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Fluctuations in the Catchability Coefficient of Atlantic Menhaden, 1968-1982

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FLUCTUATIONS IN THE CATCHABILITY COEFFICIENT OF ATLANTIC MENHADEN, 1968-1982

A Thesis

Presented to

The Faculty of the School of Marine Science

The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

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by

Steven M. Atran

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APPROVAL SHEET

This thesis is submitted in partial fulfillment of the requirements for the degree of

Master of Arts

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ABSTRACT

Weekly estimates of Atlantic menhaden abundance were derived from catch at age data for the years 1968-1982. Initial estimates of weekly catchability coefficients were calculated from the estimates of abundance and catch and effort data. Plots of the average weekly catchability coefficients for age groups 0 to 5 revealed patterns of fluctuations within a season. Between year fluctuations in catchability coefficients were found to be significantly different after accounting for the within season variation. Age groups were tested separately to eliminate age dependent variation as a possible cause of fluctuation. The relationship between catchability and abundance was calculated: predicted values of the catchability coefficient based on abundance were subtracted from the original estimates. Significant differences were also found between years for these residual catchability coefficients, thus factors in addition to abundance must contribute to between year variation in the catchability coefficients. Potential factors affecting catchability coefficients. Potential factors affecting catchability coefficients are cyclic changes, long term trends, density-dependent changes, density-independent changes, and changes due to changes in fishing effort.

FLUCTUATIONS IN THE CATCHABILITY COEFFICIENT OF ATLANTIC MENHADEN, 1968-1982

INTRODUCTION

Atlantic Menhaden - Historical Perspective

In 1621, the Indian, Squanto, showed English settlers at Plymouth, Massachusetts how to fertilize their crops with fish. Among the fish used was one the Indians called Munnawhatteaug, which means fertilizer (Frye 1978). It is from this that the name menhaden is derived. There is evidence that Squanto actually learned this method from other Europeans only a few years earlier, while he was in Europe as a slave (Ceci 1975).

The commercial fishery for menhaden began in Rhode Island in 1811. At that time, menhaden were boiled to extract the oil. Later, more efficient ways of extracting the oil were developed, and fish meal and solubles became commercially important. By the 1850's, menhaden processing plants had been established in Massachusetts and Connecticut, and in Maine by 1864. The solid material left after the oil was extracted was made into guano and sold for fertilizer (Frye 1978).

Floating factories were built in the 1870's to follow the movements of the menhaden schools and reduce the time required for the catch to reach the factory. By the late 1870's, however, floating factories were going out of use because of the introduction of steamers to the menhaden fishery (Frye 1978).

During the Civil War, Union soldiers stationed in the south noticed the abundance of menhaden in inshore waters. As a result of their observations, the menhaden fishery, which had previously existed only in the north, spread southward. By 1889 processing plants existed as far south as North Carolina (Hart 1983).

Menhaden were initially caught with haul seines or gill nets. In 1826, the purse seine was invented by John Tallman and Christopher Barker, who had started the first menhaden processing plant in Rhode Island in 1811 (Frye 1978). Purse seines came into general use during the next 40 or 50 years. Sailing vessels were used initially to operate the purse seines. Coal-fired steamers came into use after the Civil War, and these were replaced by diesel powered vessels in the 1930's (Hart 1983). The use of spotter planes began in the 1940's to guide menhaden boats to the schools (Frye 1978). More recently, technological advances such as nylon nets, pumping of fish from the nets to the hold, hydraulic winches and power blocks have allowed the menhaden fishery to operate more and more efficiently.

Initially, menhaden were important for their oil, used in tanning and curing leather, paints, rope and soap making, and for fertilizer. They were also used for food in the 1700's. Today the primary use of menhaden is for poultry feed and pet food. A new use for menhaden meal is the manufacture of surimi, artificial crab meat. The oil is used in various products including paints, soaps, lubricants, and lipstick. In Europe and in Canada the oil is used in the production of margarine (Henry et al. 1965, Frye 1978, Hart 1983).

In the 1950's and 1960's Atlantic menhaden was the largest commercial fishery in the U.S., peaking in 1956 at 712,000 metric tons (MT), worth about $20 million (Henry et al. 1965, Davis 1983). Late in the 1960's landings underwent a drastic decline, bottoming out at 161,000 MT in 1969. Since then, landings have again increased to the 300,000 MT range, and reached 382,000 MT in 1982. Although the number of Atlantic menhaden now landed is as high as it was in the 1950's, the biomass landed is reduced, partly because of a heavy fall (peanut) fishery on young of the year menhaden. Atlantic menhaden landings, combined with landings from the Gulf menhaden fishery, continues to be one of the country's most important fisheries (Davis 1983).

Life History

Adults

The Atlantic menhaden stock is believed to constitute a single population (Nicholson 1971b, 1978). From January to March, menhaden of all sizes concentrate in the offshore waters from Cape Hatteras, North Carolina to northern Florida (Nicholson 1971b). The menhaden begin migrating inshore and northward In late winter and spring. They stratify by age and size at this time, with the older and larger fish leaving first and migrating farther north (Nicholson 1971b). Maximum migration speeds of 11 to 16 km/day are reached (Dryfoos et al. 1973), and by June, the population is stratified by age and size along a north-south axis (Nicholson 1971b). Menhaden travel in surface schools, usually inside the 20 meter depth contour, although a few schools have been spotted as far out as the 55 m contour (Reintjes 1982).

In late summer, the menhaden north of Cape Cod, primarily age 4 and older, begin migrating southward (Nicholson 1971b). The southward migration begins in September off the coast of New Jersey, and by late November there are few menhaden left in the New York bight (Reintjes 1982). Along with menhaden from the Chesapeake Bay, the fish continue to move southward, eventually reaching their wintering grounds from Cape Hatteras to northern Florida during October to December (Nicholson 1971b).

Atlantic menhaden mature and begin spawning between ages 1 and 3, with most females maturing at age 2 (Higham and Nicholson 1964). In Virginia waters, menhaden are mature at about 1.5 years of age (McHugh et al. 1959).

Although menhaden spawn throughout the year, the time of spawning varies with location. In the north Atlantic, as far north as Nantucket Shoals, spawning apparently occurs from May to September. In the mid-Atlantic, there appear to be two spawning seasons, March through May and again in September and October. In the south Atlantic, spawning appears to be from October through March (Higham and Nicholson 1964). Menhaden in Virginia waters appear to have two spawning peaks, early winter and early spring (McHugh et al. 1959).

Spawning occurs in the open ocean in the mid-Atlantic and south Atlantic regions. In Virginia, spawning apparently does not occur in Chesapeake Bay, but does occur in the ocean not far outside the Virginia capes (Higham and Nicholson 1964, McHugh et al. 1959). Further north, however, eggs and larvae have been collected in harbors (Hildebrand 1963, Kuntz and Radcliffe 1917), suggesting that spawning occurs in harbors, although their presence may be due to transport.

Reported spawning temperatures for menhaden range from $9^{o}C$ to $24.4^{o}C$ (Herman 1963, Marak and Colton 1961, Marak et al. 1962), and salinity has been reported at 32.14 $^{o}/oo$ in a single observation by Marak et al. (1962).

Fecundity has been found to range from a mean of 38,000 to 631,000, with older fish producing larger numbers of ova (Higham and Nicholson 1964, Dietrich 1979). The eggs are highly transparent, buoyant and spherical, with a diameter of 1.4 - 1.6 mm. They contain a small oil globule, and are covered with a thin horny membrane (Hildebrand 1963).

Juveniles

Larval menhaden are more abundant in the upper 15 m of the water column than in the underlying waters, and wind driven currents (Ekman transport) appear to play a major role in their inshore movement to estuaries after 1 1/2 to 2 months in the ocean (Nelson et al. 1977).

The larvae are 18 - 34 mm in length when they enter the estuaries (Nelson et al. 1977, Reintjes and Pacheco 1966). Entry occurs from May to October in the New England states, October to June in the Middle Atlantic states, and December to May in the South Atlantic states. The larvae at entry are slender, transparent, and nearly colorless except for several rows of melanophores. In the estuaries, they undergo metamorphosis into juveniles with deep bodies, well developed fins, ventral scutes, scales, and a large head. Their feeding habits change from selective predation upon individual particles to nonselective filter-feeding. The juvenile menhaden are polyhaline, tolerating salinities from less than 1 $^{o}/oo$ to hypersaline environments of 60 $^{o}/oo$. They are found in water temperatures of 0^{0} C to 40^{o} C, but may suffer large mortalities if the water temperature drops below 3^{o} C for several days (Reintjes and Pacheco 1966).

Menhaden school from the time they enter the estuary as larvae (Reintjes and Pacheco 1966). They leave the estuaries in the autumn and migrate south as far as Florida. In the spring, the age I juveniles redistribute northward, with the largest fish going furthest north (Kroger and Guthrie 1973).

Statement of Problem

Management of commercial fish stocks by control of catch and/or effort is often based on models which assume that catchability, the fraction of a fish stock caught by one unit of fishing effort (Ricker 1975), remains constant throughout the fishing season. This assumption, however, is rarely, if ever, valid, and can cause analytical errors that can result in poor management.

There are many possible causes of variation in catchability. Behavioral change due to size or age may lead to variations in catchability, and has been reported to be one cause of variation for marron, Cherax tenuimanus (Morrissy and Caputi 1981). Density-dependence, or changes due to changes in abundance, has been demonstrated in some fish stocks, such as Pacific sardine, Sardinops sagax (MacCall 1975), Atlantic menhaden, Brevoortia tyrannus (Schaaf 1975), North Atlantic cod, Gadus morhua (Pope and Garrod 1975, Garrod 1977), capelin, Mallotus villosus (Ulltang 1976), and chinook salmon, Oncorynchus tshawytscha (Peterman and Steer 1981). See Appendix A for a complete discussion of types of fluctuation in catchability. Fluctuations in catchability, abundance, and fishing all contribute to fluctuations in the catch from a fish stock (Clark and Marr 1956, Pope and Garrod 1975).

If the fluctuation in catchability can be reduced by removing known causes of fluctuation, then management models in which catchability plays a role should give more accurate results. Furthermore, the remaining fluctuation may provide some insight into the behavior or availability of the fish stock, leading to further studies into the causes of fluctuation in catchability.

An inverse relationship between abundance and catchability of Atlantic menhaden (Brevoortia tyrannus) has been demonstrated by Schaaf (1975). Nicholson (1971b) showed that migrating menhaden stratify by age and size. Different migration patterns by fish of different ages results in different levels of accessibility to the fishery. Accessibility is a measurable modification of the catchability coefficient (Cushing 1968). Since the behavior of menhaden varies with age, this suggests that catchability also varies with age. If these are the only factors causing fluctuation in catchability, then removing the effect of age and abundance should leave a residual catchability coefficient which is constant except for random error or a possible cyclic variation, where the cycle occurs within the year. If there is still fluctuation, then there are other causes contributing to catchability, which can be clumped under the general term of availability.

Objectives

The first objective of this study was to determine whether the catchability of purse-seine caught Atlantic menhaden varies within a season, and if so, to qualitatively explain why such fluctuation exists.

A second objective was to determine whether such fluctuation follows a consistent pattern from year to year, after removing known or suspected causes of fluctuation, specifically, age and density-dependence.

Hypothesis

When the effects of age and density-dependent variation in catchability are removed from the catchability coefficient, then the remaining residual catchability coefficient is constant or follows a consistent temporal pattern, and the following hypothesis is true:

$$H_0: q_t = f(t)$$

with the alternative: $H_a: q_t \neq f(t)$

where: t = week of year

q_t = catchability coefficient in week t

$f(t)$ = an (unknown) function of time

The null hypothesis states that the value of q_t follows some unknown function of time. The alternative hypothesis states that q_t does not follow a function based on time.

If a constant catchability or consistent pattern exists, then the way in which catchability varies between weeks will not change significantly from year to year, and the hypothesis can be tested by comparing differences between years after removing the effect of variation between weeks. No assumption of normality or homogeneity of variance was made, and a non-parametric test, Friedman's method for randomized blocks (Sokal and Rohlf 1981), was used.

If the test showed differences between years, then where those differences exist was shown by a non-parametric multiple comparisons test based on Friedman's rank sums (Hollander and Wolfe 1973).

MATERIALS AND METHODS

Data

Weekly menhaden catch-at-age and vessel landings data from 1968 to 1982 were made available by the Beaufort Laboratory, National Marine Fisheries Service, Beaufort, North Carolina. The Atlantic coast fishery was considered as a single stock, in keeping with the practice used by the Atlantic Menhaden Management Board (1981), and based on tagging studies by Nicholson (1978). The stock was divided into age groups to eliminate differences in catchability due to age (and size) specific migration patterns.

Calculation of Weekly Abundances

The weekly landings data from Beaufort Laboratory consists of an estimate of the number of fish caught in each age group. Weeks are defined in terms of Primary Time Units, or PTU's. A PTU is a seven day period (Sunday through Saturday) which ends within a given range of dates (see table 1).

Virtual Population Analysis (VPA) was used to obtain estimates of abundance at the beginning of each week for each age group. This method involves using the solution to the catch equation developed by Murphy (1965), and modified by Tomlinson (1970). Tomlinson's method, which is incorporated in the FORTRAN program MURPHY (Abramson 1971), allows time intervals of unequal length and intervals with zero catches, provided that such zero catch intervals are not consecutive. I further modified Tomlinson's method so that consecutive intervals with zero catches are allowed (see Appendix B). This was necessary because I wished to maintain constant time intervals of one week, to conform to the Beaufort Laboratory's system of PTU's. Such short time intervals usually resulted in consecutive intervals of zero catches commonly occurring near the beginning and end of a sequence of weekly landings data for a given year and age group.

In addition to catch by age data, VPA requires estimates of instantaneous natural mortality (M) for all time intervals and an estimate of instantaneous fishing mortality (F) for one time interval. Natural mortality was assumed constant and a weekly value of .0087 was adopted based on the recommendation of the Beaufort Laboratory; thus the assumed annual natural mortality rate was 0.45. Estimates of F for the final week of landings data in each year were obtained from Table 13 of Broadhead et al. (1980) for the years 1968 - 1976 and for age groups 0 - 5. For age groups 6 - 8 the values for age 5 were used. For the years 1977 - 1982, the average values for the years 1968 - 1976 for each age group were used (1968 - 1975 for age group 0). In each case, the annual value of F from the table was divided by the number of weeks in the year that had landings data to obtain a weekly F, and M was divided by 53 to account for the 53 PTU's in the Beaufort Laboratory's system of standard weeks. Instantaneous fishing mortality values were probably overestimated since catch generally declined at the end of the season. However, in the backward solution to the catch equation, the value for F tends to converge toward its true value for a given M. Therefore, the error in abundance estimates due to this overestimation of F should be minor at the beginning of each year's landing data, though it may result in the underestimation of abundance toward the end.

Defining Effort

An index of fishing effort is needed to calculate a catchability coefficient. Effort in the menhaden purse seine fishery is difficult to define due to changes in the fishing gear and methods over the years, and differences in the sizes and types of vessels (Nicholson 1971a).

The vessel-week (number of vessel landings per week) is commonly used as the unit of fishing effort in studies of the menhaden purse-seine fishery, and is the unit used in this study. With this definition of effort, a potential problem exists, in that menhaden plant records do not indicate whether a catch represents one or more days fishing. Vessels generally land their catch daily, but in the Middle and North Atlantic areas they may land two or three days catch at one time, particularly in late spring and early fall. However, menhaden vessels generally operate continuously throughout all or part of the fishing season and fish every day that the weather permits, unless in port for repairs. Any time period that assumes continuous fishing and accounts for unproductive fishing days should be a satisfactory unit of fishing effort (Nicholson 1971a). Number of landings as a unit of effort assumes continuous fishing. Further, while the number of days that a given vessel was fishing is unknown it was assumed that such variations are fairly consistent from year to year, making between year comparisons possible.

Calculation of Weekly Catchability Coefficients

The catchability coefficient is the fraction of a fish stock which is caught by a defined unit of fishing effort (Ricker 1975). Paloheimo and Dickie (1964) mathematically describe the relationship between catch, effort, abundance, and catchability as:

$$(C/f)_t = q_t N_t \qquad (1)$$

where $(C/f)_t$ = average catch per unit effort over period t,

N_t = average abundance during period t, and

q_t = catchability during period t.

Since VPA estimates abundance at the beginning of a time period, average abundance in a period is $(N_t + N_{t+1})/2$. Average catch per unit effort in a time period can be calculated as total catch divided by total effort for that period. The above equation can be rearranged to define the catchability coefficient as:

$$q_t = (C_t/f_t) \;/\; ((N_t + N_{t+1})/2) \qquad (2)$$

This equation was used to calculate initial weekly catchability coefficients for each age group. No catchability estimate was made for weeks in which there was no catch landed for the age group considered. Also, no catchability estimate was made if abundance estimates were not made for both the week being considered and the following week, since the average abundance during the week $(N_t+N_{t+1}/2)$ was used to estimate catchability.

Initial Analysis of Weekly Catchability

Plots of weekly catchability were created for each age group. These plots were visually examined for signs of fluctuation within a season. In cases of obvious fluctuation, it was deemed unnessessary to statistically verify that the fluctuation existed, only to test whether the pattern was consistent from year to year.

The relative degree of weekly fluctuations from year to year may vary due to biotic or abiotic factors. Thus, heterogeneity of variance between years may be expected, and a nonparametric model is appropriate to test for significant difference in annual patterns of weekly catchability coefficients (q). Friedman's method for randomized blocks (Sokal and Rohlf 1981) is the nonparametric analog to the parametric ANOVA, randomized complete block design, but the rankings of the variates within each block are used rather than the actual measurements, and a chi-square statistic is computed rather than an F statistic. The "k" related samples in the study are the 15 years, 1968 - 1982, for which weekly q estimates are available. The q values in different years are related to each other by the week for which they were calculated.

Friedman's test was used to assess the significance of age specific annual variation in weekly q for age groups 0 through 6. Ages 7 and 8, as well as some years for ages 0, 5, and 6, were excluded from the analysis because of insufficient data. Where significant differences were found between years at the 0.05 alpha level, a non-parametric multiple comparisons test based on Friedman's rank sums (Hollander and Wolfe 1973) was used to identify differences.

Calculation of Catchability-Abundance Relationship

Schaaf (1975) demonstrated an inverse curvilinear relationship between catchability and abundance of the type:

$$q = aN^{-b} \tag{3}$$

where q = catchability coefficient, N = abundance, and a,b = parameters. This equation can be linearized by expressing the abscissa and ordinate values in logarithms. The equation used herein to calculate the catchability-abundance relationship for each age and year for which there were data was

$$\ln(q) = \ln(a) - b*\ln(N) \tag{4}$$

where ln indicates Naperian (natural) logarithms. Correlation coefficients between the natural log values of catchability and abundance were also calculated for each age group.

Only catchability and abundance values drawn from the middle of each season were used to calculate the parameters. This procedure eliminated possible errors in estimation of abundance and catchability due to incomplete availability at the beginning and end of the season. The weeks to be included in each calculation were determined arbitrarily by visually examining graphs of catchability vs. week for each age and year, and selecting those weeks which appeared to fall between catchability spikes caused by possible underestimation of abundance.

Analysis of Catchability Residuals, After Adjusting for Abundance

Residuals of the weekly catchability coefficients were generated by calculating catchability coefficients according to the abundance relationship, and subtracting these values from the catchability coefficients estimated from the catch and efffort data. These residuals were also examined using the Friedman test.

RESULTS

Weekly abundance estimates were made using VPA in each year from the first week in which a catch was landed until the last (tables 2-10). Weeks within this range for which no catch was reported were dealt with as described in appendix B dealing with my modification to Tomlinson's method of VPA.

Catchability coefficients (tables 11-19) and catchability residuals consisting of the catchability coefficient minus the value predicted from equation 3 (tables 21-29) were estimated for each week for which there were abundance estimates for the current and subsequent weeks, except for weeks in which no catch was landed for the age group considered.

The calculated values of the parameters used in equation 3 decreased as age increased (table 20). Because of the large coefficients used for age 0, many of the residuals for this age group were beyond the range allowed by the VAX 11/780 computer, and were therefore not included in the table.

Within Season Fluctuations

The weekly catchability for each age group and year was plotted. Pooled averages for each age group were also plotted to show representative patterns of fluctuation (figures 1 - 4). The graphs of weekly catchability appear to show a within year pattern in catchability. The first part of the catchability curve features an initial peak followed by a rapid decline. The height of this initial peak relative to the rest of the plot is most pronounced in the age 1 and age 2 fish. It becomes less pronounced and disappears altogether as the fish become older. This first peak does not occur in age 0 menhaden, which are subject to a fishery largely directed against them in the fall.

During the middle of the season, the catchability coefficient is gradually rising with time. If the menhaden stock is assumed to be at full availability during this time, then the abundance of each age group will be decreasing due to fishing and natural mortality.

Toward the end of the season, the catchability coefficient once again rises to a peak, sometimes followed by a sharp decline to zero.

The graph of the age 0 catchability coefficient is different from the other age groups. It remains at or near zero for most of the season, since no age zero fish are being caught. Near the end of the season, it rapidly rises from zero to a peak, and then quickly drops back to zero.

Tests of Hypothesis

The Friedman tests for the hypothesis of no significant differences in the pattern of catchability coefficient fluctuations between years indicated that there was at least one year which was significantly different from the others at the 0.05 alpha level for age groups 1, 2, 3, and 4 (table 30). These are also the only age groups for which sufficient data are available to include all 15 years; conversely, those age groups showing no significant differences between years (age groups 0, 5, and 6) were also those with fewer data to work with. Subsequent multiple comparisons for age groups showing significant differences between years (figure 5) showed that years which were not significantly different could be placed into two or three groups. However, no inferences could be drawn from the pattern of groupings.

After subtracting catchability due to abundance, the Friedman test was run on the residuals (table 31). All age groups, with the exception of age 5, showed significant differences. Neither the test probabilities nor the rankings of h e years in the multiple comparisons bar diagrams (figure 6) showed much change.

A week negative correlation was found between ln(q) and ln(N) for each age group, with data from all years pooled (table 32). Values ranged from -0.161 to -0.325 for age groups containing more than 100 data points. The correlation coefficient decreased toward -1.00 with increasing age, except for age 3. However, the number of data points used to calculate the correlation coefficients also decreased with increasing age.

DISCUSSION

The weak negative correlation between abundance and catchability indicates that abundance is not an overiding factor governing fluctuations in catchability. However, since a correlation, although weak, does exist, taking abundance into consideration may improve the accuracy in estimates of catchability, and enhance assessments which utilize the catchability coefficient.

For example, one method of estimating fishing mortality is from:

$$F = qf \tag{5}$$

where F = instantaneous fishing mortality, q = catchability coefficient, and f = fishing effort. This assumes that fishing mortality is proportional to effort, where q is constant. However, a simple substitution for q by it's abundance relationship, aN^{-b} (Schaaf 1975), gives:

$$F = aN^{-b}f \tag{6}$$

While this equation requires estimates of abundance as well as effort, it permits catchability, and therefore fishing mortality, to vary with abundance, and more accurately estimates F during the fishing year as population abundance declines due to both natural and fishing mortality.

Within Season Variation

The First Peak - an Availability Anomaly

The existence of this initial peak is probably due to underestimation of abundance at the beginning of the season as a result of the VPA method used. Virtual population analysis measures the "virtual" abundance, that which appears to the fishery to be there. Very early in the season, when the menhaden are migrating into the fishing area from their wintering grounds, only part of the stock is available for exploitation. This availability, or accessibility, causes a measurable modification in the catchability coefficient (Cushing 1968). Marr (1951) showed that catchability is directly related to availability. However, VPA assumes that there is full availability, thus abundance is underestimated. Several researchers have demonstrated an inverse relationship between abundance and catchability (Smith 1944, Paloheimo and Dickie 1964, Pope and Garrod 1975, Schaaf 1975, Ulltang 1976, Garrod 1977, Peterman and Steer 1981). Shardlow and Hilborn (1985) demonstrated that if the abundance is underestimated, then the catchability coefficient will be overestimated.

Theoretically, this first peak should extend up to infinity prior to the start of the season when VPA is used to estimate abundance. Had abundance been measured using a method independent of the fishery catch statistics, such as mark-recapture, the catchability coefficient would be expected to rise from zero without an early season peak, unless caused by other factors. This rise from zero or near zero catchability which occurs in many of the plots, particularly with older age groups, may be due to an earlier or faster migration of these age groups into the fishing area, or more complete recruitment of the age group at the start of the season. Younger age groups are not completely recruited into the fishery, but by age 2, the menhaden are fully recruited into the Atlantic coast purse seine fishery (Atlantic Menhaden Management Board 1981). If availability is at or near maximum by the time of the first catch, then VPA will not underestimate abundance, and consequently catchability will not be overestimated. One advantage of examining within season fluctuations of catchability, therefore, may be to determine how quickly and at what point in time a stock becomes available to the fishery.

The Middle Section - an Inverse Abundance Relationship

Schaaf (1975) reported a logarithmic inverse relationship between catchability and abundance of menhaden. This is a likely explanation for the gradual rise in catchability noted in this study during this period. An increase in this rate might be an indicator of overfishing.

The End Peak - another Availability Anomaly

As with the first peak, this peak may be due to underestimation of abundance by VPA due to decreasing availability of the menhaden as they leave the fishing grounds.

Age 0 - a Directed Effort Effect

Age 0 menhaden are fished extensively in the North Carolina fall fishery which is largely directed toward these fish. The pattern of catchability for age 0 menhaden differs from that of the other age groups in that fishing effort is specifically directed toward these fish at certain times. Paloheimo and Dickie (1964) state that when fishermen selectively apply their effort toward some schools, the result is to vary the catchability coefficient depending on age, species, and relative abundance. This effect is apparrent in the plot of average weekly catchability coefficient for age 0 menhaden, which is quite different from the plots of older age groups. When the age 0 menhaden, commonly referred to as peanuts, migrate out of Virginia and North Carolina estuaries, they become readily available close to shore where they dominate the landings, usually in December and January.

SUMMARY

Several age groups showed significant differences in catchability fluctuation between years. After calculating the relationship between catchability coefficient and abundance and subtracting catchability due to abundance from the total catchability, the residuals also showed significant differences between years for all but one age group. The correlation coefficients for age groups for which there were large amounts of data ranged from -0.161 to -0.325. It appears that density dependence is not a major cause of fluctuation in the catchability coefficient, but does explain some of the variation.

The catchability of Atlantic menhaden does not remain constant. There are fluctuations in the weekly catchability coefficient over the course of a year. Taking these fluctuations into consideration may enhance assessments which utilize the catchability coefficient, and result in more accurate estimates of fishing mortality.

The gradual rise in catchability in the middle section of most catchability plots can probably be attributed to a gradual decrease in stock abundance due to fishing and natural mortality. A departure from "normal" in this section of the catchability plot might be used to indicate the existence of over or under fishing on a given age group and year.

A directed effort on a particular age group will result in a different pattern of catchability fluctuations compared with other age groups. Although in the case of Atlantic menhaden this pattern is also readily apparent in the catch statistics, it may be possible to use this in other fisheries to indicate a directed effort when the catch data alone are more ambiguous. A directed effort effect may also occur when economic conditions favor menhaden over alternative resources.

Changes in migration patterns and behavior of Atlantic menhaden may result in changes in the pattern of catchability coefficients. If the menhaden behavior changes in response to environmental conditions, then changes in the catchability plot may be an indicator of changes in environmental factors. Conversely, if a relationship between an environmental factor and catchability can be established, then this knowledge can be used to account for some of the variablity of the catchability.

APPENDIX A

What is Catchability?

Catchability is the fraction of a fish stock which is caught by a defined unit of the fishing effort (Ricker 1975). It is a measure of how likely fish (or any exploited organisms) in a given stock are to be caught by a particular type of fishing gear.

Catchability is different for each combination of stock and fishing gear. Thus, the catchability of a stock being fished by purse seiners is different than the catchability of the same stock being fished by trawlers. Two different stocks fished by the same type of gear might have different catchabilities even if the stocks are of the same species. This could be due to biological differences between the stocks, such as different growth rates. For example, Brauhn and Kincaid (1982) found significant differences in the catchabilities of different strains and families of rainbow trout which were reared under identical conditions and fished simultaneously from the same pond. Strains were identified on the basis of differing growth rates, and families by individual ancestry.

Even for a specific type of fishing gear, differences in catchability can exist between individual pieces of gear. Differences between operating characteristics of the boats, experience of the fishermen, and changes in material, construction, or the method of using the fishing gear can all contribute to differences in the gear efficiency, which affects catchability. When a fishing fleet consists of several pieces of gear, the catchability and gear efficiency for the fishery is the average of the individual pieces of gear. Small random changes by the individual fishermen are unlikely to have a significant effect on catchability for the fleet. However, changes by several of the fishermen, such as would happen when improved gear or methods become available, will cause a long-term trend in catchability.

Literature often refers to availablility rather than catchability. Availability is the degree to which a population is accessible to the efforts of a fishery (Marr 1951). Catchability is a function of availability and gear efficiency (which is assumed constant), i.e.;

$$q = kr \tag{1}$$

where q = catchability coefficient

k = constant representing gear efficiency

r = availability, the fraction of the population available to the fishery

In the remainder of this discussion it will be assumed that only one type of gear is being considered. Therefore catchability and availability will differ only by the product of the constant k. Their variabilities will be related, the variance of q being equal to the variance of r times k^2.

Types of Variation in Catchability

Although catchability is usually assumed to be constant, it is actually subject to variation. The causes of these variations can be divided into five general categories.

1) Cyclical Changes in Catchability

In many fisheries a cyclical variation in catchability exists due to seasonal changes in fish behavior or distribution (Gulland 1964, 1969, Pope and Garrod 1975). Such changes may be the result of cyclic environmental conditions such as temperature or length of day.

Pope and Garrod (1975) show a significant change in catchability between quarters for various cod fisheries. Gulland (1964) reported that the CPUE of Arctic cod is at a minimum in the Autumn, and that in many herring fisheries and other seasonal fisheries, the CPUE is nearly zero outside the fishing season. Although Gulland (1964, 1969) felt that seasonal fluctuations are unlikely to cause serious errors when estimating annual mortality or abundance, Pope and Garrod (1975) state that a knowledge of seasonal change in catchability could be used to reduce the variance of catchability, which plays a major role in causing analytical errors in the objectives of management by catch and effort regulation. A knowledge of seasonal variation might also be used to investigate the effects of intra-seasonal management options such as changing the opening or closing dates of a fishing season, which are likely to be periods of rapidly changing catchability, or of having a split season, which would stop fishing during a period of relatively stable catchability.

Other short-term cycles may also exist. Staples and Vance (1979) found a marked tidal periodicity in the catchability of juvenile and adolescent banana prawns, Penaeus merguiensis. Morrissy and Caputi (1981) reported that variation in catchability of freshwater crayfish, marron (Cherax tenuimanus) is associated with underwater illuminance and moon phase. Such fluctuations are unlikely to be significant when examining catchability on a seasonal or longer term basis.

2) Long-term Trends

Long-term trends in catchability may be caused either by increases in fishing power or by biological changes. Such trends are usually the result of improvements in gear or fishing methods (Gulland 1964), but in many fisheries this conclusion may be questionable. The Atlantic menhaden fishery has shown a consistent increase in catchability with time. This increase has been attributed to an increase in gear efficiency (Broadhead et al. 1980), but Schaaf (1979) reported that the increase in gear efficiency since 1960 is the result of a decline in population size.

Pope and Garrod (1975) reported that the estimated catchability of Arcto-Norwegian cod for Norwegian fishermen has shown a steady increase over time, but it was not clear how much of the increase was due to increased fishing power and how much to biological change. The same stocks showed no long-term trend for the UK, USSR, or Federal Republic of Germany fishing fleets.

For the West Greenland cod stocks, Pope and Garrod (1975) reported an increase in catchability with time for all fishing fleets. This increase had been previously attributed to improved efficiency of trawls. However, Pope and Garrod noted that the catchability estimates for Portuguese dory vessels show the same trend. Since dory effort measurements exclude increases in fishing power of the mother ship, they concluded that the increase in catchability was due not to increases in fishing power, but to changes in the availability of the Greenland cod stock.

3) Density-dependent Changes

Schaaf (1975) considered fisheries to be a type of predator-prey interaction, and discussed the effect on ecosystem stability and mangement decisions of three types of relationships between catchability and abundance; catchability constant, catchability varying directly with abundance, and catchability varying inversely with abundance.

Constant catchability contributes neither stability nor instability to the system, and results in a linear relationship between CPUE and effort.

Catchability varying directly with abundance tends to stabilize a system. As abundance diminishes, so does catchability, and it becomes harder to catch members of a population. Thus, tight restrictions on catch or fishing effort are not necessary to maintain an equilibrium yield close to maximum.

Catchability varying inversely with abundance tends to destabilize a system. As abundance decreases, the proportion of the population caught by one unit of effort increases, and tight restrictions on catch or fishing effort become necessary to maintain an equilibrium yield.

MacCall (1975) found that the catchability coefficient for the Pacific sardine purse seine fishery was inversely related to abundance along a logarithmic curve.

Ulltang (1976) reported that in many purse seine fisheries, such as the Norwegian fishery for capelin in the Barents Sea, a fleet may be able to follow concentrations of fish for a long period. If the density of the school does not decrease significantly with decreasing stock size, then the proportion of fish caught by each unit of fishing effort will increase. Ulltang found that for the Norwegian purse seine fishery on spring spawning herring, catchability was inversely related to stock size logarithmically.

Schaaf (1975) found that the behavior of menhaden, which school densely and are visible from spotter planes, results in a logarithmic inverse relationship between catchability and abundance. Similar inverse relationships between catchability and abundance have been found for chinook salmon (Peterman and Steer 1981) and North Atlantic cod (Pope and Garrod 1975, Garrod 1977).

4) Density-independent changes

Density-independent changes in catchability may be caused by changes in behavior or distribution brought about by environmental fluctuations or biological changes. Morrissy and Caputi (1981) reported catchability of marron in baited drop nets to be associated with size, sex, female spawning activity, moult stage, and previous history of capture, in addition to the cyclic variables mentioned previously.

Farman et al. (1982) reported that catchability of largemouth bass in Back Bay, Virginia tournament angling was associated with water temperature, transparency and salinity.

For menhaden, Reintjes and Pacheco (1966) theorized that behavior and distribution could be affected by physical factors such as waves, currents, and turbidity, and by chemical factors such as oxygen, carbon dioxide, hydrogen sulfide, hydrogen-ion concentration, inorganic salts, and organic compounds.

5) Changes Due to Changes in Fishing Effort

Changes in catchability due to changes in fishing effort are not very common (Gulland 1964). Such changes can occur when the fishing is so intense that one piece of fishing gear interferes with another. Situations of this type might occur, for example, if gill nets are set too close together or if several purse seiners are converging on the same school or patch of fish. Gill nets and long-line fisheries may also have changes in the catchability as a result of decreased efficiency due to gear saturation (Garrod 1964).

Changes in catchability can occur as a result of a fishing fleet changing its location and distribution to concentrate on areas where the fish are most abundant (Gulland 1955). When fishermen are able to selectively apply their effort toward some schools while avoiding others, perhaps to select the schools giving maximum economic return, the result is to vary the catchability coefficient depending on age, species, and relative abundance (Paloheimo and Dickie 1964).

It is also possible that intensive fishing may change the behavior of the fish, such as breaking up the shoals of schooling fish (Gulland 1964). Nicholson (1972) reported that fishing intensity above a certain level appears to decrease the availability of menhaden to purse seines. He suggested that high fishing intensity might affect the mechanisms by which small schools coalesce into larger ones, or that it might make fish "wild", so that schools sound when vessels approach.

APPENDIX B

EXTENDING TOMLINSON'S GENERALIZED MURPHY CATCH EQUATION TO INCLUDE CONSECUTIVE ZERO'S

Murphy (1965) developed a method for estimating abundance and fishing mortality rates on a cohort of fish when catches are known within time intervals and an estimate of instantaneous fishing mortality for one time interval and natural mortality for all time intervals are available. A restriction on this method is that the time intervals must be of equal duration, and each time interval must contain catches. Tomlinson (1970) presented a generalization of Murphy`s method which allowed for variable time intervals and zero catches, provided that the first and last time intervals each contain catches and two or more consecutive zero's do not occur.

The normal method of insuring that consecutive zero's do not occur in the catch data is to pool time intervals containing zero catches with adjacent non-zero intervals. In some applications involving computer analysis of the results or comparisons among several sets of catch data, it may be desirable to keep the time intervals fixed, even if this results in consecutive zero's in the catch data. This paper will extend Tomlinson's concepts to allow for any number of consecutive zero's, provided that the first and last time intervals contain catches. The notation used follows that of Tomlinson (1970).

Equations 1 through 5, along with the accompanying explanations, are from Tomlinson (1970) and are reproduced here to provide a review of his model, upon which this extension is based:

If N_i is the number of fish in the cohort alive to begin interval i, then the number alive to begin interval i+1 is given by

$$N_{i+1} = N_i e^{(-t_i(F_i + M_i))} \qquad (1)$$

The catch in interval i is given by

$$C_i = N_i E_i$$

$$E = \frac{F_i(1-e^{(-t_i F_i + M_i))})}{F_i + M_i} \qquad (2)$$

The catch in interval i+1 is given by

$$C_{i+1} = N_i e^{(-t_i(F_i + M_i))} E_{i+1} \qquad (3)$$

A catch ratio (R_i) can be constructed for all but the last time interval. The ratio for interval i is given by

$$R_i = \frac{C_{i+1}}{C_i} = \frac{e^{(-t_i(F_i+ M_i))} E_{i+1}}{E_i} \tag{4}$$

If $C_{i+1} = 0$, then $E_{i+1} = 0$ and $r_{i+1} = 0$. In this latter case

$$R_{i+1} = \frac{C_{i+2}}{C_i} = \frac{e^{(-t_i(F_i+ M_i)-t_{i+1}(M_{i+1}))} E_{i+2}}{E_i} \tag{5}$$

Extensions to Tomlinson's Model

A generalized form of the catch ratio between any two time intervals, where the catches for all intermediate time intervals is zero, is

$$\frac{C_{i+k}}{C_i} = \frac{E_{i+k} e^{-t_i(F_i+ M_i)-t_{i+1}(M_{i+1})- \dots -t_{i+k-1}(M_{i+k-1})}}{E_i} \tag{6}$$

The Forward Solution

The forward solution involves estimating E_{i+1} from E_i or from E_{i-k}. If $C_{i+1} = 0$, then E_{i+1} and $F_{i+1} = 0$ also. When $C_{i+1} \neq 0$, find the nearest non-zero E_{i-k}, where k has a value of 0 or larger. The catch ratio needed for this estimation is C_{i+1}/C_{i-k}. By substituting the value $L = i-k$, equation 6 can be written as

$$\frac{C_{i+1}}{C_{i-k}} = \frac{C_{L+k+1}}{C_L} = \frac{E_{L+k+1}e^{-t_L(F_L+M_L)-t_{L+1}(M_L)-\ldots-t_{L+k}(M_{L+k})}}{E_L} \qquad (7)$$

Rearranging the above equation to solve for E_{i+1} and substituting back i-k for L results in

$$E_{i+1} = \frac{C_{i+1}E_{i-k}e^{t_{i-k}(F_{i-k}+M_{i-k})+t_{i-k+1}(M_{i-k+1})+\ldots+t_i(M_i)}}{C_{i-k}} \qquad (8)$$

Once the array [E] is known, the array [F] may be found by iteration from the following equation (Tomlinson 1970, eq. 7):

$$E_i = \frac{F_i(1-e^{-t_i(F_i+M_i)})}{F_i+M_i} \qquad (9)$$

The Backward Solution

The backward solution involves estimating the value of $E_i \exp[t_i(F_i + M_i)]$. This can be estimated from E_{i+k} by rearranging equation 6 as

$$E_i e^{t_i(F_i+M_i)} = \frac{C_iE_{i+k}e^{-t_{i+1}(M_{i+1})-\ldots-t_{i+k-1}(M_{i+k-1})}}{C_{i+k}} \qquad (10)$$

where $C_i \neq 0$, and all catches between C_i and $C_{i+k} = 0$. F may be found by iteration of the following equation

(Tomlinson 1970, eq. 9)

$$E_i e^{t_i(F_i + M_i)} = \frac{F_i(e^{t_i(F_i + M_i)} - 1)}{F_i + M_i} \qquad (11)$$

Once F is estimated, E can be estimated by

$$E_i = \frac{(\text{The value of } E_i e^{t_i(F_i + M_i)})}{e^{t_i(F_i + M_i)}} \qquad (12)$$

Once the arrays [E] and [F] are known, whether by forward or backward solution, the population size at the start of each time interval can be estimated from

$$N_i = \frac{C_i}{E_i} \quad \text{where } E \neq 0 \qquad (13)$$

or from equation 1.

A computer program, MURPHY, is available in Abramson (1971) to solve for population estimates, fishing mortalities, and exploitation rates using Tomlinson's model. A modified version of this program, VPAMOD, incorporating the extension for consecutive zero's was prepared to estimate weekly abundance and fishing mortalities for the Atlantic menhaden paurse seine fishery. The catch data were broken up into seasons and age groups within a season. For those data sets which do not contain consecutive zero's, and thus can be analyzed by MURPHY, the results obtained from MURPHY and from VPAMOD were identical.

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Table 1. Conversion dates for Primary Time Units (PTU)

	Week Ending			Week Ending	
PTU	From	To	PTU	From	To
1	3/01	3/07	27	8/30	9/05
2	3/08	3/14	28	9/06	9/12
3	3/15	3/21	29	9/13	9/19
4	3/22	3/28	30	9/20	9/26
5	3/29	4/04	31	9/27	10/03
6	4/05	4/11	32	10/04	10/10
7	4/12	4/18	33	10/11	10/17
8	4/19	4/25	34	10/18	10/24
9	4/26	5/02	35	10/25	10/31
10	5/03	5/09	36	11/01	11/07
11	5/10	5/16	37	11/08	11/14
12	5/17	5/23	38	11/15	11/21
13	5/24	5/30	39	11/22	11/28
14	5/31	6/06	40	11/29	12/05
15	6/07	6/13	41	12/06	12/12
16	6/14	6/20	42	12/13	12/19
17	6/21	6/27	43	12/20	12/26
18	6/28	7/04	44	12/27	*13/02
19	7/05	7/11	45	*13/03	*13/09
20	7/12	7/18	46	*13/10	*13/16
21	7/19	7/25	47	*13/17	*13/23
22	7/26	8/01	48	*13/24	*13/30
23	8/02	8/08	49	*13/31	*14/06
24	8/09	8/15	50	*14/07	*14/13
25	8/16	8/22	51	*14/14	*14/20
26	8/23	8/29	52	*14/21	*14/27
			53	*14/28	*14/29

*Months 13 and 14 refer to January and February of the following year

Table 2. Abundance Estimates for Age 0

PTU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9															
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11															
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15															
16															
17															
18															
19															
20															
21	3456174143														
22	3425871159	1206661604													
23	3396352148	1196081088					4327065858								
24	3367087448	1185233150					4283894589								
25	3337565596	1175020577					4245982371					3604284580			
26	3308302585	1164718256					4210388208					3572669823		2887079563	
27	3278295537	1153097888		4500074789			4174109358					3541352391		2861765808	
28	3250048073	1143162156		4460619184			4138143105					3510312527		2836674501	2655864229
29	3221552395	1128997080		4421509477			4102486756					3479554113		2812232268	2630268158
30	3193306582	1118756823		4382742694			4066517092	8353452237	6317587550			3449027146		2787575260	2607684427
31	3165308381	1103209506		4342990232			4031477609	8280211080	6252196389			3418786659		2763134438	2585135979
32	3134584479	1089539493		4302285181			3996130834	8207612086	6199718249	11267201878		3388817256		2738907900	2562478099
33	3101518035	1076367295		4256762225		4249998361	3961093574	8135649623	6145360539	11168413633		3358611975		2711581734	2536904250
34	3048164724	1065628343		4218152434		4211449920	3925363712	8064318110	6087762616	11072180891		3330155689		2687807206	2513126896
35	3014991512	1056446345	2569504108	4181168639		4174524891	3890750710	7981424033	6032545240	10976177341	10274510523	3301461371	2100807991	2662615500	2491472514
36	2983088553	1047340457	2519915508	4143248500		4138555058	3854284313	7911444735	5979653265	10882195835	10184425971	3272516913	2082388508	2639270297	2465862374
37	2956934507	1026817450	2498202262	4107546158		4102895160	3820496830	7834902647	5921225034	10788429293	10095131257	3243822526	2064130682	2616129803	2444615248
38	2922969512	1017630550	2475676683	4069045881		4065680978	3787511535	7737819325	5875256483	10695470650	9976128229	3215281162	2046032857	2591608775	2423551198
39	2895573787	1005202574	2455336653	4033984929		4030034018	3754362975	7667635563	5813743579	10598460366	9879610626	3187675803	2021913893	2567019887	2402668646
40	2870186059	980702244	2434180089	3977924810		3993480703	3715771436	7591125310	5763880632	10505535452	9709664646	3160208615	2005574679	2531830177	2381966829
41	2840284912	952138697	2413205596	3943047256		3959070839	3638504864	7522282006	5708115918	10413425363	9621595804	3132979895	1973923083	2495459746	2361441796
42	2818355730	930349952	2381849339	3901325446		3911206889	3511835270	7447231950	5582227874	10322122834	9487884914	3104562353	1952929803	2466785886	2340022988
43	2788385509	921348951		3844761527		3875731363	3342841874	7372930670	5552437388	9377121963	9396000995	3077726455	1903109654	2415247297	2319860158
44	2767133093	905580193		3811693184			3308480408	7268250948	5480116958	9637080734	9310856336	3050920850	1874372774	2352638393	2266772948
45	2742941596	897287103		3778215377			3279972855	7189150480	5432987479	9730023673	9209539072	2960512962	1855672095		
46	2715774488	869824629		3745858589				7031066618		9536422273	9078783512	2877896208	1839401987		
47	2693235642			3713384062						9441277032	8817044008		1823552763		
48				3681387654									1801506570		
49				3649110090									1773221273		
50															
51															
52															
53															

Table 3. Abundance Estimates for Age 1

PT	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6	[illegible]														
7	[illegible]		[illegible]		[illegible]					[illegible]	[illegible]				
8	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]				
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
42	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
44	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
45	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
46	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
47	[illegible]			[illegible]						[illegible]	[illegible]		[illegible]		
48				[illegible]									[illegible]		
49				[illegible]									[illegible]		
50													[illegible]		
51															
52															
53															

Table 4. Abundance Estimates for Age 2

[illegible]	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5							[illegible]								
6	[illegible]						[illegible]				[illegible]				
7	[illegible]		[illegible]		[illegible]		[illegible]			[illegible]	[illegible]				
8	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
9	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
42	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43		[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
44		[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
45		[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		
46		[illegible]		[illegible]			[illegible]	[illegible]			[illegible]		[illegible]		
47				[illegible]			[illegible]	[illegible]			[illegible]		[illegible]		
48				[illegible]									[illegible]		
49				[illegible]											
50															
51															
52															
53															

Table 5. Abundance Estimates for Age 3

[illegible]	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5							[illegible]								
6	[illegible]						[illegible]				[illegible]				
7	[illegible]						[illegible]				[illegible]				
8	[illegible]						[illegible]				[illegible]				
9	[illegible]			[illegible]			[illegible]				[illegible]	[illegible]		313606333	[illegible]
10	[illegible]	[illegible]		[illegible]			[illegible]				[illegible]	[illegible]	[illegible]	308196330	[illegible]
11	[illegible]	[illegible]		[illegible]			[illegible]				[illegible]	[illegible]	[illegible]	298217085	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	289884918	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	275841775	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	269682321	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	256606733	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	221515735	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	194994980	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	186221334	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	177571293	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	168498291	[illegible]
21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	152129995	[illegible]
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	140574630	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	132620758	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	124120104	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	114699683	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	108441253	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	104137473	[illegible]
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	99720629	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	96580106	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	91310346	[illegible]
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	87361726	[illegible]
32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	81917189	[illegible]
33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77850331	[illegible]
34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75421587	[illegible]
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71074346	[illegible]
36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	67662918	[illegible]
37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	66987843	[illegible]
38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	64660753	[illegible]
39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57442812	[illegible]
40	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
41	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
42	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
43		[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		[illegible]	[illegible]		[illegible]		[illegible]
44		[illegible]	[illegible]	[illegible]			[illegible]	[illegible]			[illegible]		[illegible]		
45				[illegible]			[illegible]	[illegible]					[illegible]		
46				[illegible]			[illegible]	[illegible]					[illegible]		
47				[illegible]			[illegible]	[illegible]							
48				[illegible]											
49				[illegible]											
50															
51															
52															
53															

Table 6. Abundance Estimates for Age 4

PTU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6	29061949														
7	28788778														
8	28424152														
9	27833884			23730770											
10	27196167			23515526											
11	26557661	10303574		23309347							43918250				
12	26116791	10095480		23108502	25012153					22625803	43768289		95384415	61455486	
13	25208433	10008492		22909388	24792852					19403312	42895467		94519257	60619938	20793588
14	23746793	9922253		22711889	24500590			7482642		17830270	42402747		93547683	58585536	20379852
15	22893899	9438291		22516291	23845135	9841622		7283088	8621832	16899675	41264362	28957402	89638986	54853807	20004849
16	22696624	9356956		22075012	22897618	8230947		7115329	6793722	15671235	37248094	28252738	85006984	49562800	19648735
17	22501059	9134476	9163787	21550114	22620853	7903223		6766210	5947589	15836178	33414898	27769901	80811388	44575364	18528824
18	21377447	8806397	9075128	21044117	22205684	6707427		6707989	4989064	14833095	32254099	27255817	76963666	42310697	17323478
19	21157706	8534263	8987328	20072736	21063640	6817372		6411959	4747169	13883104	31343354	27020967	74176755	38081561	16363259
20	15570003	8127916	8900377	19363607	19877901	6308255		6261487	4706265	12701785	30579403	26596713	71840650	32299337	14173080
21	13655799	7494515	8394221	18937624	19163955	5889792	4530337	5473214	4565713	11810187	28265959	25547723	67548725	29773183	13597475
22	12560012	6942181	8302867	17547490	17942229	4835196	4428016	5171418	4381618	10888743	28257912	24548181	64077766	25227676	12351746
23	10843206	6405091	8217520	15545945	16645290	4133481	4026029	5026925	3343694	10231835	26416090	22545001	61625676	21356508	10316942
24	8776657	6222335	8125689	13933352	14968826	3717169	2738437	4165618	3314883	9825844	24439416	20908977	58530475	19970662	9165294
25	7775552	5967808	8034726	12746003	12731819	3585140	2372629	4047995	3286329	8842539	22227520	18895124	55489037	18229851	9086311
26	7209103	5699291	7952136	11525401	10730716	3264830	1853081	3458361	2971610	8008944	21692373	15638543	52237693	15751331	9008819
27	6737164	5419652	7863192	10640218	8835647	2743654	1788161	2672388	2008489	7277571	20303256	14393467	49012953	14760668	8930401
28	5968693	5370494	7777617	9010259	7881905	2432387	1724462	2661859	1763033	6518694	18386980	14068383	44753485	13606231	8853452
29	5620677	5323407	7688279	8237409	7257286	2331511	1557885	2366204	1747842	6877291	16575516	13488785	41391943	12781649	8273858
30	5228733	5259048	7590696	7790323	6685609	1825874	1351435	2242564	1732782	6242775	15613912	12126542	39529543	11858586	7979136
31	5045552	5212938	7251371	7104745	6479011	1690503	1338791	2127980	1717851	6188984	15396827	10766309	37339468	10933678	7272588
32	4590304	5065743	7188890	6645720	5806711	1302877	1328246	2083738	1703049	6135657	14353880	10475885	36208738	10315039	6802636
33	4425787	4519533	7128847	5851853	5347877	1234045	1316882	1708360	1303600	6024595	14115503	10074231	35378183	9695830	6337936
34	4256086	4090470	6372087	5622768	4663249	877621	1185262	1693640	1292308	5764067	13883482	9768878	33396823	8626658	6225112
35	4128343	3878610	6317182	5404300	4021893	832271	1117857	1679047	1281232	4913900	13559370	9300908	30907219	8543197	6164885
36	4061045	3891125	6262750	4906191	3526359		843594		1044672	3898951	13383183	8649653	29265431		6111765
37	4028053	3761687	6208787	4370511	3412177		838722		1035671	3808464	13267867	8575163	26766258		6059183
38	3839929	3725275	6155289	3598534	3382776		829512		1026747	3370341	13153544	8541275	23230736		6006895
39	3174474	3697147	5954166	2644939			822365		1017900	3355245	13040207	8428028	23013006		5955136
40	2515928	3665285	5132096	2622148			815279		1009129	3227196	12927846	8457147	22814712		5903826
41	2432235	3633703	4594128	2271874			808254		1000434	3108439	12816453	6330598	22618128		5852953
42	1324380	3602393	4020728	2252298			801290			3381655	12706029	5583119	21699550		4368063
43		3571353	3799015	2232881			794385			3355103	10300151		16108865		3467216
44		2984836	3680495	2213652			787541				9147576		12548339		3437341
45				2194283			780755						12164283		
46				2175336			774027								
47				2156592											
48				2104028											
49															
50															
51															
52															
53															

Table 7. Abundance Estimates for Age 5

PTU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7	3665014														
8	3621810														
9	3551913														
10	3468514														
11	3404691														
12	3363530														
13	3318787													25115878	9385055
14	3054582				3989755					2204193	5819391		25204358	24368131	9226432
15	2906480				3676820					2150468	5729472		24791068	22989354	9098212
16	2881436	259391		4050025	3645130					2131939	5278146	2200430	24215942	21049549	9019810
17	2856608	255319		3974289	3613730					2070176	4453256	2053872	23199801	19773877	8872781
18	2831994	245149		3886859	3582592					1864218	4414885	2036174	22930993	19028793	8276782
19	2801174	240589		3337905	3551723			215615		1635328	4062150	2018630	22385741	17957602	8043055
20	1807880	209479		3558658	3521119			149815		1622940	4027148	2001236	21760285	15413539	7735268
21	1749876	200290		3428114	3301677		1640704	148594		1606973	3992449	1983992	20981935	14030221	7608617
22	1406899	158063		3281871	3278228		1524803	147284		1593126	3958048	1890681	19351596	12395778	6587748
23	1337460	114569		3134034	3218870		1389304	145885		1488834	3781112	1726527	18377315	11137111	6288965
24	1253342	104062		3030872	2933509		518982			1222987	3748532	1275123	17929307	10577741	5817704
25	1179543	94558		2360510	2681175	918823	408450			1213441	3315894	1110652	17455639	10275925	5061453
26	1151847			2881406	2281504	828013	402858			980640	3287323	1007563	16731396	9455395	4998013
27	1105068			2180460	1963696	726577	391806			872539	3166353	759561	16146310	9159162	3935868
28	1056313			2628748	1900107	658806	395084			810705	3005485	753016	15480087	8817464	3901955
29	1047211			2475254	1860028	572434	392631			803719	2885186	746520	14810609	8443908	3868333
30	997045			2398245	1822462	502365	389288			796794	2688914	740195	14339856	7915813	3835062
31	976909			2302954	1793848	465767	381899			789528	2665745	733718	13511985	7778097	3801950
32	904084			2108634	1760840	399345	382589			783122	2470037	727336	13279556	7631298	3759198
33	885014		523374	1937794	1728967	344757	379213			776374	2434275	581231	13083027	7463163	3736721
34	865290		446596	1889988	1675800	278248	285850			769685	2374894		12771940	7428798	3704528
35	857834		442746	1817663	1682365	238159				763053	2352635		12249507	7354483	3672533
36	850442		438931	1442787						664966	2320610		11741263		3640959
37	843114		435149	1422302						659237	2300657		10629846		3609595
38	835850		431399	1198921						652460	2280829		9888601		3578184
39	607270		427682	1004167							2261176		9803396		3547650
40	602037		423997	995515							2241693		9718925		3517081
41	596850		420343								2222377		9635182		3486776
42			416722								2203228		9552160		2998557
43			386481								2184244		8566534		
44											2165424				
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 6. Abundance Estimates for Age 6

PTWU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9	195266														
10	181816														
11	166576														
12	159081														
13	148806														
14	95541														
15	94718														847942
16	93502														770258
17	93092	14652													763671
18	81747	12780													757041
19	81043	12670											2512475	2042740	750518
20	80345	12561								156679			2428897	1912512	744051
21	79652	12452								114809			2407969	1426448	737640
22	78966	9307								113820			2234593	1414157	731284
23	78286									112839			2162238	1100118	624574
24	77613									111867			1895830	1090639	619192
25	39952									110903			1824395	1081242	495708
26	39608									109947			1808575	1037013	25
27	39257									109000			1793090	1028078	
28	33455									53842			1777640	895524	
29	33167									63292			1762323	888204	
30	32881									62747			1747136	792434	
31	32598									62206			1620849	752404	
32										61670			1606882	720087	
33										61139			1593036	673765	
34													1579310		
35													1565702		
36													1483890		
37													1471104		
38													1458429		
39													1229373		
40													1218780		
41													1208279		
42													1197867		
43													1187546		
44													876589		
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 9. Abundance Estimates for Age 7

PTU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7	47811														
8	41551														
9	41193														
10	40838														
11	33645														
12	33355														
13	33068														
14															
15															
16															
17															
18															
19															
20															
21															500000
22															294876
23															292335
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
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37															
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Table 10. Abundance Estimates for Age 0

PTU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18	115200														
19	113600														
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
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34															
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41															
42															
43															
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50															
51															
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Table 11. Weekly Catchability Estimates for Age 0

PTU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21	.00000009														
22		.00000016													
23		.00000353					.00000450								
24	.00000074														
25	.00000021	.00000004										.00000006			
26	.00000167	.00001034										.00000016		.00000010	
27				.00000087								.00000054		.00000008	
28	.00000062	.00002651		.00000022								.00000004			.00000519
29	.00000060	.00000335		.00000046			.00000028					.00000001		.00000049	
30	.00000079	.00004224		.00000390				.00000055	.00000153			.00000037		.00000163	
31	.00000485	.00003699		.00000528			.00000216	.00000154	.00001317			.00000061		.00000245	.00000076
32	.00001642	.00001895		.00000976			.00000159	.00000067	.00000093	.00000037				.00001115	.00000761
33	.00004470	.00001065		.00000268		.00000197	.00000045	.00000105	.00000576			.00000017		.00000253	.00000463
34	.00001253			.00000177		.00000083	.00000717	.00001381	.00000582					.00000530	
35	.00001684		.00012563	.00000304			.00001017	.00000212	.00000036		.00000015	.00000042	.00000091	.00000232	.00003525
36	.00000036	.00008243					.00000151	.00000804	.00000221		.00000016	.00000254	.00000089	.00000233	
37	.00001704	.00000005		.00000581		.00000405		.00002156	.00000084		.00004279	.00000069	.00000265	.00001335	
38	.00000597	.00005687				.00000085	.00000385	.00000453	.00000297	.00000372	.00002057		.00005381	.00001147	
39	.00000064	.00009127		.00006199		.00000298	.00003284	.00000983	.00003219	.00000010	.00026559		.00001355	.00003972	
40	.00000946	.00010468		.00000010			.00013106	.00000621	.00002933	.00000690	.00002299		.00017241	.00009991	
41	.00000821	.00056344	.00004191	.00027251		.00003172	.00054481	.00002060	.00012028	.00000052	.00016463	.00000939	.00015504	.00016890	.00000557
42	.00002283	.00003854		.00032630		.00000433	.00062226	.00009553	.00006155	.00031912	.00001767	.00002889	.00007936	.00031773	
43	.00035721	.00006462					.00005461	.00007784	.00015086	.00001690	.00002903	.00019741	.00009391	.00013580	.00033369
44	.00003670							.00005014		.00001383	.00001018	.00003356	.00005237		
45															
46															
47															
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49															
50															
51															
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Table 12. Weekly Catchability Estimates for Age 1

WEEK	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6	[illegible]														
7	[illegible]		[illegible]		[illegible]					[illegible]	[illegible]				
8	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]				
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	
40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
41	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
42	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
44	[illegible]							[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 13. Weekly Catchability Estimates for Age 2

WEEK	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5							.00058079								
6	.00020971						.00034287				.00007510				
7	.00018160		.00028289		.00025364		.00026829			.00029035	.00025414				
8	.00034083		.00062599		.00031649		.00026794		.00020804	.00007523	.00043362	.00019083		.00060229	.00015946
9	.00039098		.00054229	.00027467	.00031130	.00041548	.00017699	.00005788	.00037535	.00021404	.00038955	.00035752		.00041753	
10	.00051773	.00019836	.00067636	.00019731	.00016612	.00014098	.00014595	.00027934	.00024900	.00022030	.00018330	.00038597	.00014634	.00317704	.00014094
11	.00021910	.00013400	.00027827	.00057518	.00031087	.00013457	.00018541	.00028244	.00018636	.00024385	.00023526	.00024392	.00031397	.00017651	.00013633
12	.00038864	.00084880	.00019495	.00020452	.00024892	.00030412	.00039820	.00035224	.00008700	.00014863	.00092274	.00018766	.00021421	.00024800	.00037168
13	.00062722	.00117495	.00017380	.00021317	.00034434	.00018730	.00025089	.00059671	.00014145	.00014516	.00081213	.00020418	.00025478	.00015031	.00021624
14	.00015318	.00023659	.00028837	.00032776	.00027795	.00016848	.00022842	.00029020	.00018578	.00014346	.00081247	.00026899	.00025985	.00015582	.00062126
15	.00025889	.00024461	.00057616	.00017702	.00038633	.00017829	.00024316	.00021380	.00013138	.00044073	.00011310	.00032843	.00016215	.00024546	.00034462
16	.00027384	.00013886	.00059905	.00035737	.00034198	.00026886	.00020547	.00011891	.00013026	.00030298	.00045912	.00028630	.00021859	.00018544	.00042687
17	.00030412	.00017109	.00032921	.00016110	.00034288	.00024238	.00022205	.00040366	.00011988	.00022984	.00087402	.00026714	.00024067	.00028502	.00028984
18	.00016813	.00035350	.00015687	.00030223	.00031327	.00027088	.00024041	.00041532	.00034792	.00024808	.00078574	.00032882	.00030418	.00022415	.00035452
19	.00017518	.00050892	.00012145	.00035220	.00021784	.00021321	.00048481	.00020366	.00030613	.00019815	.00064416	.00036701	.00030735	.00018742	.00041956
20	.00016957	.00041950	.00021818	.00022260	.00036296	.00040193	.00042526	.00028855	.00032596	.00026825	.00026175	.00038825	.00010666	.00032222	.00038472
21	.00028749	.00015255	.00018266	.00019054	.00012617	.00053418	.00051802	.00010711	.00045132	.00015661	.00032648	.00033311	.00040923	.00038718	.00045712
22	.00039948	.00070534	.00022973	.00013470	.00043587	.00031749	.00061656	.00046319	.00043617	.00026076	.00083075	.00041058	.00043520	.00052941	.00038450
23	.00033338	.00017586	.00025264	.00015779	.00031138	.00051933	.00082411	.00035326	.00042343	.00029751	.00080036	.00034998	.00039182	.00041830	.00047307
24	.00026964	.00015836	.00099916	.00014885	.00021137	.00078015	.00070457	.00083176	.00035852	.00033721	.00088819	.00030733	.00047834	.00064834	.00038292
25	.00036259	.00022709	.00100670	.00018101	.00033456	.00091826	.00068355	.00052836	.00038644	.00029770	.00058423	.00052336	.00053855	.00033324	.00050938
26	.00023155	.00019939	.00061187	.00011480	.00048071	.00078473	.00080861	.00049204	.00040837	.00027720	.00075246	.00034770	.00058240	.00034976	.00041683
27	.00016918	.00021425	.00080087	.00013830	.00041816	.00058544	.00061634	.00030434	.00061686	.00055286	.00082936	.00047334	.00057858	.00027005	.00054062
28	.00021533	.00017822	.00080772	.00026090	.00013444	.00083334	.00080885	.00024092	.00088117	.00074306	.00032815	.00045530	.00042707	.00046734	.00027444
29	.00020854	.00029849	.00099959	.00014633	.00047820	.00052191	.00029852	.00025033	.00050223	.00065219	.00040550	.00032013	.00041856	.00045333	.00041436
30	.00020615	.00019864	.00093357	.00023850	.00031219	.00067048	.00080125	.00020808	.00069837	.00056613	.00045708	.00055648	.00043637	.00048441	.00060442
31	.00026803	.00041104	.00065592	.00016537	.00061036	.00066956	.00023812	.00043645	.00033278	.00047234	.00049634	.00042039	.00041858	.00064579	.00030825
32	.00025271	.00047764	.00065198	.00020451	.00026093	.00014855	.00049072	.00040600	.00031225	.00067769	.00045928	.00065088	.00030224	.00051361	.00050482
33	.00012319	.00041145	.00088433	.00011970	.00098723	.00024475	.00035591	.00017621	.00044751	.00051833	.00036364	.00045989	.00052881	.00029809	.00034241
34	.00025530	.00047186	.00065741	.00027212	.00068127	.00014945	.00011348	.00037048	.00027818	.00053367	.00051933	.00051123	.00058576	.00042925	.00065503
35	.00035211	.00076898	.00012294	.00021807	.00049630	.00031636	.00029691	.00055168	.00118494	.00060629	.00021487	.00042216	.00024365	.00020791	.00094703
36	.00067356	.00044816	.00109160	.00028233	.00018645	.00030543	.00048247	.00057898	.00039573	.00013214	.00017257	.00047165	.00027349	.00072436	.00028610
37	.00047853	.00097226	.00230850	.00024103	.00041214	.00034596	.00068733	.00081316	.00023677	.00014647	.00013286	.00014770	.00015794	.00118819	.00034381
38	.00047393	.00048859	.00098011	.00040334	.00091019	.00012116	.00016077	.00084642	.00019840	.00030982	.00034982		.00012109	.00116740	
39	.00099920	.00064181	.00038615	.00023554	.00019119	.00023882	.00106706	.00169015	.00088147	.00064478		.00065719	.00012813	.00106188	
40	.00055186	.00043875	.00048892	.00024410	.00080518	.00031014	.00039598	.00059858	.00035725	.00028102	.00027238	.00040595	.00018866	.00140130	.00120849
41	.00107385	.00037178	.00039400			.00023366	.00170762	.00072192	.00059405	.00044485	.00115783	.00087519	.00087480	.00075057	.00063413
42		.00042634	.00019364						.00056876	.00030750	.00021188		.00067142		.00009238
43		.00086360	.00049981				.00016057	.00013471	.00002261	.00018305	.00033488		.00037340	.00044427	.00006039
44								.00023756		.00028482	.00007550		.00018916		
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 14. Weekly Catchability Estimates for Age 3

PTWK	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5							.00176038								
6	.00348538						.00005978				.00005005				
7	.00020988														
8	.00032387										.00003978			.00201256	.00104285
9	.00029805			.00000254							.00084578	.00004731		.00230350	
10	.00030576	.00011981		.00000268							.00032536	.00002870	.00015283	.00082950	.00080373
11	.00033223	.00040504									.00040658	.00004632	.00032762	.00154320	.00077523
12	.00031257	.00019308	.00001752	.00000517	.00000643					.00059528	.00022485	.00007744	.00025349	.00019832	.00053157
13	.00042259	.00038195	.00008611	.00003884	.00012572	.00000944	.00009283		.00000814	.00022617	.00029849	.00016523	.00022664	.00031805	.00020254
14	.00016223	.00031191	.00026215	.00022106	.00048158	.00003581	.00004220	.00009953	.00005782	.00026805	.00034667	.00015983	.00034378	.00077587	.00043691
15	.00014130	.00007635	.00024054	.00020339	.00010503	.00038490	.00007028	.00014263	.00011875	.00030745	.00027638	.00019713	.00031983	.00058780	.00025661
16	.00011618	.00007365	.00010307	.00011876	.00009878	.00030778	.00037563	.00028369	.00004366	.00011504	.00024686	.00011537	.00021495	.00021079	.00039437
17	.00023695	.00016968	.00000188	.00016837	.00016985	.00025404	.00022389	.00037187	.00006605	.00024440	.00033857	.00018458	.00016954	.00018726	.00024315
18	.00003511	.00010879	.00018708	.00034547	.00037445	.00022038	.00021256	.00009833	.00011565	.00026225	.00036088	.00011484	.00017471	.00022797	.00033532
19	.00037849	.00013127	.00001742	.00018944	.00022819	.00036888	.00033632	.00015076	.00002151	.00027683	.00021883	.00007138	.00028857	.00036871	.00049288
20	.00026543	.00016681	.00028653	.00015062	.00018058	.00071089	.00018959	.00021565	.00003553	.00052414	.00024473	.00006146	.00033045	.00029237	.00022795
21	.00030582	.00009718	.00002927	.00027025	.00023850	.00074284	.00023378	.00044097	.00026474	.00058275	.00025688	.00014383	.00022236	.00020838	.00032584
22	.00040628	.00008138	.00000342	.00025615	.00044316	.00034826	.00030029	.00035267	.00016418	.00016857	.00020053	.00015777	.00023250	.00028228	.00030779
23	.00038275	.00009835	.00027754	.00034158	.00047024	.00262602	.00035526	.00029945	.00010310	.00011008	.00031317	.00038236	.00033358	.00031880	.00014585
24	.00029383	.00014173	.00025452	.00036568	.00067782		.00017858	.00030294	.00003899	.00052101	.00019859	.00006141	.00027763	.00027884	.00027879
25	.00031025	.00017861	.00004311	.00039931	.00061218	.00032278	.00085307	.00010943	.00010067	.00003336	.00048761	.00039362	.00030120	.00021140	.00057332
26	.00017204	.00009932	.00025731	.00032808	.00048821	.00056859	.00046506	.00085767	.00010451	.00021458	.00054514	.00027197	.00038634	.00018315	.00029755
27	.00018626	.00001488	.00000712	.00030429	.00058013	.00061954	.00027881	.00048580	.00008555	.00045680	.00048106	.00052065	.00023062	.00020219	.00020029
28	.00017276	.00001949	.00000727	.00033257	.00031625	.00021286	.00037505	.00025422	.00005105	.00034361	.00039347	.00029227	.00022138	.00033750	.00019897
29	.00020435	.00005480	.00000950	.00011014	.00036022	.00028879	.00008332	.00038187	.00003082	.00042514	.00027145	.00055275	.00028618	.00030281	.00030785
30	.00008173	.00006045	.00017662	.00020439	.00016953	.00011829	.00016786	.00020321	.00004759	.00017882	.00033327	.00088275	.00031256	.00037036	.00046185
31	.00010614	.00002653	.00007655	.00032734	.00059167	.00021508	.00019877	.00029171	.00066029	.00012287	.00038354	.00031338	.00015861	.00036245	.00024549
32	.00010744	.00029894	.00010357	.00023224	.00034923	.00084282	.00038423	.00050489	.00020681	.00013184	.00024432	.00021632	.00016845	.00019974	.00030412
33	.00015353	.00052688	.00049344	.00047720	.00097544	.00176168	.00581345	.00019813	.00005125	.00022145	.00017855	.00013637	.00030235	.00055437	.00018442
34	.00039751	.00083051	.00021388	.00034325	.00091056	.00195001	.00027363	.00007906	.00032624	.00038136	.00005398	.00003997	.00020619	.00038417	.00052130
35	.00026245	.00066841	.00006205	.00050885	.00072297	.00496154	.00195789	.00151228	.00121344	.00057887	.00085124	.00048738	.00017606	.00001278	
36	.00053524	.00027161	.00011131	.00041272	.00025727		.00029921	.00020398	.00074138	.00004530			.00068558	.00028577	.00062885
37	.00012290			.00018602	.00183012	.00055852	.00029448	.00003305	.00009018	.00000433	.00005152	.00023688	.00047564	.00152883	.00029952
38	.00039953		.00005682	.00074808		.00015291	.00010538	.00019828		.00003755	.00004682		.00015108		
39	.00065976	.00058853	.00084225	.00100767		.00006180	.00013221					.00007515			
40	.00015228	.00073405	.00047081	.00026756						.00017493		.00024843	.00008980		.00084519
41	.00157023		.00089185			.00018519			.00243838	.00198468		.00059484	.00073860		.00141843
42		.00095477	.00068103								.00053718		.00117574		.00035491
43		.00293535	.00037344				.00055521				.00123347		.00156261		
44													.00024761		
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 15. Weekly Catchability Estimates for Age 4

[illegible]	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6	.00071699														
7	.00022580														
8	.00051181														
9	.00047715			.00001389											
10	.00050120			.00002171											
11	.00036000	.00078056									.00027800				
12	.00058647				.00000107					.00126596			.00002163	.00005686	
13	.00070398				.00013907					.00022833	.00002221		.00001403	.00019605	.00008867
14	.00022303	.00027530			.00012849			.00002749		.00023037	.00013518		.00020320	.00043659	.00005945
15				.00007902	.00014802	.00038228		.00006637	.00089007	.00024512	.00052470	.00008542	.00025217	.00038601	.00005182
16		.00009728		.00008554	.00001730	.00038779		.00017567	.00057079	.00009826	.00043281	.00063759	.00023035	.00054769	.00038117
17	.00021003	.00018684	.00000578	.00007549	.00006422	.00033289			.00073995	.00020608	.00012219	.00004045	.00023984	.00020900	.00029625
18	.00008801	.00013529	.00000476	.00023458	.00018165	.00016949		.00014075	.00017795	.00022858	.00089428		.00014450	.00037610	.00038148
19	.00187536	.00023772	.00000490	.00013873	.00020152	.00025776		.00007870		.00037349	.00009061	.00003399	.00012744	.00069829	.00066010
20	.00063312	.00036381	.00024622	.00006901	.00014492	.00052096		.00072468		.00033314	.00015516	.00014465	.00029642	.00030273	.00015572
21	.00029996	.00034850	.00001520	.00043116	.00023898	.00051479	.00085540	.00018182	.00021813	.00061476	.00010684	.00016008	.00020293	.00064708	.00044173
22	.00054834	.00040344	.00001002	.00059600	.00038239	.00022620	.00031669	.00008573	.00184376	.00029120	.00026110	.00038467	.00013261	.00076334	.00096193
23	.00073143	.00013236	.00001310	.00046448	.00045878	.00037196	.00131787	.00068835		.00033087	.00030483	.00032719	.00022635	.00026609	.00056924
24	.00045916	.00018260	.00001706	.00036981	.00073335		.00057615	.00010579		.00045087	.00038727	.00053293	.00019000	.00048300	
25	.00028375	.00019091	.00001051	.00046705	.00064234	.00052598	.00082166	.00059374	.00039873	.00017984	.00006678	.00053807	.00023632	.00089219	
26	.00030965	.00031229	.00001531	.00048677	.00067430	.00077430	.00013421	.00131977	.00140465	.00044036	.00028707	.00048287	.00025110	.00029647	
27	.00054718	.00030417	.00001820	.00074958	.00051156	.00090661	.00015182	.00044257	.00058696	.00048974	.00045631	.00009413	.00037793	.00062023	
28	.00027767	.00000010	.00001870	.00047571	.00049720	.00041239	.00071592	.00020631		.00006868	.00048597	.00029112	.00030681	.00038114	.00030473
29	.00034085	.00003145	.00002551	.00021891	.00038361	.00097929	.00072292	.00027445		.00006854	.00031839	.00073578	.00020895	.00056457	.00015001
30	.00016283	.00000018	.00028295	.00045302	.00021316	.00038499		.00028324			.00002560	.00067237	.00028034	.00047737	.00042113
31	.00037098	.00020132		.00048476	.00059218	.00065069		.00007000			.00026744	.00015852	.00010568	.00042559	.00033858
32	.00022873	.00056060		.00059480	.00044135	.00024062		.00094754	.00190887	.00007239	.00306071	.00022813	.00012216	.00045607	.00033444
33	.00015636	.00065288	.00075100	.00021814	.00069680	.00166157	.00088997			.00052324	.00015127	.00016823	.00038976	.00150265	.00006969
34	.00012181	.00018356		.00008820	.00103570	.00041812	.00056638			.00116494	.00000293	.00024228	.00044050	.00030907	.00033892
35	.00006414	.00009420		.00061976	.00087062		.00410504		.00215696	.00235050	.00004323	.00056846	.00058016		
36		.00018575		.00063507	.00017219					.00021728			.00071583		
37	.00007626			.00131341						.00002805			.00132911		
38	.00158294		.00015310	.00172742						.00027505			.00061382		
39	.00113442		.00087320									.00398015			
40	.00029714		.00190871	.00125187						.00065574		.00026321			
41	.00346030		.00114365									.00183507	.00036263		.00459545
42			.00143941								.00356107		.00397179		.00346636
43		.00125248	.00008616								.00552306		.00333065		
44													.00078779		
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 18. Weekly Catchability Estimates for Age 5

PTW	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7	.00019485														
8	.00045457														
9	.00050234														
10	.00033265														
11	.00016020														
12	.00011898														
13	.00101046													.00018757	.00005088
14	.00032648				.00051597					.00007967	.00017639		.00006784	.00028200	.00003278
15											.00041204		.00007811	.00039569	
16		.00004560		.00005656						.00018258	.00069149	.00024532	.00005519	.00030453	.00004621
17		.00018732		.00006745						.00050437			.00017116	.00014351	.00029900
18	.00001084	.00008401		.00020197						.00061890	.00035048		.00007858	.00025612	.00012505
19	.00234655	.00075413		.00019992				.00174133					.00010735	.00054819	.00015168
20	.00012591	.00018223		.00017839	.00028690								.00038504	.00036965	
21	.00081821	.00113713		.00022448			.00024926					.00019933	.00013990	.00047890	.00070795
22	.00016851	.00167556		.00019465	.00004582		.00030875			.00027471	.00016590	.00041404	.00019101	.00048002	.00021581
23	.00020500	.00057300		.00012128	.00039449		.00295521			.00082511		.00138565	.00008317	.00019572	.00073233
24	.00021443	.00047569		.00006908	.00039781		.00098936				.00050934	.00070900	.00007804	.00011954	.00033682
25	.00008437			.00009474	.00059956	.00041576				.00113875		.00045719	.00015494	.00046273	
26	.00017279			.00015578	.00056010	.00063149				.00047685	.00014438	.00171654	.00012459	.00012206	.00117478
27	.00017991			.00023062	.00011402	.00031686				.00031459	.00022126		.00015367	.00029967	
28				.00029395	.00007307	.00070127					.00016508		.00015793	.00024543	
29	.00021809			.00011399	.00006213	.00056819					.00039445		.00013262	.00041046	
30	.00007080			.00017395	.00006764	.00071203							.00029408	.00011019	
31	.00029741			.00064073	.00005870	.00076422					.00040350		.00004225	.00009009	
32	.00010506			.00038256	.00005741	.00078214					.00004456	.00041226	.00005303	.00008380	
33	.00007071		.00107953	.00010977	.00006279	.00112866	.00335043				.00010677		.00012270		
34				.00087326	.00008208	.00138213					.00000562		.00021200	.00000937	
35				.00152783						.00095313	.00005101		.00041479		
36				.00003341									.00078166		
37				.00115273						.00001813			.00065408		
38	.00232461			.00099947											
39															
40															
41															.00236563
42			.00199573										.00142341		
43															
44															
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 11. Weekly Catchability Estimates for Age 6

PTW	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9	.00206168														
10	.00259351														
11	.00165531														
12	.00127947														
13	.00553321														
14															.00052140
15															
16															
17	.00058970	.00084199													
18													.00012833	.00029678	
19										.00164003				.00108283	
20													.00036910		
21		.00130392											.00011124	.00098359	.00074401
22													.00052695		
23													.00015847		.00108689
24	.00237999													.00019572	
25															
26										.00213000				.00087179	
27	.00073261														
28														.00074173	
29													.00031081	.00036671	
30														.00023584	
31														.00049412	
32															
33															
34													.00028933		
35															
36															
37													.00163790		
38															
39															
40															
41															
42													.00403159		
43															
44															
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 18. Weekly Catchability Estimates for Age 1

PTU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7	.00777784														
8															
9															
10	.00596075														
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															.00239820
22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
34															
35															
36															
37															
38															
39															
40															
41															
42															
43															
44															
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 14. Weekly Catchability Estimates for Age 0

PTDW	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18	.000026640														
19															
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
34															
35															
36															
37															
38															
39															
40															
41															
42															
43															
44															
45															
46															
47															
48															
49															
50															
51															
52															
53															

TABLE 20. Coefficients Used in the Catchability-Abundance Relationship: $\ln(q) = \ln(a) - b * \ln(N)$

Age	ln(a)	b
0	5814.75146	260.73114
1	13.64552	1.07412
2	-4.78667	0.14681
3	-6.63207	0.08351
4	-7.28095	0.04313
5	-7.49682	0.02430
6	-7.24914	0.00326
7	-4.63377	0.00027
8	-10.12862	0.00032

Table 21. Weekly Catchability Estimates for Age 0
Adjusted for Abundance

PTL	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
21															
22															
23															
24															
25												.00000009			
26												.00000023		.00000016	
27												.00000062		.00000011	
28												.00000006		.00000000	
29												.00000001		.00000074	
30								.00000082	.00000236			.00000055		.00000245	
31								.00000231	.00001978			.00000091		.00000368	
32								.00000093	.00000140	.00000055		.00000000		.00001675	
33								.00000158	.00000869	.00000000		.00000025		.00000380	
34								.00001955	.00000875	.00000000		.00000000		.00000787	
35								.00000319	.00000054	.00000000	.00000022	.00000063		.00000149	
36								.00001208	.00000331	.00000000	.00000024	.00000081		.00000389	
37								.00003240	.00000126	.00000000	.00006432	.00000103		.00002015	
38								.00000681	.00000445	.00000556	.00003081	.00000000		.00001714	
39								.00001477	.00004837	.00000014	.00039954	.00000000		.00005910	
40								.00000933	.00004406	.00001036	.00003454	.00000000		.00015017	
41								.00003095	.00018083	.00000077	.00024753	.00001411		.00025421	
42								.00014353	.00009252	.00048180	.00002655	.00004341		.00047891	
43								.00011704	.00022685	.00002539	.00004361	.00029717		.00020114	
44								.00007534	.00000000	.00002079	.00001529	.00005048			
45								.00000000		.00000000	.00000000	.00000000			
46										.00000000	.00000000				
47															
48															
49															
50															
51															
52															
53															

Table 22. Weekly Catchability Estimates for Age 1
Adjusted for Abundance

PTW	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6	[illegible]														
7	[illegible]		[illegible]		[illegible]					[illegible]	[illegible]				
8	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]				
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
41	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
42	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
44	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
45	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		
46	[illegible]			[illegible]						[illegible]	[illegible]		[illegible]		
47				[illegible]									[illegible]		
48				[illegible]									[illegible]		
49															
50															
51															
52															
53															

Table 21. Weekly Catchability Estimates for Age 2
Adjusted for Abundance

PT	1968	1969	1970	1971	1972	[illegible]	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5							[illegible]								
6	[illegible]						[illegible]				[illegible]				
7	[illegible]		[illegible]		[illegible]		[illegible]			[illegible]	[illegible]				
8	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
9	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
41	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
42		[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
43		[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
44		[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		
45		[illegible]		[illegible]			[illegible]	[illegible]			[illegible]		[illegible]		
46				[illegible]			[illegible]	[illegible]			[illegible]		[illegible]		
47				[illegible]									[illegible]		
48				[illegible]											
49															
50															
51															
52															
53															

Table 24. Weekly Catchability Estimates for Age 3 Adjusted for Abundance

STW	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5							.00235479								
6	.00015563						-.00029114				-.00017800				
7	.00004166						-.00029115				-.00025337				
8	.00021363						-.00029136				-.00019379			.00077638	.00132231
9	.00017429			-.00027230			-.00029157				-.00018469	-.00009154		.00321640	-.00074650
10	.00018652	-.00010952		-.00027029			-.00029178				.00023516	-.00012571	-.00002096	.00114244	.00036319
11	.00022470	.00032341		-.00027653			-.00029198				.00035722	-.00008346	.00023615	.00007322	.00092257
12	.00013645	.00005129	-.00026647	-.00026903	-.00026423		-.00029220			.00042681	.00038495	-.00005291	.00012305	.00031665	.00054053
13	.00033166	.00026482	-.00018350	-.00021858	-.00007612	-.00030000	-.00017873		-.00027220	.00001962	.00005817	-.00032352	.00008417	.00022607	.00001592
14	-.00003231	.00018212	.00010259	.00020858	.00045563	-.00026807	-.00022831	-.00020589	-.00018876	.00012158	.00025806	-.00032335	.00026251	.00083822	.00041298
15	-.00006421	-.00017156	.00006879	.00007615	-.00001607	.00016067	-.00018735	-.00008112	-.00018734	.00003175	.00016981	.00032533	.00022464	.00083432	.00016670
16	-.00010023	-.00010072	-.00014103	-.00010563	-.00011920	.00015591	.00011745	.00019318	-.00022156	-.00001328	.00011525	-.00009845	.00006345	.00056154	.00024487
17	.00007834	-.00003626	-.00032101	-.00002466	-.00001272	.00007778	.00034350	.00026388	-.00018816	.00003131	.00025420	-.00012475	-.00000657	.00001398	.00011254
18	-.00002753	-.00012906	-.00001471	.00024362	.00030122	.00002451	.00002281	-.00015387	-.00011385	.00001728	.00028630	-.00010124	.00000061	.00007470	.00025122
19	.00028321	-.00009577	-.00032214	.00000321	.00000853	.00024765	.00021335	-.00007555	-.00025660	.00012777	.00006686	-.00016157	.00031272	.00029058	.00049391
20	.00011911	-.00004262	.00013500	-.00005461	-.00000076	.00078565	-.00001290	.00002177	-.00023588	.00005355	.00010580	-.00013704	.00023495	.00017027	.00036439
21	.00019373	-.00014899	-.00027629	.00012381	.00006663	.00083578	.00001125	.00026327	.00011162	.00005363	.00012316	-.00008057	.00006991	.00003996	.00023245
22	.00030357	-.00017351	-.00029664	.00010247	.00029763	.00023337	.00015178	.00022730	-.00004382	-.00001238	.00003534	-.00003910	.00008333	.00015103	.00020294
23	.00029527	-.00015148	.00011389	.00023146	.00042930	.00083427	.00003124	.00014616	-.00012739	-.00013276	.00020636	.00030302	.00022584	.00020575	-.00004430
24	.00019322	-.00008349	.00018181	.00025691	.00074336	-.00033187	-.00006217	.00023783	-.00023499	.00049720	.00003666	.00073141	.00014940	.00014214	.00015873
25	.00002413	-.00002861	-.00013864	.00030014	.00065761	.00015860	.00118332	-.00014916	-.00014191	-.00023336	.00047345	.00031461	.00018351	.00002776	.00006068
26	-.00002907	-.00014857	.00066419	.00020356	.00045669	.00053220	.00035000	.00010448	-.00013736	.00002146	.00055800	.00012611	.00031277	-.00000575	.00016659
27	-.00001449	-.00027765	-.00029460	.00016627	.00059627	.00061244	.00010046	.00043383	-.00028128	.00030175	.00045556	.00065992	.01007217	.00002155	.00003181
28	-.00003614	-.00027865	-.00029462	.00020683	.00018491	-.00002807	.00009211	.00006161	-.00021818	.00008126	.00031785	.00015277	.01005636	.00022660	.00001691
29	.00001030	-.00021712	-.00029093	-.00013244	.00075101	.00006258	-.00018843	.00025516	-.00025802	.00033779	.00013750	.00006407	.01015779	.00017077	.00011836
30	-.00017600	-.00029974	-.00003671	.00006836	-.00007230	-.00017857	-.00007465	-.00001920	-.00022515	-.00004093	.00022258	.00108503	.00019186	.00027462	.00064281
31	-.00013862	-.00026381	-.00019201	.00019421	.00060437	-.00002071	-.00008876	-.00002240	.00010627	-.00012654	.00017423	.00014759	-.00004345	.00026002	.00009847
32	-.00019870	.00015163	-.00015183	.00004951	.00032922	.00095313	.00026911	.00044176	.00001137	-.00011413	.00008833	.00012093	-.00033301	.00001192	.00018521
33	-.00006876	.00048811	.00044011	.00047170	.00112568	.00241066	.00029763	-.00002255	-.00020759	.00002009	-.00001831	-.00009230	.00017231	.00054800	-.00000089
34	.00030162	.00005216	.00001181	.00021169	.00093257	.00256710	.00006288	-.00021285	.00020661	.00026302	-.00019824	-.00014778	.00022563	.00029051	.00051039
35	.00009215	.00070016	-.00027786	.00045724	.00078314	.00743606	.00126207	.00249086	.00115272	.00056445	-.00015147	.00043025	.00008873	-.00027321	-.00020112
36	.00060942	.00018081	-.00014433	.00021660	.00007546	-.00037871	.00012107	-.00003162	.00032355	-.00024957	-.00028605	-.00000014	.00075540	.00007297	-.00029021
37	-.00012268	-.00031082	-.00031207	-.00003218	.00125626	.00046725	.00011837	-.00029015	-.00017127	-.00031146	-.00021187	.00029461	.00043236	.00216658	.00016818
38	.00029875	-.00031065	-.00022683	.00083525	-.00031784	-.00015053	-.00017581	.00004167	-.00030718	-.00026180	-.00021924	-.00000149	-.00006253		-.00028105
39	.00070035	.00058865	.00058799	.00122041		-.00029101	-.00013596	-.00034996	-.00030741	-.00031851	-.00028984	.00082801	-.00029064		-.00022215
40	-.00008446	.00081461	.00078404	.00008121		-.00030263	-.00033513	-.00034120	-.00030763	-.00005625	-.00029005	.00006747	-.00015612		.00095465
41	.00213888	-.00031766	.00073467	-.00031726		-.00006805	-.00033537	-.00034144	.00341497	.00267648	-.00029526	.00059150	.00083129		.00187619
42		.00112294	.00107763	-.00031749			-.00033564	-.00034169		-.00032189	.00052003		.00149623		.00024916
43		.00437496	.00074223	-.00031772			.00050039	-.00034194			.00158867		.00209256		
44				-.00031795			-.00033657	-.00034218					.00097342		
45				-.00031818			-.00033681	-.00034243							
46				-.00031841			-.00033705	-.00034268							
47				-.00031865											
48				-.00031943											
49															
50															
51															
52															
53															

Table 25. Weekly Catchability Estimates for Age 4
Adjusted for Abundance

PT	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6	.00014904														
7	.00012609														
8	.00014198														
9	.00008859			-.00031818											
10	.00012555			-.00029859											
11	.00021200	.00003151		-.00033132							.00009561				
12	.00055501	-.00034349		-.00033144	-.00032816					.00159987	-.00032259		-.00027929	-.00023229	
13	.00073589	-.00034362		-.00033156	-.00012144					-.00000128	-.00028938		-.00029083	-.00001934	-.00022974
14	.00000534	.00007236		-.00033169	-.00013713			-.00030683		.00001282	-.00011531		-.00000538	.00029932	-.00024386
15	-.00033157	-.00036449		-.00031447	-.00010768	.00023777		-.00024852	.00119636	.00003417	.00047659	-.00019968	.00006865	.00026731	-.00025546
16	-.00033170	-.00019822		-.00030338	-.00019560	.00024594		-.00008336	.00052468	-.00018915	.00032559	-.00027210	.00003683	.00054473	.00012208
17	-.00001439	-.00006322	-.00033615	-.00021887	-.00023621	.00015754		-.00034967	.00078911	-.00002625	-.00014203	-.00025804	.00004848	-.00000628	.00009912
18	-.00032953	-.00014169	-.00033703	.00002159	-.00005131	-.00008377		-.00013704	-.00006527	.00000736	-.00018475	-.00032939	-.00009618	.00024840	.00012060
19	.00230583	.00001320	-.00033707	-.00012431	-.00002791	.00004019		-.00023188	-.00036405	.00022769	-.00019374	-.00027815	-.00012316	.00075502	.00067848
20	.00063243	.00020584	.00002710	-.00020806	-.00011510	.00044895		.00075974	-.00035199	.00019455	-.00009175	-.00011117	.00013222	.00013306	-.00010355
21	.00011662	.00018098	-.00032310	.00032016	.00002181	.00043779	-.00027226	-.00007779	-.00002400	.00020892	-.00016708	-.00008850	-.00008868	.00006845	.00033347
22	.00050139	.00026366	-.00033126	.00057584	.00024521	-.00001307	.00012600	-.00022469	.00127780	.00009900	.00006706	.00025404	-.00011867	.00084546	.00114313
23	.00079181	-.00015095	-.00032619	.00037155	.00036130	.00021925	.00171219	.00070953	-.00036026	.00015327	.00013918	.00016469	.00002444	.00007061	.00052673
24	.00035625	-.00007505	-.00032111	.00022362	.00079077	-.00035852	.00052045	-.00019560	-.00036039	.00036367	.00035985	.00047836	-.00003118	.00040139	-.00034493
25	.00008311	-.00006308	-.00033111	.00037161	.00064978	.00044531	.00091568	.00070565	.00024590	-.00003461	-.00023153	.00111576	.00003855	.00103503	-.00034506
26	.00012077	.00012013	-.00032415	.00037623	.00063840	.00083195	-.00016724	.00170272	.00187834	.00032599	.00010651	.00039671	.00006029	.00011215	-.00034519
27	.00048696	-.00034657	-.00031976	.00081162	.00043570	.00134168	-.00011248	.00030050	.00353018	.00039969	.00015133	-.00015665	.00025406	.00060454	-.00034531
28	.00006863	-.00035282	-.00031930	.00037848	.00041001	.00025104	.00072068	-.00006283	-.00037034	-.00024734	.00040515	.00010093	.00014361	.00023819	.00011638
29	.00016475	-.00030586	-.00030934	-.00001544	.00023431	.00115356	.00073686	.00004833	-.00037048	-.00024729	.00014575	.00078331	-.00006764	.00051704	-.00010871
30	-.00019789	-.00035302	-.00004127	.00034169	-.00003841	.00018316	-.00037461	.00006171	-.00037062	-.00035609	-.00029864	.00068696	.00010832	.00038481	.00029385
31	.00021067	-.00005016	-.00034843	.00038627	.00030314	.00062387	-.00037475	-.00026208	-.00037076	-.00035082	.00021987	-.00010381	-.00016547	.00030191	.00018475
32	-.00001041	.00050323	-.00034816	.00056048	.00021881	-.00001092	-.00037489	.00199318	.00261720	-.00024210	-.00024706	-.00001887	-.00014123	.00034759	.00015712
33	-.00012009	.00065455	.00079815	-.00003459	.00071434	.00225402	.00098256	-.00037085	-.00037520	.00043015	-.00011061	-.00009305	.00026451	.00195295	-.00024565
34	-.00017305	-.00006056	-.00035038	.00098888	.00129677	.00025071	.00108858	-.00037098	-.00037534	.00144076	-.00033452	.00002219	.00034259	-.00033372	-.00023733
35	-.00025059	-.00021585	-.00035051	.00059106	.00097529		.00606435		.00298356	.00336681	-.00027420	.00051783	.00052025		-.00035088
36	-.00036725	-.00007151	-.00035064	.00061580	-.00009951		-.00038230		-.00037880	-.00003235	-.00033931	-.00034579	.00016024		-.00035101
37	-.00024266	-.00035843	-.00035077	.00167625	-.00035994		-.00038244		-.00037894	-.00031762	-.00033817	-.00034592	.00110964		-.00035114
38	.00718033	-.00035857	-.00010578	.00736179			-.00038258		-.00037908	.00005599	-.00033959	-.00034605	-.00021069		-.00035127
39	.00140456	-.00035870	.00038981	-.00036392			-.00038273		-.00037922	-.00036068	-.00033972	.00530143	-.00033150		-.00035140
40	.00008332	-.00035883	.00258143	.00155788			-.00038287		-.00037936	.00062872	-.00033985	.00002453	-.00033162		-.00035153
41	.00533142	-.00035897	.00139726	-.00036631			-.00038301			-.00036139	-.00033997	.00245883	.00021513		.00681363
42		-.00035910	.00182135	-.00036645			-.00038315			-.00036153	.00523288		.02581756		.00504108
43		.00197421	.00085717	-.00036659			-.00038330				.00810428		.03488419		-.00035870
44				-.00036673			-.00038344						.00084736		
45				-.00036686			-.00038358								
46				-.00036700											
47				-.00036726											
48															
49															
50															
51															
52															
53															

Table 36. Weekly Catchability Estimates for Age 5 Adjusted for Abundance

PT	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7	-.00009149														
8	.00029958														
9	.00037179														
10	.00011532														
11	-.00014425														
12	-.00020627														
13	.00115098													-.00008397	-.00029815
14	.00010754				.00040094					-.00026920	-.00011398		-.00026497	.00005984	-.00032655
15	-.00038651				-.00038421					-.00038935	.00024600		-.00024935	.00023433	-.00037594
16	-.00038659	-.00034134		-.00029534	-.00038439					-.00023491	.00068489	-.00001721	-.00028410	.00009297	-.00038654
17	-.00038667	-.00012749		-.00026209	-.00038447					.00037963	-.00038252	-.00038978	-.00010905	-.00015240	.00007729
18	-.00031047	-.00028298		-.00007887	-.00038455					.00055736	.00015007	-.00038986	-.00024931	.00001842	-.00018843
19	.00338403	.00074601		-.00006209	-.00038463			.00235540		-.00039195	-.00038338	-.00038995	-.00020610	.00047227	-.00014821
20	-.00020121	-.00013682		-.00011556	.00005080			-.00041539		-.00038203	-.00038346	-.00039003	.00021669	.00019201	-.00037742
21	.00087953	.00135915		-.00004595	-.00038531		-.00001375	-.00041547		-.00039211	-.00038354	-.00009890	-.00015768	.00036066	.00071037
22	-.00013868	.00223036		-.00009138	-.00031771		.00007730	-.00041556		.00002425	-.00013305	.00023948	-.00008028	.00035932	-.00005268
23	-.00007724	.00045485		-.00020293	.00021477		.00470851			.00008425	-.00039404	.00179002	-.00024437	-.00007819	.00074610
24	-.00006984	.00030541		-.00028215	.00021883		.00114008			-.00039472	.00039497	.00069210	-.00025228	-.00019447	.00013030
25	-.00029820			-.00024363	.00053540	.00023629	-.00040543			.00136837	-.00038527	.00036252	-.00013613	.00032805	-.00038137
26	-.00013447			-.00015178	.00047209	.00036984	-.00040552			.00033185	-.00016757	.00229744	-.00018253	-.00019155	.00144955
27	-.00012397			-.00003799	-.00021843	.00008117	-.00040560			.00007938	-.00005114	-.00039932	-.00013877	.00006155	-.00038367
28	-.00039613			.00005754	-.00028056	.00067788	-.00040569			-.00039869	-.00013583	-.00039940	-.00013263	-.00000558	-.00038375
29	-.00008660			-.00021619	-.00029728	.00046602	-.00040577			-.00039877	.00019659	-.00039949	-.00011162	.00024471	-.00038383
30	-.00029018			-.00012578	-.00028523	.00001027	-.00040586			-.00039886	-.00038726	-.00039957	.00007346	-.00021125	-.00038391
31	.00005457			.00061658	-.00030278	.00077150	-.00040594			-.00039894	.00022531	-.00039966	-.00030882	-.00024186	-.00038399
32	-.00023954			.00019204	-.00030492	.00067226	-.00040603			-.00039902	-.00032106	.00022513	-.00029278	-.00025151	-.00038407
33	-.00029144		.00125837	-.00022507	-.00029698	.00134655	.00494331			-.00039911	-.00022744		-.00018792	-.00037771	-.00038415
34	-.00039806		-.00040451	.00092769	-.00028813	.00171796				-.00039919	-.00037996		-.00005275	-.00036373	-.00038424
35	-.00039814		-.00040459	.00198764						.00105256	-.00031183		.00025320		-.00038432
36	-.00039822		-.00040468	-.00034294						-.00040061	-.00038863		.00081790		-.00038440
37	-.00039831		-.00040476	.00138420						-.00037347	-.00038871		.00061813		-.00038448
38	.00327124		-.00040485	.00114770							-.00038879		-.00037518		-.00038456
39	-.00040153		-.00040493	-.00039862							-.00038887		-.00037526		-.00038464
40	-.00040158		-.00040502								-.00038895		-.00037533		-.00038472
41			-.00040510								-.00038904		-.00037541		.00325197
42			.00252565								-.00038912		.00179786		
43											-.00038920				
44															
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 27. Weekly Catchability Estimates for Age 6
Adjusted for Abundance

PT	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9	.00244610														
10	.00328363														
11	.00181850														
12	.00125681														
13	.00621873														
14	-.00068471														
15	-.00068473														.00011467
16	-.00068475														-.00068007
17	.00021819	.00060267													-.00068009
18	-.00068506	-.00068922											-.00048392	-.00022792	-.00068011
19	-.00068508	-.00068924								.00190258			-.00067753	.00102471	-.00068013
20	-.00068510	-.00068926								-.00068430			-.00011706	-.00067871	-.00068015
21	-.00068512	.00150205								-.00068432			-.00050997	.00085784	-.00068017
22	-.00068514									-.00068434			.00012980	-.00067928	.00046495
23	-.00068516									-.00068436			-.00043889	-.00067930	-.00068054
24	.00326539									-.00068438			-.00067816	-.00038173	.00100974
25	-.00068666									-.00068440			-.00067818	-.00067941	
26	-.00068668									.00270833			-.00067820	.00035119	
27	.00044133									-.00053561			-.00067822	-.00067576	
28	-.00068706									-.00053563			-.00067824	.00045387	
29	-.00068708									-.00053565			-.00011517	-.00012524	
30	-.00068710									-.00068567			-.00067842	-.00032502	
31										-.00068569			-.00067844	.00005911	
32													-.00067846		
33													-.00067848		
34													-.00024067		
35													-.00067862		
36													-.00067864		
37													.00184782		
38													-.00067904		
39													-.00067905		
40													-.00067907		
41													-.00067909		
42													.00568110		
43															
44															
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 26. Weekly Catchability Estimates for Age 1
Adjusted for Abundance

PTU	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7	.00224918														
8	-.00969020														
9	-.00969022														
10	-.00046152														
11	-.00969075														
12	-.00969078														
13															
14															
15															
16															
17															
18															
19															
20															
21															-.00577746
22															-.00968537
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
34															
35															
36															
37															
38															
39															
40															
41															
42															
43															
44															
45															
46															
47															
48															
49															
50															
51															
52															
53															

Table 29. Weekly Catchability Estimates for Age 8
Adjusted for Abundance

PT	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18	.00000029														
19															
20															
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															
31															
32															
33															
34															
35															
36															
37															
38															
39															
40															
41															
42															
43															
44															
45															
46															
47															
48															
49															
50															
51															
52															
53															

TABLE 30. Results of Friedman's Test for Randomized Blocks on Weekly Catchability Coefficients.

AGE GROUP	CHI-SQUARE	D.F.	P
0	19.9943	13	.0954
1	53.3286	14	< .0001
2	36.4897	14	.0009
3	74.6490	14	< .0001
4	52.5875	14	< .0001
5	10.2981	8	.2447
6	3.2400	4	.5185

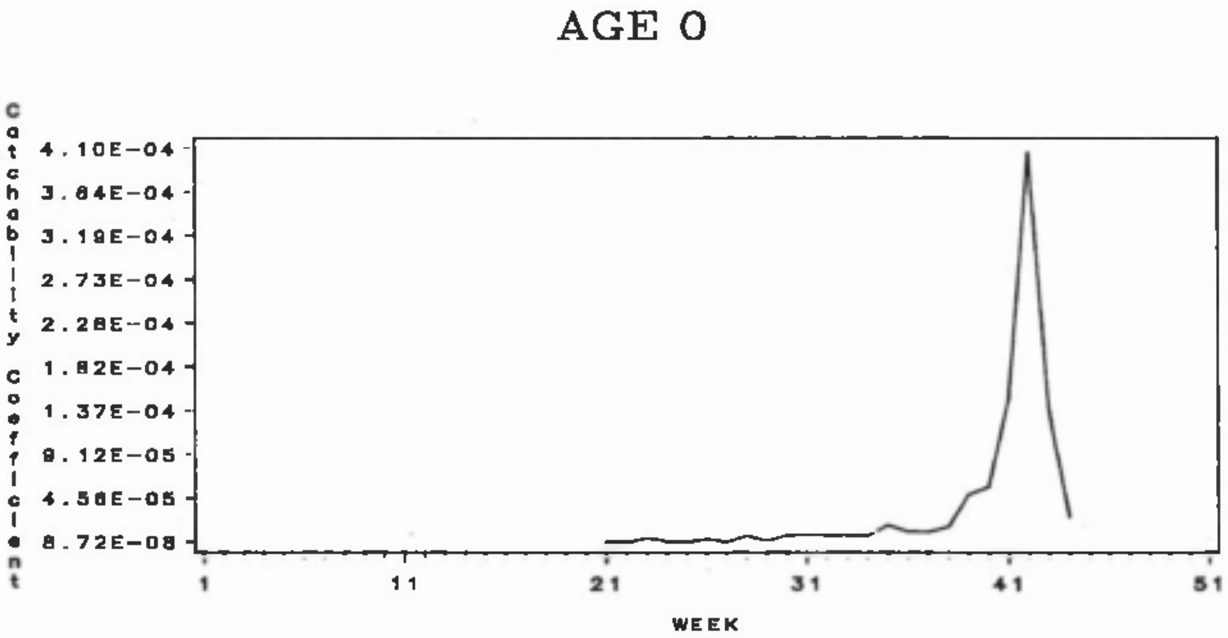
TABLE 31. Results of Friedman's Test for Randomized Blocks on Catchability Coefficient Residuals (after adjusting for abundance).

AGE GROUP	CHI-SQUARE	D.F.	P
0	15.1587	5	.0097
1	134.3467	14	< .0001
2	42.9290	14	.0001
3	76.0417	14	< .0001
4	51.0357	14	< .0001
5	9.5059	8	.3014
6	12.6400	4	.0132

TABLE 32. Correlation Coefficients Between ln(q) and ln(N).

AGE	Correlation	# Data Points
0	-0.170	200
1	-0.196	560
2	-0.269	551
3	-0.161	468
4	-0.287	356
5	-0.325	195
6	-0.519	39
7	-0.956	5
8	-1.000	2

Figure 1. Average weekly catchability coefficient - ages 0 and 1



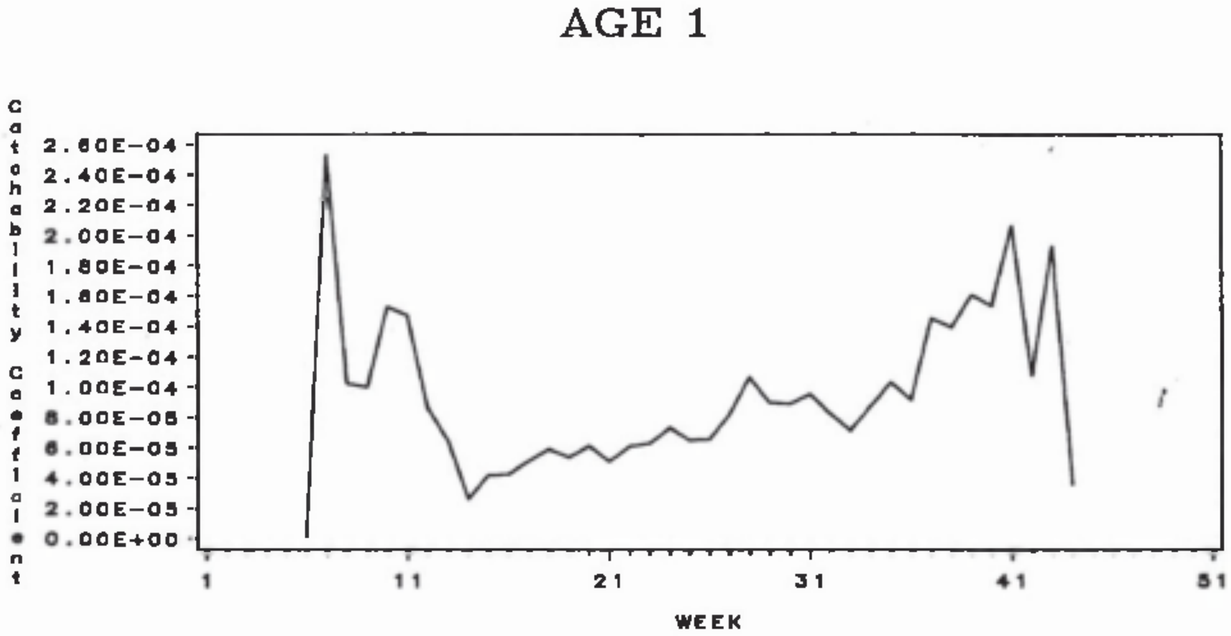
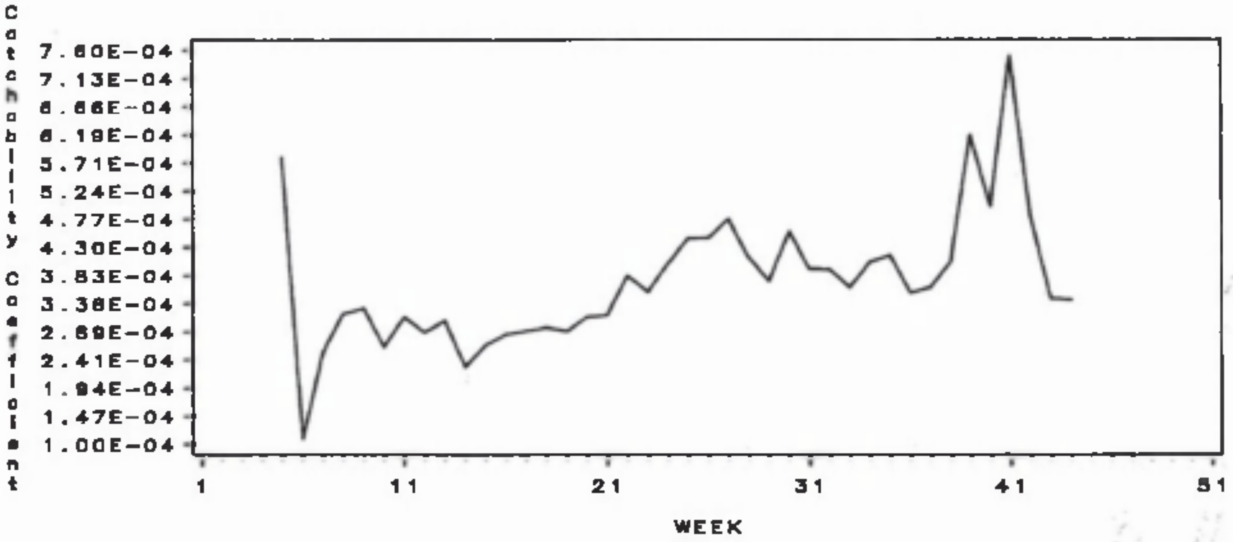


Figure 2. Average weekly catchability coefficient - ages 2 and 3

AGE 2



AGE 3

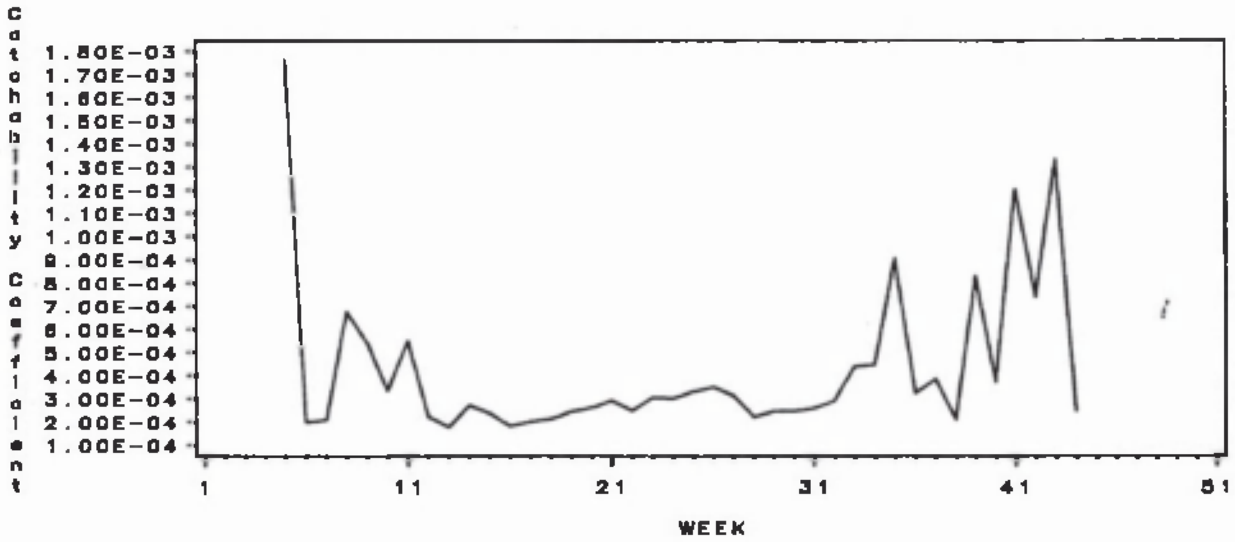
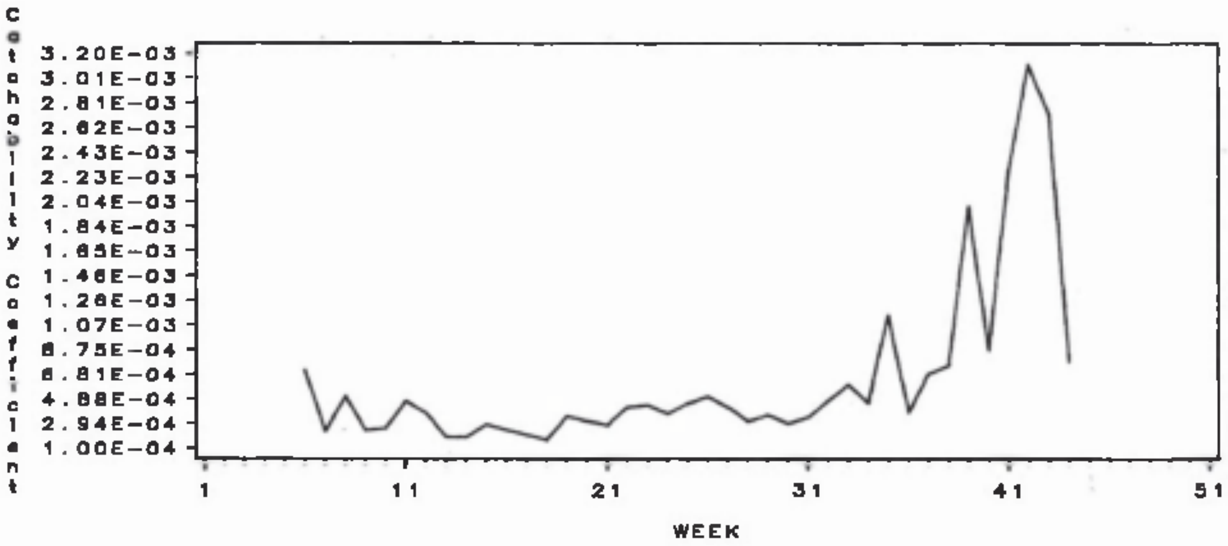


Figure 3. Average weekly catchability coefficient - ages 4 and 5

AGE 4



AGE 5

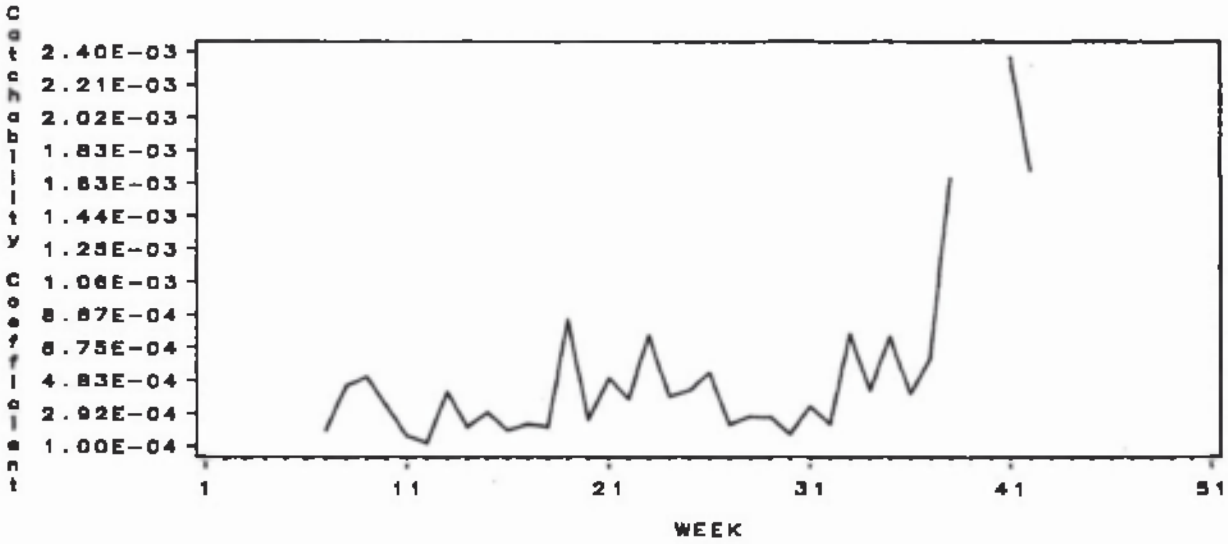
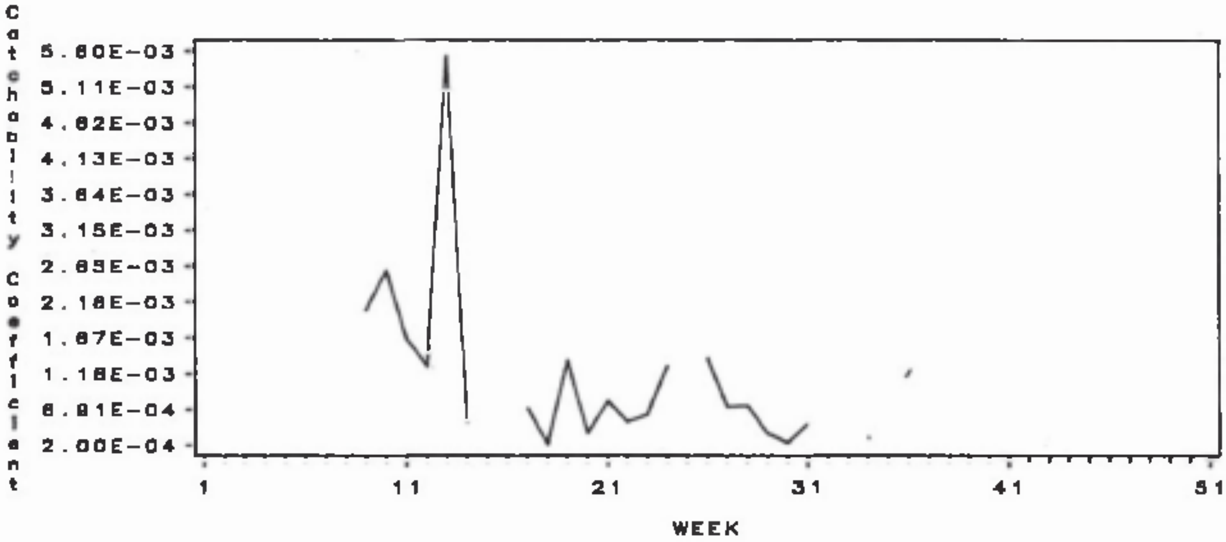


Figure 4. Average weekly catchability coefficient - ages 6 and 7

AGE 6



AGE 7

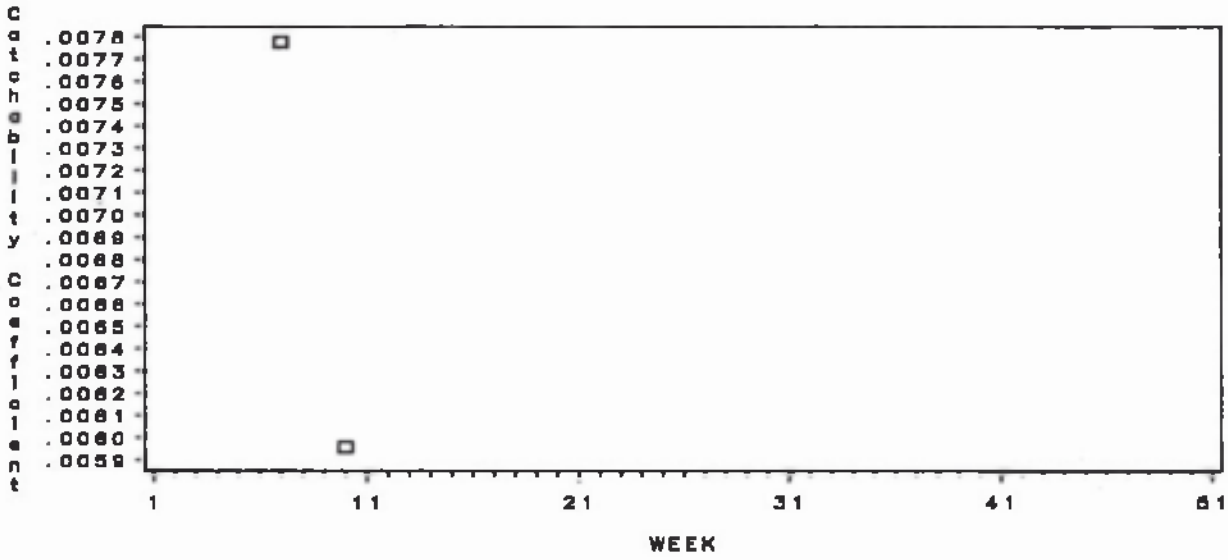


FIGURE 5. Results of Multiple Comparisons for Age Groups Whose Catchability Coefficients Show Significant Differences Between Years.

```
                           Age 1
73  75  79  77  76  74  80  71  78  81  82  69  68  72  70
--------------------------------------------------
        ----------------------------------------------
                                        -------------------


                           Age 2
71  69  68  70  78  77  80  76  72  81  75  79  73  82  74
--------------------------------------------------
    -------------------------------------------------------


                           Age 3
70  69  76  68  79  77  74  80  78  75  71  82  81  73  72
------------------------------
    --------------------------------------
            -----------------------------------------------


                           Age 4
70  76  78  80  69  82  77  75  74  68  79  71  73  72  81
--------------------------------------
    -------------------------------------------------------
```

alpha = .05

Bars indicate no significant difference was found between years.

Years arranged in ascending order of ranks of catchability coefficients for each PTU.

FIGURE 6. Results of Multiple Comparisons for Age Groups Whose Catchability Residuals Show Significant Differences Between Years.

```
                           Age 0
77  79  76  78  75  81
------------------
        ---------------

                           Age 1
71  68  69  79  73  74  78  75  81  77  70  82  80  76  72
----------
    ------------------------------
        -------------------------------
            ----------------------------------
                     ---------------------------------------

                           Age 2
71  69  70  68  78  72  76  80  77  73  75  79  82  74  81
--------------------------------------------------
    --------------------------------------------------
        ---------------------------------------------------

                           Age 3
70  69  76  68  79  77  74  75  71  80  78  81  82  73  72
------------------------------
    ------------------------------
            -----------------------------------------------

                           Age 4
70  76  69  78  80  82  77  75  74  68  79  73  71  72  81
--------------------------------------
    -------------------------------------------------------

                           Age 6
68  77  82  80  81
------
    ---------------
```

alpha = .05

Bars indicate no significant difference was found between years.

Years arranged in ascending order of ranks of catchability coefficients for each PTU.

VITA

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Born on 25 September 1955 in Quincy, Massachusetts. Graduated from Milton High School, Milton, Massachusetts in 1973. Received a B.S. in Fisheries from the University of Washington in 1977. Field biologist for Ichthyological Associates, Middletown, Delaware, 1978-1979. Entered Master's degree program in College of William and Mary, School of Marine Science in 1981. Employed since 1985 as a computer programmer/analyst at the Sandy Hook Laboratory of the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, in Highlands, New Jersey.