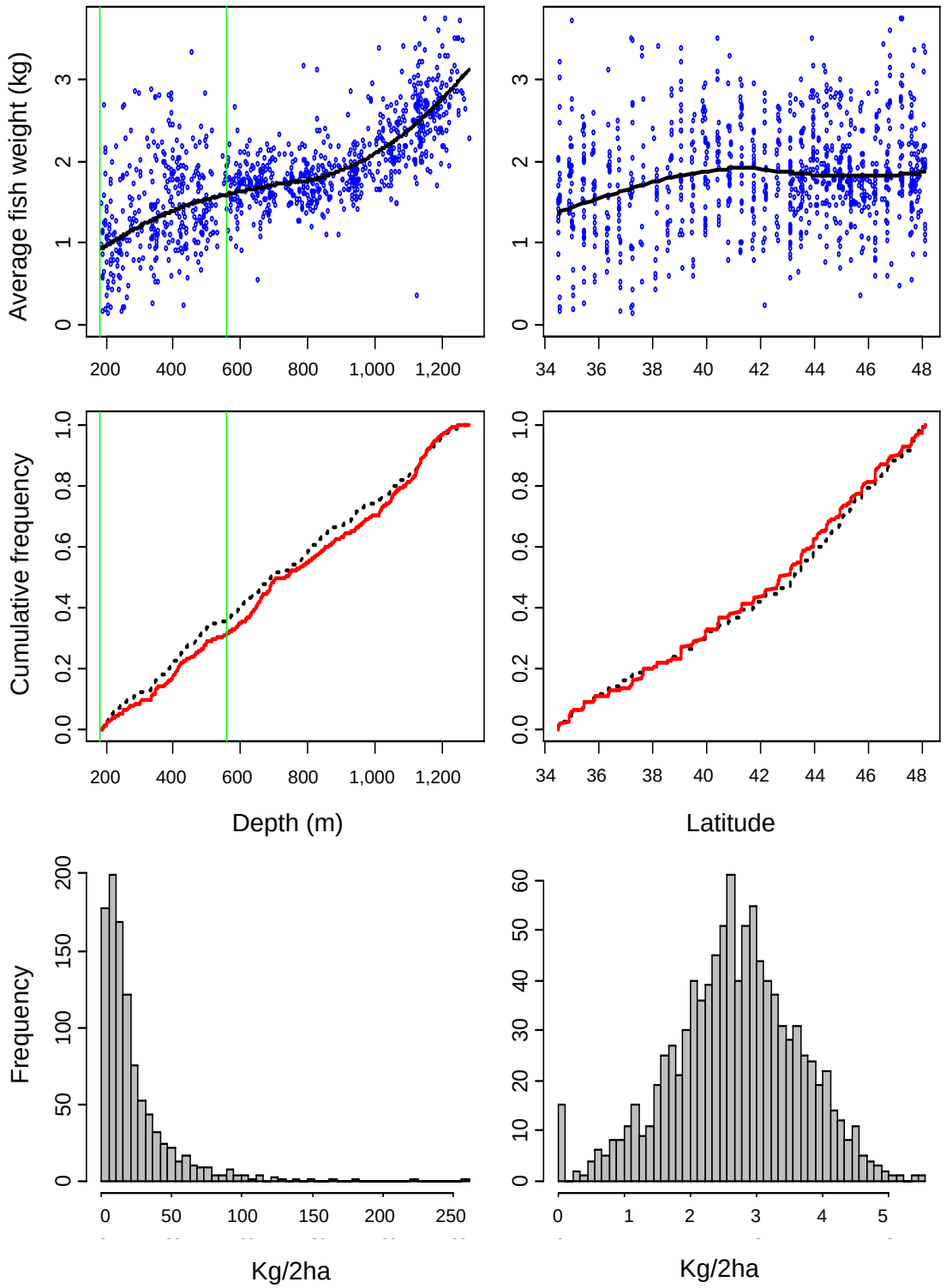


Figure B-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of sablefish caught in the AFSC slope surveys.

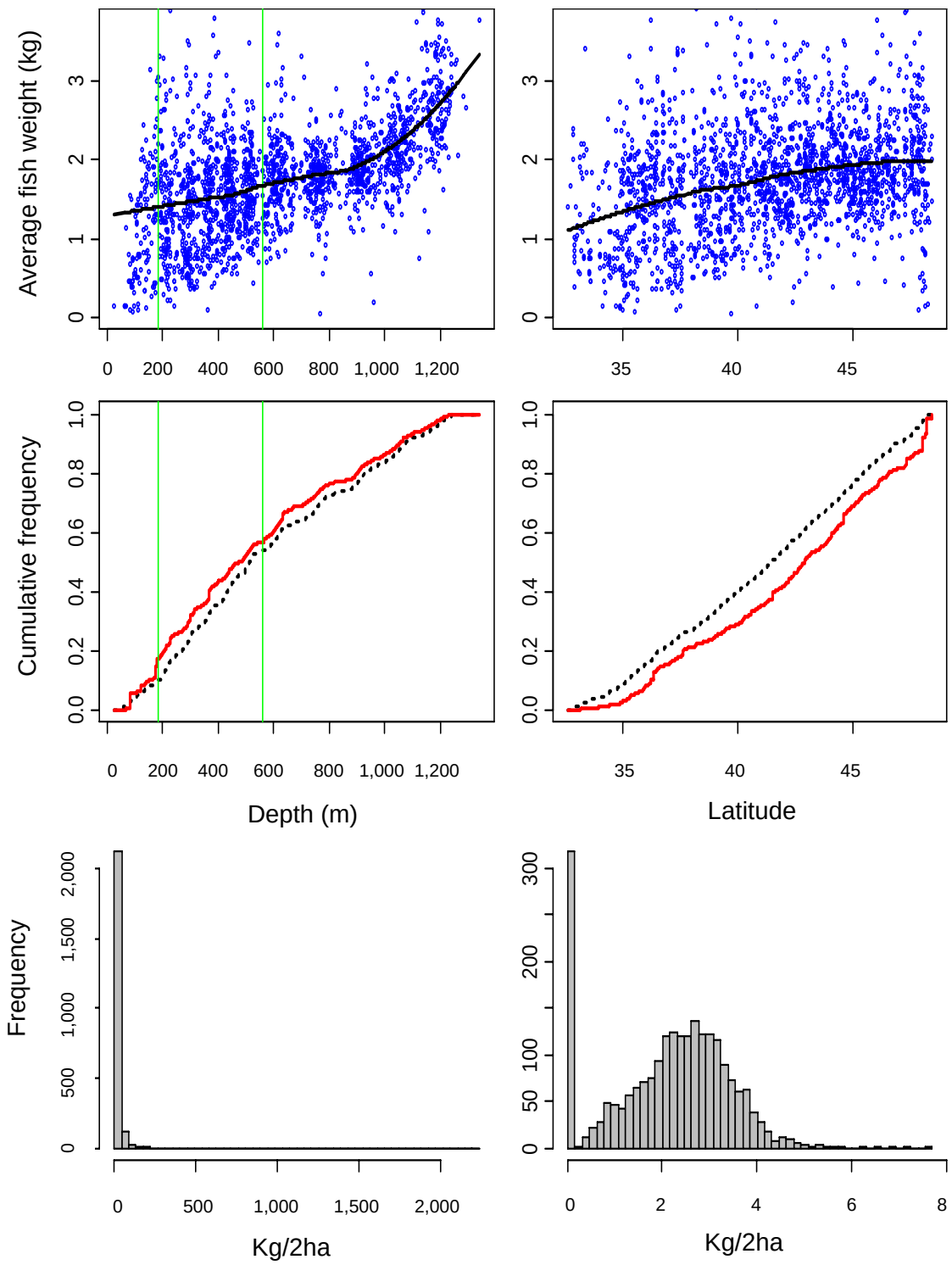
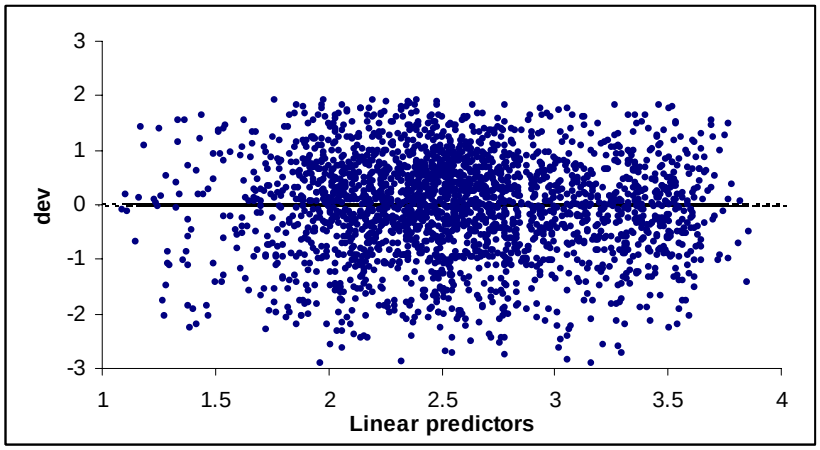
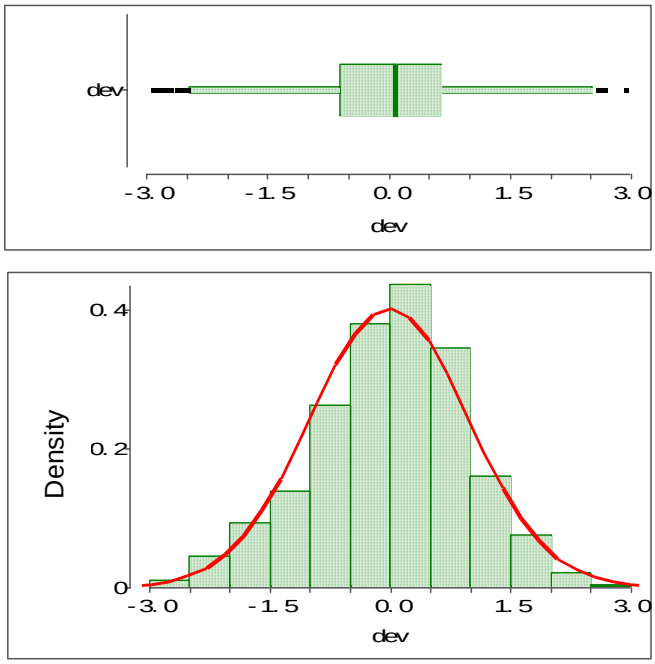


Figure B-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of sablefish caught in the NWFSC slope surveys.

A



B



C

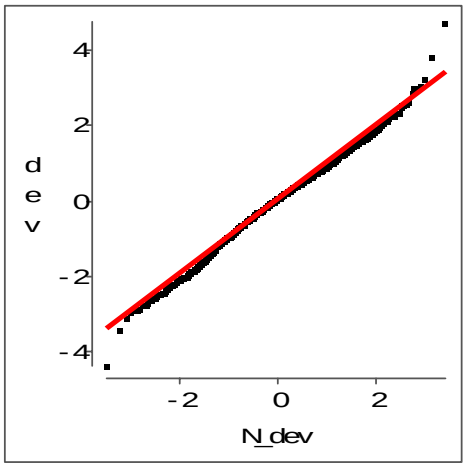


Figure B-4. Diagnostic plots from the generalized linear mixed model fit to sablefish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and C)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

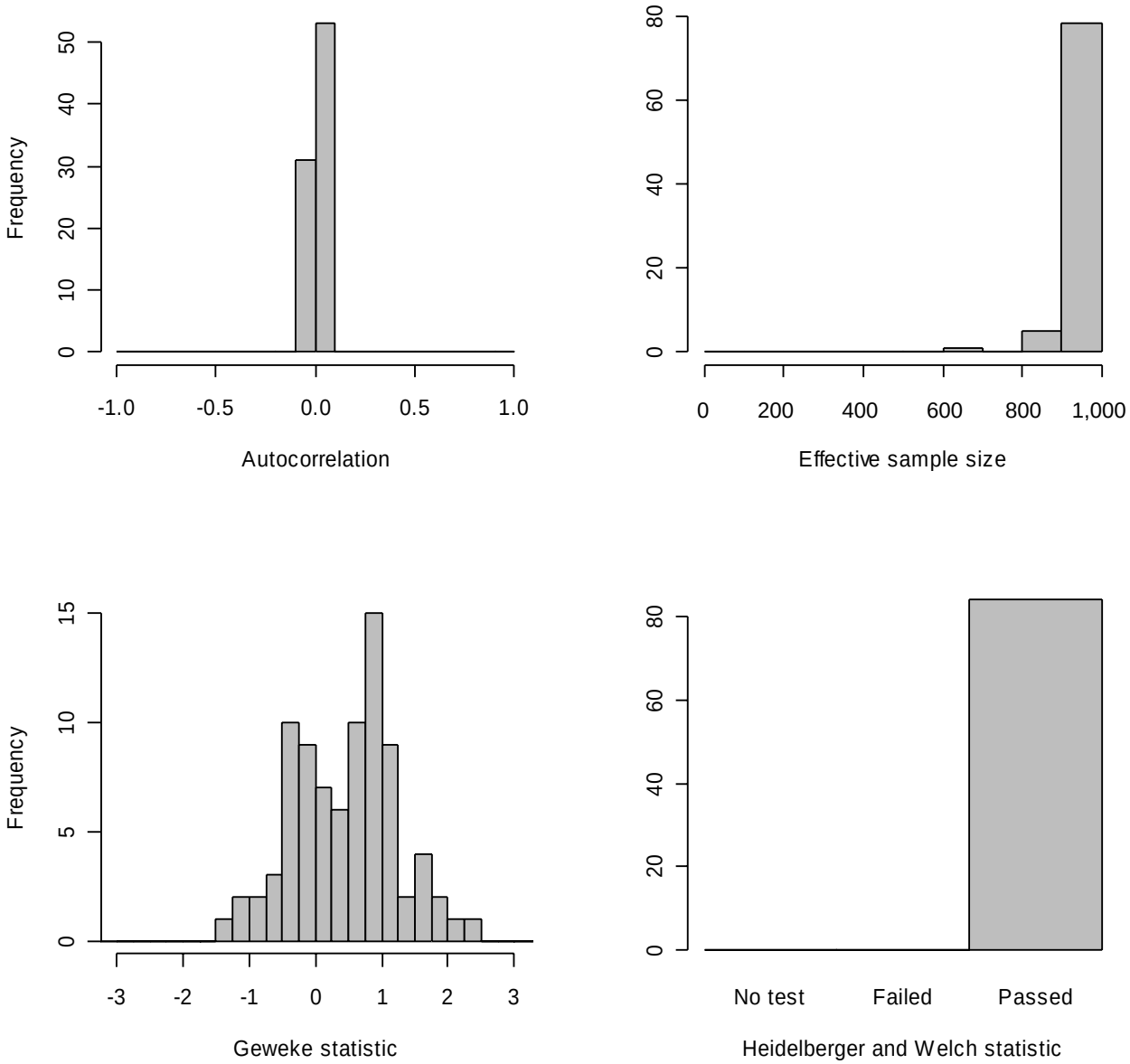
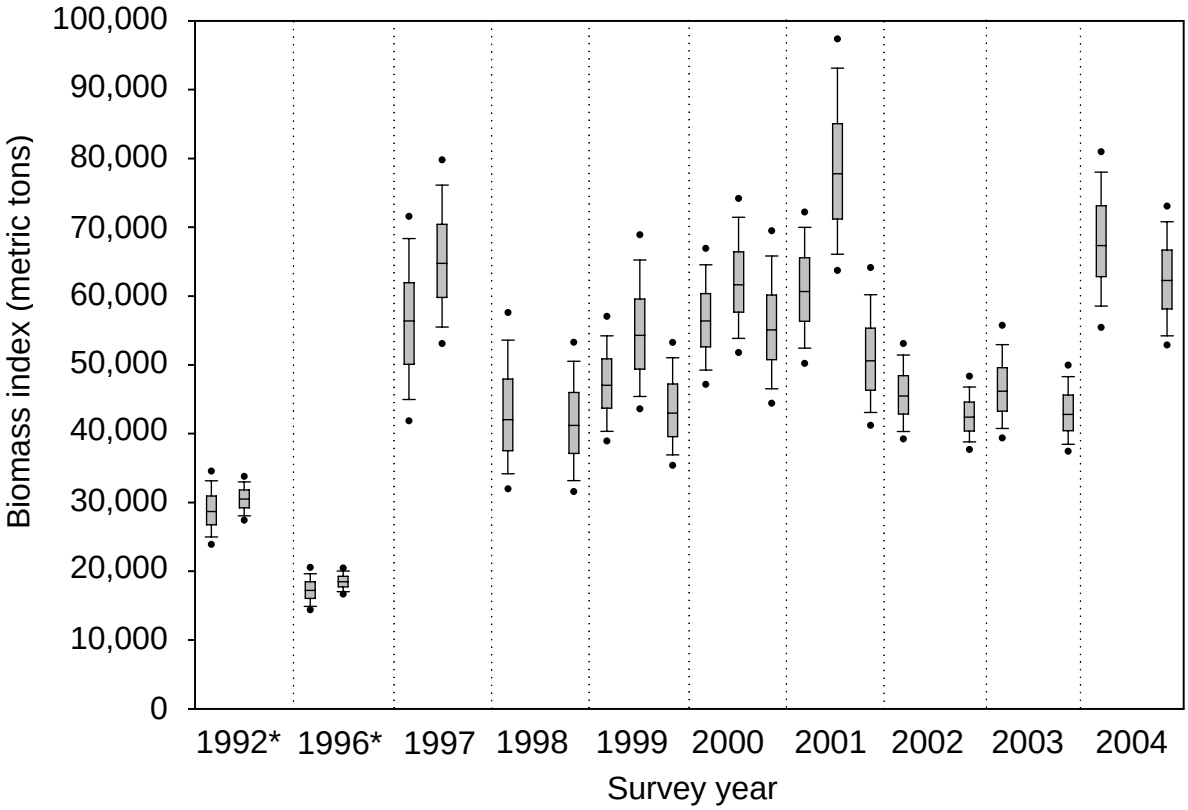


Figure B-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for sablefish. Plots shown 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.

	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	0.9	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.

	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	0.03	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.

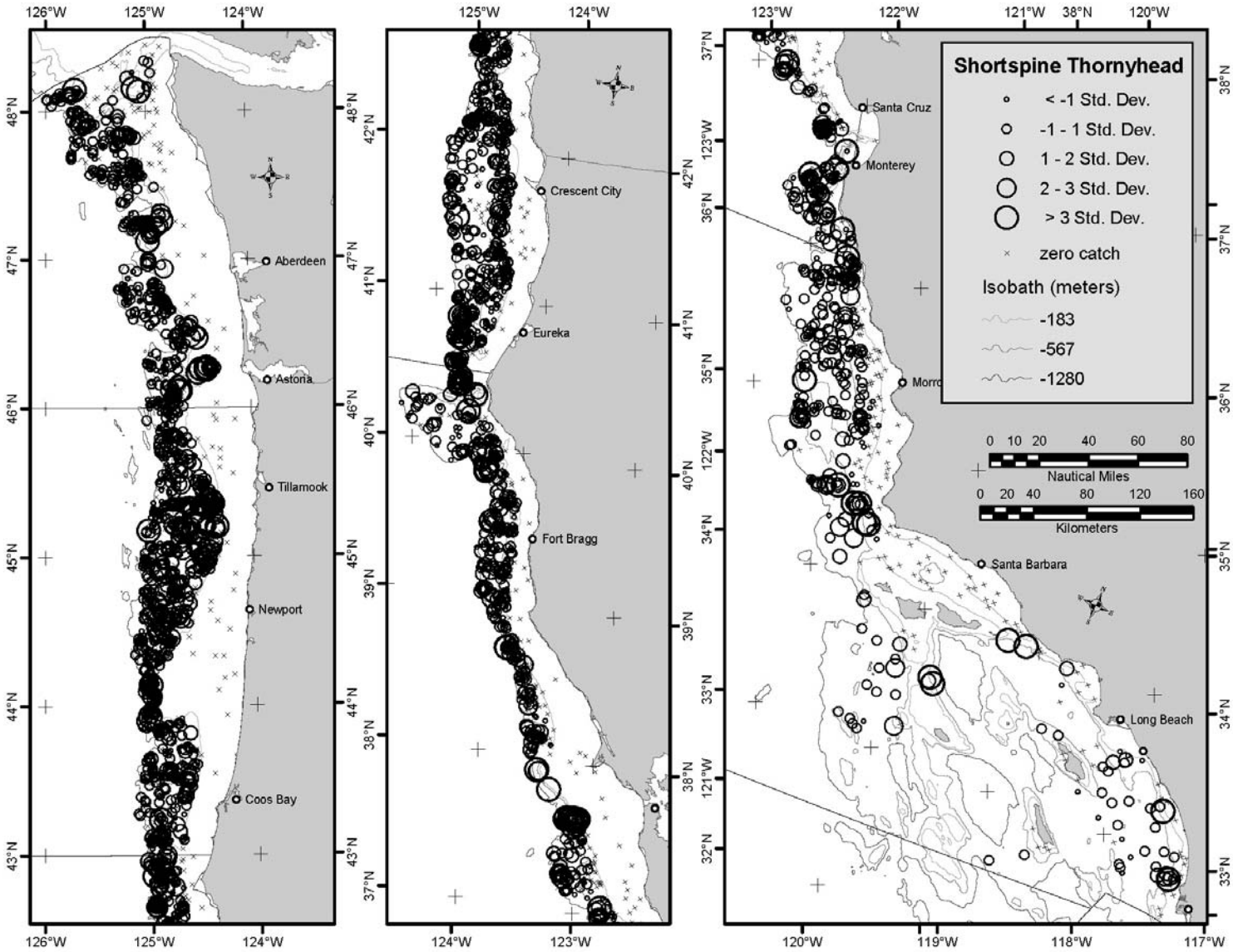


Figure C-1. Distribution of shortspine thornyhead caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

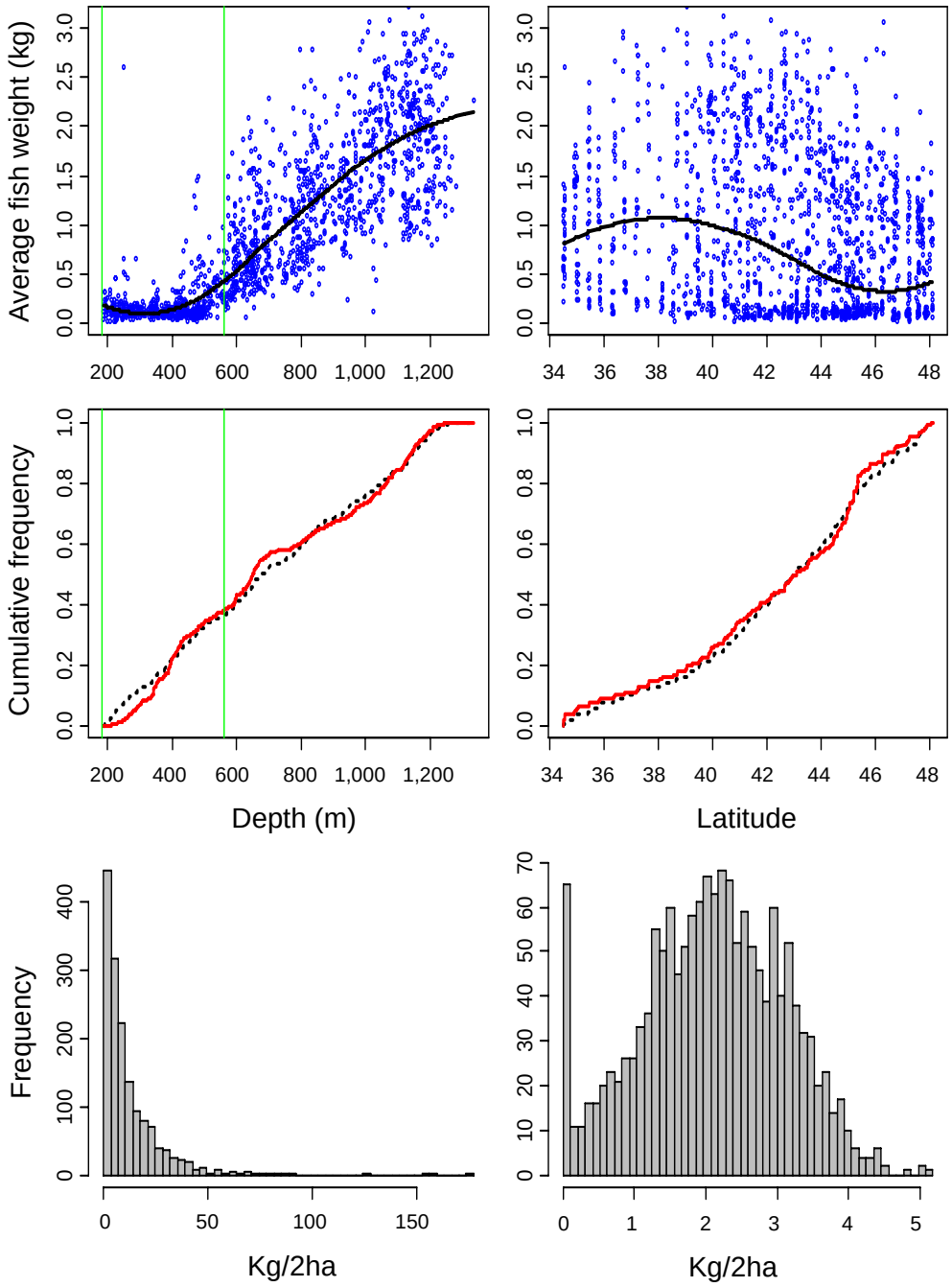


Figure C-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of shortspine thornyhead caught in the AFSC slope surveys.

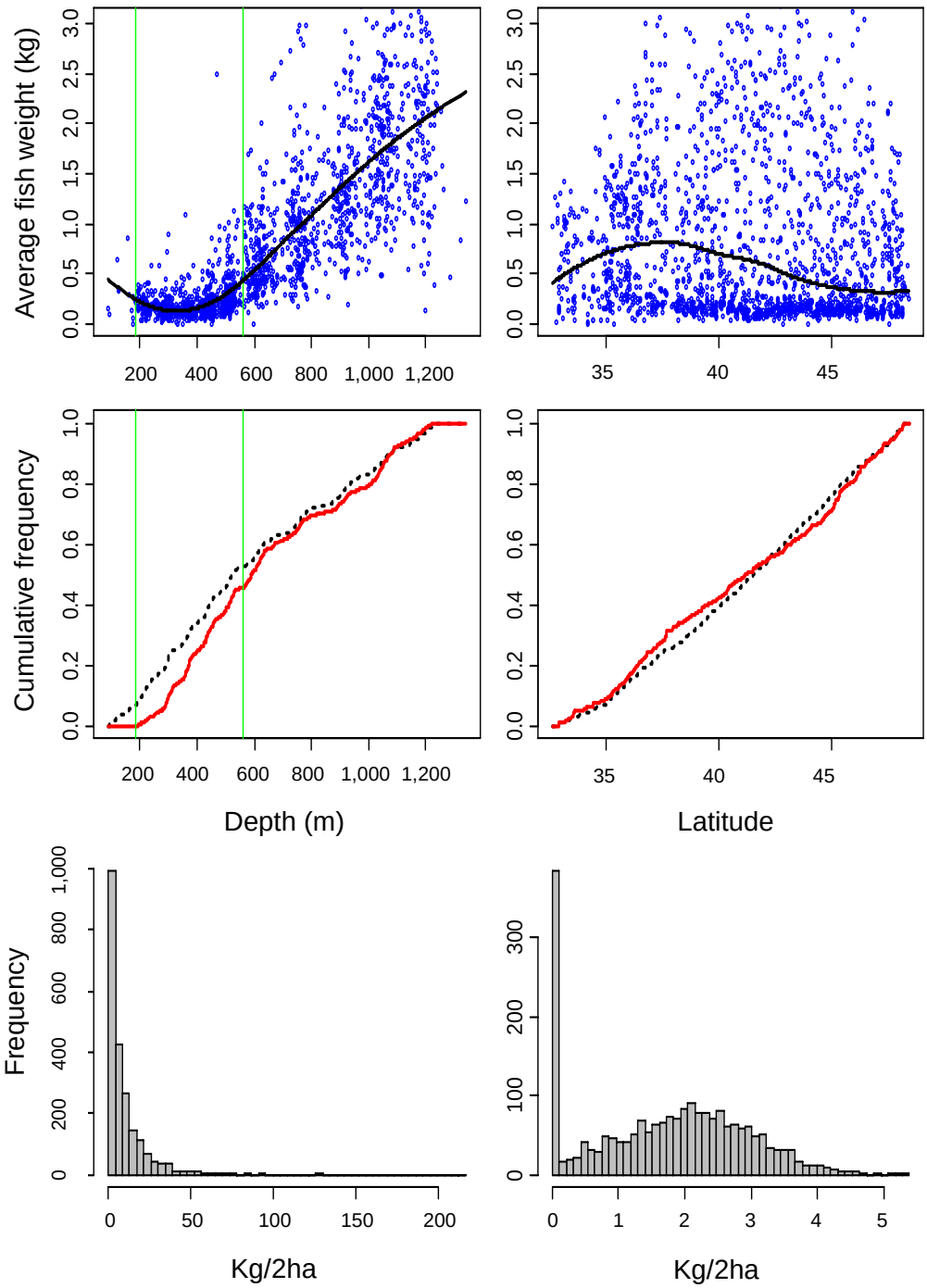


Figure C-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of shortspine thornyhead caught in the NWFSC slope surveys.

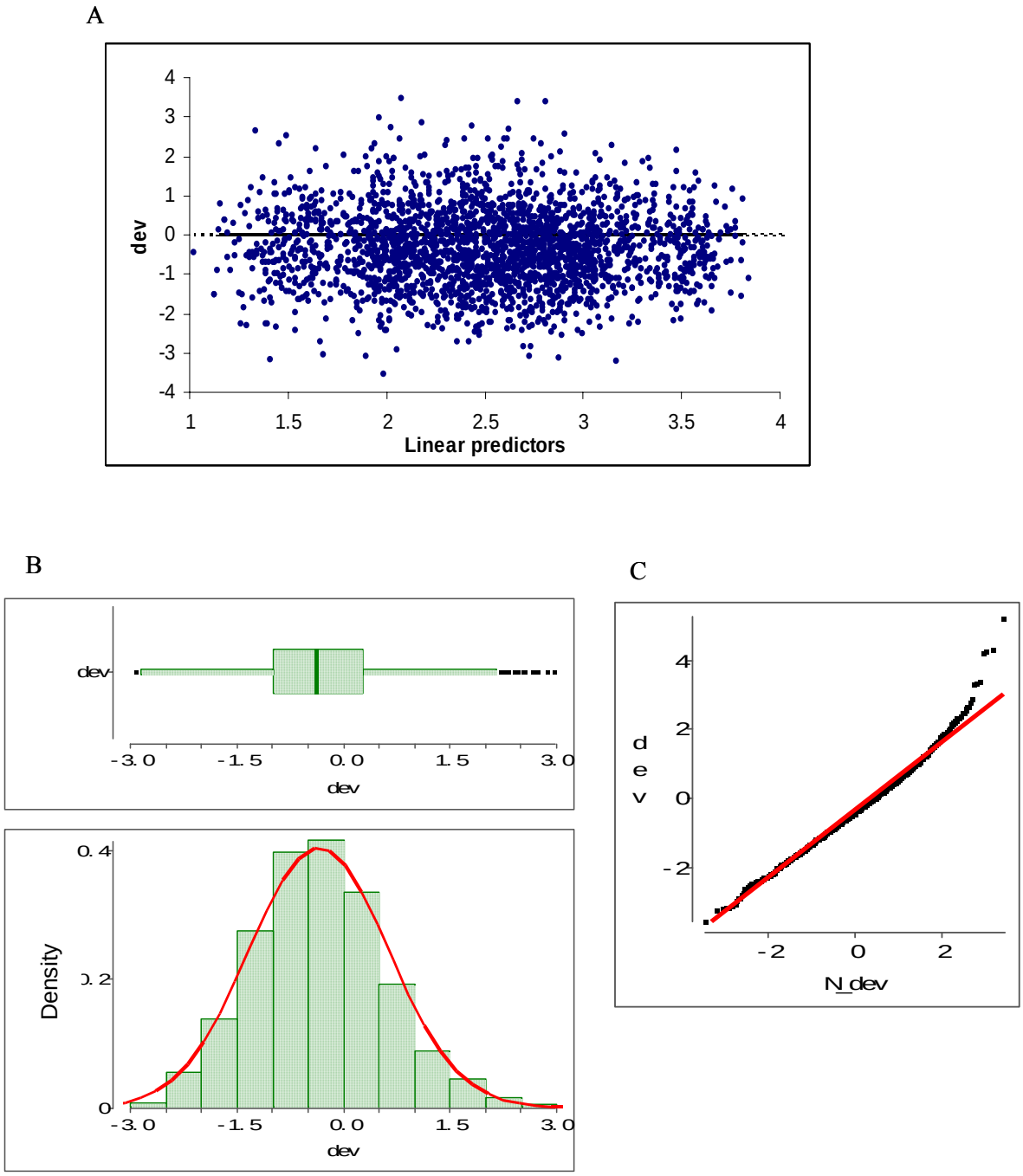


Figure C-4. Diagnostic plots from the generalized linear mixed model fit to shortspine thornyhead from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed,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

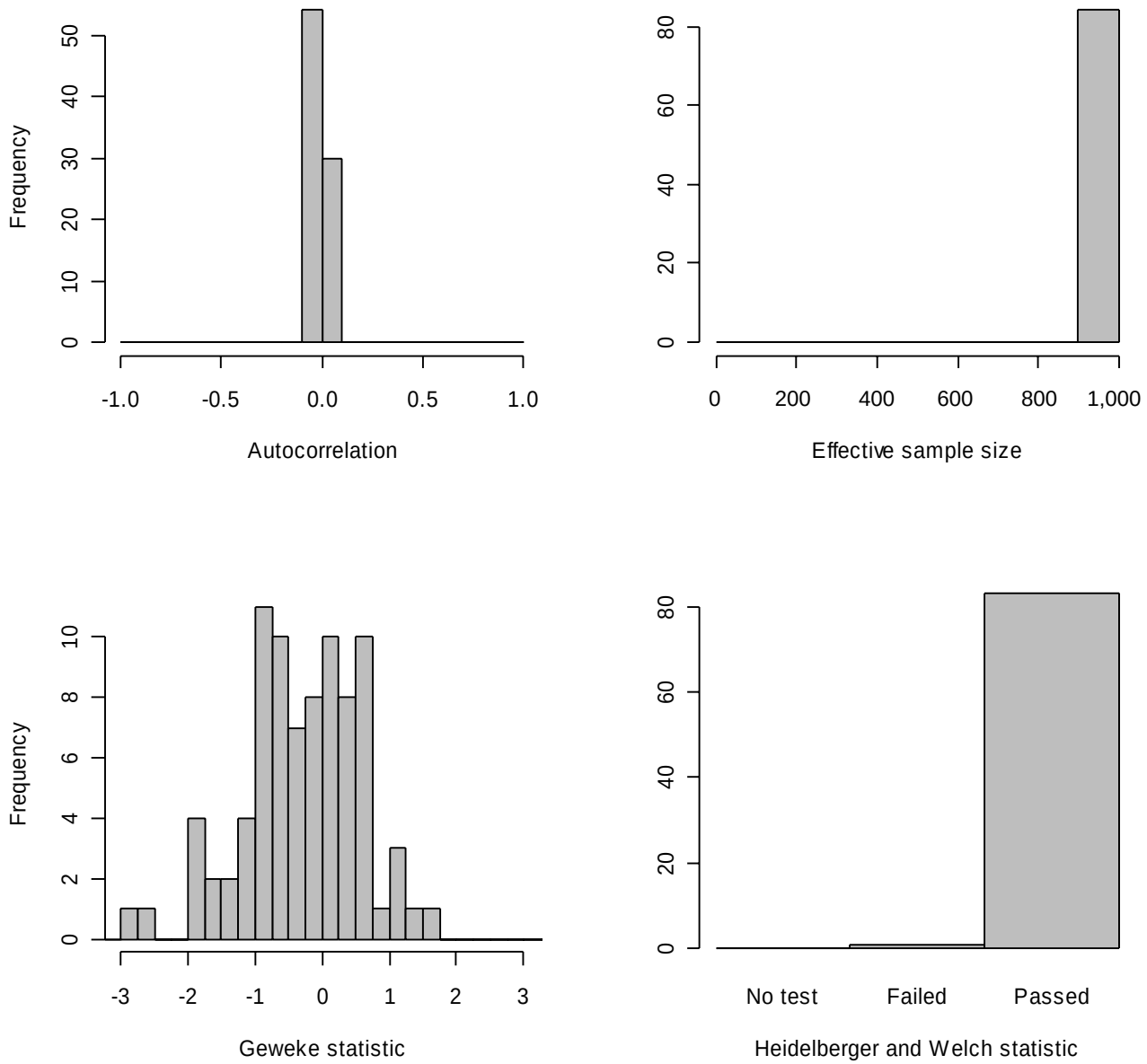
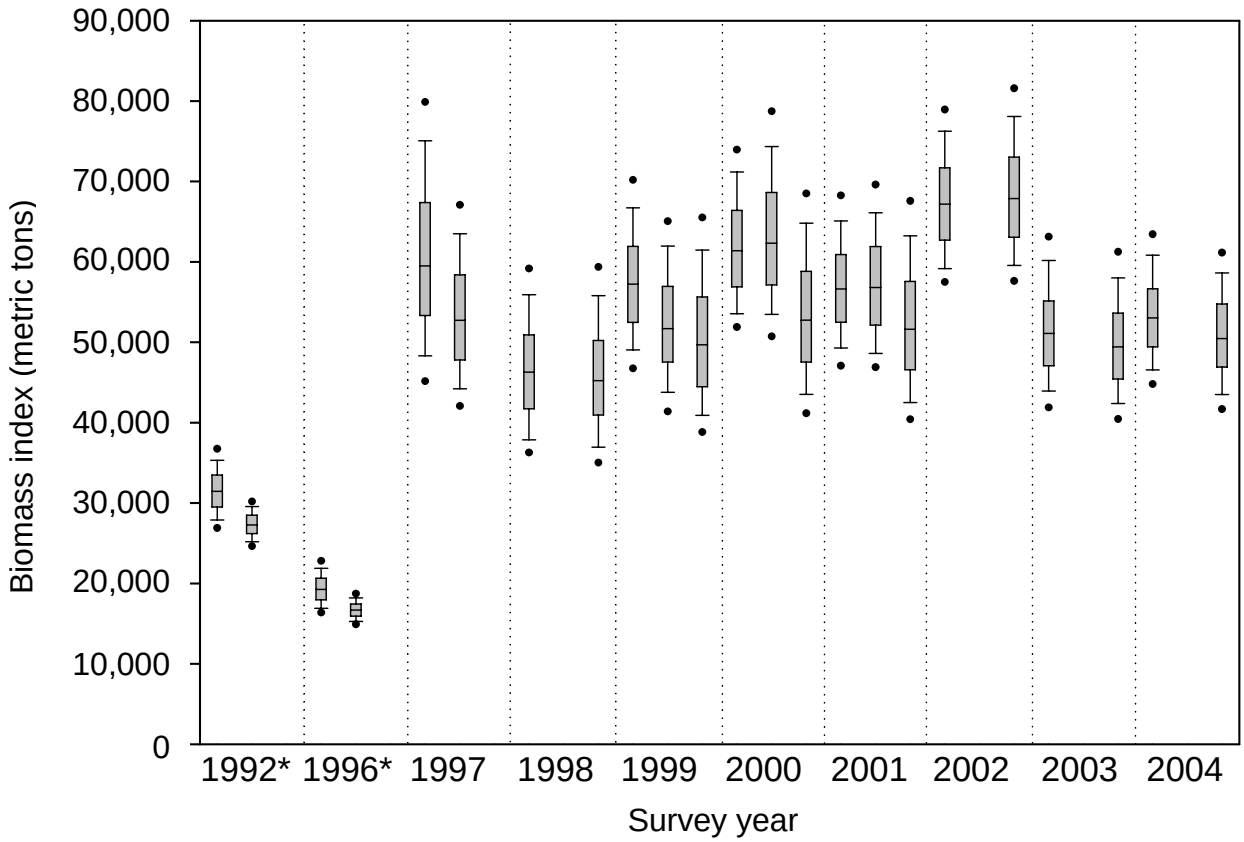


Figure C-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for shortspine thornyhead. 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 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	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.

	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*	0.19	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.

	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*	0.15	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.

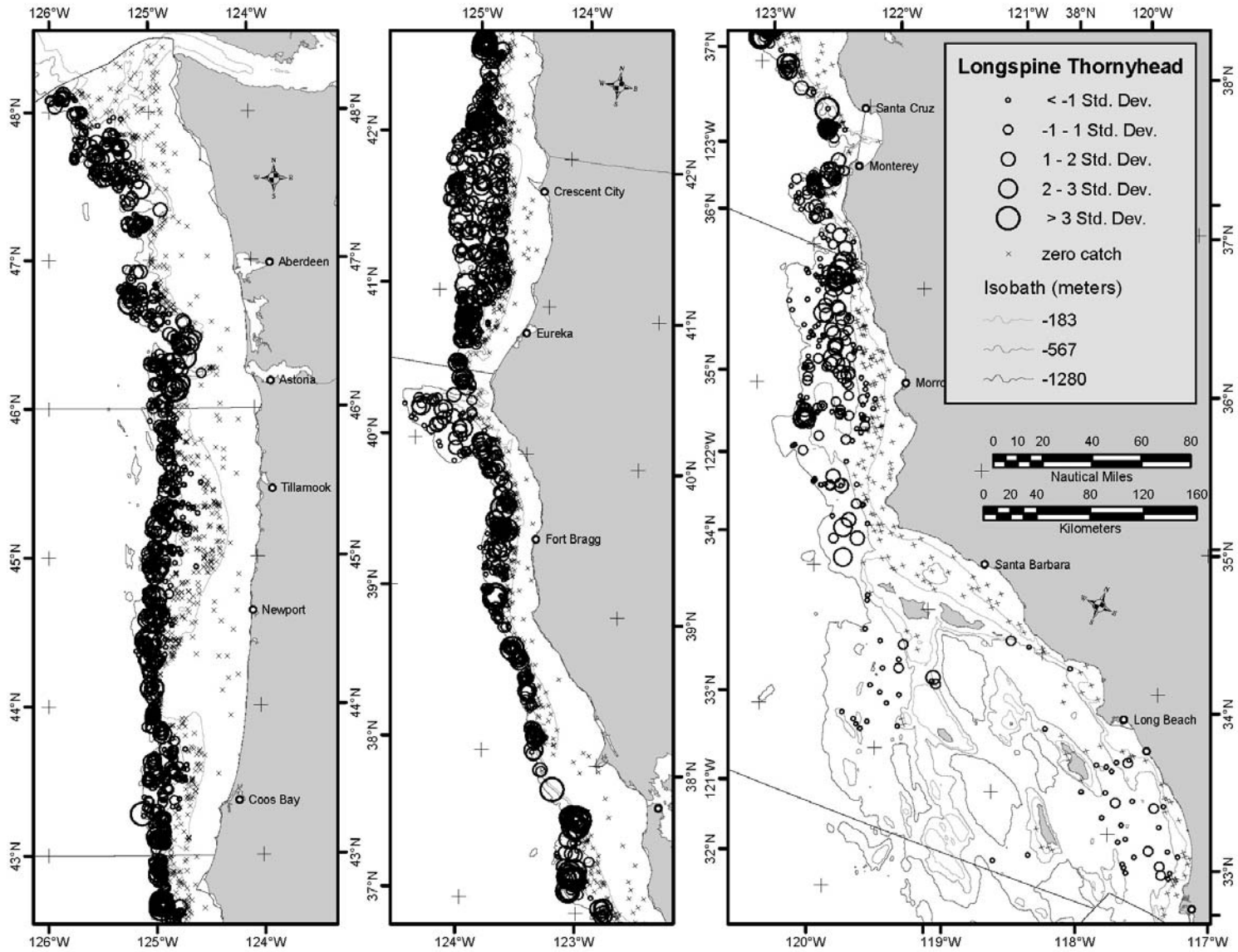


Figure D-1. Distribution of longspine thornyhead caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

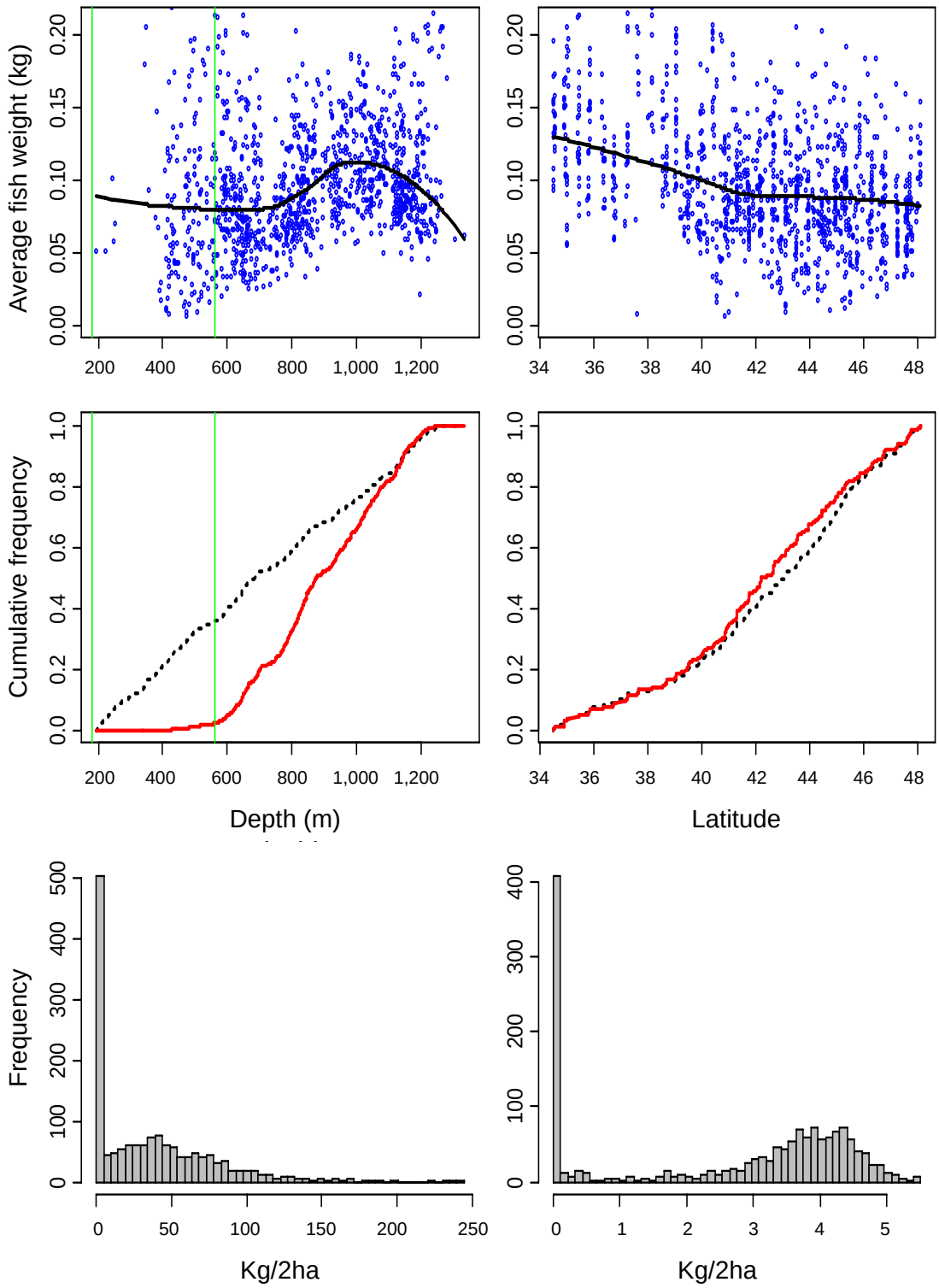


Figure D-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of longspine thornyhead caught in the AFSC slope surveys.

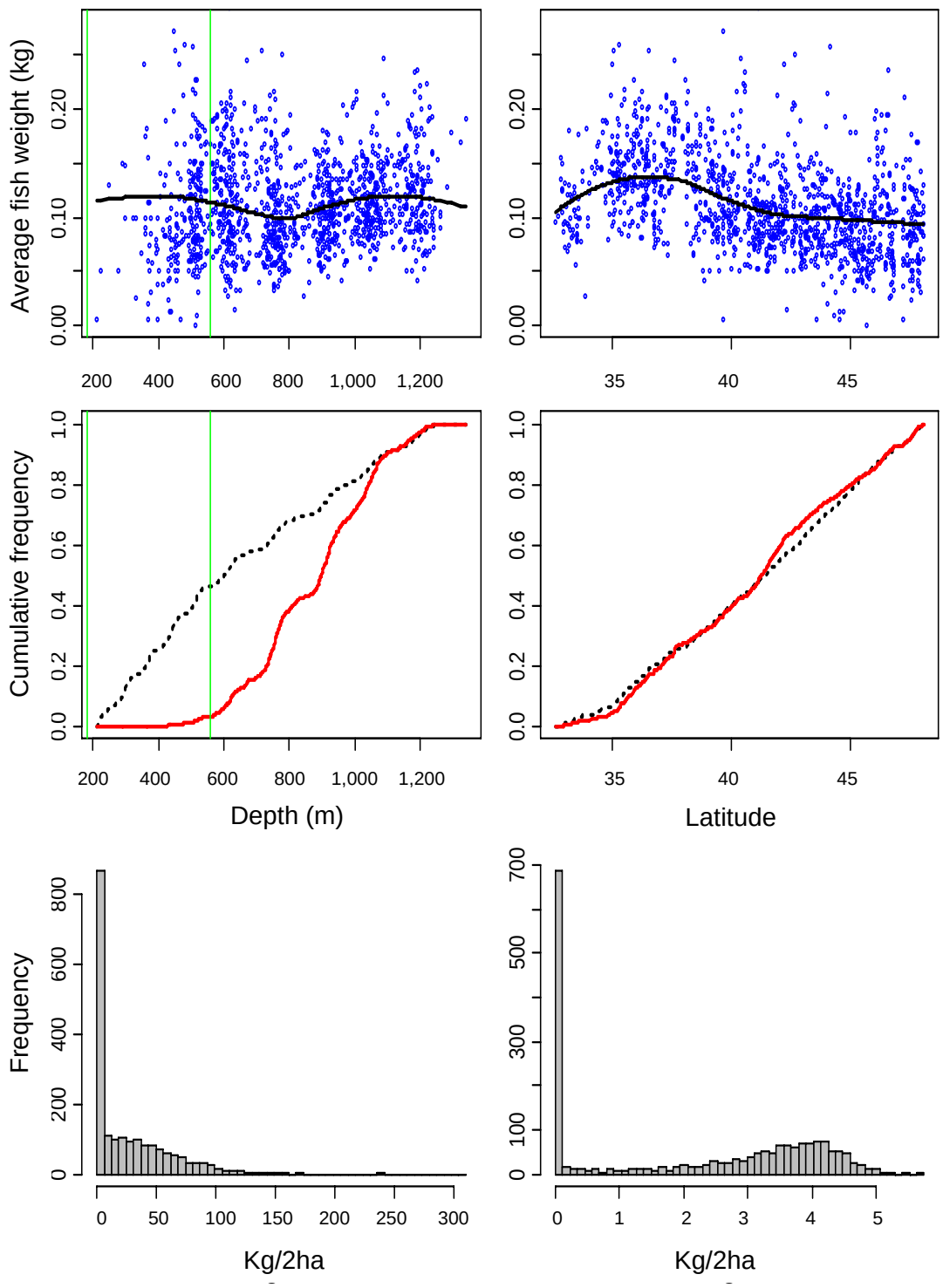


Figure D-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of longspine thornyhead caught in the NWFSC slope surveys.

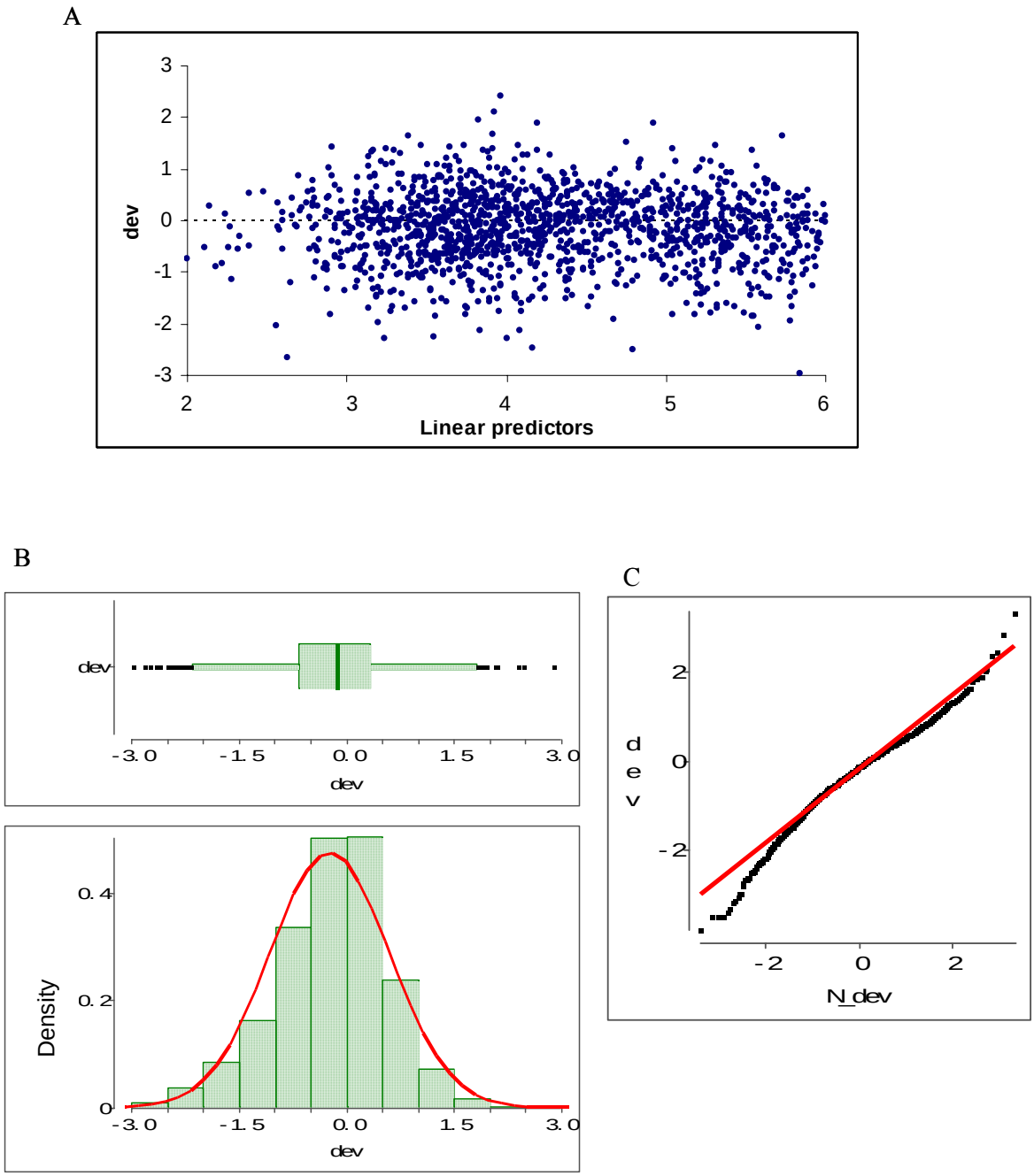


Figure D-4. Diagnostic plots from the generalized linear mixed model fit to longspine thornyhead from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed,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

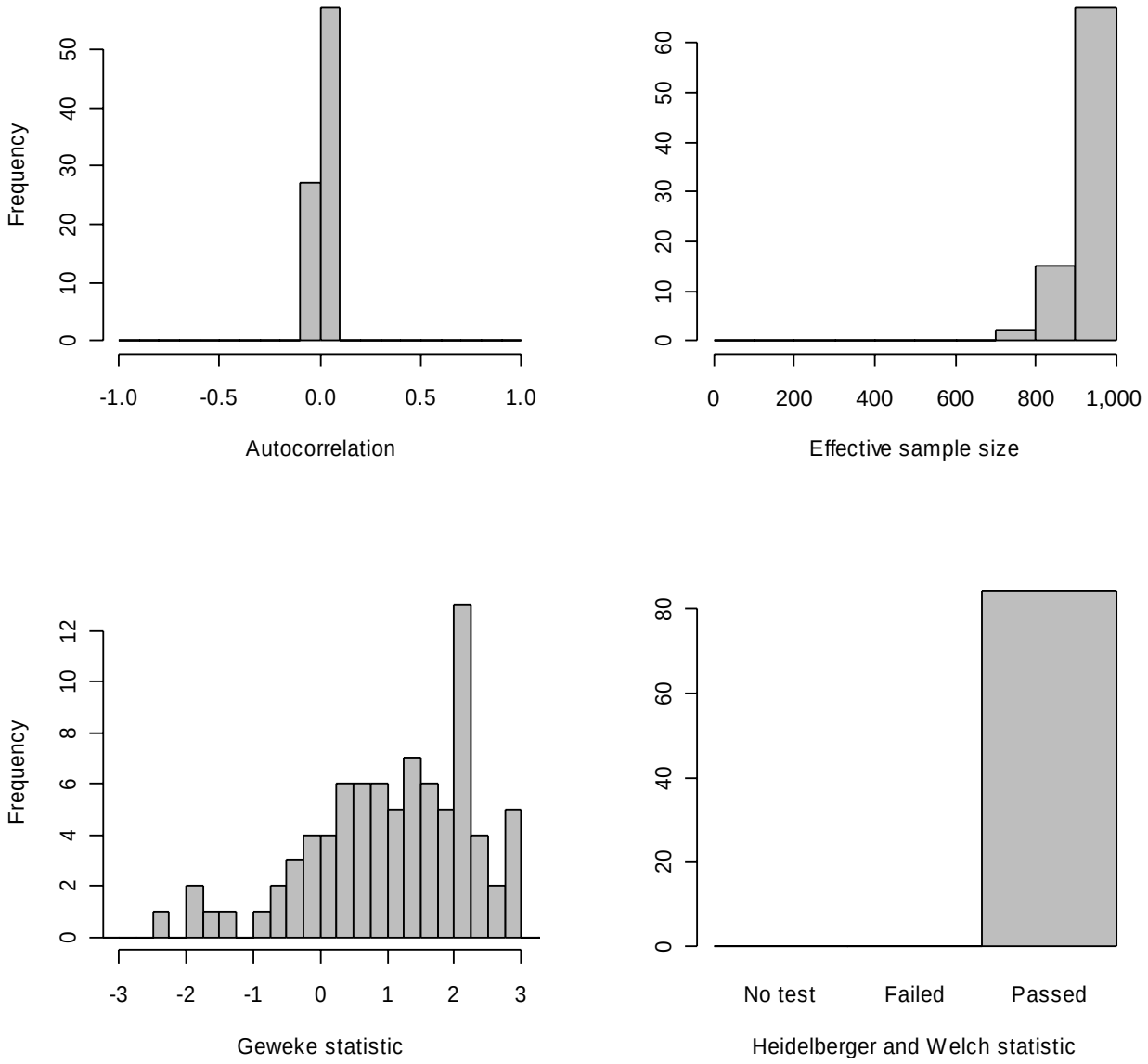
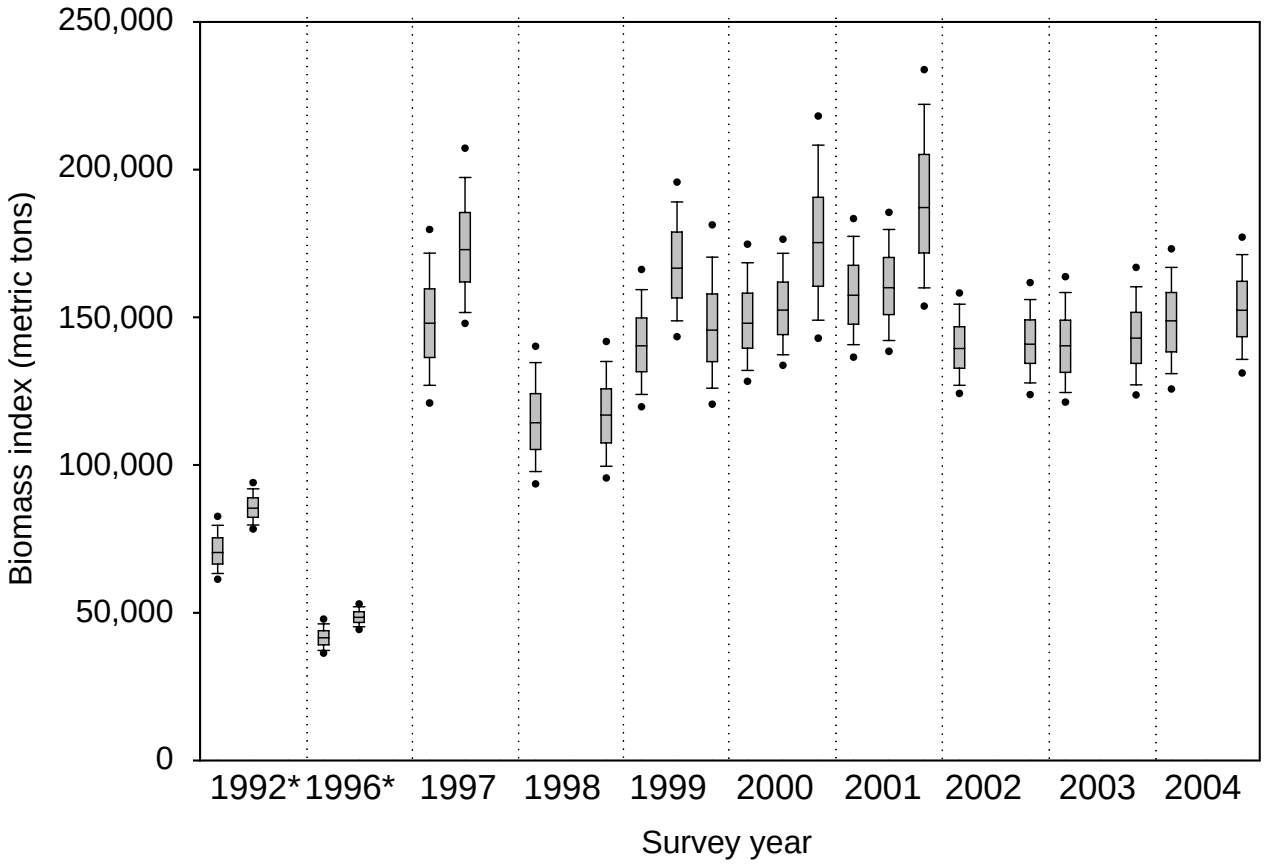


Figure D-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for longspine thornyhead. Plots 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).

	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	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.

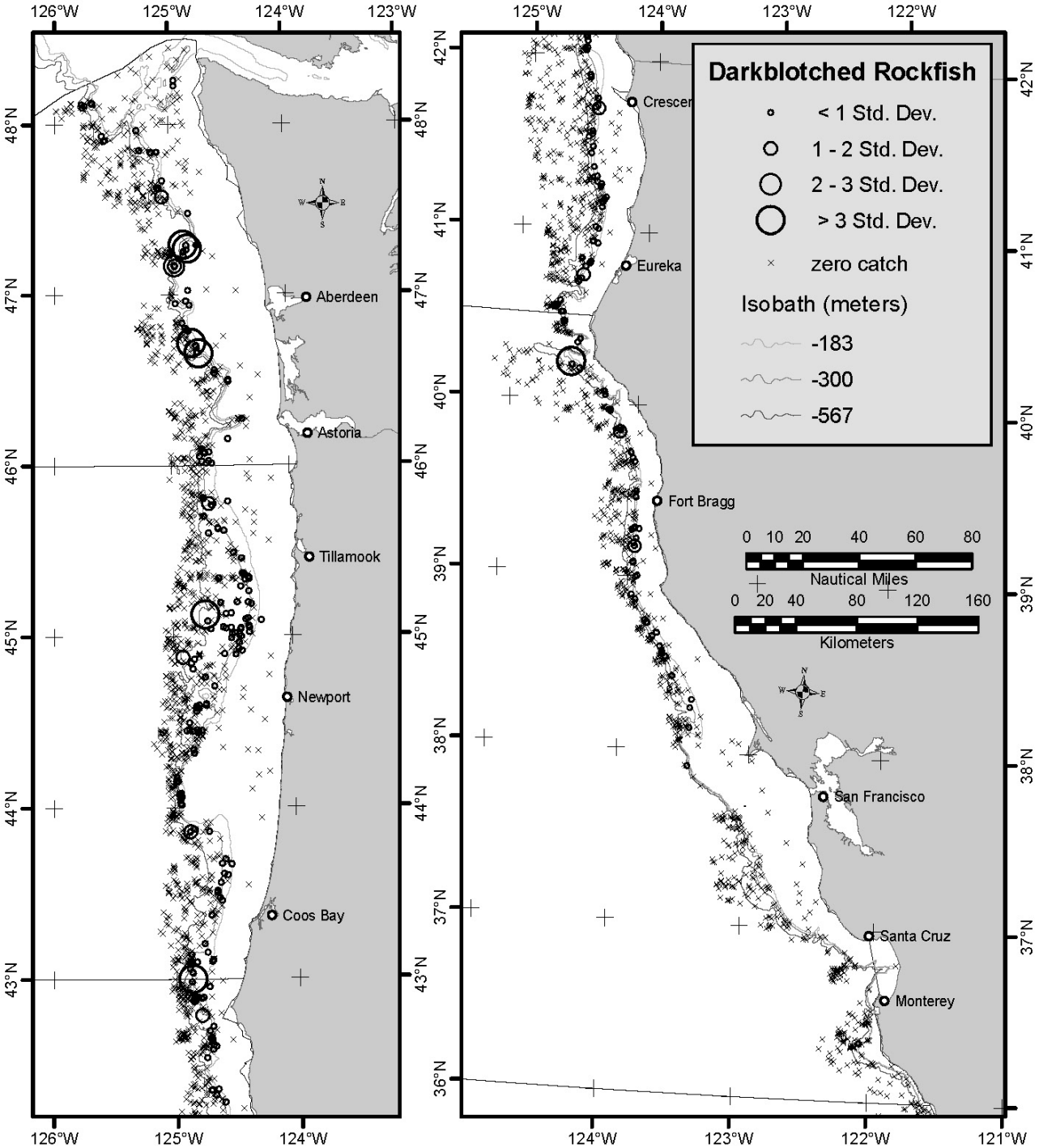


Figure E-1. Distribution of darkblotched rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

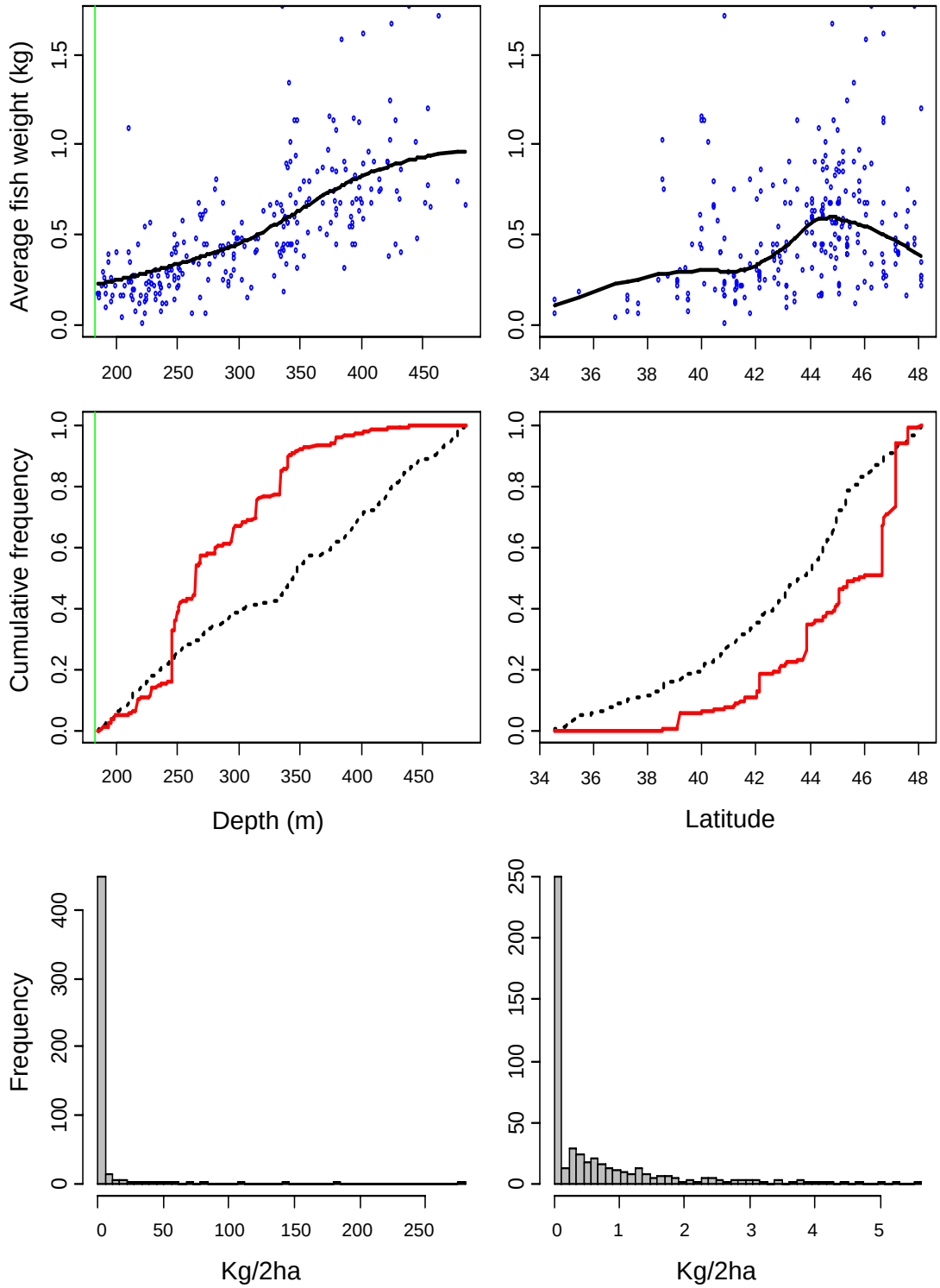


Figure E-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of darkblotched rockfish caught in the AFSC slope surveys.

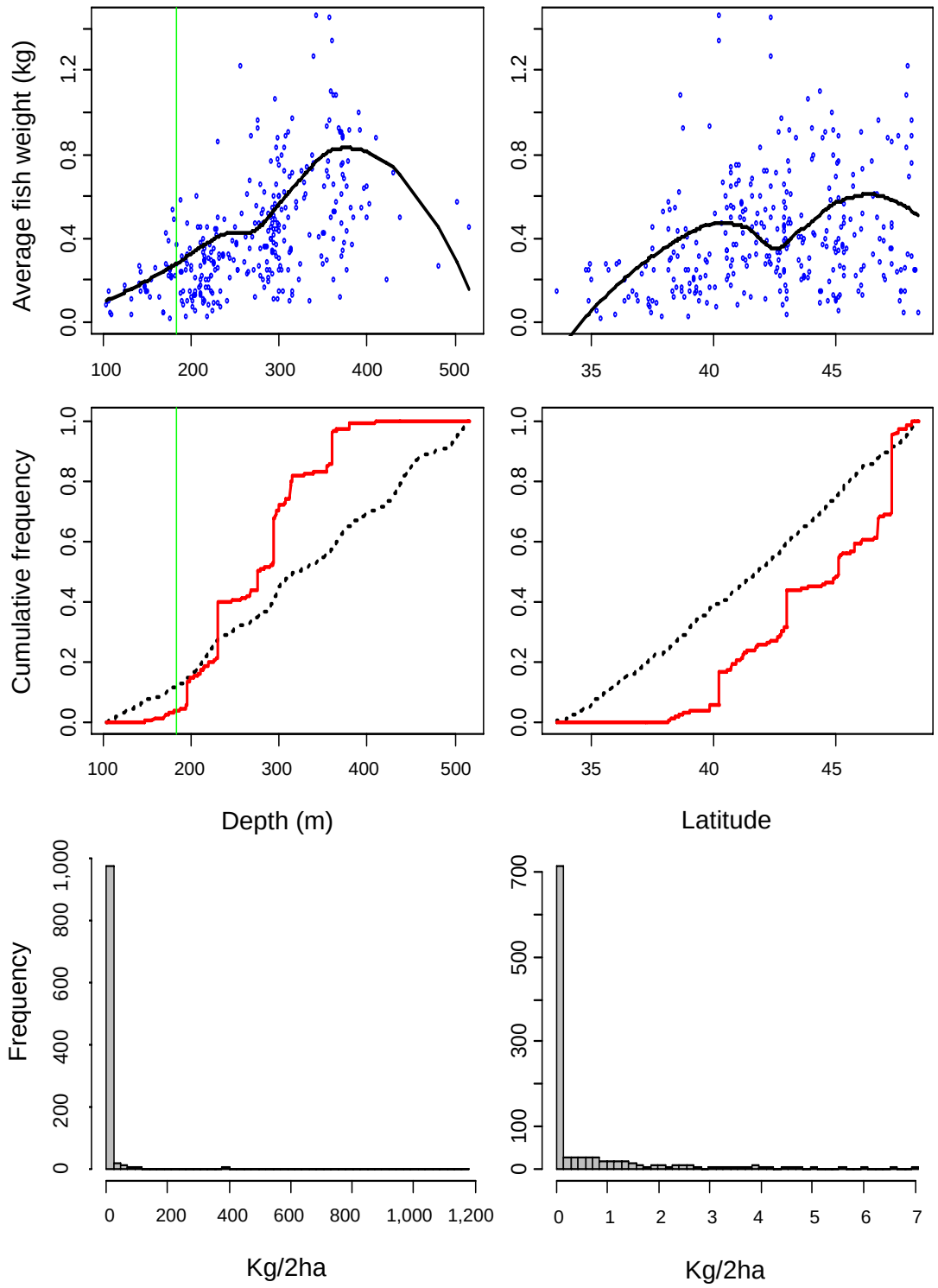
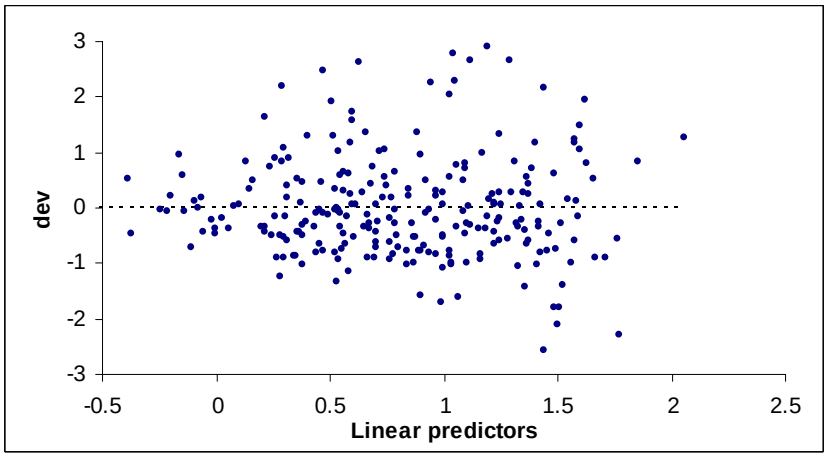
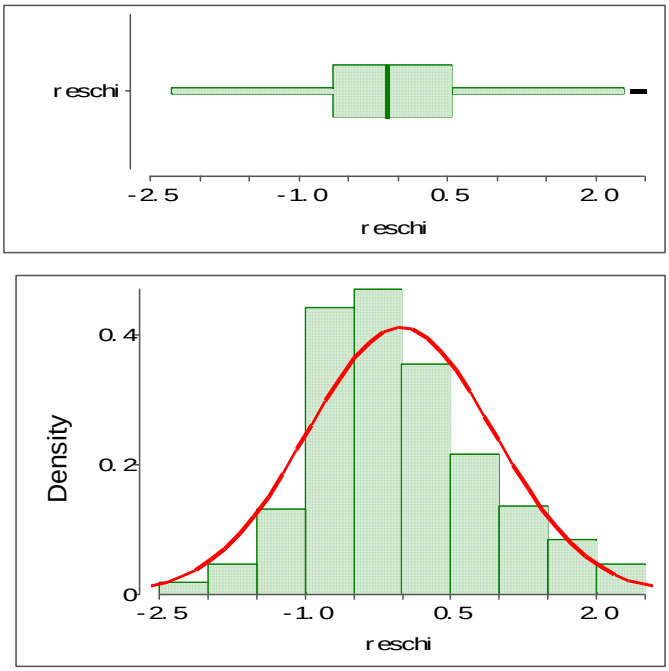


Figure E-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of darkblotched rockfish caught in the NWFSC slope surveys.

A



B



C

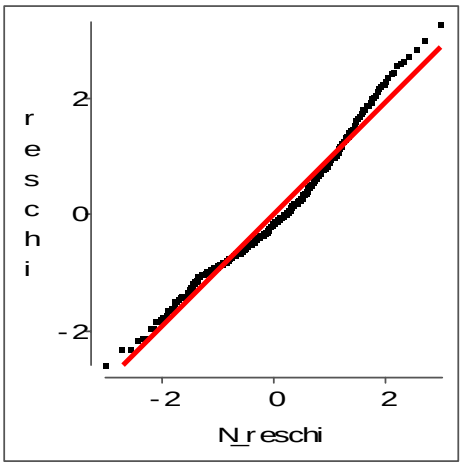


Figure E-4. Diagnostic plots from the generalized linear mixed model fit to darkblotched rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed,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

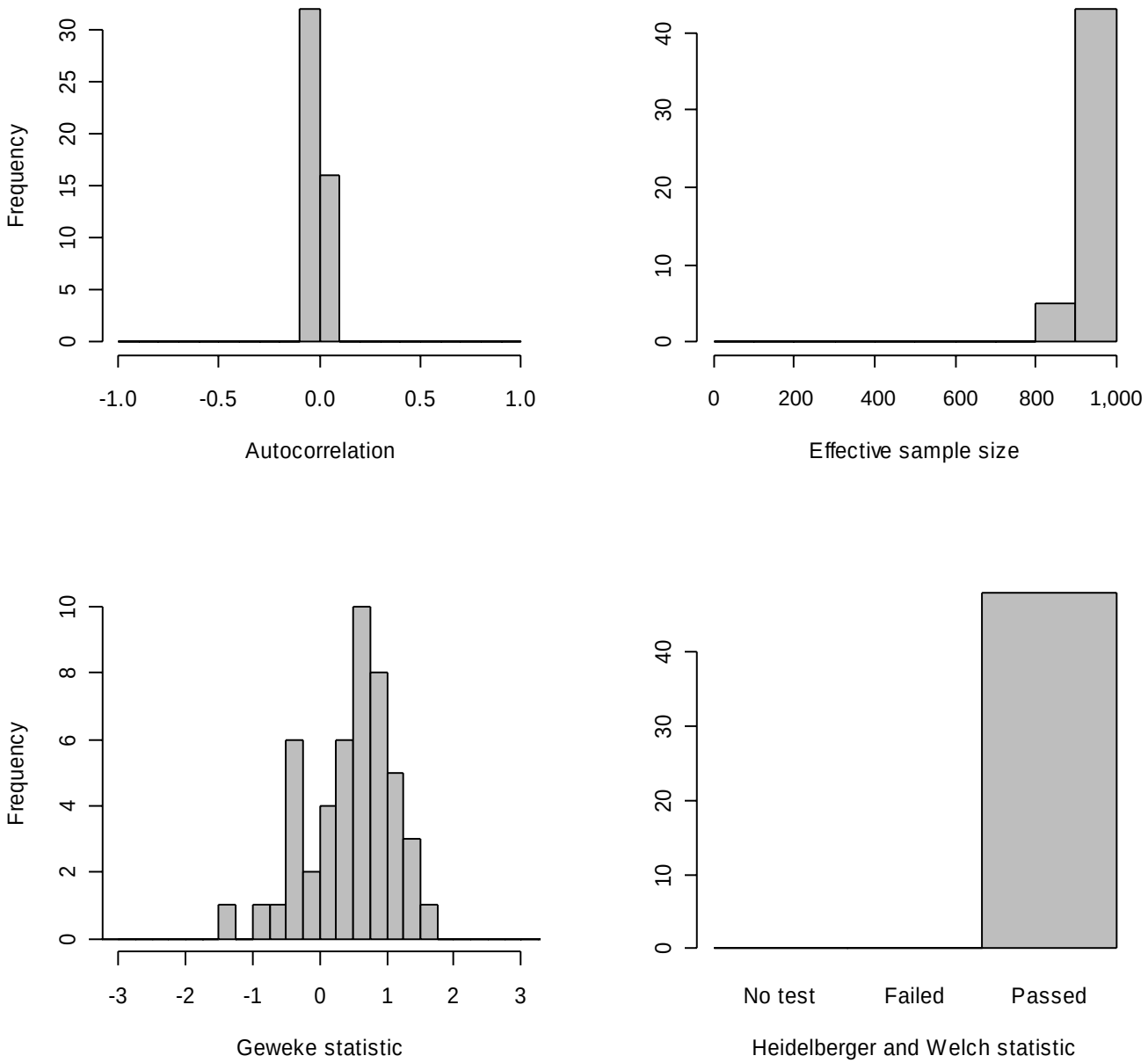
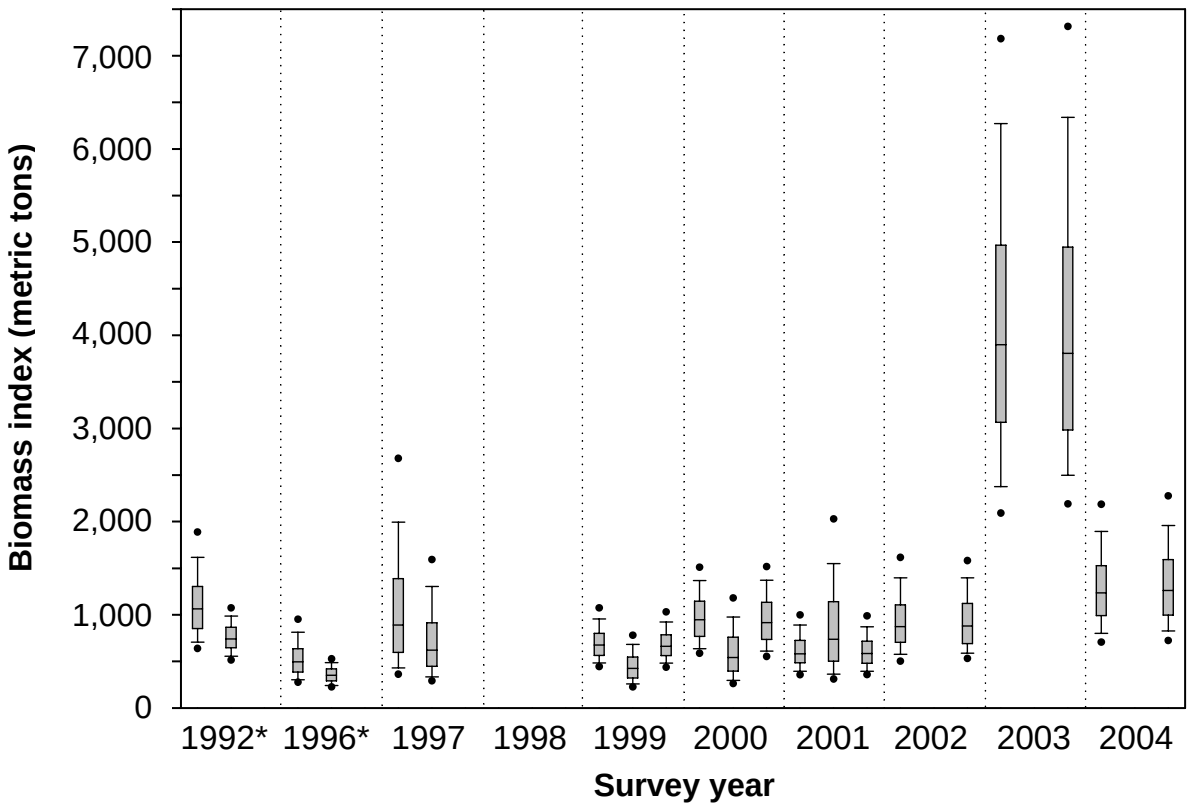


Figure E-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for darkblotched rockfish. 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 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	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.

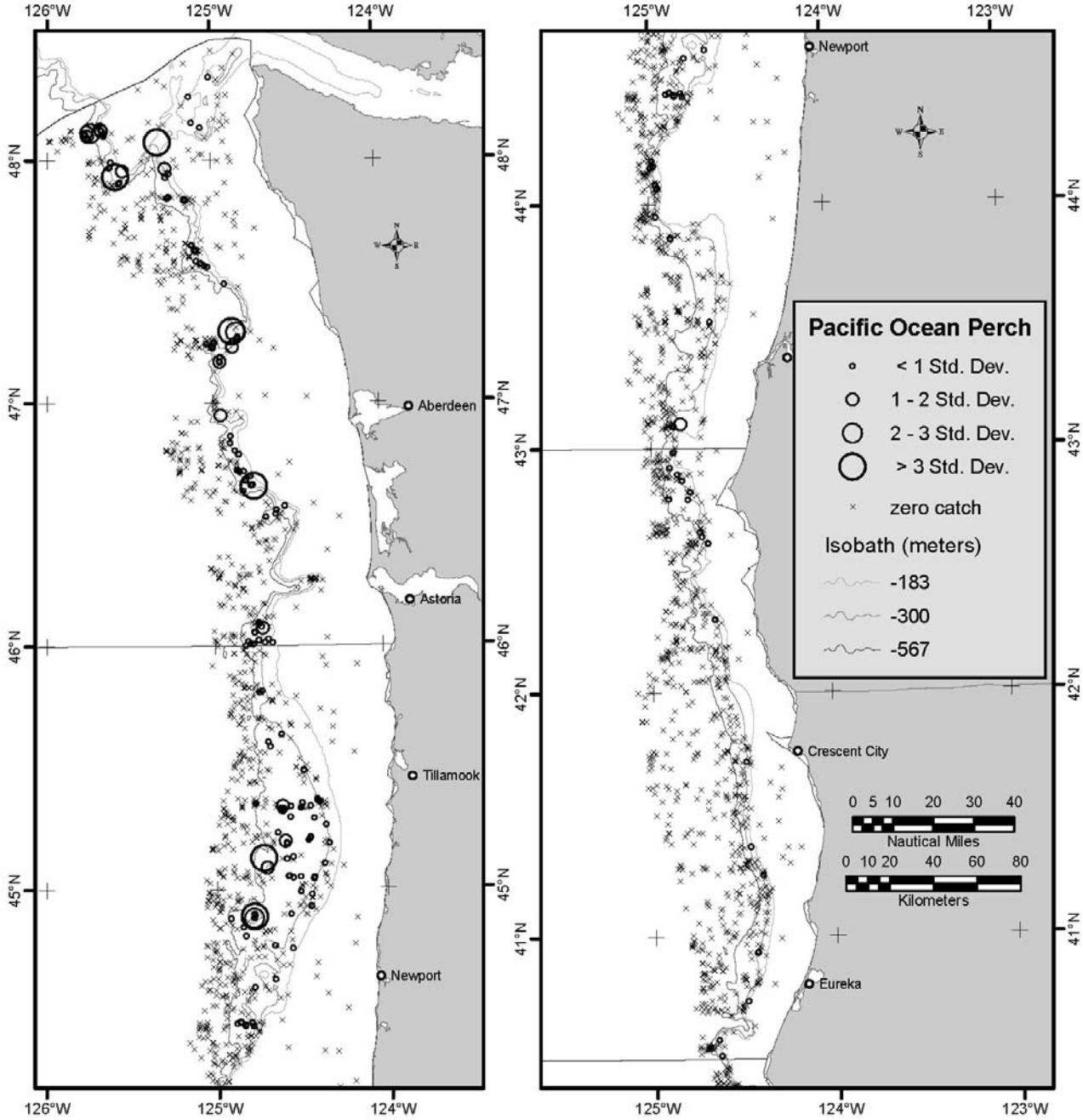


Figure F-1. Distribution of Pacific ocean perch caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

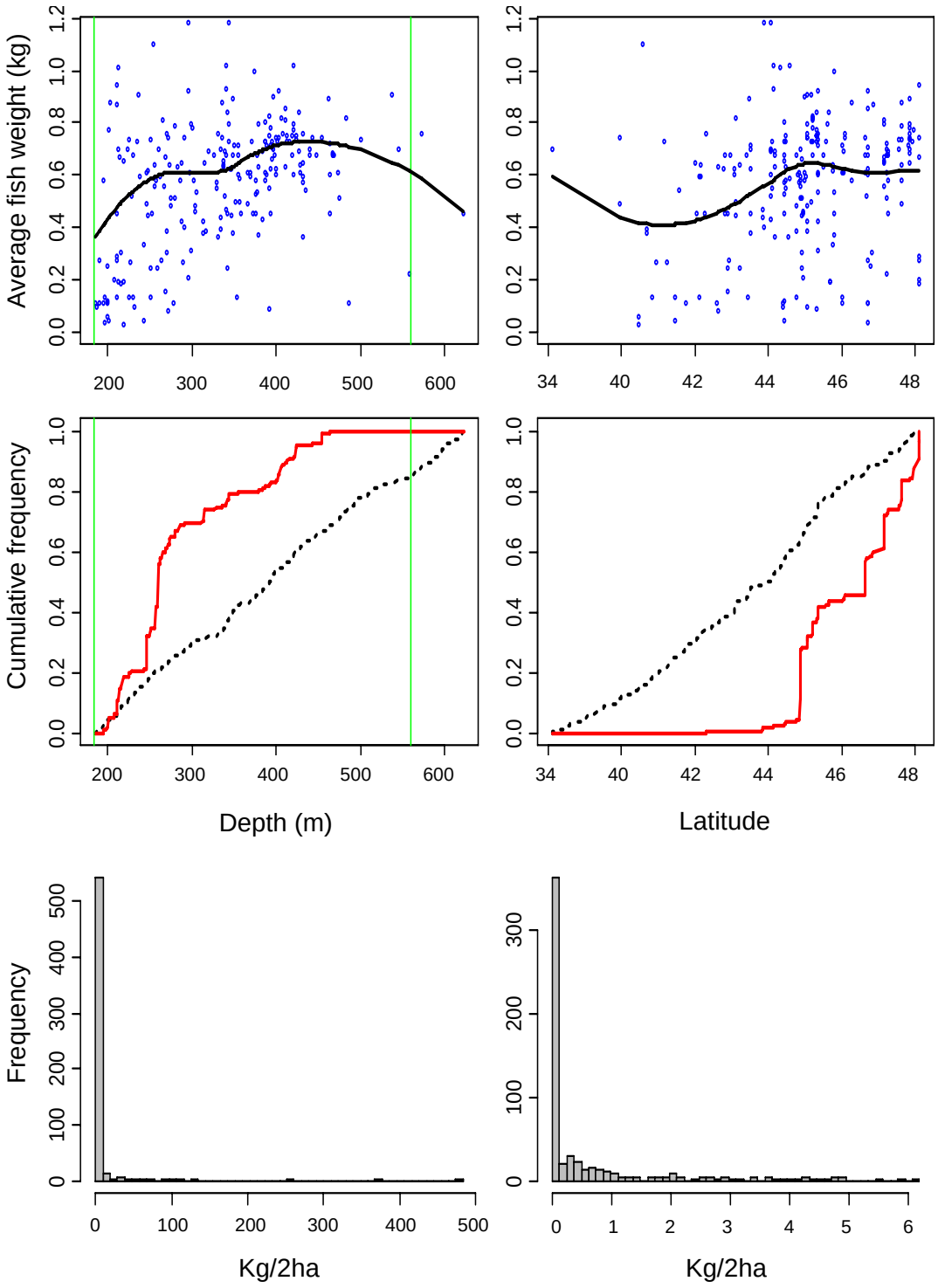


Figure F-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Pacific ocean perch caught in the AFSC slope surveys.

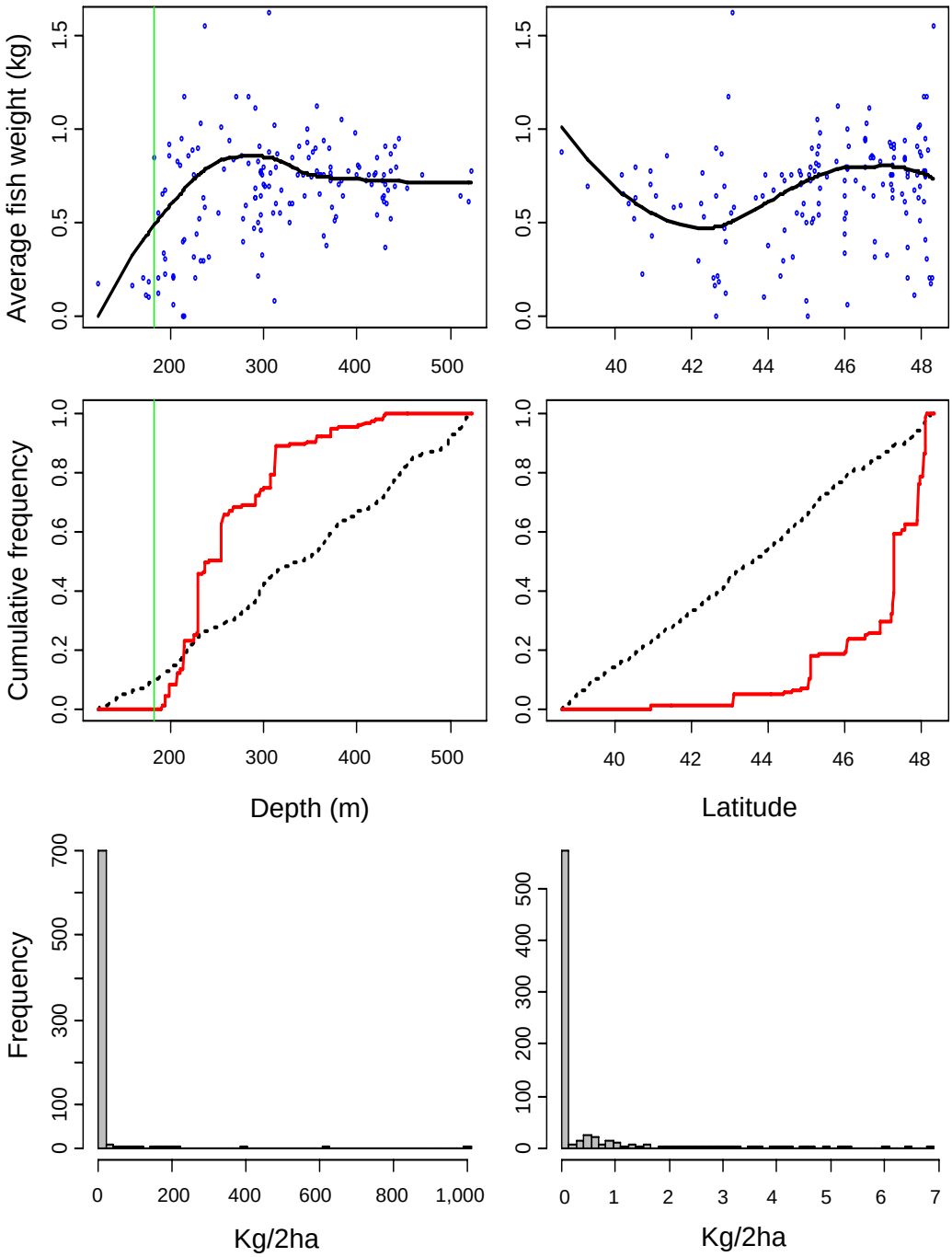


Figure F-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of Pacific ocean perch caught in the NWFSC slope surveys.

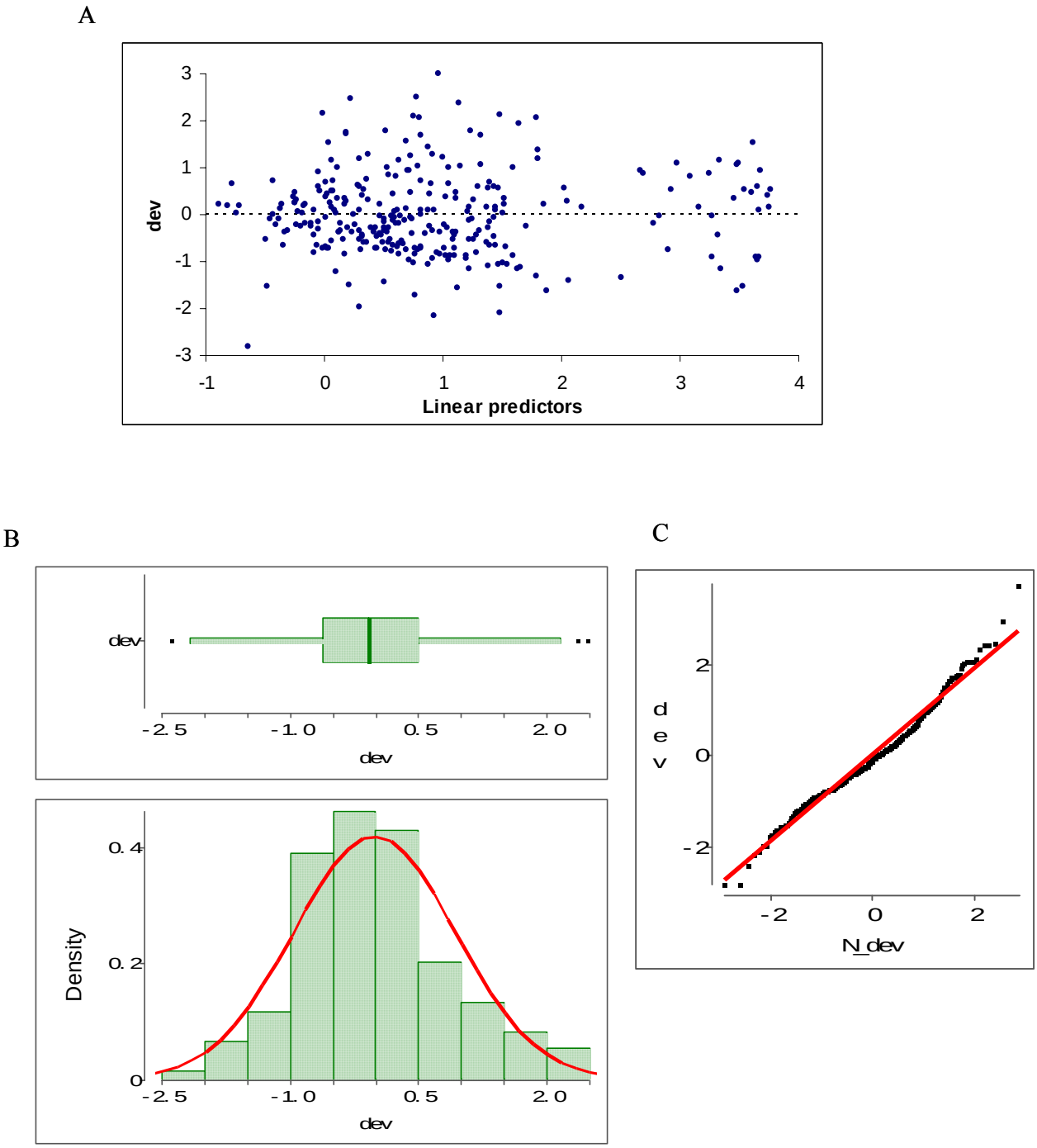


Figure F-4. Diagnostic plots from the generalized linear mixed model fit to Pacific ocean perch from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed,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

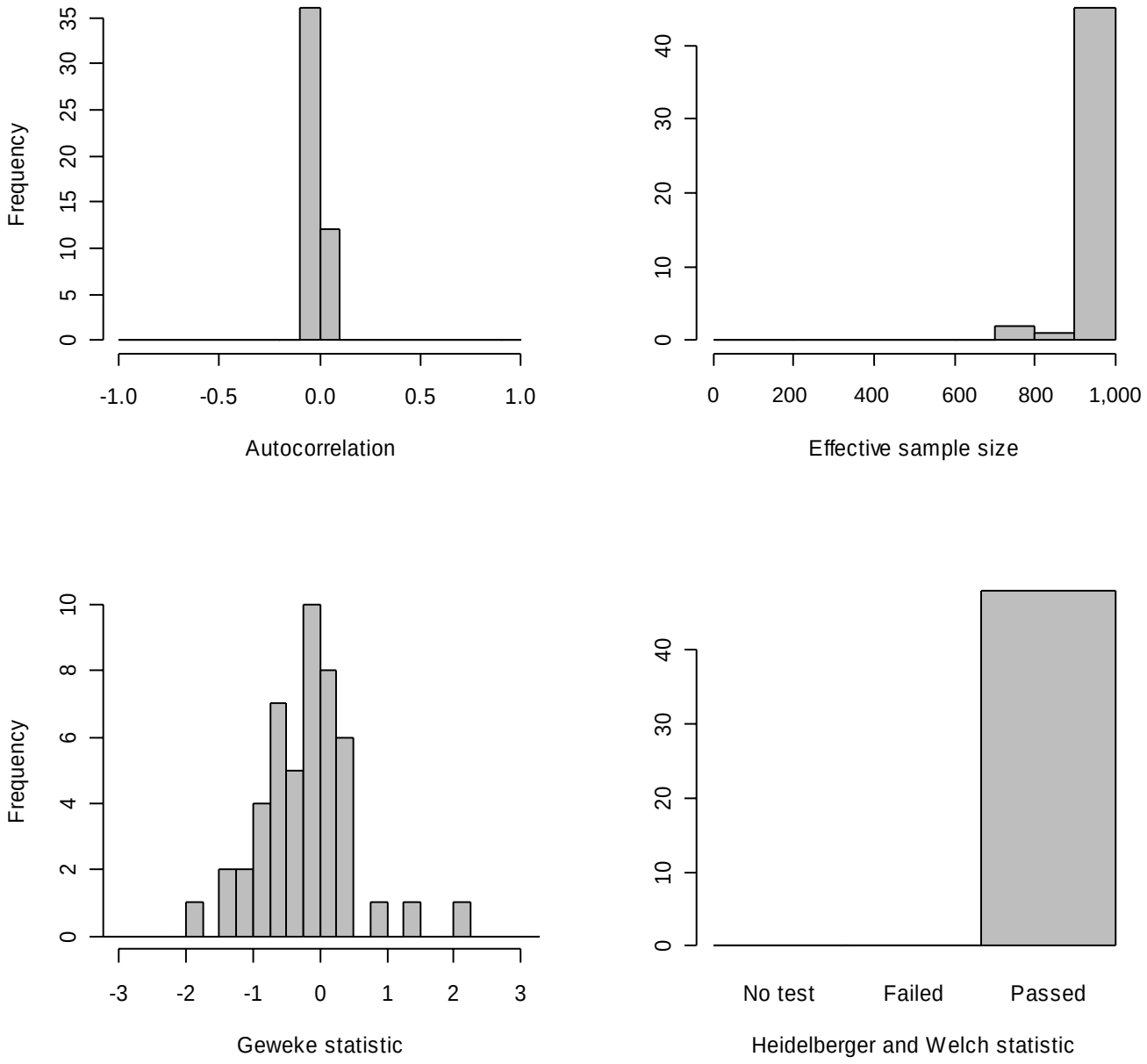
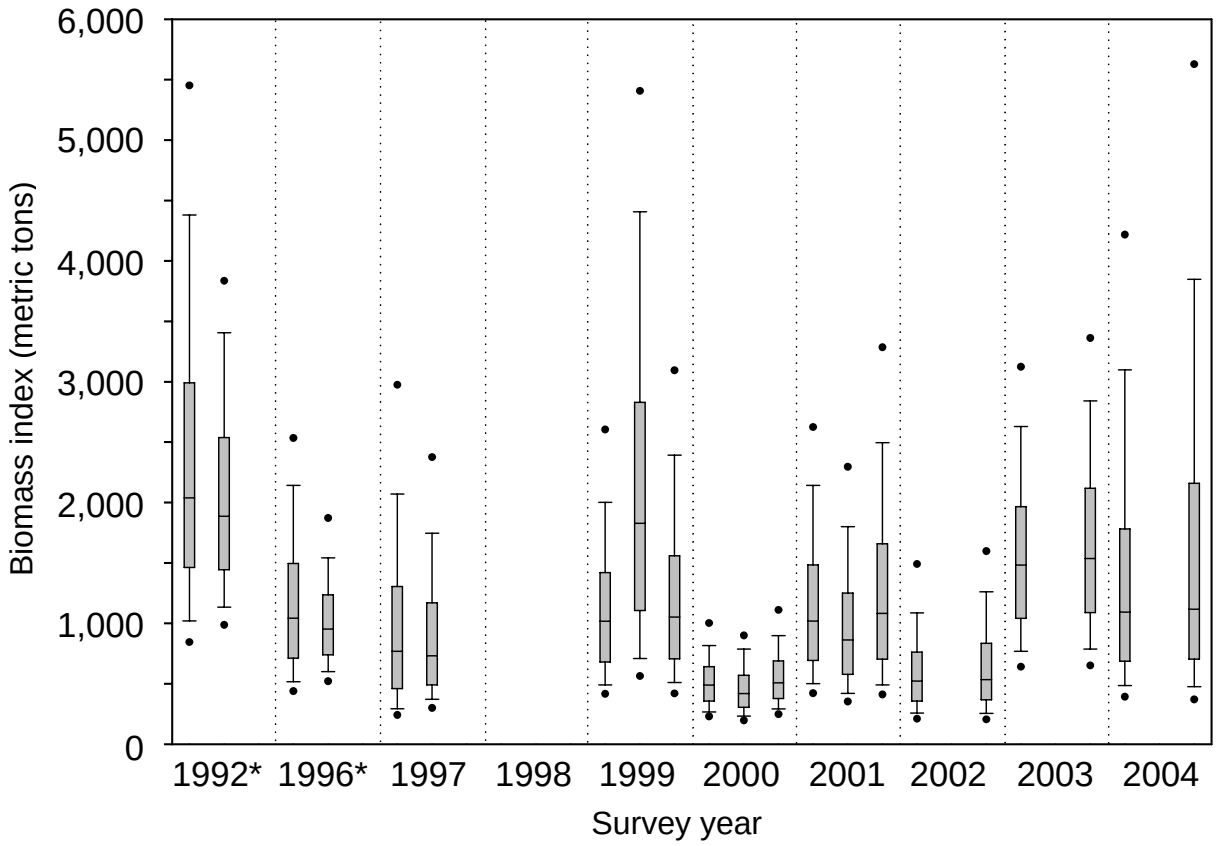


Figure F-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for Pacific ocean perch. Plots 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 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	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.

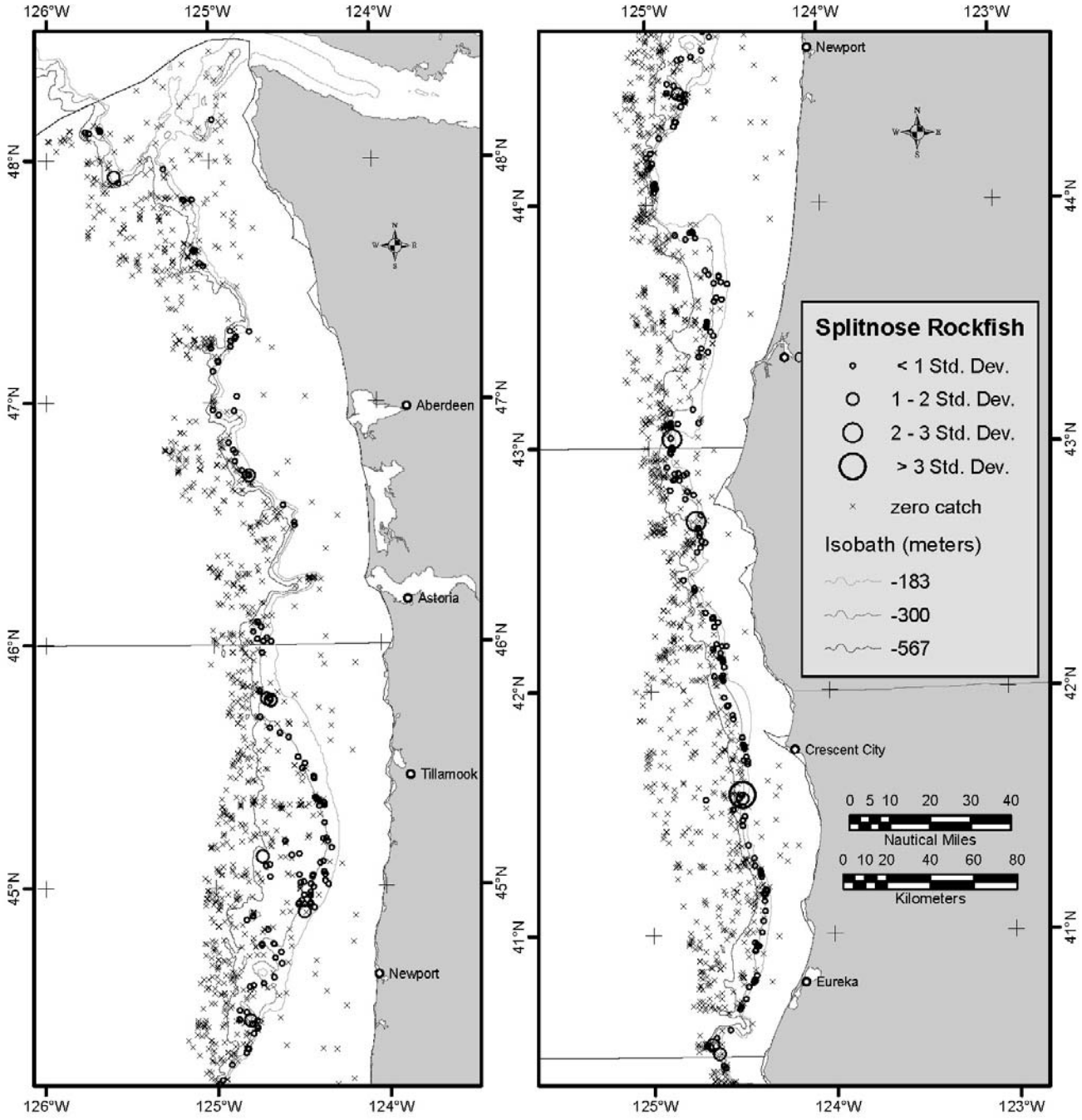


Figure G-1. Distribution of splitnose rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

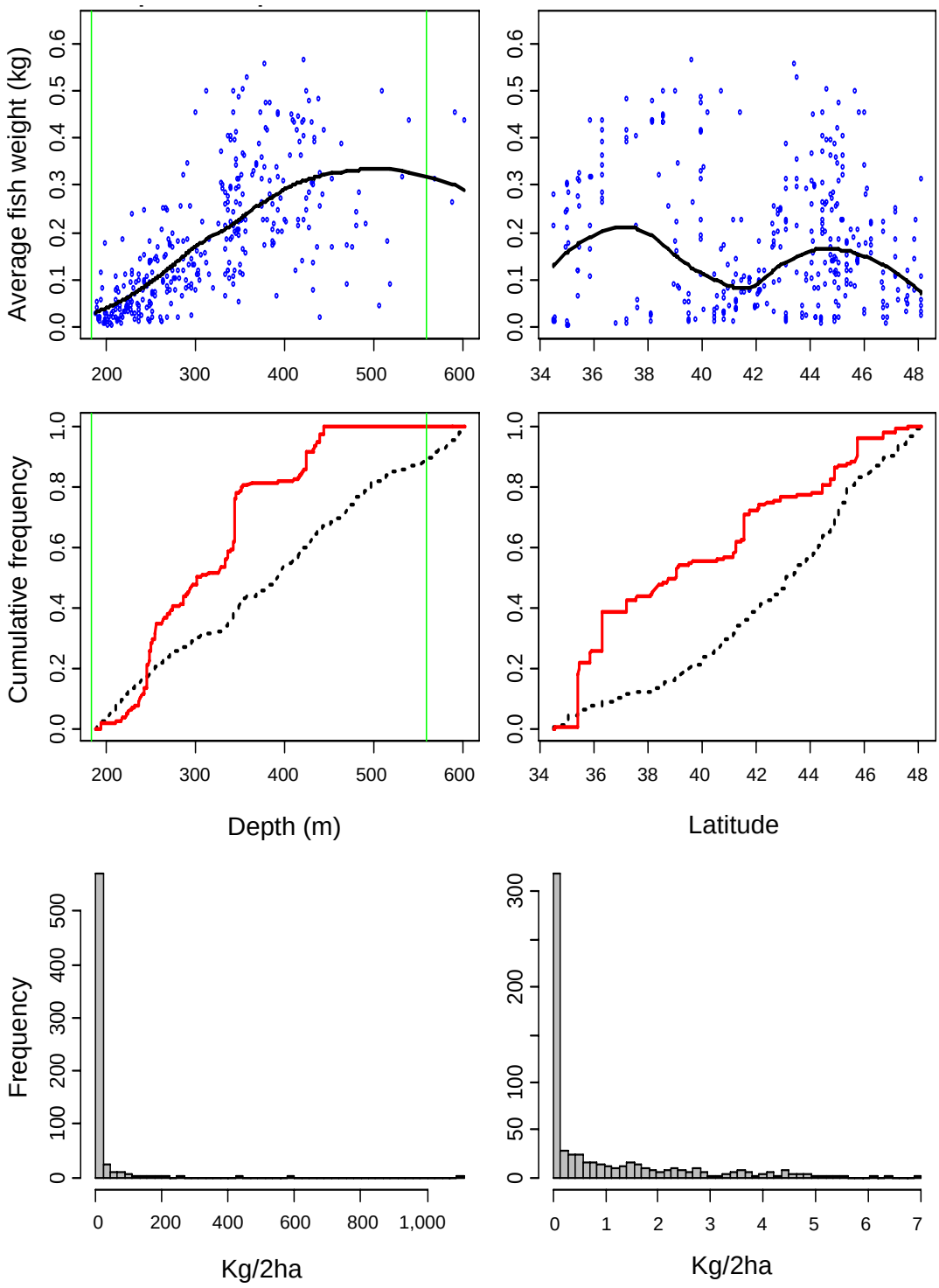


Figure G-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of splitnose rockfish caught in the AFSC slope surveys.

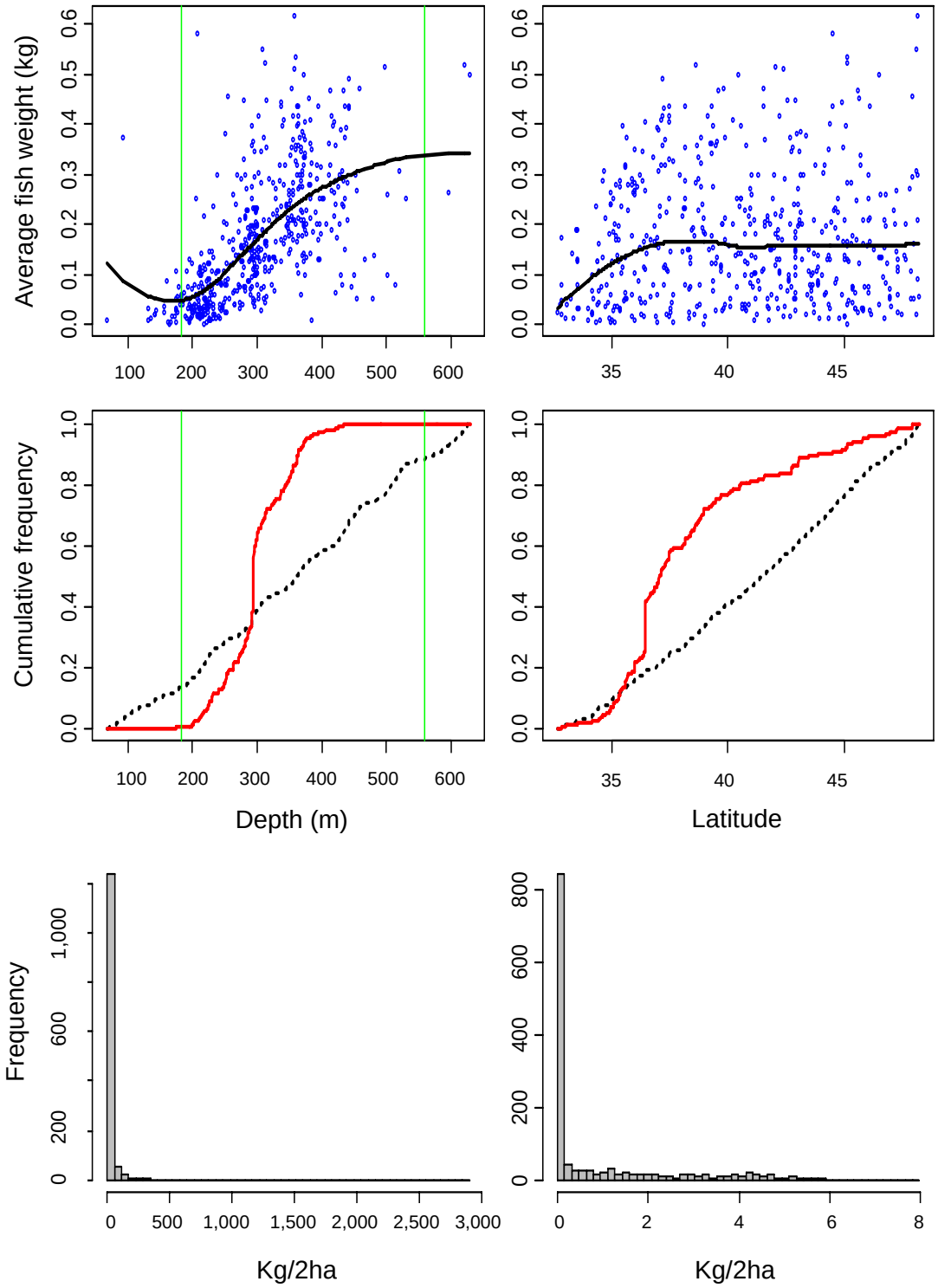


Figure G-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of splitnose rockfish caught in the NWFSC slope surveys.

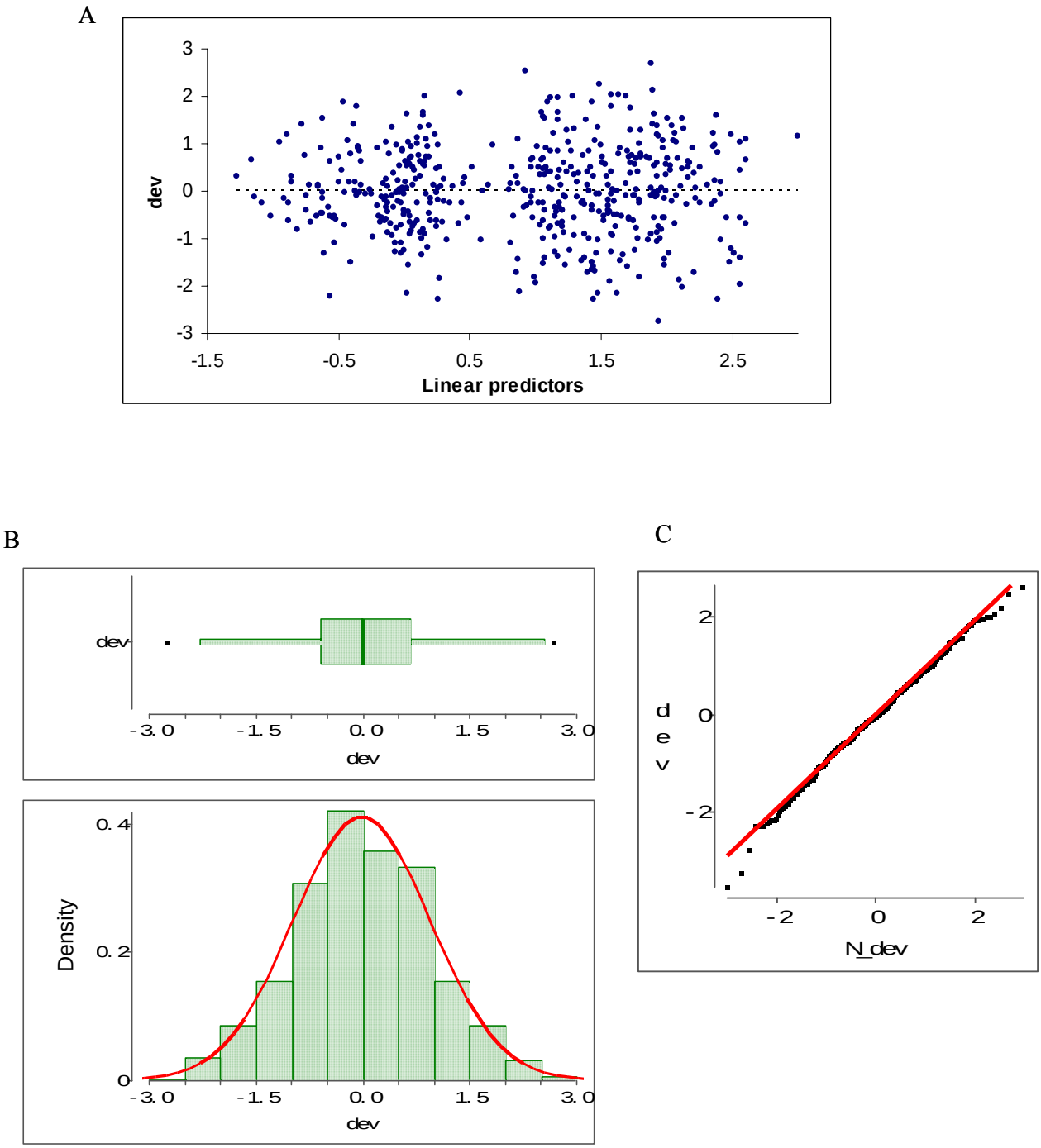


Figure G-4. Diagnostic plots from the generalized linear mixed model fit to splitnose rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed,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

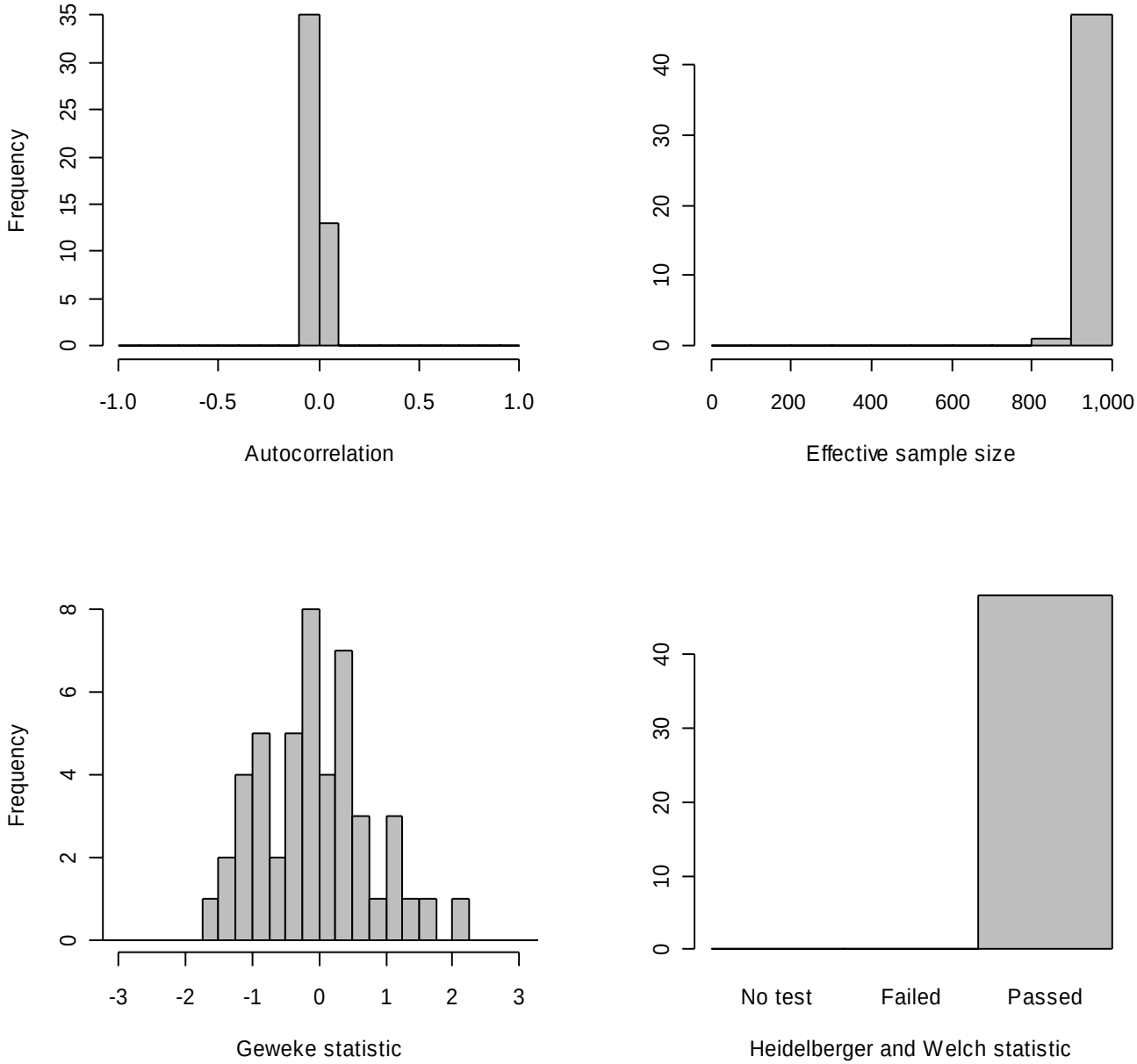
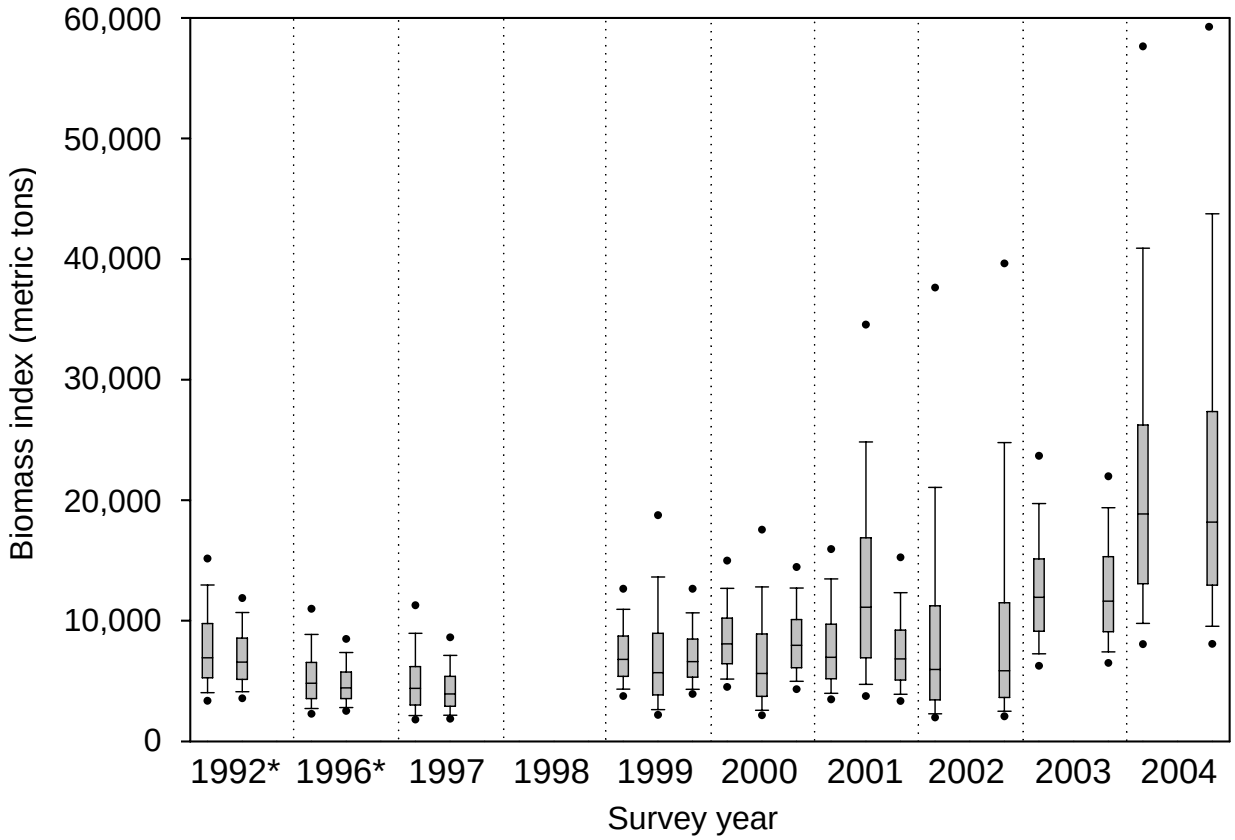


Figure G-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution of splitnose rockfish. Plots 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.

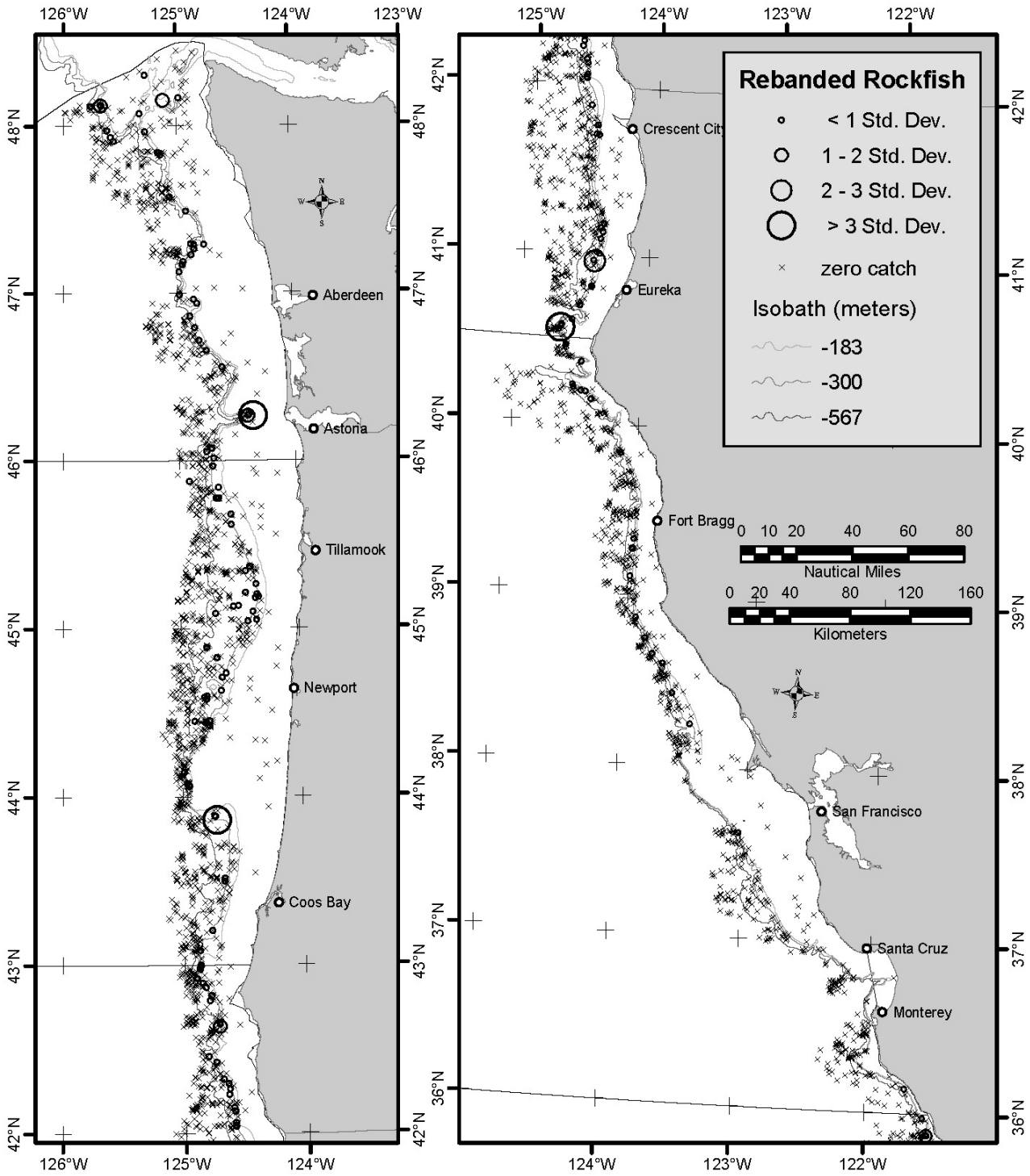


Figure H-1. Distribution of redbanded rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

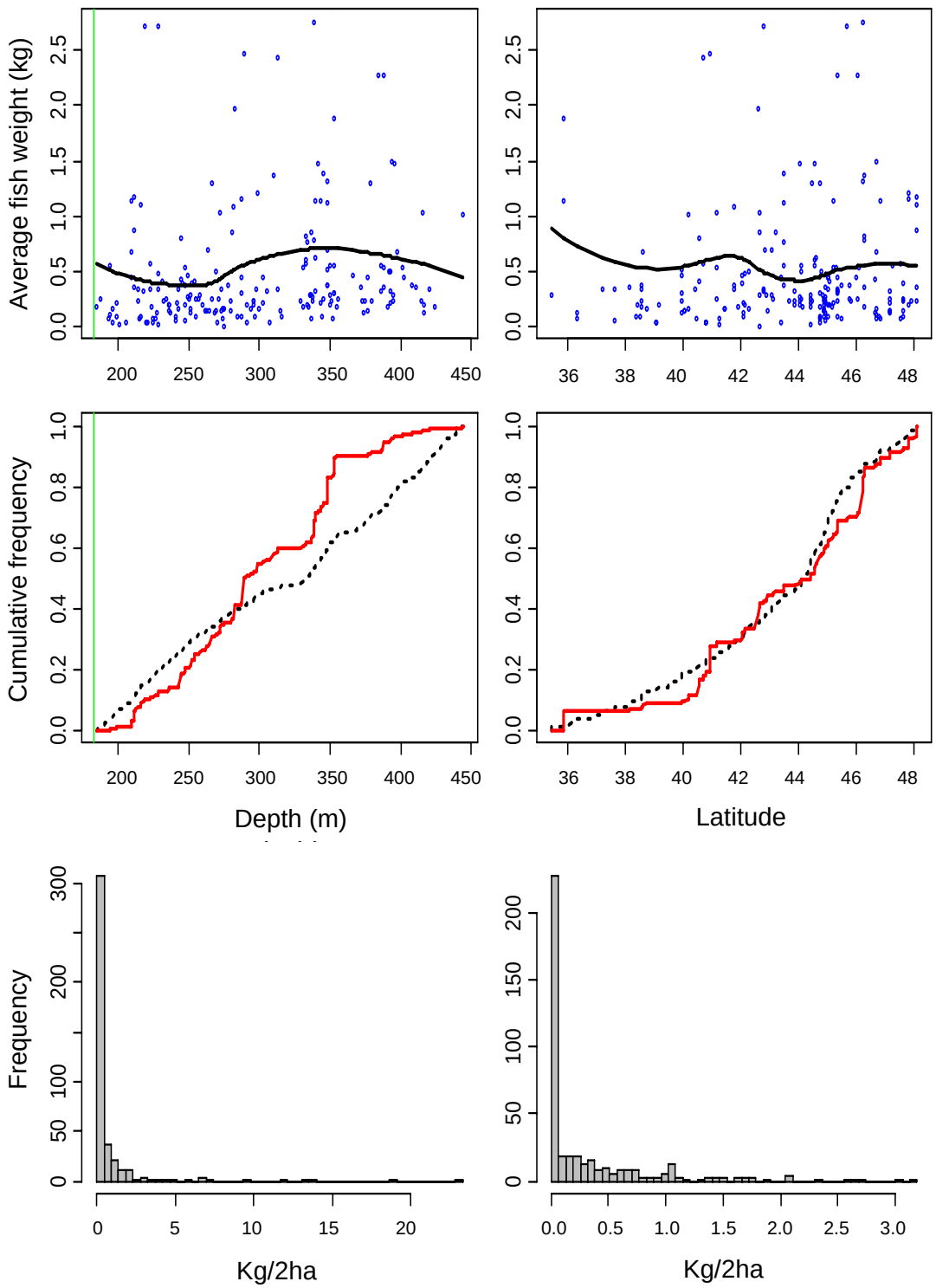


Figure H-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of redbanded rockfish caught in the AFSC slope surveys.

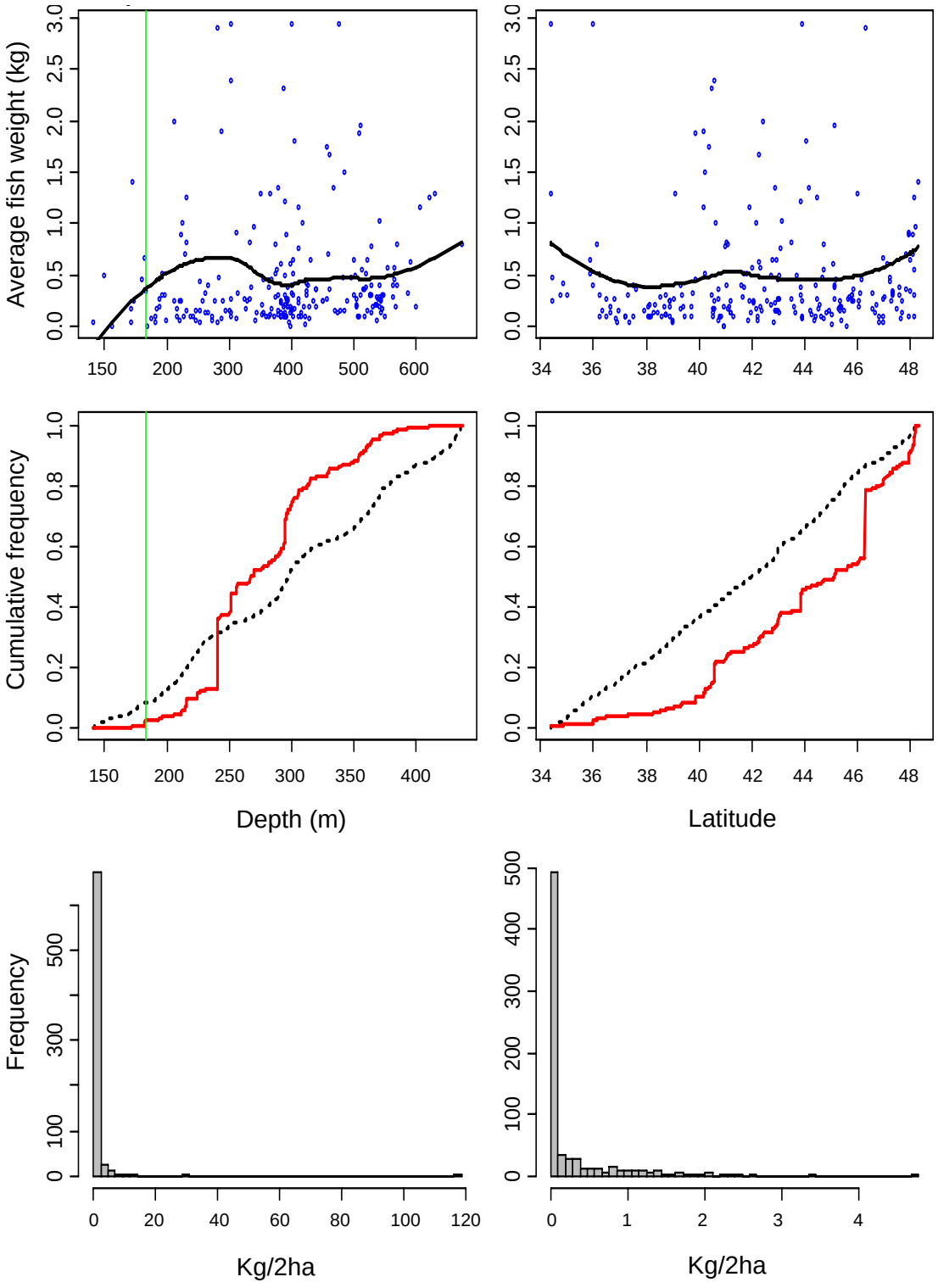
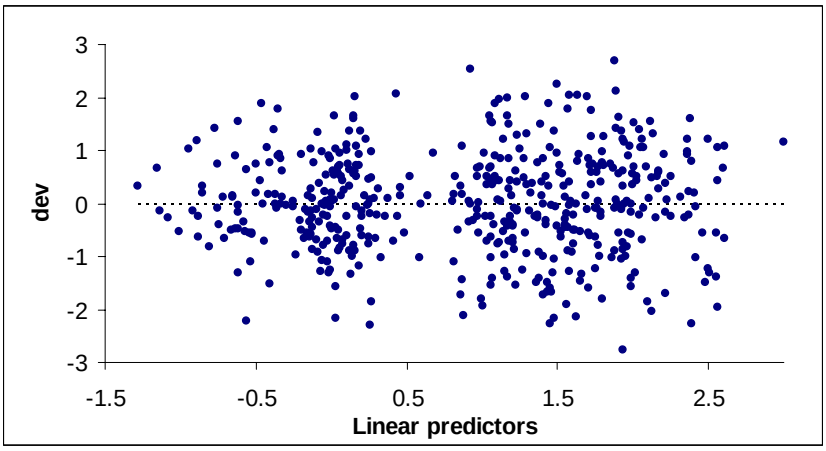
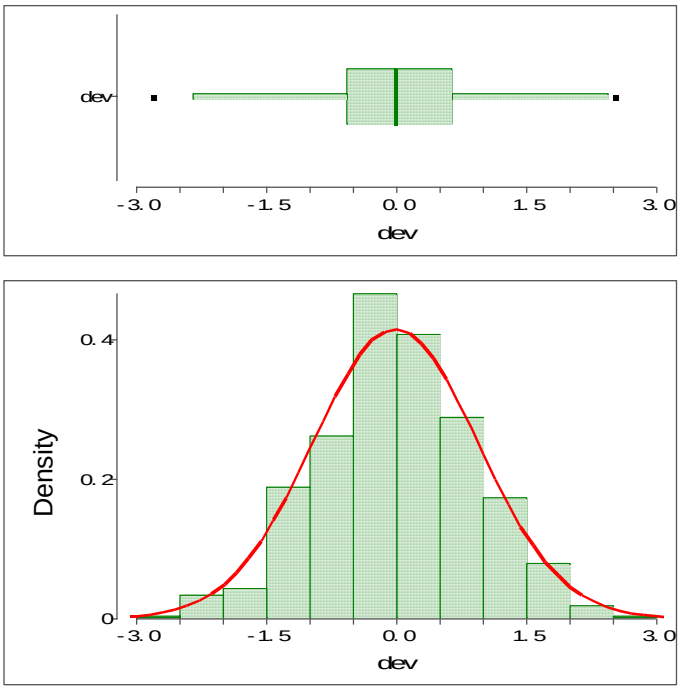


Figure H-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of redbanded rockfish caught in the NWFSC slope surveys.

A



B



C

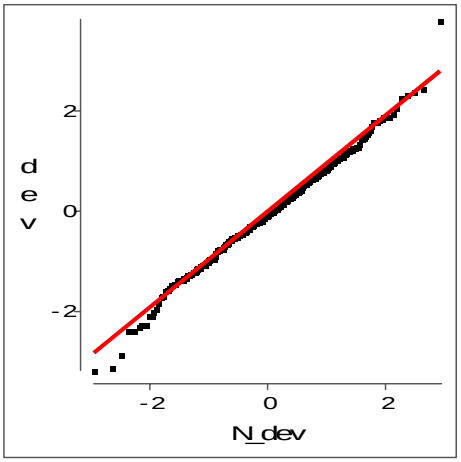


Figure H-4. Diagnostic plots from the generalized linear mixed model fit to redbanded rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed,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

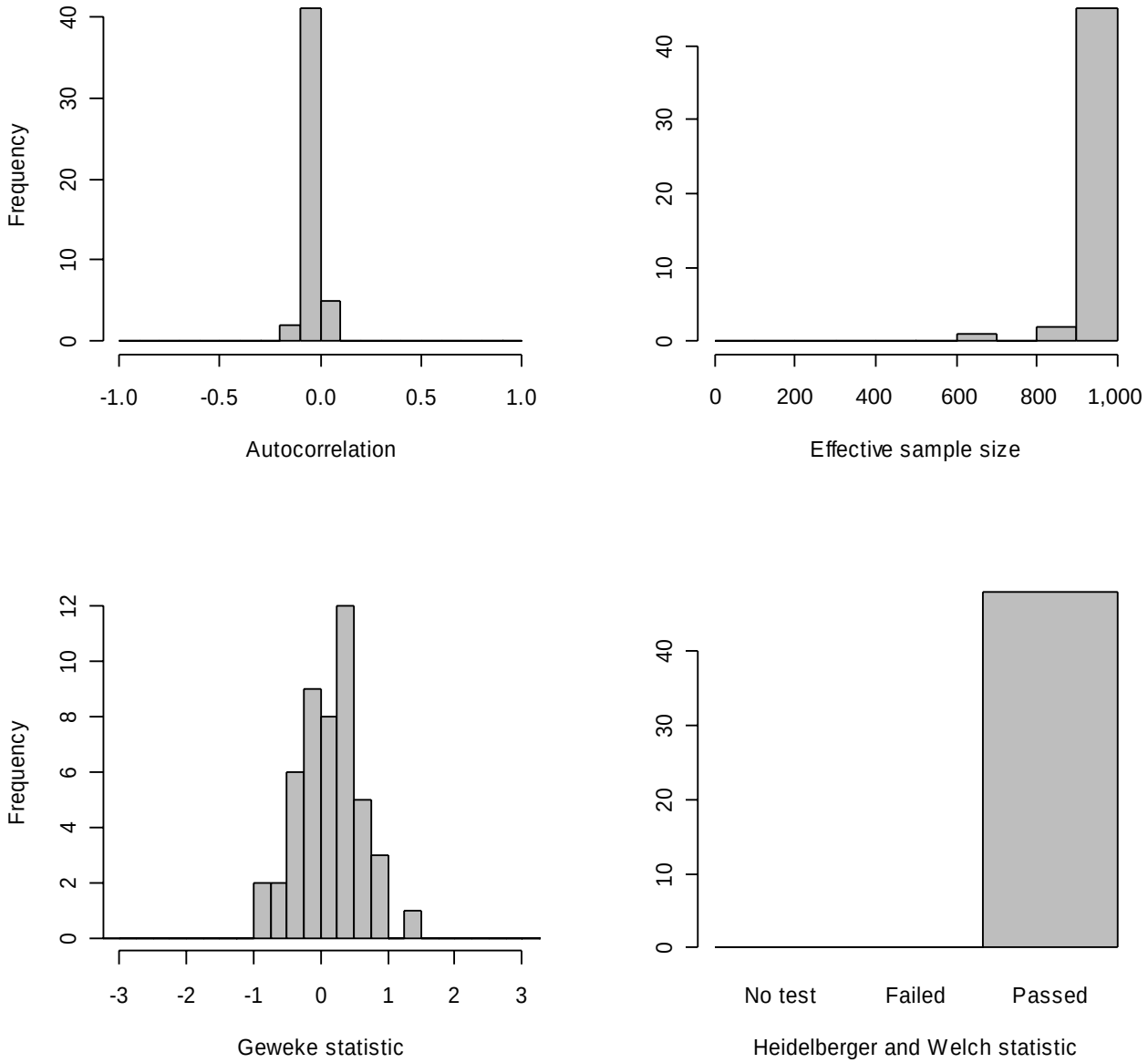
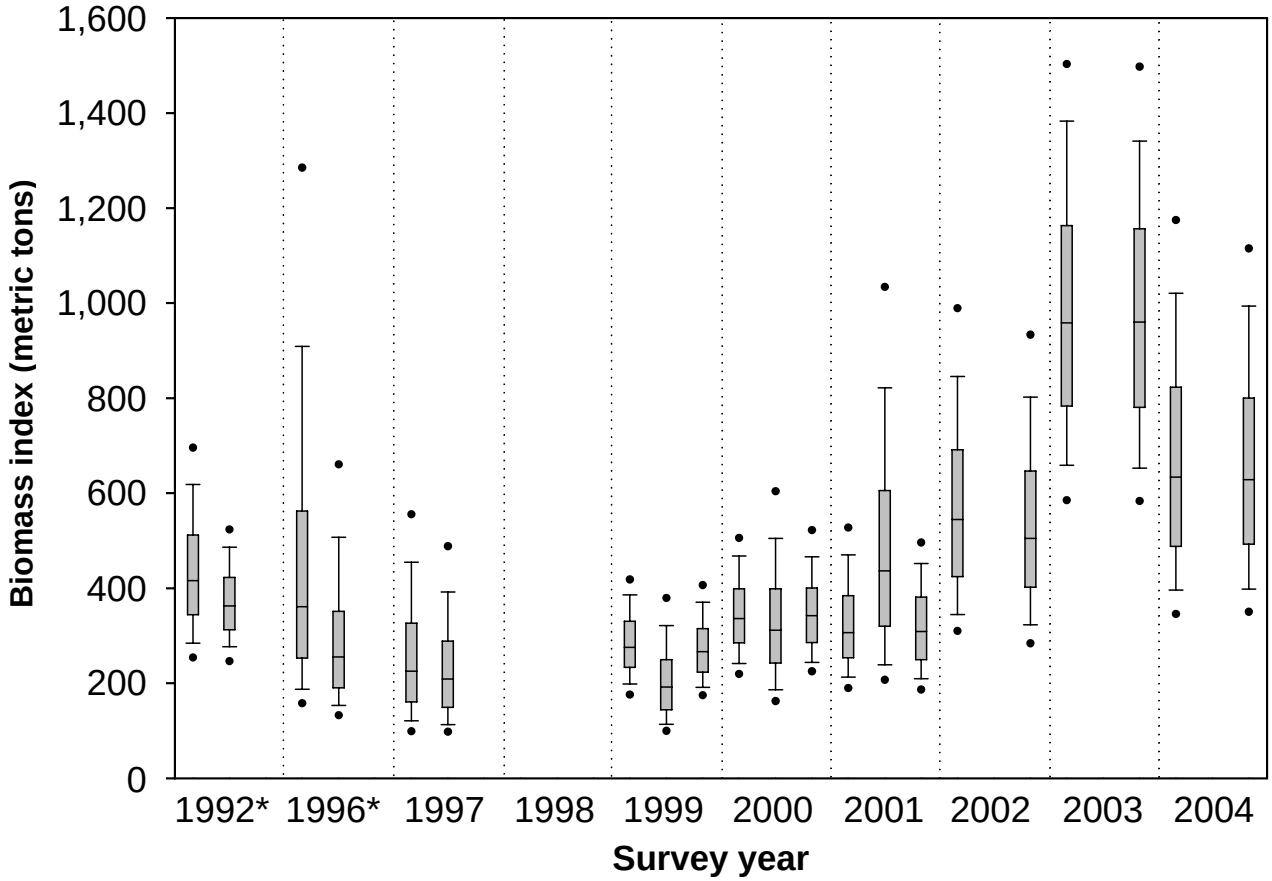


Figure H-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for redbanded rockfish. Plots 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 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	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.

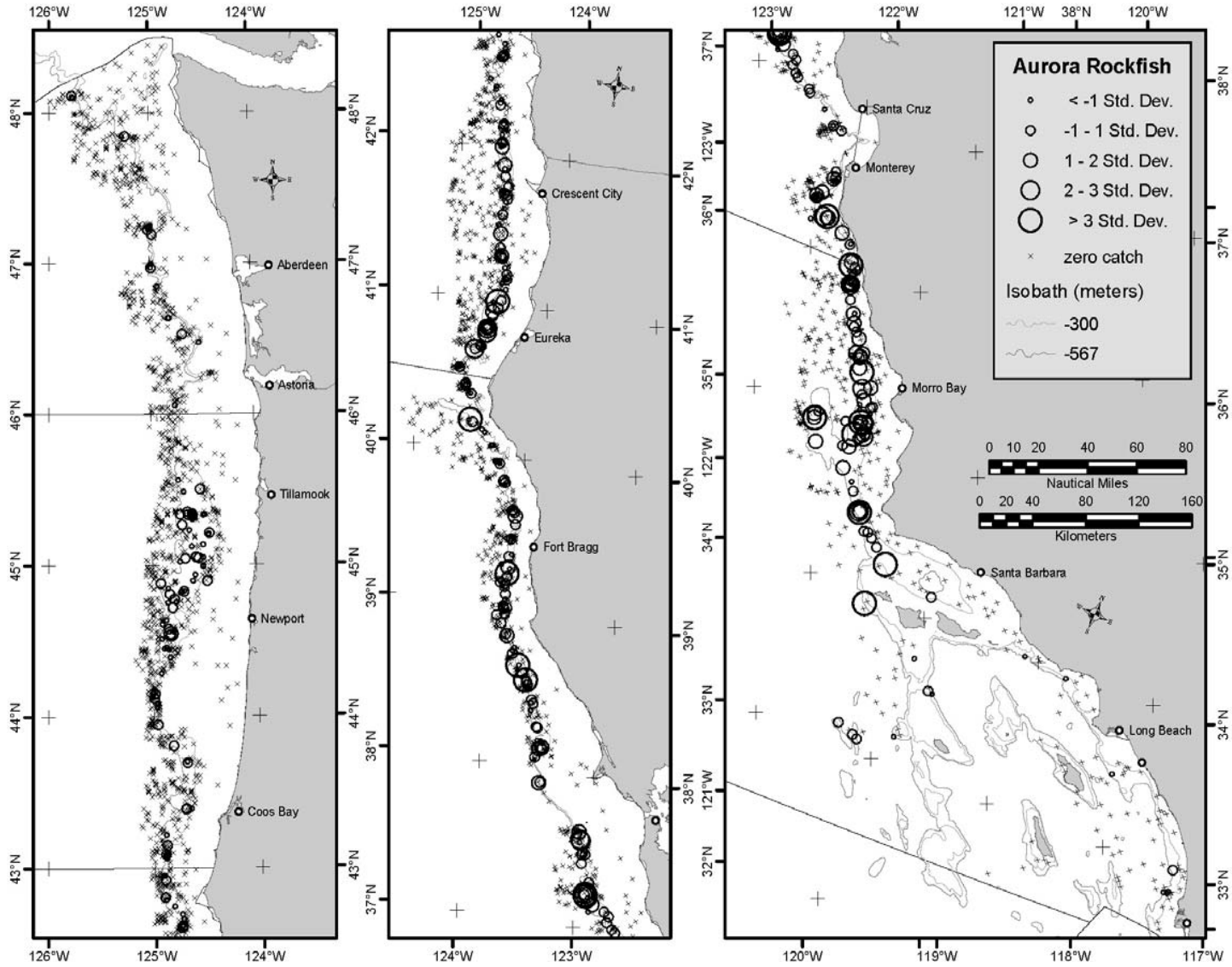


Figure I-1. Distribution of aurora rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

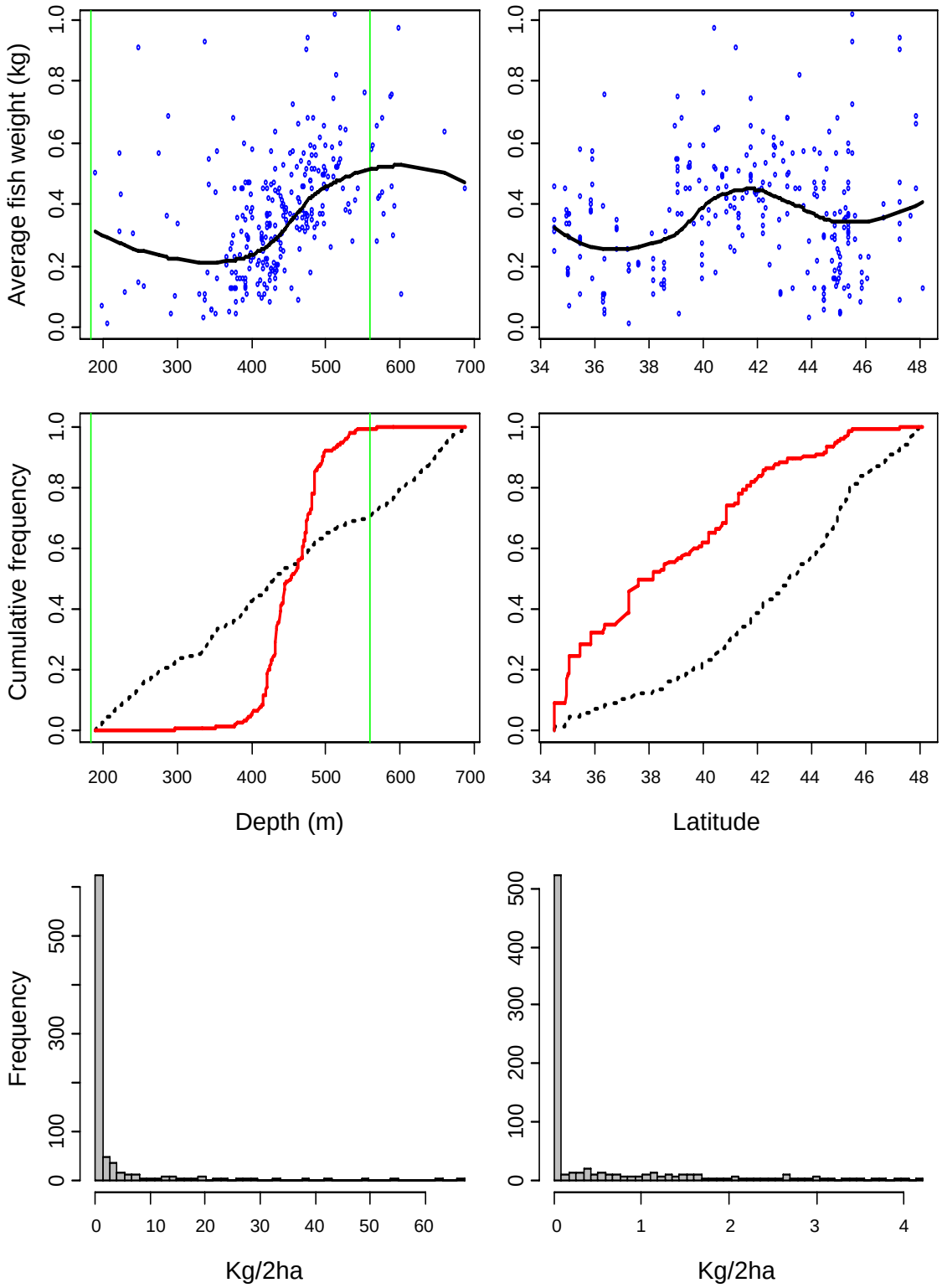


Figure I-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of aurora rockfish caught in the AFSC slope surveys.

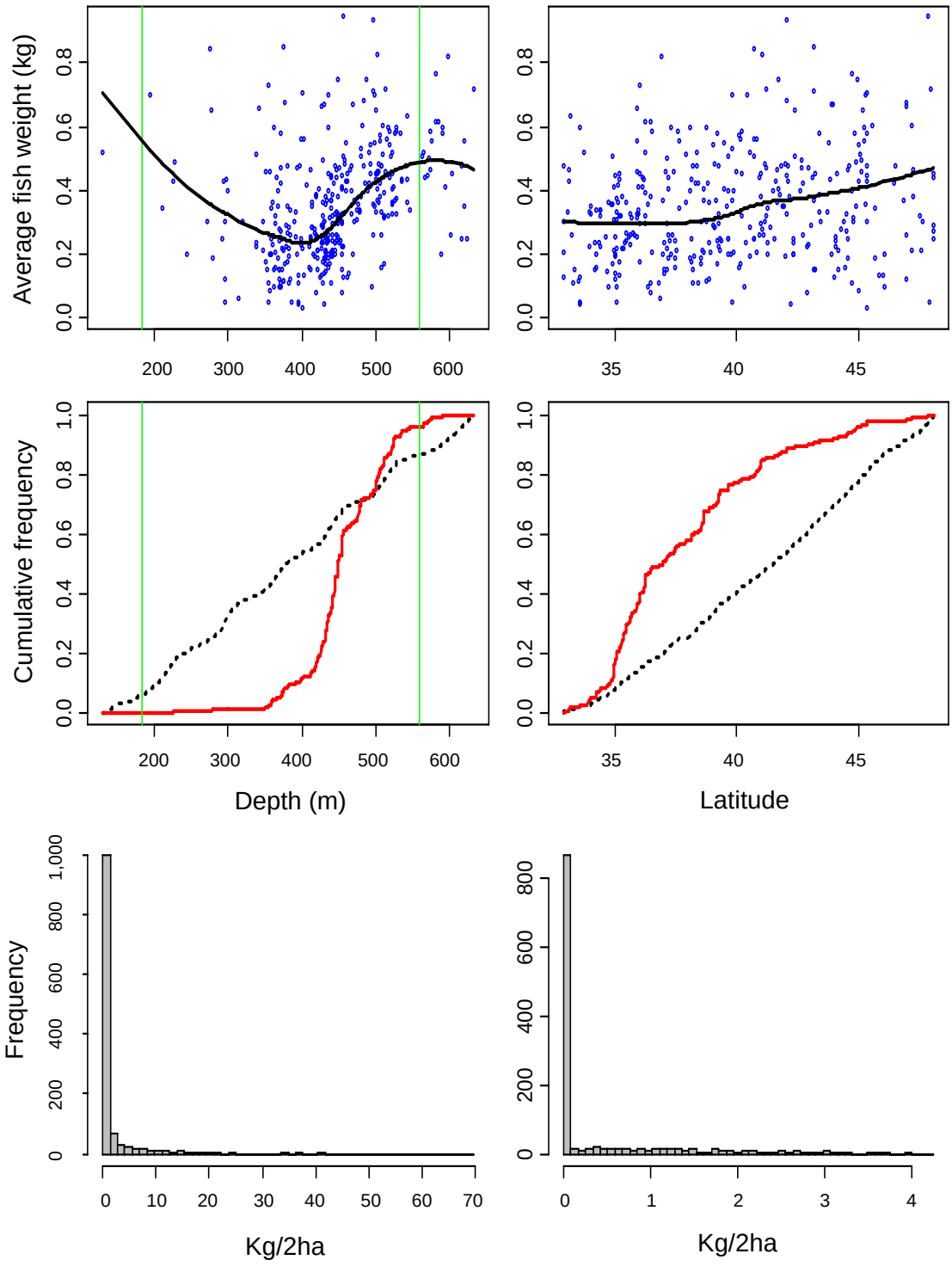


Figure I-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of aurora rockfish caught in the NWFSC slope surveys.

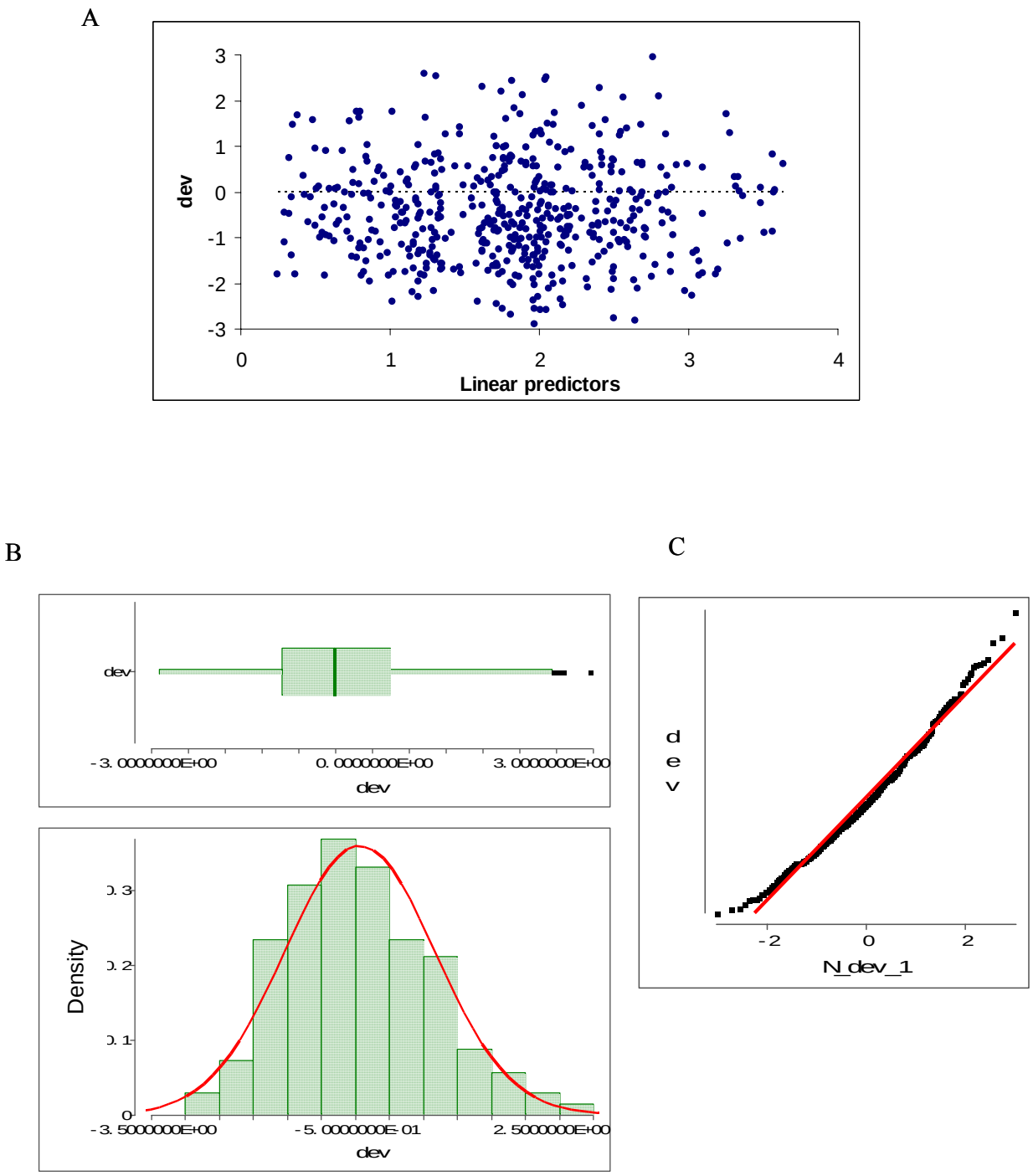


Figure I-4. Diagnostic plots from the generalized linear mixed model fit to aurora rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed, and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

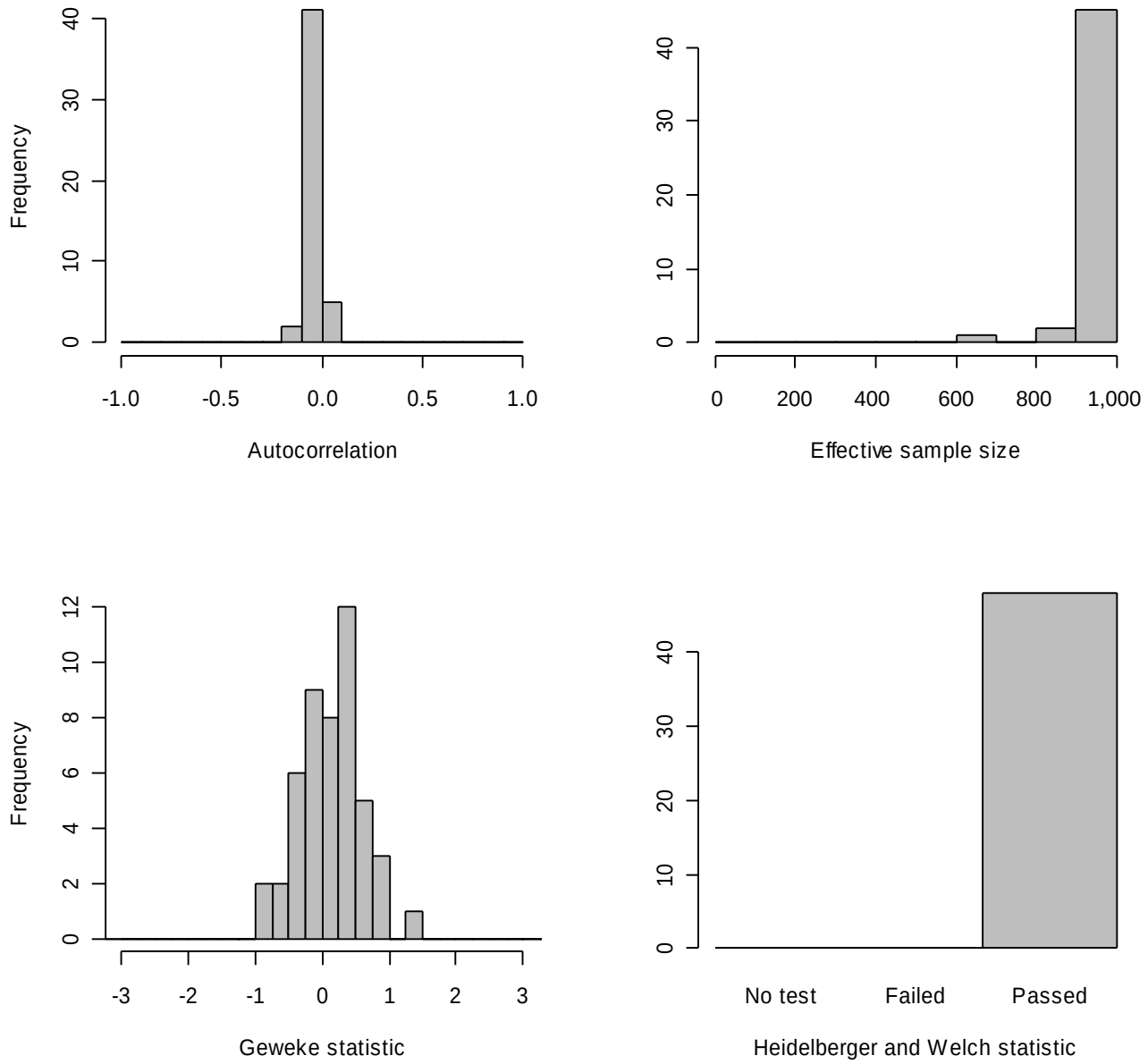
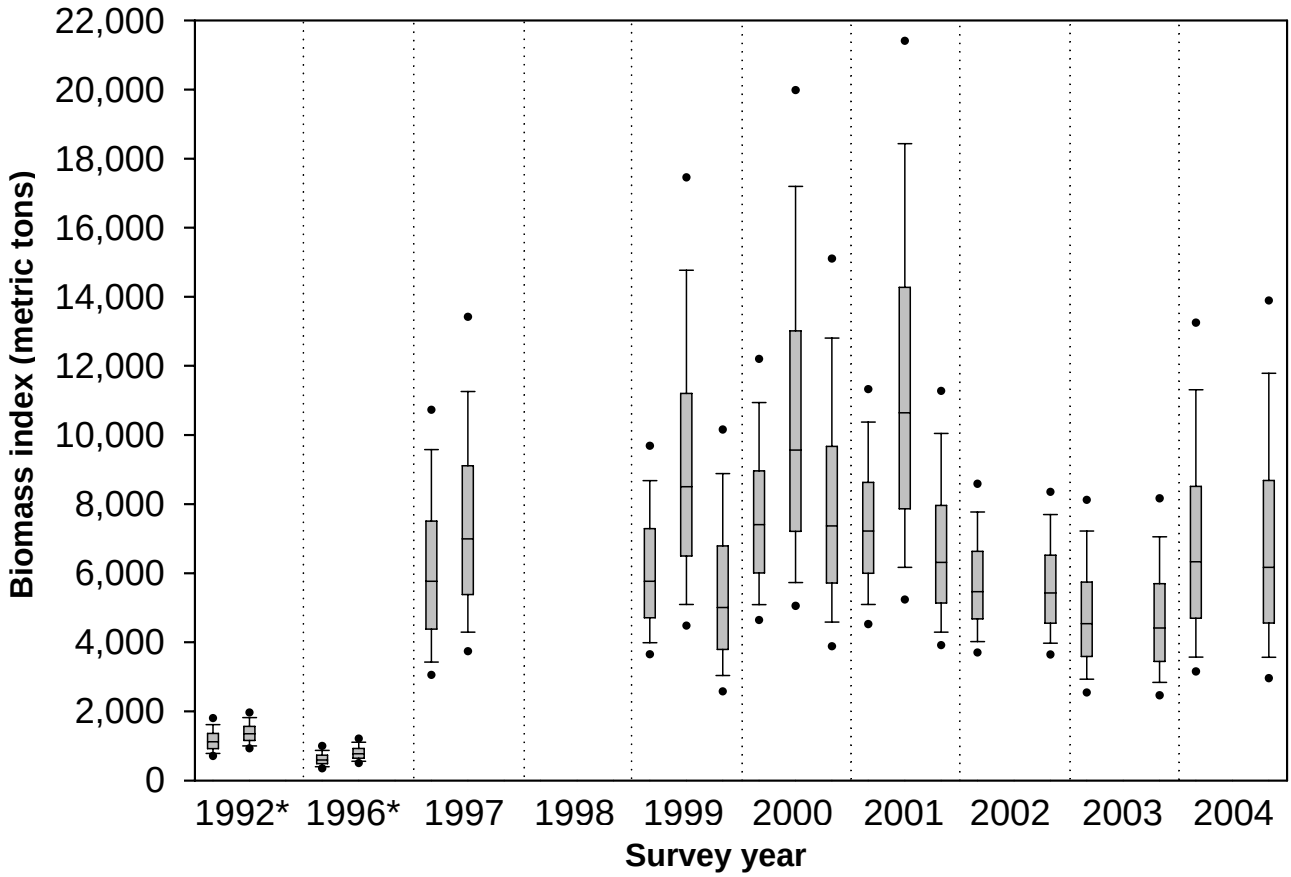


Figure I-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution of aurora rockfish. Plots shown 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.

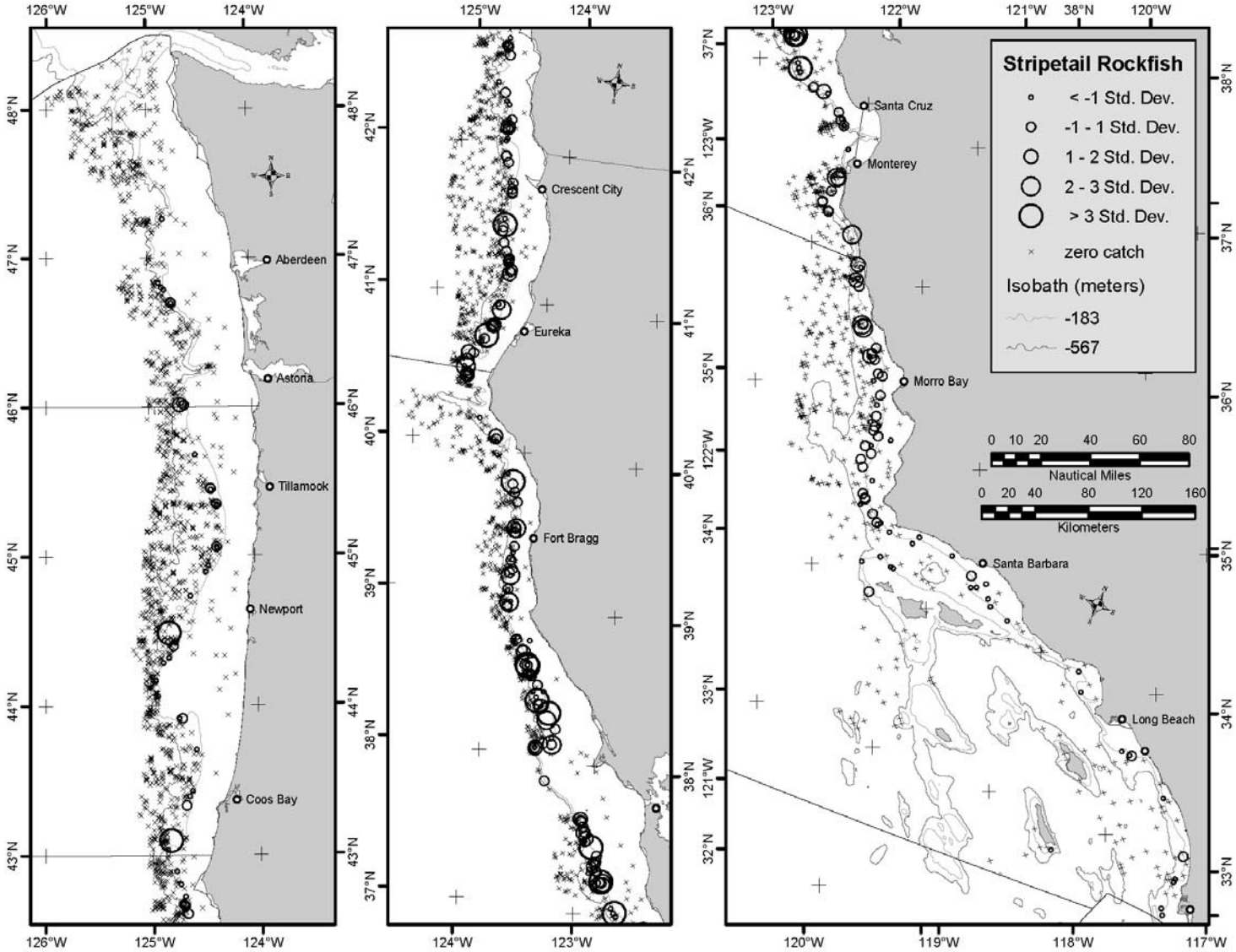


Figure J-1. Distribution of stripetail rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

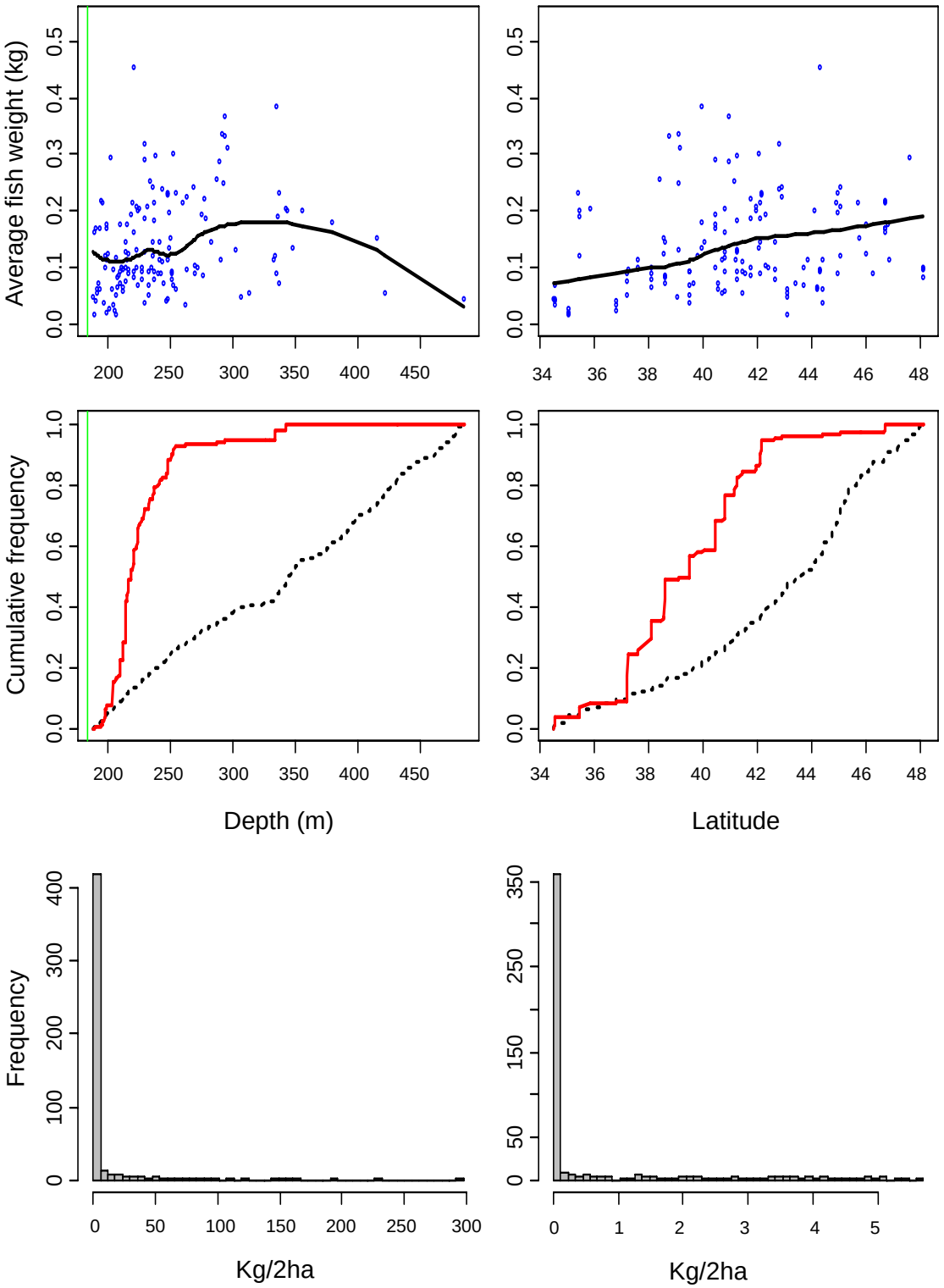


Figure J-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of stripetail rockfish caught in the AFSC slope surveys.

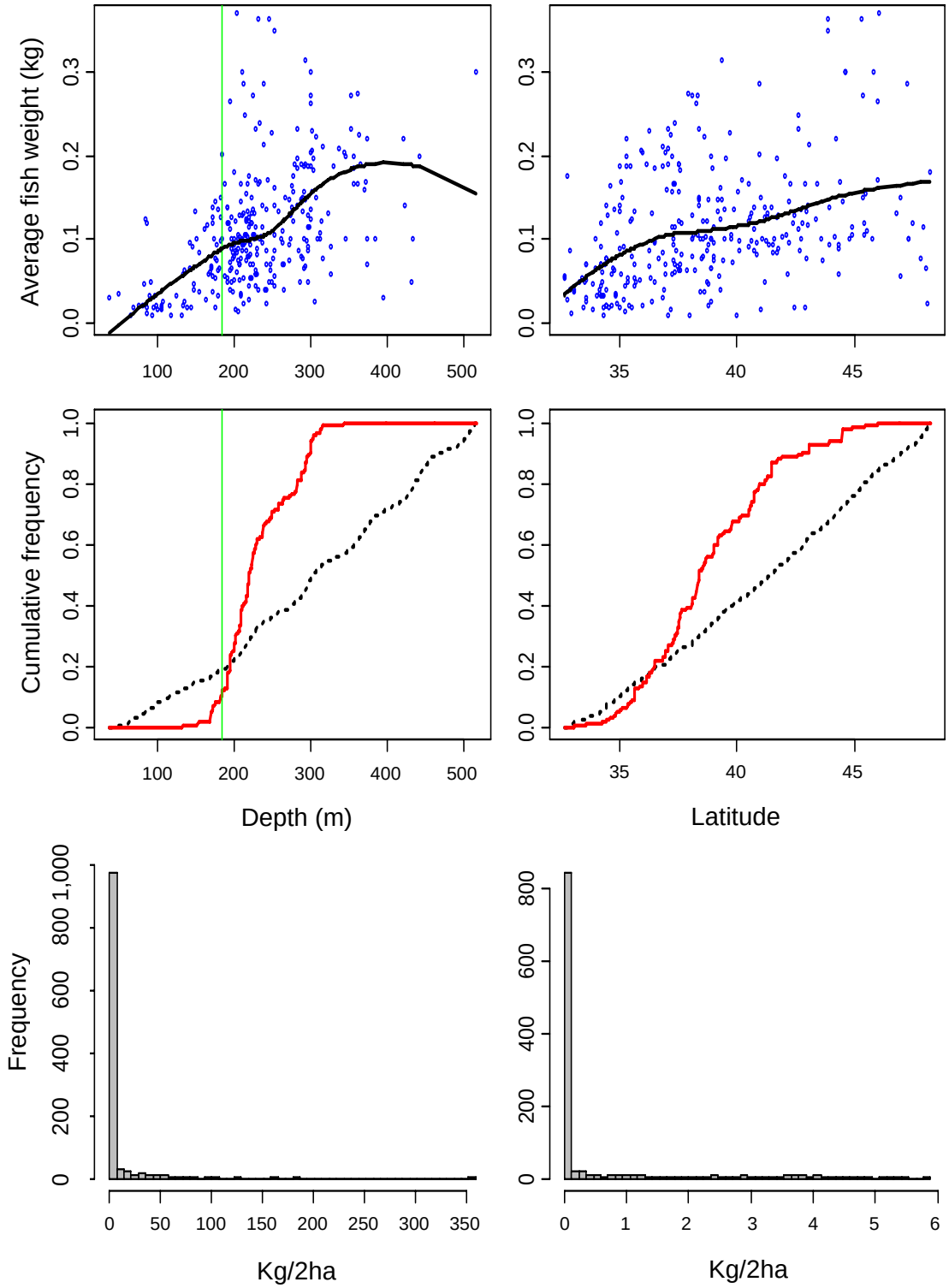


Figure J-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of stripetail rockfish caught in the NWFSC slope surveys.

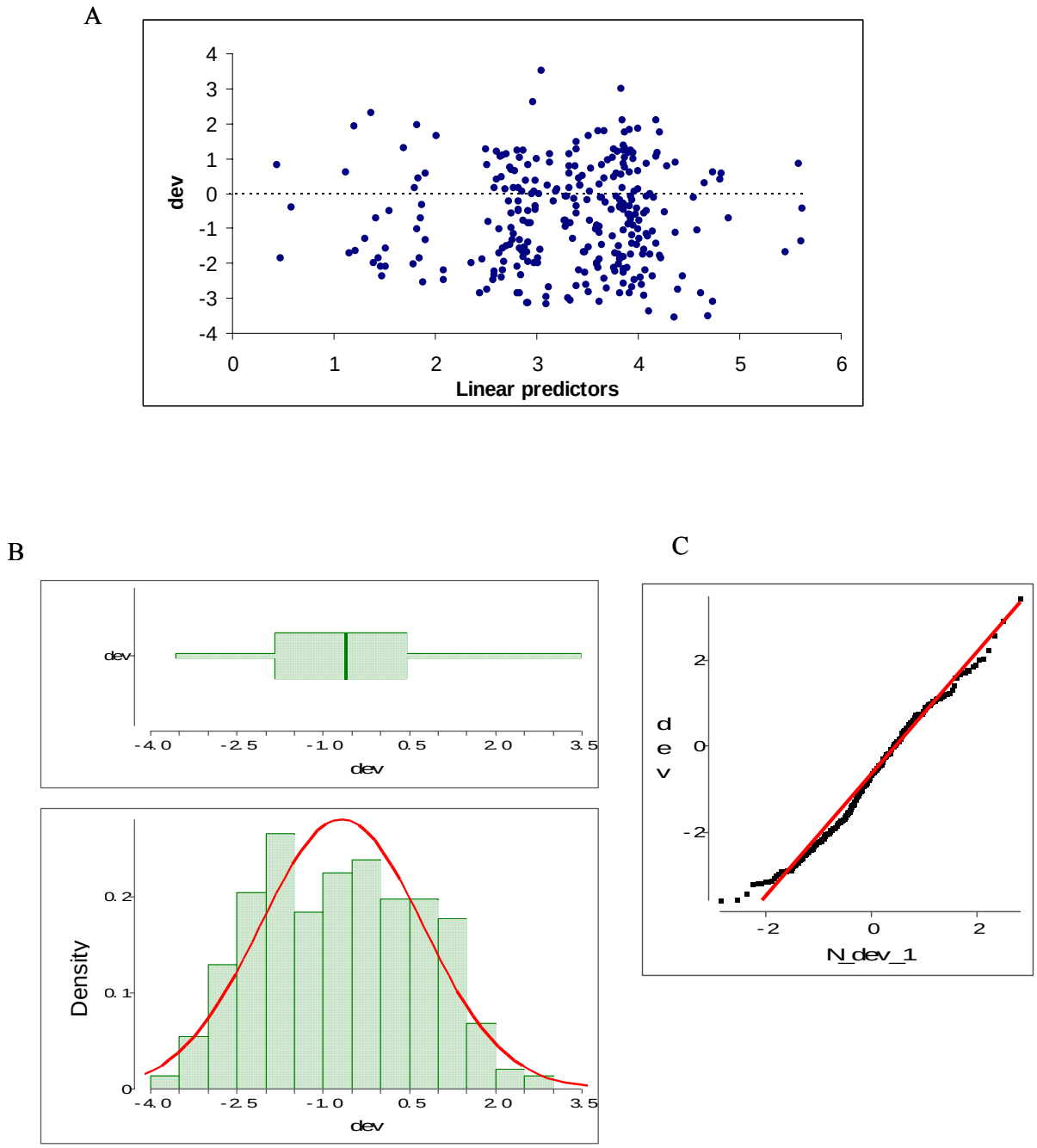


Figure J-4. Diagnostic plots from the generalized linear mixed model fit to stripetail rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed,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

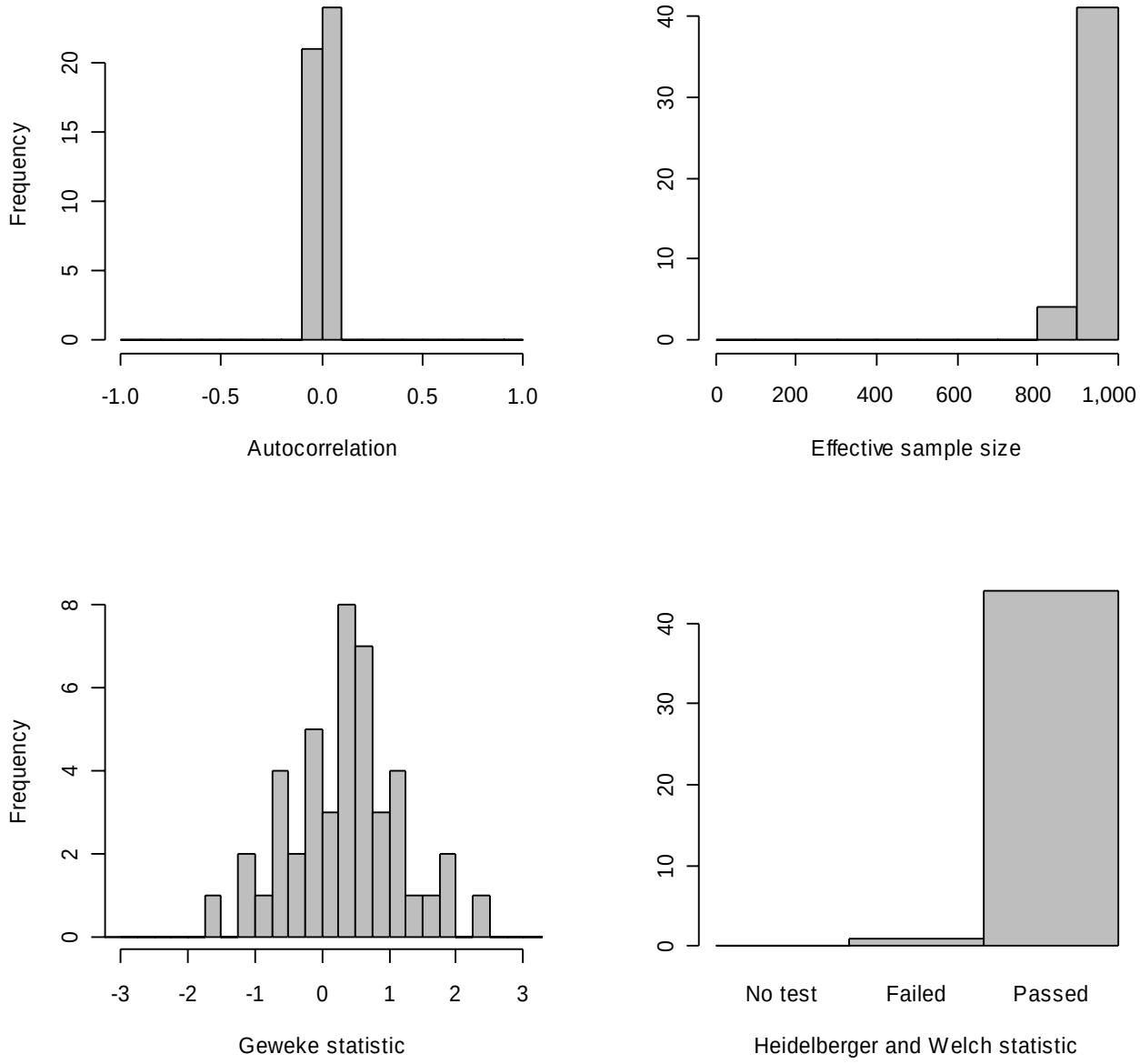
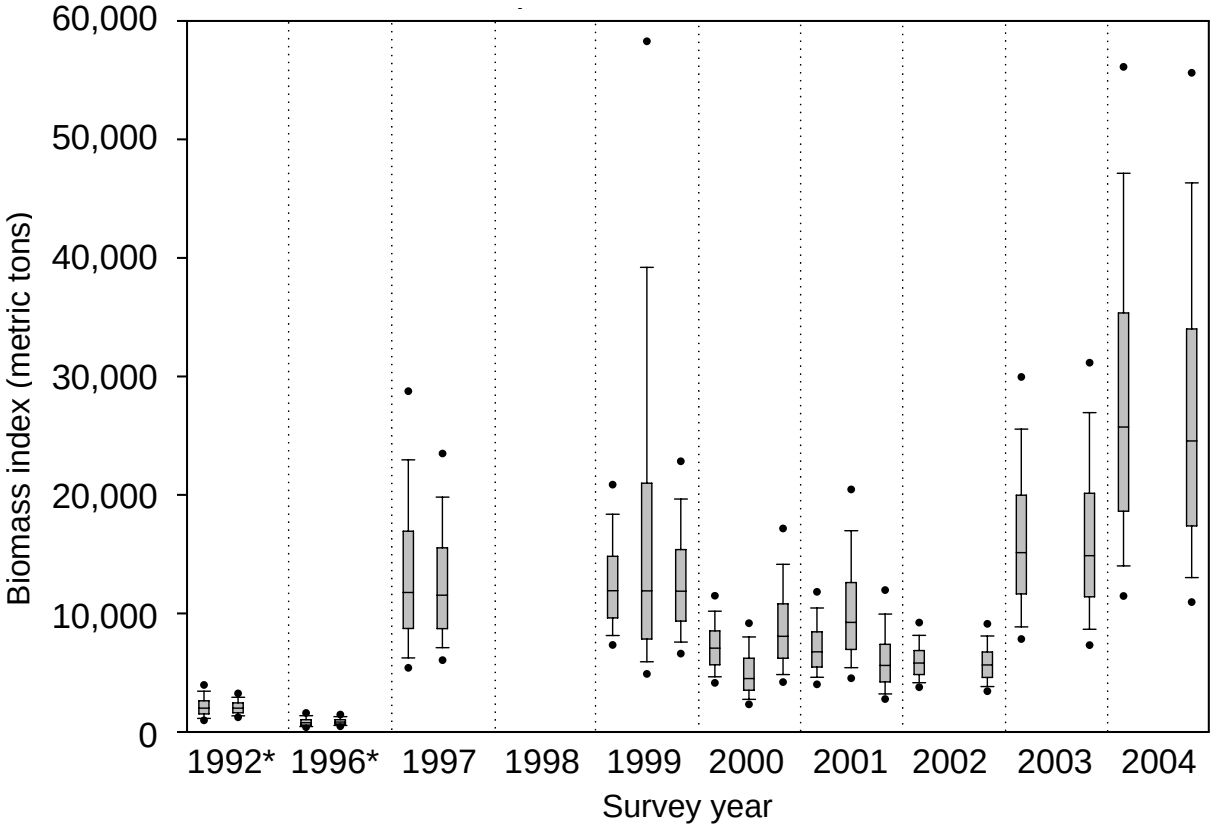


Figure J-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution of stripetail rockfish. Plots 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 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 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.

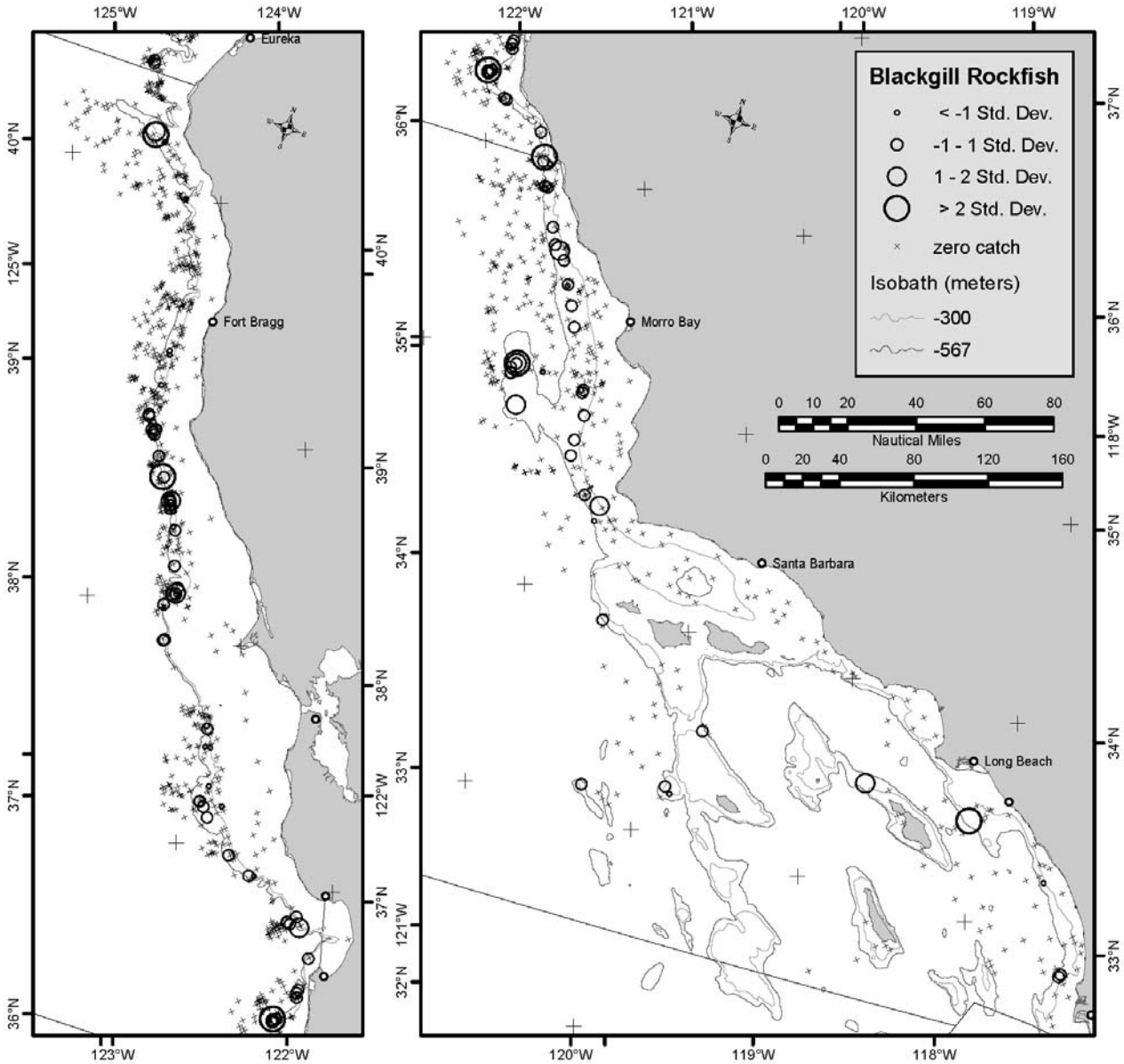


Figure K-1. Distribution of blackgill rockfish caught in the combined AFSC-NWFSC slope surveys. Graded circles represent <1 to >3 standard deviations from the mean catch.

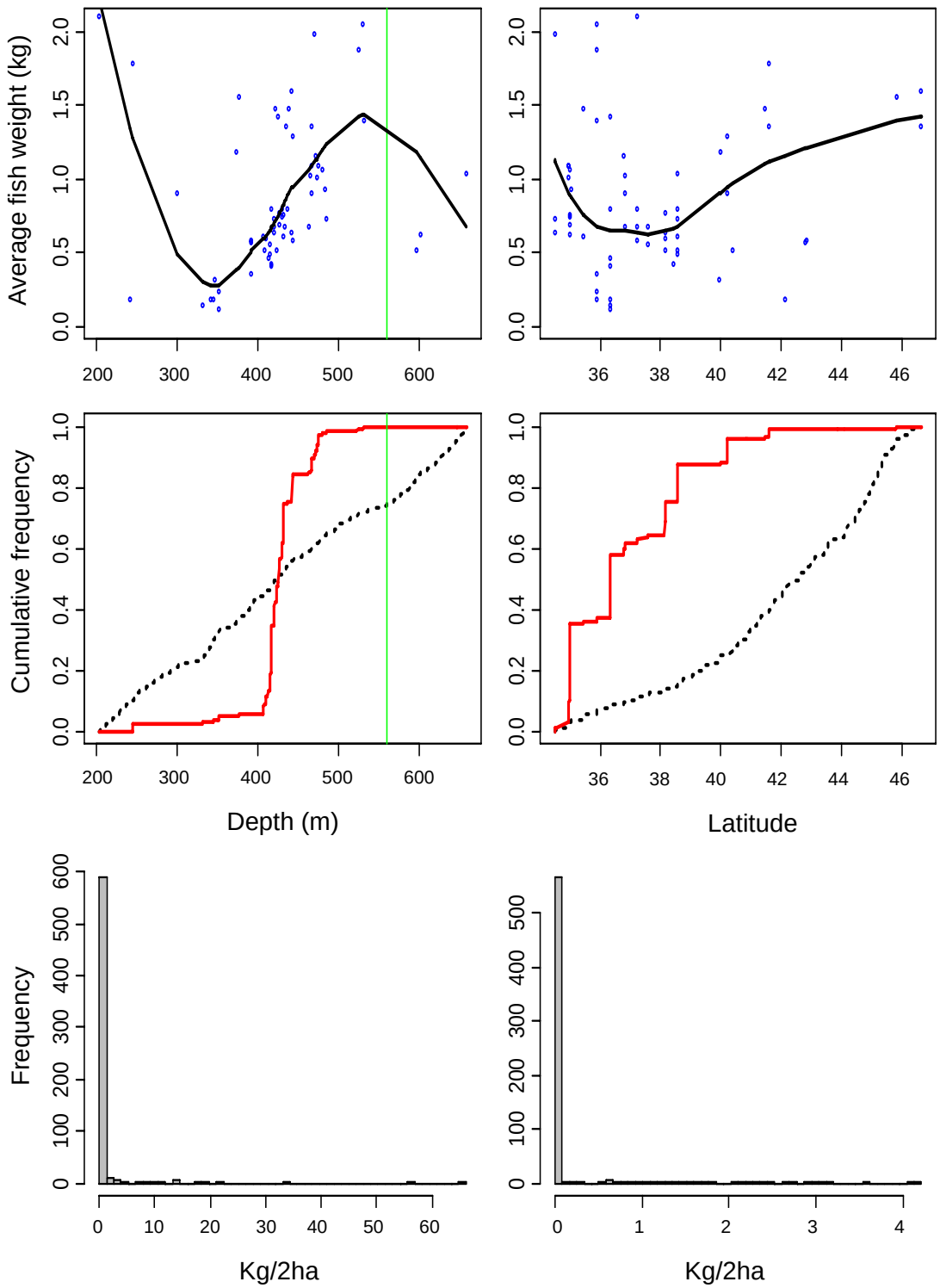


Figure K-2. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of blackgill rockfish caught in the AFSC slope surveys.

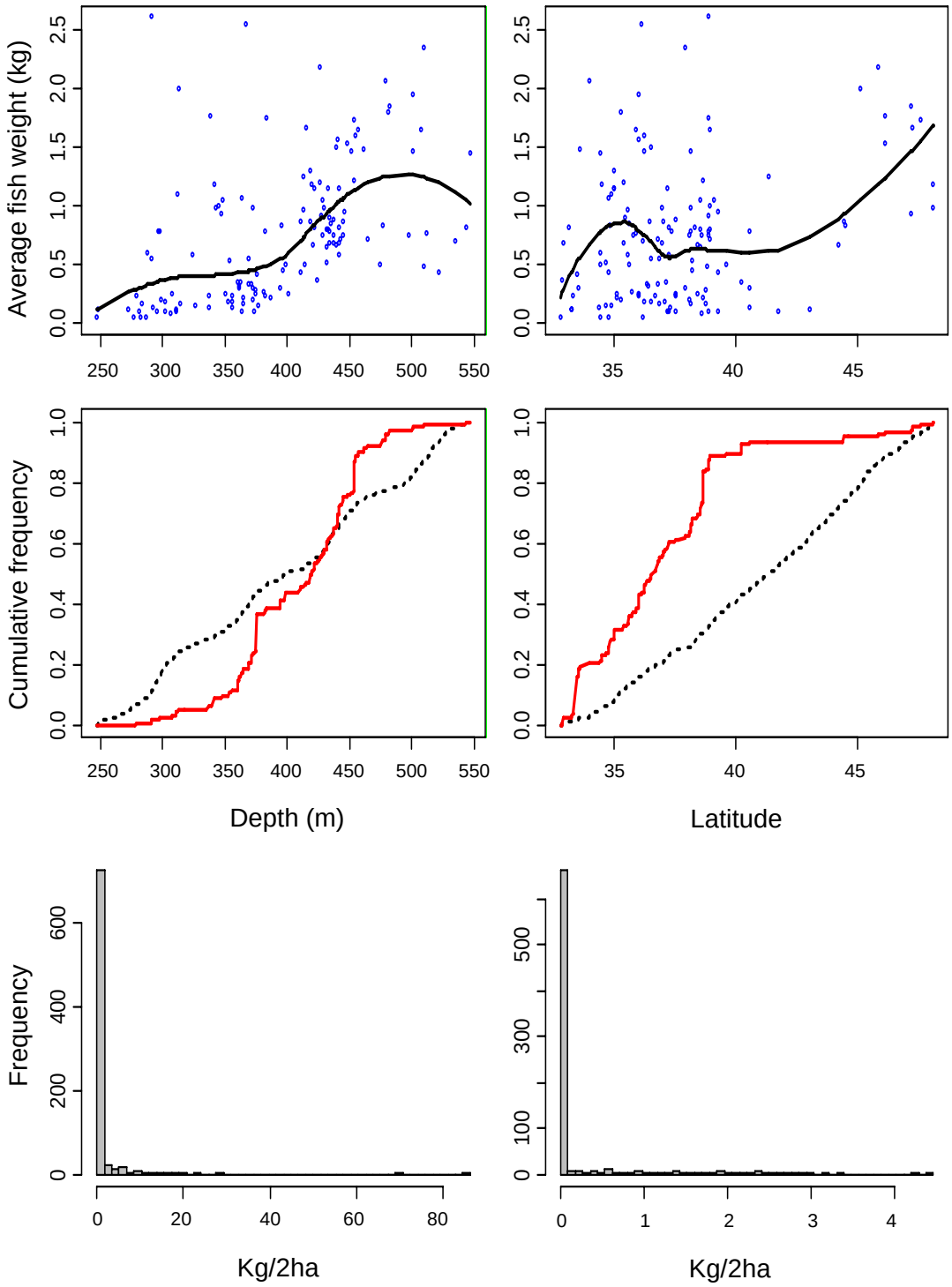
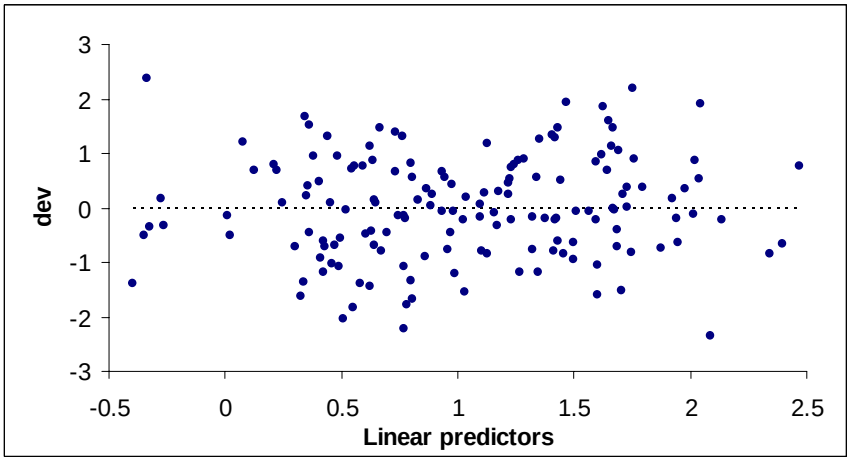
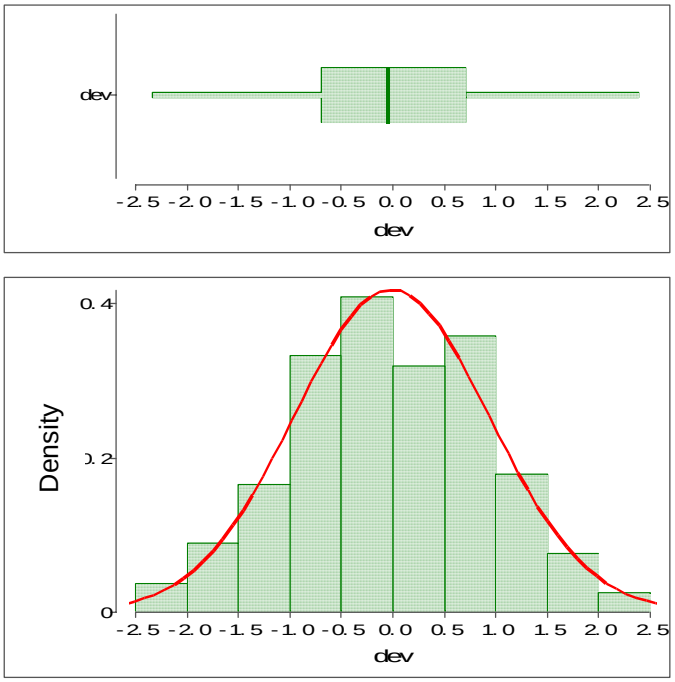


Figure K-3. Trend in average body size (top panels) as a function of depth and latitude, catch-weighted cumulative frequency distributions of depth and latitude (middle panels), and the raw and log-transformed catch distribution (bottom panels) of blackgill rockfish caught in the NWFSC slope surveys.

A



B



C

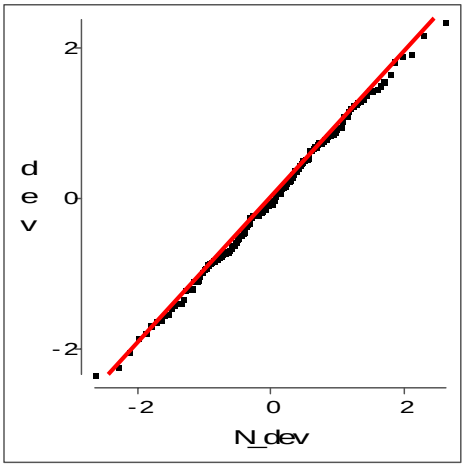


Figure K-4. Diagnostic plots from the generalized linear mixed model fit to blackgill rockfish from the combined AFSC-NWFSC slope surveys. Diagnostic plots include: A) deviance residuals plotted as a function of linear predictors, B) distribution of deviance residuals with normal density superimposed,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

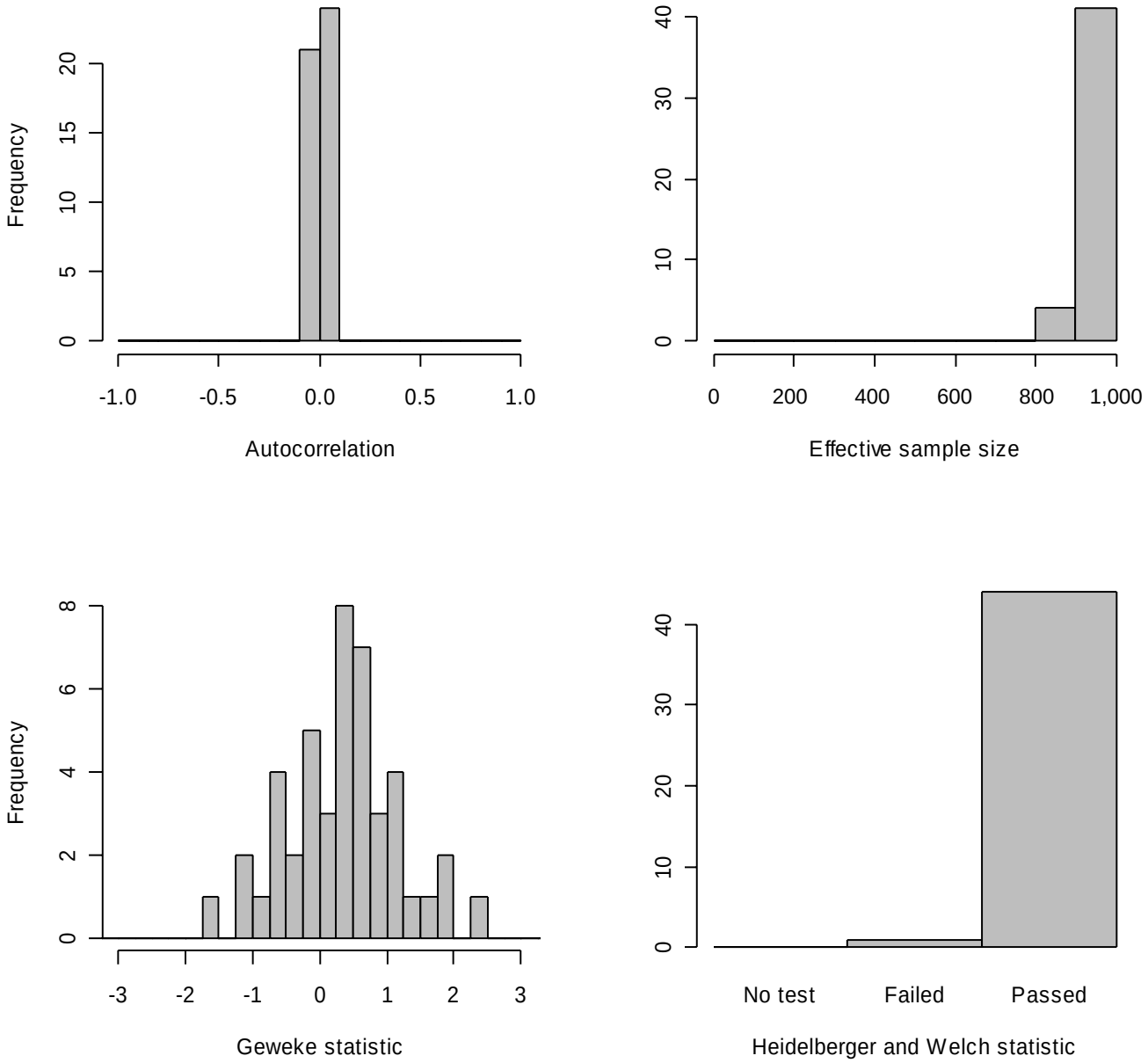
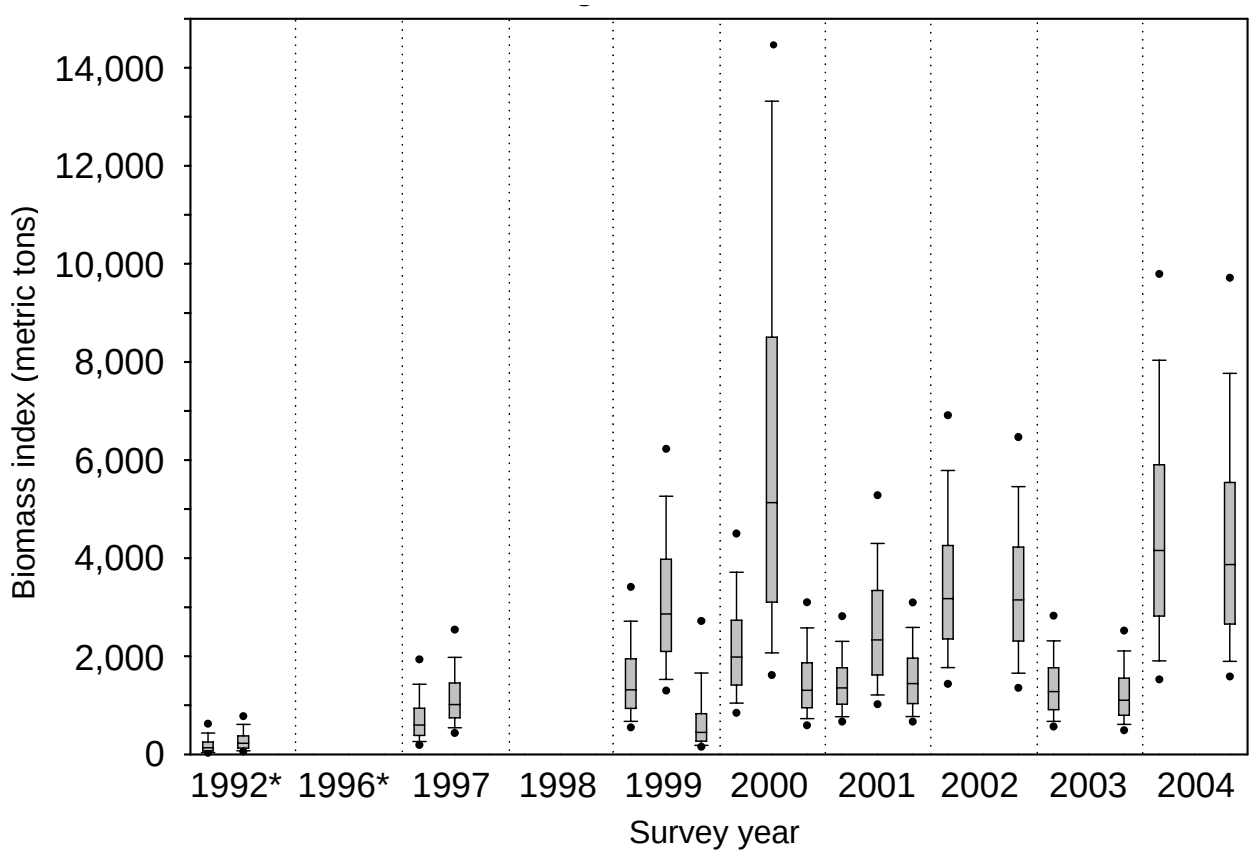


Figure K-5. Summary diagnostics for random and fixed parameters from the generalized linear mixed model based on 1,000 draws (after discarding first 50% of samples and thinned at every tenth sample) from the Markov Chain Monte Carlo simulation of the posterior distribution for blackgill rockfish. Plots 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.

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