FORECAST OF STOCK ABUNDANCE FOR 2000 ARCTIC-YUKON-KUSKOKWIM REGION HERRING FISHERIES

By

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ABSTRACT

Biomass projections are made for each Arctic-Yukon-Kuskokwim herring district using postseason escapement estimates, historical mean rates of survival, assumed recruitment rates, and current mean weights. The projected 2000 spawning biomass of the northeastern Bering Sea Pacific herring stocks (Security Cove to Norton Sound) is 48,141 tons. This is a decline from the 1999 biomass of 63,800 tons. Districts with projected declines are either those with poor aerial survey conditions in 1999, or those in which a slight decline is expected due to natural mortality as the predominant year class ages. These projections do not include age classes, generally age 3, not yet seen in the fishery.

KEY WORDS: Herring, *Clupea pallasi*, herring forecast, herring projection, Bering Sea

INTRODUCTION

The Arctic-Yukon-Kuskokwim (AYK) Region of the Bering Sea consists of all waters of Alaska extending from the latitude of Cape Newenham to the latitude of Cape Prince of Wales and includes eight commercial herring districts (Figure 1). The districts, from south to north, are Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, Nunivak Island, Cape Romanzof, Norton Sound and Port Clarence.

Forecasts of Pacific herring returning to spawn in the AYK Region of the Bering Sea are prepared annually for each district. Forecasts provide fishery managers, processors and fishermen with information on the expected biomass and age composition of herring for the coming season. Since 1987, the inshore herring fisheries in this area have been managed under the Bering Sea Herring Fishery Management Plan (5 AAC 27.060, ADF&G 1998), which specifies a threshold biomass level which must be reached in each district before commercial fishing is allowed. Fishery managers may use forecasts of returning herring when evaluating whether the threshold level of biomass has been reached. In many years, poor aerial survey conditions have precluded inseason estimates of herring abundance and managers have used the forecast abundance to set harvest levels. In addition, biomass forecasts are used by both the Alaska Board of Fisheries and North Pacific Fishery Management Council in making decisions regarding the Dutch Harbor food and bait fishery and the Bering Sea trawl fisheries.

This report documents forecasts of herring abundance in AYK herring districts for the 2000 season. Forecasts are made for the Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, Nunivak Island, Cape Romanzof, and Norton Sound Districts. No forecast has been made for the Port Clarence District, which has a very limited fishery in some years, and from which little information on stock status is available.

METHODS

Biomass Assessment

Aerial surveys have been the primary method of assessing herring biomass, timing and distribution in the Bering Sea herring fisheries since 1978. Aerial survey procedures are outlined in Lebida and Whitmore (1985). It is often difficult to obtain biomass estimates from aerial surveys in the AYK Region because of unfavorable weather, ice conditions or turbid water. In these cases, the biomass is usually assumed to equal the preseason projection. Spawn deposition observations and catch rates from commercial, test and subsistence fisheries may also be used as indicators of herring abundance.

Commercial harvests, by district, are tallied from sales receipts issued to fishermen after each delivery. Harvests are either added to or subtracted from the biomass estimate to calculate total biomass, depending on the timing of the fishery. Escapements are determined by subtracting commercial and large subsistence harvests from the estimated biomass for each district.

Biomass Sampling

Samples are collected from the commercial fishery to estimate the age composition of harvests and the mean weight-at-age of harvested herring. Variable-mesh gillnets (VMG), consisting of four panels ranging from 1.5 to 3.0 inch stretch-mesh, are used to sample the population. More detailed information on the methods for collecting samples is presented in DuBois (*in press*). No samples were collected in the Nunivak Island or Security Cove districts. Age composition from samples collected in the Nelson Island District was applied to biomass estimates for the Nunivak Island District. Likewise samples collected in the Goodnews Bay District were applied to the Security Cove District.

VMG data are used to estimate the age composition of either the entire population or the escapement, depending on the area and timing of the commercial fishery. For Cape Romanzof and Norton Sound herring stocks, the commercial fishery has historically occurred on the front-end of the migration, and therefore VMG samples are assumed to represent the total run. In Kuskokwim Area districts, the timing of the commercial fishery compared to the total run is evaluated each year and a decision to consider VMG catches as representing the entire run or just the escapement is made for each district.

Weight at Age

Mean weight-at-age estimates in the current year were used to convert biomass estimates into numbers of fish, as well as to predict the weight-at-age for the next year. A growth model (Schnute 1981) was fit to the observed mean weight-at-age in each district. Model parameters were estimated by minimizing the sum of the squared residuals, weighted by the square root of the number of herring observed in each age class, using the solver bundled with the Microsoft Excel spreadsheet program. For age classes with less than 30 observations, the estimated mean weight-at-age was taken from the growth model; otherwise, the estimated mean weight-at-age was taken as the observed mean.

Recruitment Rates

Recruitment rates, the proportion of each age class that participate in the spawning migration and thereby recruit to the fishery, are from Wespestad (1982). The recruitment rate is 0.00 for ages less than 3, 0.43, 0.86, and 0.97 for ages 3, 4, and 5, and 1.0 for ages greater than 5.

Population Model

Some notation is required to introduce the population model. Let

f	=	the age at which herring first recruit to the fishery
r_i	=	the recruitment rate for age i herring
s_i	=	the probability an age i herring will survive, excluding fishery exploitation, to age $i + 1$
R_i	=	the number of herring from brood year i-f and that survive to age f in year i,
$N_{i,j}$	=	the number of age j herring in the spawning migration in year i, and
$E_{i,j}$	=	the number of $N_{i,j}$ that are not harvested.

The expected number of herring in the spawning population can be expressed as

$$N_{i,f} = R_i r_f \tag{1}$$

and

$$N_{i,j} = E_{i-1,j-1} s_{j-1} + R_{i-(j-f)} \left(\prod_{k=f}^{j-1} (1 - r_k) s_k \right) r_j \tag{2}$$

for $j > f$. The model expressed in equations (1) and (2) are used to develop methods of estimating survival rates and forecasting herring abundance.

Forecasting Herring Biomass

Equation (2) can be modified to provide an estimator of herring abundance in the subsequent year. The equation contains an unknown parameter, R. For the forecast of age $f + 1$ abundance in year $i + 1$ from the escapement of age f fish in year i, equation (1) provides an estimate of R_i, i.e.,

$$R_i = \frac{N_{i,f}}{r_f}. \tag{3}$$

Substituting equation (3) into equation (2) provides the estimator

$$N_{i+1,f+1} = E_{i,f} s_f + N_{i,f} \left(\frac{1 - r_f}{r_f} \right) s_f r_{f+1}. \tag{4}$$

For older ages, equation (2) can be expressed as

$$R_{i-(j-f)}\left(\prod_{k=f}^{j-1}(1-r_k)\,s_k\right) = \frac{N_{i,j} - E_{i-1,j-1}\,s_{j-1}}{r_j}. \tag{5}$$

Substituting the right-hand side of equation (5), with j replaced by j-1, into equation (2) yields the estimator

$$N_{i+1,k} = E_{i,k-1}\,s_{k-1} + (N_{i,k-1} - E_{i-1,k-2}\,s_{k-2})\left(\frac{1-r_{k-1}}{r_{k-1}}\right)s_{k-1}\,r_k \tag{6}$$

for $k > f + 1$.

Equations (4) and (6) are used to forecast herring abundance for ages greater than $f = 3$, given estimates of escapement by age, estimates of survival rates (discussed below), and assumed recruitment rates (Wespestad 1982). No forecasts of abundance are currently made for herring of age 3 or less.

Survival Rate Estimation

Because AYK herring fisheries take place over a short period of time, natural mortality during the fishery is assumed to be insignificant. Survival rates can be estimated from estimated escapements in one year and the estimated inshore returns in the subsequent year, accounting for increased abundance from recruitment.

Estimators of survival rates are obtained by expressing equations (4) and (6) in terms of survival rates, i.e.,

$$s_f = \frac{N_{i+1,f+1}}{E_{i,f} + N_{i,f}\left(\frac{1-r_f}{r_f}\right)r_{f+1}} \tag{7}$$

and

$$s_k = \frac{N_{i+1,k+1}}{E_{i,k} + \left(N_{i,k} - E_{i-1,k-1}s_{k-1}\right)\left(\frac{1-r_k}{r_k}\right)r_{k+1}} \tag{8}$$

for $k > f$, respectively. Note that, because the expression for s_k in equation (8) depends on s_{k-1}, survival rates must be estimated sequentially beginning with the youngest age f.

Observed survival rates were calculated using equations (7) and (8) for each age, year and district. Any ratio greater than one was replaced by one. Mean observed survival rates by age were computed for all Kuskokwim Area herring districts combined and separately for Norton Sound. Survival rates were only included in the mean if a district had two successive years of acceptable surveys. A three parameter (quadratic) logistic function (Hosmer and Lemeshow, 1989) was fit to the means as a smoother. The parameters were estimated by minimizing the sum of the squared residuals, weighting by the number of observations included in the mean for each age, using the solver bundled with the Microsoft Excel spreadsheet program. These smoothed survival rates were used to project the 2000 return for the Kuskokwim Area and Norton Sound Districts. Because of turbid water, aerial surveys have not been successful in the Cape Romanzof Area. Therefore, survival rates estimated for the Kuskokwim Area were applied to Cape Romanzof herring.

RESULTS

Biomass Assessment and Sampling

A summary of the total biomass, harvest and escapement for each district in 1999 is presented in Table 1. DuBois and Hamner (1999) provide details on the biomass assessment and harvest for each district. Data from harvest and VMG sampling, used to estimate age composition and weight-at-age, are summarized by DuBois (*in press*). Observed mean weight-at-age and the growth model (Schnute, 1981) fit to the means are presented in Figures 2 through 6 for the Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, Cape Romanzof and Norton Sound districts, respectively.

Survival Rates

Annual estimates of herring abundance since 1980 were used to compute observed survival rates by age group for both the Kuskokwim Area and Norton Sound districts. In this time period in the Kuskokwim Area, there were only 15 data points out of a possible 77 (less than 20%) with two adjacent years with acceptable surveys (Table 2). These data include four years from Security Cove, one year from Goodnews Bay, one year from Cape Avinof, six years from Nelson Island and three years from Nunivak Island (Table 2). Mean survival rates for the Kuskokwim Area were most recently updated in 1995, when two adjacent years of acceptable surveys were flown in the Nelson Island District.

The observed survival rates (Table 2) should all be less than one, after adjusting for recruitment, because a cohort cannot increase in abundance with age. However, out of the 178 observed survival rates (age-year-district combinations), 75 or 42% were greater than one and were set to

one. This occurred most frequently in the younger age classes. Some of the less abundant older and younger age groups were not observed in many of the adjacent year combinations. For example, in the Kuskokwim Area, age-16 herring have only been observed in one year of the data included in survival rates. The mean observed survival rates and the logistic function fit to the means are graphed in Figure 7.

In Norton Sound there were 10 data points out of a possible 19 with acceptable surveys in adjacent years (Table 3) which were used to calculate survival rates. Therefore, approximately one-half of the data was acceptable, compared to less than one-fifth of the data from the Kuskokwim Area. Out of the 120 age and year combinations in the Norton Sound area, 51 or 42% were greater than one and were set to one. The mean survival rates and the logistic function fit to the means are graphed in Figure 8. Survival rates for older aged herring in Norton Sound were greater than in the Kuskokwim Area (Figure 9).

Biomass Forecasts

The year 2000 return of herring to most districts is expected to decline due to poor recruitment and the higher natural mortality of the dominant older age classes. Recruitment levels in AYK districts combined was at a record low in 1999. However this may be partly due to poor sampling of the latter part of the run. Ice and cold weather caused the migration to be delayed by about two weeks and projects were terminated earlier in the herring migration than in a normal year. Generally, ages 7 and 9 through 12 are expected to dominate the return in all districts.

The 2000 projected return to the Security Cove District is 3,622 tons (Table 4). Due to budget cuts, age composition data was not collected in the Security Cove District in 1999. The estimated 2000 herring age composition was calculated using data from the Goodnews Bay District. Ages 7, 11 and 10 are expected to dominate the returning biomass (19.1%, 16.9% and 16.4%, respectively). Figure 10 compares the 2000 projection with estimated total biomass in past years. Figure 11 shows the projected age composition of the 2000 return in both percent by number and percent by weight.

The 2000 projected return of herring to the Goodnews Bay District is 4,665 tons (Table 5 and Figure 12). Similar to Security Cove, ages 7, 11 and 10 are expected to be the dominant age classes, and comprise 19.5%, 16.7% and 16.3%, respectively, of the returning biomass (Figure 13).

The projected 2000 biomass for the Cape Avinof District is 2,868 tons (Table 6 and Figure 14). Ages 7, 10 and 9 herring are expected to comprise over one-half of the return by weight (28.5%, 14.8% and 12.3%, respectively) (Figure 15). Age 9 and older herring are expected to comprise almost one-half of the biomass.

The spawning biomass projected to return to the Nelson Island District in 2000 is 4,672 tons (Table 7 and Figure 16). Similar to Security Cove and Goodnews Bay ages 7, 10, and 11 herring are expected to dominate the returning population by weight (19.5%, 18.5% and 18.2%, respectively) (Figure 17). Age 9 and older herring are expected to comprise almost two-third of the biomass.

The biomass of herring projected to return to the Nunivak Island District in 2000 is 2,823 tons (Table 8 and Figure 18). The estimated 2000 herring age composition was calculated using data from the Nelson Island District. Ages 10, 11 and 9 herring are expected to dominate the return by weight (20.4%, 18.9% and 17.3%, respectively) (Figure 19). Age 9 and older herring are expected to comprise over two-thirds of the return.

The projected return of herring to the Cape Romanzof District in 2000 is expected to be between 2,067 and 3,067 tons based on an assessed biomass of between 3,300 and 4,300 tons in 1999 (Table 9). The midpoint of this range for 1999 was 3,800 tons, which results in a projected biomass of 2,567 tons. Ages 12, 9, and 10 herring are expected to dominate the biomass, contributing 24.7%, 21.1%, and 19.8%, respectively (Figure 20). Age 9 and older herring are expected to comprise nearly 80% of the return.

The biomass projected to return to Norton Sound in 2000 is 26,924 tons (Table 10 and Figure 21). Ages 7, 12 and 9 are expected to comprise well over one-half the returning biomass (23.3%, 22.1% and 13%, respectively) (Figure 22). Age 9 and older herring are expected to contribute over two-thirds of the return.

DISCUSSION

Comments on Current Methods

Abundance Estimates

Herring biomass estimates in the AYK area have historically been peak aerial survey estimates. However, herring spawning migrations frequently appear to consist of multiple modes of abundance. In the early to mid 1990s, herring managers began to sum aerial observations from multiple modes under some conditions. The length of time between modes, their location within a district and between-mode comparisons of age composition and gonad maturity may be used to evaluate whether, and how, to combine aerial observations. Because little is known about herring residency time on the spawning grounds or migration patterns within many districts, such evaluations may be fairly subjective. Consequently, the proportion of the returning population that is observed and identified as being discrete can vary greatly between years.

A variety of other factors can also influence the accuracy of aerial survey biomass estimates. Environmental conditions during surveys are frequently poor in several districts, particularly in the Cape Romanzof and Kuskokwim Area districts. Factors that may influence the accuracy of aerial survey estimates include the training and experience of observers, errors in estimating the surface area of variously shaped schools, variability in the depth and density of schools, and the presence of other species. In addition, very little data on the relationship between the surface area of schools at various water depths and biomass are available from AYK districts. Conversion factors being used

were developed in the Togiak herring district, but their applicability in AYK districts has not been verified.

Because of the factors mentioned above, the accuracy of biomass estimates probably varies greatly between years. Forecasts can differ substantially from the aerial estimates in any given year, and between-year variability in the biomass estimates is believed to be the single greatest source of error in the forecasts.

Estimates of Age Composition

Age composition generally changes throughout the migration, with older fish arriving before younger fish (DuBois *in press*). VMG samples are collected during the bulk of the migration in most districts in most years. However, abundance information with which to weight age composition estimates is not available through time, and samples are generally pooled. Therefore, data from the tails of the migration may overly influence age composition estimates. The degree to which this tends to bias age composition estimates is unknown, but the bias may be somewhat consistent between years. Measures of fishing effort have been considered for use as weights, but no dedicated attempt to explore their utility has been made to date.

Several aspects of VMG sampling complicate estimation of age composition. Herring year classes have been documented to be segregated geographically (offshore vs nearshore) (Taylor 1969). Spatial segregation may also vary with year-class strength (Guiblin et al. 1996). Age or size segregation may even occur in individual schools (Rowell et al. 1990). Although crews are instructed to make short sets and sample many schools, the logistics of weather and time may prevent this. The relatively small number of VMG sampling crews may not be sufficient to adequately sample some districts, particularly the larger districts such as Norton Sound. Finally, VMG nets, consisting of four panels with different mesh sizes, may not adequately sample the population. These nets were designed in the 1970's, when the large, older aged herring now present in many populations had yet to be observed. Some research into the size selectivity of current VMG nets has been conducted and more is being planned.

Errors in aging herring and differences among scale readers have been documented (Brannian 1988, Kimura and Lyons 1991). Aging errors are most frequent between adjacent ages and are made more often with older aged fish. Errors in aging may result in over estimating weak cohorts and under estimating strong cohorts.

Recruitment

The recruitment rates used in AYK herring districts are from early catches, 1959-1978, in the Bering Sea when stocks were near virgin levels (Wespestad 1980). Estimated survival rates greater than 1.0 for the younger age classes may be partly attributed to deviations from the assumed recruitment rates. In addition, although current methods assume that recruitment rates are fixed, they almost certainly vary between year classes. This component of current methods is probably most in need of modification, but improvements may be difficult to develop.

No biomass forecasts are made for age classes that have not yet been seen in the fishery. Herring exhibit large fluctuations in recruitment, and methods of economically and accurately making such forecasts have not been developed.

Survival Rates

Current estimates of survival rates are strictly conditioned on the assumed recruitment rates (Equations 7 and 8). Difficulties in estimating abundance as well as aging error may both contribute to inaccurate estimation of survival rates. The error in estimating survival rates may be greater when recruitment is highly variable, as occurs in herring populations. In addition, as with recruitment rates, survival rates almost certainly vary through time. The degree to which survival rates vary is difficult to assess given the extreme variability inherent in biomass estimates.

Potential Alternative Methods

In recent years, many areas of the state have switched to using an age-structured-analysis model (ASA) to forecast herring returns. The feasibility of using ASA models to forecast AYK herring abundance was examined in 1993 and 1994. The models developed were very unstable and gave grossly different forecasts with only minor changes to the data or model assumptions. For that reason, the models were not adopted. We suspect that highly variable recruitment and biomass assessments, as well as errors in age composition estimates, were primary reasons the models were so unstable.

In spite of these problems, ASA models likely offer the greatest potential to improve future forecasts. In 1997, an ASA model was developed to forecast returns to the Norton Sound fishery (Williams, 1997). The properties of this model and its potential for implementation need to be investigated more fully.

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Table 1. Total biomass, harvest, and escapement in tons of herring by district for the Arctic-Yukon-Kuskowim Region, 1999.

District	Total Biomass	Assessment Method	Commerical Harvest	Escapement
Security Cove	5,261	aerial survey	1,072	4,189
Goodnews Bay	6,896	aerial survey	1,366	5,530
Cape Avinof	3,555	projection	533	3,022
Nelson Island	6,655	aerial survey	1,366	5,289
Nunivak Island	3,319	projection	0	3,319
Cape Romanzof	3,800	spawn index	533	3,267
Norton Sound	34,314	aerial survey	2,760	31,554

Table 2. Estimated survival rates in consecutive years having acceptable biomass assessments in Kuskokwim Area herring districts since 1980.

District	Years	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10	Age-11	Age-12	Age-13	Age-14	Age-15	Age-16	Age-17
SEC	1983-1984		1.0000	0.5002	0.7741	0.8970	0.8170	1.0000	0.6508	0.4398	0.0000	0.0000			0.0000		
SEC	1984-1985		1.0000	1.0000	1.0000	1.0000	0.6129	0.8473	0.1892	0.3323	0.0912						
SEC	1991-1992		1.0000	1.0000	0.8255	0.9236	1.0000	0.8711	1.0000	1.0000	0.5260	0.9375	0.5606	0.3230	0.0000		
SEC	1992-1993		1.0000	1.0000	0.6134	1.0000	1.0000	0.6221	0.7086	1.0000	0.4187	0.6697	0.4106	0.0000	0.0000		
GNB	1984-1985		1.0000	1.0000	0.9734	0.9613	1.0000	1.0000	0.5071	0.7974	0.7221	0.2196					
CAV	1991-1992		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9247	0.6241	0.0126	0.0000	0.0000		
NEL	1983-1984				1.0000	1.0000	0.8603	1.0000	1.0000	0.0000	0.2978						
NEL	1990-1991		1.0000	0.6994	0.7812	0.6960	0.9088	0.5156	0.6210	0.7309	0.7671	0.5387	0.7248	0.1828			
NEL	1991-1992		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8147	0.5708	0.0831	0.0000		
NEL	1992-1993		1.0000	1.0000	1.0000	1.0000	0.8940	0.6877	0.7339	0.3294	0.2293	0.3235	0.2186	0.1539	0.0000		
NEL	1993-1994		0.5850	0.6173	0.4459	0.9257	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.5519	0.5424	0.3326		
NUN	1991-1992			1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.3237	0.2431	0.0384	0.0000		
NUN	1992-1993		1.0000	1.0000	1.0000	0.3218	0.9858	0.8410	0.7136	0.8304	0.2114	0.0681	0.1348	0.0000	0.0000		
NUN	1993-1994		1.0000	0.7254	0.9667	0.7829	1.0000	1.0000	0.8628	0.8693	0.4416	0.5241	0.4032	0.4032			
NEL	1994-1995		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8564	0.9381	0.5091	0.5690	0.9323	1.0000	1.0000	1.0000	
No. Obs.		0	13	14	15	15	15	15	15	15	15	13	11	11	10	1	0
Mean			0.9681	0.8959	0.8920	0.9006	0.9386	0.8923	0.7896	0.7512	0.5426	0.5087	0.4330	0.2479	0.1333	1.0000	
Smoothed		0.9489	0.9437	0.9356	0.9235	0.9060	0.8808	0.8445	0.7932	0.7221	0.6283	0.5135	0.3875	0.2668	0.1673	0.0962	0.0514

Table 3. Estimated survival rates in consecutive years having acceptable biomass assessments in the Norton Sound herring district since 1980.

Years	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age-8	Age-9	Age-10	Age-11	Age-12	Age-13	Age-14	Age-15	Age-16	Age-17
1983-1984		1.0000	1.0000	0.7416	0.7036	0.4772	1.0000	0.3782	0.7425	0.3307						
1986-1987		1.0000	0.8615	1.0000	1.0000	1.0000	1.0000	0.8594	0.6865	0.2738	0.0000					
1987-1988		1.0000	1.0000	0.3401	0.7502	1.0000	1.0000	0.9811	0.5351	1.0000	1.0000		0.0000			
1990-1991		0.8251	0.6045	1.0000	1.0000	1.0000	1.0000	0.9392	0.6662	0.6581	1.0000	1.0000				
1991-1992		1.0000	1.0000	1.0000	1.0000	0.9358	0.9266	1.0000	0.7936	0.4881	0.6069	1.0000	1.0000			
1992-1993		1.0000	0.7422	0.4283	0.4764	0.6690	1.0000	1.0000	0.6269	0.5917	1.0000	0.4189	0.1609	0.0414		
1993-1994		0.5704	1.0000	1.0000	1.0000	1.0000	0.8607	0.4202	0.4765	0.3430	0.2999	0.1622	0.3622	0.0098		
1994-1995		1.0000	0.9376	1.0000	0.6464	1.0000	0.5923	1.0000	1.0000	1.0000	0.5232	1.0000	1.0000	0.2585		
1997-1998		0.6350	0.9541	1.0000	1.0000	0.9979	0.7319	1.0000	0.6590	0.8348	0.5215	1.0000	0.3667	0.5880		
1998-1999		1.0000	1.0000	0.7273	0.9904	0.6264	0.8415	1.0000	0.4804	0.7611	0.4175	0.5082	0.5667	0.8096	0.7203	1.0000
No. Obs.	0	10	10	10	10	10	10	10	10	10	9	7	7	5	1	1
Mean		0.9030	0.9100	0.8237	0.8567	0.8706	0.8953	0.8578	0.6667	0.6281	0.5966	0.7270	0.4938	0.3415	0.7203	1.0000
Smoothed	0.9320	0.9182	0.9019	0.8827	0.8604	0.8346	0.8051	0.7718	0.7347	0.6939	0.6498	0.6031	0.5544	0.5046	0.4547	0.4057

Table 4. Security Cove District summary of the 1999 Pacific herring harvest, escapement and total run biomass, and the 2000 projected biomass by age.

1999 Total Run Summary

Year Class	Age Class	Harvest Biomass (tons)	Harvest Number of Fish	Escapement Biomass (tons)	Escapement Number of Fish	Total Run Biomass (tons)	Total Run Number of Fish	Estimated Weight (g)	Percent by Weight	Percent by Number
1997	2	0	0	0	0	0	0	83	0.0	0.0
1996	3	0	0	3	19,006	3	19,006	125	0.0	0.1
1995	4	0	0	52	285,097	52	285,097	167	1.0	1.7
1994	5	2	7,761	121	532,181	123	539,943	207	2.3	3.2
1993	6	80	287,167	639	2,774,945	719	3,062,112	213	13.7	18.3
1992	7	85	271,644	462	1,710,583	547	1,982,227	250	10.4	11.8
1991	8	165	496,721	617	2,014,686	782	2,511,407	283	14.9	15.0
1990	9	211	589,856	690	2,071,706	900	2,661,562	307	17.1	15.9
1989	10	245	659,708	800	2,204,751	1,045	2,864,458	331	19.9	17.1
1988	11	202	512,244	516	1,463,498	718	1,975,742	330	13.7	11.8
1987	12	63	155,225	201	456,155	264	611,381	392	5.0	3.7
1986	13	19	46,568	52	114,039	72	160,606	404	1.4	1.0
1985	14	0	0	36	76,026	36	76,026	429	0.7	0.5
1984	15	0	0	0	0	0	0	441	0.0	0.0
1983	16	0	0	0	0	0	0	452	0.0	0.0
1982	17	0	0	0	0	0	0	461	0.0	0.0
Totals & Means:		1,072	3,026,894	4,189	13,722,673	5,261	16,749,567	285	100.0	100.0

2000 Projection Summary

Year Class	Age Class	Recruitment Schedule	1998 Escapement	Survival Rates	Projection Projected Weight (g)	Projection Biomass (tons)	Projection Number of Fish	Projection Percent by Weight	Projection Percent by Number
1998	2	0.00	0	0.949	92	0	0	0.0	0.0
1997	3	0.43	73,923	0.944	126	0	0	0.0	0.0
1996	4	0.86	609,868	0.936	159	7	38,384	0.2	0.3
1995	5	0.97	5,562,737	0.924	191	63	298,550	1.7	2.7
1994	6	1.00	1,275,179	0.906	221	120	491,469	3.3	4.5
1993	7	1.00	1,607,834	0.881	250	693	2,514,100	19.1	22.8
1992	8	1.00	961,004	0.845	277	460	1,506,681	12.7	13.7
1991	9	1.00	572,906	0.793	303	568	1,701,402	15.7	15.5
1990	10	1.00	1,053,409	0.722	327	592	1,643,277	16.4	14.9
1989	11	1.00	351,136	0.628	349	613	1,592,051	16.9	14.5
1988	12	1.00	184,809	0.514	371	376	919,516	10.4	8.4
1987	13	1.00	36,962	0.388	390	101	234,236	2.8	2.1
1986	14	1.00	36,962	0.267	409	20	44,190	0.5	0.4
1985	15	1.00	0	0.167	426	10	20,284	0.3	0.2
1984	16	1.00	0	0.096	442	0	0	0.0	0.0
1983	17	1.00	0	0.051	457	0	0	0.0	0.0
Totals & Means:			12,326,729		299	3,622	11,004,140	100.0	100.0

Table 5. Goodnews Bay District summary of the 1999 Pacific herring harvest, escapement and total run biomass, and the 2000 projected biomass by age.

1999 Total Run Summary

		Harvest		Escapement		Total Run				
Year Class	Age Class	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Estimated Weight (g)	Percent by Weight	Percent by Number
1997	2	0	0	0	0	0	0	83	0.0	0.0
1996	3	0	0	3	22,484	3	22,484	125	0.0	0.1
1995	4	0	0	62	337,259	62	337,259	167	0.9	1.7
1994	5	3	9,890	143	629,550	146	639,440	207	2.1	3.2
1993	6	102	365,923	887	3,282,653	988	3,648,577	246	14.3	18.2
1992	7	108	346,144	613	2,023,553	721	2,369,697	276	10.5	11.8
1991	8	210	632,949	804	2,383,296	1,014	3,016,245	305	14.7	15.0
1990	9	268	751,626	897	2,450,748	1,165	3,202,374	330	16.9	15.9
1989	10	312	840,635	1,052	2,608,135	1,365	3,448,770	359	19.8	17.2
1988	11	258	652,728	727	1,731,262	985	2,383,991	375	14.3	11.9
1987	12	81	197,796	237	539,614	318	737,411	392	4.6	3.7
1986	13	25	59,339	62	134,904	86	194,242	404	1.3	1.0
1985	14	0	0	43	89,936	43	89,936	429	0.6	0.4
1984	15	0	0	0	0	0	0	441	0.0	0.0
1983	16	0	0	0	0	0	0	452	0.0	0.0
1982	17	0	0	0	0	0	0	461	0.0	0.0
Totals & Means:		1,366	3,857,030	5,530	16,233,395	6,896	20,090,425	311	100.0	100.0

2000 Projection Summary

					Projection				
Year Class	Age Class	Recruitment Schedule	1998 Escapement	Survival Rates	Projected Weight (g)	Biomass (tons)	Number of Fish	Percent by Weight	Percent by Number
1998	2	0.00	0	0.949	81	0	0	0.0	0.0
1997	3	0.43	157,529	0.944	126	0	0	0.0	0.0
1996	4	0.86	596,022	0.936	168	8	45,407	0.2	0.3
1995	5	0.97	3,279,130	0.924	208	79	343,403	1.7	2.6
1994	6	1.00	779,499	0.906	244	157	583,726	3.4	4.5
1993	7	1.00	1,754,064	0.881	277	908	2,974,084	19.5	22.9
1992	8	1.00	1,248,817	0.845	306	602	1,782,346	12.9	13.7
1991	9	1.00	874,055	0.793	332	737	2,012,694	15.8	15.5
1990	10	1.00	1,252,685	0.722	355	761	1,943,933	16.3	14.9
1989	11	1.00	740,373	0.628	376	780	1,883,335	16.7	14.5
1988	12	1.00	267,700	0.514	393	472	1,087,752	10.1	8.4
1987	13	1.00	167,438	0.388	409	125	277,092	2.7	2.1
1986	14	1.00	117,643	0.267	423	24	52,275	0.5	0.4
1985	15	1.00	16,710	0.167	435	11	23,995	0.2	0.2
1984	16	1.00	0	0.096	445	0	0	0.0	0.0
1983	17	1.00	0	0.051	454	0	0	0.0	0.0
Totals & Means:			11,251,666		325	4,665	13,010,040	100.0	100.0

Table 6. Cape Avinof District summary of the 1999 Pacific herring harvest, escapement and total run biomass, and the 2000 projected biomass by age.

1999 Total Run Summary

		Harvest		Escapement		Total Run				
Year Class	Age Class	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Estimated Weight (g)	Percent by Weight	Percent by Number
1997	2	0	0	0	0	0	0	48	0.0	0.0
1996	3	0	0	11	106,560	11	106,560	90	0.3	0.9
1995	4	0	0	234	1,518,482	234	1,518,482	140	6.6	13.2
1994	5	0	0	81	399,601	81	399,601	185	2.3	3.5
1993	6	27	86,103	756	2,957,044	783	3,043,147	234	22.0	26.5
1992	7	39	116,051	232	772,561	271	888,612	277	7.6	7.7
1991	8	85	239,590	379	1,092,241	464	1,331,831	316	13.1	11.6
1990	9	127	333,179	504	1,305,362	630	1,638,541	349	17.7	14.3
1989	10	96	239,590	441	1,092,241	537	1,331,831	366	15.1	11.6
1988	11	114	265,795	259	586,081	373	851,876	397	10.5	7.4
1987	12	30	71,128	112	239,760	142	310,889	414	4.0	2.7
1986	13	11	22,462	13	26,640	24	49,102	446	0.7	0.4
1985	14	4	7,487	0	0	4	7,487	435	0.1	0.1
1984	15	0	0	0	0	0	0	472	0.0	0.0
1983	16	0	0	0	0	0	0	484	0.0	0.0
1982	17	0	0	0	0	0	0	494	0.0	0.0
Totals & Means:		533	1,381,385	3,022	10,096,574	3,555	11,477,958	281	100.0	100.0

2000 Projection Summary

					Projection				
Year Class	Age Class	Recruitment Schedule	1998 Escapement	Survival Rates	Projected Weight (g)	Biomass (tons)	Number of Fish	Percent by Weight	Percent by Number
1998	2	0.00	46,078	0.949	47	0	0	0.0	0.0
1997	3	0.43	253,430	0.944	90	0	0	0.0	0.0
1996	4	0.86	760,290	0.936	139	33	215,200	1.1	2.4
1995	5	0.97	4,895,093	0.924	188	334	1,609,696	11.6	18.3
1994	6	1.00	1,006,179	0.906	235	96	369,031	3.3	4.2
1993	7	1.00	1,802,572	0.881	277	818	2,679,082	28.5	30.4
1992	8	1.00	1,730,012	0.845	314	236	680,472	8.2	7.7
1991	9	1.00	786,002	0.793	346	352	922,398	12.3	10.5
1990	10	1.00	1,267,805	0.722	373	425	1,035,413	14.8	11.8
1989	11	1.00	214,300	0.628	395	344	788,708	12.0	9.0
1988	12	1.00	169,231	0.514	414	168	368,235	5.9	4.2
1987	13	1.00	119,886	0.388	430	58	123,117	2.0	1.4
1986	14	1.00	46,078	0.267	442	5	10,323	0.2	0.1
1985	15	1.00	0	0.167	453	0	0	0.0	0.0
1984	16	1.00	0	0.096	461	0	0	0.0	0.0
1983	17	1.00	0	0.051	468	0	0	0.0	0.0
Totals & Means:			13,096,955		296	2,868	8,801,674	100.0	100.0

Table 7. Nelson Island District summary of the 1999 Pacific herring harvest, escapement and total run biomass, and the 2000 projected biomass by age.

1999 Total Run Summary

		Harvest		Escapement		Total Run				
Year Class	Age Class	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Estimated Weight (g)	Percent by Weight	Percent by Number
1997	2	0	0	0	0	0	0	42	0.0	0.0
1996	3	0	0	16	160,588	16	160,588	92	0.2	0.8
1995	4	0	0	148	995,648	148	995,648	135	2.2	5.2
1994	5	2	8,536	141	649,877	143	658,413	197	2.1	3.5
1993	6	28	85,361	865	3,206,703	893	3,292,063	246	13.4	17.3
1992	7	98	273,154	257	867,024	354	1,140,178	282	5.3	6.0
1991	8	268	682,885	795	2,320,119	1,063	3,003,004	321	16.0	15.8
1990	9	386	904,823	977	2,628,123	1,363	3,532,946	350	20.5	18.6
1989	10	300	674,349	1,091	2,698,009	1,390	3,372,358	374	20.9	17.7
1988	11	188	401,195	608	1,413,455	796	1,814,650	398	12.0	9.5
1987	12	49	102,433	260	572,039	309	674,472	415	4.6	3.5
1986	13	31	59,752	37	84,777	69	144,530	431	1.0	0.8
1985	14	17	34,144	54	110,385	71	144,530	443	1.1	0.8
1984	15	0	0	32	64,235	32	64,235	454	0.5	0.3
1983	16	0	0	0	0	0	0	462	0.0	0.0
1982	17	0	0	8	16,059	8	16,059	469	0.1	0.1
Totals & Means:		1,366	3,226,632	5,289	15,787,042	6,655	19,013,674	318	100.0	100.0

2000 Projection Summary

					Projection				
Year Class	Age Class	Recruitment Schedule	1998 Escapement	Survival Rates	Projected Weight (g)	Biomass (tons)	Number of Fish	Percent by Weight	Percent by Number
1998	2	0.00	33,663	0.949	16	0	0	0.0	0.0
1997	3	0.43	286,132	0.944	79	0	0	0.0	0.0
1996	4	0.86	1,060,372	0.935	141	50	324,243	1.1	2.5
1995	5	0.97	7,995,049	0.923	196	224	1,038,406	4.8	8.1
1994	6	1.00	1,338,357	0.906	244	161	600,031	3.5	4.7
1993	7	1.00	3,421,753	0.881	285	913	2,904,631	19.5	22.5
1992	8	1.00	3,052,536	0.845	320	270	763,501	5.8	5.9
1991	9	1.00	1,521,244	0.793	350	756	1,959,341	16.2	15.2
1990	10	1.00	1,944,704	0.723	375	863	2,085,153	18.5	16.2
1989	11	1.00	559,182	0.629	397	853	1,949,851	18.2	15.1
1988	12	1.00	430,180	0.515	415	407	889,628	8.7	6.9
1987	13	1.00	25,693	0.389	430	140	294,657	3.0	2.3
1986	14	1.00	0	0.269	442	16	33,012	0.3	0.3
1985	15	1.00	0	0.169	453	15	29,672	0.3	0.2
1984	16	1.00	0	0.098	462	6	10,862	0.1	0.1
1983	17	1.00	0	0.052	469	0	0	0.0	0.0
Totals & Means:			21,668,865		329	4,672	12,882,989	100.0	100.0

Table 8. Nunivak Island District summary of the 1999 Pacific herring harvest, escapement and total run biomass, and the 2000 projected biomass by age.

1999 Total Run Summary

		Harvest		Escapement		Total Run				
Year Class	Age Class	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Estimated Weight (g)	Percent by Weight	Percent by Number
1997	2	0	0	0	0	0	0	42	0.0	0.0
1996	3	0	0	8	80,089	8	80,089	92	0.2	0.8
1995	4	0	0	74	496,553	74	496,553	135	2.2	5.2
1994	5	0	0	71	328,365	71	328,365	197	2.1	3.5
1993	6	0	0	445	1,641,827	445	1,641,827	246	13.4	17.3
1992	7	0	0	177	568,633	177	568,633	282	5.3	6.0
1991	8	0	0	530	1,497,667	530	1,497,667	321	16.0	15.8
1990	9	0	0	680	1,761,961	680	1,761,961	350	20.5	18.6
1989	10	0	0	693	1,681,872	693	1,681,872	374	20.9	17.7
1988	11	0	0	397	905,007	397	905,007	398	12.0	9.5
1987	12	0	0	154	336,374	154	336,374	415	4.6	3.5
1986	13	0	0	34	72,080	34	72,080	431	1.0	0.8
1985	14	0	0	35	72,080	35	72,080	443	1.1	0.8
1984	15	0	0	16	32,036	16	32,036	454	0.5	0.3
1983	16	0	0	0	0	0	0	462	0.0	0.0
1982	17	0	0	4	8,009	4	8,009	469	0.1	0.1
Totals & Means:		0	0	3,319	9,482,552	3,319	9,482,552	318	100.0	100.0

2000 Projection Summary

					Projection				
Year Class	Age Class	Recruitment Schedule	1998 Escapement	Survival Rates	Projected Weight (g)	Biomass (tons)	Number of Fish	Percent by Weight	Percent by Number
1998	2	0.00	17,822	0.949	42	0	0	0.0	0.0
1997	3	0.43	151,486	0.944	92	0	0	0.0	0.0
1996	4	0.86	528,499	0.936	135	24	161,741	0.9	2.1
1995	5	0.97	3,806,981	0.924	197	112	516,814	4.0	6.8
1994	6	1.00	637,210	0.906	246	82	303,245	2.9	4.0
1993	7	1.00	1,915,120	0.881	282	462	1,487,495	16.4	19.5
1992	8	1.00	1,826,581	0.845	321	177	500,852	6.3	6.6
1991	9	1.00	1,073,445	0.793	350	488	1,264,779	17.3	16.6
1990	10	1.00	1,446,329	0.722	374	576	1,397,587	20.4	18.3
1989	11	1.00	478,843	0.628	398	533	1,214,479	18.9	15.9
1988	12	1.00	273,891	0.514	415	260	568,616	9.2	7.4
1987	13	1.00	35,644	0.388	431	82	172,728	2.9	2.3
1986	14	1.00	8,911	0.267	443	14	27,931	0.5	0.4
1985	15	1.00	0	0.167	454	10	19,231	0.3	0.3
1984	16	1.00	0	0.096	462	3	5,360	0.1	0.1
1983	17	1.00	0	0.051	469	0	0	0.0	0.0
Totals & Means:			12,200,762		335	2,823	7,640,860	100.0	100.0

Table 9. Cape Romanzof District summary of the 1999 Pacific herring harvest, escapement and total run biomass, and the 2000 projected biomass by age.

1999 Total Run Summary

		Harvest		Escapement		Total Run				
Year Class	Age Class	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Biomass (tons)	Number of Fish	Estimated Weight (g)	Percent by Weight	Percent by Number
1998	2	0	0	0	0	0	0	44	0.0	0.0
1997	3	0	0	3	32,040	3	32,040	93	0.1	0.3
1996	4	0	0	27	170,881	27	170,881	145	0.7	1.6
1995	5	1	2,468	18	85,441	19	87,909	197	0.5	0.8
1994	6	8	27,148	434	1,634,050	442	1,661,198	242	11.6	16.0
1993	7	1	2,468	23	74,760	24	77,228	279	0.6	0.7
1992	8	87	241,866	582	1,708,810	669	1,950,676	311	17.6	18.8
1991	9	109	286,290	599	1,602,010	708	1,888,300	340	18.6	18.2
1990	10	32	78,977	235	576,723	267	655,700	370	7.0	6.3
1989	11	211	501,008	969	2,306,894	1,180	2,807,902	381	31.0	27.1
1988	12	44	101,189	214	491,283	258	592,472	396	6.8	5.7
1987	13	20	44,424	48	106,801	68	151,225	407	1.8	1.5
1986	14	8	17,276	54	117,481	62	134,757	420	1.6	1.3
1985	15	7	14,808	50	106,801	57	121,609	427	1.5	1.2
1984	16	1	2,468	5	10,680	6	13,148	437	0.2	0.1
1983	17	2	4,936	5	10,680	8	15,616	437	0.2	0.2
Totals & Means:		533	1,325,327	3,267	9,035,335	3,800	10,360,661	333	100.0	100.0

2000 Projection Summary

					Projection				
Year Class	Age Class	Recruitment Schedule	1998 Escapement	Survival Rates	Projected Weight (g)	Biomass (tons)	Number of Fish	Percent by Weight	Percent by Number
1999	2	0.00	0	0.949	45	0	0	0.0	0.0
1998	3	0.43	36,409	0.944	94	0	0	0.0	0.0
1997	4	0.86	191,147	0.935	146	10	64,692	0.4	1.0
1996	5	0.97	2,302,872	0.923	196	39	179,989	1.5	2.6
1995	6	1.00	263,966	0.906	241	21	78,887	0.8	1.2
1994	7	1.00	2,157,236	0.881	280	456	1,480,122	17.8	21.8
1993	8	1.00	2,093,520	0.845	313	23	65,834	0.9	1.0
1992	9	1.00	336,784	0.793	340	541	1,443,090	21.1	21.2
1991	10	1.00	2,430,304	0.723	363	509	1,271,034	19.8	18.7
1990	11	1.00	964,840	0.629	382	175	416,798	6.8	6.1
1989	12	1.00	309,477	0.515	397	635	1,451,959	24.7	21.4
1988	13	1.00	191,147	0.389	409	114	253,060	4.4	3.7
1987	14	1.00	172,943	0.269	419	19	41,588	0.7	0.6
1986	15	1.00	27,307	0.169	427	15	31,579	0.6	0.5
1985	16	1.00	9,102	0.098	433	9	18,060	0.3	0.3
1984	17	1.00	0	0.052	438	1	1,042	0.0	0.0
Totals & Means:			11,487,054		343	2,567	6,797,736	100.0	100.0

Table 10. Norton Sound District summary of the 1999 Pacific herring harvest, escapement and total run biomass, and the 2000 projected biomass by age.

1999 Total Run Summary

Year Class	Age Class	Harvest				Escapement		Total Run				
		Gillnet (tons)	B. Seine (tons)	Total (tons)	Total (number)	Biomass (tons)	Number of Fish	Mean Weight (g)	Biomass (tons)	Number of Fish	Percent by Weight	Percent by Number
1997	2	0	0	0	0	0	0	6	0	0	0.0	0.0
1996	3	0	0	0	0	133	1,649,109	73	133	1,649,109	0.4	1.6
1995	4	0	0	0	0	575	4,205,228	124	575	4,205,228	1.7	4.0
1994	5	0	0	0	0	633	3,174,535	181	633	3,174,535	1.8	3.0
1993	6	20	0	20	76,628	6,262	25,025,228	227	6,282	25,101,857	18.3	24.1
1992	7	0	0	0	0	486	1,814,020	243	486	1,814,020	1.4	1.7
1991	8	289	0	289	796,934	3,915	12,038,495	297	4,204	12,835,430	12.3	12.3
1990	9	388	0	388	1,011,494	3,985	11,296,396	322	4,373	12,307,890	12.7	11.8
1989	10	616	0	616	1,455,938	4,478	11,378,852	360	5,094	12,834,790	14.8	12.3
1988	11	982	0	982	2,237,547	8,084	20,036,674	369	9,066	22,274,220	26.4	21.4
1987	12	205	0	205	459,770	1,476	3,504,357	385	1,681	3,964,126	4.9	3.8
1986	13	109	0	109	245,211	743	1,690,337	400	853	1,935,547	2.5	1.9
1985	14	89	0	89	183,908	300	659,644	418	389	843,552	1.1	0.8
1984	15	55	0	55	107,280	404	865,782	428	459	973,062	1.3	0.9
1983	16	7	0	7	15,326	59	123,683	432	66	139,009	0.2	0.1
1982	17	0	0	0	0	20	41,228	441	20	41,228	0.1	0.0
Totals & Means:		2,760	0	2,760	6,590,035	31,554	97,503,566	299	34,314	104,093,601	100.0	100.0

2000 Projection Summary

Year Class	Age Class	1998 Escapement	Recruitment Schedule	Survival Rates	Projection				
					Projected Weight (g)	Biomass (tons)	Number of Fish	Percent by Weight	Percent by Number
1998	2	0.00	0	0.932	14	0	0	0.0	0.0
1997	3	114472.25	0	0.918	71	0	0	0.0	0.0
1996	4	1087486.36	1	0.902	128	456	3,240,471	1.7	4.1
1995	5	34513382.86	1	0.883	180	867	4,376,549	3.2	5.6
1994	6	1831555.97	1	0.860	225	710	2,862,087	2.6	3.7
1993	7	20490532.44	1	0.835	265	6,278	21,530,929	23.3	27.5
1992	8	13622197.54	1	0.805	298	498	1,513,924	1.8	1.9
1991	9	12134058.32	1	0.772	327	3,490	9,691,966	13.0	12.4
1990	10	46361260.55	1	0.735	351	3,372	8,718,277	12.5	11.1
1989	11	5208487.30	1	0.694	371	3,420	8,359,513	12.7	10.7
1988	12	4636126.06	1	0.650	388	5,950	13,903,225	22.1	17.7
1987	13	1659847.60	1	0.603	403	1,010	2,277,294	3.8	2.9
1986	14	1717083.72	1	0.554	415	466	1,019,429	1.7	1.3
1985	15	171708.37	1	0.505	425	171	365,691	0.6	0.5
1984	16	57236.12	1	0.455	433	208	436,867	0.8	0.6
1983	17	57236.12	1	0.406	440	27	56,241	0.1	0.1
Totals & Means:		143,662,672			312	26,924	78,352,462	100.0	100.0

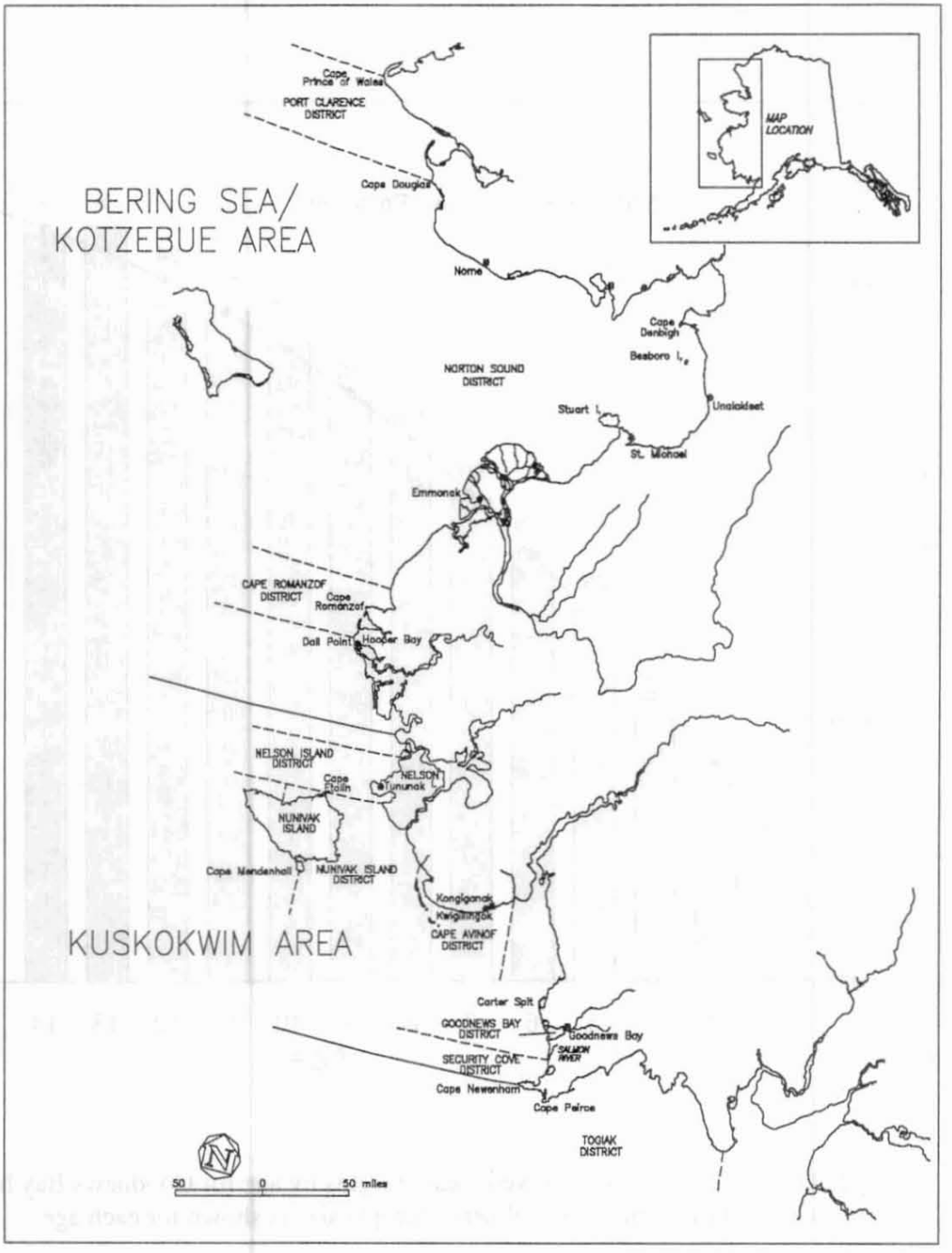

Figure 1. Commercial herring fishing districts within the Arctic-Yukon -Kuskokwim Region of the northeastern Bering Sea, Alaska.

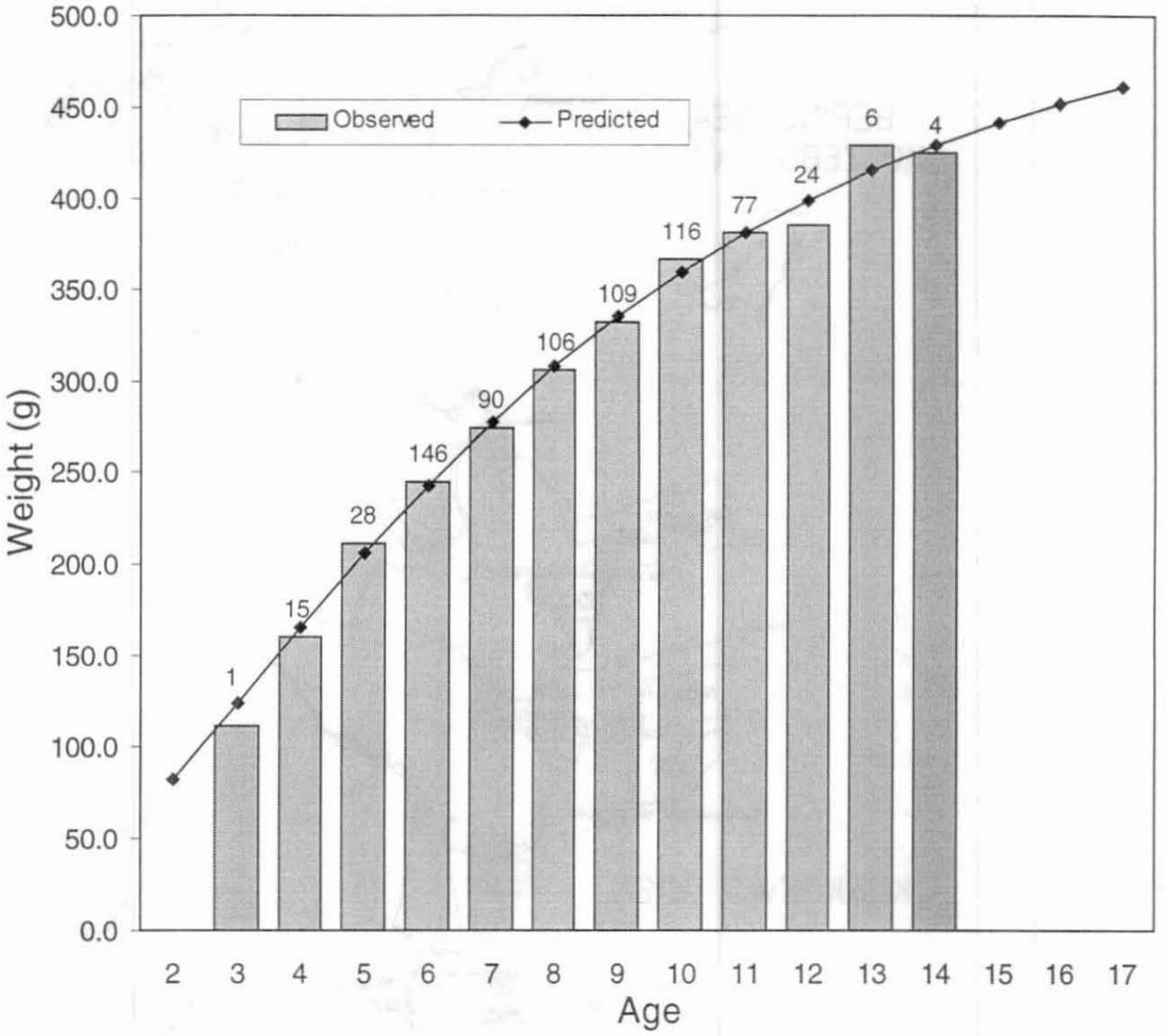

Figure 2. Growth curve fit to observed mean weights by age for Goodnews Bay herring caught in variable mesh gillnets. Sample size is shown for each age.

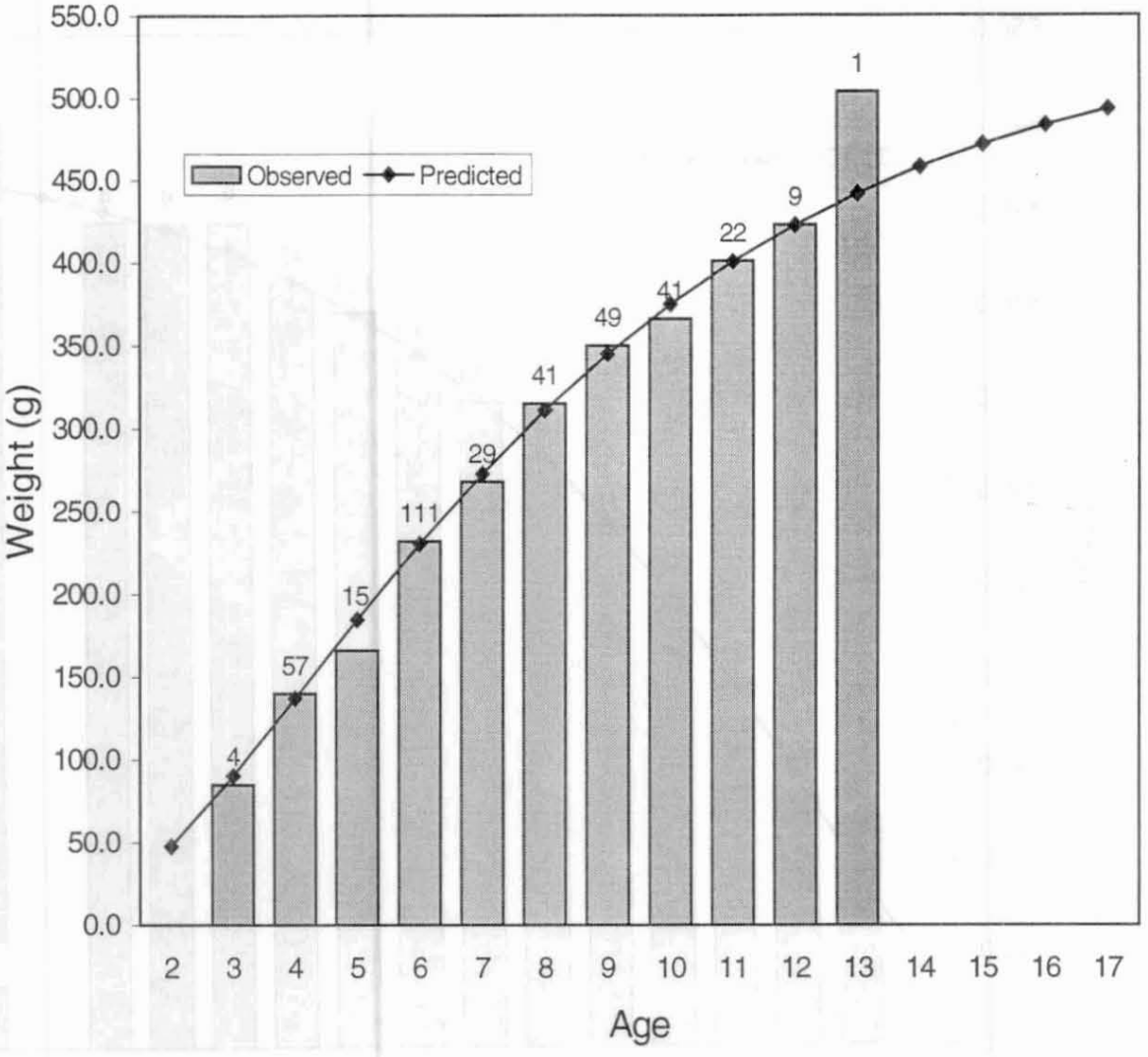

Figure 3. Growth curve fit to observed mean weights by age for Cape Avinof herring caught in variable mesh gillnets. Sample size is shown for each age.

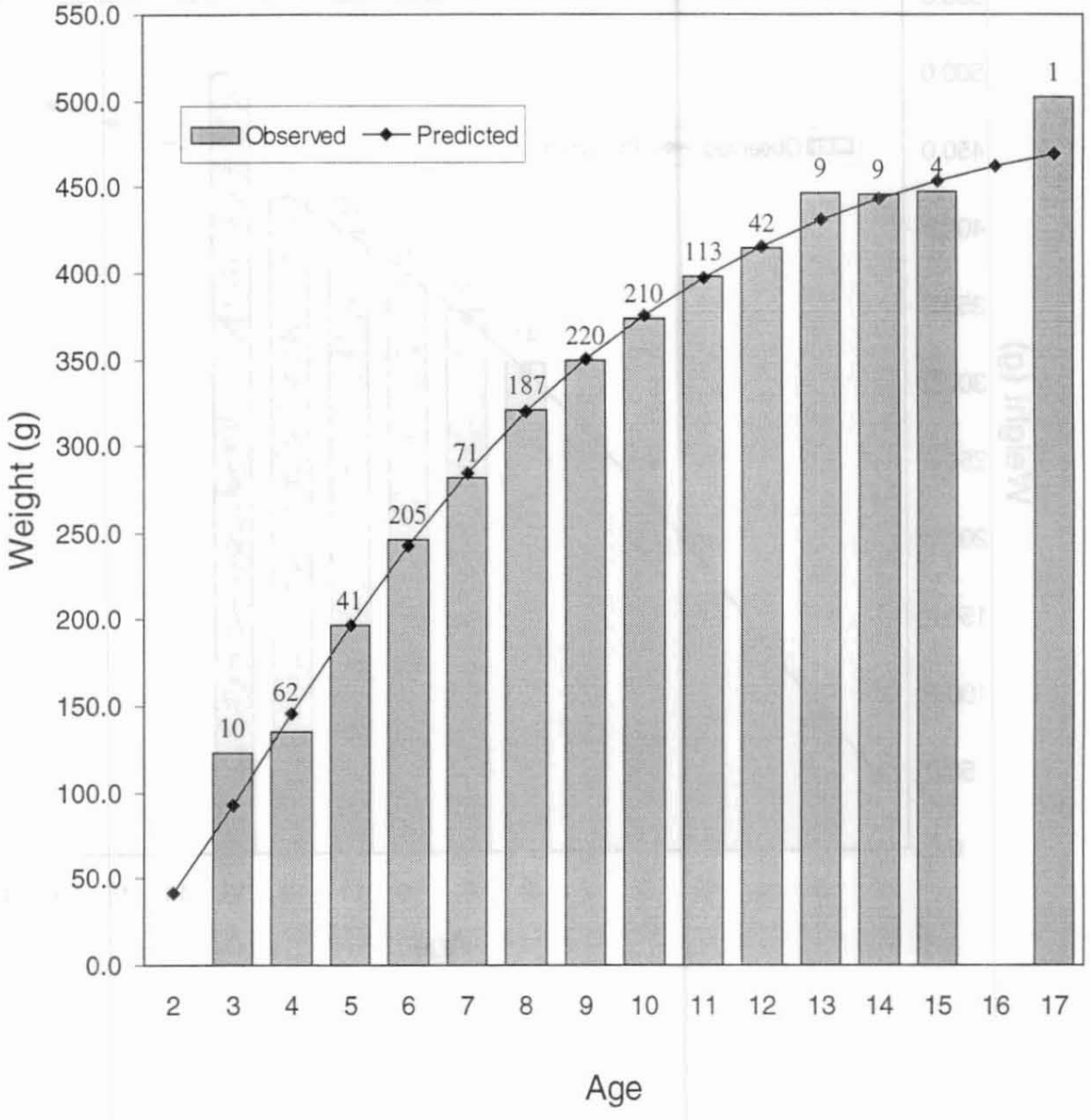

Figure 4. Growth curve fit to observed mean weights by age for Nelson Island herring caught in variable mesh gillnets. Sample size is shown for each age.

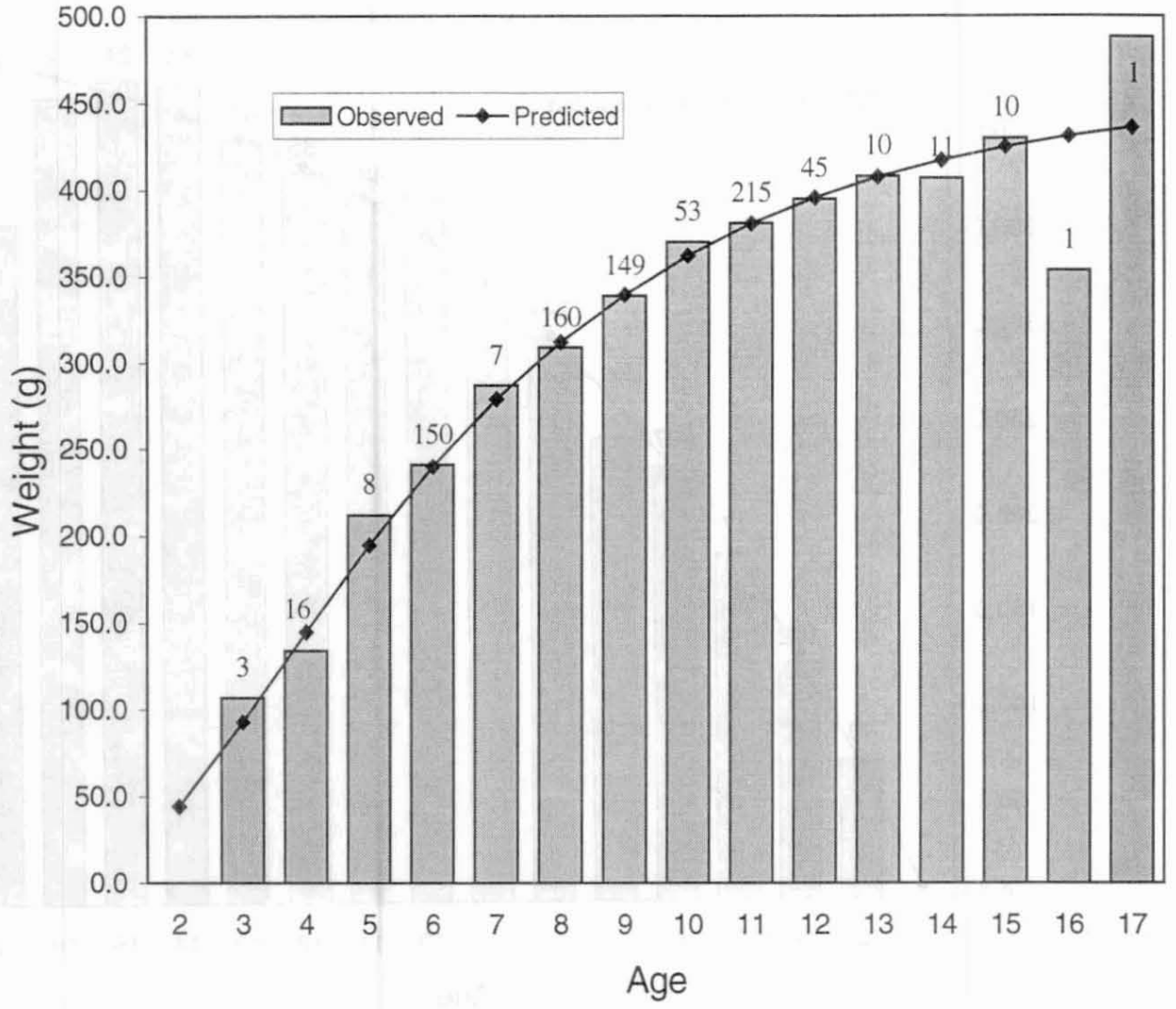

Figure 5. Growth curve fit to observed mean weights by age for Cape Romanzof herring caught in variable mesh gillnets. Sample size is shown for each age.

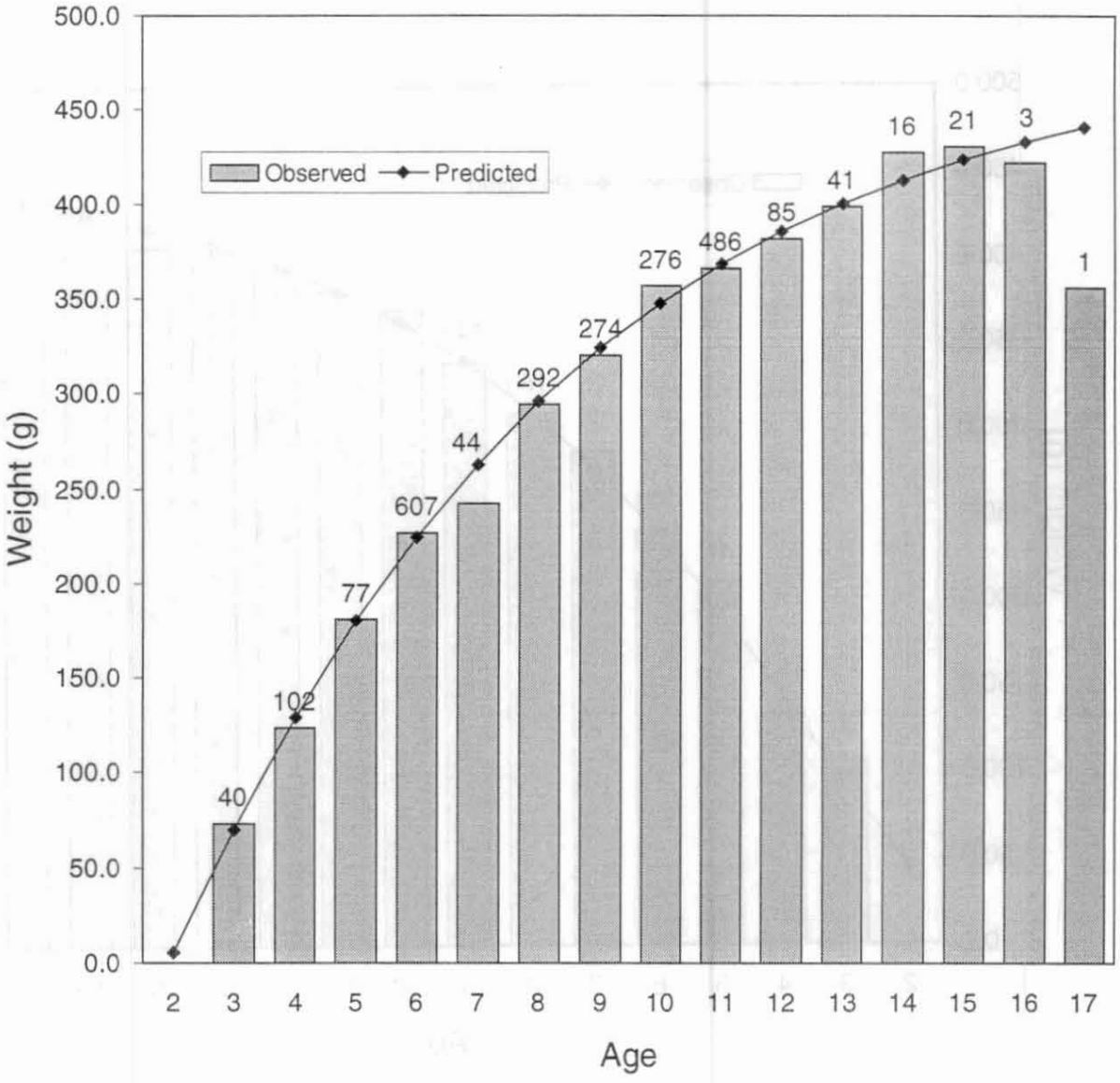

Figure 6. Growth curve fit to observed mean weights by age for Norton Sound herring caught in variable mesh gillnets. Sample size is shown for each age.

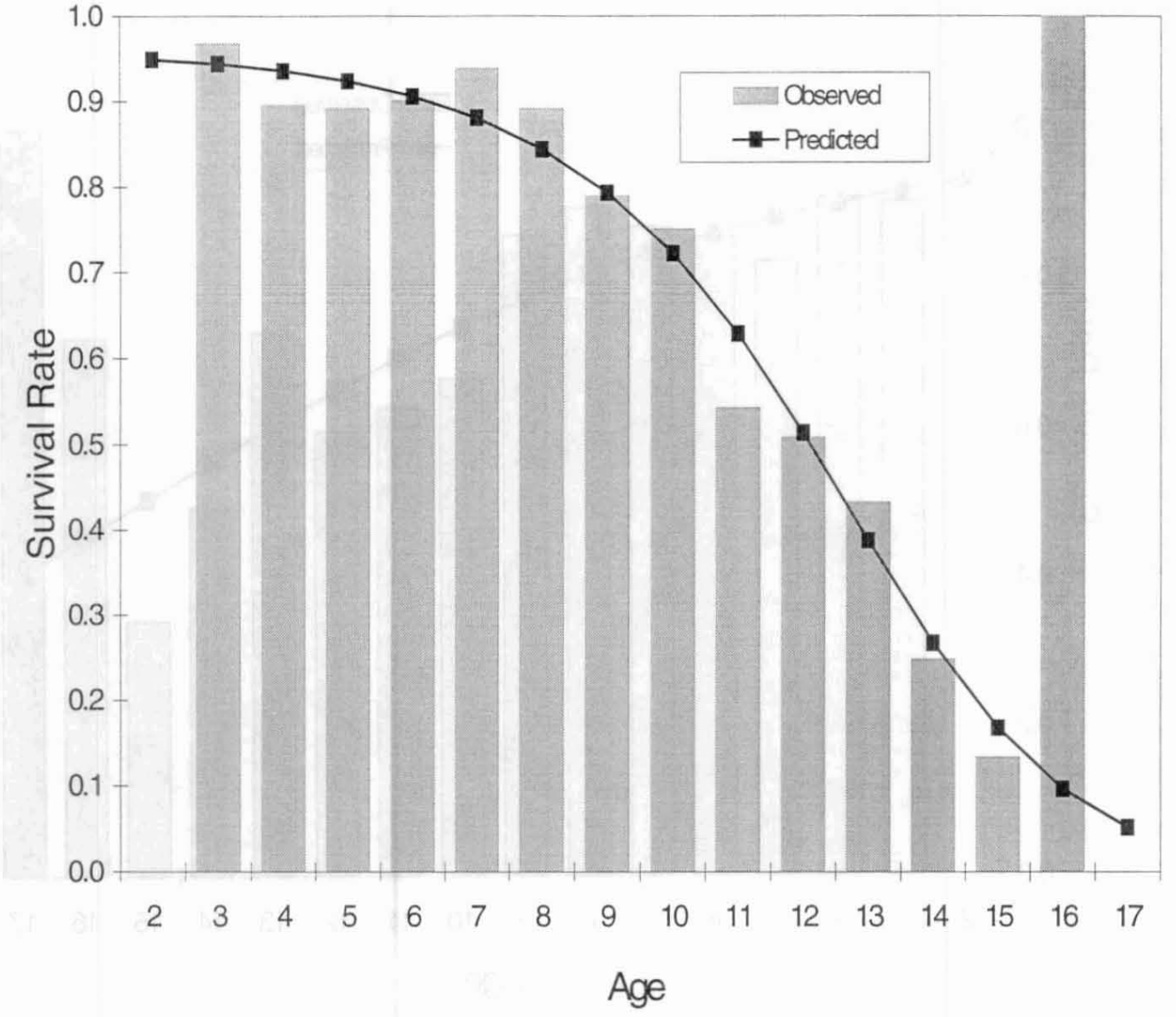

Figure 7. Observed and smoothed survival rates for Kuskokwim Area herring used for forecasting the 2000 herring returns to both the Kuskokwim Area districts and the Cape Romanzof District.

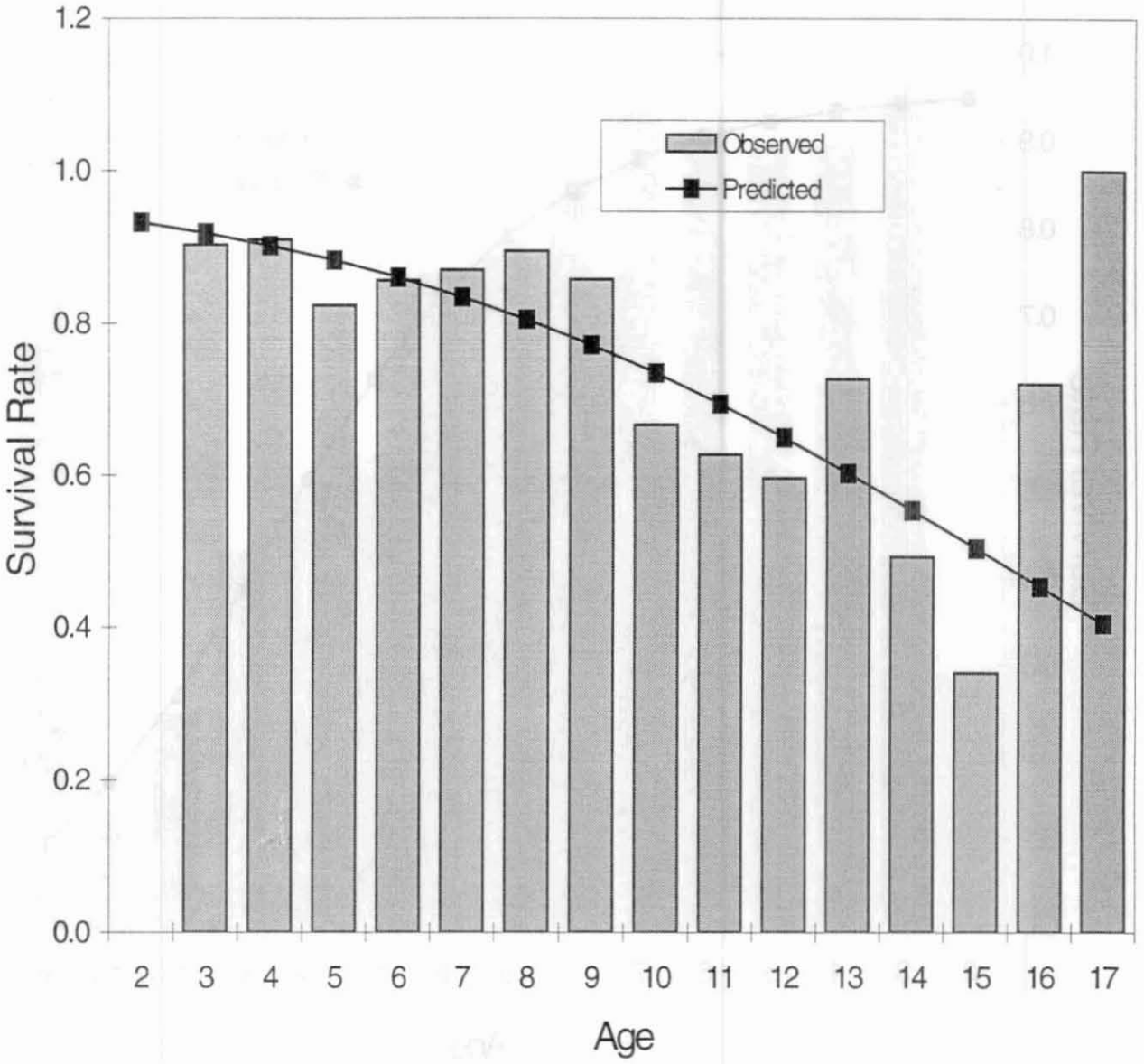

Figure 8. Observed and smoothed survival rates for Norton Sound herring used for forecasting the 2000 herring returns.

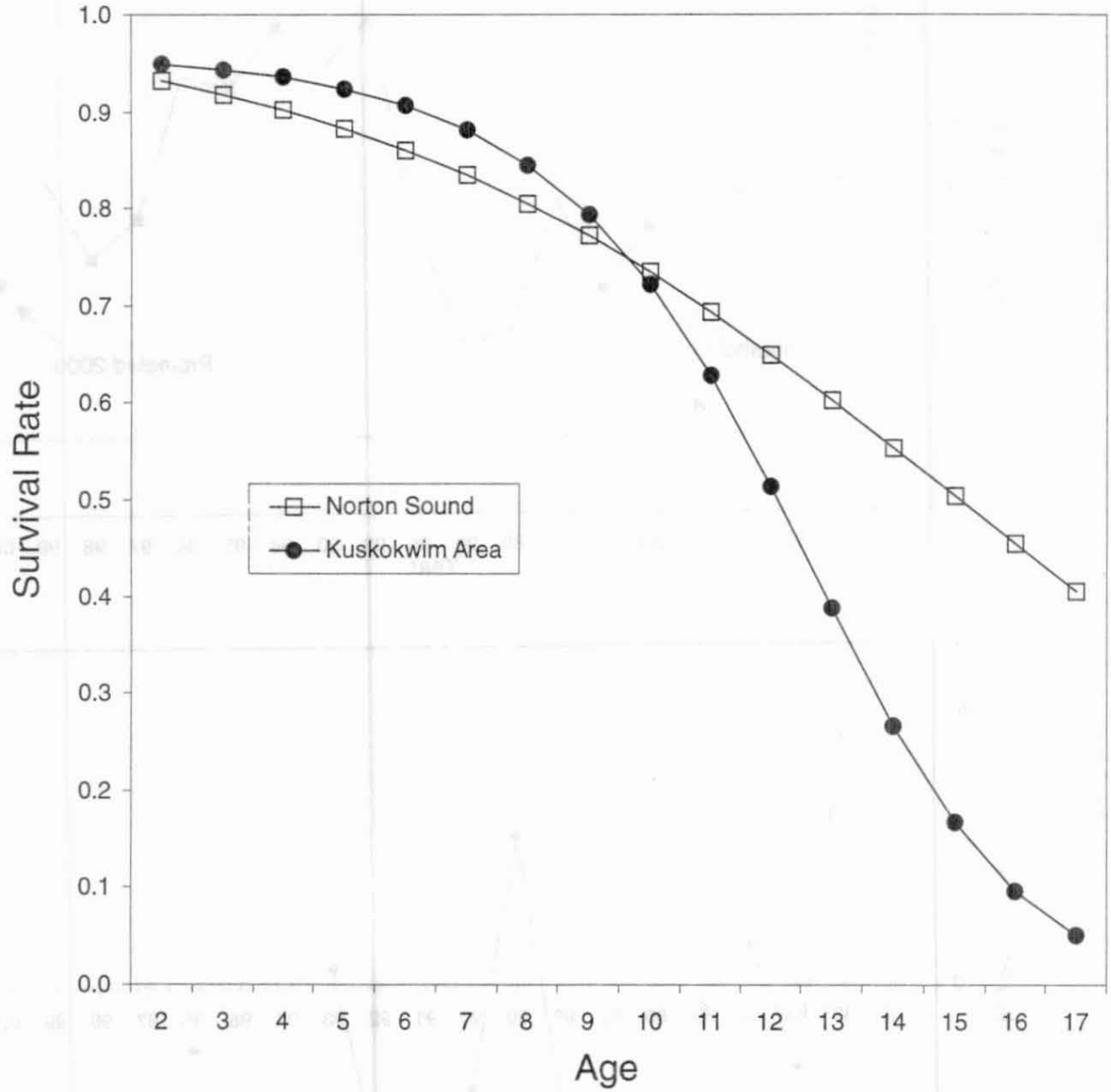

Figure 9. Comparison of Kuskokwim Area and Norton Sound herring survival rates used in forecasting the 2000 herring returns.

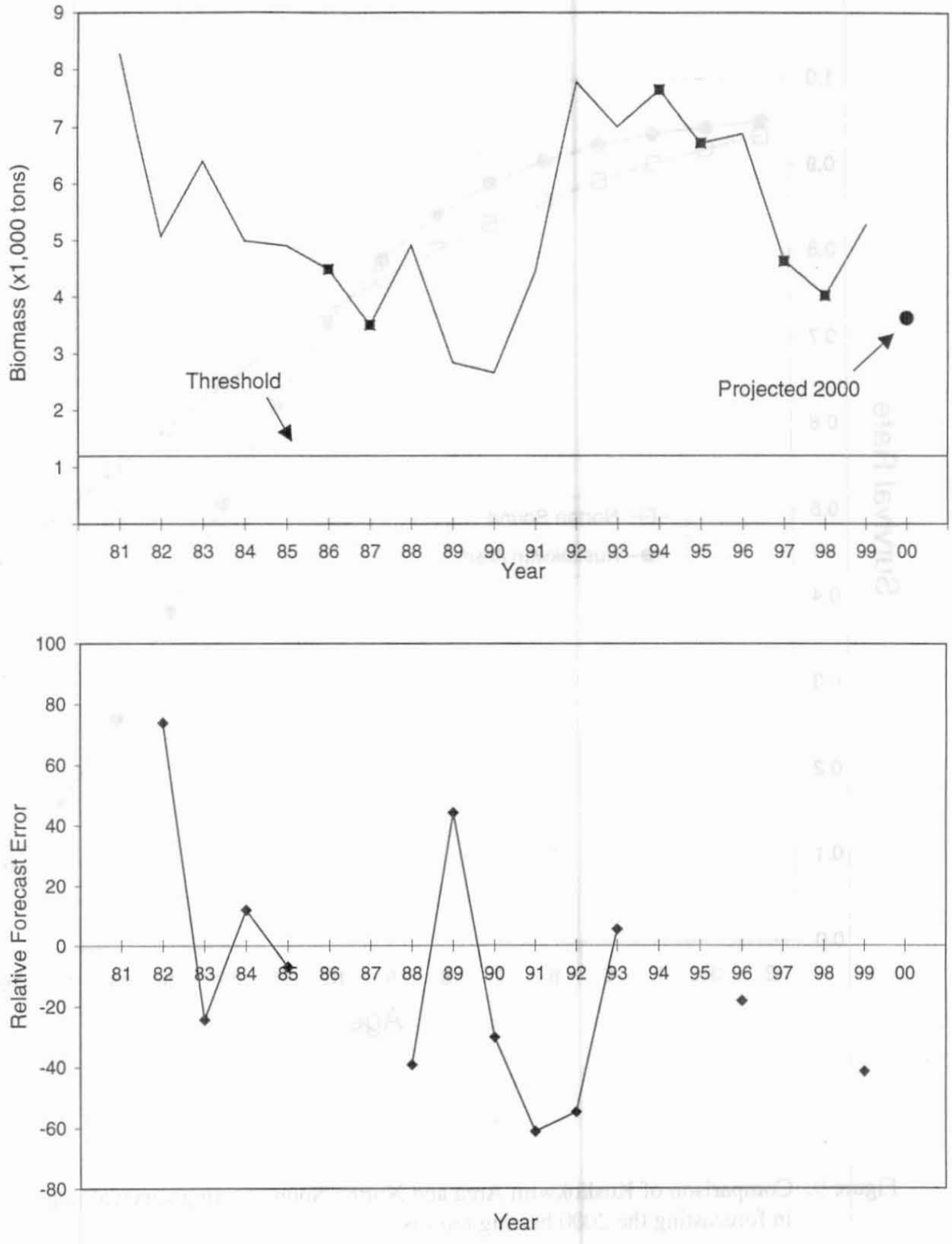

Figure 10. Security Cove District herring biomass, 1981-1999, with 2000 projected biomass (top) and the relative forecast error (bottom). Squares in the top graph and gaps in the bottom graph denote years when it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection or some other method was used to estimate biomass.

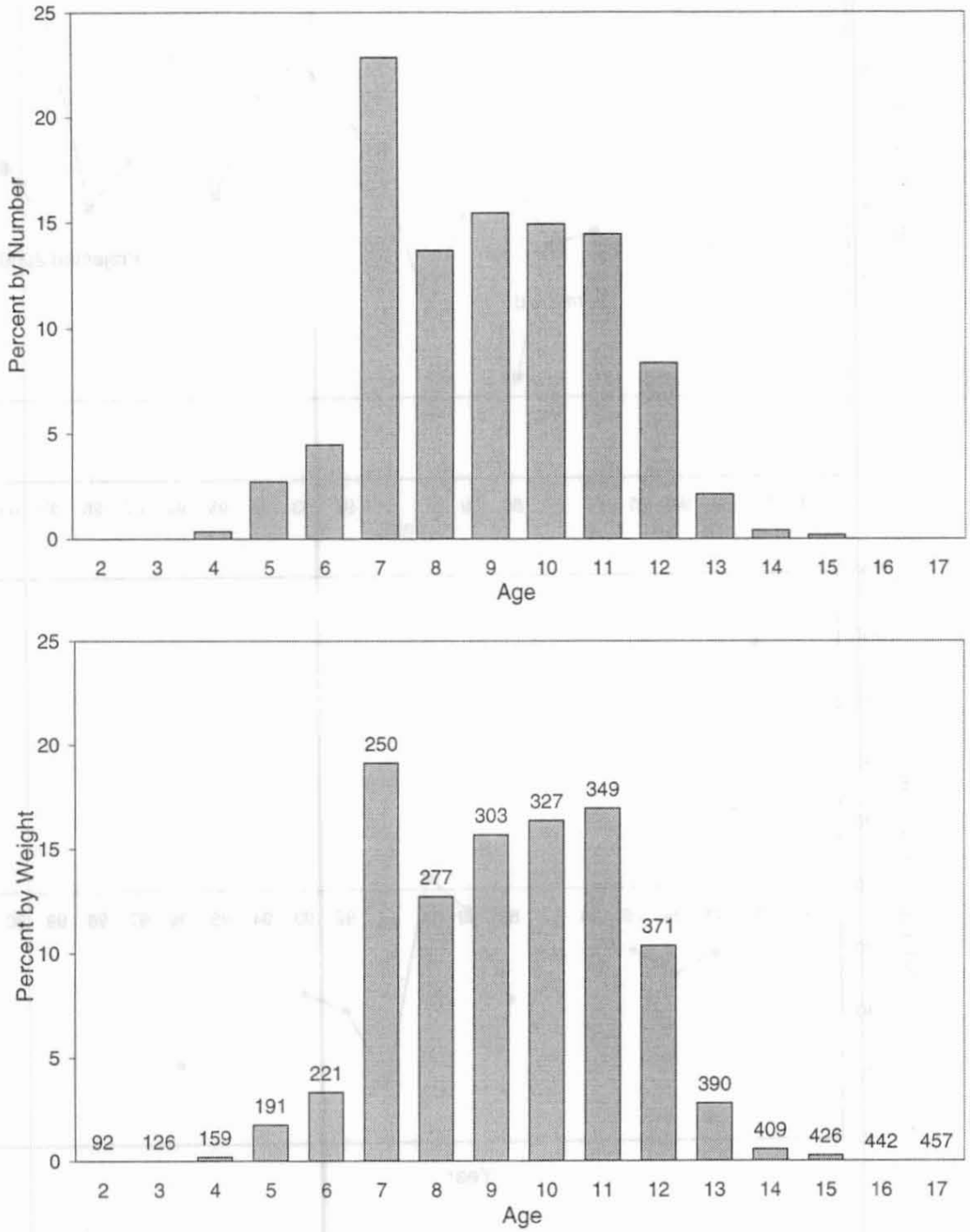

Figure 11. Projected age composition for 2000 Security Cove District herring, in percent by number (top) and percent by weight (bottom), with projected weight at age in grams.

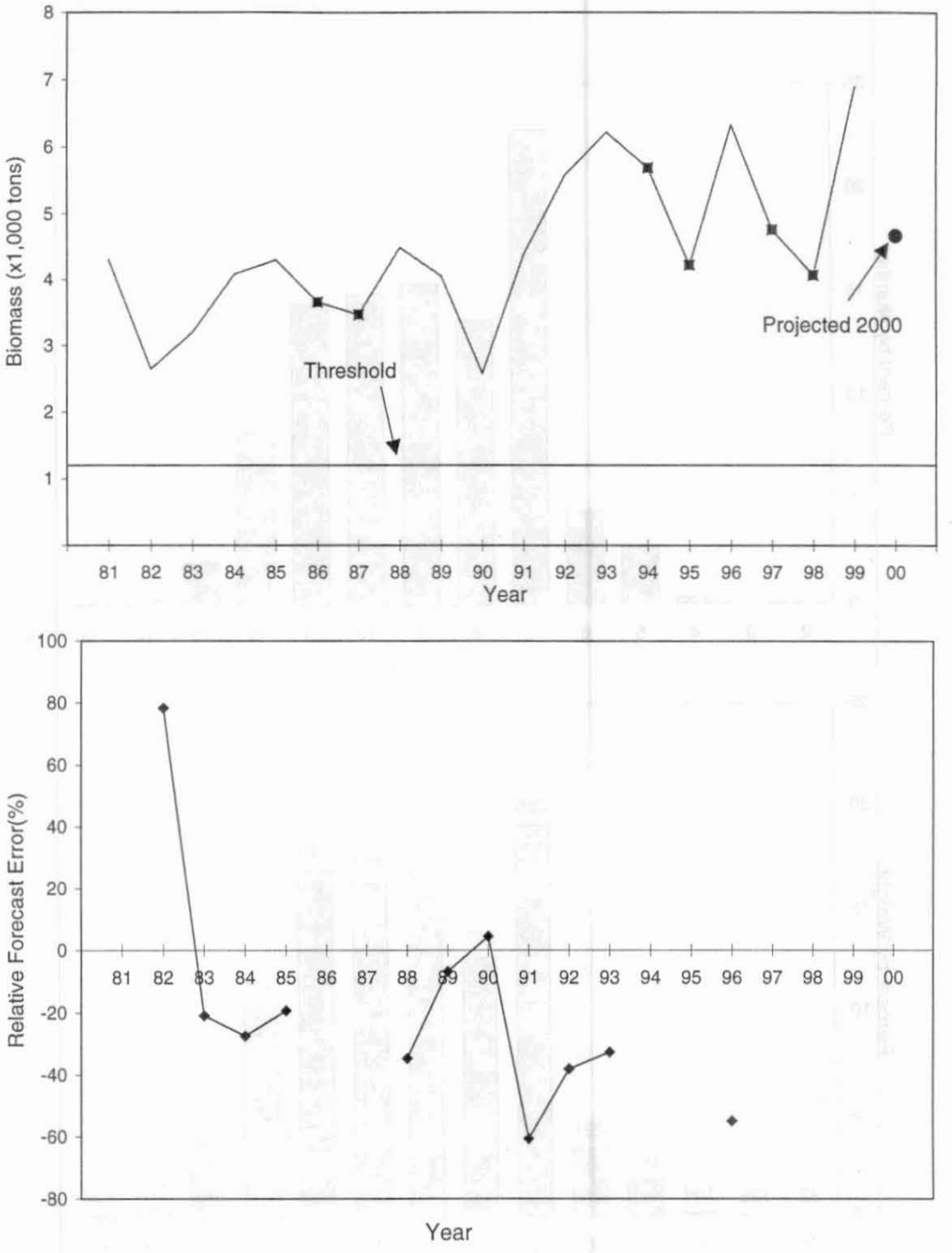

Figure 12. Goodnews Bay District herring biomass, 1981-1999, with 2000 projected biomass (top) and the relative forecast error (bottom). Squares in the top graph and gaps in the bottom graph denote years when it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection or some other method was used to estimate biomass.

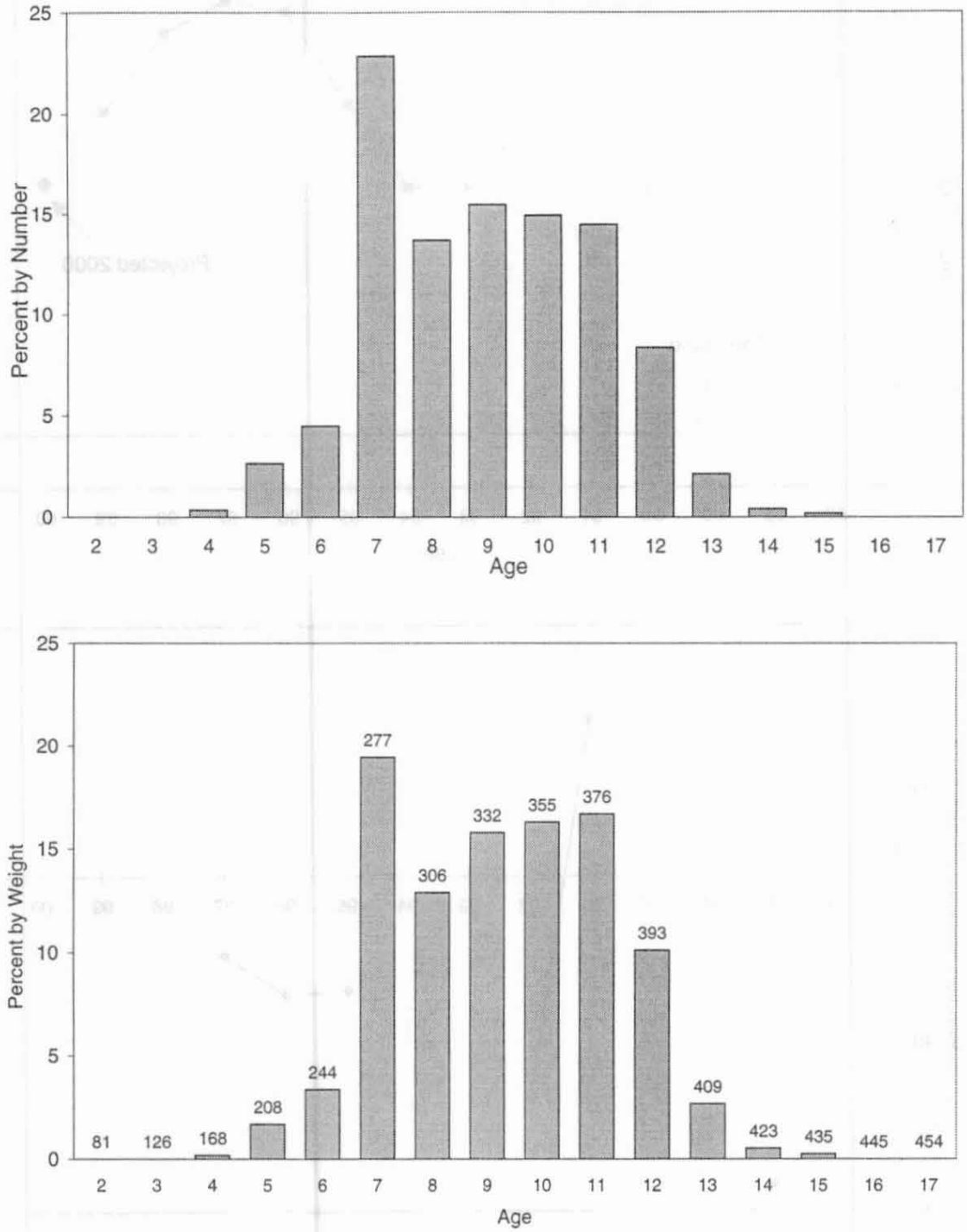

Figure 13. Projected age composition for 2000 Goodnews Bay District herring in percent by number (top) and percent by weight (bottom) with projected weight at age in grams.

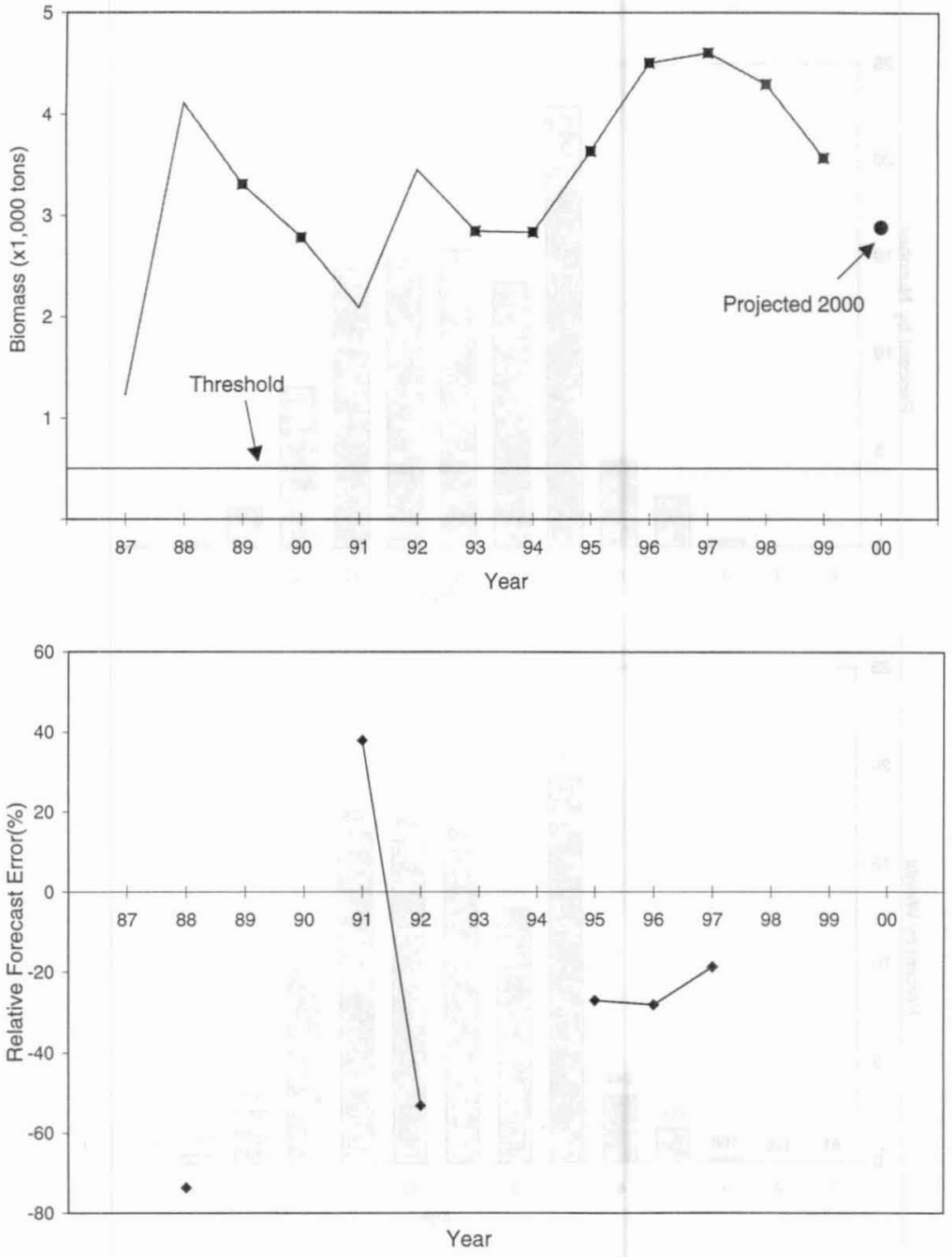

Figure 14. Cape Avinof District herring biomass, 1981-1999, with 2000 projected biomass (top) and the relative forecast error (bottom). Squares in the top graph and gaps in the bottom graph denote years when it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection or some other method was used to estimate biomass.

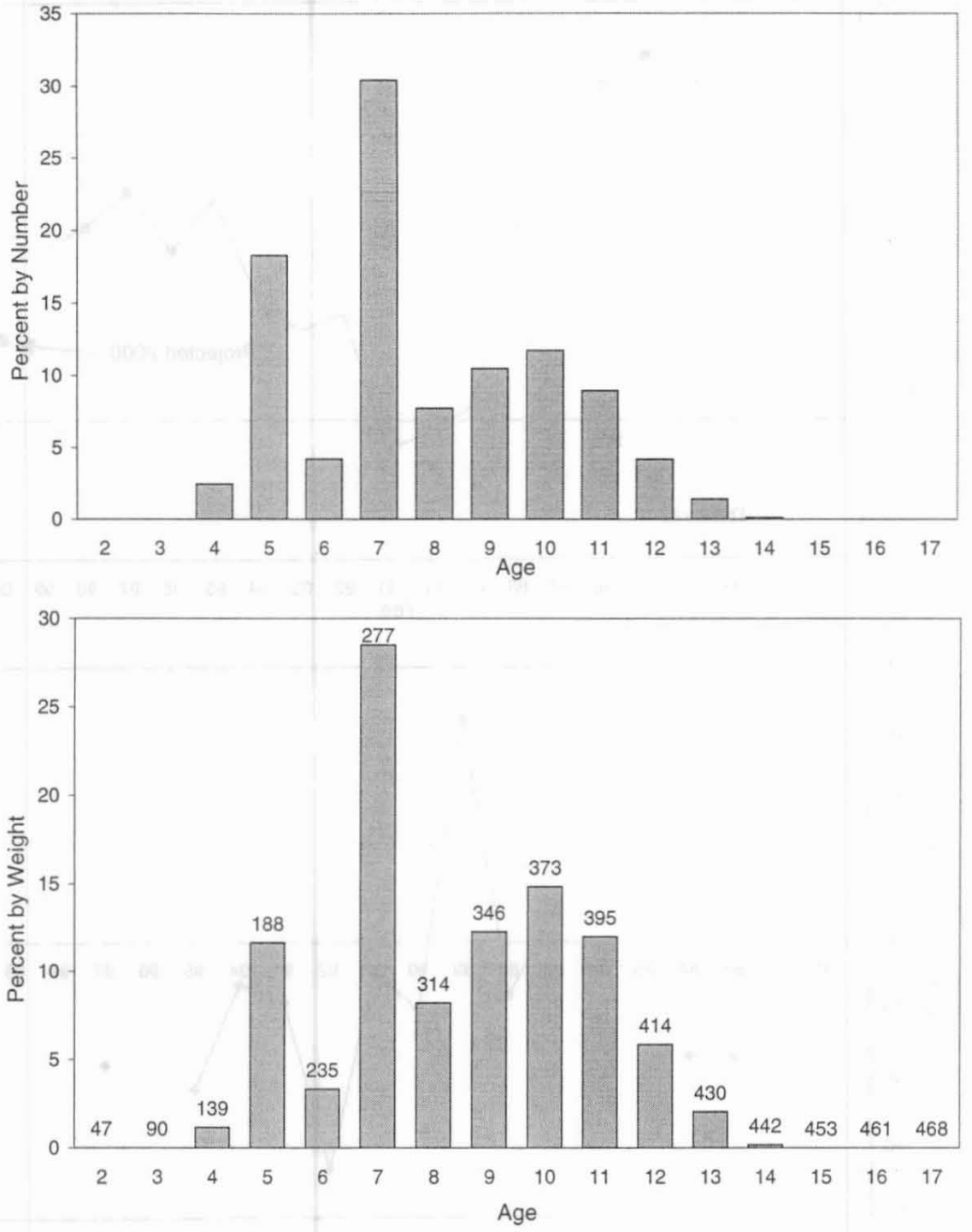

Figure 15. Projected age composition for 2000 Cape Avinof District herring, in percent by number (top) and percent by weight (bottom), with projected weight at age in grams.

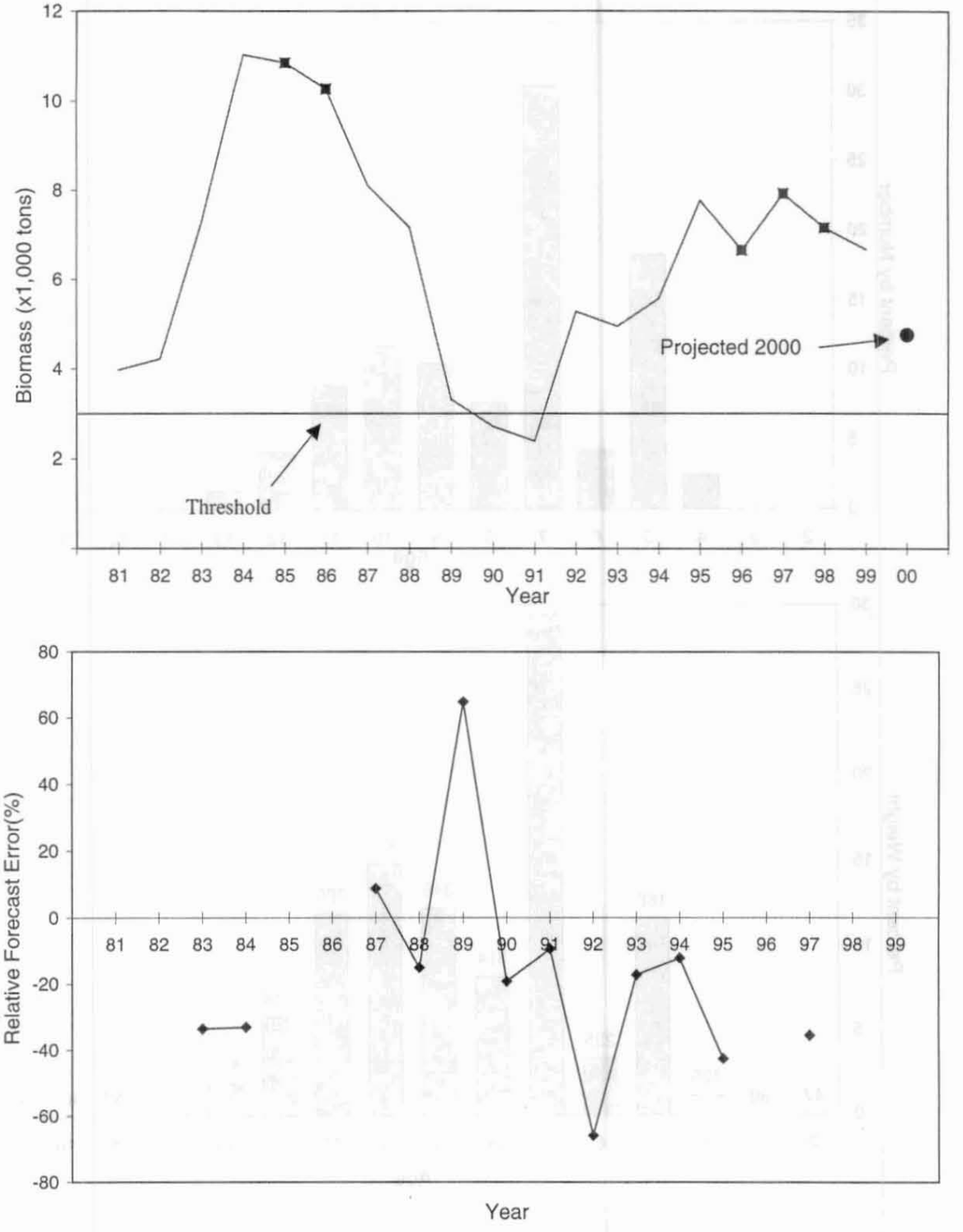

Figure 16. Nelson Island District herring biomass, 1981-1999, with 2000 projected biomass (top) and the relative forecast error (bottom). Squares in the top graph and gaps in the bottom graph denote years when it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection or some other method was used to estimate biomass.

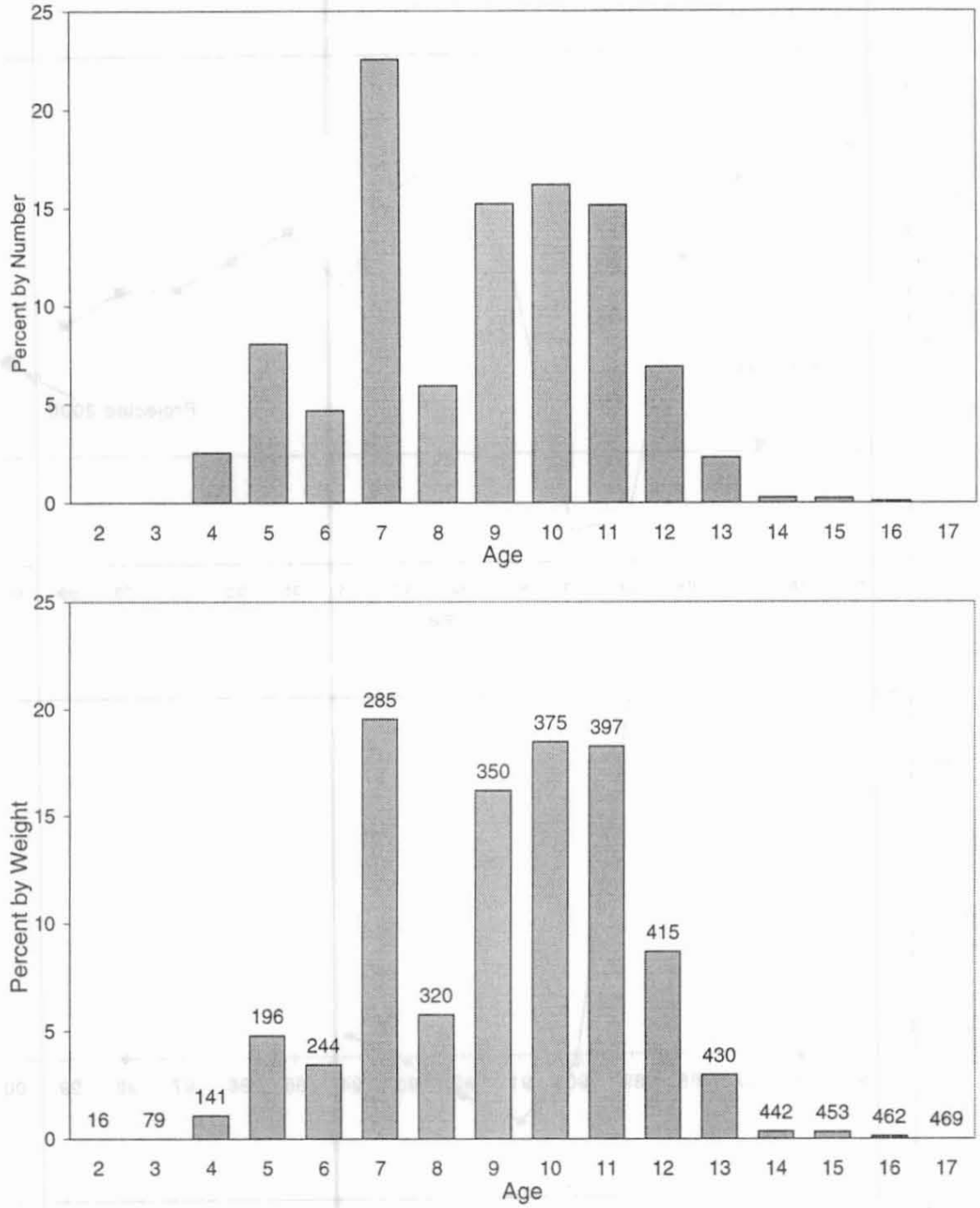

Figure 17. Projected age composition for 2000 Nelson Island District herring, in percent by number (top) and percent by weight (bottom), with projected weight at age in grams.

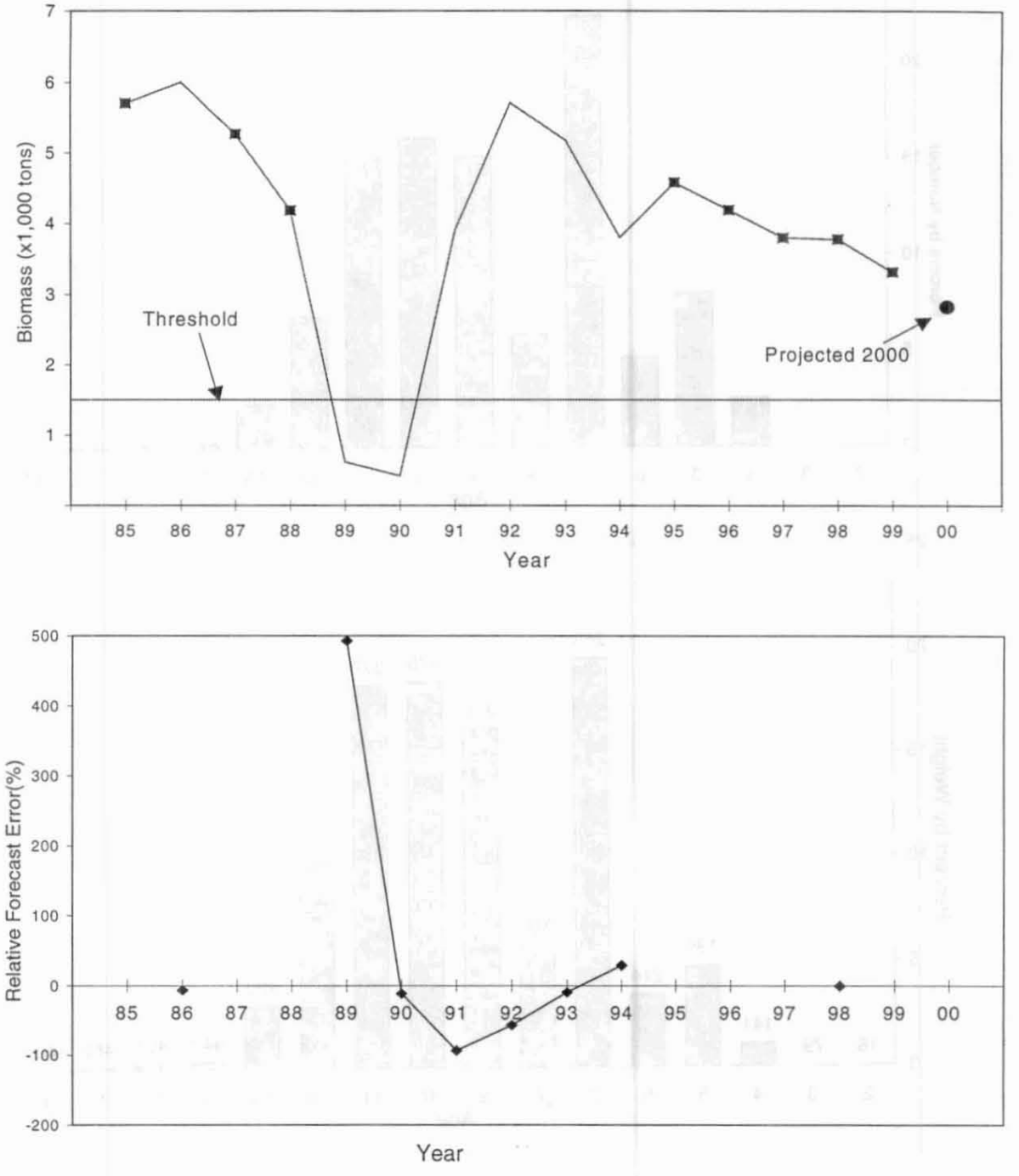

Figure 18. Nunivak Island District herring biomass, 1981-1999, with 2000 projected biomass (top) and the relative forecast error (bottom). Squares in the top graph and gaps in the bottom graph denote years when it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection or some other method was used to estimate biomass.

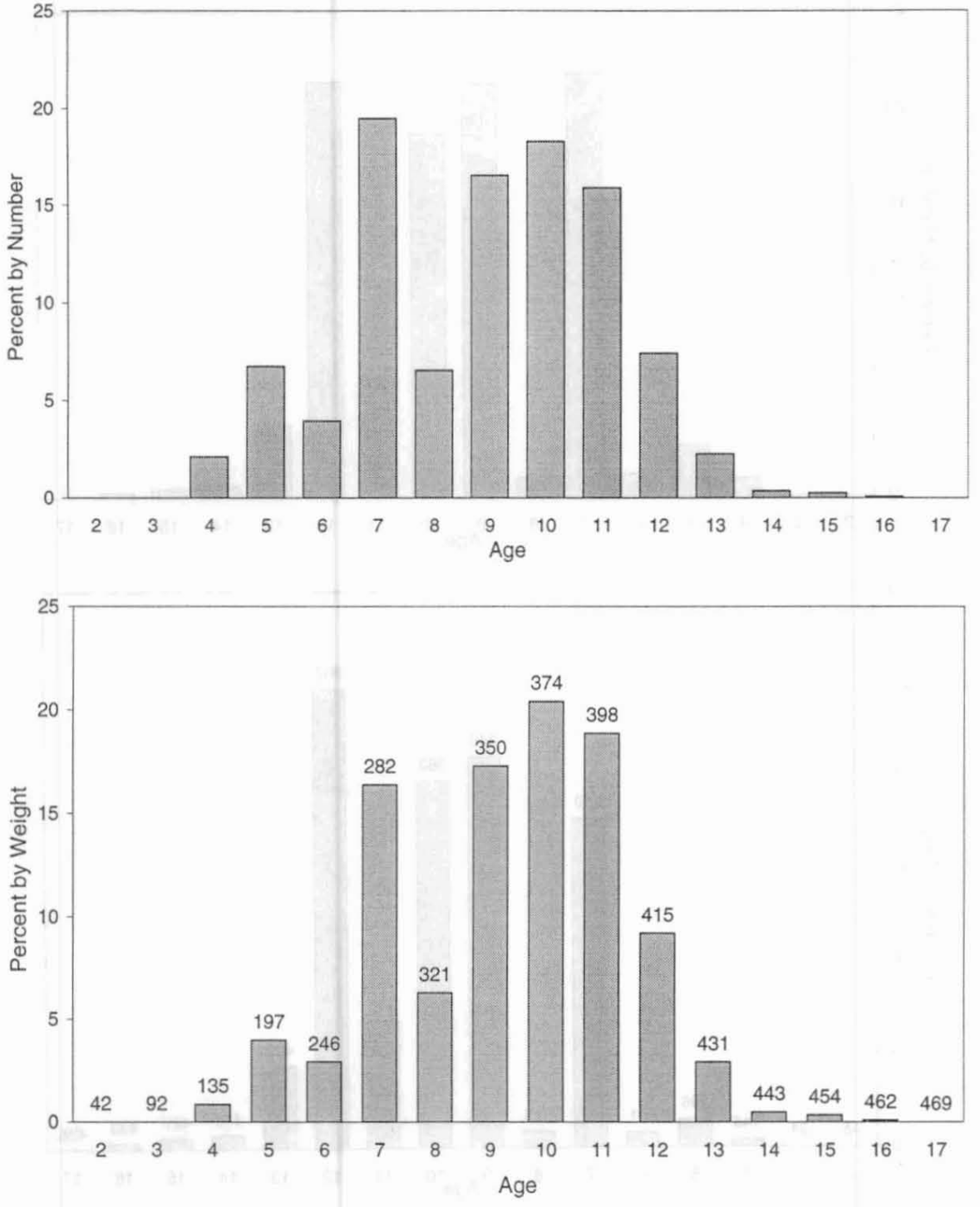

Figure 19. Projected age composition for 2000 Nunivak Island District herring, in percent by number (top) and percent by weight (bottom), with projected weight at age in grams.

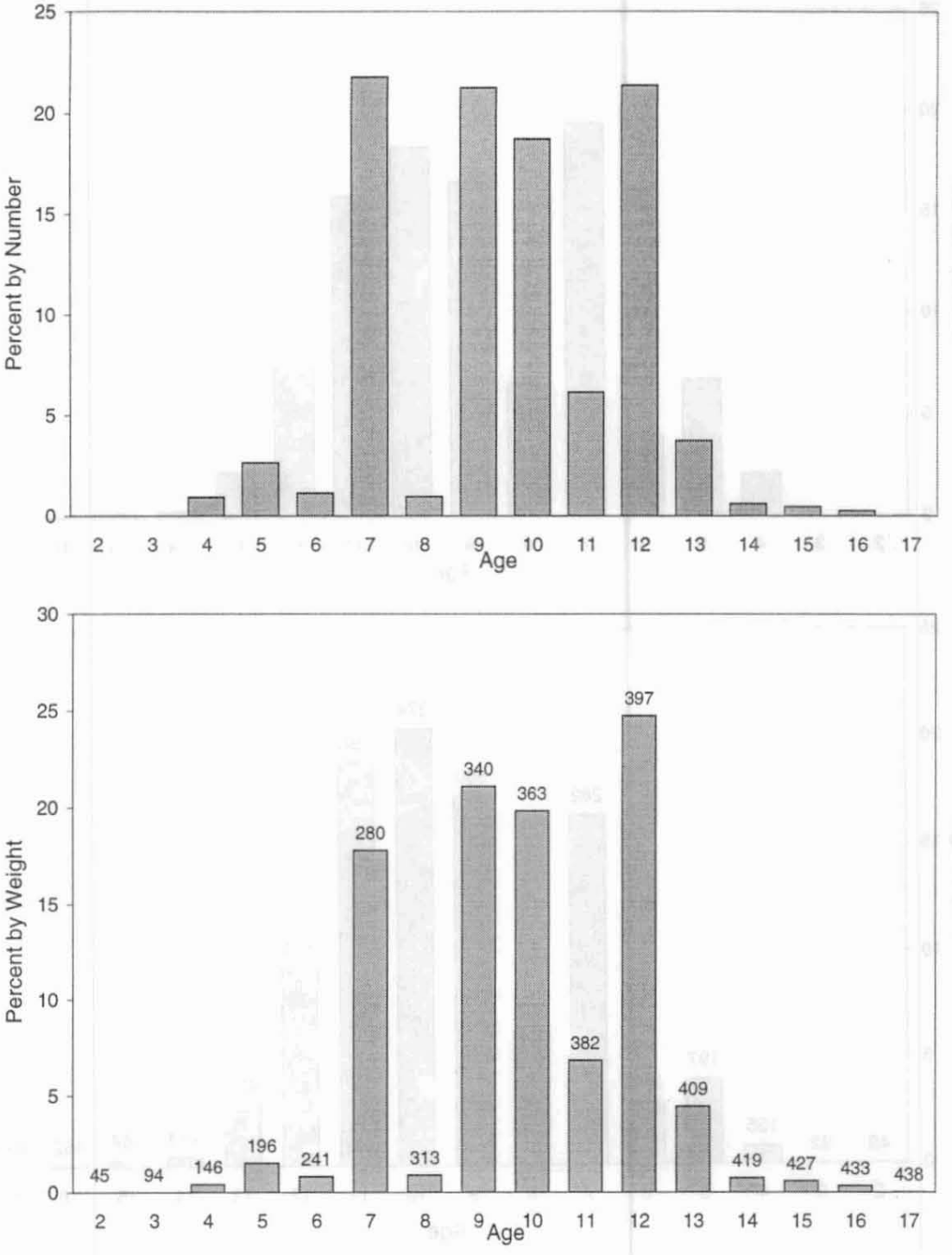

Figure 20. Projected age composition for 2000 Cape Romanzof District herring, in percent by number (top) and percent by weight (bottom), with projected weight at age in grams.

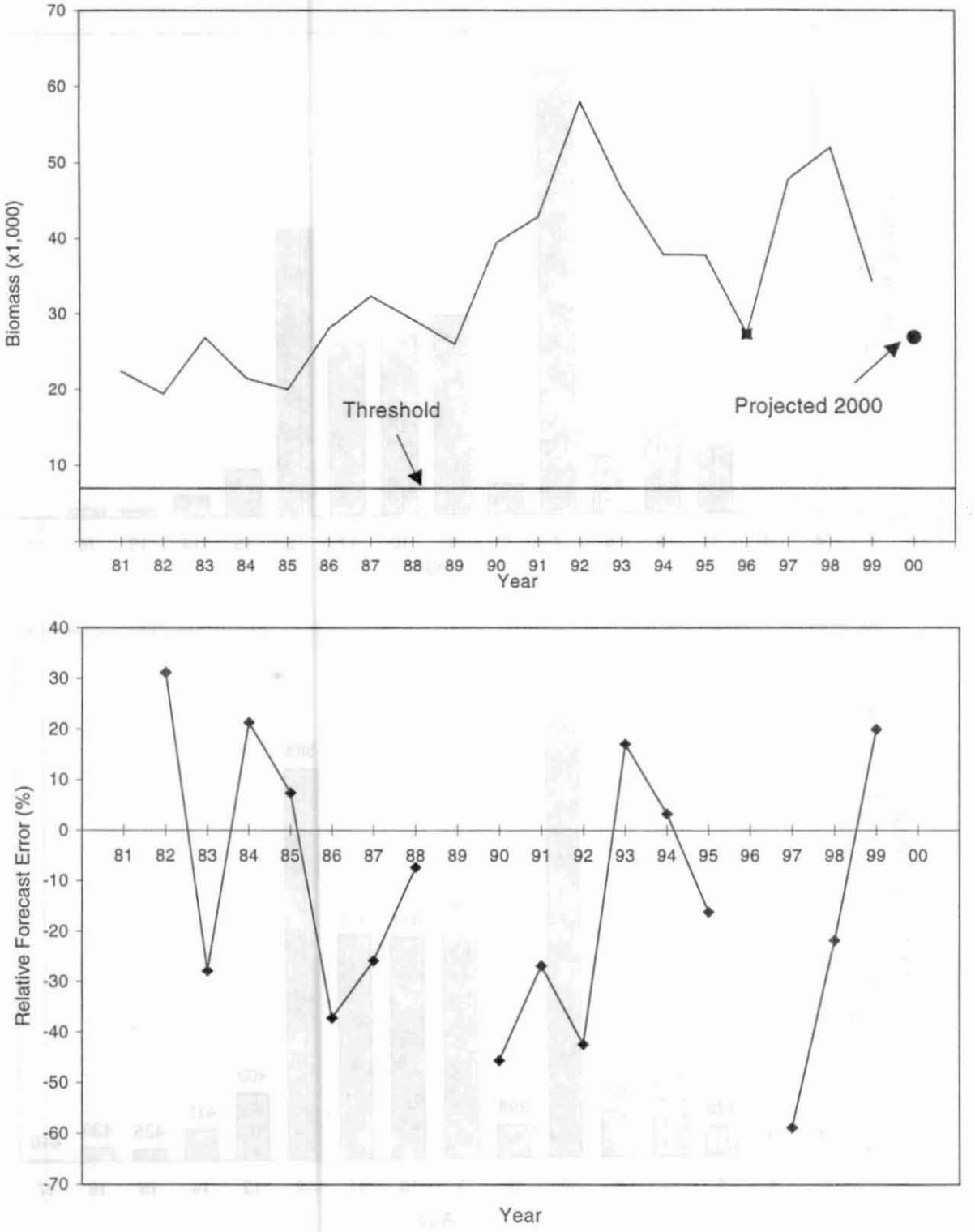

Figure 21. Norton Sound District herring biomass, 1981-1999, with 2000 projected biomass (top) and the relative forecast error (bottom). Squares in the top graph and gaps in the bottom graph denote years when it was not possible to obtain an aerial survey estimate of biomass; therefore the preseason projection or some other method was used to estimate biomass.

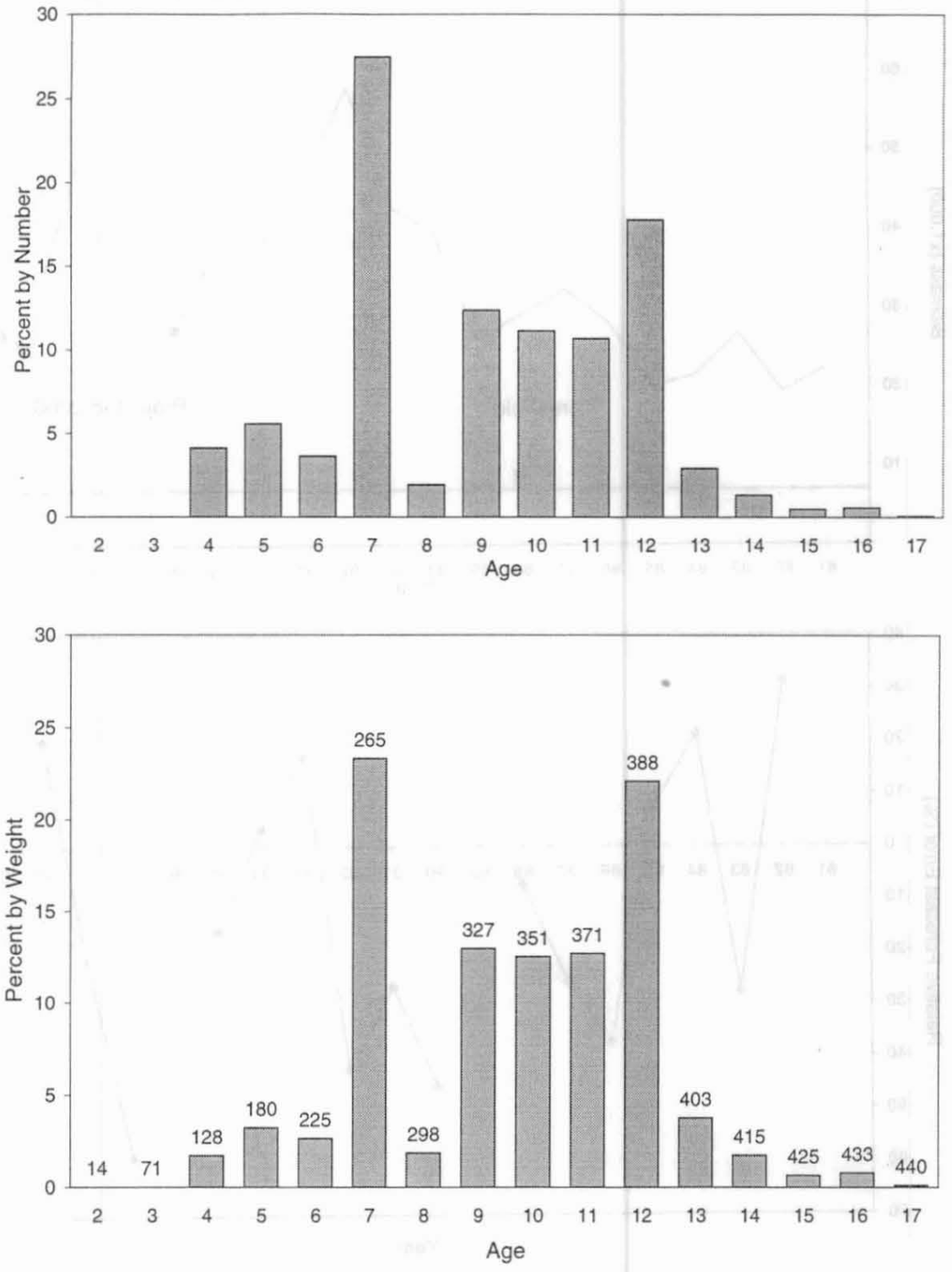

Figure 22. Projected age composition for 2000 Norton Sound District herring, in percent by number (top) and percent by weight (bottom), with projected weight at age in grams.