Effective fishing effort in the Oregon groundfish trawl fishery

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ABSTRACT

In this study logbook data from the Oregon bottom trawl fishery were used to estimate effective, standardized catch-per-unit-effort (CPUE) for fifteen groundfish species or species groups. The data, which included skippers' tow-by-tow estimates of retained catch, were compared with landing receipts to remove inaccurate information; trips influenced by regulatory trip limits and tows longer than four hours duration were also excluded. From the remaining data a subset was chosen for detailed analysis to identify influential factors, to develop simplified statistical models of catch rates for each species, and to identify boats that could be used for estimating standardized CPUE. Excluded from the detailed analyses were boats that did not operate throughout the study period, and areas in which there was limited fishing.

The selected data were analyzed in a stepwise manner using generalized linear models of catch rates to measure the importance of the factors *Year* (1987-93), *Season* (bimonthly intervals), *Boat* (29 boats), *Net* type (generic bottom trawl, trawl with roller gear, sole trawl), *Latitude* (20 minute intervals), and *Depth* (40 fathom intervals). Because for each species there were large numbers of tows with catches that were zero, catch rates were modeled using a delta-lognormal distribution; the numbers of tows with non-zero catch were treated as binomial random variables and the catch rates for the non-zero tows were treated as lognormal random variables.

The process of data verification and screening resulted in the exclusion of data from about half the fishing trips. The data subsets that were subjected to the detailed analyses of influential factors consisted of tow-by-tow catch rates (lb/hr) from 26,256 tows. In the logistic regression analyses of the zero-catch tows, essentially all factors were found to be highly significant (P<1%) for all species from both states. *Boat* was the first or second most influential factor for 12 of the 15 species, and *Depth* was the first or second most influential factor in 12 combinations. In the analyses with pairwise interactions, the *Year·Boat* interaction was the first or second most influential interaction for all 15 species. In the analyses with lognormal models of the non-zero tows, essentially all factors were found to be highly significant (P<1%) and *Boat* was the most influential factor for 14 of 15 species and was the second most influential factor for one other species, *Latitude* was the second most influential factor for 7 species, and the *Year·Boat* interaction was the first or second most influential interaction for 13 of 15 species. Estimates of annual fishing power coefficients were examined to identify boats with stable fishing power.

To estimate standardized CPUE for each species for individual areas (defined by the factors *Latitude* and *Depth*), the simplified statistical models, developed from the detailed analyses, were applied to data from the top 40 boats for each species from each state. The data were further restricted to those areas that had been fished in during the entire study period. The area-specific CPUE estimates, defined as the estimated average catch (lb) per hour of towing for those boats selected as the standards, were then averaged to estimate the effective, standardized CPUE for each species. There were substantial declines indicated for lingcod, miscellaneous rockfish, and sablefish, and moderate declines for petrale sole, Dover sole, and arrowtooth flounder; and there were increases indicated for English sole, rex sole, widow rockfish, yellowtail rockfish, and thornyheads.

INTRODUCTION

Stock assessments for many important groundfish resources, off the U.S. west coast and elsewhere, are based on analyses of the age distribution of the catch, so-called catch-at-age analyses (e.g., Pacific Fishery Management Council, 1996, Appendices A-F). Because of a fundamental indeterminacy in the underlying mathematics of the catch process, however, it is impossible to estimate the size of a stock solely from observations of catch-at-age (Pope, 1977; Deriso et al., 1985). Additional information is needed to "tune" the analysis and thereby limit the range of feasible estimates for stock abundance and fishing mortality.

For most assessments of U.S. west coast groundfish stocks the catch-at-age data are analyzed using the Stock Synthesis model (Methot, 1990) and the analyses are tuned to estimates of biomass derived from research trawl surveys. These surveys use gear and methods that are consistent from survey to survey, and the sampling stations are selected randomly to avoid bias. However, results from the groundfish trawl surveys may not be entirely adequate for tuning a stock assessment because: (1) the surveys are conducted relatively infrequently (every third year); (2) the surveys sample only from areas that can be easily trawled and with gear that is not well suited to certain species; and (3) the estimates of biomass derived from the survey can be quite variable. The goal of the project described in this report was to use data from trawl logbooks to derive estimates of "annual effective fishing effort", which could be used as an alternative source of information with which to tune assessments of west coast groundfish stocks.

Effort and Catch-per-Unit-Effort Indices

Using fishing effort in catch-at-age analyses has been a standard practice of the International Pacific Halibut Commission (IPHC, and Cook, 1993) and Europe (Pope and Shepherd, 1985; Large, 1992). The basic idea can be summarized using the following standard equations of fisheries science, which relate catch (C) accumulating during a time interval (t) with stock biomass (B), the fishing mortality coefficient (F), and fishing effort (f):

$$C \approx B \cdot F \cdot t \; ; \qquad (1)$$

$$F = q \cdot f \; ; \qquad (2)$$

$$C \approx B \cdot q \cdot f \cdot t \; . \qquad (3)$$

The coefficient q, which is usually described as the catchability coefficient, is the instantaneous rate of fishing mortality caused by one unit of fishing effort.

Equations (1) and (3) do not account for the changes in biomass caused by natural mortality or by the fishing process itself and therefore are approximations, which are valid for small catches or short time intervals. If the fishing fleet doubles in size and the stock biomass remains unchanged, then the fishing mortality coefficient and the catch should also approximately double. Alternatively, if the fishing fleet and the stock biomass remain unchanged but the fleet doubles the time it spends fishing, the catch should approximately double. By calculating values for annual fishing effort, trends in annual fishing mortality can be estimated, which in turn can be used to tune the catch-at-age analysis. Or, equivalently, trends in catch-per-unit-effort (CPUE) can be derived from a simple rearrangement of equation (3),

$$CPUE = C \,/\, (f \cdot t) \approx B \cdot q \; , \qquad (4)$$

and used as an index of stock biomass for tuning the catch-at-age analysis.

The principles underlying the use of effort and catch-per-unit-effort data are very simple, but applications of the theory to real data are much more complicated. A simple tabulation of the number of hours of fishing is almost certainly not a valid index of the rate of fishing mortality, and the simple ratio of pounds caught over hours fished is not likely to provide a valid index of stock biomass. Several technical problems must first be resolved. (1) Because all fishing boats and gear may not be equally effective at catching fish, the relationship between fishing mortality and effort can become distorted if there are changes from year to year in the composition of the fleet or in the fishing technology of the individual boats. (2) Because the geographic distribution of fishing may shift from year to year, the relationship between fishing mortality and effort can be influenced by the distribution of the fish stock. (3) Because regulatory "trip limits" may force fishermen to discard some of their catch, the reported landings may be less than the actual catch.

catch.

With regard to the first problem, various techniques have been developed for calculating standardized measures of fishing effort that account for vessel differences (e.g., Robson, 1966; Gavaris, 1980). For the second problem, standard techniques are available to produce a measure of the "effective" fishing effort (Beverton and Holt, 1957), which reconciles disparities between the spatial distributions of the fish stock and the fishing effort. A simple solution to the third problem is to exclude catch and effort data from any fishing trips that came close to achieving the trip limits. To our knowledge, these procedures have never been used with commercial catch and fishing effort data from the U.S. west coast groundfish fishery.

This report documents an application of these basic procedures to trawl logbook data obtained from Oregon, and then presents the resulting indices of effective fishing effort and effective, standardized catch-per-unit-effort. More or less identical procedures were applied to trawl logbook data obtained from California and Washington in a parallel project funded by the National Oceanic and Atmospheric Administration, Saltonstall-Kennedy program (Sampson, 1996). To simplify comparisons with the California and Washington logbook data, the tables and figures in this report follow the same format as the tables and figures in the completion report for the Saltonstall-Kennedy project. Also, in the text I have indicated if there were substantive differences in how the Oregon data were processed relative to how the California and Washington data were processed.

DATA PROCESSING AND ANALYTICAL METHODS

The fishery agencies of California, Oregon, and Washington routinely collect landings statistics for all commercial fisheries that operate along the U.S. west coast, including the fishery for groundfish (Sampson, Crone, and Tagart, In Press). All three states monitor the number and sizes of individual deliveries of groundfish by means of a system of "fish tickets". These fish tickets are the official fish landing receipts that record the weight and composition (by species or species group) of all commercially caught groundfish. In addition, each state requires all individuals who operate groundfish trawl gear to maintain a standard "Washington-Oregon-California Trawl Logbook" and submit completed logbooks to agency staff. The fish tickets record the official landing weights of groundfish on a (more or less) trip-by-trip basis, but they contain no detailed information about fishing locations. In contrast, the logbooks record on a tow-by-tow basis the amount of time spent trawling and the skippers' estimates of retained catch; logbooks are the only source of detailed information about fishing locations and the amount of time spent fishing, but their accuracy and reliability are uncertain.

The Logbook and Fish Ticket Data

For this project we obtained fish ticket data files and trawl logbook data files from the Oregon Department of Fish and Wildlife (ODFW). We also received copies of documentation and supporting files that contained various code lists. The data files were stored in the form of FoxPro database files on a microcomputer system at the Hatfield Marine Science Center in Newport, Oregon. Initial processing and screening of the data was conducted using routines developed under the database management system known as Visual FoxPro for Windows, version 3.

The original proposal for this project specified that we would analyze logbook data for the years 1985 through 1992. Preliminary screening of the Oregon logbook files indicated that the data for 1985 and 1986, which had been keypunched by the ODFW Marine Habitats program, were in a different form and were less complete than the data for later years. We decided to limit our analyses of Oregon data to the years 1987-93. In the Saltonstall-Kennedy project we limited our analyses to data for the years 1985-91 for California and 1986-92 for Washington.

To keep the data files from becoming unmanageably large and because of differences among the states in the data formats and coding, the data from the three states were maintained as separate files and were processed and analyzed separately. The states differed with respect to the groundfish species contained in their logbooks and with respect to the size of landings of these species. For example, arrowtooth flounder are almost absent from groundfish landings in California and are a small component (less than 3% by weight) of the landings reported in the Oregon logbooks (Table 1), but they are a reasonable component (more than 14%) of the landings reported in the Washington logbooks. Furthermore, the three states were inconsistent with regard to the level of identification of rockfish species. The logbook data from Oregon contained the most detailed resolution of rockfish species.

For this study of the Oregon logbook data we chose to focus on the following 15 species, which in general represented the species with the greatest retained catches as reported in the Oregon logbook data files.

Species [1]
Arrowtooth flounder (*Atheresthes stomias*)
Dover sole (*Microstomus pacificus*)
English sole (*Pleuronectes vetulus*)
Petrale sole (*Eopsetta jordani*)
Rex sole (*Errex zachirus*)
Pacific sanddab (*Citharichthys sordidus*)
Pacific ocean perch (*Sebastes alutus*)
Widow rockfish (*Sebastes entomelas*)
Yellowtail rockfish (*Sebastes flavidus*)
Small rockfish (*Sebastes* sp.) [2]
Miscellaneous rockfish (*Sebastes* sp.) [3]
Thornyheads (*Sebastolobus* sp.)
Pacific cod (*Gadus macrocephalus*)
Sablefish (*Anoplopoma fimbria*)
Lingcod (*Ophiodon elongatus*)

We did not include Pacific hake (*Merluccius productus*) in this or the Saltonstall-Kennedy study because most retained catches of this species are taken with mid-water trawls. In our analyses of catch rates (but not in the initial data processing and screening) we excluded data from catches taken with midwater trawls because catch rates from midwater tows are probably not good indicators of fish abundance. To maintain proportionality between fishing effort and fishing mortality, the measure of fishing effort should include the time spent searching for suitable schools of fish, not just the time spent trawling. In midwater trawl operations the time spent towing the net can be very small relative to the time spent searching for suitable concentrations of fish.

The logbook data files from the three states differed in the spatial resolution of the tow location data. The Oregon files reported the latitude and longitude coordinates and depth of each

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<1> In this report the term "species" is used to denote both the notion of a particular biological species (e.g., widow rockfish, *Sebastes entomelas*) as well as a group of similar biological species (e.g., rockfish, *Sebastes* spp.).

<2> Landings of "small rockfish" in Oregon typically include the following rockfish species (in decreasing order by weight): yellowmouth (*S. reedi*); darkblotched (*S. crameri*); redstripe (*S. proriger*); and greenstriped (*S. elongatus*) (Crone, 1995).

<3> Landings of "miscellaneous rockfish" in Oregon typically include the following rockfish species (in decreasing order by weight): canary (*S. pinnniger*); bocaccio (*S. paucispinus*); darkblotched (*S. crameri*); and shortraker (*S. borealis*) (Crone, 1995).

starting tow location. In contrast, the California files recorded each tow location using a "block code", with each block corresponding (more or less) to a rectangle defined by 10 minutes of latitude and 10 minutes of longitude. The depth datum associated with each tow represented the average of the starting and ending depths. The Washington files reported the latitude and longitude coordinates of each starting tow location and reported minimum and maximum depths.

For all three states processing of the logbook data for each of the species consisted of the same five basic steps (Figure 1): (1) match logbook data with fish ticket data and identify fishing trips for which the skipper's estimates of retained catch were consistent with the official landing weights; (2) screen the data to identify fishing trips that were not influenced by trip limit regulations; (3) analyze subsets of the verified data to identify influential factors, to develop simplified statistical models for CPUE, and to identify boats that could be used for estimating standardized CPUE; (4) apply the simplified statistical models to the full data set to estimate standardized CPUE for individual areas; and (5) average the area-specific CPUE estimates to estimate the effective, standardized CPUE for all areas.

Identifying Logbooks with Consistent Information

As a partial verification of the accuracy of the skippers' estimates of retained catch (the hails reported in the logbooks), we compared on a species by species basis the sum of the hails for a given trip with either the official fish ticket weight for that trip, or the sum of the fish ticket weights if a particular trip had more than one associated fish ticket. For each trip and species we calculated the ratio

$$R = \Sigma_{tow} \text{ hailed weight } / \ \Sigma_{ticket} \text{ landed weight } .$$

If the skippers had been perfectly accurate in their estimates of the retained catches, then these ratios would all have been exactly equal to one. We examined distributions of the ratios to identify ones that differed substantially from the norm and we rejected logbook hails for a given trip and species if the calculated ratio R for that trip and species fell outside the range 0.6 - 1.1. We selected this particular range of values on an arbitrary basis. If the logbook hails fell within this range, then we calculated adjusted hails by multiplying each raw hail by 1/R so that the sum of the adjusted hails for each trip and species were equal to the actual landed weight. We made one exception to this adjustment procedure for trips that had no hails of a particular species, but which had landings under 50 pounds (22.7 kg). For these trips we treated the zero hails as valid information.

The first step in the verification process was matching the logbooks with the fish tickets. Because the Oregon logbook files always contained fish ticket serial numbers, it was very simple to match logbooks with fish tickets, and it was not necessary to use the complicated data processing algorithm that we developed as part of the Saltonstall-Kennedy project. Before the Oregon logbook data are keypunched, the logbooks are reviewed by ODFW port biologists and matched by hand with corresponding fish tickets (Sampson, Crone, and Saelens, In Press).

Identifying Trips that were Uninfluenced by Trip Limits

Trip limits are a form of regulation used by the Pacific Fishery Management Council to control the rate at which the fishing fleet achieves the annual catch quotas (PFMC, 1993). The goal of these regulations is to avert the premature fishery closures that would occur if the allowable catch of a species was taken before the end of a year. During the period 1987-93 many of the U.S. west coast groundfish stocks were thought to be declining, and the PFMC gradually reduced the annual catch quotas and forced the trawl fishery to operate under increasingly complex and restrictive trip limits (Table 2).

One undesirable side effect of trips limits is that they result in fish being discarded at sea when catches are made that exceed the limits (Pikitch et al., 1988). With respect to logbooks, if skippers hailed only their retained catch but discarded appreciable quantities of fish at sea, then the catch rates (pounds per hour of towing) indicated by the logbook data would underestimate the true catch rates. To avoid this problem we used a suite of data processing algorithms (Figure 2) to identify fishing trips that attained 90% or more of a trip limit. In our subsequent analyses of catch rates we excluded logbook information for a given species if it came from one of these trips.

The trip limit screening programs were applied separately to the data from each state. As a consequence, our programs may have missed potential trip limit overages by boats that made landings in two or more states during a given accounting period. We also made simplifying assumptions for those trip limits that were specific to a geographic area. For example, the trip limits that we applied to the Oregon data for Sebastes complex and for yellowtail rockfish were always the more restrictive limits for north of Coos Bay, Oregon. Also, we never applied the bocaccio trip limit to the Oregon data.

Analysis of Major Factors that Influence Catch Rates

Fisheries scientists (e.g., Gulland, 1964; Garrod, 1964) have long recognized that catch rates (catch per fishing hour) are influenced by numerous factors and that the simplest equation for catch per unit effort (eq. 4) does not adequately account for the variability that is commonly observed in real catch rate data.

Catch rates usually differ from location to location because fish are not evenly distributed on the fishing grounds. Catch rates are likely to change through time because fish abundance varies from year to year, and fish may alter their behavior as seasonal conditions change or even during the course of a day. Also, fishing boats and gear are not all equal in their ability to catch fish, and fishing technology changes; boats are often described as differing in their "fishing power" (Pope and Parrish, 1964; Robson, 1966).

Statistical Models for Catch Rates.

One approach to conducting a formal statistical analysis of catch rate data is to assume that the data (which we denote by U) can be represented by an equation of the form

$$U = Q_{boat} \cdot Q_{gear} \cdot Q_{area} \cdot Q_{season} \cdot B_{year} \cdot \epsilon , \qquad (5)$$

where the coefficients Q_{boat} and Q_{gear} measure the fishing power of the boats and gear, the coefficients Q_{area} and Q_{season} account for the spatial and seasonal distribution of the fish, the term B_{year} is the annual fish abundance, and ϵ is a normally distributed random error term. Because information on the absolute magnitude of fish abundance is generally unavailable, the term B_{year} is interpreted as an index of annual abundance. This form of equation is sometimes described as a multiplicative model for catch rates; variants of it have been applied in numerous studies of catch and effort data (e.g., Gavaris, 1980; Kimura, 1981; Large, 1992).

Upon taking logarithms equation (5) is transformed to a simple linear equation,

$$\log(U) = Q'_{boat} + Q'_{gear} + Q'_{area} + Q'_{season} + B'_{year} + \epsilon , \qquad (6)$$

where $Q'_x = \log(Q_x)$, $B'_{year} = \log(B_{year})$, and $\epsilon' = \log(\epsilon)$. In addition to the main effects given in equation (6) one can easily incorporate interaction terms. For example, the term $Q'_{area \cdot year}$ could be included to account for annual changes in spatial distribution. Data that conform to this type of model can be analyzed readily using standard linear regression procedures.

Before applying equation (6) to real catch rate data one must eliminate all occurrences of zero catch rates, because the logarithm of zero is undefined. This problem usually does not arise when analyzing catch rate data that have been coarsely aggregated, say for annual data from a large class of fishing vessel operating over a large area. In our case, however, we wanted to examine the data on as fine a level of resolution as possible and exploration of the data for each of the species showed high proportions of tows with zero catches (e.g., Figure 3).

In our formal statistical analyses of the logbook catch rate data (after verification and adjustment based on the fish ticket data and screening for trip limit influences) we modeled catch rates using the so-called "delta distribution" (Pennington, 1983, 1996). Whether or not a tow resulted in a non-zero catch was explicitly modeled as a binomial random variable (with success probability p) and the magnitude of a non-zero catch (Y) was modeled as a lognormally distributed random variable, as in equation (6). The overall catch rate from this compound model is simply the product

$$U = p \cdot Y . \qquad (7)$$

To our knowledge, the delta distribution has not previously been applied in an analysis of commercial fishery data, although it has been used for the analysis of research trawl survey data (Pennington, 1996; Stefánsson, 1996).

We modeled the probability of a non-zero catch using a logistic model of the form

$$\log[p/(1-p)] = \Sigma_i \, q_{\text{factor } i} \, , \qquad (8)$$

and we modeled the non-zero catch with the model

$$\log(Y) = \Sigma_i \, Q'_{\text{factor } i} \, . \qquad (9)$$

We used the Generalized Linear Interactive Modeling statistics program (GLIM, version 4, Francis et al., 1993) to fit the models to the data using the method of maximum likelihood. We applied equation (8) to aggregated data, counts for each combination of factors of the number of tows with non-zero catch versus the total number of tows. The catch rate data for equation (9) were the tow-by-tow adjusted hails over the hours of towing.

Stepwise Analysis of Influential Factors.

To determine which factors and factor combinations had the most influence on the observed catch rates in the Oregon data we conducted a series of stepwise analyses for each species: one set of analyses to gauge the importance of factors that might influence the probability of a non-zero catch; another set to gauge the importance of factors influencing the size of a non-zero catch. For these analyses we used a subset of the verified, adjusted, and screened data. Because the complete data sets were unmanageably large, we selected data only for those boats that had operated during all years of the data series, 1987-93. The data subset was further restricted to those boats that had valid data for at least 600 tows during the seven year period and to those areas (*Latitude-Depth* factor combinations) in which at least 300 tows had been made.

In GLIM a statistic known as the "deviance" measures how well a statistical model fits the observed data (McCullagh and Nelder, 1983). If a model has been correctly specified, then the deviance is distributed approximately as a chi-square random variable and changes in the deviance relative to changes in the degrees of freedom can be used to judge the importance of different factors. In the stepwise analyses we initially fit the data with models that contained all the main factors and then removed each factor from the model, one at a time. At the next stage we added interaction terms, one at a time, for each pairwise combination of the main factors.

We judged the relative importance of each factor and factor combination using an adjusted R-square statistic (Seber, 1977),

$$\text{adj. } R^2 = 1 - (\text{deviance}_{full}/\text{df}_{full}) \;/\; (\text{deviance}_{reduced}/\text{df}_{reduced}) \;,$$

where df denotes the model degrees of freedom and the subscript "full" indicates values from the more complete model. This statistic is similar to the standard linear correlation coefficient (r), but with an adjustment to reflect differences in model complexity. Within a given class of models, a model with more parameters will always produce a better fit to a given data set than one with fewer parameters (i.e., it will produce a larger value for r^2), but the increased predictive power may be inconsequential relative to the loss of degrees of freedom.

We formally tested the statistical significance of each factor and factor combination using an F statistic,

$$F = \frac{(\text{deviance}_{reduced} - \text{deviance}_{full}) \;/\; (\text{df}_{reduced} - \text{df}_{full})}{\text{deviance}_{full} \;/\; \text{df}_{full}} \;.$$

Because the analyses were based on highly unbalanced data, with missing information for numerous factor combinations, the probability levels associated with the F statistics should be interpreted with caution.

Potential Factors.

In our catch rate analyses we examined the influence of the following discrete factors: *Boat; Net* type (standard bottom trawl, bottom trawl equipped with roller gear, sole trawl); *Bimonthly* period (Jan./Feb., Mar./Apr., etc.); and *Year*. We developed discrete categories for the continuous variables tow latitude and depth. Values for the factor *Latitude* were based on the reported starting tow locations rounded to 20 minutes of latitude (e.g., 40°0' to 40°20', 40°20' to 40°40', etc.), and values for the factor *Depth* were based on the starting tow depth rounded to 40 fathom (73.2 meter) depth increments (e.g., 0 to 40 fathoms, 40 to 80 fathoms, etc.). These particular methods for categorizing the latitude and depth information were arbitrary, but they produced groupings that were reasonably fine-scale and yet consistent with what we believed was the underlying (but unknown) precision of the tow location and depth data.

Prior to conducting detailed statistical analyses of the logbook data we excluded information from tows that were longer than four hours. This was done to reduce the chances of mis-classifying tows with respect to the factor *Latitude*. For example, given a towing speed of two to three nautical miles per hour, a four hour tow could cover a distance equivalent to eight to twelve minutes of latitude; hence the value of the factor *Latitude* for this tow would not likely differ by more than one classification unit (20 minutes) from the correct value. With a ten hour or longer tow, however, the value of the factor *Latitude* could easily be off by one or two units. Exploratory tabulations of the data on hours of towing indicated that we would eliminate from about 20% of the tows in the early years of the study and about 40% of the tows from the later years (Figure 4). In contrast, we found in the Saltonstall-Kennedy project that only about 13% of the tows in the Washington logbook data were longer than four hours duration.

In the analyses with a logistic model for the probability of a non-zero catch, equation (8), we included Tow *Hours* as a potential explanatory variable and treated it as a continuous variable. It seemed reasonable to postulate that long tows would be more likely to encounter a particular species than short tows.

Selecting Reference Boats for Standardized CPUE

If a given fishing boat undergoes modifications, such as installation of a new engine or use of a new trawl, then the fishing power of that boat is likely to change. As these changes occur throughout the fleet, overall catch rates may increase even though fish abundance is static or decreasing. Our method for avoiding this problem was to standardize catch rates relative to one or more fishing boats that appeared to have stable fishing power coefficients.

To examine the relative stability of each boat's fishing power we fit a model that contained a *Year·Boat* interaction term plus all the main factors (but not the Tow *Hours* variable). From the fit to this model for each state we extracted estimates of $Q'_{Year \cdot Boat}$, which we interpreted as year-specific fishing power coefficients. We used these coefficients to select for each species two or more boats whose fishing power coefficients were the most consistent through time, as gauged by the residual variation about linear trends in the coefficients. Our selections were also based on whether the boats made reasonable catches of the particular species, because we considered it inappropriate to apply boats that consistently made small catches as a standard. We subsequently used these reference boats to predict standardized catch rates (see below). In effect, we assumed that variation in average catch rates for these standard boats were due to changes in fish abundance rather than to changes in their fishing power.

The rationale for our approach to selecting the reference boats was based on the following arguments: (1) because the fish species under consideration were long-lived, changes in fish abundance were likely to occur gradually; (2) changes in the fishing power of individual boats were likely to occur abruptly when the fishing gear, engines, or electronics were replaced; (3) changes to an individual boat were more likely to result in increased rather than decreased fishing power; and (4) because boats were likely to undergo improvements independently of one another, changes in fishing power were unlikely to be synchronized among boats.

Estimating Standardized CPUE

In our stepwise analyses of influential factors we used a subset of the data to determine which factors and factor combinations were most influential in accounting for the variability in the observed data. From the results of those analyses we developed model structures for representing the catch rate information. However, because these models were based on a small amount of the available information, we presumed that more accurate estimates could be derived from fitting the models to more complete data sets. We attempted to apply the models to the full sets of the verified, adjusted, and screened data. These data sets contained information from hundreds of boats, most of which fished very sporadically. Given the computer memory and processing constraints of the machines available to us, it seemed infeasible to fit the models to the complete data sets. Instead, for each species we selected data from the 40 boats that landed the greatest amounts of each particular species during the study period, and then fit the statistical models to these data.

In addition, we limited our analyses at this step to data from areas that had been fished in during the entire study period. Many of the fishing areas for which logbook data were available were not fished in consistently during the study period. Unless we estimated catch rates for these areas using data from surrounding regions, these areas would not provide information that could be reliably incorporated into an index of stock abundance, such as effective CPUE. For example, suppose there was a certain region that produced high catch rates during one particular year, but which was not fished in during the other years. The overall catch rate for the particular year would be artificially inflated by including the catch and effort data from the particular region.

For the selected areas we used the parameter estimates from the fitted models to estimate annual area-specific catch rates (pounds per tow hour) for those boats that we had chosen as reference boats, and we treated these as our estimates of standardized CPUE. In any model with more than one factor variable, there is insufficient information to determine uniquely all the model parameters (Francis et al., 1993). To remove this fundamental indeterminacy GLIM sets one level from each factor to zero. For our analysis at this step we specified *Boat* codes for the reference boats so that GLIM set their parameter estimates to zero. The parameter estimates for one *Net* type (generic bottom trawl) and one *Bimonthly* period (January-February) were also set to zero. The value of the standardized CPUE for a given area and year represents the estimated average catch per hour by the standard boats fishing in that area with a bottom trawl during January or February of that particular year. For *Area* a and *Year* y we calculated it as

$$std\_CPUE_{a,y} = \hat{p}_{a,y} \cdot \hat{Y}_{a,y} \quad (10)$$

where

$$\hat{p}_{a,y} = 1 \,/\, [\, 1 + \exp(\, q\_Year_y + q\_Area_a \,)\,] \quad (11)$$

and

$$\hat{Y}_{a,y} = \exp(\, Q'\_Year_y + Q'\_Area_a \,) \cdot \exp(\, ½ \cdot Dev/df \,) \,. \quad (12)$$

Areas were defined according to the factors *Latitude* and *Depth*.

The last term of equation (12) is a correction for logarithmic transformation bias. The item "Dev" denotes the deviance statistic from fitting the model to the data and the item "df" denotes the corresponding residual degrees of freedom. Pennington (1983) suggests using a more precise bias correction, which he denotes by the function $G_n(t)$. In our applications the models had large numbers of degrees of freedom, so that the function $G_n(t)$ was well approximated by exp(t) (Gavaris, 1980).

Estimating Effective CPUE and Effective Effort

Because fish are not evenly distributed on the fishing grounds, the effectiveness of a unit of fishing effort depends on where it is applied. All else being equal, an hour of towing that occurs in an area with a high density of fish will result in a larger catch than one that occurs in an area with a low density of fish. This basic principle is behind the notion of effective catch-per-unit-effort and effective fishing effort (Beverton and Holt, 1957). We derived values for the effective CPUE from the sets of standardized CPUE estimates by calculating a weighted average of the area-specific values,

$$eff\_CPUE_y = \Sigma_a \,(\, W_a \cdot std\_CPUE_{a,y} \,) \,/\, \Sigma\, W_a \,. \quad (13)$$

In all our analyses the fishing areas, which were defined in terms of latitude and depth, were irregular in size and shape.

Ideally, the W_a values applied in equation (13) would be proportional to the size of each area so that the product of W_a with $std\_CPUE_{a,y}$ would accurately reflect the exploitable biomass in each area. Although we could have tried to determine the size of the fishing areas from charts or by using a geographic information system, the task would have been large and tedious. Instead, we used the verified logbook data to estimate the relative sizes of each 40 fathom depth category within standard rectangular blocks defined by 20 minutes of latitude and 10 minutes of longitude. The size of the standard blocks, which varied by latitude but not by longitude, were determined using the MapINFO geographic information system. For each category of latitude the W values for depth category d were calculated using

$$W_d = std\_Block \cdot \Sigma_b \ (N\_Tows_{d,b} \ / \ N\_Tows_b \ ) \ , \qquad (14)$$

where std_Block denotes the size of the standard block (square kilometers), $N\_Tows_{d,b}$ was the number of tows (across all years) from depth category d in standard block b, and N_Tows_b was the total number of tows (across all years) from standard block b. We excluded blocks if the total number of tows in a given block was less than 10, on the grounds that such rare tow locations probably represented information that had been incorrectly reported or keypunched.

We estimated the annual effective trawl fishing effort by the simple ratios of the total trawl landings over the estimated effective CPUE,

$$effective\_Effort_y = Landings_y \ / \ eff\_CPUE_y \ . \qquad (15)$$

The landings information was derived from simple tabulations of the fish ticket data, without regard to the (unknown) area of capture.

For the purpose of comparison, we also calculated a "raw" annual catch rate index for each species based on the raw effort and catch data from all the logbook and corresponding fish ticket data,

$$raw\_CPUE_y \ = \ \Sigma \ Landings_y \ / \ \Sigma \ Tow\_Hours_y \ . \qquad (16)$$

This index had no corrections for fishing power or area fished.

RESULTS

Logbooks with Consistent Information

In the logbook files for Oregon for 1987-93 there was information on a total of about 20,000 fishing trips, and the logbook data were matched with fish ticket data for all the trips (Table 3). (ODFW does not include data from a logbook in its files unless they can be matched with corresponding fish tickets.) On average there were 1.11 fish tickets per trip for those trips with logs matched to tickets. If this same ratio is applied to all the trawl fish tickets, including those without logbooks, it implies that the Oregon logbook files contained data for about 79% of all the trawl trips that landed in Oregon during the study period.

The ratios of trip hail weights over ticket landing weights were reasonably consistent from species to species (Figure 5). On average about 22 percent of trips either reported landings of a given species but no hails (zero hail-to-landing ratio), or hails but no landings (infinite hail-to-landing ratio) (Table 4). For the remainder of the trips the hail-to-landing ratios were asymmetrically distributed around a peak of about 0.9 (Figure 5) with relatively few trips with ratios in excess of 1.5, but substantially greater numbers of trips with ratios of 0.5 or less. For our catch rate analyses we decided to omit data from trips whose hail-to-landing ratios fell outside the range 0.6 to 1.1, which resulted in the exclusion for a given species of about 43% of the non-zero trips from Oregon on average.

Trips Uninfluenced by Trip Limits

The apparent influence of trip limits on the Oregon logbook data was quite variable during the years of the study. From 50-84 percent of the trips each year that landed widow rockfish were identified as being uninfluenced by trip limits (Table 5); from 46-76 percent of yellowtail rockfish trips, 68-93 percent of the sablefish trips, and 60-79 percent of the Pacific ocean perch trips each year seemed to be uninfluenced by trip limits. The trip limits on Sebastes complex, deepwater complex, and thornyheads, however, appeared to have relatively little influence on trips landing in Oregon.

Major Factors Influencing Catch Rates

In our stepwise analyses to determine which factors had the most influence on catch rates we found in general that removal of each main factor (*Year*, *Boat*, *Net*, *Latitude*, *Depth*, *Bimonth*) resulted in a statistically significant (P<1%) degradation in the fit to the data, but the factors differed substantially in their relative amounts of influence (Table 6). For example, with the logistic model for the probability of a non-zero catch of English sole, removal of any single factor produced a significant F statistic, but the factor *Boat* accounted for about 31% of the residual variation (as measured by the adjusted R^2 statistic) and the factor *Hours* accounted for only about 3%. In the logistic models, removal of the continuous variable *Hours* was generally of much less consequence than removal of any of the factor variables.

To examine the importance of interactions, such as year to year changes in catch rates by depth, pairwise combinations of each factor were added to the base models (Table 7). Some of the interaction effects were not statistically significant (P>5%) for a few species (e.g., the *Net·Bimonth* interaction for the logistic and lognormal models for the widow rockfish data.), but most of the two-factor interactions were statistically significant (P<1%). The adjusted R^2 statistics for the different interactions varied greatly, however, indicating that certain interactions would provide much greater explanatory power than others.

To achieve our objective of developing models for estimating catch rates we needed to select models that explained reasonable amounts of the variability in the data but were as simple as possible. To facilitate comparisons among the states (Oregon in this report, and California and Washington in the Saltonstall-Kennedy report) and among the different species, it seemed sensible that we apply models with similar structure (but possibly different parameter values) to all the data. To select these models we determined which factors were most influential across all states and species.

As measured by the adjusted R^2 statistics in the analyses of the logistic models with single factors (Table 6 in this report and in the Saltonstall-Kennedy report), *Depth* was the first or second most influential factor in 31 of the 35 different state-species combinations, and *Boat* was the first or second most influential factor in 30 combinations (Table 8 in this report and in the Saltonstall-Kennedy report). In the analyses of logistic models with pairwise interactions (Table 7 in this report and in the Saltonstall-Kennedy report), the *Year·Boat* interaction was the first or second most influential interaction for 29 of 35 combinations. In the analyses of the lognormal models, *Boat* was the first or second most influential factor in 32 of the 35 combinations, *Latitude* was the first or second most influential factor in 12 combinations, and *Depth* was the first or second most influential factor in 8 combinations. The *Year·Boat* interaction was the first or second most influential interaction for 29 of 35 combinations.

For all subsequent analyses of catch rates we used models with the factors *Year, Boat, Net, Latitude, Depth*, and *Bimonth* and the *Year·Boat* interaction.

Reference Boats for Standardizing CPUE

To estimate year-specific fishing power coefficients, $Q'_{Year\cdot Boat}$, we fit a logistic and a lognormal model to the data for each species, with each model containing all the main factors plus a *Year·Boat* interaction term. The coefficients estimated by this process (Table 9) measured on an annual basis the fishing power of each boat relative to one boat that was selected arbitrarily. For the Oregon data the reference boat was the one with federal documentation number 218272.

For many species there were inconsistent temporal trends among the boats in their relative fishing power coefficients, with some boats showing an increase and others a decrease (e.g., Figure 6). Some of the variability in the coefficients was no doubt due to random noise in the data, but the earlier stepwise analyses (above) for each species had demonstrated that for at least one of the boats there were statistically significant (P<1%) changes from year to year in fishing power. The boats that we selected as reference boats for estimating standardized CPUE had relatively low variability in fishing power, and similar averages and temporal trends (Table 9).

Standardized CPUE

We estimated standardized CPUE only for those areas in which there had been fishing during all years of the study. These standard areas were defined by combinations of the factors *Latitude* and *Depth*. From the Oregon data we analyzed information from a total of 85,731 tows that were distributed across 176 out of 240 possible areas (Table 10). In the raw data files, prior to validation and trip limit screening, there was information from a total of 167,803 tows (96% bottom tows and 4% midwater tows). For any given species, from 58-93% of the bottom tows were zero-catch tows from trips that were uninfluenced by trip limits or were from trips that had valid hail-to-landing ratios and were uninfluenced by trip limits.

Only data from the top 40 boats for a given species were used to estimate standardized CPUE. This procedure of limiting the data resulted in only modest data reductions. Landings taken from the standard fishing areas by the top 40 boats accounted for 73-97 percent of the total landings that we could have used to estimate standardized CPUE (Table 11). However, these landings by the top 40 boats were very small relative to the total landings reported in the fish ticket files, that is, we did not use large amounts of the available information. For example, the data used to estimate standardized CPUE for thornyheads accounted for only about 4% of the total landings of thornyheads and the data used to estimate standardized CPUE for widow rockfish accounted for only 6% of the widow rockfish landings, but the data used to estimate standardized CPUE for sanddab accounted for 46% of the sanddab landings. We excluded data for a given species because it came from: (a) areas that had not been fished in during all years of the study; (b) boats that were not amongst the top 40 producers; (c) trips with bad hail-to-landing ratios; (d) trips that had potentially been influenced by trip limits; (e) tows that were longer than four hours duration; or (f) tows made using midwater trawls.

The values for standardized CPUE in pounds per hour of towing were derived from estimated parameters for each species for levels of the factors *Year*, *Latitude*, and *Depth* (Table 12). The parameters values for the first levels of factors *Latitude*

(42.000 degrees) and *Depth* (20 fathoms) were set to zero by GLIM. For estimating standardized CPUE we set the parameter values for *Net* and *Bimonth* to zero (i.e., generic bottom trawl operated during January and February). Values for standardized CPUE by area (e.g., Table 13) were derived using equations (10), (11), and (12). For example, the probability of a non-zero catch of English sole in 1987 from the area associated with *Latitude* 42.500 and *Depth* 220 was estimated to be

$$1 / \{ 1 + \exp[-(-2.883+4.236-3.121)] \} = 0.146 ,$$

the average catch rate on non-zero tows was estimated to be

$$\exp(3.832+0.959-0.942 + \tfrac{1}{2}\cdot 23469.0/20314) = 83.6 \text{ lb/hr} ,$$

and the average catch rate for all tows was estimated to be

$$0.146 \cdot 83.6 = 12.2 \text{ lb/hr} .$$

Effective CPUE and Effective Effort

Weighted averages of the standardized CPUE values were developed to estimate the effective CPUE. The area-specific standardized CPUE values (e.g., Table 13) were multiplied times estimates of the surface area of each area (Table 14), then combined over geographic regions, and finally divided by the total surface area of the regions. We developed estimates of effective CPUE for each state (Figure 7)and by International North Pacific Fishery Commission (INPFC) statistical region (Table 14). The boundaries of the INPFC regions, which are based on latitude, did not exactly coincide with the latitudinal boundaries of our areas. We assigned areas between 40°20' and 43°00' to the Eureka region, areas between 43°00' and 47°20' to the Columbia region, and areas north of 47°20' to the Vancouver region.

The estimates of effective CPUE for the Oregon data indicated substantial declines for lingcod, miscellaneous rockfish, and sablefish, and moderate declines for petrale sole, Dover sole, and arrowtooth flounder. The estimates indicated increases for English sole, rex sole, widow rockfish, yellowtail rockfish, and thornyheads.

To derive estimates of the effective trawl fishing effort for each species we took the estimates of statewide effective CPUE for each species and divided them into the corresponding trawl landings reported in the fish ticket files (Table 16). This approach assumes that the estimates of effective CPUE are valid reflections of standardized catch rates, even for areas that produced landed catches but which were not included in the set of standard areas because they were not fished in during all years of the study period.

For the trips with logbooks and matching fish tickets the ratios of total landed catch divided by the total hours of trawling provided measures of average catch rates (Table 17) that were much simpler to calculate than the estimates of effective, standardized CPUE. However, for many species (e.g., petrale sole, lingcod, and widow rockfish) the absolute size of the raw CPUE was much lower than the effective CPUE (Figure 7). The raw effort data includes many hours of towing in areas of relatively low abundance. For several species (e.g., English sole, rex sole, and widow rockfish) the general trend indicated by the effective CPUE was contrary to the trend indicated by the raw CPUE.

DISCUSSION AND CONCLUSIONS

In traditional analyses of fishing power and standardized CPUE, the fishing power coefficients are estimated from ratios of catch rates relative to some standard class of boat and gear; catch rates are then standardized by dividing by the fishing power coefficients (e.g., Beverton and Holt, 1957). We could not use this approach in this study because we used the delta distribution to model catch rates and because there were large differences among boats in the probability of making non-zero catches. To help understand the problem, consider two boats (A and B) both fishing in the same place at the same time. The probabilities that the boats make non-zero catches are

$$p_A = 1 / [1 + \exp(\mu + q_A)]$$

and

$$p_B = 1 / [1 + \exp(\mu + q_B)] .$$

The coefficient μ represents the characteristics of the particular place and time. The ratio of the catch rates from the two boats is partially determined by the ratio of the probabilities that they make non-zero catches,

$$\frac{p_A}{p_B} = \frac{1 / [1 + \exp(\mu + q_A)]}{1 / [1 + \exp(\mu + q_B)]} .$$

It is impossible to remove μ from this ratio, which implies that the ratio (and hence the fishing power coefficients for the two boats) will change whenever μ changes (when the boats fish at different locations). To avoid this problem we directly estimated catch rates for the standard boats.

Because fishery logbook data are recorded by a wide variety of individual skippers, it seems unreasonable to expect that the information contained in the logbook databases would be absolutely consistent. Even the best scientists using the most rigorous methods are sometimes unable to reproduce the results of an experiment. We made considerable attempts to identify inconsistent data and exclude them from our analyses, but we do not guarantee that we were successful. We take some comfort, however, from the fact that many of the intermediate results from our analyses were consistent with our expectations and with the findings of other studies. For example, the changes in catch rates that were estimated to occur with depth and latitude seemed generally in keeping with catch rates reported from research trawl surveys (Jay, 1996). We did not, however, attempt to compare formally the results from our analyses with the corresponding trawl survey data. Starr and Fox (In press) in a study of Oregon trawl logbook data found good correspondence between the logbook data and trawl survey data with regard to locations that produced high and low catch rates of five species: Dover sole, English sole, sablefish, yellowtail rockfish, and thornyheads.

One major shortcoming of logbook data is the limited accuracy of the tow-by-tow estimates of retained catch. We found that skippers in general seemed to underestimate their retained catches (e.g., Figure 5). The distributions of hail-to-landing ratios were very similar from year to year and among the species, and the distributions we obtained with the Oregon data were comparable to those we obtained in the Saltonstall-Kennedy project with the California and Washington data.

Our choice of a range for valid hail-to-landing ratios was arbitrary. By limiting the ratios to the range 0.6 to 1.1 we may have needlessly excluded usable information. It would be instructive to repeat the GLIM analyses with data that had been screened more liberally. Comparisons of the results from the two sets of analyses would indicate whether the results were sensitive to the accuracy with which skippers hailed their retained catches. If the skippers were consistent in the degree to which they underestimated (or overestimated) their catches, then the procedure of dividing the hails by the hail-to-landing ratios would have produced reasonable estimates of retained catch, even for hail-to-landing ratios that differed markedly from one.

Also, we arbitrarily chose a cutoff to identify trips that were uninfluenced by trip limits. Based on the observed frequency distributions of trip-by-trip landings (e.g., Figure 8), the 90% cutoff that we used appears to be a reasonable one for removing trips that may have been influenced by trips limits. In general, trips that caught just under the trip limits occurred with high frequency relative to smaller landings. However, this apparent ability to accurately target a trip limit seems inconsistent with our finding that hail-to-landing ratios were highly variable and that skippers generally tended to underestimate their retained catch. Another feature in some of the trip frequency tabulations was an apparent disregard (or ignorance) of the trip limits. For example, there was a 30,000 pound weekly trip limit for widow rockfish at the start of 1989, which was reduced to 10,000 pounds per week as of April 26th (Table 2), but during the later period there were unusually high numbers of 20,000 pound landings (Figure 8), which suggests that these fishers were behaving as if a 20,000 pound per week limit had been in effect.

It would be instructive to repeat the GLIM analyses using data only from those trips that had apparently been influenced by trip limits. All else being equal, the average catch rates from these trips should, in theory, be less than the average catch rates from the trips that had not been influenced by trip limits, with the differences in catch rates being a measure of the amount of discarding due to trip limits.

We also made arbitrary decisions in the way we grouped the data with respect to fishing locations and time of year. Our method for classifying the data, by 20 minutes of latitude and 40 fathom depth intervals and two month periods, assumed that catch rates were homogeneous at this scale of resolution. If we had conducted a nested series of analyses, with data aggregated at different levels (e.g., 40 minutes versus 20 minutes versus 10 minutes of latitude) it might have been possible to objectively determine an appropriate scale of resolution. Such techniques are sometimes used in ecological field studies to select the size of sampling quadrats (Mead, 1974).

With respect to the information on fishing locations, we were hampered by the lack of data on ending tow locations in the logbook data files. We felt obliged to exclude from our analyses data from long tows because of our ignorance of which areas had actually been covered by these tows. A boat that towed due north for twelve hours might experience very different catch rates than an identical boat that towed due south for twelve hours, even though both boats started from the exact same location. The same problem exists for shorter tows, but the differences in catch rates from short tows are likely to be less extreme. It would have greatly facilitated the process of classifying the tow locations if data had been available for the starting and ending tow locations, and for the starting and ending depths. Although all these items were generally reported in the logbooks, they were not all keypunched and entered into the logbook data files.

It is likely that some of the tows recorded in the Oregon logbook data occurred over a wide range of depths and thus were mis-classified with respect to the factor *Depth*, which was based solely on the starting depth. As a consequence, the estimated depth-specific catch rates may have been artificially smoothed by tows that covered wide depth ranges. In the Saltonstall-Kennedy project we were able to conduct exploratory tabulations of starting and ending tow depths recorded in the Washington data. The tabulations indicated that about 84% of the tows had starting and ending depths that differed by less than 20 fathoms.

Relatively large proportions of the tows in the Oregon data from the later years of the study were excluded from the GLIM analyses because they were longer than four hours duration

(Figure 4). It is likely that many of these tows occurred in deep water and caught species from the deepwater complex. The exclusion of these tows may be the reason why the raw CPUE values were greater than the effective CPUE values for thornyheads, sablefish, Dover sole, and arrowtooth flounder (Figure 7).

In the stepwise analyses with GLIM the interaction terms *Year·Latitude* and *Year·Depth* were relatively small in general, which suggests that there were no large annual changes during the study period in the spatial distributions of the particular species examined. Similarly, the relative unimportance of the interaction terms *Latitude·Bimonth* and *Depth·Bimonth* suggests that seasonal changes in fish distribution were weak also.

Because logbooks contain information about retained catch but not discarded catch, catch rates derived from logbooks can be influenced by changing market conditions, particularly for species with limited markets and low prices. For example, the erratic pattern in the effective CPUE series for sanddab could be due to variable retention of this species, rather than to a sudden changes in its abundance.

To some unknown degree our estimates of effective CPUE were determined by the boats we chose to use as the standard reference boats. It would instructive to generate sets of effective CPUE estimates based on random selections of reference boats. Such an analysis would demonstrate whether the effective CPUE estimates were robust to the choice of standard boats.

For estimating effective CPUE we chose to exclude areas that were not fished in every year rather than trying to estimate standardized CPUE for missing year-area combinations. It is possible that the trends in catch rates from the sampled areas are not representative of trends from the unsampled areas. One could use the models and parameter values developed in this study to predict catch rates for the areas that were not fished in every year. The predicted values could be compared with the data available for these areas to test the validity of extrapolating into these missing year-area combinations.

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Table 1. Retained catches reported in Oregon logbooks.

Species	1987	1988	1989	1990	1991	1992	1993
	Reported catch in 1000s of pounds.						
Arrowtooth flounder	843.8	712.4	1418.8	3038.7	3571.0	3070.6	2900.1
Butter sole	7.9	0.9	0.7		1.2	0.1	0.2
Curlfin sole	3.9	3.9	3.1	0.1	0.8	0.1	0.7
Sanddab	341.4	112.5	143.2	284.4	433.6	423.8	403.2
Dover sole	8798.1	12518.1	14991.0	13063.6	15340.8	9916.5	11687.3
English sole	874.8	813.3	1096.1	794.2	1454.2	960.3	1194.3
Lingcod	737.8	1287.0	1493.0	1119.1	2284.9	734.2	1234.1
Miscellaneous flatfish	1.6	11.7	2.5	20.8	12.7	16.5	6.1
Miscellaneous rockfish	4272.4	5522.7	6535.1	3919.2	4982.9	3706.3	4301.3
Pacific cod	780.6	1456.8	1246.6	328.9	904.8	710.1	784.0
Petrale sole	1287.7	1308.5	1401.1	1232.2	1503.1	1194.8	1389.5
Pacific ocean perch	696.8	1002.7	1237.8	847.0	1346.6	948.9	1193.0
Rex sole	396.2	415.2	398.2	319.5	705.4	510.9	381.7
Rock sole	1.6	5.5	4.2	3.7	2.5	0.5	2.1
Shark	7.1	0.6	1.4	3.5	1.4	21.1	58.8
Sablefish	3176.1	3031.0	3670.3	3676.0	3834.8	3658.4	4117.9
Skate	10.1		2.6	0.2		0.5	0.8
Small rockfish	1064.4	1785.1	1802.9	1911.4	1975.7	1216.0	3172.8
Sand sole	422.8	292.1	391.0	397.3	531.8	308.4	392.9
Starry flounder	149.0	251.7	363.3	139.5	593.8	127.6	134.0
Thornyhead rockfish	736.2	1323.9	3542.6	6674.7	5455.8	6643.0	7708.5
Whiting (Pacific hake)	284.6	310.9	126.4	3777.0	25515.3	98522.8	76199.3
Widow rockfish	10721.0	8247.2	10800.4	8541.4	5713.3	5226.6	8220.2
Yellowtail rockfish	2796.4	3484.2	2683.2	2581.6	2681.7	4793.1	3746.9
Total	38412	43898	53356	52674	78848	142711	129230

Table 2. Pacific Fishery Management Council groundfish trips limits.

Year	Widow Rk.	Sebastes	Yellowtail Rk	Sablefish [1]	Pac. Oc. Perc	Deepwater	Bocaccio	Thornyheads
1987	1/1: 30000 lb / week. Only 1 landing per week of more than 3000 lb.	1/1: N of Coos Bay, 25000 lb / week, 50000 biweekly, or 12500 lb twice a week. Landings under 3000 lb unrestricted. S of Coos Bay, 40000 lb/trip.	1/1: N of Coos Bay, 10000 lb / week, 20000 biweekly, or 5000 lb twice a week. Landings under 3000 lb unrestricted.	1/1: 5000 lb / trip of small fish.	1/1: Min of 5000 lb or 20% of fish on board. Landings under 1000 lb unrestricted, regardless of percentage.			
	5/3: Fishing week changed from Sunday through Saturday to Wednesday through Tuesday.	5/3: Fishing week changed from Sunday through Saturday to Wednesday through Tuesday.	5/3: Fishing week changed from Sunday through Saturday to Wednesday through Tuesday.	10/2: Max of 6000 lb or 20% of fish on board, including no more than 5000 lbs of small fish.				
	11/25: Fishery closed.		7/22: N of Coos Bay, 7500 lb/week, 15000 lb bi-weekly, or 3750 lb twice a week.	10/22: Fishery closed.				

Table 2. Pacific Fishery Management Council groundfish trips limits (continued).

Year	Widow Rk.	Sebastes	Yellowtail Rk	Sablefish [1]	Pac. Oc. Perc	Deepwater	Bocaccio	Thornyheads
1988	1/1: 30000 lb / week. Only 1 landing per week of more than 3000 lb. Landings under 3000 lb unrestricted.	1/1: N of Coos Bay, 25000 lb/week, 50000 bi-weekly, or 12500 lb twice a week. Landings under 3000 lb unrestricted. S of Coos Bay, 40000 lb/trip.	1/1: N of Coos Bay, 10000 lb / week, 20000 biweekly, or 5000 lb twice a week. Landings under 3000 lb unrestricted.	1/1: Max of 6000 lbs or 20% of fish on board. Only 2 landings / week over 1000 lb. Landings under 1000 lb unrestricted, regardless of percentage. Limit of 5000 lb/trip of small fish.	1/1: Min of 5000 lb or 20% of fish on board. Landings under 1000 lb unrestricted, regardless of percentage.			
	9/21: 3000 lb / trip		10/5: N of Coos Bay, 7500 lb / week. Bi-weekly and twice weekly options remain in effect (at reduced rates).	8/3: Only 1 landing / week, not to exceed 2000 lb, regardless of percentage.				
				10/5: Removed 1 landing / week restriction, but 2000 lb limit still in effect.				

Table 2. Pacific Fishery Management Council groundfish trips limits (continued).

Year	Widow Rk.	Sebastes	Yellowtail Rk	Sablefish [1]	Pac. Oc. Perc	Deepwater	Bocaccio	Thornyheads
1989	1/1: 30000 lb / week. Only 1 landing per week of more than 3000 lb. Landings under 3000 lb unrestricted. 4/26: 10000 lb / week. 10/11: 3000 lb/trip. No restriction on frequency of landings.	1/1: N of Coos Bay, 25000 lb / week, 50000 biweekly, or 12500 lb twice a week. Landings under 3000 lb unrestricted. S of Coos Bay, 40000 lb/trip.	1/1: N of Coos Bay, 7500 lb / week, 15000 lb biweekly, or 3750 lb twice a week. Landings under 3000 lb unrestricted. 7/26: Max of 3000 lb/trip or 20% of Sebastes complex.	1/1: Max of 1000 lb/trip or 45% of deepwater complex. Limit of 5000 lb/trip of small fish. 4/26: One landing per week with max of 1000 lb or 25% of deepwater complex. Limit of 5000 lb/landing of small fish. Biweekly and twice weekly options available. 10/4: max of 1000 lb or 25% of deepwater complex.	1/1: Min of 5000 lb or 20% of fish on board. Landings under 1000 lb unrestricted, regardless of percentage. 7/26: Min of 2000 lb or 20% of fish on board. No restrictions on trip frequency. Landings under 1000 lb unrestricted, regardless of percentage. 12/13: Fishery closed in Columbia area.	4/26: defined as sablefish, Dover sole, arrowtooth flounder, and thornyheads. 1 landing/week over 4000 lb, not to exceed 30000 lb. Landings under 4000 lb unrestricted. Biweekly and twice weekly options available. 10/4: Removed poundage and trip frequency limits.		

Table 2. **Pacific Fishery Management Council groundfish trips limits (continued).**

Year	Widow Rk.	Sebastes	Yellowtail Rk	Sablefish [1]	Pac. Oc. Perc	Deepwater	Bocaccio	Thornyheads
1990	1/1: 15000 lb / week, 25000 lb per two weeks. Landings under 3000 lb not restricted.	1/1: N of Coos Bay, 25000 lb / week, 50000 lb biweekly, or 12500 lb twice a week. Landings under 3000 lb unrestricted. S of Coos Bay, 40000 lb / trip.	1/1: N of Coos Bay, 7500 lb/week, 15000 lb biweekly, or 3750 lb twice a week. Landings under 3000 lb unrestricted.	1/1: One landing per week with max of 1000 lb or 25% of deepwater complex. Limit of 5000 lb/landing of small fish. Biweekly and twice weekly options available.	1/1: Min of 3000 lb or 20% of fish on board. Landings under 1000 lb unrestricted, regardless of percentage.	1/1: No restrictions.		
	12/12: Fishery closed.		7/25: N of Coos Bay, max of 3000 lb / week or 20% of Sebastes complex. Biweekly and twice weekly options remain in effect.	10/3: max of 1000 lb or 25% of deepwater complex.		10/3: 15000 lb/trip. Only 1 landing / week over 1000 lb. Biweekly and twice weekly options available.		

Table 2. Pacific Fishery Management Council groundfish trips limits (continued).

Year	Widow Rk.	Sebastes	Yellowtail Rk	Sablefish [1]	Pac. Oc. Perc	Deepwater	Bocaccio	Thornyheads
1991	1/1: 10000 lb / week, only 1 landing / week over 3000 lb, or 20000 lb biweekly with 1 landing in that 2 week period over 3000 lb. Landings under 3000 lb unrestricted.	1/1: N of Coos Bay, 25000 lb / week, 50000 lb biweekly, or 12500 lb twice a week. Landings under 3000 lb unrestricted. S of Coos Bay, 25000 lb / trip.	1/1: N of Coos Bay, 5000 lb/week, 10000 lb biweekly, or 3000 lb twice a week. Landings under 3000 lb unrestricted.	1/1: One landing per week with max of 1000 lb or 25% of deepwater complex. Limit of 5000 lb/landing of small fish. Biweekly and twice weekly options available.	1/1: Min of 3000 lb or 20% of fish on board. Landings under 1000 lb unrestricted, regardless of percentage.	1/1: 27500 lb/week. Only 1 landing / week over 4000 lb. Biweekly and twice weekly options available. Landings under 4000 lb unrestricted.	1/1: S of Coos Bay, 5000 lb/trip. No trip frequency restriction.	1/1: 7500 lb/week. Biweekly and twice weekly options available. Landings under 4000 lb unrestricted.
	9/25: 3000 lb / trip. No restriction on landing frequency.		4/24: N of Coos Bay, 5000 lb once per 2 weeks.					7/31: 12500 lb/week. Biweekly and twice weekly options available.

Table 2. Pacific Fishery Management Council groundfish trips limits (continued).

Year	Widow Rk.	Sebastes	Yellowtail Rk	Sablefish [1]	Pac. Oc. Perc	Deepwater	Bocaccio	Thornyheads
1992	1/1: 30000 lb cumulative per 4 week period.	1/1: 50000 lb cumulative per 2 week period.	1/1: N of C. Lookout, 8000 lb cumulative per 2 week period.	1/1: Max of 25% of deepwater complex or 1000 lb per landing. Limit of 5000 lb/landing of small fish.	1/1: Min of 3000 lb or 20% of fish on board. Landings under 1000 lb unrestricted, regardless of percentage.	1/1: 55000 lb cumulative per 2 week period.	1/1: S of C. Mendocino, 10000 lb cumulative per 2 week period.	1/1: 25000 lb cumulative per 2 week period.
	8/12: 3000 lb / trip. No restriction on frequency of landings.		7/29: N of Coos Bay, 6000 lb cumulative per 2 week period.			10/7: 50000 lb cumulative per 2 week period.		7/29: 20000 lb cumulative per 2 week period.
	12/2: 30000 lb cumulative per 4 week period.							10/7: 15000 lb cumulative per 2 week period.

Table 2. Pacific Fishery Management Council groundfish trips limits (continued).

Year	Widow Rk.	Sebastes	Yellowtail Rk	Sablefish [1]	Pac. Oc. Perc	Deepwater	Bocaccio	Thornyheads
1993	1/1: 30000 lb cumulative per 4 week period.	1/1: 50000 lb cumulative per 2 week period.	1/1: N of Coos Bay, 8000 lb cumulative per 2 week period.	1/1: Max of 25% of deepwater complex or 1000 lb per landing. Limit of 5000 lb/landing of small fish.	1/1: Min of 3000 lb or 20% of fish on board. Landings under 1000 lb unrestricted, regardless of percentage.	1/1: 45000 lb cumulative per 2 week period.	1/1: S of C. Mendocino, 10000 lb cumulative per 2 week period.	1/1: 20000 lb cumulative per 2 week period.
	12/1: 3000 lb / trip. No restriction on frequency of landings.		4/21: N of Coos Bay, 6000 lb cumulative per 2 week period.	9/8: Max of 1000 lb per landing or 25% of deepwater complex, not to exceed 3000 lb per landing.		4/21: 60000 lb cumulative per 4 week period.	10/6: S of C. Mendocino, 15000 lb cumulative per 2 week period.	4/21: 35000 lb cumulative per 4 week period.
				12/1: 1000 lb / trip. One landing / wk.		12/1: 5000 lb / trip. One landing / wk.		

[1] Sablefish restrictions based on size were not applied in this project.

Table 3. Results from algorithm to match logbooks with fish tickets.

Information Source Oregon	No. of Items 1987	1988	1989	1990	1991	1992	1993	Total
Logbook Trips	2107	2404	2641	2454	3287	3581	3565	20039
Fish Ticket Deliveries	3138	3561	3797	3639	4610	4835	4707	28287
Log Trips w Tickets	2107	2395	2633	2451	3285	3580	3565	20016
Logs without Tickets	0%	0%	0%	0%	0%	0%	0%	0%
Tickets without Logs	23%	24%	23%	23%	21%	21%	17%	21%

Table 4. Summary of hail to landing ratios.

Oregon	1987	1988	1989	1990	1991	1992	1993	Total
A. No. of Trips with Hail / Landing Ratio in (0.6 - 1.1).								
Arrowtooth Flounder	251	285	412	546	700	533	561	3288
Dover Sole	1078	1333	1497	1463	1901	1533	1883	10688
English Sole	661	696	752	645	1023	789	1055	5621
Petrale Sole	676	749	828	786	1035	814	1006	5894
Rex Sole	419	432	476	418	631	440	606	3422
Sand Dab	251	163	171	229	340	221	200	1575
Misc. Rockfish	634	822	906	756	1002	792	1017	5929
Small Rockfish	220	303	381	458	567	379	768	3076
Pac. Ocean Perch	179	263	350	326	486	401	527	2532
Thornyheads	269	537	791	1064	1331	1133	1464	6589
Widow Rockfish	454	505	617	665	681	641	860	4423
Yellowtail Rockfish	298	446	462	534	740	707	855	4042
Lingcod	462	625	787	784	997	742	947	5344
Pacific Cod	409	562	501	389	686	528	629	3704
Sablefish	667	990	1049	1135	1442	1290	1643	8216
B. Total Number of Trips (with Hails or Landings).								
Arrowtooth Flounder	589	765	949	977	1330	1078	1315	7003
Dover Sole	1528	1900	2112	1981	2530	2073	2509	14633
English Sole	1239	1481	1564	1257	1821	1587	2056	11005
Petrale Sole	1351	1621	1814	1494	1968	1589	2075	11912
Rex Sole	930	1024	1129	896	1239	1037	1501	7756
Sand Dab	413	290	321	344	489	340	314	2511
Misc. Rockfish	1374	1767	1963	1567	2127	2041	2458	13297
Small Rockfish	585	775	897	969	1161	904	1592	6883
Pac. Ocean Perch	344	533	629	588	877	726	971	4668
Thornyheads	750	1181	1481	1571	1968	1671	2130	10752
Widow Rockfish	594	712	889	938	1095	1190	1718	7136
Yellowtail Rockfish	459	704	815	796	1140	1307	1814	7035
Lingcod	1242	1568	1807	1562	1992	1614	2085	11870
Pacific Cod	1029	1361	1153	784	1292	1103	1362	8084
Sablefish	1203	1746	1886	1802	2241	2170	2705	13753

Table 4. Summary of hail to landing ratios (continued).

Oregon	1987	1988	1989	1990	1991	1992	1993	Total
C. Number of Trips with Landings but No Hails								
Arrowtooth Flounder	173	294	283	176	306	338	466	2036
Dover Sole	119	132	104	70	88	127	133	773
English Sole	241	395	358	280	331	422	510	2537
Petrale Sole	287	409	384	258	360	376	527	2601
Rex Sole	239	309	324	224	280	384	549	2309
Sand Dab	65	60	63	52	70	52	60	422
Misc. Rockfish	224	311	294	282	381	673	761	2926
Small Rockfish	214	284	302	241	258	292	417	2008
Pac. Ocean Perch	36	51	43	38	54	93	163	478
Thornyheads	151	184	180	86	107	138	192	1038
Widow Rockfish	34	67	86	76	133	310	545	1251
Yellowtail Rockfish	69	118	178	100	174	409	724	1772
Lingcod	359	396	416	297	395	383	496	2742
Pacific Cod	346	495	360	211	255	342	426	2435
Sablefish	182	244	219	131	120	365	433	1694
D. Number of Trips with Hails but No Landings								
Arrowtooth Flounder	17	8	10	13	11	6	5	70
Dover Sole	21	33	27	26	25	17	18	167
English Sole	59	69	47	37	48	27	18	305
Petrale Sole	27	45	47	46	57	34	22	278
Rex Sole	55	47	51	36	30	13	8	240
Sand Dab	12	9	8	11	12	5	4	61
Misc. Rockfish	70	92	67	45	33	24	23	354
Small Rockfish	5	26	24	6	8	5	20	94
Pac. Ocean Perch	40	83	79	39	38	24	29	332
Thornyheads	73	83	63	24	19	12	7	281
Widow Rockfish	27	32	30	21	25	10	15	160
Yellowtail Rockfish	15	37	20	12	8	4	4	100
Lingcod	101	85	64	37	64	26	18	395
Pacific Cod	25	20	7	6	19	6	2	85
Sablefish	16	20	19	17	12	2	2	88

Table 5. Trips not influenced by trip limits.

Oregon	1987	1988	1989	1990	1991	1992	1993	Total
Total no. trips with Logbooks and Tickets	2107	2395	2633	2451	3285	3580	3565	20016
No. trips by species, with landings greater than zero:								
Widow Rockfish	574	684	869	925	1077	1192	1727	7048
Sebastes Complex	1668	2044	2209	1950	2572	2533	3072	16048
Yellowtail Rockfish	452	675	795	791	1141	1312	1850	7016
Sablefish	1191	1735	1869	1797	2234	2177	2713	13716
Pac. Ocean Perch	306	457	551	552	845	704	944	4359
Deepwater Complex	1599	2005	2180	2066	2590	2388	2885	15713
Thornyheads	681	1108	1420	1559	1951	1664	2126	10509
Percent of trips uninfluenced by trip limits:								
Widow Rockfish	50%	69%	57%	60%	69%	82%	84%	71%
Sebastes Complex	91%	89%	91%	92%	95%	98%	99%	94%
Yellowtail Rockfish	63%	67%	66%	67%	46%	68%	76%	66%
Sablefish	93%	85%	78%	73%	68%	72%	75%	76%
Pac. Ocean Perch	79%	79%	60%	76%	71%	78%	79%	75%
Deepwater Complex	100%	100%	92%	92%	83%	97%	93%	93%
Thornyheads	100%	100%	100%	100%	82%	95%	95%	95%

Table 6. Analysis of influential factors. Analysis of deviance for stepwise removal of factors from the base models with discrete factors *YEAR, BOAT, NET, LATITUDE, DEPTH,* and *BIMONTH,* and continuous variable Tow *HOURS in the* logistic models. The first line for each species shows the base results.

	Logistic models.							**Lognormal models.**						
Sp./Model	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank
English	6879.2	3723						11565.8	9927					
YEAR	7117.0	3729	6	21.4	1.00	3.2	6	11602.8	9933	6	5.3	1.00	0.3	5
BOAT	10051.2	3751	28	61.3	1.00	31.0	1	14505.5	9954	27	93.5	1.00	20.0	1
NET	7240.3	3725	2	97.7	1.00	4.9	4	11573.1	9929	2	3.1	0.96	0.0	6
LATITUDE	7579.0	3738	15	25.2	1.00	8.9	3	13072.5	9942	15	86.2	1.00	11.4	2
DEPTH	7705.7	3729	6	74.5	1.00	10.6	2	11816.4	9933	6	35.8	1.00	2.1	4
BIMONTH	7242.2	3728	5	39.3	1.00	4.9	5	11936.0	9932	5	63.5	1.00	3.1	3
HOURS	6993.9	3724	1	62.1	1.00	1.6	7							
none	18920.9	3786	63	103.4	1.00	63.0		17514.7	9988	61	83.7	1.00	33.6	
Petrale	7406.5	3523						7132.0	7725					
YEAR	7456.6	3529	6	4.0	1.00	0.5	6	7474.8	7731	6	61.9	1.00	4.5	3
BOAT	10405.5	3551	28	50.9	1.00	28.3	1	8124.9	7753	28	38.4	1.00	11.9	1
NET	7765.1	3525	2	85.3	1.00	4.6	3	7136.6	7727	2	2.5	0.92	0.0	6
LATITUDE	7608.0	3538	15	6.4	1.00	2.2	4	7431.1	7740	15	21.6	1.00	3.8	4
DEPTH	9805.7	3529	6	190.2	1.00	24.3	2	7809.3	7731	6	122.3	1.00	8.6	2
BIMONTH	7561.0	3528	5	14.7	1.00	1.9	5	7283.6	7730	5	32.8	1.00	2.0	5
HOURS	7406.8	3524	1	0.2	0.31	-0.0	7							
none	16774.8	3586	63	70.7	1.00	55.1		10410.4	7787	62	57.3	1.00	30.9	
Rex	7443.8	3634						5446.4	5814					
YEAR	7555.8	3640	6	9.1	1.00	1.3	5	5556.0	5820	6	19.5	1.00	1.9	5
BOAT	10449.3	3662	28	52.4	1.00	28.2	1	8260.6	5839	25	120.2	1.00	33.8	1
NET	7771.4	3636	2	80.0	1.00	4.2	3	5482.4	5816	2	19.2	1.00	0.6	6
LATITUDE	7845.0	3649	15	13.1	1.00	4.7	2	5774.4	5829	15	23.3	1.00	5.4	3
DEPTH	7606.3	3640	6	13.2	1.00	2.0	4	6042.0	5820	6	106.0	1.00	9.8	2
BIMONTH	7541.7	3639	5	9.6	1.00	1.2	6	5652.5	5819	5	44.0	1.00	3.6	4
HOURS	7528.4	3635	1	41.3	1.00	1.1	7							
none	16228.8	3697	63	68.1	1.00	53.3		12490.3	5873	59	127.4	1.00	56.0	
Sanddab	4174.6	4424						2975.9	2659					
YEAR	4329.8	4430	6	27.4	1.00	3.5	5	3018.3	2665	6	6.3	1.00	1.2	3
BOAT	5958.1	4452	28	67.5	1.00	29.5	1	4009.5	2677	18	51.3	1.00	25.3	1
NET	4200.2	4426	2	13.6	1.00	0.6	7	2977.0	2661	2	0.5	0.39	-0.0	6
LATITUDE	4404.9	4439	15	16.3	1.00	4.9	4	3246.6	2672	13	18.6	1.00	7.9	2
DEPTH	4558.7	4430	6	67.8	1.00	8.3	3	2983.0	2661	2	3.2	0.96	0.2	5
BIMONTH	4918.4	4429	5	157.7	1.00	15.0	2	3009.9	2664	5	6.1	1.00	0.9	4
HOURS	4313.1	4425	1	146.7	1.00	3.2	6							
none	11822.9	4487	63	128.7	1.00	64.2		5678.6	2705	46	52.5	1.00	46.7	
Lingcod	6677.0	3285						7698.4	5436					
YEAR	6767.8	3291	6	7.4	1.00	1.2	4	7899.7	5442	6	23.7	1.00	2.4	3
BOAT	7841.4	3313	28	20.5	1.00	14.1	2	10438.3	5464	28	69.1	1.00	25.9	1
NET	6677.7	3287	2	0.2	0.15	-0.1	7	7706.3	5438	2	2.8	0.94	0.1	5
LATITUDE	7029.2	3300	15	11.5	1.00	4.6	3	8163.0	5451	15	21.9	1.00	5.4	2
DEPTH	7982.8	3291	6	107.1	1.00	16.2	1	7804.5	5441	5	15.0	1.00	1.3	4
BIMONTH	6707.2	3290	5	3.0	0.99	0.3	6	7710.3	5441	5	1.7	0.86	0.1	6
HOURS	6738.7	3286	1	30.3	1.00	0.9	5							
none	12330.0	3348	63	44.1	1.00	44.8		13253.0	5497	61	64.3	1.00	41.3	

Table 6. Analysis of influential factors (continued).

	Logistic models.							Lognormal models.						
Sp./Model	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank
Pac. cod	6757.4	3701						6405.0	4645					
YEAR	7375.9	3707	6	56.5	1.00	8.2	3	7195.6	4651	6	95.6	1.00	10.9	2
BOAT	7408.8	3729	28	12.7	1.00	8.1	4	7321.9	4671	26	25.6	1.00	12.0	1
NET	6776.5	3703	2	5.2	1.00	0.2	6	6421.0	4647	2	5.8	1.00	0.2	6
LATITUDE	7551.9	3716	15	29.0	1.00	10.2	2	6654.4	4660	15	12.1	1.00	3.4	3
DEPTH	8159.2	3707	6	128.0	1.00	17.0	1	6540.6	4649	4	24.6	1.00	2.0	5
BIMONTH	7041.9	3706	5	31.2	1.00	3.9	5	6566.9	4650	5	23.5	1.00	2.4	4
HOURS	6758.6	3702	1	0.7	0.58	-0.0	7							
none	13295.4	3764	63	56.8	1.00	48.3		9103.4	4703	58	33.7	1.00	28.8	
Widow	2454.7	3873						2499.3	1166					
YEAR	2805.0	3879	6	92.1	1.00	12.4	2	2562.2	1172	6	4.9	1.00	2.0	2
BOAT	3521.8	3901	28	60.1	1.00	29.8	1	3003.4	1183	17	13.8	1.00	15.6	1
NET	2558.8	3875	2	82.1	1.00	4.0	5	2535.4	1168	2	8.4	1.00	1.3	3
LATITUDE	2607.6	3888	15	16.1	1.00	5.5	4	2522.5	1180	14	0.8	0.30	-0.3	6
DEPTH	2615.5	3879	6	42.3	1.00	6.0	3	2519.8	1170	4	2.4	0.95	0.5	5
BIMONTH	2465.3	3878	5	3.3	1.00	0.3	7	2539.9	1171	5	3.8	1.00	1.2	4
HOURS	2468.3	3874	1	21.4	1.00	0.5	6							
none	7240.5	3936	63	119.9	1.00	65.5		3870.1	1214	48	13.3	1.00	32.8	
Small Rock	3993.0	3960						2483.0	1719					
YEAR	4223.0	3966	6	38.0	1.00	5.3	4	2594.8	1725	6	12.9	1.00	4.0	2
BOAT	5538.1	3988	28	54.7	1.00	27.4	1	3195.5	1743	24	20.6	1.00	21.2	1
NET	3996.0	3962	2	1.4	0.76	0.0	6	2553.3	1721	2	24.3	1.00	2.6	3
LATITUDE	4248.6	3975	15	16.9	1.00	5.7	3	2551.7	1733	14	3.4	1.00	1.9	5
DEPTH	4456.4	3966	6	76.6	1.00	10.3	2	2542.5	1724	5	8.2	1.00	2.1	4
BIMONTH	4018.7	3965	5	5.1	1.00	0.5	5	2500.8	1724	5	2.5	0.97	0.4	6
HOURS	3993.1	3961	1	0.0	0.14	-0.0	7							
none	9834.4	4023	63	92.0	1.00	58.8		4595.0	1775	56	26.1	1.00	44.2	
Misc. Rock	7147.4	3261						9095.2	5319					
YEAR	7224.7	3267	6	5.9	1.00	0.9	5	9492.3	5325	6	38.7	1.00	4.1	2
BOAT	9646.0	3289	28	40.7	1.00	25.3	1	13354.0	5347	28	88.9	1.00	31.5	1
NET	7158.2	3263	2	2.5	0.91	0.1	7	9212.5	5321	2	34.3	1.00	1.2	5
LATITUDE	7277.3	3276	15	4.0	1.00	1.3	3	9262.9	5334	15	6.5	1.00	1.5	4
DEPTH	7684.3	3267	6	40.8	1.00	6.8	2	9262.6	5325	6	16.3	1.00	1.7	3
BIMONTH	7230.6	3266	5	7.6	1.00	1.0	4	9164.5	5324	5	8.1	1.00	0.7	6
HOURS	7207.2	3262	1	27.3	1.00	0.8	6							
none	12876.6	3324	63	41.5	1.00	43.4		17755.9	5381	62	81.7	1.00	48.2	
Yellowtail	3062.1	3625						2137.8	1206					
YEAR	3438.5	3631	6	74.3	1.00	10.8	3	2159.7	1212	6	2.1	0.95	0.5	5
BOAT	3984.7	3653	28	39.0	1.00	22.6	1	2736.8	1229	23	14.7	1.00	20.4	1
NET	3215.9	3627	2	91.1	1.00	4.7	4	2222.9	1208	2	24.0	1.00	3.7	2
LATITUDE	3172.3	3640	15	8.7	1.00	3.1	5	2190.1	1220	14	2.1	0.99	1.3	4
DEPTH	3514.7	3631	6	89.3	1.00	12.7	2	2153.4	1210	4	2.2	0.93	0.4	6
BIMONTH	3109.9	3630	5	11.3	1.00	1.4	7	2187.0	1211	5	5.6	1.00	1.8	3
HOURS	3120.9	3626	1	69.7	1.00	1.9	6							
none	7252.5	3688	63	78.7	1.00	57.0		4236.8	1260	54	21.9	1.00	47.3	

Table 6. Analysis of influential factors (continued).

	Logistic models.							Lognormal models.						
Sp./Model	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank
P.O.Perch	944.6	3900						310.4	218					
YEAR	996.8	3906	6	35.9	1.00	5.1	4	336.5	224	6	3.1	0.99	5.2	3
BOAT	1183.6	3928	28	35.2	1.00	19.6	1	358.8	232	14	2.4	1.00	7.9	1
NET	973.5	3902	2	59.6	1.00	2.9	6	312.1	220	2	0.6	0.46	-0.3	6
LATITUDE	1064.1	3915	15	32.9	1.00	10.9	3	348.0	227	9	2.9	1.00	7.1	2
DEPTH	1131.5	3906	6	128.5	1.00	16.4	2	329.3	222	4	3.3	0.99	4.0	4
BIMONTH	988.3	3905	5	36.1	1.00	4.3	5	320.6	223	5	1.4	0.79	1.0	5
HOURS	944.7	3901	1	0.4	0.46	-0.0	7							
none	2287.8	3963	63	88.0	1.00	58.0		522.6	259	41	3.6	1.00	29.4	
Thornyhds	2392.6	3813						786.7	836					
YEAR	2608.4	3819	6	57.3	1.00	8.1	5	805.4	842	6	3.3	1.00	1.6	5
BOAT	2963.6	3841	28	32.5	1.00	18.7	2	936.0	861	25	6.3	1.00	13.4	1
NET	2605.9	3815	2	170.0	1.00	8.1	4	789.0	838	2	1.2	0.71	0.1	6
LATITUDE	2474.4	3828	15	8.7	1.00	2.9	6	857.2	850	14	5.3	1.00	6.7	2
DEPTH	3045.9	3819	6	173.5	1.00	21.3	1	816.6	842	6	5.3	1.00	3.0	3
BIMONTH	2635.6	3818	5	77.4	1.00	9.1	3	808.3	841	5	4.6	1.00	2.1	4
HOURS	2403.4	3814	1	17.1	1.00	0.4	7							
none	5922.0	3876	63	89.3	1.00	58.9		1224.6	894	58	8.0	1.00	31.3	
Sablefish	3939.6	3223						3238.3	2207					
YEAR	4093.2	3229	6	20.9	1.00	3.6	5	3704.8	2213	6	53.0	1.00	12.4	1
BOAT	4618.2	3251	28	19.8	1.00	14.0	3	3657.2	2234	27	10.6	1.00	10.4	2
NET	4215.5	3225	2	112.8	1.00	6.5	4	3247.4	2209	2	3.1	0.95	0.2	6
LATITUDE	4025.0	3238	15	4.7	1.00	1.7	6	3385.6	2221	14	7.2	1.00	3.7	3
DEPTH	5631.6	3229	6	230.7	1.00	29.9	1	3291.3	2213	6	6.0	1.00	1.3	4
BIMONTH	4630.9	3228	5	113.1	1.00	14.8	2	3263.4	2212	5	3.4	1.00	0.5	5
HOURS	3962.0	3224	1	18.3	1.00	0.5	7							
none	9675.8	3286	63	74.5	1.00	58.5		4717.9	2267	60	16.8	1.00	29.5	
Dover sole	7528.3	3831						12188.2	9837					
YEAR	7614.7	3837	6	7.3	1.00	1.0	6	12477.8	9843	6	39.0	1.00	2.3	5
BOAT	10569.0	3859	28	55.3	1.00	28.2	3	16234.2	9865	28	116.6	1.00	24.7	1
NET	8278.0	3833	2	190.8	1.00	9.0	4	12245.5	9839	2	23.1	1.00	0.4	6
LATITUDE	8050.3	3846	15	17.7	1.00	6.1	5	13577.8	9852	15	74.8	1.00	10.1	2
DEPTH	10879.6	3837	6	284.2	1.00	30.7	1	13395.5	9843	6	162.4	1.00	9.0	3
BIMONTH	10516.0	3836	5	304.1	1.00	28.3	2	12772.8	9842	5	94.4	1.00	4.5	4
HOURS	7567.2	3832	1	19.8	1.00	0.5	7							
none	20273.2	3894	63	102.9	1.00	62.3		21515.8	9899	62	121.4	1.00	43.0	
Arrowtooth	3791.9	3918						1406.4	1393					
YEAR	3876.3	3924	6	14.5	1.00	2.0	7	1454.8	1399	6	8.0	1.00	2.9	3
BOAT	5200.4	3946	28	52.0	1.00	26.6	1	1981.4	1417	24	23.7	1.00	27.8	1
NET	3999.4	3920	2	107.2	1.00	5.1	5	1415.4	1395	2	4.4	0.99	0.5	6
LATITUDE	4198.9	3933	15	28.0	1.00	9.3	3	1525.1	1407	14	8.4	1.00	6.9	2
DEPTH	4559.0	3924	6	132.1	1.00	16.7	2	1449.3	1399	6	7.1	1.00	2.5	5
BIMONTH	4186.0	3923	5	81.4	1.00	9.3	4	1448.8	1398	5	8.4	1.00	2.6	4
HOURS	3874.9	3919	1	85.8	1.00	2.1	6							
none	7914.2	3981	63	67.6	1.00	51.3		3210.5	1450	57	31.3	1.00	54.4	

Table 7. Analysis of influential factors, part 2. Analysis of deviance for stepwise addition of pairwise interactions to the base models with discrete factors *YEAR* (Y), *BOAT* (Bo), *NET* (N), *LATITUDE* (L), *DEPTH* (D), and *BIMONTH* (Bi), and continuous variable Tow *HOURS* in the logistic models. The first line for each species shows the base results.

	Logistic models.							Lognormal models.						
Sp./Model	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank
English	6879.2	3723						11565.8	9927					
Y.Bo	5483.2	3558	165	5.5	1.00	16.6	1	10836.9	9798	129	5.1	1.00	5.1	3
Y.N	6781.0	3711	12	4.5	1.00	1.1	13	11550.3	9917	10	1.3	0.79	0.0	15
Y.L	6217.7	3633	90	4.3	1.00	7.4	3	11101.2	9839	88	4.7	1.00	3.2	6
Y.D	6629.1	3687	36	3.9	1.00	2.7	8	11434.1	9899	28	4.1	1.00	0.9	10
Y.Bi	6754.8	3693	30	2.3	1.00	1.0	14	11355.8	9897	30	6.1	1.00	1.5	8
Bo.N	6669.3	3690	33	3.5	1.00	2.2	10	11529.4	9910	17	1.8	0.98	0.1	13
Bo.L	6259.4	3572	151	2.3	1.00	5.2	6	10976.6	9815	112	4.7	1.00	4.0	5
Bo.D	6232.0	3640	83	4.6	1.00	7.3	4	10492.9	9869	58	17.4	1.00	8.7	2
Bo.Bi	6177.9	3587	136	3.0	1.00	6.8	5	10943.5	9814	113	4.9	1.00	4.3	4
N.L	6705.2	3700	23	4.2	1.00	1.9	11	11523.5	9911	16	2.3	1.00	0.2	12
N.D	6821.3	3713	10	3.2	1.00	0.6	15	11468.1	9920	7	12.1	1.00	0.8	11
N.Bi	6759.4	3713	10	6.6	1.00	1.5	12	11539.7	9917	10	2.3	0.99	0.1	14
L.D	6311.5	3700	23	14.5	1.00	7.7	2	10413.8	9905	22	49.8	1.00	9.8	1
L.Bi	6564.8	3649	74	2.4	1.00	2.6	9	11184.3	9853	74	4.5	1.00	2.6	7
D.Bi	6629.0	3693	30	4.6	1.00	2.9	7	11378.6	9904	23	7.1	1.00	1.4	9
Petrale	7406.5	3523						7132.0	7725					
Y.Bo	6329.0	3360	163	3.5	1.00	10.4	2	6340.0	7586	139	6.8	1.00	9.5	2
Y.N	7356.7	3511	12	2.0	0.98	0.3	14	7067.6	7715	10	7.0	1.00	0.8	13
Y.L	6897.8	3433	90	2.8	1.00	4.4	8	6620.1	7638	87	6.8	1.00	6.1	6
Y.D	7255.0	3487	36	2.0	1.00	1.0	12	6972.1	7692	33	5.3	1.00	1.8	9
Y.Bi	7220.7	3493	30	3.0	1.00	1.7	9	6978.7	7695	30	5.6	1.00	1.8	10
Bo.N	7240.6	3488	35	2.3	1.00	1.3	11	7088.8	7704	21	2.2	1.00	0.3	15
Bo.L	6674.5	3376	147	2.5	1.00	6.0	7	6726.5	7614	111	4.1	1.00	4.3	8
Bo.D	6485.7	3440	83	5.9	1.00	10.3	3	6394.2	7660	65	13.6	1.00	9.6	1
Bo.Bi	6417.8	3391	132	4.0	1.00	10.0	4	6513.1	7613	112	6.5	1.00	7.3	3
N.L	7252.9	3500	23	3.2	1.00	1.4	10	7054.8	7706	19	4.4	1.00	0.8	11
N.D	7324.6	3514	9	4.4	1.00	0.9	13	7074.7	7716	9	7.0	1.00	0.7	14
N.Bi	7380.3	3513	10	1.2	0.74	0.1	15	7063.8	7715	10	7.5	1.00	0.8	12
L.D	6726.2	3500	23	15.4	1.00	8.6	5	6731.7	7702	23	19.9	1.00	5.3	7
L.Bi	6706.2	3449	74	4.9	1.00	7.5	6	6593.8	7655	70	8.9	1.00	6.7	5
D.Bi	6555.7	3494	29	15.6	1.00	10.8	1	6621.8	7701	24	24.7	1.00	6.9	4
Rex	7443.8	3634						5446.4	5814					
Y.Bo	5976.4	3470	164	5.2	1.00	15.9	1	4679.2	5702	112	8.3	1.00	12.4	1
Y.N	7393.1	3622	12	2.1	0.98	0.4	14	5417.1	5804	10	3.1	1.00	0.4	13
Y.L	6795.4	3544	90	3.8	1.00	6.4	4	5079.8	5728	86	4.8	1.00	5.3	4
Y.D	7200.8	3598	36	3.4	1.00	2.3	9	5355.4	5785	29	3.4	1.00	1.2	10
Y.Bi	7263.7	3604	30	3.0	1.00	1.6	10	5262.4	5784	30	6.7	1.00	2.9	7
Bo.N	7285.8	3601	33	2.4	1.00	1.2	11	5433.3	5800	14	1.0	0.55	0.0	15
Bo.L	6825.9	3480	154	2.0	1.00	4.2	7	5194.1	5725	89	3.1	1.00	3.2	6
Bo.D	6911.4	3551	83	3.3	1.00	5.0	5	5274.2	5762	52	3.6	1.00	2.3	9
Bo.Bi	6429.2	3498	136	4.1	1.00	10.3	2	5007.9	5715	99	5.1	1.00	6.5	3
N.L	7327.0	3609	25	2.3	1.00	0.9	12	5413.1	5801	13	2.7	1.00	0.4	12
N.D	7410.1	3624	10	1.6	0.91	0.2	15	5430.8	5807	7	2.4	0.98	0.2	14

Table 7. **Analysis of influential factors, part 2** (continued).

	Logistic models.							Lognormal models.						
Sp./Model	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank
N.Bi	7389.5	3624	10	2.7	1.00	0.5	13	5415.1	5805	9	3.7	1.00	0.4	11
L.D	7133.8	3611	23	6.8	1.00	3.6	8	5297.1	5792	22	7.4	1.00	2.4	8
L.Bi	6813.0	3560	74	4.5	1.00	6.6	3	4970.6	5745	69	8.0	1.00	7.6	2
D.Bi	7036.2	3604	30	7.0	1.00	4.7	6	5235.4	5790	24	9.7	1.00	3.5	5
Sanddab	4174.6	4424						2975.9	2659					
Y.Bo	3303.4	4259	165	6.8	1.00	17.8	1	2655.5	2592	67	4.7	1.00	8.5	1
Y.N	4143.4	4412	12	2.8	1.00	0.5	14	2957.2	2653	6	2.8	0.99	0.4	11
Y.L	3638.0	4334	90	7.1	1.00	11.0	2	2741.2	2599	60	3.7	1.00	5.8	3
Y.D	4023.8	4388	36	4.6	1.00	2.8	8	2932.4	2647	12	3.3	1.00	1.0	10
Y.Bi	3846.6	4394	30	12.5	1.00	7.2	6	2837.0	2629	30	4.3	1.00	3.6	7
Bo.N	4088.4	4386	38	2.4	1.00	1.2	11	2975.7	2656	3	0.0	0.01	-0.1	15
Bo.L	3948.7	4268	156	1.6	1.00	2.0	9	2812.6	2624	35	4.4	1.00	4.2	5
Bo.D	3657.6	4338	86	7.1	1.00	10.6	3	2840.6	2640	19	6.6	1.00	3.9	6
Bo.Bi	3678.3	4288	136	4.3	1.00	9.1	4	2714.7	2604	55	4.6	1.00	6.8	2
N.L	4086.2	4399	25	3.8	1.00	1.6	10	2966.5	2653	6	1.4	0.79	0.1	14
N.D	4158.2	4414	10	1.7	0.94	0.2	15	2969.1	2656	3	2.0	0.89	0.1	13
N.Bi	4142.2	4414	10	3.5	1.00	0.6	13	2961.1	2651	8	1.7	0.90	0.2	12
L.D	3927.6	4401	23	12.0	1.00	5.4	7	2916.1	2648	11	4.9	1.00	1.6	8
L.Bi	3780.0	4350	74	6.1	1.00	7.9	5	2776.1	2610	49	3.8	1.00	5.0	4
D.Bi	4113.3	4394	30	2.2	1.00	0.8	12	2919.9	2651	8	6.4	1.00	1.6	9
Lingcod	6677.0	3285						7698.4	5436					
Y.Bo	5475.1	3123	162	4.2	1.00	13.7	1	6533.0	5287	149	6.3	1.00	12.7	1
Y.N	6646.9	3274	11	1.3	0.81	0.1	14	7611.6	5426	10	6.2	1.00	0.9	13
Y.L	6298.3	3195	90	2.1	1.00	3.0	6	7163.8	5347	89	4.5	1.00	5.4	4
Y.D	6524.1	3249	36	2.1	1.00	1.2	9	7570.4	5410	26	3.5	1.00	1.2	12
Y.Bi	6563.8	3255	30	1.9	1.00	0.8	11	7463.2	5406	30	5.7	1.00	2.5	6
Bo.N	6574.8	3254	31	1.6	0.99	0.6	12	7520.5	5416	20	6.4	1.00	2.0	8
Bo.L	6056.4	3140	145	2.2	1.00	5.1	3	7098.6	5317	119	3.8	1.00	5.7	3
Bo.D	6235.2	3201	84	2.7	1.00	4.2	4	7441.0	5369	67	2.8	1.00	2.1	7
Bo.Bi	6066.4	3152	133	2.4	1.00	5.3	2	7050.3	5312	124	3.9	1.00	6.3	2
N.L	6563.6	3263	22	2.6	1.00	1.0	10	7543.1	5417	19	5.9	1.00	1.7	11
N.D	6658.4	3275	10	0.9	0.48	-0.0	15	7636.9	5428	8	5.5	1.00	0.7	14
N.Bi	6639.1	3275	10	1.9	0.96	0.3	13	7655.3	5426	10	3.1	1.00	0.4	15
L.D	6395.3	3262	23	6.2	1.00	3.5	5	7520.8	5413	23	5.6	1.00	1.9	9
L.Bi	6421.6	3212	73	1.8	1.00	1.6	7	7373.7	5364	72	3.3	1.00	2.9	5
D.Bi	6518.6	3255	30	2.6	1.00	1.5	8	7541.3	5416	20	5.6	1.00	1.7	10
Pac. Cod	6757.4	3701						6405.0	4645					
Y.Bo	5342.4	3538	163	5.7	1.00	17.3	1	5795.1	4533	112	4.3	1.00	7.3	1
Y.N	6570.2	3689	12	8.8	1.00	2.5	8	6336.9	4637	8	6.2	1.00	0.9	9
Y.L	5997.0	3611	90	5.1	1.00	9.0	3	6038.0	4577	68	4.1	1.00	4.3	3
Y.D	6440.5	3665	36	5.0	1.00	3.8	7	6318.6	4628	17	3.7	1.00	1.0	8
Y.Bi	6259.6	3671	30	9.7	1.00	6.6	4	6253.0	4615	30	3.7	1.00	1.7	6
Bo.N	6599.7	3668	33	2.7	1.00	1.5	13	6347.7	4630	15	2.8	1.00	0.6	11
Bo.L	6141.7	3553	148	2.4	1.00	5.3	5	6036.1	4550	95	2.9	1.00	3.8	4
Bo.D	6479.2	3617	84	1.8	1.00	1.9	9	6277.8	4606	39	2.4	1.00	1.2	7
Bo.Bi	5911.6	3565	136	3.8	1.00	9.2	2	5896.0	4539	106	3.7	1.00	5.8	2
N.L	6638.0	3679	22	3.0	1.00	1.2	14	6359.6	4631	14	2.4	1.00	0.4	13
N.D	6741.9	3691	10	0.9	0.42	-0.0	15	6376.8	4640	5	4.1	1.00	0.3	14

Table 7. Analysis of influential factors, part 2 (continued).

	Logistic models.							Lognormal models.						
Sp./Model	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank
N.Bi	6631.7	3691	10	7.0	1.00	1.6	11	6382.0	4637	8	2.1	0.97	0.2	15
L.D	6596.1	3678	23	3.9	1.00	1.8	10	6343.0	4627	18	2.5	1.00	0.6	10
L.Bi	6341.6	3627	74	3.2	1.00	4.2	6	6122.6	4580	65	3.2	1.00	3.1	5
D.Bi	6596.8	3671	30	3.0	1.00	1.6	12	6357.2	4631	14	2.5	1.00	0.4	12
Widow	2454.7	3873						2499.3	1166					
Y.Bo	1820.1	3712	161	8.0	1.00	22.6	1	2306.1	1103	63	1.5	0.99	2.5	3
Y.N	2373.8	3861	12	11.0	1.00	3.0	10	2451.6	1157	9	2.5	0.99	1.1	10
Y.L	2034.5	3783	90	8.7	1.00	15.1	2	2302.0	1107	59	1.6	1.00	3.0	1
Y.D	2407.1	3837	36	2.1	1.00	1.0	13	2444.6	1149	17	1.5	0.92	0.7	12
Y.Bi	2277.9	3843	30	9.9	1.00	6.5	6	2411.0	1139	27	1.5	0.96	1.2	8
Bo.N	2106.1	3837	36	17.6	1.00	13.4	3	2447.1	1156	10	2.5	0.99	1.2	9
Bo.L	2258.4	3722	151	2.1	1.00	4.3	8	2344.9	1119	47	1.6	0.99	2.2	5
Bo.D	2286.4	3792	81	3.4	1.00	4.9	7	2364.5	1137	29	2.2	1.00	3.0	2
Bo.Bi	2105.9	3739	134	4.6	1.00	11.1	4	2304.6	1102	64	1.5	0.99	2.4	4
N.L	2372.3	3849	24	5.6	1.00	2.8	11	2422.9	1154	12	3.0	1.00	2.1	6
N.D	2412.3	3864	9	7.6	1.00	1.5	12	2460.3	1161	5	3.7	1.00	1.1	11
N.Bi	2445.2	3863	10	1.5	0.87	0.1	15	2467.4	1157	9	1.7	0.91	0.5	14
L.D	2354.3	3850	23	7.1	1.00	3.5	9	2453.6	1153	13	1.7	0.93	0.7	13
L.Bi	2234.8	3799	74	5.1	1.00	7.2	5	2334.9	1108	58	1.3	0.95	1.7	7
D.Bi	2425.6	3843	30	1.5	0.97	0.4	14	2481.2	1151	15	0.6	0.09	-0.6	15
Small Rock	3993.0	3960						2483.0	1719					
Y.Bo	2788.0	3796	164	10.0	1.00	27.2	1	2201.8	1641	78	2.7	1.00	7.1	2
Y.N	3937.3	3948	12	4.7	1.00	1.1	14	2471.1	1708	11	0.7	0.31	-0.2	15
Y.L	3421.4	3870	90	7.2	1.00	12.3	2	2281.7	1649	70	2.1	1.00	4.2	4
Y.D	3886.4	3924	36	3.0	1.00	1.8	10	2398.8	1694	25	2.4	1.00	2.0	9
Y.Bi	3722.3	3930	30	9.5	1.00	6.1	6	2320.9	1689	30	3.9	1.00	4.9	3
Bo.N	3883.6	3924	36	3.1	1.00	1.8	9	2403.2	1701	18	3.1	1.00	2.2	8
Bo.L	3597.5	3809	151	2.8	1.00	6.3	5	2345.3	1663	56	1.7	1.00	2.4	6
Bo.D	3609.3	3873	87	4.7	1.00	7.6	4	2357.3	1671	48	1.9	1.00	2.3	7
Bo.Bi	3477.3	3825	135	4.2	1.00	9.8	3	2184.7	1637	82	2.7	1.00	7.6	1
N.L	3922.6	3936	24	2.9	1.00	1.2	12	2432.1	1699	20	1.8	0.98	0.9	12
N.D	3964.5	3950	10	2.8	1.00	0.5	15	2470.3	1713	6	1.5	0.82	0.2	13
N.Bi	3937.6	3950	10	5.6	1.00	1.1	13	2470.8	1709	10	0.8	0.42	-0.1	14
L.D	3780.9	3937	23	9.6	1.00	4.8	8	2420.2	1702	17	2.6	1.00	1.6	11
L.Bi	3682.1	3886	74	4.4	1.00	6.0	7	2334.6	1657	62	1.7	1.00	2.5	5
D.Bi	3894.3	3930	30	3.3	1.00	1.7	11	2412.0	1701	18	2.8	1.00	1.8	10
Misc. Rock	7147.4	3261						9095.2	5319					
Y.Bo	5727.6	3098	163	4.7	1.00	15.6	1	8390.6	5179	140	3.1	1.00	5.3	1
Y.N	7057.8	3250	11	3.8	1.00	0.9	12	9053.4	5308	11	2.2	0.99	0.3	15
Y.L	6688.2	3171	90	2.4	1.00	3.8	7	8686.0	5234	85	2.9	1.00	2.9	5
Y.D	7020.1	3225	36	1.6	0.99	0.7	14	8895.0	5285	34	3.5	1.00	1.6	8
Y.Bi	6990.3	3231	30	2.4	1.00	1.3	10	8928.2	5289	30	3.3	1.00	1.3	9
Bo.N	7003.4	3228	33	2.0	1.00	1.0	11	8996.6	5296	23	2.5	1.00	0.7	11
Bo.L	6573.8	3114	147	1.8	1.00	3.7	8	8503.5	5203	116	3.1	1.00	4.4	2
Bo.D	6564.5	3178	83	3.4	1.00	5.8	3	8677.4	5242	77	3.3	1.00	3.2	4
Bo.Bi	6355.2	3127	134	2.9	1.00	7.3	2	8553.7	5199	120	2.7	1.00	3.8	3
N.L	7052.2	3238	23	1.9	0.99	0.6	15	9009.0	5300	19	2.7	1.00	0.6	13
N.D	7074.0	3251	10	3.4	1.00	0.7	13	9025.2	5310	9	4.6	1.00	0.6	12
N.Bi	6993.2	3251	10	7.2	1.00	1.9	9	9052.2	5309	10	2.5	1.00	0.3	14
L.D	6762.2	3238	23	8.0	1.00	4.7	5	8831.8	5296	23	6.9	1.00	2.5	6

Table 7. Analysis of influential factors, part 2 (continued).

	Logistic models.							Lognormal models.						
Sp./Model	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank
L.Bi	6629.1	3187	74	3.4	1.00	5.1	4	8807.4	5247	72	2.4	1.00	1.8	7
D.Bi	6795.4	3231	30	5.6	1.00	4.0	6	8932.1	5291	28	3.5	1.00	1.3	10
Yellowtail	3062.1	3625						2137.8	1206					
Y.Bo	2370.6	3461	164	6.2	1.00	18.9	1	1858.0	1119	87	1.9	1.00	6.3	1
Y.N	2951.0	3614	11	12.4	1.00	3.3	6	2120.9	1197	9	1.1	0.61	0.0	12
Y.L	2790.1	3535	90	3.8	1.00	6.6	3	1938.0	1144	62	1.9	1.00	4.4	2
Y.D	2945.8	3589	36	3.9	1.00	2.8	10	2107.5	1191	15	1.1	0.69	0.2	10
Y.Bi	2949.7	3595	30	4.6	1.00	2.9	9	2032.1	1176	30	2.0	1.00	2.5	3
Bo.N	2937.2	3592	33	4.6	1.00	3.2	7	2110.8	1192	14	1.1	0.64	0.1	11
Bo.L	2799.2	3473	152	2.1	1.00	4.6	5	1970.8	1137	69	1.4	0.98	2.2	4
Bo.D	2901.0	3545	80	2.5	1.00	3.1	8	2046.4	1175	31	1.7	0.99	1.8	7
Bo.Bi	2595.6	3489	136	4.6	1.00	11.9	2	1975.6	1129	77	1.2	0.88	1.3	8
N.L	2964.3	3601	24	5.0	1.00	2.6	11	2068.4	1190	16	2.5	1.00	1.9	6
N.D	3035.5	3615	10	3.2	1.00	0.6	14	2132.5	1201	5	0.6	0.29	-0.2	15
N.Bi	2977.9	3615	10	10.2	1.00	2.5	12	2122.3	1196	10	0.9	0.44	-0.1	14
L.D	2998.2	3602	23	3.3	1.00	1.5	13	2098.2	1191	15	1.5	0.90	0.6	9
L.Bi	2857.8	3551	74	3.4	1.00	4.7	4	1992.0	1148	58	1.4	0.98	2.1	5
D.Bi	3029.2	3595	30	1.3	0.87	0.2	15	2117.7	1195	11	1.0	0.58	0.0	13
P.O.Perch	944.6	3900						310.4	218					
Y.Bo	733.8	3736	164	6.5	1.00	18.9	2	201.1	178	40	2.4	1.00	20.6	2
Y.N	924.1	3888	12	7.2	1.00	1.9	14	280.3	209	9	2.5	0.99	5.8	7
Y.L	813.9	3810	90	6.8	1.00	11.8	4	180.8	179	39	3.3	1.00	29.0	1
Y.D	889.3	3864	36	6.7	1.00	5.0	8	242.2	199	19	2.9	1.00	14.5	4
Y.Bi	865.9	3870	30	11.7	1.00	7.6	7	270.9	194	24	1.2	0.74	1.9	14
Bo.N	901.3	3863	37	5.0	1.00	3.7	11	289.1	208	10	1.5	0.87	2.4	11
Bo.L	731.7	3749	151	7.2	1.00	19.4	1	247.9	195	23	2.1	1.00	10.7	5
Bo.D	822.0	3814	86	6.6	1.00	11.0	5	280.9	203	15	1.4	0.86	2.8	9
Bo.Bi	798.5	3765	135	5.1	1.00	12.4	3	240.4	184	34	1.6	0.97	8.2	6
N.L	892.7	3875	25	9.0	1.00	4.9	9	292.1	211	7	1.9	0.93	2.8	10
N.D	933.2	3890	10	4.8	1.00	1.0	15	301.4	213	5	1.3	0.72	0.6	15
N.Bi	920.8	3890	10	10.1	1.00	2.3	12	290.9	209	9	1.6	0.87	2.2	12
L.D	894.5	3877	23	9.4	1.00	4.7	10	294.1	211	7	1.7	0.88	2.1	13
L.Bi	846.3	3826	74	6.0	1.00	8.7	6	230.5	190	28	2.4	1.00	14.8	3
D.Bi	916.9	3870	30	3.9	1.00	2.2	13	272.7	200	18	1.5	0.92	4.2	8
Thornyhds	2392.6	3813						786.7	836					
Y.Bo	1832.8	3648	165	6.8	1.00	19.9	1	578.8	758	78	3.5	1.00	18.9	1
Y.N	2295.4	3801	12	13.4	1.00	3.8	10	744.9	825	11	4.2	1.00	4.1	8
Y.L	2098.6	3723	90	5.8	1.00	10.2	3	655.6	772	64	2.4	1.00	9.8	2
Y.D	2211.1	3777	36	8.6	1.00	6.7	7	716.9	806	30	2.6	1.00	5.5	5
Y.Bi	2288.7	3783	30	5.7	1.00	3.6	12	737.1	806	30	1.8	1.00	2.8	10
Bo.N	2237.9	3778	35	7.5	1.00	5.6	8	755.3	822	14	2.4	1.00	2.4	11
Bo.L	2122.5	3660	153	3.0	1.00	7.6	5	696.4	785	51	2.0	1.00	5.7	4
Bo.D	2168.8	3732	81	4.8	1.00	7.4	6	709.1	796	40	2.2	1.00	5.3	7
Bo.Bi	1950.3	3677	136	6.1	1.00	15.5	2	660.2	768	68	2.2	1.00	8.6	3
N.L	2289.6	3787	26	6.6	1.00	3.7	11	742.3	820	16	3.1	1.00	3.8	9
N.D	2362.3	3803	10	4.9	1.00	1.0	14	771.7	829	7	2.3	0.98	1.1	14
N.Bi	2369.8	3803	10	3.7	1.00	0.7	15	772.8	826	10	1.5	0.86	0.6	15
L.D	2252.1	3790	23	10.3	1.00	5.3	9	764.1	824	12	2.0	0.98	1.5	13
L.Bi	2124.5	3739	74	6.4	1.00	9.5	4	699.3	785	51	1.9	1.00	5.3	6
D.Bi	2323.5	3783	30	3.8	1.00	2.1	13	750.8	814	22	1.8	0.98	2.0	12

Table 7. **Analysis of influential factors, part 2** (continued).

	Logistic models.							Lognormal models.						
Sp./Model	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank	Dev.	d.f.	Δ df	F	Pr(F)	Ad R^2 (%)	Rank
Sablefish	3939.6	3223						3238.3	2207					
Y.Bo	3298.0	3059	164	3.6	1.00	11.8	1	2785.3	2085	122	2.8	1.00	9.0	1
Y.N	3897.5	3212	11	3.2	1.00	0.7	14	3204.2	2197	10	2.3	0.99	0.6	12
Y.L	3654.4	3133	90	2.7	1.00	4.6	4	2853.3	2124	83	3.5	1.00	8.4	2
Y.D	3841.3	3187	36	2.3	1.00	1.4	11	3097.4	2174	33	3.0	1.00	2.9	6
Y.Bi	3760.7	3194	29	5.2	1.00	3.7	6	3156.4	2178	29	1.9	1.00	1.2	9
Bo.N	3815.3	3191	32	3.3	1.00	2.2	8	3189.0	2191	16	2.1	0.99	0.8	10
Bo.L	3561.4	3084	139	2.4	1.00	5.5	3	2932.6	2113	94	2.3	1.00	5.4	3
Bo.D	3710.8	3145	78	2.5	1.00	3.5	7	3016.4	2146	61	2.6	1.00	4.2	5
Bo.Bi	3547.1	3089	134	2.6	1.00	6.1	2	2956.5	2111	96	2.1	1.00	4.6	4
N.L	3853.5	3200	23	3.1	1.00	1.5	10	3201.5	2188	19	1.3	0.84	0.3	14
N.D	3917.7	3214	9	2.0	0.96	0.3	15	3224.6	2200	7	1.3	0.77	0.1	15
N.Bi	3875.5	3213	10	5.3	1.00	1.3	12	3209.7	2197	10	2.0	0.97	0.4	13
L.D	3831.5	3200	23	3.9	1.00	2.0	9	3171.9	2190	17	2.7	1.00	1.3	8
L.Bi	3678.9	3149	74	3.0	1.00	4.4	5	3081.2	2148	59	1.9	1.00	2.2	7
D.Bi	3875.1	3195	28	1.9	1.00	0.8	13	3180.2	2182	25	1.6	0.97	0.7	11
Dover Sole	7528.3	3831						12188.2	9837					
Y.Bo	6505.0	3669	162	3.6	1.00	9.8	2	10984.7	9696	141	7.5	1.00	8.6	2
Y.N	7389.6	3819	12	6.0	1.00	1.5	13	12109.9	9826	11	5.8	1.00	0.5	14
Y.L	7060.3	3741	90	2.8	1.00	4.0	8	11724.8	9749	88	4.4	1.00	2.9	7
Y.D	7312.1	3795	36	3.1	1.00	2.0	10	11970.9	9801	36	4.9	1.00	1.4	10
Y.Bi	7266.6	3801	30	4.6	1.00	2.7	9	11963.9	9807	30	6.1	1.00	1.5	9
Bo.N	7317.5	3797	34	3.2	1.00	1.9	11	12062.5	9814	23	4.4	1.00	0.8	12
Bo.L	6839.3	3675	156	2.4	1.00	5.3	6	11536.8	9711	126	4.4	1.00	4.1	5
Bo.D	6733.6	3746	85	5.2	1.00	8.5	3	11422.3	9766	71	9.2	1.00	5.6	4
Bo.Bi	6158.4	3697	134	6.1	1.00	15.2	1	11292.9	9723	114	6.8	1.00	6.3	3
N.L	7333.3	3805	26	3.9	1.00	1.9	12	12135.3	9816	21	2.0	1.00	0.2	15
N.D	7395.6	3821	10	6.9	1.00	1.5	14	12050.0	9828	9	12.5	1.00	1.0	11
N.Bi	7449.2	3821	10	4.1	1.00	0.8	15	12100.7	9827	10	7.1	1.00	0.6	13
L.D	6879.6	3808	23	15.6	1.00	8.1	5	10961.8	9814	23	47.7	1.00	9.9	1
L.Bi	6757.4	3757	74	5.8	1.00	8.5	4	11637.5	9767	70	6.6	1.00	3.8	6
D.Bi	7127.07	3801	30	7.13	1	4.58	7	11929.1	9809	28	7.61	1	1.85	8
Arrowtooth	3791.9	3918						1406.4	1393					
Y.Bo	2456.1	3753	165	12.4	1.00	32.4	1	1137.2	1309	84	3.7	1.00	14.0	1
Y.N	3763.0	3906	12	2.5	1.00	0.5	15	1376.9	1385	8	3.7	1.00	1.5	10
Y.L	3108.6	3828	90	9.4	1.00	16.1	2	1225.6	1316	77	2.5	1.00	7.8	3
Y.D	3547.1	3882	36	7.4	1.00	5.6	7	1345.2	1361	32	1.9	1.00	2.1	8
Y.Bi	3604.6	3888	30	6.7	1.00	4.2	10	1349.0	1364	29	2.0	1.00	2.0	9
Bo.N	3550.5	3881	37	7.1	1.00	5.5	8	1360.8	1384	9	5.2	1.00	2.6	6
Bo.L	3411.0	3761	157	2.7	1.00	6.3	4	1205.6	1327	66	3.4	1.00	10.0	2
Bo.D	3494.9	3834	84	3.9	1.00	5.8	6	1331.4	1351	42	1.8	1.00	2.4	7
Bo.Bi	3275.3	3782	136	4.4	1.00	10.5	3	1288.6	1324	69	1.8	1.00	3.6	4
N.L	3573.8	3892	26	9.1	1.00	5.1	9	1375.9	1380	13	2.4	1.00	1.2	11
N.D	3724.0	3908	10	7.1	1.00	1.5	13	1402.8	1388	5	0.7	0.39	-0.1	15
N.Bi	3744.4	3908	10	5.0	1.00	1.0	14	1384.9	1387	6	3.6	1.00	1.1	12
L.D	3660.3	3895	23	6.1	1.00	2.9	11	1375.9	1377	16	1.9	0.98	1.0	13
L.Bi	3503.6	3844	74	4.3	1.00	5.8	5	1311.3	1345	48	2.0	1.00	3.4	5
D.Bi	3672.4	3888	30	4.2	1.00	2.4	12	1373.1	1370	23	1.4	0.92	0.7	14

Table 8. Summary of major influential factors.

Species	Logistic models for Pr(non-zero catch). 1st	2nd	Lognormal models for size of non-zero catch. 1st	2nd
Single Factors				
English Sole	BOAT	DEPTH	BOAT	LATITUDE
Petrale Sole	BOAT	DEPTH	BOAT	DEPTH
Rex Sole	BOAT	LATITUDE	BOAT	DEPTH
Sanddab	BOAT	BIMONTH	BOAT	LATITUDE
Lingcod	DEPTH	BOAT	BOAT	LATITUDE
Pacific Cod	DEPTH	LATITUDE	BOAT	YEAR
Widow Rockfish	BOAT	YEAR	BOAT	YEAR
Small Rockfish	BOAT	DEPTH	BOAT	YEAR
Misc. Rockfish	BOAT	DEPTH	BOAT	YEAR
Yellowtail Rock.	BOAT	DEPTH	BOAT	NET
Pac. Oc. Perch	BOAT	DEPTH	BOAT	LATITUDE
Thornyheads	DEPTH	BOAT	BOAT	LATITUDE
Sablefish	DEPTH	BIMONTH	YEAR	BOAT
Dover Sole	DEPTH	BIMONTH	BOAT	LATITUDE
Arrowtooth Fl.	BOAT	DEPTH	BOAT	LATITUDE
Pairwise Interactions				
English Sole	YEARxBOAT	LATxDEPTH	LATxDEPTH	BOATxDEPTH
Petrale Sole	DEPTHxBIMONTH	YEARxBOAT	BOATxDEPTH	YEARxBOAT
Rex Sole	YEARxBOAT	BOATxBIMONTH	YEARxBOAT	LATxBIMONTH
Sanddab	YEARxBOAT	YEARxLAT	YEARxBOAT	BOATxBIMONTH
Lingcod	YEARxBOAT	BOATxBIMONTH	YEARxBOAT	BOATxBIMONTH
Pacific Cod	YEARxBOAT	BOATxBIMONTH	YEARxBOAT	BOATxBIMONTH
Widow Rockfish	YEARxBOAT	YEARxLAT	YEARxLAT	BOATxDEPTH
Small Rockfish	YEARxBOAT	YEARxLAT	BOATxBIMONTH	YEARxBOAT
Misc. Rockfish	YEARxBOAT	BOATxBIMONTH	YEARxBOAT	BOATxLAT
Yellowtail Rock.	YEARxBOAT	BOATxBIMONTH	YEARxBOAT	YEARxLAT
Pac. Oc. Perch	BOATxLAT	YEARxBOAT	YEARxLAT	YEARxBOAT
Thornyheads	YEARxBOAT	BOATxBIMONTH	YEARxBOAT	YEARxLAT
Sablefish	YEARxBOAT	BOATxBIMONTH	YEARxBOAT	YEARxLAT
Dover Sole	BOATxBIMONTH	YEARxBOAT	LATxDEPTH	YEARxBOAT
Arrowtooth Fl.	YEARxBOAT	YEARxLAT	YEARxBOAT	BOATxLAT

Table 9. Estimates of *Boat* by *Year* fishing power coefficients.

Boat in bold were used as the reference boats for standardizing CPUE.

Estimated **logistic** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
English										
241862	6.713	6.264	6.784	6.239	5.646	4.584	5.791	6.003	-0.259	0.257
220086	2.842	2.385	3.233	4.262	2.803	3.037	3.744	3.187	0.128	0.324
640718	0.970	1.631	1.906	0.922	2.529	1.048	2.594	1.657	0.155	0.402
247438	3.421	4.095	5.102	5.068	4.634	3.852	5.705	4.554	0.211	0.440
227594	1.934	3.658	4.561	5.503	4.164	5.874	6.840	4.648	0.670	0.511
565479	3.327	5.085	3.162	3.583	2.150	2.705	2.069	3.154	-0.341	0.513
219897	2.271	2.978	3.640	3.597	1.703	2.981	4.265	3.062	0.145	0.661
239090	2.982	2.478	4.539	5.087	4.808	3.580	4.407	3.983	0.241	0.699
261197	1.808	3.796	4.832	5.510	5.610	4.427	6.066	4.578	0.529	0.780
247779	4.408	4.190	5.052	5.129	4.791	3.798	7.070	4.920	0.248	0.839
226541	1.440	2.297	2.983	3.432	4.069	1.866	4.991	3.011	0.388	0.880
640904	3.887	5.465	5.356	2.955	4.073	3.394	5.116	4.321	-0.062	0.980
536838	1.465	1.427	0.110	1.775	2.242	2.251	5.026	2.042	0.517	1.005
223582	1.330	3.665	3.468	3.785	6.616	4.329	4.650	3.978	0.516	1.250
249439	5.114	4.288	5.766	5.986	3.972	3.133	-0.075	4.026	-0.703	1.987
504299	-3.891	-3.044	-2.712	-2.364	-5.957	-6.529	-3.424	-3.989	-0.315	2.174
277034	3.830	7.169	9.177	6.776	6.234	5.806	9.538	6.933	0.409	3.100
626917	-4.632	-3.582	-5.354	-3.746	-3.875	-4.957	1.095	-3.579	0.568	3.180
521200	-4.674	-2.680	-3.075	-4.829	-3.455	-6.300	1.200	-3.402	0.357	5.048
512179	1.795	-5.151	-6.377	-1.498	-1.267	-0.133	0.917	-1.673	0.447	8.323
528842	-6.579	-0.060	-7.956	2.067	1.995	1.323	3.098	-0.873	1.491	9.767
299710	1.057	2.638	3.167	2.300	-4.641	-1.707	4.555	1.053	-0.214	9.925
Petrale										
536838	0.458	-0.338	-0.010	0.133	-0.698	-1.729	-0.953	-0.448	-0.275	0.200
227594	3.103	2.036	1.978	1.231	0.389	0.765	1.169	1.524	-0.355	0.252
219897	3.330	3.006	2.284	1.317	-0.209	-1.779	-1.218	0.962	-0.918	0.282
640718	2.021	0.811	-0.710	-0.356	-1.156	-1.372	-1.441	-0.315	-0.543	0.288
277034	1.199	1.713	2.558	1.314	0.693	0.516	0.784	1.254	-0.197	0.319
247438	1.388	1.952	1.614	1.472	0.862	-0.214	1.281	1.194	-0.193	0.320
239090	2.886	1.711	1.344	0.907	0.672	1.060	1.713	1.470	-0.196	0.364
517487	-0.795	-0.264	-2.010	-0.876	-1.736	-1.756	-3.437	-1.553	-0.380	0.415
241862	4.294	3.337	2.750	2.298	1.656	0.543	2.169	2.435	-0.466	0.426
261197	0.681	1.482	0.955	2.508	0.658	0.137	1.206	1.090	-0.050	0.564
640904	1.737	2.535	2.479	0.818	1.156	-0.962		1.294	-0.551	0.632
247779	2.351	1.310	2.740	2.054	1.483	-0.443	1.008	1.500	-0.314	0.644
220086	1.185	1.370	1.847	1.594	-0.196	-1.227	0.258	0.690	-0.358	0.654
226541	0.614	1.207	1.841	2.336	1.013	0.555	-0.592	0.996	-0.205	0.706
223582	1.697	1.997	2.252	2.039	2.858	-0.018	-0.492	1.476	-0.357	0.948
512179	-0.520	-1.643	-4.382	-4.259	-5.886	-5.301	-4.868	-3.837	-0.781	1.104
580792	-1.062	1.130	-1.221	-1.613	-0.695	-3.544	-2.111	-1.302	-0.427	1.168
299710	2.387	1.950	-0.292	-0.409		-4.546	-1.893	-0.467	-0.969	1.497
565479	-0.133	4.050	-1.129	-0.061	-1.413	-1.630	-1.643	-0.280	-0.578	2.527
626917	-6.417	-7.153	-8.177	-7.559	-8.077	-9.532	-4.126	-7.292	0.079	2.854
504299	0.405	-5.684	-6.431	-6.685	-9.345	-10.19	-7.954	-6.555	-1.322	3.882
589552	6.548	-0.028	-0.132	-0.138	-2.156	-1.107	-0.023	0.423	-0.853	4.524

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated logistic model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Rex sole										
227594	-0.865	-0.432	0.031	-0.101	1.483	2.922	2.061	0.728	0.605	0.328
536838	-0.378	0.255	1.448	-0.202	1.308	0.564	0.147	0.449	0.073	0.473
226541	0.780	-0.485	1.649	1.320	2.245	2.496	1.299	1.329	0.290	0.591
626917	-7.965	-8.103	-9.202	-8.577	-6.541	-6.671	-7.921	-7.854	0.202	0.733
504299	-7.518	-7.753	-5.616	-7.048	-8.142	-8.104	-7.033	-7.316	-0.063	0.744
241862	-0.402	-0.119	1.744	0.036	2.688	1.815	1.030	0.970	0.325	0.874
247438	-1.642	-1.629	-0.500	-1.944	1.422	-0.077	-1.470	-0.834	0.198	1.266
220086	0.520	-1.368	1.244	-0.530	1.405	1.498	-0.822	0.278	0.067	1.366
219897	1.074	-0.403	1.642	0.975	2.911	3.819	0.494	1.502	0.285	1.702
521200	-9.978	-8.484	-6.935	-9.807	-5.319	-7.352	-7.176	-7.864	0.439	1.886
565479	-0.528	-4.827	-2.857	-1.448	-1.814	-1.772	-4.677	-2.560	-0.189	2.542
640718	-2.312	-6.148	-1.650	-4.181	-3.429	-0.743	-2.281	-2.963	0.326	2.736
512179	-8.544	-8.552	-8.337	-5.161	-7.916	-1.658	-2.222	-6.056	1.185	2.770
532419	-4.252	-2.185	-2.635	-4.231	1.997	-1.814	-1.871	-2.142	0.447	3.463
223582	0.689	-0.887	-0.846	-1.048	4.680	1.523	0.483	0.656	0.347	3.523
527718	-6.650	1.812	3.676					-0.387	5.163	3.628
261197	-10.15	-2.738	-1.179	-0.014	2.109	0.238	1.026	-1.530	1.528	5.963
640904	1.460	-0.721	0.534	-2.432	-7.797	-0.618	-1.746	-1.617	-0.634	7.254
239090	0.037	-1.381	-0.234	-0.402	0.760	-8.435	-1.011	-1.524	-0.581	8.197
247779	0.611	-0.540	1.076	0.112	0.666	-9.591	-3.873	-1.648	-1.142	8.959
517487	-10.41	-1.979	-8.968	-0.653	0.438	0.607	0.127	-2.976	1.649	9.245
520470	-9.258	-10.84	-8.236	-1.684	0.860	-7.061	-1.490	-5.387	1.427	11.09
Sanddab										
299710	-17.39	-17.23	-17.17	-12.42	-14.89	-21.00	-15.32	-16.49	0.034	7.106
521200	-12.59	-12.32	-15.32	-10.80	-19.20	-20.31	-16.18	-15.24	-1.095	7.352
527718	-7.654	-10.75	-10.91	-4.535				-8.463	0.920	7.695
220086	-8.381	-8.597	-12.07	-3.660	-11.04	-12.66	-9.320	-9.389	-0.354	8.588
247779	-7.725	-7.345	-11.52	-4.028	-13.09	-11.62	-8.876	-9.172	-0.485	8.705
512179	-16.58	-16.03	-18.90	-13.11	-22.75	-22.69	-18.57	-18.38	-0.826	9.230
528842	-16.87	-16.70	-18.66	-12.20	-11.64	-19.83	-16.70	-16.09	0.044	9.469
226541	-9.694	-9.708	-8.878	-1.959	-11.03	-10.71	-8.519	-8.642	-0.022	9.487
249439	-7.877	-6.867	-9.223	-2.009	-10.87	-12.77	-10.07	-8.525	-0.715	9.612
626917	-15.89	-14.49	-16.34	-9.479	-18.75	-19.34	-15.33	-15.66	-0.373	9.901
227594	-7.966	-7.006	-8.483	-1.448	-11.02	-11.30	-7.068	-7.756	-0.301	10.34
536838	-16.68	-16.45	-17.08	-10.30	-12.40	-20.01	-16.45	-15.62	-0.062	10.41
247438	-7.766	-6.368	-5.985	0.546	-8.642	-9.388	-6.012	-6.231	-0.123	10.63
517487	-14.58	-16.11	-16.99	-9.243	-19.84	-18.92	-15.52	-15.89	-0.403	11.26
223582	-7.285	-7.420	-9.274	-1.438	-11.12	-13.03	-8.861	-8.346	-0.635	11.52
219897	-6.834	-7.359	-8.303	-0.278	-11.27	-9.787	-6.675	-7.216	-0.263	11.82
520470	-17.24	-17.94	-14.76	-8.462	-18.83	-16.95	-14.95	-15.59	0.171	11.94
640718	-10.82	-18.93	-18.16	-11.57	-13.94	-20.13	-16.74	-15.76	-0.569	12.02
640904	-21.04	-18.58	-18.72	-11.59	-21.92	-21.10	-18.64	-18.80	-0.038	12.03
589552	-18.31	-17.73	-18.54	-9.940	-21.23	-19.69	-16.64	-17.44	-0.057	13.05
504299	-14.76	-13.87	-14.68	-7.594	-20.18	-20.26	-14.92	-15.18	-0.670	16.35
532419	-18.52	-18.10	-18.58	-10.59	-19.75	-21.87	-9.942	-16.76	0.609	19.57

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **logistic** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Lingcod										
580792	-1.350	-1.461	-1.946	-2.595	-1.782	-2.262	-1.426	-1.832	-0.060	0.203
247438	-1.517	-2.199	-1.762	-2.953	-2.713	-3.951	-2.977	-2.582	-0.316	0.225
536838	-1.404	-1.061	-1.491	-0.801	-0.048	-1.619	-0.415	-0.977	0.118	0.281
241862	-0.529	-1.656	-0.559	-1.843	-1.160	-2.104	-1.321	-1.310	-0.138	0.283
517487	-1.832	-2.403	-1.482	-2.045	-0.723	-2.250	-1.701	-1.777	0.052	0.303
227594	-2.548	-2.414	-1.893	-3.187	-2.896	-3.890	-2.374	-2.743	-0.123	0.353
261197	-3.438	-3.585	-2.507	-1.753	-1.170	-2.525	-0.976	-2.279	0.387	0.361
226541	-2.231	-3.932	-3.977	-3.915	-4.597	-5.855	-4.540	-4.150	-0.407	0.406
589552	-1.589	-2.279	-1.819	-3.337	-2.181	-2.957	-1.350	-2.216	-0.036	0.513
527718	-0.460	-1.686	-0.877	-3.114				-1.534	-0.715	0.515
520470	-1.292	-1.467	-1.136	-1.364	-0.701	-3.741	-2.543	-1.749	-0.281	0.717
277034	-0.698	-0.993	-0.444	-2.122	-1.737	-1.495	0.619	-0.981	0.059	0.828
640718	-4.820	-1.914	-0.969	-2.218	-0.968	-1.209	-0.152	-1.750	0.551	0.875
512179	1.614	-1.550	-0.069	-1.430	-0.247	-1.638	-0.439	-0.537	-0.233	1.077
219897	-3.563	-2.985	-4.179	-4.637	-4.393	-6.271	-9.676	-5.101	-0.897	1.361
220086	-1.995	-2.645	-3.188	-3.823	-4.211	-7.410	-3.903	-3.882	-0.581	1.445
528842	1.565	-2.961	-2.034	-2.609	-1.860	-2.073	-1.857	-1.690	-0.297	1.818
532419	-4.524	-4.192	-0.422	-1.648	-3.978	-3.078	-2.551	-2.913	0.164	2.096
299710	-0.274	-2.385	-1.391	-1.317	-5.397	-1.550	-1.358	-1.953	-0.200	2.498
565479	-10.81	-4.299	-5.186	-4.830	-3.935	-3.960	-4.450	-5.352	0.750	3.363
239090	-9.912	-4.863	-2.373	-1.873	-1.246	-2.800	-1.032	-3.443	1.139	3.700
249439	-0.915	-1.971		-2.480	-1.552	-9.232	-7.753	-3.984	-1.215	4.756
Pac.Cod										
277034	-2.283	-1.220	-1.733	-1.040	-0.956	-0.900	-0.367	-1.214	0.256	0.082
239090	-4.230	-0.144	-2.371	-2.027	-2.244	-1.957	-2.245	-2.174	0.088	1.375
640718	-5.273	-1.938	3.656	4.132	5.289	6.555	6.969	2.770	1.977	3.067
517487	-5.370	-2.720	3.690	3.678	4.529	5.541	5.208	2.079	1.753	4.228
241862	-5.030	-2.253	3.833	2.868	4.849	3.200	5.515	1.855	1.556	4.271
580792	-4.018	-2.121	4.293	5.402	6.122	5.882	5.615	3.025	1.669	4.967
261197	-5.269	-2.820	3.653	3.654	5.670	3.887	5.330	2.015	1.687	4.999
536838	-4.958	-1.866	3.718	5.055	6.162	4.778	5.147	2.577	1.645	5.422
223582	-5.212	-0.678	5.197	5.232	6.937	6.189	5.934	3.371	1.747	6.441
299710	-6.083	-1.298	4.333	5.722	5.576	5.677	5.755	2.812	1.811	6.579
249439	-11.77	-8.604	-1.104	-1.212	-1.032	-0.980	-0.506	-3.602	1.754	6.772
226541	-4.405	-2.057	5.306	5.039	6.500	5.428	4.920	2.962	1.576	7.021
504299	-14.08	-5.781	-2.790	-2.983	-4.002	-3.542	-3.115	-5.184	1.291	8.619
219897	-4.356	-1.799	6.191	5.659	4.747	2.871	3.995	2.473	1.177	9.622
247438	-5.680	-1.471	5.838	5.230	5.835	3.775	4.141	2.524	1.427	9.951
220086	-6.459	-1.850	5.884	5.324	5.616	3.715	4.791	2.432	1.593	10.66
227594	-5.548	-1.459	6.775	6.204	5.728	4.284	4.732	2.959	1.474	11.45
512179	-3.706	-1.405	4.552	4.730	5.176	3.050	-2.129	1.467	0.509	12.85
565479	-8.160	-2.539	4.460	5.004	3.975	3.548	1.609	1.128	1.464	13.33
532419	-6.395	-2.526	4.517	-4.175	-3.094	-3.782	3.443	-1.716	0.693	14.47
521200	-11.88	-10.35	3.199	-3.256	-2.282	3.022	3.214	-2.618	2.376	14.60
527718	-0.710	-9.727	-0.899	-1.576				-3.228	0.623	18.26

Table 9. **Estimates of *Boat* by *Year* fishing power coefficients** (continued).

Estimated **logistic** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Widow										
261197	-14.57	-14.49	-14.99	-14.55	-14.52	-14.84	-14.82	-14.68	-0.034	0.033
219897	-13.26	-14.17	-13.70	-13.97	-14.44	-14.44	-14.53	-14.07	-0.181	0.062
565479	-14.63	-15.16	-15.78	-15.07	-15.16	-15.28	-15.90	-15.28	-0.123	0.120
241862	-14.16	-14.53	-15.40	-14.92	-15.36	-15.24	-14.97	-14.94	-0.136	0.122
247779	-14.53	-14.93	-14.91	-14.03	-15.40	-15.47	-15.34	-14.94	-0.143	0.180
226541	-14.86	-15.23	-14.89	-14.07	-14.73	-15.25	-15.34	-14.91	-0.047	0.181
239090	-15.05	-14.06	-14.72	-14.52	-15.63	-15.51	-15.89	-15.05	-0.226	0.198
249439	-12.56	-12.86	-12.85	-13.43	-13.52	-13.40	-12.21	-12.98	-0.025	0.243
640904	-13.74	-14.38	-14.64	-14.21	-14.95	-13.54		-14.24	-0.008	0.285
247438	-13.59	-13.96	-14.10	-13.78	-15.08	-14.71	-13.55	-14.11	-0.084	0.302
299710	-7.073	-5.886	-4.350	-5.493	-4.957	-3.795	-4.614	-5.167	0.391	0.479
517487	-4.469	-7.059	-5.401	-4.118	-4.556	-5.065	-4.243	-4.987	0.197	0.858
626917	-3.815	-5.909	-7.974	-4.829	-5.272	-5.070		-5.478	-0.035	1.958
532419	-14.32	-5.268	-6.448	-6.035	-3.376	-4.158	-2.515	-6.017	1.454	5.532
536838	-14.91	-7.546	-5.686	-3.768	-6.991	-3.060	-3.636	-6.514	1.482	6.463
223582	-14.28	-14.30	-14.28	-13.85	-14.99	-6.970	-4.279	-11.85	1.570	7.295
220086	-4.847	-5.020	-14.22	-14.07	-13.81	-14.04	-14.14	-11.45	-1.626	7.503
512179	-16.13	-7.604	-7.520	-3.511	-3.553	-3.251	-4.385	-6.565	1.711	7.606
521200	-15.01	-3.351	-6.238	-4.974	-6.202	-3.674	-3.954	-6.200	1.163	10.13
528842	-5.366	-14.36	-6.276	-3.840	-4.642	-5.254	-4.501	-6.319	0.801	10.15
277034	-15.48	-16.73	-17.14	-17.07	-8.273	-17.03	-16.48	-15.46	0.188	10.19
580792	-15.74	-7.182	-15.21	-4.836	-5.730	-3.678	-3.815	-8.027	1.867	11.06
Small Rock.										
589552	-14.16	-13.84	-12.95	-14.70	-14.63	-13.88	-14.51	-14.10	-0.101	0.330
220086	-14.93	-13.45	-12.50	-15.09	-14.21	-13.78	-14.49	-14.06	-0.036	0.814
247438	-14.05	-13.31	-12.00	-14.46	-14.84	-13.85	-13.46	-13.71	-0.077	0.822
512179	-5.008	-5.528	-1.621	-3.743	-2.562	-2.804	-2.832	-3.443	0.394	1.236
504299	-6.629	-5.699	-6.638	-3.125	-5.654	-6.313	-6.721	-5.826	-0.019	1.612
249439	-14.00	-12.67	-10.76	-14.67	-14.32	-13.54	-12.66	-13.23	-0.046	1.773
532419	-15.58	-13.95	-13.01	-7.888	-5.175	-6.132	-4.098	-9.405	2.069	1.841
241862	-7.889	-16.03	-14.81	-17.25	-16.57	-16.52	-17.43	-15.21	-1.120	5.325
226541	-15.49	-14.42	-12.90	-14.82	-7.520	-14.37	-6.464	-12.28	1.163	7.457
239090	-6.886	-13.50	-2.983	-6.566	-4.588	-5.186	-4.878	-6.369	0.752	8.929
247779	-17.43	-15.35	-7.088	-5.306	-8.732	-8.381	-5.751	-9.719	1.690	9.339
223582	-14.95	-13.47	-12.44	-14.83	-14.97	-4.467	-3.992	-11.30	1.726	10.31
520470	-16.05	-4.699	-3.655	-5.753	-4.166	-2.755	-4.116	-5.885	1.399	11.80
261197	-7.193	-6.718	-15.11	-6.778	-8.892	-16.65	-17.26	-11.23	-1.566	12.35
227594	-8.546	-14.31	-13.48	-7.086	-7.102	-14.47	-15.18	-11.45	-0.495	12.48
565479	-6.574	-6.860	-5.609	-15.21	-5.874	-4.517	-7.074	-7.388	0.104	12.59
580792	-16.37	-14.51	-3.175	-4.273	-4.771	-5.356	-4.452	-7.558	1.874	13.32
517487	-16.26	-3.409	-3.313	-4.550	-4.225	-2.695	-2.434	-5.269	1.499	13.56
640904	-6.274	-6.080	-5.714	-16.81	-6.819	-15.95	-16.02	-10.52	-1.789	14.04
640718	-15.31	-14.18	-12.91	-6.027	-14.57	-14.16	-3.564	-11.53	1.201	15.46
219897	-13.93	-13.25	-2.960	-14.89	-14.37	-14.16	-14.62	-12.60	-0.546	16.94
626917	-7.140	-16.64	-15.51	-4.599	-4.856	-7.480	-4.431	-8.665	1.325	19.00

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Boat No. (Federal)	Estimated logistic model coeficients. 1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Misc. Rock.										
626917	-0.088		0.873	1.974	3.113	-1.513	3.219	1.263	0.283	3.113
219897	-3.044	-2.337	-3.372	-2.882	3.732	-1.988	5.268	-0.660	1.169	6.451
226541	0.357	-0.235	-2.042	2.519	5.259	-1.024	5.663	1.500	0.773	6.501
220086	-1.531	-2.162	-2.003	4.350	4.460	-0.959	5.699	1.122	1.091	6.846
247779	-0.927	-1.014	-1.725	5.057	6.051	-0.069	6.564	1.991	1.148	7.584
536838	0.819	-0.044	-0.406	7.918	6.791	1.683	6.607	3.338	1.001	8.349
517487	0.567	-2.329	-1.366	5.738	5.676	0.094	6.329	2.101	1.042	8.586
241862	-0.705	-1.920	-2.107	5.288	6.330	-0.125	6.326	1.870	1.183	8.841
247438	0.449	-0.333	-1.303	6.023	6.786	0.119	6.831	2.653	1.005	8.910
580792	0.859	1.714	-1.139	6.528	7.017	0.445	7.154	3.225	0.875	8.990
261197	-1.082	-3.511	-2.819	4.969	5.926	0.201	7.103	1.541	1.454	9.316
520470	-1.345	-1.646	-1.677	6.656	4.952	-0.777	5.912	1.725	1.076	9.740
640718	0.721	-0.064	-0.520	7.604	8.235	1.348	7.081	3.486	1.095	9.955
504299	-10.00	-1.143	-1.221	-3.176	5.774	0.202	6.610	-0.423	2.126	10.37
223582	-9.388	-1.295	-3.617	2.638	7.507	0.629	6.805	0.468	2.270	11.19
277034	0.081	-0.006	-2.404	4.714	3.678	-2.780	7.960	1.606	0.863	12.28
227594	0.326	-1.135	-2.466	4.754	4.643	-3.681	5.470	1.130	0.623	12.55
521200	0.023	-0.702	-2.081	4.382	-3.451	0.651	8.550	1.053	0.961	12.64
640904	-9.392	-10.80	-3.973	4.581	4.440	0.352	5.262	-1.361	2.667	12.83
528842	7.927	-1.270	-1.242	5.542	7.274	0.713	6.745	3.670	0.319	16.42
532419	-2.760	-9.384	-0.593	5.599	-3.478	0.680	1.785	-1.164	1.103	16.60
249439	-2.787	-4.496	-9.972	2.440	-3.460	-9.222	-2.530	-4.290	-0.077	17.97
Yellowtail										
536838	-7.350	-5.352	-5.603	-5.027	-4.200	-2.952	-3.035	-4.788	0.684	0.216
527718	-14.59	-15.55	-14.88					-15.00	-0.142	0.219
247438	-14.84	-15.79	-15.34	-15.49	-16.19	-15.54	-14.69	-15.41	0.003	0.272
517487	-4.381	-6.115	-4.954	-5.142	-4.294	-3.248	-3.618	-4.536	0.310	0.488
249439	-13.05	-13.19	-11.80	-14.17	-13.74	-13.54	-12.41	-13.13	-0.025	0.653
239090	-16.51	-16.98	-13.89	-15.22	-15.16	-15.02	-15.49	-15.47	0.205	0.841
520470	-4.409	-7.766	-6.234	-6.113	-6.425	-6.003	-4.987	-5.991	0.057	1.139
226541	-8.161	-6.950	-5.677	-5.230	-6.623	-6.405	-7.950	-6.714	0.028	1.173
640718	-6.968	-3.949	-4.103	-3.654	-4.166	-0.876	-3.567	-3.898	0.582	1.562
299710	-5.336	-4.503	-6.360	-6.664	-0.931	-4.953	-4.549	-4.757	0.246	3.272
640904	-14.71	-6.933	-5.702	-6.097	-4.967	-3.279	-3.262	-6.421	1.513	4.561
247779	-14.71	-15.92	-14.56	-15.00	-6.801	-6.968	-6.849	-11.54	1.759	4.844
512179	-5.334	-6.591	-7.043	-6.397	-7.636	-6.041	-14.51	-7.651	-0.965	5.335
580792	-14.21	-16.50	-7.615	-6.486	-4.449	-4.500	-5.212	-8.425	1.934	6.640
521200	-13.03	-14.71	-5.892	-5.058	-4.705	-3.303	-5.491	-7.456	1.665	7.160
565479	-15.46	-16.17	-15.55	-7.345	-14.55	-6.030	-7.257	-11.77	1.638	8.784
532419	-6.889	-6.039	-5.297	-6.155	-12.62	-3.323	-4.008	-6.333	0.241	8.982
223582	-16.35	-17.15	-15.82	-16.62	-15.38	-6.127	-4.204	-13.09	2.104	9.291
220086	-8.283	-16.40	-8.488	-16.82	-15.70	-15.56	-16.41	-13.95	-1.068	9.316
504299	-5.095	-6.760	-6.841	-13.00	-3.974	-4.035	-5.785	-6.498	0.223	9.322
241862	-15.19	-15.36	-15.39	-15.82	-15.49	-6.548	-4.052	-12.55	1.819	9.644
277034	-5.653	-15.77	-15.85	-15.87	-15.85	-15.25	-14.87	-14.16	-0.951	9.992

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **logistic** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
P.O.Perch										
227594	-29.42	-28.85	-28.59	-28.60	-28.89	-28.28	-28.07	-28.67	0.175	0.052
219897	-26.61	-27.09	-26.60	-27.34	-27.87	-27.76	-27.59	-27.26	-0.198	0.087
220086	-28.82	-28.25	-27.67	-28.06	-28.33	-27.89	-28.06	-28.15	0.084	0.102
521200	-16.51	-16.84	-17.40	-17.63	-16.58	-16.97		-16.99	-0.050	0.190
512179	-27.55	-26.05	-26.34	-27.21	-27.47	-26.94	-26.98	-26.93	-0.043	0.305
527718	-25.25	-24.55	-22.21	-22.34				-23.59	1.106	0.336
565479	-29.05	-27.95	-28.49	-27.69	-26.69	-28.06	-28.12	-28.01	0.156	0.413
277034	-28.37	-26.03	-26.40	-26.15	-25.71	-26.50	-26.05	-26.46	0.240	0.507
239090	-29.45	-27.27	-26.54	-26.71	-27.71	-26.31	-26.82	-27.26	0.309	0.707
247779	-29.18	-25.93	-27.63	-27.43	-26.49	-26.47	-25.18	-26.90	0.431	0.845
640904	-26.29	-27.44	-27.39	-29.70	-28.08	-28.01	-27.20	-27.73	-0.163	0.983
247438	-25.29	-27.19	-25.67	-27.13	-28.29	-27.35	-25.79	-26.67	-0.159	1.089
249439	-25.47	-25.38	-19.27	-26.05	-26.92	-25.54	-21.78	-24.35	0.111	7.543
223582	-28.31	-27.30	-27.75	-27.83	-27.69	-18.62	-17.72	-25.03	1.758	7.720
532419	-29.80	-17.91	-17.31	-18.03	-15.92	-14.90	-13.71	-18.23	1.989	10.18
261197	-30.17	-19.92	-27.89	-27.73	-27.99	-28.02	-28.07	-27.11	-0.357	10.18
226541	-29.57	-29.44	-28.15	-28.17	-19.63	-28.15	-28.71	-27.40	0.488	10.99
580792	-28.83	-16.51	-17.75	-17.38	-16.90	-16.57	-16.28	-18.60	1.371	11.84
520470	-28.67	-27.81	-28.92	-29.66	-18.62	-28.36	-28.24	-27.18	0.374	13.94
626917	-16.98	-15.16	-16.06	-16.21	-18.32	-28.04	-16.06	-18.12	-0.902	16.30
640718	-28.90	-17.22	-28.86	-17.31	-17.20	-18.47	-17.29	-20.75	1.572	19.52
517487	-19.46	-20.47	-29.54	-29.25	-17.36	-27.91	-28.31	-24.62	-1.045	22.69
Thornyhds										
640718	-22.54	-25.91	-23.18	-24.20	-23.89	-22.59	-23.73	-23.72	0.084	1.302
247779	-20.22	-28.96	-21.22	-21.68	-20.05	-18.68	-20.13	-21.56	0.786	8.666
536838	-11.69	-22.65	-21.51	-21.80	-21.00	-21.83	-22.13	-20.37	-1.042	9.849
277034	-8.906	-17.06	-17.48	-19.71	-18.59	-16.04	-15.16	-16.14	-0.637	10.55
219897	-19.38	-30.95	-29.33	-31.43	-31.62	-30.27	-30.91	-29.13	-1.268	11.55
517487	-12.73	-23.77	-23.95	-22.53	-22.23	-20.61	-22.57	-21.20	-0.767	12.41
247438	-18.86	-30.54	-29.15	-31.01	-31.42	-29.87	-29.63	-28.64	-1.187	12.67
226541	-13.57	-25.04	-22.71	-23.62	-23.83	-30.73	-24.64	-23.45	-1.633	13.43
249439	-17.54	-29.69	-26.26	-29.78	-30.00	-27.88	-27.32	-26.92	-1.052	13.98
239090	-21.53	-30.50	-28.97	-22.25	-22.74	-28.49	-29.48	-26.28	-0.486	14.17
227594	-21.14	-32.71	-23.35	-24.90	-31.92	-30.77	-31.00	-27.97	-1.223	15.09
512179	-8.685	-20.08	-21.60	-22.24	-23.87	-19.86	-22.09	-19.77	-1.502	15.24
261197	-21.21	-31.45	-29.91	-24.37	-21.51	-20.20	-20.23	-24.12	1.209	15.38
220086	-20.64	-31.84	-30.90	-31.45	-31.69	-30.19	-24.98	-28.81	-0.375	18.01
521200	-18.69	-20.84	-19.90	-29.00	-19.78	-16.41	-26.53	-21.59	-0.520	18.95
528842	-21.78	-34.03	-20.41	-23.12	-21.51	-20.46	-22.59	-23.41	0.844	19.61
580792	-9.097	-23.53	-21.80	-23.60	-21.81	-21.05	-21.10	-20.28	-1.109	19.68
520470	-19.67	-31.60	-22.75	-23.42	-23.16	-31.09	-22.77	-24.92	-0.310	20.36
626917	-18.24	-28.67	-28.55	-28.74	-20.46	-28.02	-21.78	-24.92	-0.043	20.97
527718	-27.04	-17.18	-26.50	-27.60				-24.58	-1.101	22.52
223582	-20.80	-30.09	-31.03	-31.62	-21.14	-21.44	-21.13	-25.32	0.936	23.52
241862	-18.47	-22.05	-29.61	-30.93	-20.68	-20.29	-20.62	-23.23	0.214	24.11

Table 9. **Estimates of *Boat* by *Year* fishing power coefficients** (continued).

Estimated **logistic** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Sablefish										
512179	-7.567	-7.242	-8.308	-10.53	-9.633	-9.511	-9.939	-8.961	-0.464	0.579
277034	-6.278	-4.717	-4.946	-7.226	-5.402	-5.828	-5.611	-5.715	-0.024	0.715
517487	-8.379	-6.744	-6.934	-7.923	-5.892	-5.296	-7.138	-6.901	0.274	0.801
226541	-7.197	-5.802	-6.561	-8.527	-6.165	-8.095	-8.659	-7.287	-0.306	0.908
580792	-9.142	-6.571	-6.398	-7.074	-5.148	-6.608	-6.492	-6.776	0.326	0.943
261197	-5.963	-6.787	-5.877	-7.556	-5.006	-6.247	-7.968	-6.486	-0.145	0.956
640718	-7.828	-6.005	-6.788	-8.249	-5.795	-7.918	-8.145	-7.247	-0.135	0.991
536838	-6.788	-5.628	-5.765	-5.927	-4.396	-6.198	-8.119	-6.117	-0.134	1.220
241862	-8.536	-6.811	-5.899	-8.791	-5.371	-6.429	-7.047	-6.983	0.206	1.435
626917	-14.14	-13.91	-14.47	-14.04	-12.16	-8.976	-8.827	-12.36	1.003	1.438
589552	-4.757	-6.457	-6.695	-9.090	-5.582	-4.567	-7.757	-6.415	-0.147	2.549
249439	-14.79	-13.51	-10.65	-15.77	-14.29	-14.81	-13.47	-13.90	-0.081	2.665
521200	-7.806	-6.408	-6.232	-9.318	-12.70	-8.270		-8.455	-0.694	3.982
247438	-14.10	-14.07	-12.58	-15.13	-14.39	-9.075	-15.11	-13.49	0.183	4.369
223582	-8.801	-6.674	-6.537	-10.07	-3.090	-6.464	-7.596	-7.034	0.267	4.490
239090	-8.052	-6.453	-12.83	-8.440	-6.133	-6.649	-8.020	-8.082	0.228	4.946
219897	-15.40	-14.01	-12.67	-9.627	-14.27	-15.59	-9.454	-13.00	0.467	5.507
227594	-8.812	-6.911	-6.955	-8.934	-7.862	-15.32	-16.48	-10.18	-1.455	6.125
247779	-7.339	-13.82	-5.767	-6.831	-5.331	-7.304	-7.170	-7.651	0.499	6.852
504299	-16.16	-6.746	-11.54	-7.329	-8.675	-9.703	-7.233	-9.627	0.848	7.745
520470	-14.44	-12.96	-5.013	-8.303	-5.153	-7.548	-8.787	-8.887	0.988	8.544
528842	-16.13	-8.364	-5.915	-7.145	-5.253	-8.748	-7.627	-8.455	0.907	9.178
Dover sole										
512179	-8.376	-8.769	-9.230	-10.12	-9.670	-9.485	-11.58	-9.604	-0.410	0.304
580792	-7.314	-8.767	-8.198	-7.443	-6.593	-7.864	-8.911	-7.870	-0.049	0.675
532419	-8.077	-8.303	-7.387	-8.698	-5.719	-7.607	-7.490	-7.612	0.172	0.782
227594	-4.525	-7.465	-6.029	-5.871	-5.579	-7.198	-7.353	-6.289	-0.268	0.865
640718	-6.029	-8.092	-8.809	-7.888	-6.701	-8.723	-8.189	-7.776	-0.201	0.887
640904	-8.280	-6.367	-6.182	-4.320	-4.573	-5.752		-5.912	0.568	0.918
241862	-4.933	-5.913	-4.832	-5.162	-4.570	-3.307	-6.542	-5.037	0.023	1.049
565479	-6.258	-6.489	-6.124	-5.769	-8.954	-6.178	-8.245	-6.860	-0.292	1.103
219897	-4.562	-6.346	-4.801	-4.410	-3.527	-5.853	-6.324	-5.118	-0.108	1.103
247438	-7.505	-8.819	-7.276	-6.813	-5.847	-6.764	-8.712	-7.391	0.069	1.132
536838	-4.929	-7.723	-7.600	-6.670	-6.581	-7.413	-9.730	-7.235	-0.456	1.146
220086	-5.838	-8.168	-5.762	-5.812	-5.537	-6.285	-7.860	-6.466	-0.074	1.150
261197	-5.458	-7.737	-5.430	-4.154	-4.374	-5.081	-6.066	-5.471	0.162	1.307
517487	-8.441	-9.013	-7.264	-5.486	-7.636	-7.414	-9.277	-7.790	0.011	1.646
277034	-4.170	-4.320	-3.195	-3.010	-1.558	-3.228	-5.795	-3.611	-0.038	1.740
226541	-7.239	-7.098	-4.814	-3.000	-5.218	-5.051	-6.674	-5.585	0.192	2.145
299710	-6.305	-7.695	-6.651	-5.171		-7.947	-10.97	-7.457	-0.571	2.224
239090	-4.807	-8.463	-7.789	-6.271	-4.081	-7.914	-5.575	-6.414	0.089	2.811
589552	-3.371	-8.939	-7.818	-8.281	-5.608	-8.620	-10.86	-7.642	-0.700	3.677
520470	-10.47	-11.60	-8.031	-6.226	-6.329	-11.17	-10.27	-9.156	0.112	5.078
521200	-15.51		-8.316	-13.04	-12.70	-13.20	-10.23	-12.16	0.402	5.615
626917	-12.12	-14.51	-12.10	-12.05	-6.202	-13.94	-10.76	-11.67	0.397	6.676

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **logistic** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Arrowtooth										
504299	-19.18	-19.16	-19.18	-19.32	-19.11	-18.20	-20.15	-19.18	-0.032	0.315
227594	-9.248	-7.796	-8.318	-9.620	-9.775	-10.01	-10.49	-9.322	-0.343	0.363
521200	-20.43	-19.59	-19.09	-19.38	-18.89	-17.47	-19.62	-19.21	0.246	0.547
640718	-12.71	-13.16	-11.56	-11.80	-10.66	-12.51	-12.78	-12.17	0.072	0.734
626917	-16.53	-19.07	-18.53	-19.28	-18.29	-19.17	-21.34	-18.89	-0.514	0.823
565479	-8.856	-10.87	-10.71	-12.75	-11.18	-11.47	-13.75	-11.37	-0.584	0.842
249439	-19.20	-18.71	-16.97	-20.98	-19.53	-19.49	-19.32	-19.17	-0.160	1.312
536838	-15.17	-14.64	-11.67	-11.00	-11.08	-10.71	-11.86	-12.30	0.657	1.325
512179	-21.00	-19.51	-20.69	-21.89	-21.52	-20.53	-13.26	-19.77	0.726	6.364
223582	-21.93	-19.26	-10.78	-12.34	-10.73	-11.81	-11.18	-14.00	1.686	7.923
580792	-22.19	-12.22	-12.91	-11.45	-10.16	-11.07	-10.71	-12.96	1.411	8.145
527718	-5.688	-5.225	-16.38	-16.97				-11.07	-4.500	8.299
247438	-11.03	-9.126	-9.233	-10.20	-11.67	-12.06	-21.37	-12.10	-1.404	8.797
241862	-21.62	-12.48	-21.06	-22.38	-21.24	-21.60	-23.89	-20.61	-0.901	9.971
261197	-11.70	-13.77	-12.92	-22.56	-13.37	-21.55	-23.52	-17.06	-1.838	11.31
226541	-11.35	-12.85	-11.34	-13.47	-11.41	-12.60	-23.55	-13.80	-1.291	11.44
532419	-14.04	-21.98	-11.34	-20.66	-19.03	-18.81	-20.89	-18.11	-0.782	12.64
277034	-22.09	-11.32	-7.750	-8.003	-6.950	-5.172	-7.121	-9.772	2.071	12.90
220086	-12.49	-14.29	-14.27	-21.89	-21.41	-20.98	-13.95	-17.04	-0.890	13.58
528842	-21.72	-13.06	-9.817	-10.53	-11.04	-12.80	-15.78	-13.53	0.611	15.23
517487	-23.94	-12.14	-10.77	-9.432	-10.13	-10.57	-12.28	-12.75	1.385	16.44
247779	-9.965	-18.84	-21.08	-11.23	-10.42	-10.87	-12.07	-13.50	0.724	17.89

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **lognormal** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
English										
527718	1.930	3.813						2.872	1.883	0.000
520470	4.148			4.043	4.498			4.230	0.059	0.042
565479	3.927	4.393	4.432	4.407	5.043	4.652	5.502	4.622	0.209	0.058
640904	3.737	4.285	3.450	3.744	3.427	3.129	3.325	3.585	-0.128	0.067
580792	5.106	4.902		5.163	4.208	4.439	4.504	4.720	-0.121	0.075
220086	4.492	4.938	4.817	5.489	5.071	4.989	4.687	4.926	0.034	0.095
247438	2.944	2.456	2.774	3.621	3.233	3.187	3.241	3.065	0.100	0.095
241862	3.818	4.382	3.435	4.188	3.904	3.774	3.433	3.848	-0.068	0.104
239090	3.797	3.932	3.570	4.603	4.636	4.144	4.371	4.150	0.115	0.105
223582	4.535	5.599	4.800	5.258	5.090	4.630	4.705	4.945	-0.041	0.141
227594	4.715	4.965	4.074	4.927	4.362	4.795	5.301	4.734	0.061	0.148
640718	4.157	3.996	3.331	4.553	3.856	4.061	4.433	4.055	0.053	0.148
247779	3.562	4.118	3.169	3.697	3.588	4.222	3.275	3.662	-0.008	0.155
532419	4.450		3.273	3.517			3.493	3.683	-0.131	0.166
249439	3.474	3.676	2.664	3.924	3.834	3.396	3.714	3.526	0.047	0.168
219897	4.885	5.177	5.030	6.361	5.457	5.389	5.052	5.336	0.048	0.234
261197	2.815	4.161	3.757	4.368	3.641	3.392	3.439	3.653	0.008	0.266
226541	4.366	5.038	4.575	6.094	5.408	5.017	4.720	5.031	0.066	0.316
277034	4.066	4.365	4.108	5.425	4.941	3.685	3.803	4.342	-0.047	0.387
536838	4.062	4.596	5.311	3.560	3.317	2.287	2.514	3.664	-0.402	0.427
299710	2.780	4.193	3.648	5.192		5.477	4.578	4.311	0.321	0.446
528842	4.899	3.884		6.107	4.379	4.702		4.794	0.053	0.674
Petrale										
241862	3.811	3.621	2.802	3.183	2.618	2.539	2.240	2.973	-0.252	0.044
219897	5.074	4.622	4.045	4.202	3.967	3.251	3.527	4.098	-0.266	0.052
226541	4.312	3.974	3.785	4.306	3.676	3.540	3.227	3.831	-0.151	0.052
261197	3.448	3.171	2.664	2.984	2.268	1.950	2.253	2.677	-0.229	0.056
565479	4.185	4.341	3.734	4.011	3.246	2.946	3.135	3.657	-0.230	0.058
512179	4.075	3.699	3.002	3.328	3.026	2.099	1.645	2.982	-0.374	0.081
220086	5.205	4.690	3.972	4.270	4.036	3.208	3.640	4.146	-0.271	0.092
247779	3.422	3.584	2.983	2.381	2.856	3.218	2.777	3.032	-0.100	0.122
580792	4.427	4.176	3.930	4.683	3.807	4.667	3.640	4.190	-0.054	0.161
223582	4.738	4.254	3.471	4.148	3.290	2.299	2.983	3.598	-0.334	0.180
640904	2.994	3.796	3.100	2.273	2.895	2.311		2.895	-0.198	0.181
227594	4.931	4.862	3.751	4.281	3.642	3.108	3.945	4.074	-0.235	0.183
239090	4.061	3.749	2.628	3.148	3.297	2.749	3.377	3.287	-0.121	0.193
249439	3.460	3.409		3.959	3.165	2.482		3.295	-0.144	0.200
520470	3.499	4.002	2.999	4.310	3.748	4.467		3.838	0.154	0.211
536838	4.763	3.577	2.774	2.389	2.080	1.941	2.236	2.823	-0.412	0.239
247438	2.718	3.272	2.430	2.254	3.637	2.136	2.445	2.699	-0.067	0.289
521200	2.475		3.172	3.016		1.460		2.531	-0.201	0.423
640718	5.006	4.496	3.143	3.195	3.422	3.043	4.165	3.781	-0.184	0.439
517487	4.546	4.115	2.174	3.907	3.219	2.476	2.480	3.274	-0.301	0.445
532419	2.253	3.370	3.110	1.496		2.009		2.448	-0.189	0.474
589552	3.435	4.238	2.997	4.954	2.652	2.065	3.044	3.341	-0.209	0.749

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **lognormal** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Rex sole										
277034	3.281	3.624						3.453	0.343	0.000
527718	4.633	2.703						3.668	-1.930	0.000
249439	2.598	2.469					2.948	2.672	0.070	0.010
239090	3.425	3.355	4.161	3.771	4.098		4.085	3.816	0.122	0.059
226541	3.637	3.935	4.218	4.633	4.352	4.062	4.474	4.187	0.104	0.065
517487	4.485	3.861		4.271	3.696	3.641		3.991	-0.129	0.066
241862	2.425	2.267	2.955	2.020	2.572	2.025	1.862	2.304	-0.091	0.105
219897	4.144	3.643	4.906	5.060	5.141	5.160	5.341	4.771	0.245	0.117
220086	3.427	3.803	4.821	4.485	4.657	4.569	4.425	4.312	0.156	0.142
223582	3.703	4.030	4.301	4.297	3.982	3.339	2.982	3.805	-0.138	0.157
299710	2.517					4.481	3.890	3.629	0.282	0.195
247438	1.198	1.304	2.558	2.563	1.747	1.976	2.491	1.977	0.158	0.227
247779	2.914	3.323	1.969	2.487	2.506		3.373	2.762	0.034	0.291
227594	3.579	3.170	3.620	3.461	4.446	4.917	3.412	3.801	0.136	0.315
536838	3.182	3.326	3.767	3.572	3.514	1.802	2.318	3.069	-0.210	0.324
580792	3.220		4.822	3.363	3.328	3.897	3.115	3.624	-0.054	0.404
532419	4.135	3.208	3.928	3.730	2.392	4.182	3.954	3.647	-0.005	0.412
589552	4.071	2.838	4.685		4.260	3.987		3.968	0.091	0.436
565479	2.632	2.379	3.878	3.753	4.078	2.982	5.227	3.561	0.328	0.460
261197	2.250	2.692	4.203	3.528	3.782	2.691		3.191	0.137	0.508
512179	4.993			5.640		3.887		4.840	-0.187	0.565
640904	1.935	3.018	4.023	2.232		2.405	2.034	2.608	-0.087	0.586
Sanddab										
640718	5.756				3.610			4.683	-0.536	0.000
247779	3.925	1.906	4.199	3.169	3.282	2.425	3.274	3.169	-0.065	0.614
226541	5.567	4.414	5.485	6.941	5.146	5.398	4.466	5.345	-0.060	0.700
277034	4.909		4.758	7.085				5.584	0.611	0.825
565479	5.085				3.861	5.819		4.922	0.017	0.976
241862	4.278			5.495	2.487	3.922	2.865	3.809	-0.252	1.093
219897	5.805	2.777	5.501	5.915	5.249	6.064	5.059	5.196	0.146	1.169
227594	5.430	2.211	4.770	5.510	3.603	5.434	4.278	4.462	0.065	1.466
239090	4.796	2.315		5.802	3.783	6.083	5.726	4.751	0.349	1.488
247438	4.101	0.491	3.617	3.858	2.945	4.375	3.593	3.283	0.199	1.533
261197	5.206	1.760	4.713	4.840	3.789		4.555	4.144	0.081	1.552
223582	5.904	2.058	5.042	5.651	5.197	5.653	4.501	4.858	0.112	1.687
249439	5.585	2.079	2.575	5.536	4.884	4.918	4.053	4.233	0.121	1.905
220086	6.110	2.318	6.704	6.107	4.448	5.679	4.474	5.120	-0.016	2.248
299710										
504299										
512179										
517487										
520470										
521200										
527718										
528842	3.585							3.585		

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **lognormal** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Lingcod										
247779	2.403		1.585	1.710	1.965	1.207	1.047	1.653	-0.196	0.067
512179	4.000	4.561	4.301	4.658	4.118	3.996	4.020	4.236	-0.045	0.068
227594	2.001	2.681	1.903	1.711	1.914	1.814	1.319	1.906	-0.135	0.082
299710	2.656	3.038	2.231	2.898		3.174	3.206	2.867	0.095	0.089
249439	1.585	2.090		1.289	1.871			1.709	-0.023	0.119
241862	2.029	2.153	2.220	2.059	2.092	1.490	0.583	1.804	-0.207	0.147
277034	2.083	2.055	2.549	2.695	3.076	3.054	2.073	2.512	0.089	0.168
580792	4.908	3.218	3.895	3.038	3.344	2.826	2.537	3.395	-0.302	0.202
219897	2.937	2.939	2.268	2.549	3.071	1.616		2.563	-0.169	0.204
239090	2.394	1.876	1.651	1.950	2.938	3.064		2.312	0.195	0.211
220086	3.569	2.565	1.983	1.768	2.641	1.552	1.637	2.245	-0.256	0.221
640904	1.669	1.764	2.725	1.562	2.672			2.078	0.180	0.245
261197	2.097	3.495	3.124	2.091	2.275	1.651	1.745	2.354	-0.200	0.297
247438	0.764	1.234	0.834	1.032	1.736	0.485	-0.241	0.835	-0.129	0.305
640718	3.379	2.399	3.136	2.081	3.712	2.714	2.927	2.907	-0.005	0.317
536838	1.805	2.970	3.014	2.944	2.583	1.739	1.657	2.387	-0.119	0.329
520470	5.600	6.659	5.464	4.002	3.658	3.047	3.036	4.495	-0.597	0.338
589552	2.193	3.283	3.488	3.056	2.709	1.490	3.039	2.751	-0.065	0.464
504299	5.544	5.103		3.018	4.497	4.030	3.936	4.355	-0.254	0.465
517487	2.961	3.946	4.082	2.394	3.905	2.650	2.335	3.182	-0.166	0.469
226541	2.500	3.120	2.868	2.952	3.405	1.049	1.789	2.526	-0.205	0.496
565479	1.754	1.832	2.431	3.624	1.488	1.525		2.109	-0.028	0.663
Pac.Cod										
239090	1.839	4.300						3.070	2.461	0.000
277034	2.773	3.294						3.034	0.521	0.000
640718	3.691	4.155	4.398		4.754		4.803	4.360	0.177	0.029
589552	5.614	4.911	4.238	5.071	4.371			4.841	-0.233	0.175
521200	4.320		4.147			5.840		4.769	0.325	0.201
299710	3.189	4.328	3.898	3.935		3.526	4.633	3.918	0.102	0.217
223582	2.396	3.718	3.965	3.611	3.822	3.218	4.091	3.546	0.141	0.243
528842	5.825	5.734	5.437	3.243	4.530	3.437		4.701	-0.507	0.425
226541	2.948	5.107	4.724	4.659	4.792	4.152	4.664	4.435	0.118	0.444
512179	5.329	6.610	6.702	5.831	4.927	4.924		5.721	-0.227	0.456
517487	2.879	4.703	4.565	3.505	3.638	3.513	4.587	3.913	0.065	0.476
532419	2.298	4.514	4.425				5.342	4.145	0.391	0.629
220086	2.348	4.276	4.419	4.552	4.420	2.734	4.345	3.871	0.104	0.794
227594	2.102	4.629	3.990	3.923	3.877	2.730	4.633	3.698	0.132	0.818
580792	3.901	5.094	5.803	4.686	4.766	3.582	6.139	4.853	0.095	0.820
261197	2.545	4.678	4.410	2.906	3.699	2.099	3.692	3.433	-0.087	0.880
219897	2.841	4.758	4.640	4.144	4.616	2.320	4.238	3.937	-0.025	0.927
520470	5.453	2.663	4.026	4.518	4.747	3.406		4.136	-0.100	0.959
241862	2.060	3.635	3.949	2.353	3.183	0.697	3.076	2.708	-0.128	1.148
565479	2.097	4.472	4.820	3.213	3.721	1.994	4.219	3.505	0.011	1.261
247779	1.657		3.627	3.369	3.066	1.242	4.360	2.887	0.183	1.285
247438	0.638	3.848	2.816	3.308	2.494	0.846	2.255	2.315	-0.053	1.419

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **lognormal** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Widow										
220086	5.554	7.669						6.612	2.115	0.000
223582	3.176					5.473		4.325	0.459	0.000
504299	7.644	7.490			7.207	6.693	7.570	7.321	-0.072	0.116
520470	6.229		6.659	6.368	7.503	6.797	7.845	6.900	0.235	0.154
536838	4.722	4.663	5.339	3.629	3.971	3.954		4.380	-0.218	0.240
512179	6.463	6.685	5.472	7.026	6.459	6.311		6.403	0.003	0.270
580792	7.039	7.511		6.789	5.534	6.606		6.696	-0.233	0.304
626917	8.725	8.086	6.978	8.507	7.804	7.912		8.002	-0.097	0.343
521200	7.026	8.187	6.693	7.013	5.687	6.189		6.799	-0.325	0.360
517487	7.408	6.204	5.917	6.411	5.171	5.613	6.599	6.189	-0.156	0.411
299710	5.704	5.874	4.042	6.359		5.892	5.724	5.599	0.062	0.618
589552	3.996	5.784	6.059		4.824	4.641		5.061	-0.019	0.720
527718	6.183	8.066	6.654					6.968	0.236	0.905
532419	6.746	6.901	3.406	7.704	6.306	5.721		6.131	-0.075	2.194
227594	6.223		2.494		4.282			4.333	-0.485	2.536
528842	6.958		4.654	8.510	5.717	4.019		5.972	-0.392	2.689
219897										
226541										
239090										
241862										
247438										
247779										
Small Rock.										
223582	4.040					3.148		3.594	-0.178	0.000
226541	5.648				5.706			5.677	0.014	0.000
640718	4.517			5.524				5.021	0.336	0.000
227594	3.864			4.392	4.437			4.231	0.151	0.003
532419	6.127			5.368	5.370	5.333		5.550	-0.168	0.018
261197	5.138	5.203		4.403	3.709			4.613	-0.366	0.049
277034	3.161	3.434	2.584		3.390	2.983		3.110	-0.014	0.119
527718	3.227	3.440	4.848					3.838	0.810	0.119
299710	4.772		5.750	5.278				5.267	0.214	0.132
517487	5.730	6.169	6.122	5.004	4.693	3.827		5.258	-0.430	0.198
640904	3.269	4.204	3.396		2.911			3.445	-0.169	0.215
239090	3.002		3.725	2.334	2.488	2.332	2.986	2.811	-0.096	0.250
504299	5.161	6.473	5.626	5.287	4.588	4.519	4.802	5.208	-0.215	0.252
580792	5.303		6.115	5.032	5.041	4.131		5.124	-0.243	0.285
536838	4.866	6.167	4.594	5.072	4.709	4.213		4.937	-0.205	0.299
626917	5.095			6.005	5.811	4.670	5.914	5.499	0.052	0.329
247779	3.031		3.575	3.828	4.405	2.541		3.476	0.020	0.516
528842	6.381		7.518			5.665		6.521	-0.181	0.666
521200	4.475	7.413	4.599	5.513	4.989	4.924		5.319	-0.118	1.135
520470	6.474	9.116	5.757	5.891	4.793	5.644		6.279	-0.485	1.400
565479	2.850	5.347	5.495		2.547	2.843	3.954	3.839	-0.166	1.580
512179	1.692	6.883	5.888	5.866	4.689	4.609	5.321	4.993	0.184	2.573

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **lognormal** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Misc. Rock.										
527718	4.915	4.080						4.498	-0.835	0.000
640904	3.956		3.257					3.607	-0.350	0.000
247779	2.953	2.577	3.247	3.086	3.322	3.438	4.089	3.245	0.186	0.057
580792	5.745	5.744	6.473	5.993	6.182	6.810	6.575	6.217	0.155	0.062
261197	4.450	4.042	4.291	3.544	3.956	3.982	4.354	4.088	-0.027	0.092
226541	5.671	5.104	5.228	5.548	5.280	6.275	5.677	5.540	0.086	0.121
241862	3.434	2.575	3.374	2.713	3.414	2.915	2.710	3.019	-0.052	0.129
504299	6.333	5.778	6.762		6.340	6.051		6.253	-0.007	0.135
565479	4.451			4.287		5.255		4.664	0.144	0.137
219897	4.550	3.936	5.263		5.107	5.341	5.187	4.897	0.163	0.152
220086	5.648	5.508	5.263	4.813	5.047	6.067	5.544	5.413	0.021	0.169
640718	5.816	4.473	5.716	5.583	5.468	5.781	5.672	5.501	0.069	0.197
247438	4.174	4.009	3.189	3.168	3.673	3.780	4.326	3.760	0.017	0.205
512179	5.179	5.914	7.069	6.479	6.430	6.786	6.513	6.339	0.182	0.231
536838	5.519	4.673	4.730	4.683	4.315	5.573	5.429	4.989	0.040	0.248
517487	7.568	6.267	5.799	6.163	5.654	5.408	6.127	6.141	-0.221	0.263
521200	6.131	5.100	6.356	6.130		7.065	6.305	6.181	0.159	0.264
589552	5.604	5.073	6.670	5.878	5.331	5.387	6.458	5.772	0.066	0.338
626917	5.977		6.464	6.196	4.994	6.645	6.287	6.094	0.024	0.340
223582	4.841	5.523	5.132	3.578	4.483	4.592		4.692	-0.169	0.340
227594	5.128	5.033	5.276	3.834	5.194	5.622	4.503	4.941	-0.028	0.347
520470	8.635	7.216	6.691	6.810	6.928	6.778	7.506	7.223	-0.144	0.372
Yellowtail										
219897	2.612				1.884			2.248	-0.182	0.000
220086	1.846		2.685					2.266	0.419	0.000
223582	2.689					2.288		2.489	-0.080	0.000
241862	3.488					2.636		3.062	-0.170	0.000
247779	2.754				3.185	3.557		3.165	0.145	0.013
565479	2.623			3.390		2.391		2.801	-0.023	0.270
227594	3.826		5.122	4.033	3.956	2.395	2.874	3.701	-0.284	0.543
528842	4.385	2.451	5.342	4.237	4.058	5.098	6.086	4.522	0.325	0.848
517487	4.249	2.183	5.697	4.058	4.336	4.232	5.142	4.271	0.193	1.026
580792	4.857		6.734	5.997	4.041	5.020		5.330	-0.128	1.039
521200	5.419		5.640	7.409	4.588	5.177		5.647	-0.088	1.096
226541	1.928	0.703	3.669	4.435	2.232	3.546	3.195	2.815	0.287	1.218
520470	4.680	6.229	5.729	4.161	3.492	6.612	6.314	5.317	0.123	1.387
536838	5.912	2.339	4.608	5.334	3.043	4.424	4.526	4.312	-0.055	1.528
299710	2.771	1.426	5.681	4.294		4.803	4.738	3.952	0.407	1.555
626917	7.045	4.183		7.737	6.725	7.132		6.564	0.268	1.596
261197	2.873			5.709		3.893		4.158	0.263	1.627
640718	4.576	1.406	5.218	4.894	3.404	4.807		4.051	0.195	1.934
589552	4.723	0.902	4.833	4.345	3.866	4.855		3.921	0.259	2.094
532419	2.855	0.796	5.782	5.374		6.471	6.140	4.570	0.745	2.096
512179	4.507	3.434	7.527	8.383	7.490	6.593		6.322	0.670	2.183
504299	5.863	3.768	8.393		5.387	5.904	6.274	5.932	0.089	2.187

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **lognormal** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
P.O.Perch										
223582	6.516					11.04		8.777	0.904	0.000
241862	5.140						5.957	5.549	0.136	0.000
626917	5.276	4.334		6.765	7.613			5.997	0.711	0.480
504299	3.628	5.011	3.779		6.191		5.139	4.750	0.277	0.680
521200	4.343	4.289	3.403	3.572	3.913	6.489		4.335	0.279	0.981
532419	4.516	6.429	3.096	4.403	5.817	6.289		5.092	0.238	1.509
517487	4.338	7.021			5.277			5.545	0.046	1.844
580792	6.046	5.109	3.323	7.048	6.955	10.38		6.476	0.883	2.822
528842	6.334	6.438	2.249	3.787	5.611			4.884	-0.410	2.879
589552	5.810	6.577	2.202		6.149			5.185	-0.082	4.033
536838	3.225				4.050	9.613	5.737	5.656	0.667	4.973
299710	2.594	6.688	2.806			9.058	4.933	5.216	0.529	5.551
219897										
220086										
226541	5.426							5.426		
227594										
239090										
247438										
247779										
249439										
261197	3.818							3.818		
277034										
Thornyhds										
227594	0.070		0.424					0.247	0.177	0.000
239090	0.420			1.488				0.954	0.356	0.000
504299	3.482				1.860			2.671	-0.405	0.000
565479	3.279					0.420		1.850	-0.572	0.000
626917	1.149				1.515			1.332	0.091	0.000
640904	0.067			0.440	0.655	0.708		0.468	0.134	0.001
261197	0.771			1.148	1.120	1.204		1.061	0.087	0.003
241862	0.383	0.421			-0.093	0.294		0.251	-0.058	0.036
528842	2.159		1.570	2.022	1.137	1.289		1.635	-0.182	0.076
520470	1.162		1.782	2.072	1.211			1.557	0.070	0.183
521200	2.164	1.411	2.401		3.264			2.310	0.354	0.217
223582	1.111				0.992	-0.191		0.637	-0.194	0.253
277034	3.474	1.659	2.319	2.522	2.461	2.225	1.583	2.320	-0.157	0.282
512179	2.537	2.432	1.770	2.349	0.440	1.106	1.468	1.729	-0.257	0.301
640718	1.557	-0.028	1.486	2.167	1.699	1.750		1.439	0.195	0.439
580792	3.313	1.047	2.304	1.607	1.932	2.266		2.078	-0.094	0.553
589552	1.386	2.332	3.119		1.359			2.049	-0.039	0.709
536838	3.316	0.966	1.288	0.045	0.102	-0.876	0.901	0.820	-0.433	0.871
247779	0.618		1.286	-0.619	0.269	2.325		0.776	0.173	1.112
226541	4.613	2.513	3.100	0.340	1.500		1.573	2.273	-0.480	1.133
532419	1.073			2.057	-0.297	2.301		1.284	0.078	1.364
299710	2.122		1.338	1.791		5.188		2.610	0.607	1.461

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Estimated **lognormal** model coeficients.

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
Sablefish										
219897	5.770			5.266				5.518	-0.168	0.000
527718	6.510	3.620						5.065	-2.890	0.000
626917	5.789					4.971		5.380	-0.164	0.000
640904	5.883		5.229	4.918	4.936			5.242	-0.253	0.016
247779	4.748		4.350	4.976	4.573	5.184	5.316	4.858	0.111	0.079
241862	4.488	5.292	4.387	4.741	4.274	4.450	4.569	4.600	-0.056	0.100
536838	4.377	4.854	4.579	4.650	4.362	3.640	4.586	4.435	-0.072	0.127
512179	3.378	4.217	4.554	4.382	5.162	4.411	5.166	4.467	0.227	0.132
220086	6.465	5.719	6.000			5.193	5.929	5.861	-0.104	0.141
261197	5.773	6.244	5.772	4.825	4.348	4.247	4.457	5.095	-0.334	0.144
227594	5.432	4.434	4.108	4.809	3.685			4.494	-0.312	0.203
589552	4.863	4.648	4.808	5.314	4.358	3.745	4.978	4.673	-0.068	0.231
277034	3.979	3.613	4.861	5.190	4.645	4.062	4.988	4.477	0.132	0.270
226541	5.961	5.968	6.268	5.645	4.918	5.095	6.330	5.741	-0.071	0.281
580792	4.002	5.014	6.198	5.253	5.783	5.327	6.596	5.453	0.285	0.340
520470	6.385		6.070	6.243	6.072	4.313		5.817	-0.318	0.349
239090	5.773	6.573		4.289	4.915	5.112	4.283	5.158	-0.285	0.358
504299	6.457	6.307		5.166	6.776	6.258		6.193	-0.018	0.369
532419	6.840	6.500	4.860	4.425	3.974	4.609	4.437	5.092	-0.424	0.402
517487	5.508	5.354	5.772	6.696	4.580	4.351	6.120	5.483	-0.049	0.668
565479	4.805	2.699	4.552	3.571		3.737		3.873	-0.095	0.671
223582	5.050	4.819	4.598	6.278	4.456	3.361	4.888	4.779	-0.127	0.672
Dover sole										
504299	4.405				4.558			4.482	0.038	0.000
521200	5.184		4.305					4.745	-0.440	0.000
527718	1.548	0.743						1.146	-0.805	0.000
626917	3.416				3.291			3.354	-0.031	0.000
536838	3.589	3.122	3.126	2.889	2.519	2.072	1.631	2.707	-0.306	0.021
277034	3.800	3.904	4.160	4.220	3.819	4.444	4.327	4.096	0.083	0.034
223582	4.115		3.853	3.742	3.355	3.934	3.784	3.797	-0.052	0.052
219897	4.106	3.766	4.188	4.323	3.873	4.577	4.735	4.224	0.114	0.063
220086	4.077	3.887	4.104	3.531	3.561	4.443	4.082	3.955	0.021	0.103
239090	3.708	2.913	2.964	3.168	2.762	3.483	2.958	3.137	-0.047	0.106
249439	2.946	2.416		3.204	2.504	2.293		2.673	-0.072	0.127
241862	3.230	3.184	3.783	3.472	2.909	4.147	3.715	3.491	0.090	0.140
226541	3.018	3.703	4.195	4.386	3.543	4.351	4.563	3.966	0.189	0.147
227594	4.025	3.157	3.733	4.174	4.019	5.127	4.725	4.137	0.226	0.175
261197	3.853	3.350	4.194	3.947	3.558	4.777	3.846	3.932	0.078	0.184
532419	2.951	2.878	2.551	3.868	2.840	3.466	4.268	3.260	0.193	0.217
640718	3.647	2.515	2.279	3.116	2.654	2.745	3.445	2.914	0.008	0.253
247438	1.113	0.496	0.557	0.872	0.086	1.786	1.233	0.878	0.088	0.277
640904	4.276	3.490	4.039	4.929	3.513	4.001		4.041	-0.012	0.285
247779	3.287		2.564	3.372	2.604	4.221	4.134	3.364	0.184	0.352
580792	3.463	2.865	4.009	4.846	3.312	4.324	4.006	3.832	0.138	0.357
589552	4.019	2.341	2.042	2.634	3.615	3.464	2.897	3.002	0.016	0.520

Table 9. Estimates of *Boat* by *Year* fishing power coefficients (continued).

Boat No. (Federal)	1987	1988	1989	1990	1991	1992	1993	Mean	Trend Slope	Resid. Var.
	Estimated **lognormal** model coeficients.									
Arrowtooth										
219897	2.964	3.216						3.090	0.252	0.000
527718	4.155	2.874						3.515	-1.281	0.000
532419	3.255		4.612					3.934	0.678	0.000
640904	4.332					4.083		4.208	-0.050	0.000
520470	3.301		3.193	3.550	3.551			3.399	0.074	0.016
223582	1.769		2.023	2.092	2.858	3.106		2.370	0.278	0.049
247438	-0.223	-0.151	0.356	-0.197	0.317	-0.050		0.009	0.049	0.060
239090	1.639	1.411					4.668	2.573	0.552	0.156
227594	1.435	1.675	2.701	2.445	2.251	1.905	1.885	2.042	0.049	0.187
226541	3.001	3.660	3.701	3.588	3.274	2.465		3.282	-0.113	0.187
589552	3.151	3.980	2.477	1.744				2.838	-0.572	0.364
517487	3.370	2.631	3.780	3.435	2.894	1.557		2.945	-0.246	0.417
261197	4.565	4.073	4.106		6.211			4.739	0.452	0.417
220086	3.569	3.874	4.919				3.353	3.929	-0.074	0.444
536838	1.198	2.119	2.597	1.982	2.565	1.036	0.902	1.771	-0.110	0.460
299710	2.976	2.008	2.085			4.043	2.757	2.774	0.153	0.521
640718	2.701	2.239	3.794	4.207	3.244	3.251	2.140	3.082	-0.007	0.595
565479	2.381	1.241	2.775	3.389	2.152	2.423	1.176	2.220	-0.067	0.612
277034	4.255	6.714	4.752	4.559	5.026	5.102		5.068	-0.029	0.743
247779	3.633			4.106	3.292	2.642	0.818	2.898	-0.404	0.772
528842	4.651	2.261	2.318	2.586	3.808	4.444		3.345	0.111	1.144
580792	4.366	1.908	2.049	4.562	4.252	5.616		3.792	0.451	1.497

Table 10. Spatial distribution of tows used to derive standardized CPUE.
The tabulated values are the number of tows. The areas shown with tows were fished in every year of the study period. Standardized CPUE estimates were made only for these areas.

Latitude Class	40 Fathom Depth Class Midpoint												
	460	420	380	340	300	260	220	180	140	100	60	20	Total
48.167			35	122	220	294	293	321	439	1420	1071	383	4598
47.833		31		228	327	293	425	390	441	575	137	301	3148
47.500				117	160	149	145	138	170	892	905	764	3440
47.167				79	115	166	223	166	359	1488	966		3562
46.833				98	185	207	286	308	403	1681	1265	618	5051
46.500			29	72	129	129	184	168	193	656	3867	1319	6746
46.167				138	253	331	411	283	339	1745	2836	4612	10948
45.833			69	167	229	301	508	466	728	1954	988	211	5621
45.500				57	214	589	721	366	244	1089	302		3582
45.167				51	156	189	554	419	185	431	376	481	2842
44.833				55		239	695	918	708	1391	1791	492	6289
44.500					72		422	779	1121	1565	1621	822	6402
44.167			41	74	141	104	71	83	90	1411	1481	974	4470
43.833		39	68	180	449	605	366	657	368	1675	1484	767	6658
43.500			90	148	302	119	127	101	188	505	1000	837	3417
43.167			46	109	307	247	329	575	383	1508	695	107	4306
42.833			47	137	334	221	256	521	166	519	314		2515
42.500	17	33	58	112	158	113	142	150	149	306	377		1615
42.167			28	64	76		38	28			144		378
41.833										44	99		143
Total	17	103	511	2008	3827	4296	6196	6837	6674	20855	21719	12688	85731

Table 11. Landings associated with estimates of standardized CPUE.

Landings (1000s lb) from the standard areas (Table 9) by the top 40 boats, which were used for estimating standardized CPUE. The landings are also shown relative to those by all boats from the standard areas, and relative to the landings by all boats from all areas (Tickets).

	1987	1988	1989	1990	1991	1992	1993	Total
English Sole								
Top 40 Boats	476	403	553	391	622	448	560	3453
As % of All Boats	81%	84%	86%	86%	84%	83%	79%	83%
As % of Tickets	36%	32%	36%	35%	33%	32%	35%	34%
Petrale Sole								
Top 40 Boats	391	441	547	368	389	294	350	2779
As % of All Boats	65%	72%	80%	77%	73%	68%	71%	73%
As % of Tickets	21%	22%	29%	22%	19%	17%	21%	22%
Rex Sole								
Top 40 Boats	209	192	179	166	307	270	177	1500
As % of All Boats	89%	89%	90%	86%	93%	97%	89%	91%
As % of Tickets	33%	26%	29%	33%	32%	37%	29%	31%
Sanddab								
Top 40 Boats	268	77	65	214	274	292	312	1503
As % of All Boats	97%	94%	93%	98%	96%	97%	99%	97%
As % of Tickets	58%	32%	40%	50%	40%	45%	50%	46%
Lingcod								
Top 40 Boats	286	602	833	533	1555	298	393	4501
As % of All Boats	70%	88%	87%	81%	92%	73%	71%	84%
As % of Tickets	23%	32%	38%	33%	50%	22%	24%	35%
Pacific Cod								
Top 40 Boats	359	672	568	138	359	317	373	2786
As % of All Boats	73%	87%	89%	90%	86%	85%	83%	84%
As % of Tickets	25%	30%	33%	27%	32%	35%	36%	31%
Widow Rockfish								
Top 40 Boats	438	406	350	692	417	1274	1640	5218
As % of All Boats	76%	69%	61%	80%	76%	90%	81%	79%
As % of Tickets	3%	3%	2%	6%	4%	12%	11%	6%
Small Rockfish								
Top 40 Boats	305	401	630	591	593	456	1264	4240
As % of All Boats	76%	79%	86%	82%	88%	81%	86%	84%
As % of Tickets	15%	14%	21%	20%	17%	23%	29%	21%
Misc. Rockfish								
Top 40 Boats	706	1239	1997	1085	1312	1408	1327	9073
As % of All Boats	59%	78%	87%	88%	81%	83%	72%	79%
As % of Tickets	10%	15%	22%	20%	17%	22%	20%	18%

Table 11. Landings associated with estimates of standardized CPUE (cont.).

	1987	1988	1989	1990	1991	1992	1993	Total
Yellowtail Rockfish								
Top 40 Boats	299	452	305	360	359	616	632	3022
As % of All Boats	71%	82%	71%	87%	83%	86%	75%	79%
As % of Tickets	9%	10%	8%	10%	10%	8%	12%	9%
Pacific Ocean Perch								
Top 40 Boats	106	211	204	149	196	163	228	1259
As % of All Boats	80%	92%	95%	92%	92%	85%	87%	90%
As % of Tickets	10%	15%	13%	14%	12%	14%	15%	13%
Thornyheads								
Top 40 Boats	119	222	496	395	333	225	215	2006
As % of All Boats	77%	78%	90%	84%	77%	76%	71%	80%
As % of Tickets	8%	10%	9%	4%	4%	2%	2%	4%
Sablefish								
Top 40 Boats	900	563	745	387	354	196	204	3348
As % of All Boats	71%	74%	87%	74%	73%	66%	55%	73%
As % of Tickets	16%	12%	13%	7%	7%	4%	4%	9%
Dover Sole								
Top 40 Boats	2902	4306	4763	2868	2153	1404	1408	19804
As % of All Boats	68%	79%	81%	69%	66%	67%	59%	72%
As % of Tickets	22%	26%	24%	17%	11%	11%	10%	17%
Arrowtooth Flounder								
Top 40 Boats	182	214	498	875	1894	1489	1478	6631
As % of All Boats	65%	84%	92%	93%	97%	96%	96%	94%
As % of Tickets	11%	16%	20%	22%	41%	33%	41%	30%

Table 12. Parameter estimates for deriving standardized CPUE.

Logistic Model Coefficients for Pr(Non-Zero Catch)

Year	ENG	PET	REX	DAB	LIN	COD	WID	SROC
1987	-2.883	-2.529	-1.286	-0.121	0.157	-4.337	-7.838	-5.758
1988	-3.089	-2.297	-1.240	-1.079	0.564	-4.192	-8.103	-7.132
1989	-2.640	-1.784	-1.387	-3.918	0.415	-5.922	-6.768	-6.141
1990	-1.984	-2.493	-0.646	-2.141	0.070	-6.663	-6.258	-4.528
1991	-3.044	-2.797	-1.206	-0.531	0.491	-5.390	-6.028	-4.677
1992	-2.263	-1.176	-0.508	-1.759	-0.070	-5.554	-6.096	-5.395
1993	-1.971	-1.240	-0.185	-1.650	0.052	-4.409	-5.237	-5.464

Latitude	ENG	PET	REX	DAB	LIN	COD	WID	SROC
42.167	1.342	1.612	2.928	0.348	-0.801	0.886	-0.582	-0.335
42.500	4.236	2.677	2.864	1.336	-0.948	0.456	-1.375	0.349
42.833	4.449	3.224	1.105	-2.512	-0.999	-0.130	-2.482	0.375
43.167	3.971	2.631	0.395	-2.797	-1.074	0.056	-1.990	0.137
43.500	4.413	2.634	1.089	0.627	-1.825	-0.094	-3.086	0.042
43.833	4.055	2.675	1.307	0.829	-1.939	-0.129	-2.213	-0.078
44.167	4.012	2.184	1.449	0.153	-2.538	-0.976	-2.053	-1.555
44.500	3.732	1.829	2.215	0.064	-1.378	1.119	-0.928	-0.783
44.833	2.883	2.082	1.087	0.106	-1.088	1.490	-1.728	-0.221
45.167	2.122	1.736	1.408	-0.653	-2.398	0.936	-3.043	-0.441
45.500	2.850	1.960	1.418	-0.162	-1.831	2.194	-1.165	-0.944
45.833	3.664	2.792	1.429	0.692	-2.272	1.859	-0.632	-1.281
46.167	4.082	2.389	2.371	1.040	-2.506	2.320	-0.463	-1.439
46.500	3.490	2.322	2.316	1.157	-2.024	2.626	-1.364	-2.290
46.833	3.803	1.984	1.654	1.764	-1.600	2.378	-1.495	-1.990
47.167	3.528	1.989	1.511	0.665	-1.744	2.487	-1.250	-1.720
47.500	4.197	2.335	2.303	0.902	-1.907	3.104	-2.799	-1.949
47.833	3.634	2.208	1.131	0.958	-1.517	2.690	-2.106	-1.719
48.167	4.052	2.148	1.829	0.770	-1.760	2.748	-2.221	-1.452

Depth	ENG	PET	REX	DAB	LIN	COD	WID	SROC
60	-0.389	2.579	0.644	-0.444	1.881	2.565	4.875	3.762
100	-1.435	1.422	0.330	-2.471	1.966	1.944	5.562	4.420
140	-2.309	0.675	0.343	-5.743	1.203	0.736	5.310	5.301
180	-2.189	1.821	0.504	-5.367	-0.111	-0.290	4.674	5.764
220	-3.121	1.452	0.338	-6.470	-1.039	-1.114	3.992	5.241
260	-4.247	0.208	-0.163	-6.125	-1.788	-2.147	2.621	4.467
300	-5.198	-0.824	-0.494	-10.21	-2.738	-2.340	1.975	3.445
340	-5.566	-1.501	-0.687	-5.925	-3.255	-3.510	-1.966	3.195
380	-5.105	-2.414	-1.090	-9.373	-2.874	-2.451	2.066	2.403
420	-5.026	-1.280	-1.121	-9.634	-2.451	-1.340	-2.438	2.908
460	-7.740	-4.134	-2.275	-8.263	-5.754	-3.611	-3.269	-3.326

Table 12. Parameter estimates for standardized CPUE (cont.).

Logistic Model Coefficients for Pr(Non-Zero Catch)

Year	MROC	YEL	POP	THO	SAB	DOV	ARR
1987	-0.224	-6.310	-23.02	-11.40	-8.492	-5.316	-3.219
1988	0.356	-5.623	-15.73	-10.21	-8.448	-4.682	-3.910
1989	-0.032	-5.548	-17.50	-9.347	-9.216	-5.750	-4.261
1990	-1.171	-4.921	-17.07	-8.670	-8.578	-5.833	-4.040
1991	-0.512	-4.279	-15.90	-8.395	-8.585	-5.048	-3.545
1992	-0.465	-3.462	-16.32	-8.849	-8.560	-5.823	-4.384
1993	-0.493	-3.352	-15.94	-8.664	-8.027	-4.290	-4.257

Latitude	MROC	YEL	POP	THO	SAB	DOV	ARR
42.167	-0.781	-1.224	3.386	1.760	1.398	1.044	0.210
42.500	-1.084	-0.300	2.662	1.098	0.803	0.436	0.288
42.833	-2.036	-2.249	1.885	0.017	0.844	0.489	-2.240
43.167	-2.204	-2.000	-0.101	-0.476	0.627	0.266	-1.912
43.500	-2.460	-0.890	2.713	0.625	0.816	0.055	-1.258
43.833	-2.337	-1.129	1.763	-0.311	0.626	0.543	-2.320
44.167	-1.653	0.412	3.143	-0.663	0.889	-0.468	-2.743
44.500	-1.607	-0.068	4.694	-0.614	0.453	-0.682	-2.543
44.833	-2.288	-0.050	5.259	-0.223	0.344	-0.595	-2.516
45.167	-2.159	-1.396	5.474	0.680	0.587	-0.226	-2.365
45.500	-1.636	-0.445	5.688	0.069	0.417	0.536	-1.874
45.833	-2.011	-0.176	5.365	-0.271	0.461	0.033	-1.701
46.167	-1.879	0.521	6.092	-0.420	0.845	0.775	-1.149
46.500	-1.633	0.932	5.682	-0.083	0.757	0.706	-1.091
46.833	-1.479	1.071	5.738	-0.681	0.095	-0.220	-2.168
47.167	-1.993	0.810	6.346	-0.148	0.442	0.035	-1.591
47.500	-2.077	0.339	6.026	-0.172	0.677	0.703	-1.314
47.833	-1.763	-0.649	6.498	-0.569	0.571	0.023	-1.076
48.167	-1.518	0.029	6.250	-0.451	0.401	-0.782	-1.077

Depth	MROC	YEL	POP	THO	SAB	DOV	ARR
60	1.172	4.191	5.300	4.227	4.496	2.846	2.629
100	2.037	4.373	7.890	6.953	6.464	3.793	3.988
140	1.833	2.423	9.751	8.438	7.528	4.433	4.614
180	1.444	1.409	10.06	9.069	8.081	5.163	4.798
220	1.529	1.212	10.27	9.443	8.673	6.074	4.770
260	0.939	0.280	9.404	10.37	9.510	7.739	4.629
300	-0.234	0.278	8.214	11.19	10.22	8.576	4.319
340	-0.733	-1.039	7.700	11.93	10.52	8.010	3.959
380	-1.597	0.225	7.759	12.49	10.63	8.091	2.920
420	-1.923	-1.766	6.431	12.35	10.42	7.629	3.009
460	-4.528	-2.163	4.559	11.94	15.15	7.074	2.877

Table 12. Parameter estimates for standardized CPUE (cont.).

Lognormal Model Coefficients for Catch Rate (lb/hr) of Non-Zero Catches

Parameters shown as "aliased" could not be estimated due to insufficient information.

Year	ENG	PET	REX	DAB	LIN	COD	WID	SROC
1987	3.832	3.543	2.023	2.028	2.932	3.381	5.111	4.374
1988	3.723	3.537	2.667	2.107	2.637	3.123	3.935	4.620
1989	4.120	3.786	2.456	1.995	2.597	2.908	5.135	3.683
1990	3.926	3.648	2.516	2.075	2.444	2.241	4.790	3.835
1991	3.980	3.220	2.584	2.119	2.127	2.412	4.266	3.615
1992	4.028	3.279	2.851	2.384	2.043	3.022	4.350	3.203
1993	3.788	2.870	2.534	1.994	1.554	2.403	4.671	3.596

Latitude	ENG	PET	REX	DAB	LIN	COD	WID	SROC
42.167	0.860	0.484	1.673	0.823	-0.417	0.983	-0.368	0.023
42.500	0.959	1.194	1.931	1.251	-0.529	-0.377	-0.191	0.215
42.833	0.743	0.943	2.255	3.203	-0.948	-0.433	0.193	0.075
43.167	0.556	0.655	2.070	1.725	-0.841	0.050	0.337	-0.055
43.500	0.916	0.377	2.086	2.855	-1.215	-0.214	0.202	-0.252
43.833	0.585	0.620	2.412	3.640	-1.178	-0.386	0.316	0.109
44.167	0.879	0.349	2.178	3.490	-1.272	-1.199	0.013	-0.038
44.500	1.299	0.412	1.898	3.233	-0.744	-0.312	0.344	0.491
44.833	0.387	0.320	1.826	3.097	-0.548	0.001	0.114	0.523
45.167	0.376	0.180	1.782	2.292	-1.609	-0.749	-0.837	0.359
45.500	0.469	0.210	2.188	2.331	-0.838	0.129	-0.001	0.338
45.833	0.754	0.843	2.273	2.110	-0.744	-0.107	0.064	0.326
46.167	0.894	0.721	2.873	2.135	-1.019	0.023	-0.211	0.478
46.500	0.609	0.543	2.601	2.316	-0.484	0.224	-0.529	0.426
46.833	0.532	0.546	2.308	1.881	-0.230	0.270	-0.148	0.929
47.167	0.864	0.370	3.060	1.169	-0.176	0.424	0.200	1.074
47.500	1.633	0.771	2.629	1.843	-0.206	0.877	-0.713	1.109
47.833	0.927	1.055	2.455	2.300	0.410	0.592	-0.070	1.043
48.167	1.306	0.942	2.474	2.440	0.014	0.892	-0.332	1.190

Depth	ENG	PET	REX	DAB	LIN	COD	WID	SROC
60	-0.009	0.530	-0.695	-0.180	1.222	0.870	2.117	0.705
100	-0.265	0.009	-0.869	-0.546	1.096	0.645	2.124	0.644
140	-0.416	0.171	-0.512	-2.265	1.031	0.156	1.860	0.875
180	-0.656	0.734	-0.451	-1.392	0.637	-0.055	1.788	0.901
220	-0.942	0.708	-0.570	-4.969	0.612	-0.068	1.222	0.827
260	-1.001	0.157	-0.597	-1.938	0.480	-0.362	1.639	0.314
300	-1.034	-0.070	-0.568	aliased	0.049	-0.199	1.872	0.057
340	-0.672	0.101	-0.698	-0.203	0.513	-0.471	aliased	0.557
380	-2.099	-0.283	-0.941	aliased	0.197	2.083	0.226	0.357
420	0.906	-0.047	-0.554	aliased	0.688	-0.767	aliased	1.521
460	aliased	aliased	0.813	aliased	aliased	aliased	aliased	aliased

Residual Variance Statistics (Goodness of Fit)

	ENG	PET	REX	DAB	LIN	COD	WID	SROC
Deviance	23469.0	19009.5	9364.2	5099.8	23583.1	13538.6	9379.2	10722.6
d.f.	20314	17848	10592	4514	14297	9674	4053	6667

Table 12. Parameter estimates for standardized CPUE (cont.).

Lognormal Model Coefficients for Catch Rate (lb/hr) of Non-Zero Catches

Parameters shown as "aliased" could not be estimated due to insufficient information.

Year	MROC	YEL	POP	THO	SAB	DOV	ARR
1987	3.379	8.487	6.561	1.285	2.240	3.921	1.962
1988	2.813	8.811	5.732	1.590	2.152	4.187	2.731
1989	2.661	7.892	5.196	1.824	1.384	3.957	2.839
1990	2.491	6.907	5.416	1.517	1.096	3.610	2.574
1991	2.789	7.979	5.469	1.651	1.141	3.611	2.161
1992	2.071	7.665	4.563	1.851	1.417	3.659	2.149
1993	2.323	8.396	4.921	1.843	1.187	3.448	1.495

Latitude	MROC	YEL	POP	THO	SAB	DOV	ARR
42.167	-0.379	-1.100	0.387	2.588	1.372	0.264	-0.689
42.500	-0.847	-1.439	-0.099	2.057	1.249	0.703	-1.087
42.833	-1.024	-2.652	-1.383	2.302	1.043	0.412	-0.978
43.167	-0.954	-1.832	-1.632	2.215	1.088	0.263	-0.778
43.500	-1.669	-2.622	-1.664	2.448	0.983	0.131	-0.451
43.833	-1.151	-3.175	-1.284	2.182	1.061	0.516	-0.602
44.167	-0.297	-2.796	-0.913	2.302	1.452	0.548	-0.455
44.500	-0.348	-3.316	-0.229	2.516	1.583	-0.360	-0.187
44.833	-0.454	-3.520	-0.306	2.588	1.155	-0.099	-0.188
45.167	-0.492	-3.495	-0.321	2.724	1.293	-0.075	-0.644
45.500	-0.310	-2.841	-0.176	2.579	1.258	0.227	-0.160
45.833	-0.546	-3.048	-0.607	2.199	1.301	0.124	-0.198
46.167	-0.678	-2.770	-0.177	2.439	1.645	0.554	-0.006
46.500	-0.621	-2.398	-0.738	2.672	1.726	0.505	0.388
46.833	-0.417	-2.245	-0.506	2.509	1.275	0.317	-0.349
47.167	-0.540	-2.461	0.132	2.698	1.403	0.305	0.462
47.500	-0.575	-2.172	-0.386	2.510	1.409	0.544	0.536
47.833	-0.474	-2.632	-0.043	2.327	1.436	0.582	0.787
48.167	-0.230	-2.514	aliased	2.454	1.513	0.455	1.229

Depth	MROC	YEL	POP	THO	SAB	DOV	ARR
60	0.508	0.655	-0.867	-0.589	-0.073	0.471	0.529
100	0.668	0.739	-0.375	-0.813	0.200	1.128	1.241
140	0.859	0.357	0.056	-0.428	0.355	1.315	1.645
180	0.656	0.523	-0.157	-0.433	0.472	1.291	1.522
220	0.584	-0.179	-0.506	-0.201	0.637	1.632	1.359
260	0.329	0.690	-0.756	-0.055	0.823	2.069	1.322
300	0.024	0.171	-1.185	0.152	1.020	2.152	1.060
340	-0.143	-1.936	-0.964	0.487	1.240	2.125	0.969
380	-0.384	-0.799	-1.435	1.012	1.595	2.113	0.822
420	-0.199	aliased	aliased	1.275	1.453	1.979	1.049
460	aliased	aliased	aliased	1.421	1.418	2.273	0.676

Residual Variance Statistics (Goodness of Fit)

	MROC	YEL	POP	THO	SAB	DOV	ARR
Deviance	33932.1	6399.7	4091.6	11383.8	16702.6	47048.1	10190.7
d.f.	18051	3353	2813	10904	13395	32727	7139

Table 13. Examples of area-specific estimates of standardized CPUE.

Latitude Class	40 Fathom Depth Class Midpoint: 420	380	340	300	260	220	180	140	100	60	20
	1987 - Probability of a Non-Zero Catch of Lingcod.										
48.167		0.011	0.008	0.013	0.033	0.067	0.153	0.402	0.590	0.569	0.168
47.833	0.022		0.010	0.016	0.041	0.083	0.187	0.461	0.647	0.627	0.204
47.500			0.007	0.011	0.028	0.058	0.135	0.367	0.554	0.533	0.148
47.167			0.008	0.013	0.033	0.068	0.155	0.405	0.594	0.573	
46.833			0.009	0.015	0.038	0.077	0.175	0.440	0.628	0.608	0.191
46.500		0.009	0.006	0.010	0.025	0.052	0.122	0.340	0.525	0.504	0.134
46.167			0.004	0.006	0.016	0.033	0.079	0.241	0.405	0.385	0.087
45.833		0.007	0.005	0.008	0.020	0.041	0.098	0.287	0.463	0.442	0.108
45.500			0.007	0.012	0.030	0.062	0.144	0.384	0.572	0.552	
45.167			0.004	0.007	0.018	0.036	0.087	0.262	0.432	0.411	0.096
44.833			0.015		0.062	0.122	0.261	0.568	0.738	0.721	0.283
44.500				0.019		0.095	0.209	0.496	0.678	0.659	0.228
44.167		0.005	0.004	0.006	0.015	0.032	0.077	0.235	0.398	0.378	0.085
43.833	0.014	0.009	0.007	0.011	0.027	0.056	0.131	0.359	0.546	0.525	0.144
43.500		0.011	0.007	0.012	0.031	0.063	0.145	0.386	0.574	0.553	0.159
43.167		0.022	0.015	0.025	0.063	0.124	0.264	0.571	0.741	0.724	0.286
42.833		0.024	0.016	0.027	0.067	0.132	0.279	0.589	0.755	0.739	
42.500	0.038	0.025	0.017	0.029	0.071	0.138	0.289	0.602	0.764	0.748	
42.167		0.029	0.020	0.033		0.157	0.320			0.775	
41.833									0.893	0.885	
	1987 - Standardized CPUE (lb/hr) for Lingcod.										
48.167		0.6	0.6	0.6	2.3	5.3	12.5	48.9	76.6	83.9	7.3
47.833	2.8		1.1	1.1	4.3	9.9	22.8	83.4	124.9	137.4	13.2
47.500			0.4	0.4	1.6	3.7	8.9	35.8	57.7	63.0	5.2
47.167			0.5	0.5	1.9	4.5	10.5	40.8	63.8	69.8	
46.833			0.5	0.5	2.1	4.8	11.2	42.0	63.9	70.2	6.5
46.500		0.3	0.3	0.3	1.1	2.5	6.1	25.1	41.4	45.1	3.5
46.167			0.1	0.1	0.4	0.9	2.3	10.5	18.7	20.2	1.3
45.833		0.2	0.2	0.2	0.7	1.5	3.8	16.3	28.2	30.5	2.2
45.500			0.2	0.2	0.9	2.1	5.0	20.0	31.7	34.7	
45.167			0.1	0.1	0.2	0.6	1.4	6.3	11.1	12.0	0.8
44.833			0.6		2.5	5.6	12.2	39.4	54.7	60.6	7.0
44.500				0.4		3.5	8.0	28.3	41.3	45.5	4.6
44.167		0.1	0.1	0.1	0.3	0.7	1.7	7.9	14.3	15.4	1.0
43.833	0.4	0.2	0.1	0.1	0.6	1.4	3.3	13.3	21.5	23.5	1.9
43.500		0.2	0.2	0.2	0.6	1.5	3.5	13.7	21.8	23.9	2.0
43.167		0.5	0.5	0.5	1.9	4.2	9.2	29.5	40.9	45.4	5.3
42.833		0.5	0.5	0.5	1.8	4.0	8.7	27.4	37.5	41.6	
42.500	1.9	0.8	0.7	0.8	2.9	6.4	13.8	42.6	57.7	64.1	
42.167		1.0	0.9	1.0		8.2	17.1			74.2	
41.833									114.4	128.6	

Table 14. Estimates of spatial extent of *Latitude* by *Depth* areas.

The estimates of surface area were derived from the distributions of tows reported in the the logbook data across all years of the study. If less than 10 tows were reported in a given area, the surface area is shown as a blank.

Oregon - Estimated Surface Area (km^2)

Latitude Class	40 Fathom Depth Class Midpoint											
	460	420	380	340	300	260	220	180	140	100	60	20
48.167			73.7	285.8	186.9	182.3	164.0	219.9	278.5	740.2	912.9	528.1
47.833		51.2		312.1	236.0	209.3	316.7	272.5	278.0	415.8	462.9	904.1
47.500				247.8	218.5	115.5	105.3	94.2	109.0	480.2	492.3	774.9
47.167				92.0	105.1	106.0	115.3	69.1	130.3	483.8	754.6	
46.833				85.5	148.0	134.9	146.1	147.6	121.7	521.1	981.2	493.4
46.500			47.3	212.3	238.8	110.7	132.4	113.0	91.7	246.8	699.9	869.2
46.167				121.7	143.6	181.6	178.3	103.7	96.5	425.6	680.4	1178.2
45.833			133.0	36.4	78.9	95.2	111.5	101.9	170.8	878.4	955.9	511.0
45.500				19.7	120.8	283.1	519.0	191.6	188.2	649.9	529.1	
45.167				65.9	132.7	158.9	521.2	454.8	205.9	454.8	475.7	579.8
44.833				146.1		207.9	341.9	522.0	373.5	587.8	1236.9	724.6
44.500					51.4		175.4	269.0	331.2	628.6	1367.4	1117.0
44.167			46.3	98.5	136.9	83.7	32.0	23.1	32.5	588.1	1508.1	749.1
43.833		60.0	208.1	150.6	478.6	487.6	269.5	414.7	148.6	659.5	1083.6	871.6
43.500			210.7	159.4	330.2	82.2	111.1	69.2	125.5	374.1	635.6	496.1
43.167			114.7	56.1	245.0	176.4	261.0	259.0	158.3	1046.7	510.6	459.0
42.833			21.7	159.7	226.1	273.0	232.2	327.4	163.2	659.8	495.1	
42.500	34.9	75.9	93.1	128.6	201.0	64.3	74.4	135.7	105.8	393.9	627.7	
42.167			124.2	241.4	209.3		75.9	57.0			365.1	
41.833										173.5	457.5	

Table 15. Estimates of effective catch-per-unit-effort (lb/hr).

Region / Species	1987	1988	1989	1990	1991	1992	1993
Statewide							
English Sole	72.15	59.61	104.97	104.24	78.56	107.41	91.10
Petrale Sole	104.40	108.85	152.44	116.84	71.04	99.05	65.34
Rex Sole	44.55	86.16	66.28	87.60	80.22	126.23	97.79
Sanddab	49.72	31.41	2.50	13.71	44.28	25.40	18.70
Lingcod	25.15	21.81	19.88	14.88	12.77	9.37	6.06
Pacific Cod	32.55	26.82	7.85	2.23	6.92	11.42	11.83
Widow Rockfish	43.07	10.26	122.22	137.53	99.55	102.12	285.11
Small Rockfish	56.90	23.07	21.14	75.50	55.51	23.00	32.44
Misc. Rockfish	22.25	17.16	12.10	4.84	10.33	5.20	6.56
Yellowtail Rock	133.20	319.49	134.73	77.15	322.94	333.28	718.97
Pac. Oc. Perch	0.11	35.08	5.92	10.41	24.52	7.63	13.85
Thornyheads	10.40	21.44	33.83	28.49	34.17	38.51	39.55
Sablefish	47.59	44.03	16.93	14.87	15.54	20.60	18.26
Dover Sole	302.71	437.90	290.17	202.01	232.15	212.56	221.61
Arrowtooth Fl.	13.61	19.23	16.70	15.02	13.76	7.64	4.37
INPFC Area - Eureka							
English Sole	45.77	37.66	66.95	67.78	49.67	69.22	59.26
Petrale Sole	150.96	155.31	212.39	168.58	104.50	135.41	89.47
Rex Sole	27.77	53.62	41.46	53.81	49.87	77.40	59.81
Sanddab	6.16	3.74	0.30	1.62	5.35	3.01	2.21
Lingcod	37.76	30.52	28.52	22.71	18.09	14.69	9.28
Pacific Cod	12.82	11.06	2.00	0.50	1.99	3.15	4.55
Widow Rockfish	60.10	14.37	166.36	183.54	131.44	135.26	360.50
Small Rockfish	93.32	42.61	36.11	105.36	79.14	36.12	51.38
Misc. Rockfish	28.59	20.09	15.06	7.31	13.94	6.96	8.83
Yellowtail Rock	401.95	1003.81	425.42	254.41	1108.34	1178.40	2546.71
Pac. Oc. Perch	0.01	3.71	0.39	0.74	2.43	0.66	1.36
Thornyheads	24.35	40.76	57.49	45.30	53.11	62.21	62.83
Sablefish	69.43	64.00	26.33	21.85	22.85	30.21	25.70
Dover Sole	517.94	732.24	505.15	352.89	393.27	371.17	365.66
Arrowtooth Fl.	8.63	13.65	12.63	10.91	9.18	5.91	3.30

Table 15. Estimates of effective catch-per-unit-effort (lb/hr) (continued

Region / Species	1987	1988	1989	1990	1991	1992	1993
INPFC Area - Columbia							
English Sole	65.60	54.07	95.67	95.52	71.29	98.23	83.49
Petrale Sole	92.62	96.57	135.14	103.66	63.00	87.64	57.83
Rex Sole	44.15	85.42	65.67	86.98	79.54	125.36	97.17
Sanddab	58.96	36.93	2.92	16.02	52.31	29.73	21.89
Lingcod	19.82	17.37	15.77	11.70	10.15	7.34	4.76
Pacific Cod	23.63	19.60	5.24	1.44	4.75	7.77	8.56
Widow Rockfish	47.43	11.29	134.88	152.00	110.09	112.91	315.72
Small Rockfish	53.35	21.55	19.82	70.09	51.63	21.54	30.39
Misc. Rockfish	20.51	16.12	11.23	4.30	9.42	4.75	5.99
Yellowtail Rock	100.73	234.60	98.56	54.59	221.41	223.15	480.74
Pac. Oc. Perch	0.09	32.75	5.17	9.23	22.75	6.96	12.83
Thornyheads	8.38	18.30	29.76	25.51	30.78	34.34	35.41
Sablefish	41.15	38.11	14.35	12.83	13.41	17.78	15.96
Dover Sole	251.45	366.47	239.90	166.87	193.43	175.60	186.35
Arrowtooth Fl.	7.81	10.40	8.80	8.04	7.67	3.99	2.30
INPFC Area - Vancouver							
English Sole	116.92	97.22	168.83	164.66	127.95	170.90	143.86
Petrale Sole	124.96	131.60	188.00	140.06	83.96	124.51	82.00
Rex Sole	56.97	110.18	84.76	111.91	102.58	161.21	124.80
Sanddab	35.57	23.94	2.03	10.89	32.61	19.96	14.63
Lingcod	39.81	35.22	31.88	23.45	20.56	14.65	9.54
Pacific Cod	83.17	67.61	22.70	6.68	19.32	32.27	30.43
Widow Rockfish	12.48	2.96	36.67	42.56	31.38	32.00	98.01
Small Rockfish	48.86	17.10	17.23	79.55	56.98	20.89	29.14
Misc. Rockfish	25.65	19.69	13.93	5.56	11.91	5.99	7.57
Yellowtail Rock	102.10	249.75	105.55	61.50	260.47	269.80	581.95
Pac. Oc. Perch	0.34	82.56	16.54	28.19	58.83	19.18	33.38
Thornyheads	10.05	22.44	36.00	30.44	36.53	41.11	42.24
Sablefish	61.04	56.44	21.88	19.10	19.96	26.44	23.26
Dover Sole	383.33	553.78	366.74	255.13	293.95	268.48	279.60
Arrowtooth Fl.	41.54	60.45	53.03	47.42	42.66	24.32	13.87

Table 16. Trawl landings and estimates of effective fishing effort.

Species	1987	1988	1989	1990	1991	1992	1993
			Landings (1000s pounds)				
English Sole	1308.7	1277.0	1525.3	1121.2	1863.5	1380.3	1580.3
Petrale Sole	1878.3	1986.7	1903.2	1638.8	2053.2	1694.8	1701.0
Rex Sole	630.0	733.7	622.7	500.0	947.3	730.3	603.0
Sanddab	460.2	238.8	162.1	429.4	690.3	645.6	621.9
Lingcod	1230.1	1904.4	2195.1	1592.3	3107.1	1348.3	1613.9
Pacific Cod	1431.8	2218.4	1707.0	508.3	1129.9	911.9	1038.3
Widow Rockfish	13940.7	12052.0	15235.7	12199.1	9645.2	10985.0	14660.0
Small Rockfish	1984.5	2821.6	2999.3	2960.9	3412.7	1951.2	4355.4
Misc. Rockfish	6854.2	8052.8	9048.5	5339.4	7951.4	6462.0	6565.0
Yellowtail Roc	3458.3	4720.5	3842.0	3569.2	3637.1	7815.7	5119.9
Pac. Oc. Perch	1038.4	1396.7	1555.0	1082.6	1653.3	1185.6	1558.9
Thornyheads	1427.3	2221.7	5551.1	9976.2	7709.0	9424.5	9779.0
Sablefish	5555.1	4769.1	5728.3	5553.1	5396.0	5434.5	5417.8
Dover Sole	13264.7	16851.8	19562.1	16511.7	19387.1	13354.2	14249.3
Arrowtooth Fl.	1598.2	1355.0	2495.1	3979.6	4592.2	4535.7	3649.5
			Effective Fishing Effort (100s hours)				
English Sole	181.4	214.2	145.3	107.6	237.2	128.5	173.5
Petrale Sole	179.9	182.5	124.9	140.3	289.0	171.1	260.3
Rex Sole	141.4	85.2	94.0	57.1	118.1	57.9	61.7
Sanddab	92.6	76.0	647.3	313.1	155.9	254.1	332.6
Lingcod	489.2	873.1	1104.2	1070.0	2432.2	1439.1	2662.2
Pacific Cod	439.8	827.3	2174.8	2278.3	1632.6	798.3	877.5
Widow Rockfish	3236.4	11745.2	1246.6	887.0	968.9	1075.7	514.2
Small Rockfish	348.7	1223.1	1419.0	392.2	614.8	848.2	1342.5
Misc. Rockfish	3080.1	4694.0	7479.0	11042.8	7698.3	12438.6	10000.7
Yellowtail Roc	259.6	147.8	285.2	462.6	112.6	234.5	71.2
Pac. Oc. Perch	93046.4	398.1	2628.9	1040.1	674.3	1554.8	1125.4
Thornyheads	1373.0	1036.2	1641.1	3501.1	2255.8	2447.2	2472.8
Sablefish	1167.3	1083.2	3384.2	3733.3	3472.0	2638.7	2967.7
Dover Sole	438.2	384.8	674.2	817.4	835.1	628.3	643.0
Arrowtooth Fl.	1174.0	704.6	1493.7	2649.0	3336.8	5936.6	8352.1

Table 17. Landings, effort, and raw CPUE for trips with logbooks and tickets.

Species	1987	1988	1989	1990	1991	1992	1993
			Landings (1000s pounds)				
English Sole	1052.6	1007.8	1272.9	915.5	1612.5	1139.4	1401.0
Petrale Sole	1469.1	1498.0	1572.2	1337.6	1682.5	1325.6	1502.4
Rex Sole	495.6	567.8	522.8	417.8	847.7	630.7	501.2
Sanddab	398.4	162.6	141.5	325.0	494.2	473.0	453.0
Lingcod	932.3	1555.3	1738.7	1308.8	2635.7	889.1	1341.8
Pacific Cod	1085.8	1843.5	1566.2	414.6	1040.2	830.4	939.8
Widow Rockfish	11136.3	8798.8	11464.9	8797.8	5998.4	5760.4	8873.2
Small Rockfish	1372.3	2184.3	2319.3	2190.3	2134.3	1450.9	3463.8
Misc. Rockfish	4940.1	6126.8	6900.2	4216.2	5273.0	4180.9	4750.9
Yellowtail Rockf	3023.3	3796.1	3053.6	2825.8	2886.3	5319.0	4257.6
Pac. Oc. Perch	783.9	1103.4	1338.9	894.0	1433.0	984.3	1295.3
Thornyheads	995.6	1722.6	4185.9	7321.1	5694.0	6913.3	7868.1
Sablefish	3941.8	3688.0	4413.0	4271.3	4137.7	4037.0	4535.7
Dover Sole	9715.8	13467.7	15841.2	13844.2	15832.1	10393.0	12331.9
Arrowtooth Fl.	1128.5	1019.6	2085.1	3454.0	4200.1	3623.6	3375.6
Number of Trips	2107	2395	2633	2451	3285	3580	3565
Trawl Hours	6516.9	7377.2	8095.9	8913.5	11647.1	11681.5	13644.1
			Raw CPUE (lb/hr)				
English Sole	161.52	136.61	157.23	102.70	138.44	97.54	102.68
Petrale Sole	225.43	203.05	194.20	150.07	144.46	113.48	110.11
Rex Sole	76.05	76.97	64.58	46.87	72.78	53.99	36.73
Sanddab	61.13	22.04	17.48	36.46	42.43	40.49	33.20
Lingcod	143.05	210.83	214.76	146.84	226.29	76.11	98.34
Pacific Cod	166.61	249.89	193.45	46.52	89.31	71.08	68.88
Widow Rockfish	1708.83	1192.70	1416.14	987.02	515.01	493.12	650.34
Small Rockfish	210.58	296.09	286.47	245.73	183.25	124.21	253.87
Misc. Rockfish	758.05	830.50	852.31	473.01	452.73	357.91	348.21
Yellowtail Rockf	463.91	514.57	377.18	317.02	247.81	455.33	312.04
Pac. Oc. Perch	120.28	149.56	165.38	100.30	123.03	84.26	94.93
Thornyheads	152.77	233.50	517.05	821.35	488.87	591.82	576.67
Sablefish	604.85	499.91	545.10	479.19	355.26	345.59	332.43
Dover Sole	1490.86	1825.58	1956.69	1553.17	1359.31	889.69	903.82
Arrowtooth Fl.	173.16	138.21	257.55	387.50	360.61	310.20	247.41

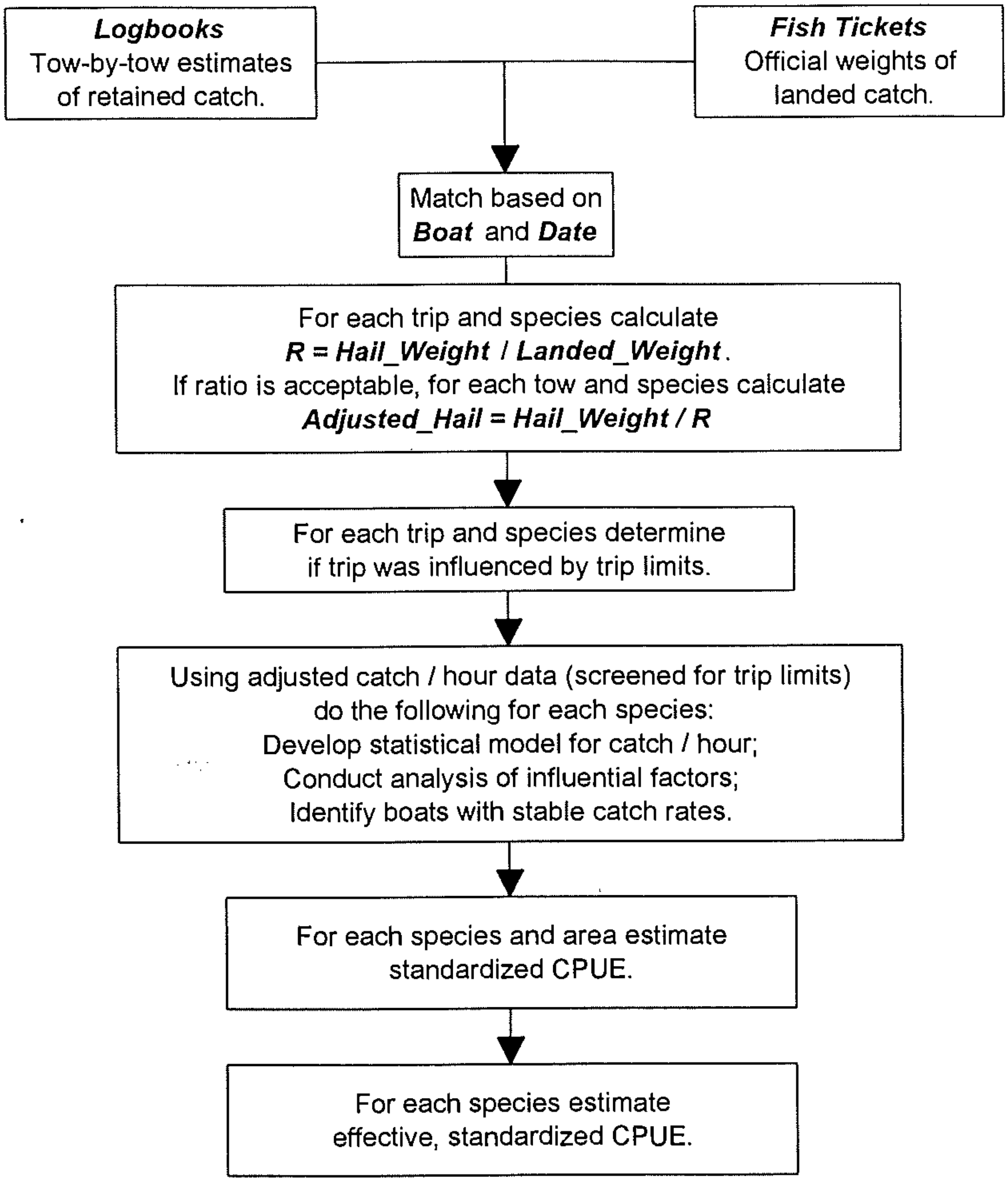


Figure 1. Overview of data processing and analysis.

```
/* (1) Summarize ticket landing weights by trip. */

Create TRIPSUM file with LOGTIK.BOAT, LOGTIK.RETURN_DATE,
  sum(TIK.TOT_LBS) as TOT_LBS,;     /* total catch */
  sum(TIK.WID_LBS) as WID_LBS,;     /* widow rockfish */
  sum(TIK.SEB_LBS) as SEB_LBS,;     /* sebastes complex */
  sum(TIK.SAB_LBS) as SAB_LBS,;     /* sablefish */
  group by LOGTIK.BOAT, LOGTIK.RETURN_DATE
  from LOGTIK,     /* data from logs w_tickets */
       TIK         /* data from tickets */
  where LOGTIK.BOAT+LOGTIK.RETURN_DATE = TIK.BOAT+TIK.DATE,

Append TRIPSUM with NOLOG.BOAT, NOLOG.RETURN_DATE,
  sum(TIK.TOT_LBS) as TOT_LBS,;     /* total catch */
  sum(TIK.WID_LBS) as WID_LBS,;     /* widow rockfish */
  sum(TIK.SEB_LBS) as SEB_LBS,;     /* sebastes complex */
  sum(TIK.SAB_LBS) as SAB_LBS,;     /* sablefish */
  group by NOLOG.BOAT, NOLOG.RETURN_DATE
  from NOLOG,      /* data from trips w/o tickets */
       TIK         /* data from tickets */
  where TIK.TICKET_ID = NO_LOG.TICKET_ID


/* (2) Identify trips potentially influenced by the limits. */

/* define some constants */
TOL = 1-0.1                /* tolerance for catch limits */
DAY1 = {01/06/88}          /* 1st day of fishing week no. 1 */

/* widow rockfish limits */
WID_INC    =  3000         /* incidental allowance */
WID_WKLY   = 30000         /* weekly */
WID_DATE   = {09/21/88}    /* incidental only */

/* Sebastes complex limits (North of Coos Bay) */
SEB_INC    =  3000         /* incidental allowance */
SEB_WKLY   = 25000         /* weekly */
SEB_BIWK   = 50000         /* biweekly */
SEB_TWIC   = 12500         /* twice-weekly */
```

Figure 2. Example of algorithm used to identify trips unaffected by trip limits.

Trip limit regulations vary by year and sometimes by latitude. This algorithm, which is for 1988 data from Oregon, assumes that all landings by Oregon boats were taken in waters north of Coos Bay.

```
/* yellowtail rockfish limits */
YEL_INC    =  3000          /* incidental allowance */
YEL_WKLY1 = 10000           /* weekly, period 1 */
YEL_BIWK1 = 20000           /* biweekly, period 1 */
YEL_TWIC1 =  5000           /* twice-weekly, period 1 */
YEL_DATE  = {10/05/88}      /* date of change in limits
YEL_WKLY2 =  7500           /* weekly, period 2 */
YEL_BIWK2 = 15000           /* biweekly, period 2 */
YEL_TWIC2 =  3750           /* twice-weekly, period 2 */

/* Sablefish limits */
SAB_INC1  = 1000            /* incidental allowance */
SAB_PCT1  =   20            /* allowed % of total catch */
SAB_LIM1  = 6000            /* trip catch limit */
SAB_FREQ1 =    2            /* trip frequency limit */
SAB_DATE1 = {08/03/88}      /* date of 1st limit change */
SAB_WKLY2 = 2000            /* weekly */
SAB_FREQ2 =    1            /* trip frequency limit */
SAB_DATE2 = {10/05/88}      /* date of 2nd limit change */
SAB_WKLY3 = 2000            /* weekly */
SAB_FREQ3 =  999            /* trip frequency limit */

/* Pacific ocean perch limits */
POP_INC   = 1000            /* incidental allowance */
POP_PCT   = 20              /* allowed % of total catch */
POP_LIM   = 5000            /* trip catch limit */

use TRIPSUM
add fields WID_CODE, SEB_CODE, YEL_CODE, SAB_CODE, POP_CODE
add field WEEK_NUM = floor((RETURN_DATE-DAY1)/7)+1
sort by BOAT and RETURN_DATE

for each trip in TRIPSUM

  if new BOAT
    initialize weekly and biweekly counters
  else if new WEEK_NUM
    initialize weekly and biweekly counters and flags

  /* check widow rockfish limits */
  if WID_INC < WID_LBS
    increment WIDWKCNT
  case WID_LBS <= WID_INC*TOL        /* catch < incidental */
    replace WID_CODE with OKTRIP
  case RDATE >= WID_DATE             /* change to incidental */
    replace WID_CODE with VIOLATION
  case WID_LBS <= WID_WKLY*TOL       /* catch < weekly */
    replace WID_CODE with            /* only 1 per week */
      if(WIDWKCNT <= 1, OKTRIP , VIOLATION)
  otherwise                          /* weekly < catch */
    replace WID_CODE with VIOLATION
```

Figure 2. Example trip limit algorithm (continued).

```
/* check Sebastes complex limit */
case SEB_LBS <= SEB_INC*TOL      /* catch < incidental */
  replace SEB_CODE with OKTRIP
case SEBBILAST               /* biweekly catch previous week */
  replace SEB_CODE with VIOLATION
case SEB_LBS <= SEB_TWIC*TOL     /* catch < twice-weekly */
  replace SEB_CODE with
    if( SEBTWCNT <= 2 and SEBWKCNT = 0 and SEBBICNT = 0,
      OKTRIP, VIOLATION )
case SEB_LBS <= SEB_WKLY*TOL     /* catch < weekly */
  replace SEB_CODE with
    if( SEBTWCNT + SEBWKCNT <= 1 and SEBBICNT = 0,
      OKTTRIP, VIOLATION )
case not SEBBIWKOK           /* catch > incidental prev week */
  replace SEB_CODE with VIOLATION
case SEB_LBS <= SEB_BIWK*TOL     /* catch < biweekly */
  replace SEB_CODE with
    if( SEBTWCNT + SEBWKCNT + SEBBICNT <= 1,
       OKTRIP, VIOLATION )
otherwise                        /* biweekly < catch */
  replace SEB_CODE with VIOLATION

if SEB_CODE in OKLIST    /* possible weekly or twice-weekly */
  if SEB_LBS between( SEB_WKLY*TOL, SEB_WKLY*(2-TOL) )
    or SEB_LBS between( SEB_TWIC*TOL, SEB_TWIC*(2-TOL) )
    replace SEB_CODE with VIOLATION

/* check yellowtail rockfish limits */
PER = if( RDATE < YEL_DATE, 1, 2 )    /* period index */
case YEL_LBS <= YEL_INC*TOL           /* catch < incidental */
  replace YEL_CODE with OKTRIP
case YELBILAST               /* biweekly catch previous week */
  replace YEL_CODE with VIOLATION
case YEL_LBS <= YEL_TWIC[PER]*TOL     /* catch < twice-wkly */
replace YEL_CODE with
  if( YELTWCNT <= 2 and YELWKCNT=0 and YELBICNT = 0,
    OK_TRIP, VIOLATION )
case YEL_LBS <= YEL_WKLY[PER]*TOL     /* catch < weekly */
replace YEL_CODE with
  if( YELTWCNT + YELWKCNT <=1 and YELBICNT = 0,
    OKTRIP, VIOLATION )
case not YELBIWKOK           /* catch > incidental prev week */
  replace YEL_CODE with VIOLATION
case YEL_LBS <= YEL_BIWK[PER]*TOL     /* catch < biweekly */
  replace YEL_CODE with
    if( YELTWCNT + YELWKCNT + YELBICNT <=1,
      OKRIP, VIOLATION )
otherwise                             /* biweekly < catch */
  replace YEL_CODE with VIOLATION
```

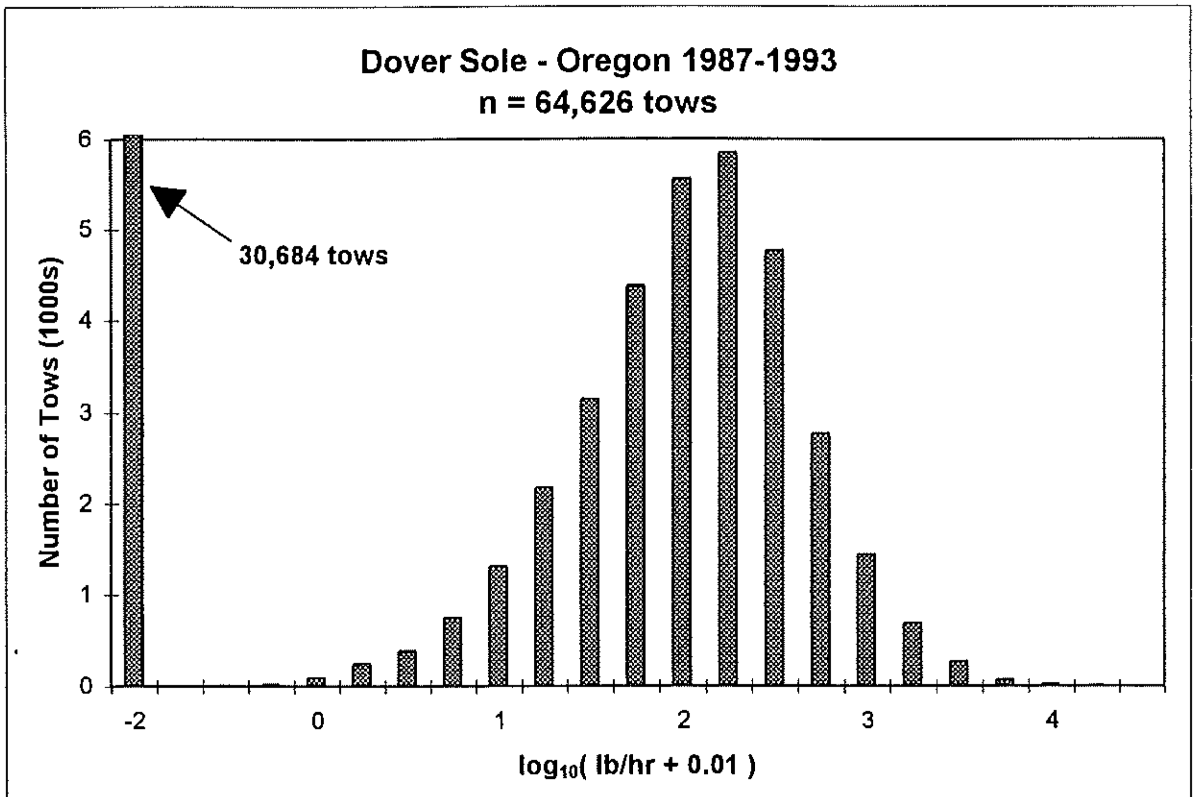
Figure 2. Example trip limit algorithm (continued).

```
if YEL_CODE in OKLIST      /* possible weekly or twice weekly */
  if YEL_LBS between( YEL_WKLY[PER]*TOL, YEL_WKLY[PER]*(2-TOL))
  or YEL_LBS between( YEL_TWIC[PER]*TOL, YEL_TWIC[PER]*(2-TOL))
  replace YEL_CODE with VIOLATION

/* check sablefish limits */
if SAB_INC1 < SAB_LBS
  increment SABWKCNT
if RDATE < SAB_DATE1                   /* 1st limit change */
  case SAB_LBS <= SAB_INC1*TOL         /* catch < incidental */
    replace SAB_CODE with OKTRIP
                                       /* catch < trip limit */
  case SAB_LBS <= TOL*max( SAB_LIM1, SAB_PCT1/100*TOT_LBS )
    replace SAB_CODE with
      if( SABWKCNT <= SAB_FREQ1, OKTRIP, VIOLATION )
  otherwise                            /* trip limit < catch */
    replace SAB_CODE with VIOLATION
else
  PER = if( RDATE < SAB_DATE2, 2, 3 )       /* period index */
  if SAB_LBS <= SAB_WKLY[PER]*TOL           /* catch < weekly */
    replace SAB_CODE with
      if( SABWKCNT <= SAB_FREQ[PER], OKTRIP, VIOLATION )
  else                                      /* weekly < catch */
    replace SAB_CODE with VIOLATION

/* check Pacific ocean perch limits */
case POP_LBS <= POP_INC*TOL            /* catch < incidental */
  replace POP_CODE with OKTRIP
                                       /* catch < trip limit */
case POP_LBS <= TOL*min( POP_LIM, POP_PCT/100*TOT_LBS )
  replace POP_CODE with OKTRIP
otherwise                              /* trip limit < catch */
  replace POP_CODE with VIOLATION
```

Figure 2. Example trip limit algorithm (continued).



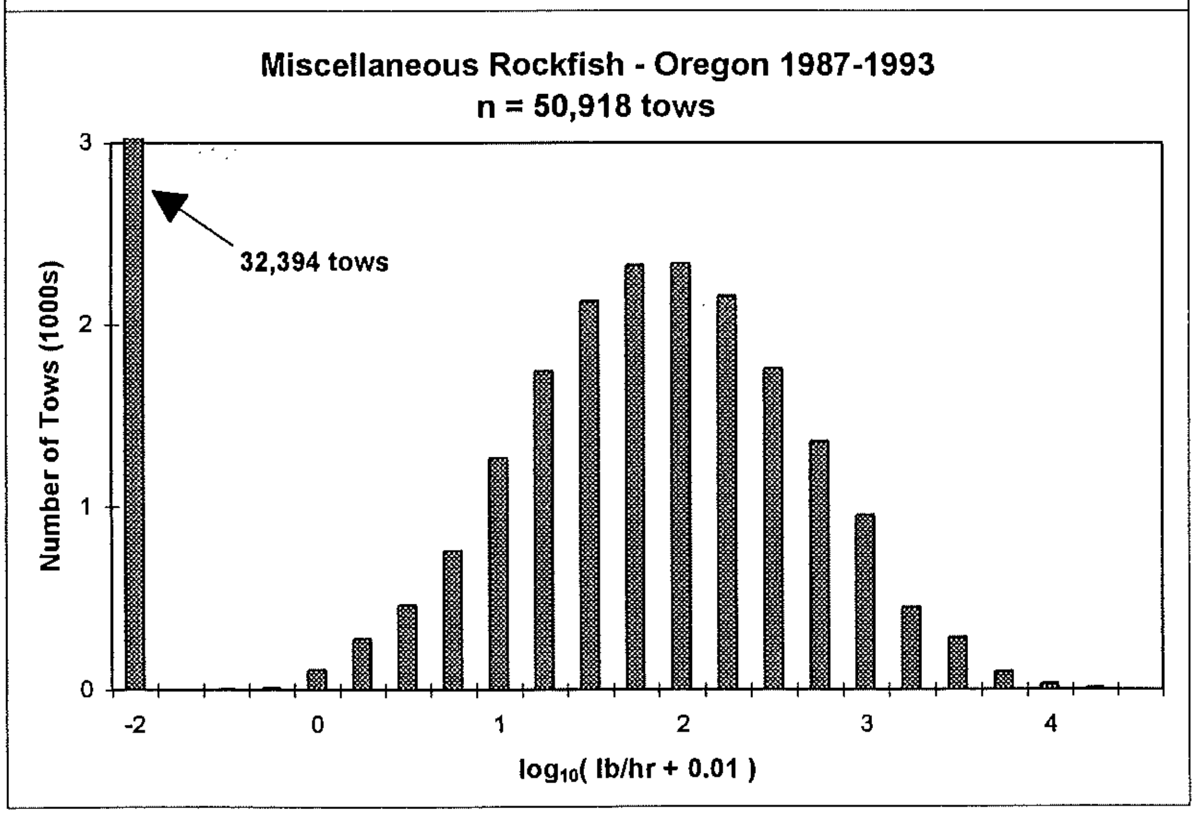


Figure 3. Observed catch rates for each species generally conformed to a lognormal distribution, except for all the tows with zero catch.

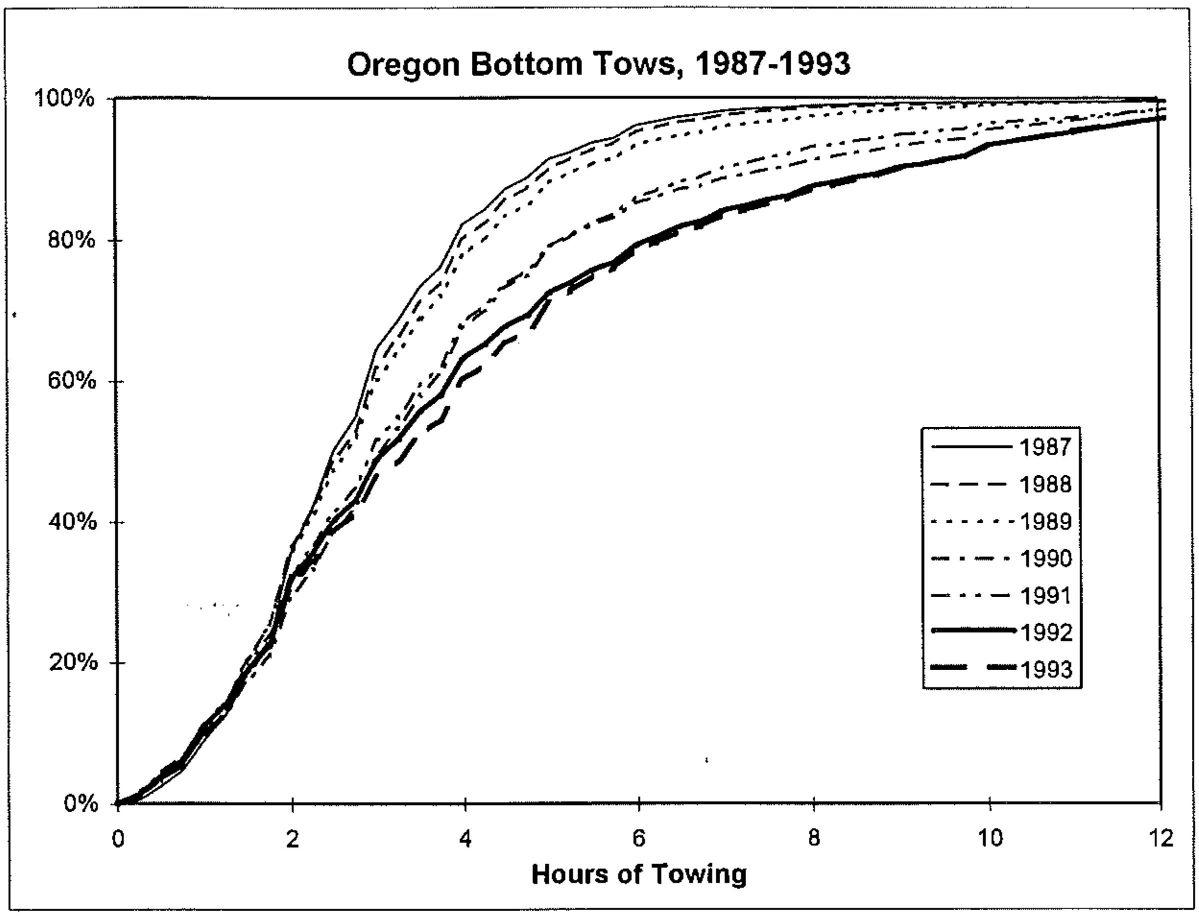


Figure 4. Cumulative distributions of bottom and roller trawl tow times. From our analyses we excluded tows longer than four hours.

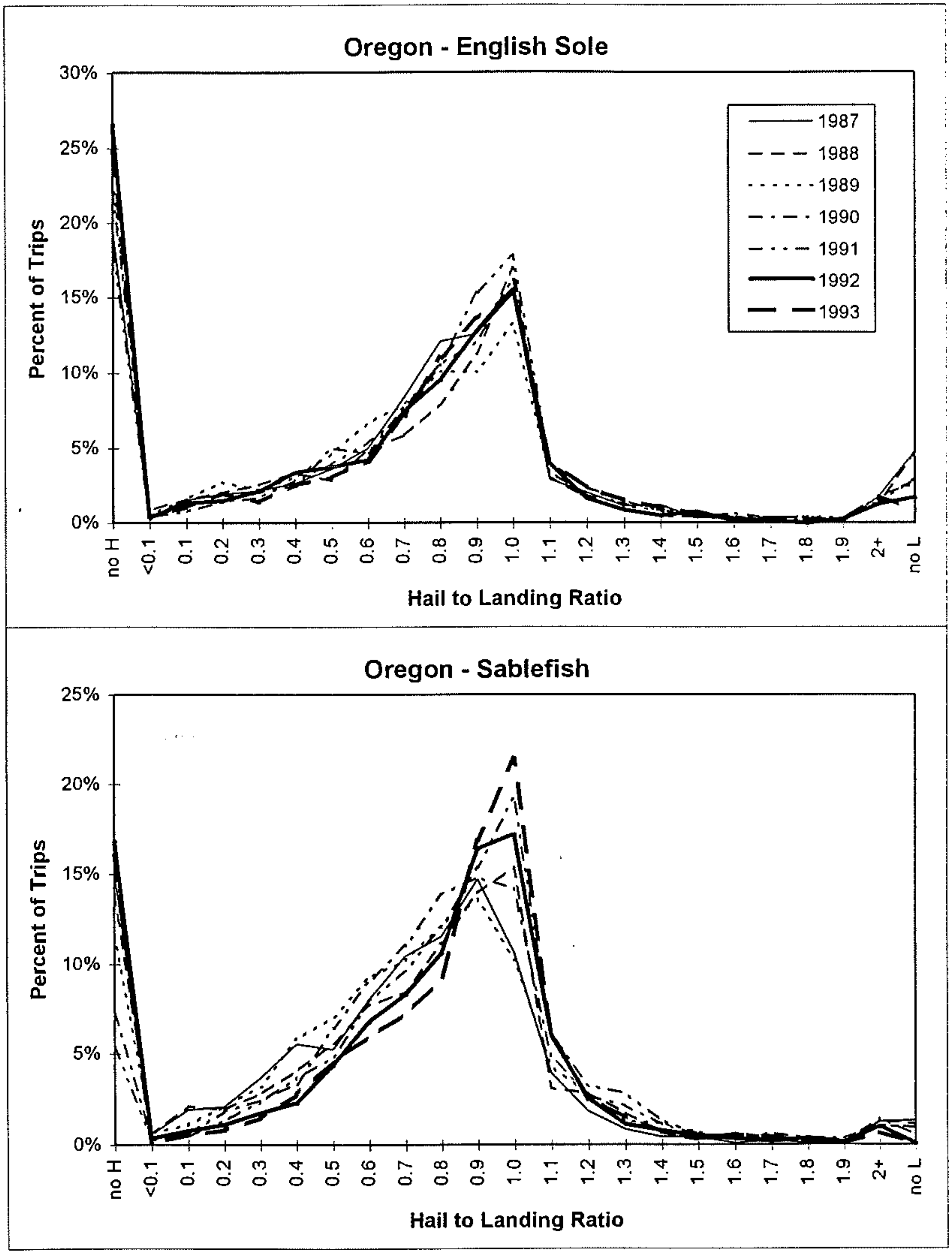


Figure 5. Example distributions of hail to landing ratios. The items "no H" and "no L" are hails without landings and landings without hails.

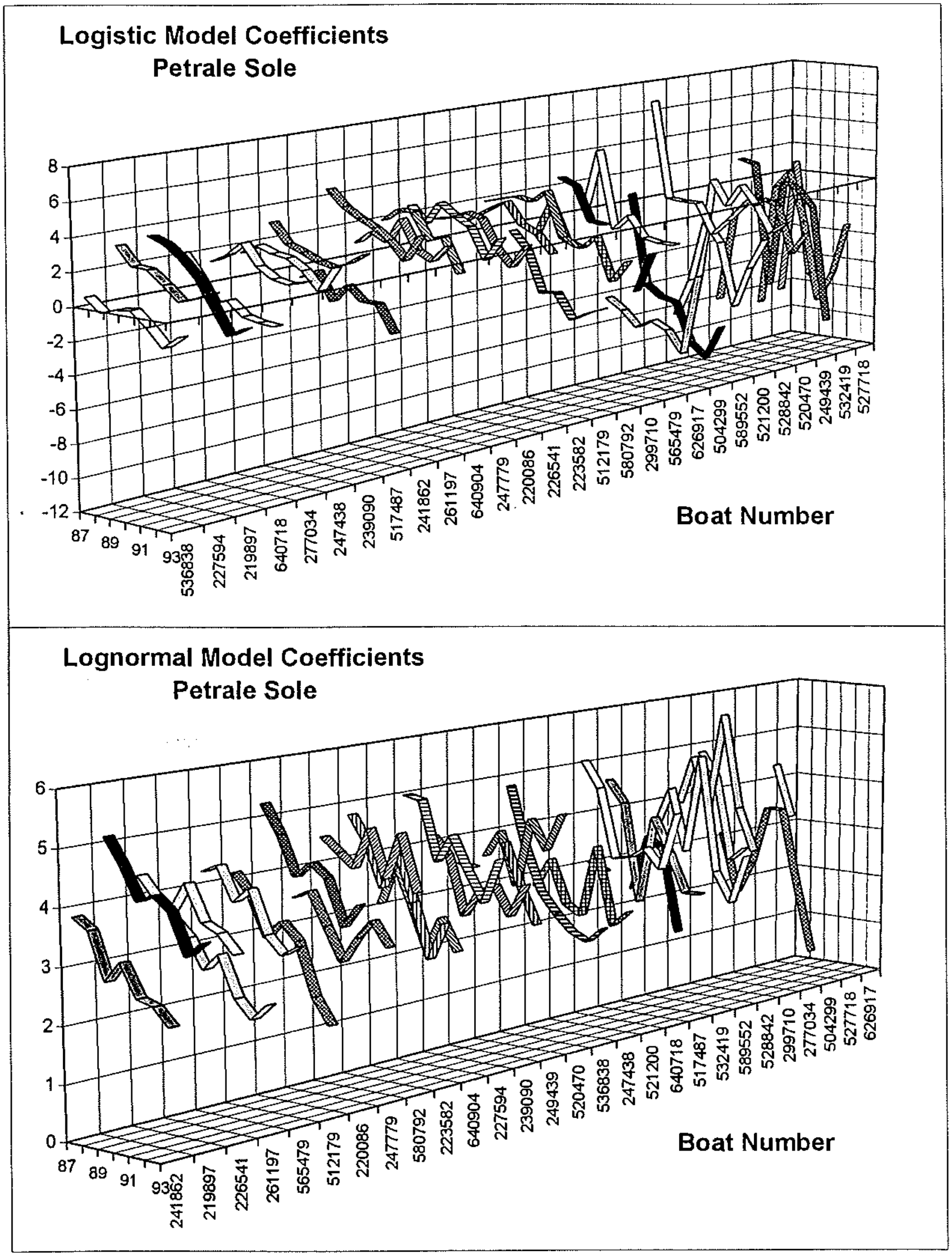


Figure 6. Examples of variability in annual fishing power coefficients.

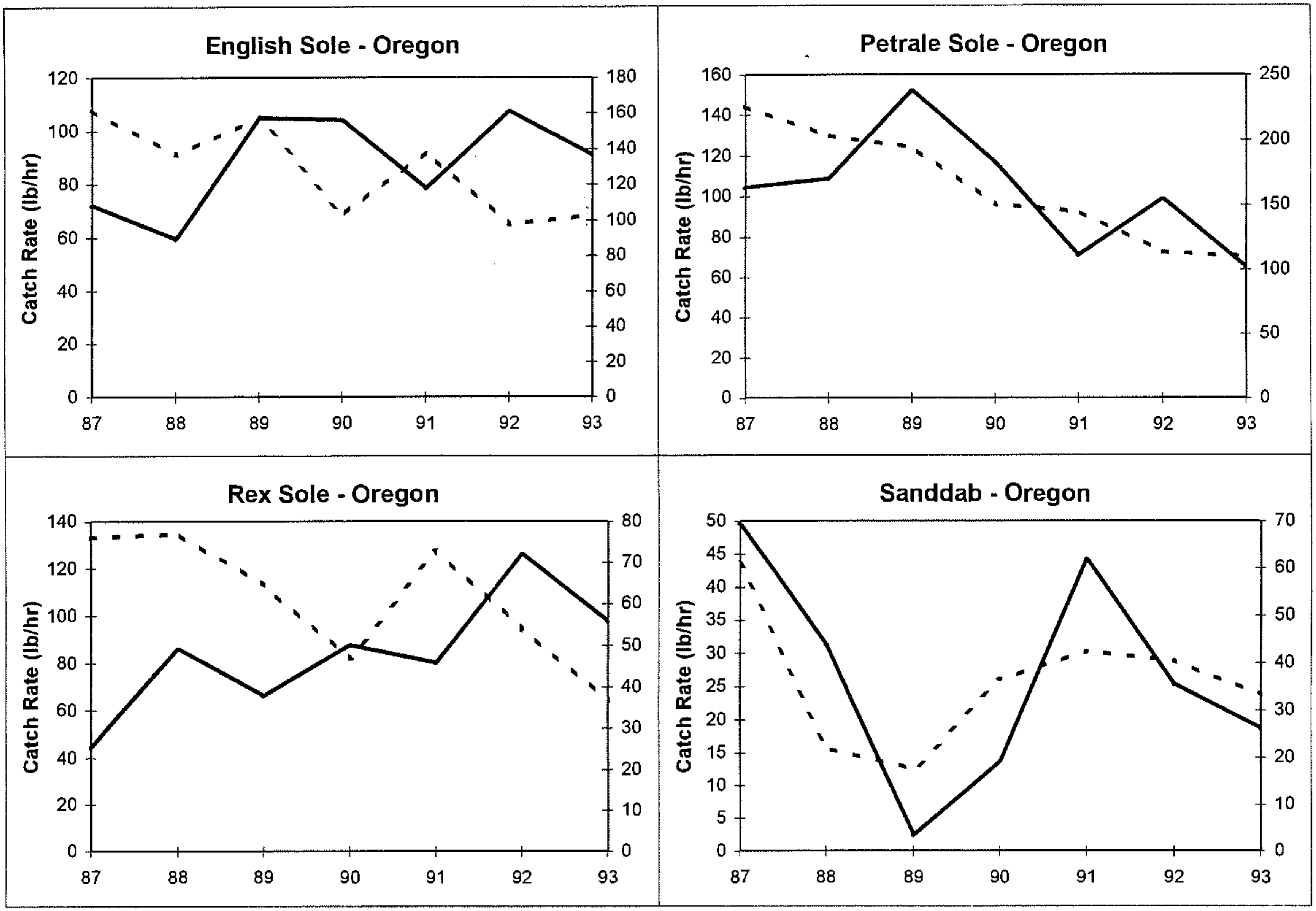


Figure 7. Statewide estimates of effective CPUE (solid line, left axis) and raw CPUE (dotted line, right axis).

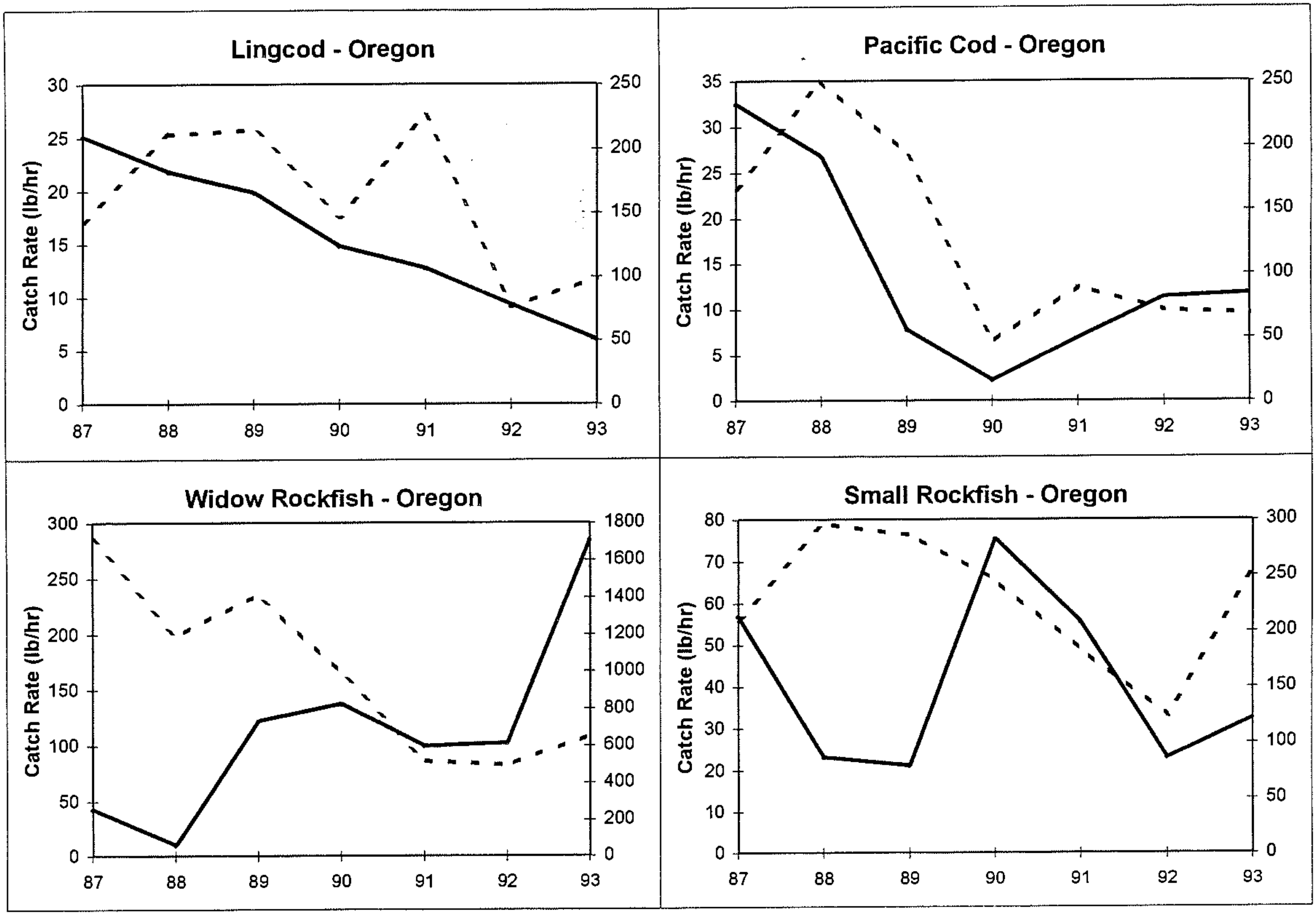


Figure 7. Statewide estimates of effective CPUE (solid line, left axis) and raw CPUE (dotted line, right axis) (continued).

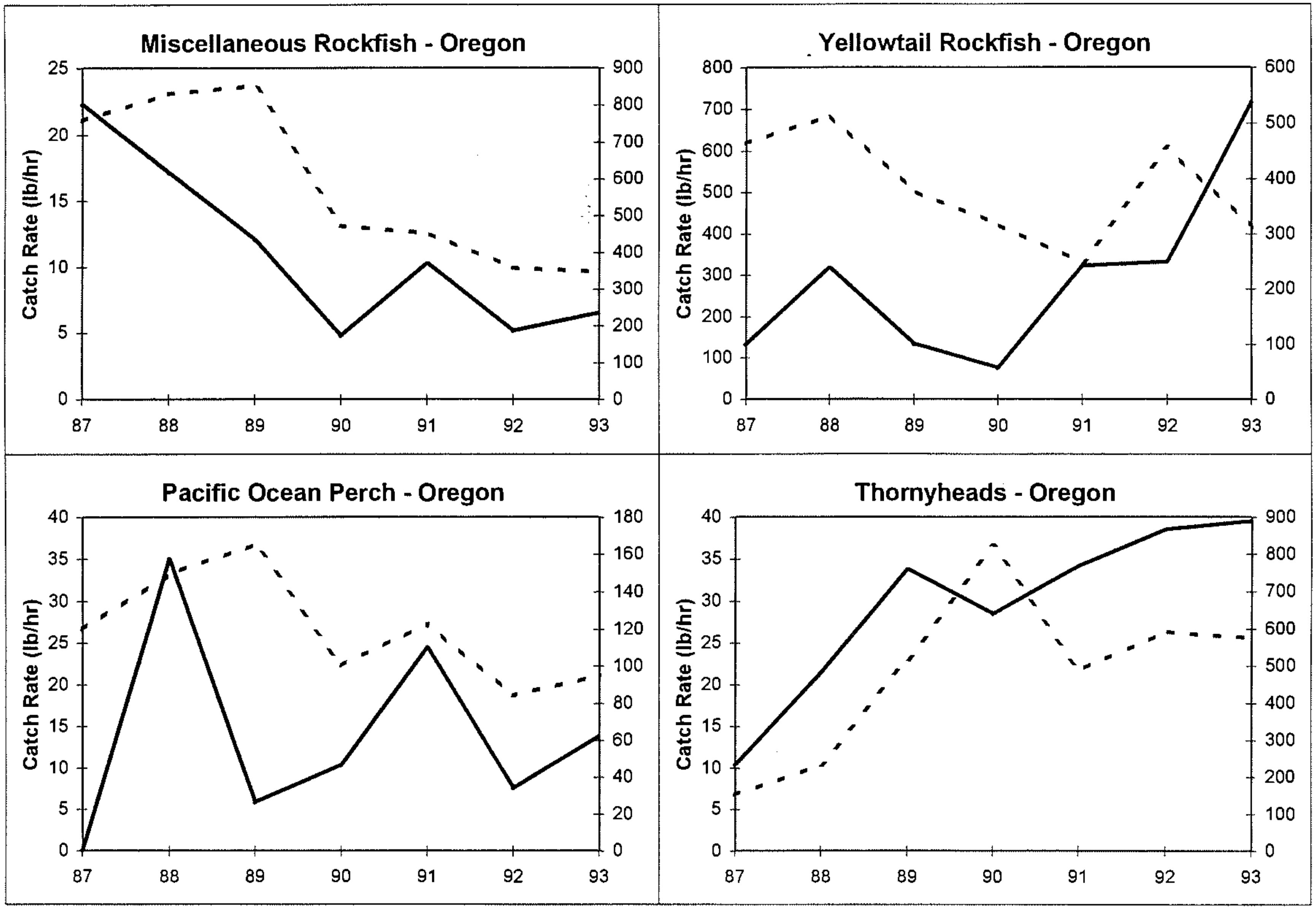


Figure 7. Statewide estimates of effective CPUE (solid line, left axis) and raw CPUE (dotted line, right axis) (continued).

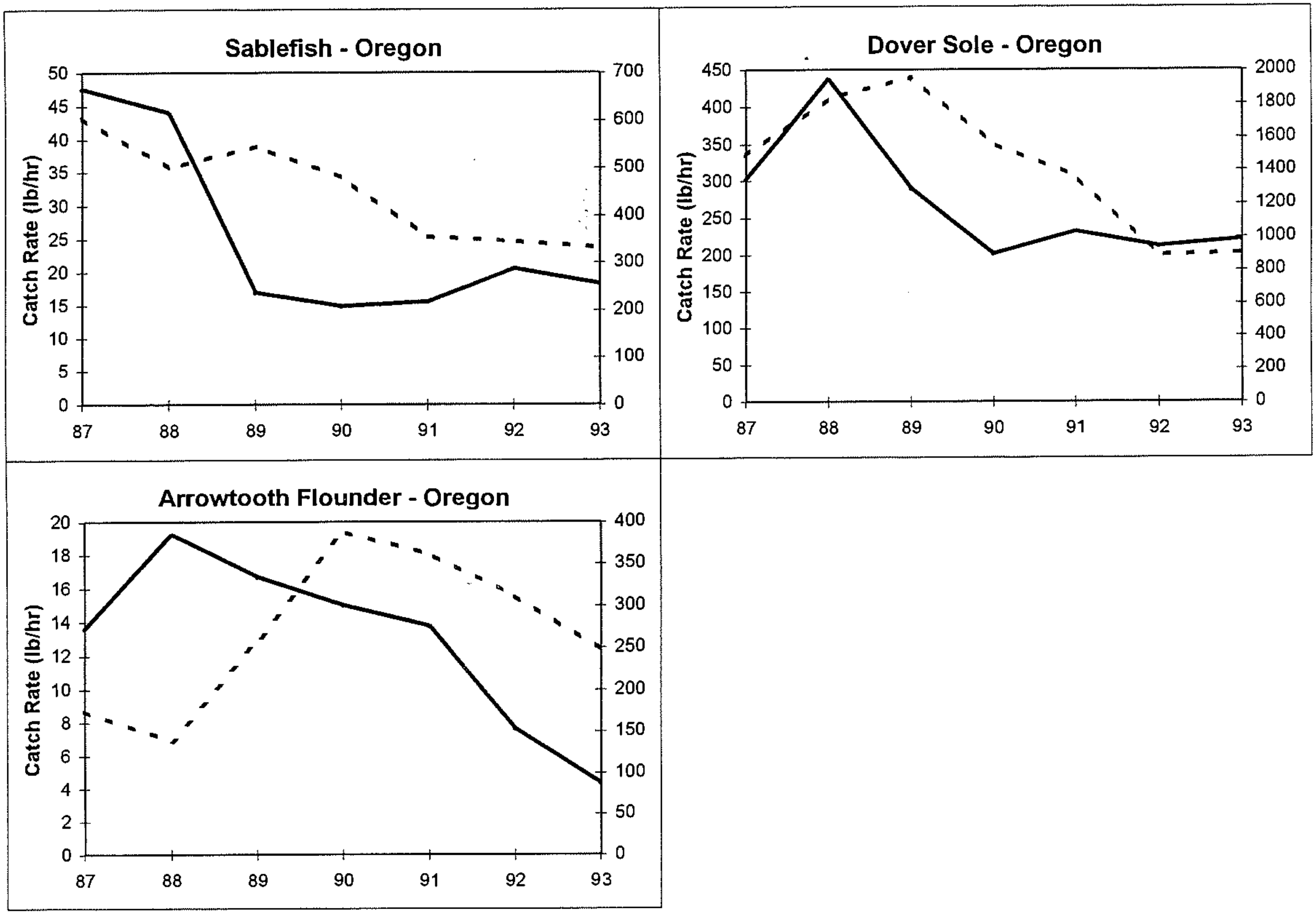


Figure 7. Statewide estimates of effective CPUE (solid line, left axis) and raw CPUE (dotted line, right axis) (continued).

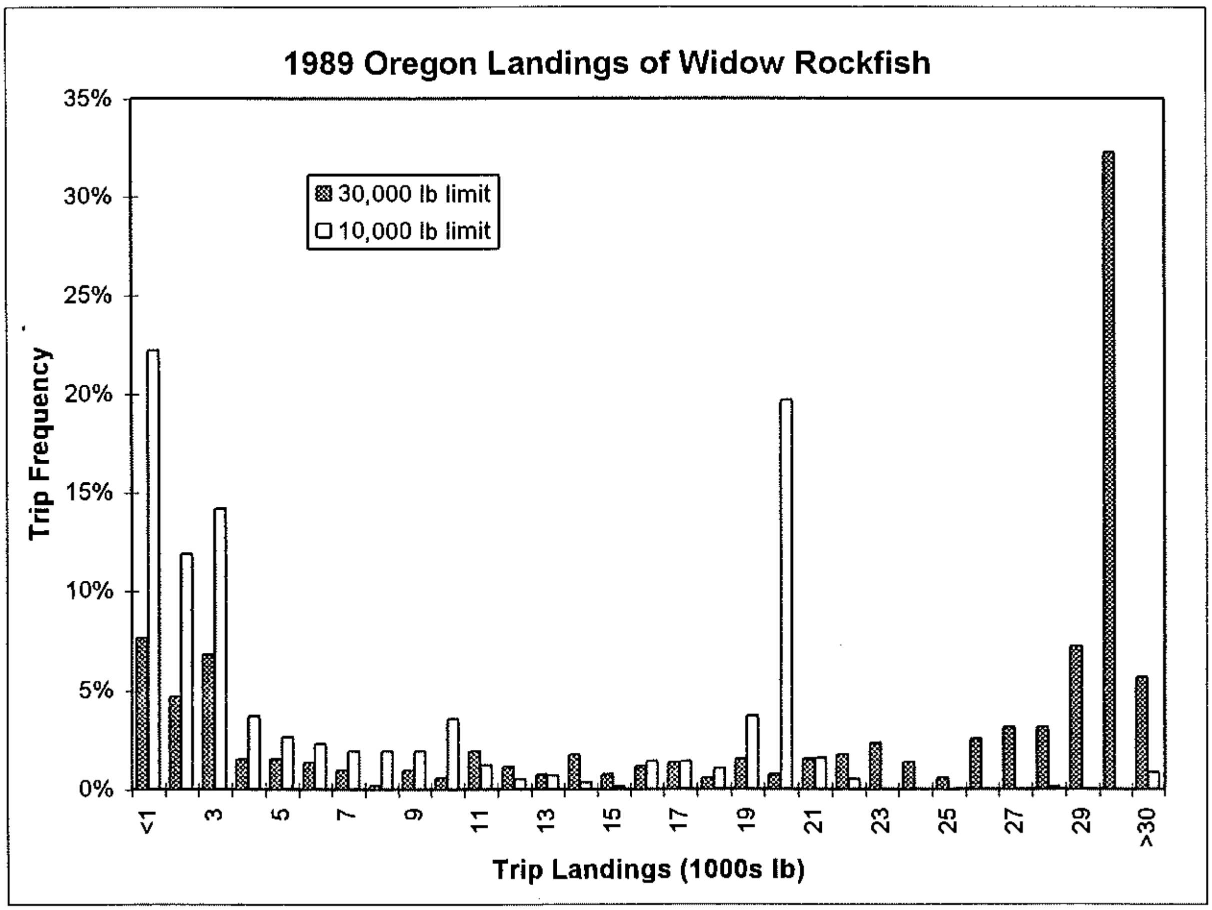


Figure 8. Example distributions of widow rockfish landings by trip, excluding trips that caught none. In 1989 the trip limit was 30,000 lb per week prior to 4/26 and 10,000 lb per week thereafter until 10/11.