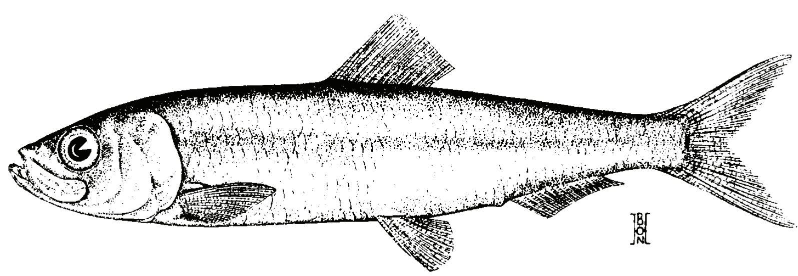
STATE OF WASHINGTON **November 2009**

2008 Washington State Herring Stock Status Report



by Kurt C. Stick and Adam Lindquist

Washington Department of
FISH AND WILDLIFE
Fish Program
Fish Management Division

FPA 09-05

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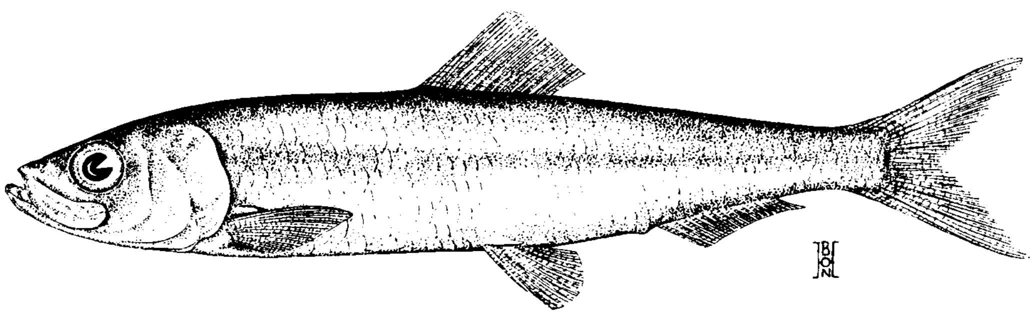

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Abstract

This is the fourth edition of the Washington Department of Fish and Wildlife herring stock status report. Similar to previous editions, this document uses localized documented herring spawning grounds in Washington waters to represent discrete stocks. Several genetic studies published since 2001 have demonstrated that some Puget Sound herring stocks (e.g. Cherry Point and Squaxin Pass) are genetically distinct from other Puget Sound and British Columbia herring. However, differentiation has not been demonstrated between other sampled Puget Sound spawning aggregations, suggesting that sufficient gene flow between stocks may occur that reduces genetic divergence. The results of these studies indicate that it may be more meaningful to examine abundance trends of Puget Sound herring on a larger scale than the individual stock level presented in this report and point out the importance of annual sampling of all known spawning populations in Puget Sound.

The cumulative abundance of south and central Puget Sound herring stocks in recent years is comparable to that observed in the 1970's and 1980's, while the Cherry Point stock, and cumulative north Puget Sound (excluding the Cherry Point stock) and Strait of Juan de Fuca regional spawning biomasses are at low levels of abundance. Stock status classifications reported since 1994 have also followed similar trends, with the south/central region stocks generally considered healthy or moderately healthy and the other regions considered less healthy. For the 2007-08 period, less than half (47%) of Puget Sound herring stocks are classified as healthy or moderately healthy. This is the lowest percentage of individual stocks meeting these criteria since development of the stock status summary in 1994, although very similar to the status breakdown for the previous two-year periods (2003-04 and 2005-06).

Introduction

The purpose of this report is to provide an evaluation of the current status of Pacific herring (*Clupea pallasii)* resource in Washington. This report is the fourth edition published by the Washington Department of Fish and Wildlife (WDFW) that addresses the status of the herring resource in Washington waters. The previous editions are *1994 Washington State Baitfish Stock Status Report* (WDFW 1995), *1996 Forage Fish Stock Status Report* (Lemberg et al. 1997), and *2004 Washington State Herring Stock Status Report* (Stick 2005).

Forage fishes in general, and herring specifically, are vital components of the marine ecosystem and are a valuable indicator of the overall health of the marine environment. Many species of sea birds, marine mammals, and finfish, including lingcod (*Ophiodon elongatus*), chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon, depend on herring as an important prey item (DFO 2001, Fresh et al. 1981). Significant predation occurs at each stage of the herring life cycle starting with predation on deposited spawn by invertebrates, gulls and diving ducks.

Similar to previous editions, this document uses localized documented herring spawning grounds in Washington waters to represent discrete stocks. Evidence of stock structure may be shown through differences in demographic population statistics (age composition, growth rate, fecundity, etc.), morphology (morphometrics and meristics), or genetics (differentiation at allozyme or DNA loci) (O'Toole et al. 2000, Stout et al. 2001). Status reviews of Puget Sound[1] Pacific herring status conducted by the National Marine Fisheries Service concluded that local populations are the appropriate scale for fisheries management activities for Puget Sound herring (Stout et al. 2001) and that subpopulation structure is essential for the preservation of spawning potential and genetic and life history diversity (Gustafson et al. 2006).

A summary of Puget Sound herring life history information is presented to provide background for the following section discussing herring stock structure/identification. Several genetic studies published since 2001 have demonstrated that some Puget Sound herring stocks (e.g. Cherry Point and Squaxin Pass) are genetically distinct from other Puget Sound and British Columbia samples (Beacham et al. 2001, 2002, 2008, Small et al. 2005, Mitchell 2006). However, differentiation has not been demonstrated between other sampled Puget Sound herring stocks.

The stock assessment methodologies and criteria for evaluating the status of herring stocks in this report are generally similar to previous editions. The current sampling design for Washington herring calls for annual assessment of each stock in Puget Sound in order to provide an estimate of spawning biomass. Stock profiles, which include spawning location and timing information, annual run size estimates, and age and survival data are presented for each known Washington herring stock. The definitions for stock profile criteria follow this section.

[1] For the purposes of this report "Puget Sound" is considered to include all Washington state waters east of Port Angeles in the Strait of Juan de Fuca, including the San Juan Islands and the U.S. portion of the Strait of Georgia.

Following the Puget Sound stock status profiles, stock status summaries for 1994, 1996, 1998, 2000, 2002, 2004, 2006, and 2008 are provided and are followed by a discussion and graph of cumulative herring spawner biomass estimates for the 1975-2008 period.

In general, the abundance of south and central Puget Sound herring stocks in recent years is comparable to the 1970's and 1980's, while the Cherry Point stock, and cumulative north Puget Sound (excluding the Cherry Point stock) and Strait of Juan de Fuca regional spawning biomasses are at low levels of abundance. Stock status classifications reported since 1994 have also followed similar trends, with south/central stocks generally considered healthy or moderately healthy and the other regions considered less healthy.

An updated summary of Puget Sound herring fisheries and landings through 2007 is provided in the next section. Herring were included in the 1974 "Boldt Decision" defining Native American fishing rights, and therefore Washington stocks and fisheries are jointly co-managed statewide by WDFW and locally by area Tribal governments. Currently, the only active commercial herring fishery in Washington waters is the bait fishery which provides product primarily for recreational salmon fisheries.

A section discussing annual natural mortality for adult herring within Puget Sound is presented. Herring typically mature during the second or third year and recruit to the spawning population at that time. Although herring have been reported to live as long as fifteen years, currently relatively few appear to be surviving longer than age 5 or 6 in Puget Sound. Stock assessment results continue to indicate a high level of natural mortality for Puget Sound herring compared to the 1970s.

The final section gives a synopsis of available information for coastal herring. Stock profiles for Willapa Bay and Grays Harbor (spawning activity first documented in 1998) are included.

An appendix containing herring age composition summaries through 2008 is included. Estimated spawning biomass (tons) and number of fish at age are reported. These estimates are calculated from herring biological data resulting from acoustic/trawl surveys.

Pacific Herring Life History

Herring spawn for the first time at age two or three throughout Puget Sound at specific grounds between early January and mid-June, depending on the stock. Eggs are deposited mainly on marine vegetation in the intertidal and shallow subtidal zone. Spawning may occur during the day or at night (Hay 1986, WDFW unpub. data). Eggs hatch in approximately ten to fourteen days, depending on water temperature. Larval herring are about 7.5 mm (0.25 inch) in length upon hatching with limited ability to swim and are dispersed by tidal currents. However, herring larvae hatched in enclosed waters are dispersed at a relatively slow rate and can be found in the general spawning area up to eight weeks after spawning (Millikan and Penttila 1974, Trumble 1983). After the first week of drift, the larvae exhaust their yolk sac nutritional reserves and must be in the presence of microplankton of appropriate type and density to begin feeding successfully on their own (Penttila 2007).

Approximately twelve weeks after hatching the larval herring reach a length of about 30 mm (1.2 inches) and are recognizable as juvenile herring. Young-of-the-year (YOY) herring are one of the most abundant pelagic fishes found in nearshore waters of Puget Sound, particularly in the summer (Trumble 1983). Summer surface tow net surveys conducted in central and south Puget Sound indicated that YOY herring are concentrated along shorelines in June, but become widely dispersed through the summer (Gonyea et al. 1982, 1983).

Trumble (1983) stated that many juvenile herring overwinter in central and southern Puget Sound and migrate to Pacific Ocean feeding grounds from March to July, not returning to their spawning grounds until their first year of maturity. Two types of herring have long been recognized in the Canadian Strait of Georgia, based on their migratory habits: large "migratory" populations that migrate to offshore feeding grounds and minor local populations that are often found near the head of inlets or as "resident" populations in inshore areas year-round (Taylor 1964). The most typical situation there is for herring to migrate from offshore feeding grounds to nearshore holding areas one to several months before spawning, followed by a final movement to their spawning location a few days to a few weeks prior to spawning (Haegele and Schweigert 1985); similar to behavior attributed to a number of Puget Sound stocks (Trumble 1983). Following spawning, spent herring typically immediately leave the vicinity of their spawning grounds (Haegele and Schweigert 1985, Penttila 2007).

Significant natal homing, similar to salmon, has been attributed to Puget Sound herring and is based primarily on observed consistency of spawning timing and location (Bargmann 1998). However, unlike salmon, all herring do not typically die after their first spawning, and individual fish may spawn for several more years.

Greater length-at-age (i.e. faster growth rate) suggests that a herring stock is migratory, due to assumed greater productivity of ocean feeding grounds. Differences in growth rate has repeatedly been stated as evidence to support the classification of the Squaxin Pass (Case Inlet) herring population as resident (smaller size at age) and the Cherry Point stock as migratory (larger size at age) (Trumble 1983, Gonyea and Trumble 1983, Day 1987, Lassuy 1989). Chapman et al. (1941) also reported a tendency for an increase in growth rate for herring stocks in northern Puget Sound compared to the southern end of Puget Sound.

Tagging of adult herring on their spawning grounds in the 1950's from the Port Orchard-Port Madison, Quilcene Bay, and Holmes Harbor stocks is summarized in Gustafson et al. (2006) and documents significant migration of at least some of each stock to offshore feeding grounds. For each tagged stock at least one recovery was made on Swiftsure Bank (off southwest tip of Vancouver Island) or the west coast of Vancouver Island in the summer, in addition to tag returns at or near their tagging site. There were also tag returns for each tagged stock from the former reduction fishery in the southeast Vancouver Island region that occurred mostly from October to January.

History of Puget Sound Herring Stock Identification

The importance of the stock structure throughout the range of Pacific herring has been recognized since the start of management efforts. The recognition of individual stocks within the Puget Sound herring resource has been proposed for many years. Temporal and spatial specificity of observed spawn deposition and differences in biological data were the first characteristics used to support the independence of each spawning aggregation as a discrete stock.

Based largely on the fact that herring tend to return to spawn at about the same locations at about the same time year after year, Chapman et al. (1941) concluded their thesis that each spawning population is independent from any other received strong corroboration. Chapman et al. also suggested that the independence of spawning populations was demonstrated and that there was little, if any, intermixing between different spawning populations in Washington. This study formed the basis for considering each spawning aggregation to represent a discrete stock and this definition has continued to the present. Cleaver and Franett (1946) stated that it had been demonstrated that the stocks of herring in Washington are independent of each other based mainly on the consistency of spawning location and timing. However, their conclusions appear to be based entirely on the previous Chapman et al. (1941) study. Williams (1959) reported that the Chapman et al. study demonstrated that the stocks of herring in Puget Sound were somewhat independent of each other and that localized stocks that may be depleted receive very little recruitment from other stocks.

Based on differences in spawn timing and location, growth rates, patterns of annulus formation, and incidence of internal parasites, Trumble (1983) determined that several major discrete spawning herring populations existed in Puget Sound, and that several smaller stocks may also exist. Cherry Point (Strait of Georgia) and Case Inlet (Squaxin Pass) herring exhibited the most distinct characteristics that separated them from herring in other areas of Puget Sound. Trumble (1983) further stated that "spawning populations appear to maintain independence from other populations, and interbreeding between populations seems limited…".

Early genetic work, based on allozyme variation (Grant and Utter 1984), did not support the existence of discrete populations within Puget Sound herring. This study, which included samples from south Puget Sound (Hale Passage) and the Strait of Georgia (Cherry Point stock) observed genetic differentiation only over relatively large geographic areas, such as between Asian and eastern Pacific regions, and perhaps between Gulf of Alaska and California herring samples. Later studies, using mitochondrial DNA variation (Schweigert and Withler 1990) and ribosomal DNA sequence variation (Domanico et al. 1996), also did not provide any evidence of local genetic differentiation of eastern Pacific herring.

The analysis of microsatellite DNA loci appears to be a milestone in the detection of genetic variation among populations in more local areas of the eastern Pacific Ocean, such as Puget Sound and Canadian Strait of Georgia. Analyses completed by O'Connell et al. (1998) of Alaska herring were the first to suggest that microsatellite DNA loci detected genetic differentiation than with previous techniques used.

The initial documentation of significant genetic differentiation for Washington state herring was reported by Beacham et al. (2001, 2002), who found that herring spawning at Cherry Point were distinct from sampled Canadian Strait of Georgia herring. However, these studies also found little genetic variation among British Columbia (B.C.) herring stocks. This finding was considered consistent with estimated straying rates from tagging studies among stocks that are sufficient to homogenize allele frequencies over large geographic areas.

Tagging studies of B.C. herring have indicated a high fidelity (repeat homing to a spawning location) rate of 75-96% of tagged fish at-large for one year, which also indicates a sizable straying rate of 4-25% (Ware et al. 2000). It should be noted that this is not a measure of natal homing. Gustafson et al. (2006) concluded that the high fidelity rate provides the biological basis for existing B.C. herring stock management because most of the adult herring return to the same region to spawn the following year and that the observed straying rates reduce genetic divergence among the five major populations. In his analysis of the same tagging data, Hay (2001) suggests a minimum area size of about 500 km^2 to support high fidelity. Ware et al. (2000) also concluded that their analysis suggests that the straying rate is density-dependent; it appears to increase linearly as the population increases.

The dramatic one-year increase in spawning biomass observed for the Discovery Bay herring stock in 2006 may be an example of significant straying of adults to different spawning grounds. The estimated spawning biomass for this stock in 2006 was 1,325 tons. The presumed 2 to 5 year old adults that would have comprised most of the 2006 spawning biomass were spawned in years that had a mean spawning biomass of only 186 tons and spawning biomass for the two years following 2006 was less than 250 tons.

Small et al. (2005) examined temporal and spatial genetic variation for herring, including samples of prespawning adult herring from Cherry Point, Semiahmoo Bay, Fidalgo Bay, Port Gamble, and Squaxin Pass collected over intervals of two to four years. They demonstrated consistent genetic differentiation between the Cherry Point, Squaxin Pass, and the other three Washington samples and considered the degree of genetic differentiation for these two stocks (Cherry Point and Squaxin Pass) to be “remarkable” given the small spatial scale involved. Late spawn timing (Cherry Point) and geographic isolation (Squaxin Pass) were suggested as the primary causes for the observed levels of genetic distinctiveness.

The genetic differentiation of the Cherry Point herring stock was further demonstrated by Mitchell (2006). Microsatellite DNA loci were examined for samples from Cherry Point, Semiahmoo Bay, Port Gamble, Quartermaster Harbor, and Squaxin Pass herring with an increased temporal scale of six years. Genetic differentiation was consistent over six years for the Cherry Point stock (samples from 1999, 2004, and 2005), but the genetic differentiation of Squaxin Pass (Case Inlet) fish from 1999 was not observed in 2005 samples. However, 2007 samples again demonstrated differentiation (Mitchell et al. (in prep)). There was a lack of genetic differentiation among the other area samples in this study.

Interestingly, in 2008, significant spawning activity (approximately 500 tons of spawners) was documented for the first time in an area not previously known to support spawning activity in south Puget Sound at the north end of Carr Inlet (Purdy/Henderson Bay). This location is relatively far (approx. 10 miles) from the closest previously documented spawning grounds in Wollochet Bay. Spawning was in mid-March, which is considerably later than Wollochet Bay spawning but within the documented spawn timing for the Squaxin Pass stock. Spawning activity here was obvious with significant numbers of seabirds and harbor seals indicating the location of spawn deposition, making it likely that this location had not previously hosted annual spawn deposition. If that is the case, occurrences such as this do not support the concept of stock discreteness based primarily on spawning location and timing. Sampling effort will be made in 2009 to document continued spawning activity in this area and to collect age composition and genetic samples via acoustic/trawl assessment.

The most recent study involving samples from Washington herring again produced results showing genetic differentiation of Cherry Point herring (Beacham et al. 2008). Significant differentiation was observed between the Cherry Point stock and samples from the Kilisut Harbor (Port Townsend) and Skagit Bay prespawning fish in 2004, but no significant difference observed between the Port Townsend and Skagit Bay samples. On average, the Washington herring were also distinct from those in other regions, particularly those in British Columbia. Similar to previous studies, the authors suggested that unique spawning timing has led to the observed genetic differentiation of the Cherry Point stock. Also noteworthy from this work based on summer mixed-stock samples is the indication that “resident” herring from the west side of the Strait of Georgia are primarily derived from primary-timed spawning (i.e. “migratory”) populations that did not migrate to offshore summer feeding grounds. Conversely, samples of “resident” herring from the east side of the strait had higher proportions of mainland inlet origin (“resident”) fish.

It is most likely that Puget Sound herring consist of a combination of “migratory” and “resident” fish. It is also probable that many of the stocks in Puget Sound consist of migratory and resident individuals, as suggested by Penttila (1986). The review of genetic studies to date involving Puget Sound herring provides solid evidence of the genetic distinctness of the Cherry Point stock. It also appears that the Squaxin Pass (Case Inlet) stock may also be genetically differentiated from other herring populations, although the results from 2005 samples (Mitchell 2006) presumed to be from the same prespawning aggregation as other years is troublesome.

The observed lack of differentiation among other genetically sampled herring stocks from Puget Sound (Quartermaster Harbor, Port Gamble, Kilisut Harbor, Skagit Bay, Fidalgo Bay, and Semiahmoo Bay) suggests sufficient gene flow between populations, particularly those with similar spawn timing, that would reduce genetic divergence. With the exception of Cherry Point and possibly Squaxin Pass herring, Puget Sound herring stocks may be part of a metapopulation similar to the model assumed for B.C. herring. The development of new methods to detect genetic differentiation presented above also points out the possibility that future technologies may demonstrate that further population discreteness for Puget Sound herring exists. While it is important to protect all documented herring spawning grounds it may be more meaningful to examine abundance trends on a larger scale than the individual stock level presented in this report.

Potentially relevant to the discussion of stock structure and identification of Puget Sound herring is the fourth of a series of papers by Ware and Tovey (2004) outlining evidence that B.C. herring are spatially structured and interact as a metapopulation. They analyzed spawn time series between 1943 and 2002 for indications of “disappearance” and “recolonization” events at the spatial scale of “sections”, which on average contain about 250 km (150 miles) of shoreline. A disappearance event was assumed to have occurred in a section when five consecutive years of no spawn appeared in the time series. A recolonization event was assumed to have occurred when spawning was documented after a disappearance event. The authors identified 82 spawn disappearance events for the sixty year period examined and found that more than half (55%) of the sections was identified to have experienced one or more disappearance events. They found that sections with larger amounts of spawn habitat experienced fewer disappearance events than smaller sections and stated that the high degree of straying between nearby sections explain why herring spawning aggregations at the section spatial-scale are so dynamic. The authors also mention that their analysis may have overestimated the frequency of disappearance events in sections with very small spawn habitat indices (i.e. smaller spawning biomass) because it was not always known if a section had received survey effort.

If Puget Sound herring stocks, with the demonstrated exceptions of Cherry Point and Squaxin Pass, interact as a metapopulation similar to that attributed to B.C. herring, observed “disappearance” and/or dramatic decreases in abundance (e.g. N.W. San Juan Island, Kilisut Harbor, and Discovery Bay) of individual stocks may not be cause for major concern. Due to uncertainties of stock structure, annual sampling of all known spawning stocks in Puget Sound should continue. Additional collection of genetic samples involving as many spawning aggregations as possible should be pursued.

In general, the results of genetic studies to date also support current management of the commercial herring bait fishery, which operates on a maximum harvest guideline based on regional cumulative spawning biomass estimates.

Stock Profile Parameters

The parameters used to develop each profile are described below. Specific status ratings for each stock take into account all measurable factors available but are weighted toward spawning biomass average and trend, recruitment, and annual survival.

Stock Definition

Herring routinely spawn at specific sites or grounds throughout Washington waters each year. Documented Puget Sound spawning areas through the 2008 spawning season are shown in the map on page 15. For this report, localized spawning grounds are considered to represent a discrete stock. This assumption is based in part on early meristic studies, which concluded that heterogeneity exists among herring samples taken from various spawning areas throughout Puget Sound (Chapman et al. 1941). In addition, WDFW assessment survey results have indicated stock specific characteristics such as different growth characteristics, distinctive spawning location and timing, and prespawner holding area behavior, which have supported the assumption of stock autonomy for Puget Sound herring presented in this report (Trumble 1983 and O'Toole 2000).

However, recent genetic studies have suggested that only the Cherry Point and Squaxin Pass herring stocks are genetically distinct from each other and other Washington and British Columbia stocks (Beacham et al. 2001, 2002, 2008, Small et al. 2005, Mitchell 2006). Genetic distinction between other sampled Puget Sound stocks has not been demonstrated (Small et al. 2005, Mitchell 2006, Beacham et al. 2008).

Stock based assessment data are very useful for localized fisheries management issues and plans. However, if straying rates between Puget Sound herring stocks are comparable to reported British Columbia herring behavior based on tagging results (Ware et al. 2000; Hay et al. 2001), it may be necessary to reconsider what represents a "stock" for Puget Sound herring. Further discussion of this topic is presented later in this document. Recent genetic studies suggest it may be more meaningful to examine herring abundance trends in Puget Sound on a larger scale than the presented stock structure.

Overview

Overview provides any unique information about or characteristics of the stock.

Spawning Ground

The **Spawning Ground** map depicts the cumulative documented spawning ground for each stock. Herring deposit transparent, adhesive eggs primarily on lower intertidal and shallow subtidal eelgrass and marine algae. In Washington most spawning activity takes place between 0 and -10 feet MLLW in tidal elevation.

Prespawner Holding Area

Where known, the **Prespawner Holding Area** depicts the location, usually adjacent to the spawning ground in deeper waters, where ripening adult herring congregate and hold prior to spawning. Schools of prespawning adults typically begin concentrating three to four weeks or more before the first spawning event (Trumble et al. 1982).

Spawning Timing

Spawning Timing for herring in Washington lasts from late January through early June, with each stock generally spawning for approximately a 2-month period. The spawning timing figure for each stock indicates the occurrence of any documented spawning activity within the first or second half of a month. Observed peak spawning is indicated by cross-hatched cells.

Length Data

The **Length Data** such as mean length-at-age and other basic growth data provides additional evidence for stock separation. For example, some faster growing stocks (e.g. Cherry Point) are more likely to have an annual migration from inshore spawning grounds to more productive open ocean feeding areas, while other slower growing stocks (e.g. Squaxin Pass) might be more "resident," remaining inside the Puget Sound basin year round. Mean standard length (mm) at age for age 2, 3, 4, and 5 herring are reported for the 2008 spawning season or the most recent year data were available.

Spawning Biomass

Spawning Biomass is the term used to quantify the tonnage of spawner herring abundance. Two methods are used to provide quantitative estimates of herring abundance; spawn deposition surveys (Stick 1994) and acoustic/trawl surveys (Burton 1991). Prior to 1996, the spawning biomass for the 10-12 larger Puget Sound stocks typically was assessed by both methods each year while the smaller 6-8 stocks were surveyed by spawn deposition surveys on a 3-year rotational basis. Since 1996, duplicate assessment coverage has been reduced and assessment for all known herring stocks is attempted each year by either one or both methods. <u>If both methods are utilized, the spawn deposition estimate is used as the final run size estimate if survey coverage is considered to be adequate.</u> Final spawning biomass estimates also include any directed spawner fishery harvest that may have occurred. The two assessment techniques have generally shown good correspondence (Burton 1991). The years when significant variance occurs are usually associated with sampling related problems such as survey timing, adverse weather, equipment malfunctions, etc.

Spawn Deposition Surveys

Spawn Deposition Surveys provide a direct estimate of herring spawning biomass. Marine vegetation on spawning grounds is sampled for location of spawn deposition and spawn density, and those data are converted to an estimate of spawning escapement (Stick 1994). These surveys are generally conducted weekly during a stock's spawning season to document cumulative spawn deposition.

Acoustic/Trawl Surveys

Acoustic/Trawl Surveys are conducted on the prespawner holding areas early in, or prior to, the spawning season when prespawner abundance is peaking. This method utilizes computer interfaced echosounding equipment that produces real-time estimates of total fish abundance, which are apportioned to herring biomass based on trawl catch data (Lemberg et al. 1990). The weighted data from all trawl samples for each stock are pooled and extrapolated to the final spawning biomass estimate from spawn deposition surveys, if that estimate is used as the final spawning biomass amount. Analyses of the trawl caught samples provide the basis for detailed stock indices such as biomass age composition, annual survival rates, and recruitment (O'Toole 1993).

Recruitment

Recruitment is an estimate of the biomass of new spawners in a particular year. New recruits consist of 2-year old spawners plus the calculated biomass of 3-year old spawners that spawned for the first time.

Annual Survival

The **Annual Survival** rate is the estimated percentage of spawning herring (age 3 and older) in a particular year that survived to spawn again in the following year.

Biomass Age Composition

Biomass Age Composition represent estimated tonnage at age of the current year's spawning run and is estimated from acoustic/trawl data.

Spawner Fishery

Spawner Fishery summarizes adult (spawner) herring harvests. Potential adult herring fisheries in recent years have been limited to the Cherry Point stock (the commercial product is roe). No harvest of this stock has been allowed there since 1996 due to low spawning biomass abundance.

Spawn-on-kelp (SOK) and sac-roe fisheries have been allowed when the Cherry Point stock size is considered appropriate for harvest (minimum of 3,200 tons).

Fish handling practices inherent to the SOK fishery result in predisposition of herring populations to epizootic mortality from viral hemorrhagic septicemia (VHS). These epizootics, characterized by high mortality and massive viral shedding among affected cohorts, frequently occur in herring impoundments used for a closed pound SOK fishery (Hershberger et al. 1999). In addition to creating localized epizootics inside the herring impoundments, shed waterborne virus can emanate from the net pens and represent a significant risk factor for initiating VHS epizootics in unconfined herring over a larger geographic area. SOK fishery management options exist that can decrease the probability of localized VHS epizootics within herring net pens (Hershberger et al. 2001), and should be considered if /when conditions warrant reopening of SOK fisheries.

Data Quality

Data Quality - Determined by the relative amount of stock assessment data.

- **Good** - A continuous time series of acoustic-trawl data and spawn deposition data.
- **Fair** - A continuous time series of spawn deposition data only.
- **Poor** - An incomplete time series of either type of stock assessment data.

Recent Trend

Recent Trend - Slope of the regression for the most recent five years (2004-2008) of spawning biomass estimates.

- **Increasing** - Statistically significant positive slope (95% confidence level).
- **Stable** - Slope not statistically significant.
- **Decreasing** - Statistically significant negative slope (95% confidence level) .

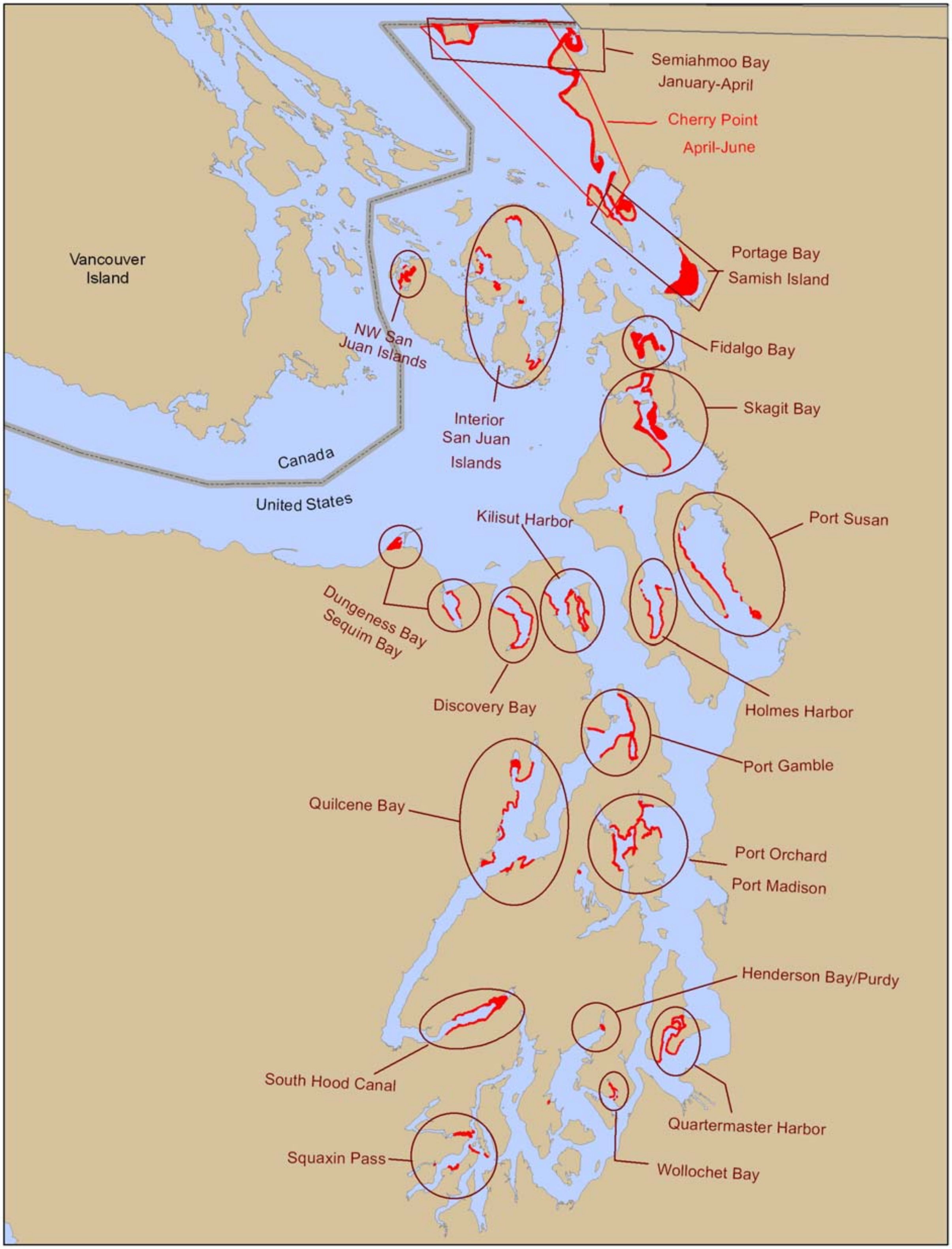
Stock Status

Describes a stock's current condition based primarily on most recent 2 year abundance (spawning biomass) compared to long-term (25 year) mean abundance. Stock criteria such as survival, recruitment, age composition, and spawning ground habitat condition are also considered.

- **Healthy** - A stock with recent 2-year mean abundance above or within 10% of the 25 year mean (1984-2008).
- **Moderately Healthy** - A stock with recent 2-year mean abundance within 30% of the 25 year mean, and/or with high dependence on recruitment.
- **Depressed** - A stock with recent abundance well below the long-term mean, but not so low that permanent damage to the stock is likely (i.e., recruitment failure).

Critical - A stock with recent abundance so low that permanent damage to the stock is likely or has already occurred (i.e., recruitment failure).
Disappearance - A stock that can no longer be found in a formerly consistently utilized spawning ground.
Insufficient Data- Insufficient assessment data to identify stock status with confidence.

Documented Puget Sound Herring Spawning Grounds



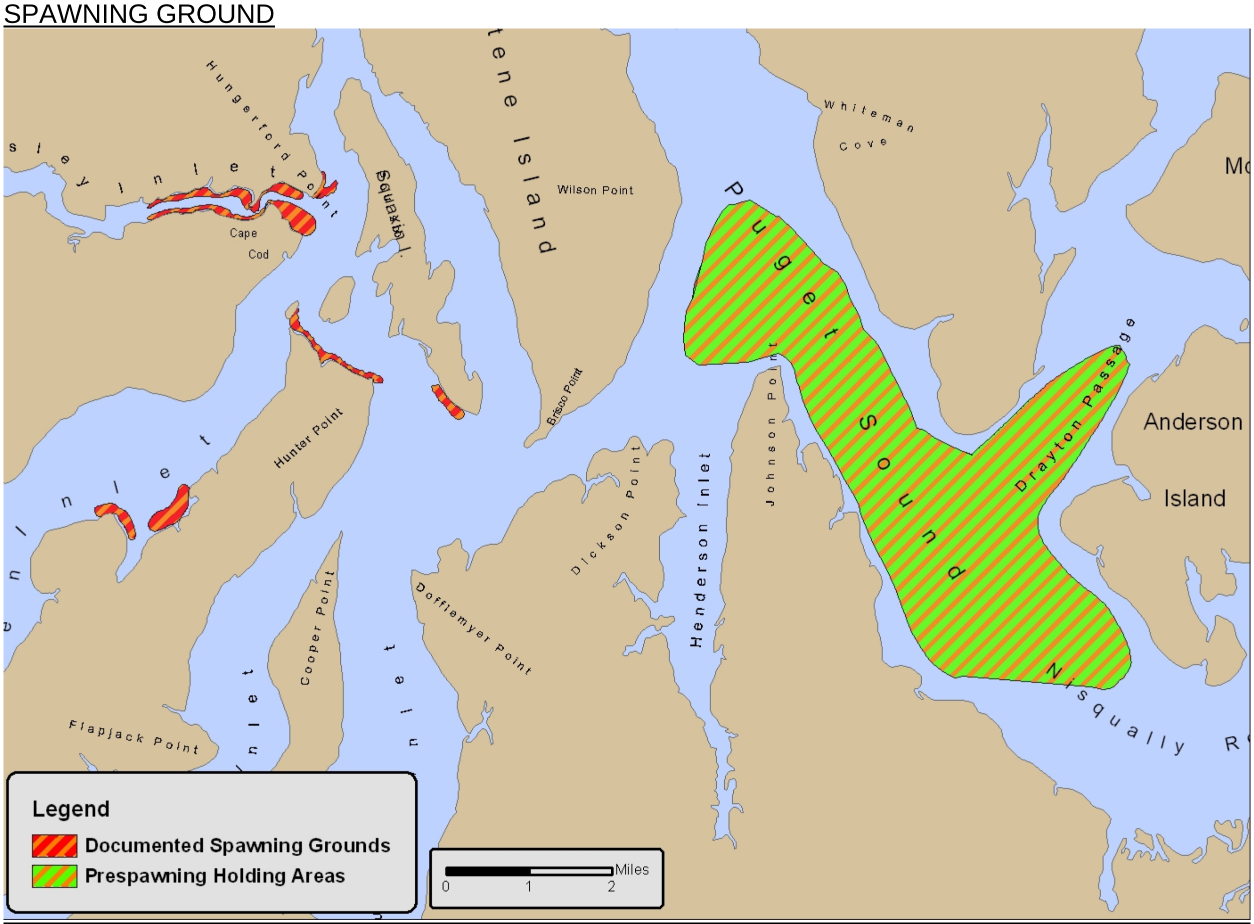
South/Central Puget Sound Herring Stock Profiles

Squaxin Pass Herring Stock

OVERVIEW

The southernmost stock within the Puget Sound basin, Squaxin Pass herring exhibit unusual spawning behavior. Marine algae normally utilized for spawning substrate by herring are sparse in this area and spawn deposition often occurs on rocks and gravel, occasionally quite deep. Such behavior does not lend itself well to assessment from the spawn deposition survey methods, which may explain the large differences between the spawn deposition and acoustic/trawl survey estimates for this stock. The Squaxin Pass herring stock has the slowest known growth rate in Washington. Abundance of this stock has been relatively high in recent years, averaging over 1,100 tons for the last ten years. Genetic study results mentioned previously in this report have demonstrated genetic differentiation of this stock from others in Puget Sound. Geographic isolation is suggested as the primary cause for the observed genetic divergence. Observed spawn deposition in Carr Inlet in 2008 could be attributed to this stock.

SPAWNING GROUND



SPAWNING TIMING

Jan	Feb	March	April	May	June

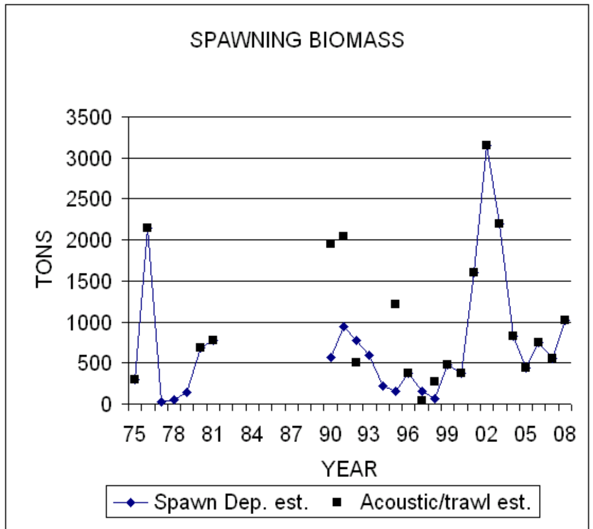
MEAN LENGTH OF 2/3 YEAR OLDS

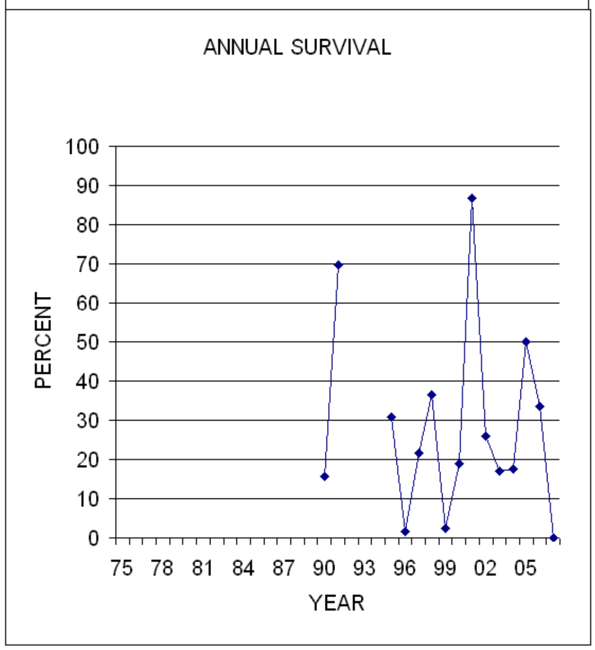
127mm/175mm (2008)

STOCK STATUS PROFILE for Squaxin Pass Herring Stock

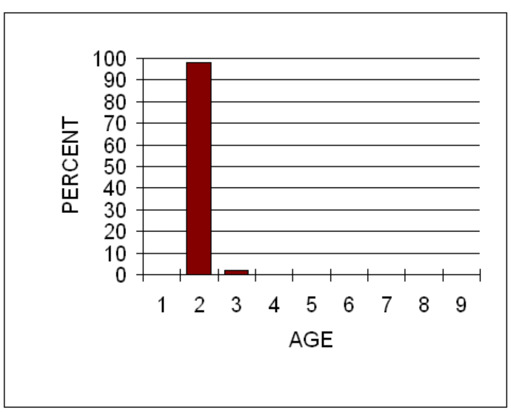
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75		298	298	
76		2138	2138	
77	20		20	
78	58		58	
79	137		137	
80		683	683	
81		772	772	
82				
83				
84				
85				
86				
87				
88				
89				
90	566	1950	566	
91	943	2035	943	839
92	771	507	771	0
93	596		596	
94	225		225	
95	157	1219	157	
96		374	374	315
97	149	35	149	141
98	68	275	68	25
99		474	474	442
2000		371	371	360
2001		1597	1597	1120
2002		3150	3150	1301
2003		2201	2201	1159
2004		828	828	425
2005		436	436	259
2006		755	755	433
2007		557	557	260
2008		1025	1025	1025
MEAN:				
25 year	434	1080	802	
5 year		720	720	





2008 BIOMASS AGE COMPOSITION



STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
stable

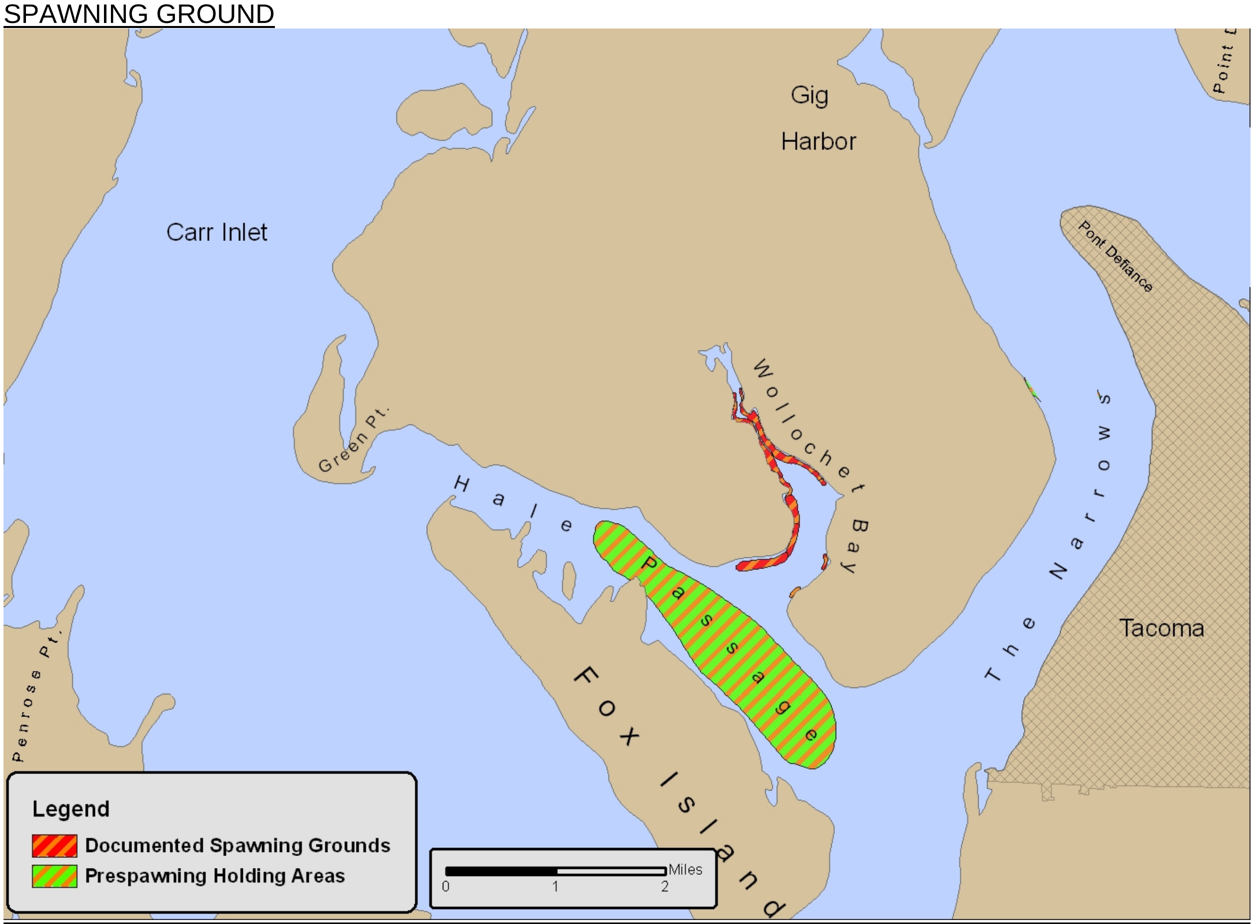
STOCK STATUS (2 year)
healthy: 99% of 25 yr mean spawning biomass

Wollochet Bay Herring Stock

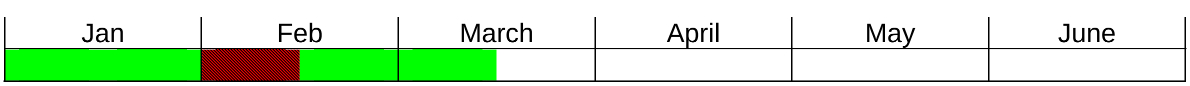
OVERVIEW

The Wollochet Bay stock's spawning grounds were recently documented with spawn first observed during the 2000 season. This confirms reported spawning activity from the late 1930s (Chapman et al. 1941). Stock size appears to be small, with a high of 152 tons estimated in 2003. Prespawning fish attributed to this spawning ground appear to congregate in Hale Passage. Spawn timing is early with a peak in late January to early February. Timing of spawning activity here is earlier than that observed in 2008 in Carr Inlet (Purdy/Henderson Bay), which was in mid to late March, suggesting that these stocks are discrete.

SPAWNING GROUND



SPAWNING TIMING



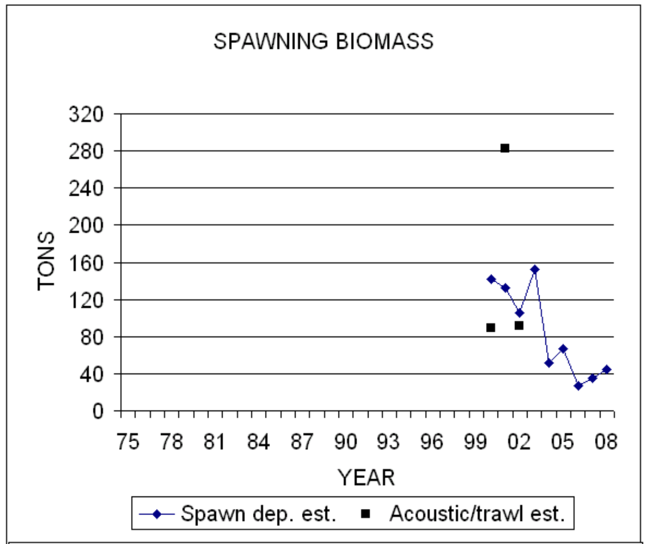
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

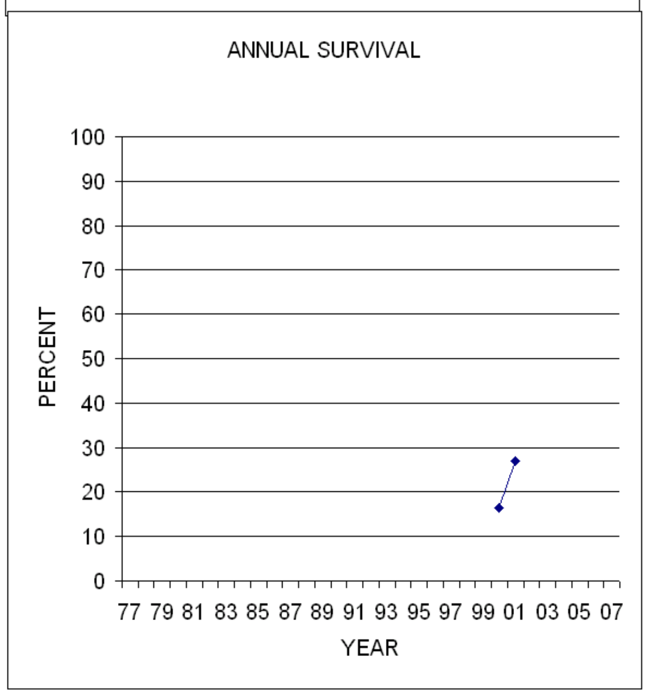
139mm/150mm/181mm/196mm (2002)

STOCK STATUS PROFILE for Wollochet Bay Herring Stock

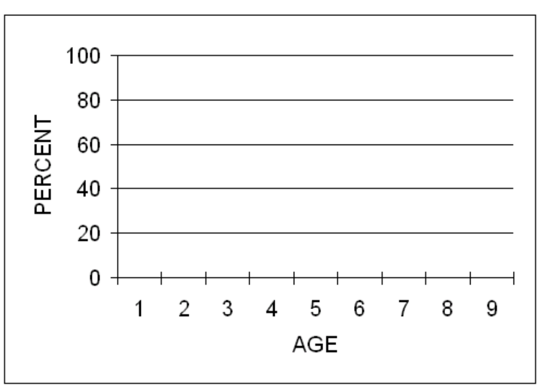
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76				
77				
78				
79				
80				
81				
82				
83				
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				
95				
96				
97				
98				
99				
2000	142	89	142	
2001	133	282	133	101
2002	106	92	106	57
2003	152		152	
2004	52		52	
2005	67		67	
2006	27		27	
2007	35		35	
2008	45		45	
MEAN:				
25 year	84	154	84	
5 year	45		45	





2008 BIOMASS AGE COMPOSITION



STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
poor

RECENT TREND (5 year)
stable

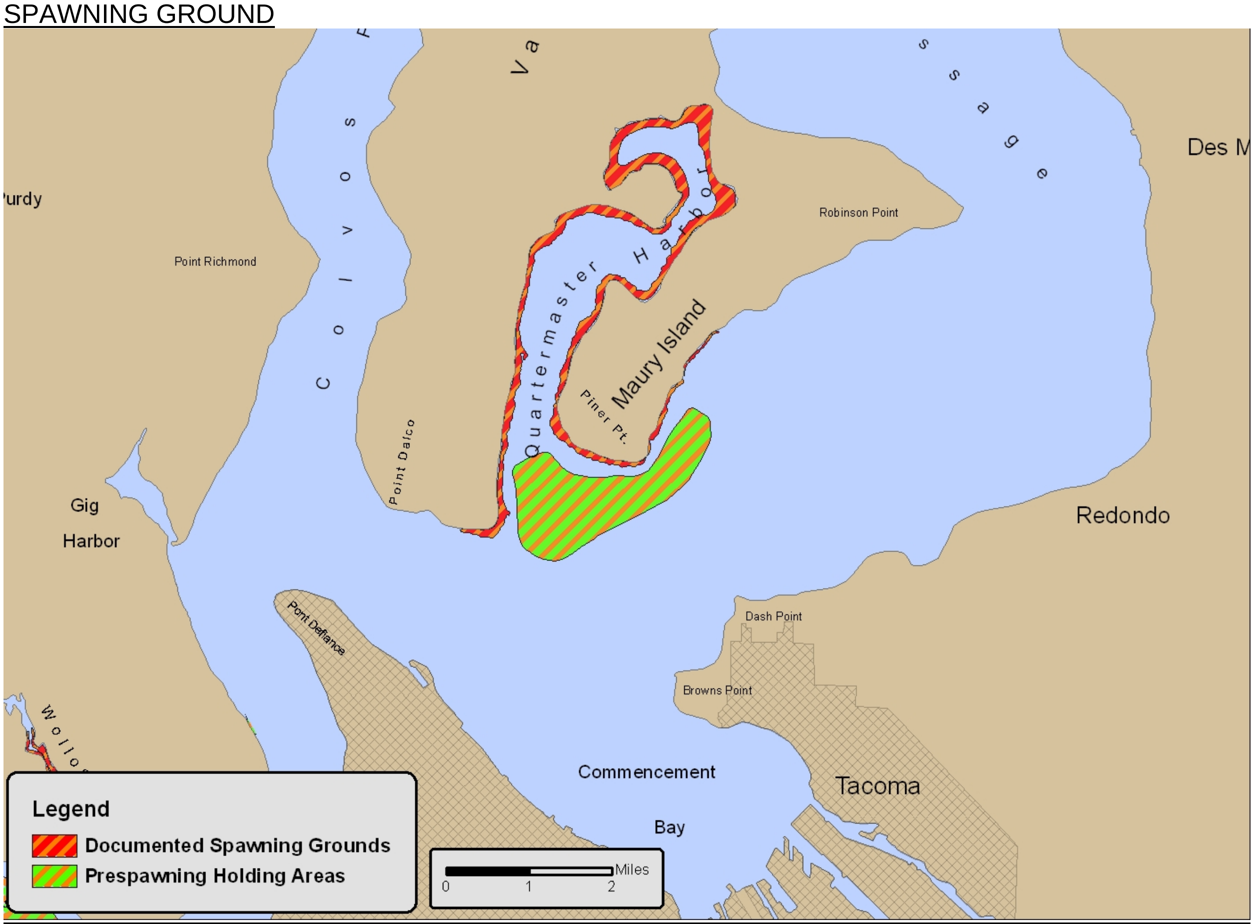
STOCK STATUS (2 year)
insufficient data

Quartermaster Harbor Herring Stock

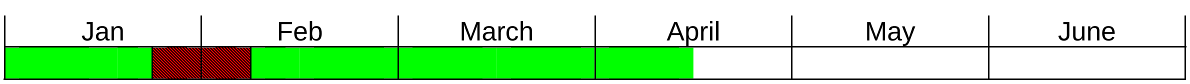
OVERVIEW

The Quartermaster Harbor herring stock spawning activity occurs relatively early in the year, with spawning often beginning in early January. Spawn deposition is typically centered near Dockton on Maury Island. Growth and spawning behavior characteristics for this stock are considered to be average for central/south Puget Sound. Spawning biomass peaked in 1995 at 2,001 tons, followed by a general decrease through 2008. One genetic study (Mitchell 2006) that included a sample from this stock did not demonstrate genetic differentiation between it and other Puget Sound samples, with the exception of Squaxin Pass and Cherry Point herring.

SPAWNING GROUND



SPAWNING TIMING



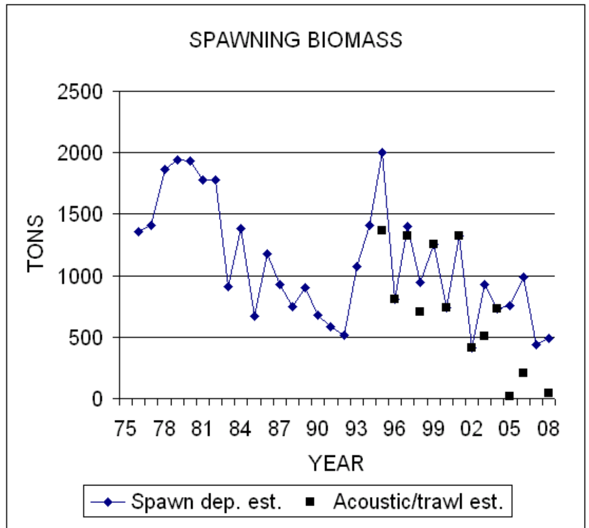
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

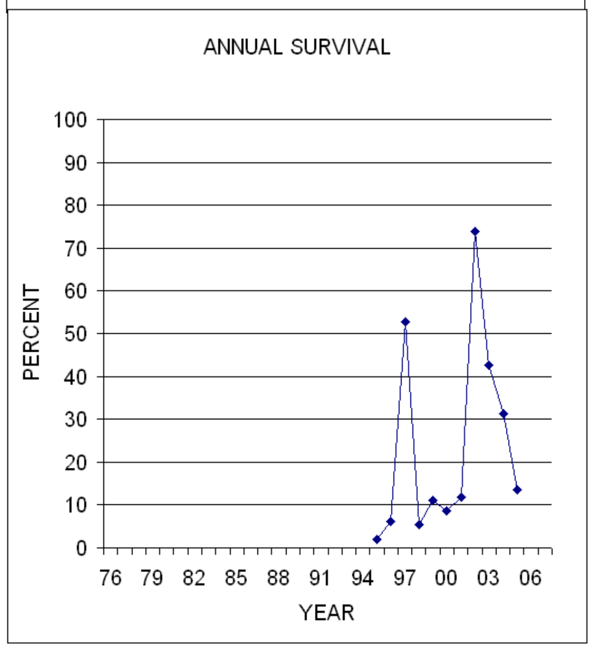
129mm/166mm/187mm/199mm (2008)

STOCK STATUS PROFILE for Quartermaster Harbor Herring Stock

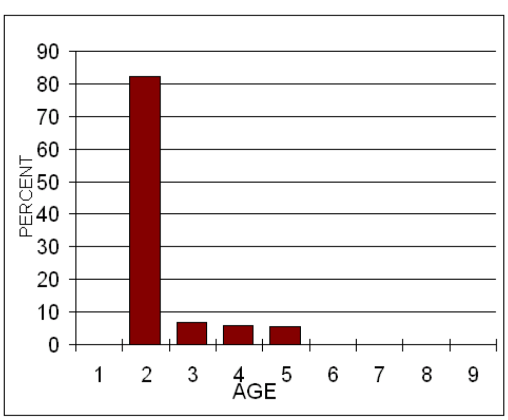
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76	1357		1357	
77	1423		1413	
78	1860		1860	
79	1941		1941	
80	1930		1930	
81	1777		1777	
82	1778		1778	
83	909		909	
84	1386		1386	
85	667		667	
86	1181		1181	
87	924		924	
88	750		750	
89	898		898	
90	681		681	
91	580		580	
92	518		518	
93	1075		1075	
94	1412		1412	
95	2001	1362	2001	
96		805	805	757
97	1402	1321	1402	438
98	947	701	947	0
99		1257	1257	1200
2000		743	743	562
2001		1320	1320	1224
2002		416	416	213
2003	930	506	930	655
2004		727	727	136
2005	756	18	756	534
2006	987	209	987	846
2007	441		441	
2008	491	46	491	
MEAN:				
25 year	949	725	932	
5 year	669	250	680	





2008 BIOMASS AGE COMPOSITION



STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
stable

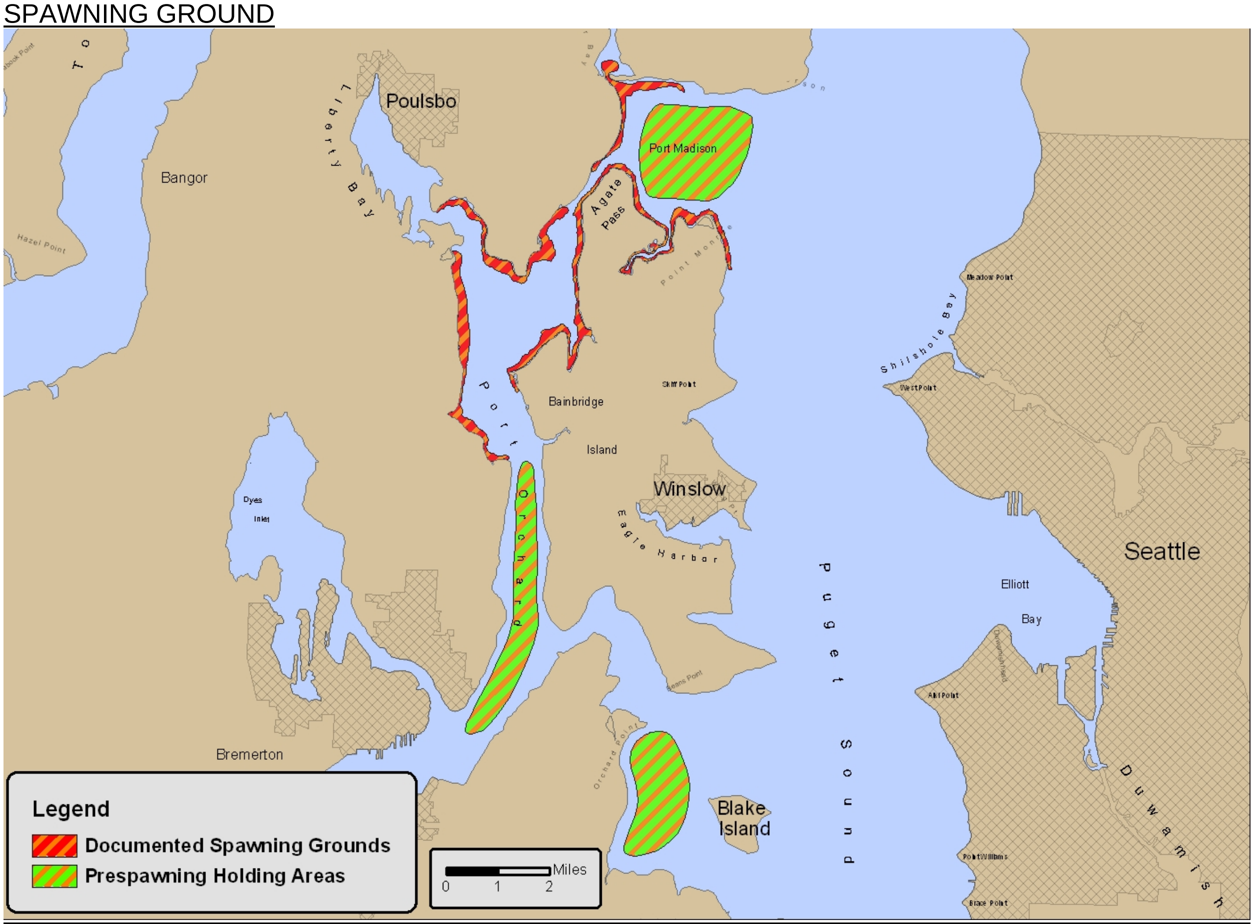
STOCK STATUS (2 year)
depressed: 50% of 25 yr mean spawning biomass

Port Orchard/Madison Herring Stock

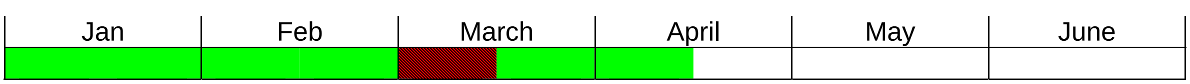
OVERVIEW

The Port Orchard/Madison herring stock abundance has been fairly stable since a low point in the 1990s, with a mean spawning biomass of over 1,500 tons in the last ten years. Spawn deposition in recent years has primarily been observed in Hidden Cove (north Bainbridge Island) and Point Bolin (southeast of Poulsbo) areas. Several separate prespawner holding areas are reliably observed, with a significant increase in abundance in the Yukon Harbor holding area east of Blake Island noted in recent years. Inclusion of samples from this stock for future genetic studies would be desirable, given the significant size of observed spawning biomass for this area and the central location of its spawning grounds.

SPAWNING GROUND



SPAWNING TIMING



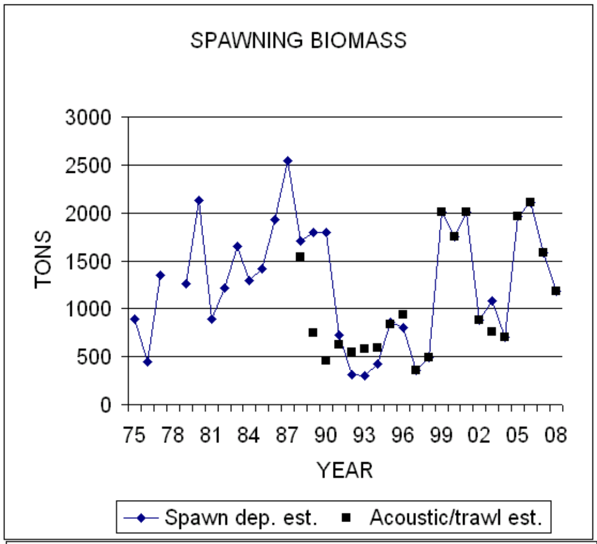
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

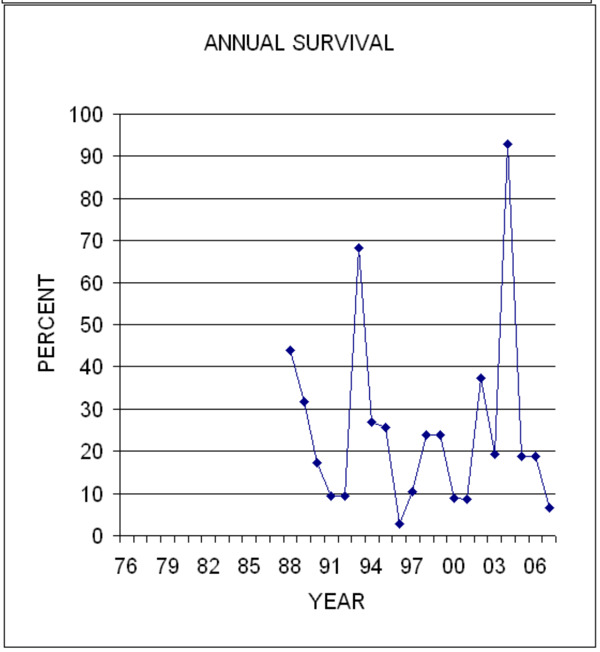
142mm/168mm/178mm/182mm (2008)

STOCK STATUS PROFILE for Port Orchard/Madison Herring Stock

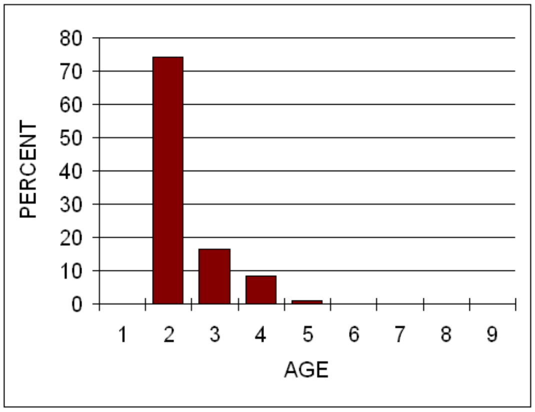
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75	887		887	
76	447		447	
77	1348		1348	
78				
79	1255		1255	
80	2133		2133	
81	891		891	
82	1214		1214	
83	1651		1651	
84	1293		1293	
85	1415		1415	
86	1926		1926	
87	2538		2538	
88	1705	1537	1705	
89	1739	743	1795	853
90	1795	456	1795	1123
91	722	630	722	339
92	314	544	314	223
93	304	582	304	256
94	424	596	424	104
95	863	831	863	708
96	806	932	806	517
97		360	360	325
98		489	489	439
99		2006	2006	1809
2000		1756	1756	1139
2001		2007	2007	1770
2002		878	878	648
2003	1085	755	1085	673
2004		700	700	398
2005		1958	1958	1176
2006		2112	2112	1647
2007		1589	1589	1089
2008		1186	1186	963
MEAN:				
25 year	1209	1078	1281	
5 year		1509	1509	





2008 BIOMASS AGE COMPOSITION



STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
good

RECENT TREND (5 year)
stable

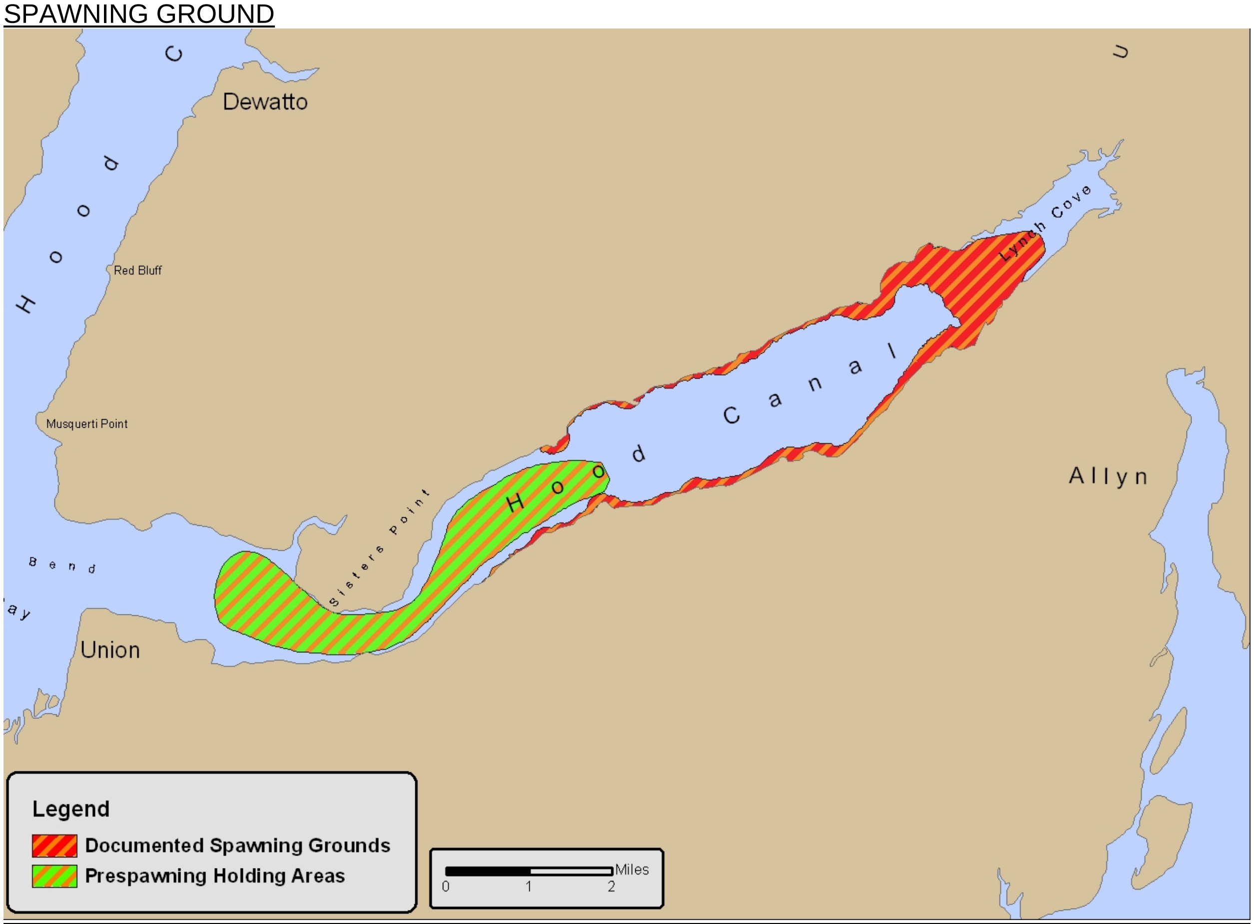
STOCK STATUS (2 year)
healthy: 108% of 25 yr mean spawning biomass

South Hood Canal Herring Stock

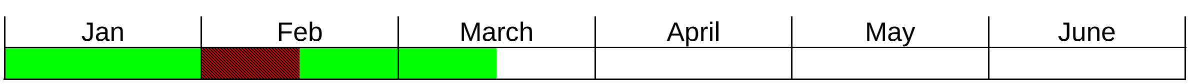
OVERVIEW

Spawning activity by this small herring stock is generally confined to Lynch Cove at the head of south Hood Canal. Spawning starts relatively early (by mid-January) and typically is finished by early March. Estimated spawning biomass averages slightly over 200 tons, with a high of 516 tons observed in 1999, and a low of 70 tons estimated in 2007. Effects of low dissolved oxygen levels in mainstem Hood Canal on the abundance of this stock are unknown. However, other than the mentioned decrease in 2007, estimated spawning biomass has been fairly stable. The location of this stock’s spawning grounds at the end of Hood Canal could contribute to genetic differentiation similar to that observed for Squaxin Pass and remote inlet “resident” herring populations in British Columbia, although stock samples have not been included in any study to date.

SPAWNING GROUND



SPAWNING TIMING



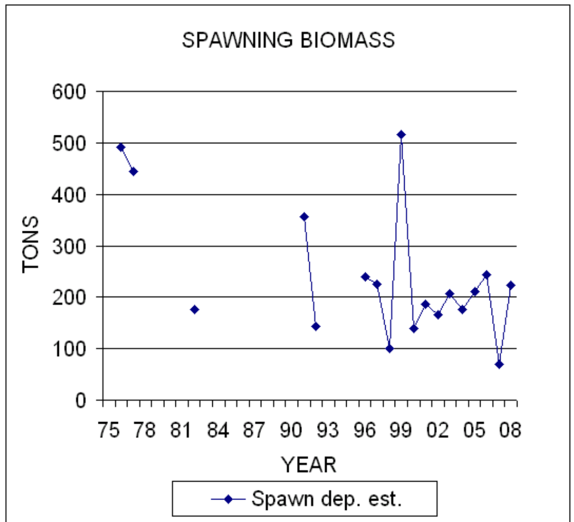
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

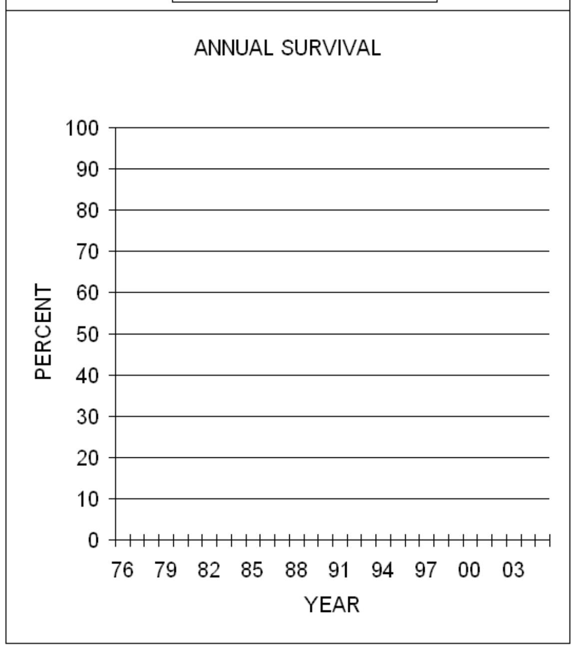
No data

STOCK STATUS PROFILE for South Hood Canal Herring Stock

STOCK ASSESSMENT

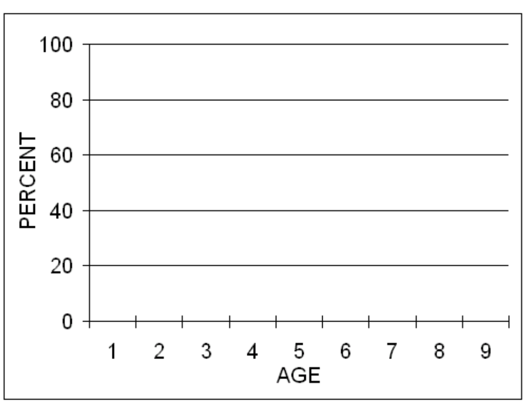
	SPAWNING BIOMASS (tons)			
YEAR	SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76	492		492	
77	444		444	
78				
79				
80				
81				
82	177		177	
83				
84				
85				
86				
87				
88				
89				
90				
91	357		357	
92	144		144	
93				
94				
95				
96	239		239	
97	226		226	
98	101		101	
99	516		516	
2000	140		140	
2001	187		187	
2002	166		166	
2003	207		207	
2004	176		176	
2005	210		210	
2006	244		244	
2007	70		70	
2008	223		223	
MEAN:				
25 year	214		214	
5 year	185		185	





no data

2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
poor

RECENT TREND (5 year)
stable

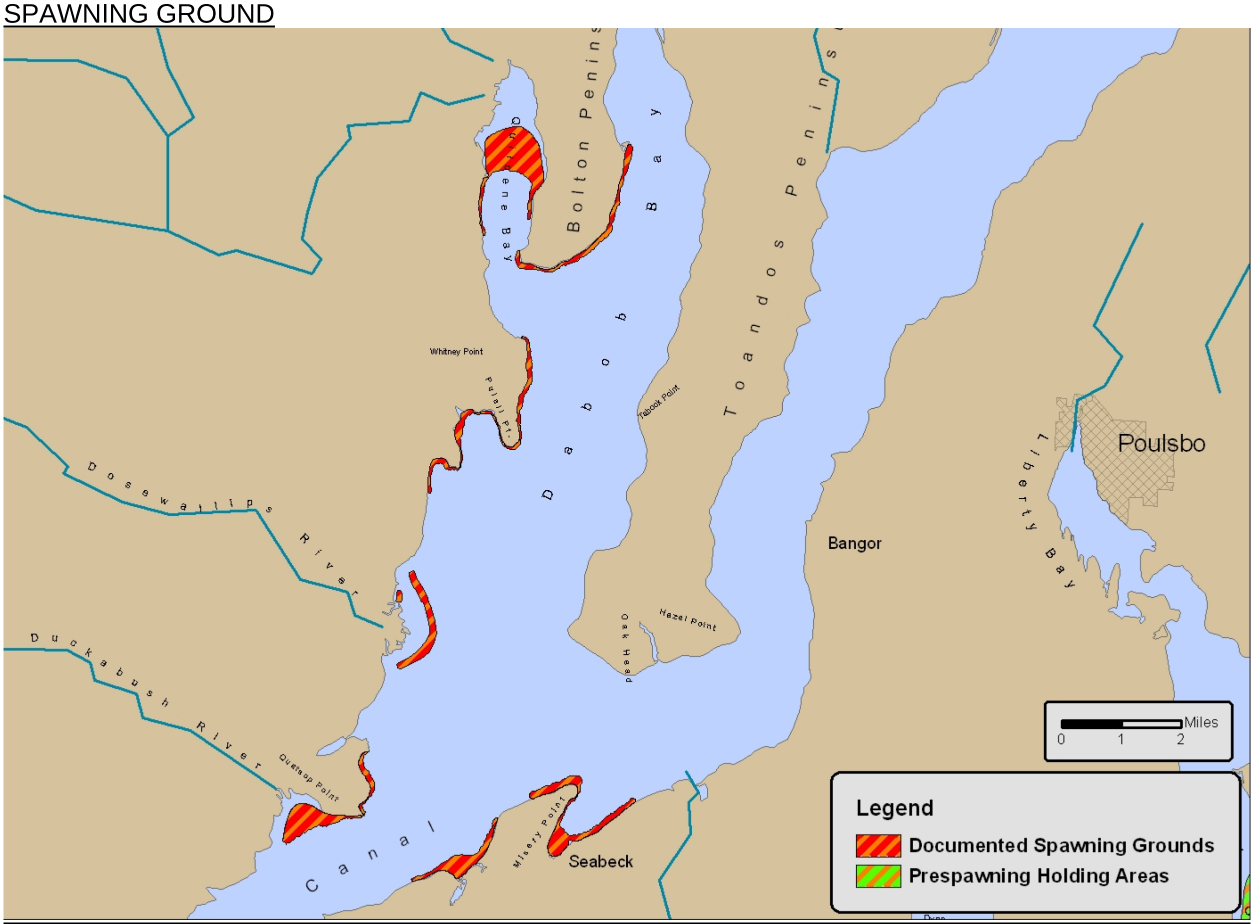
STOCK STATUS (2 year)
depressed: 69% of 25 yr mean spawning biomass

Quilcene Bay Herring Stock

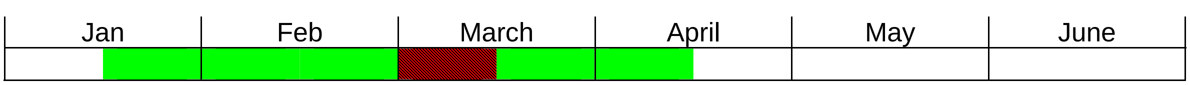
OVERVIEW

The Quilcene Bay herring stock is currently one of the largest in Puget Sound with mean annual spawning biomass of over 2,100 tons since 1999. Based primarily on fishery landings, this stock was considered to be one of the largest herring stocks in Washington waters in the 1930's through the 1950's (Chapman et al. 1941, Williams 1959), followed by an apparent significant decrease in abundance from that time to the mid-1990's. Documented spawning grounds have been significantly expanded since 1998. Most spawn deposition in recent years has occurred at the south end of the Bolton Peninsula and the shoreline from Jackson Cove to Point Whitney. An observed inverse abundance relationship with the Port Gamble herring stock may indicate spawning stock linkage, with intermixing and straying between spawning grounds probable. Limited tagging recoveries suggest that this stock is "migratory", with migration to summer offshore feeding grounds.

SPAWNING GROUND



SPAWNING TIMING



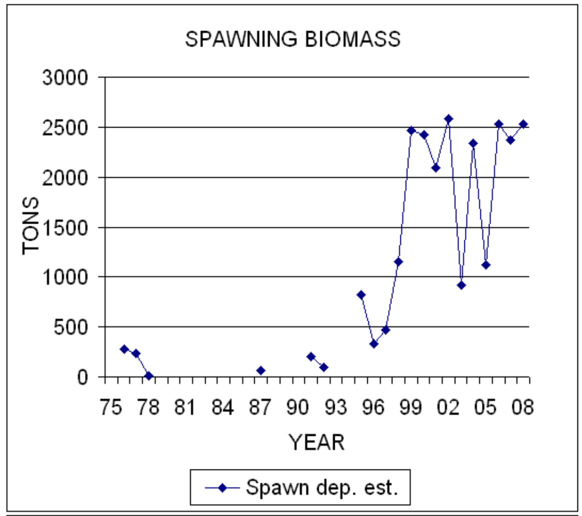
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

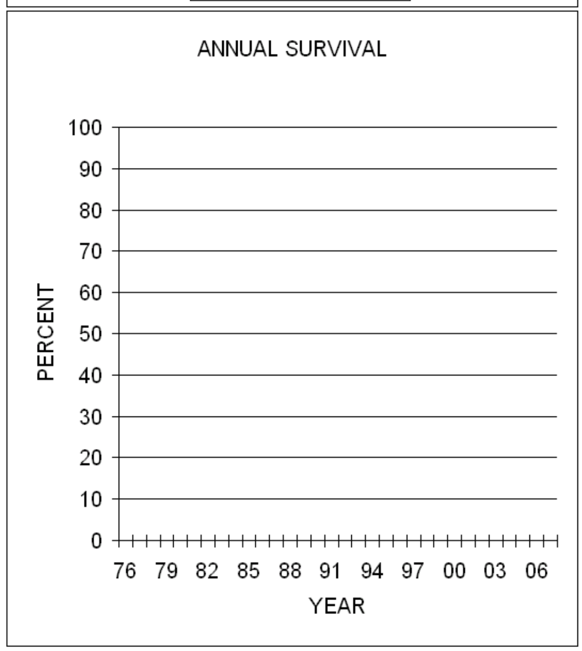
No data

STOCK STATUS PROFILE for Quilcene Bay Herring Stock

STOCK ASSESSMENT

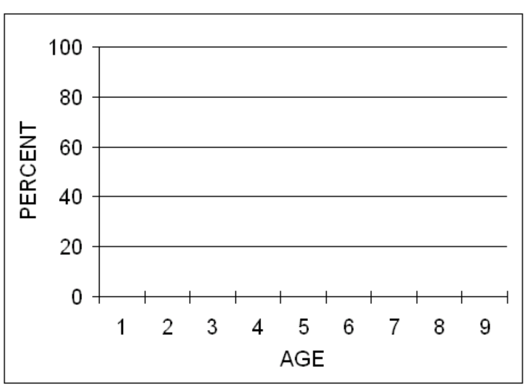
YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76	279		279	
77	232		232	
78	14		14	
79				
80				
81				
82				
83				
84				
85				
86				
87	68		68	
88				
89				
90				
91	204		204	
92	97		97	
93				
94				
95	817		817	
96	328		328	
97	465		465	
98	1152		1152	
99	2464		2464	
2000	2426		2426	
2001	2091		2091	
2002	2585		2585	
2003	916		916	
2004	2342		2342	
2005	1125		1125	
2006	2530		2530	
2007	2372		2372	
2008	2531		2531	
MEAN:				
25 year	1442		1442	
5 year	2180		2180	





no data

2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair/poor

RECENT TREND (5 year)
stable

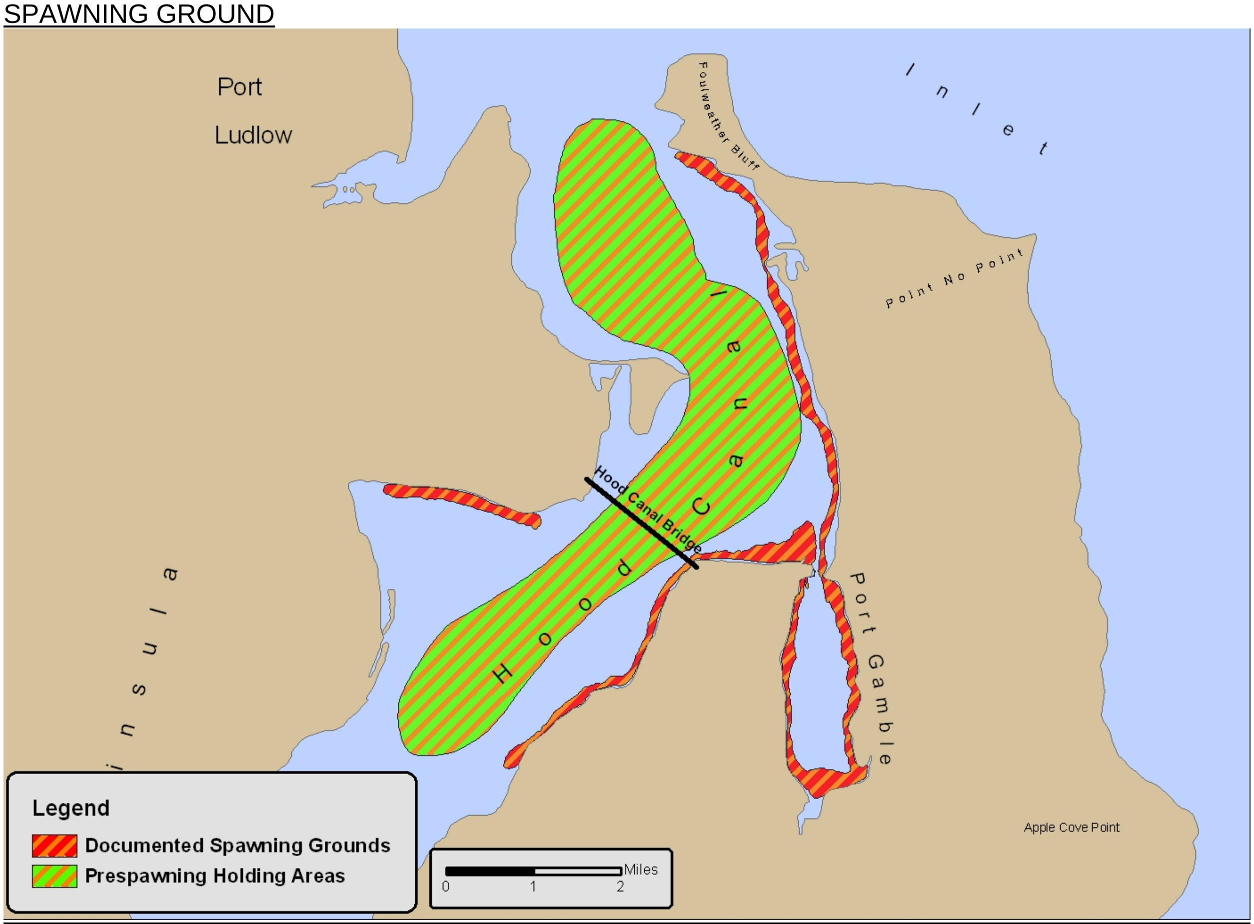
STOCK STATUS (2 year)
healthy: 170% of 25 yr mean spawning biomass

Port Gamble Herring Stock

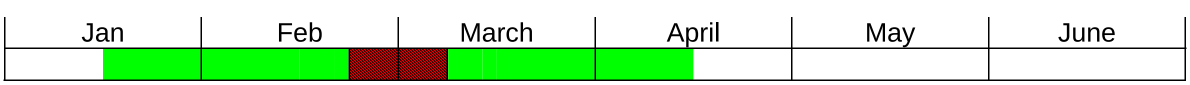
OVERVIEW

The Port Gamble herring stock has generally been considered one of the larger stocks in Puget Sound since quantitative survey effort began in the late 1970's. However, it has followed a decreasing trend since 2000, when the spawning biomass estimate was almost 2,500 tons. A record low of only 208 tons was estimated in 2008. Spawning activity is centered in Port Gamble Bay. Since 2003, previously reliable prespawner concentrations have inexplicably not been located by acoustic/trawl surveys; followed by normal distribution and timing of spawn deposition. Abundance trends compared to Quilcene Bay stock may indicate linkage between the two stocks. Genetic samples from this stock were not considered distinct from other Puget Sound populations (Small 2005, Mitchell 2006). Interestingly, in descriptions of known spawning grounds at the time, there is no mention of this area by Chapman et al. (1941) or Williams (1959).

SPAWNING GROUND



SPAWNING TIMING



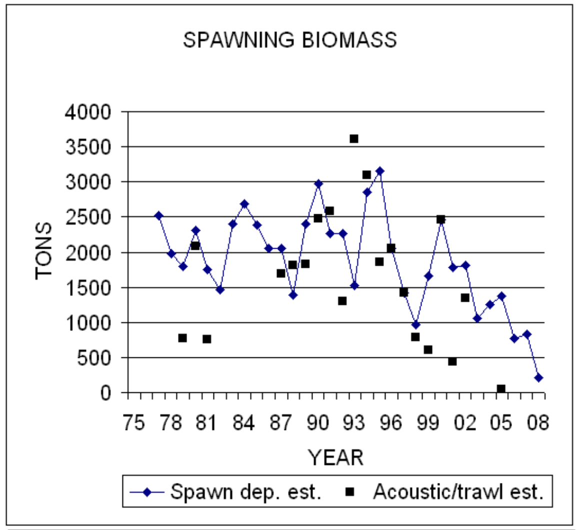
MEAN LENGTH OF 2/3/4/5/6/7/9 YEAR OLDS

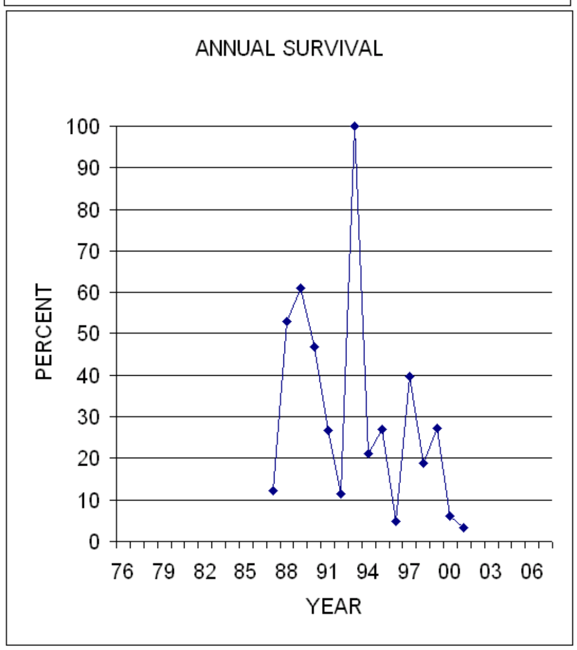
144mm/158mm/170mm/180mm/184mm/180mm/187mm (2005)

STOCK STATUS PROFILE for Port Gamble Herring Stock

STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76				
77			2525	
78	1984		1984	
79	1790	772	1790	
80	2309	2077	2309	
81	1753	761	1753	
82	1463		1463	
83	2407		2407	
84	2685		2685	
85	2387		2387	
86	2050		2050	
87	2046	1688	2046	
88	1390	1808	1390	980
89	2395	1824	2395	1567
90	2969	2470	2969	811
91	2259	2579	2259	655
92	2270	1291	2270	1569
93	1521	3614	1521	1225
94	2857	3099	2857	327
95	3158	1862	3158	2402
96		2058	2058	947
97		1419	1419	1250
98	971	792	971	346
99	1664	608	1664	1429
2000		2459	2459	1916
2001	1779	444	1779	1526
2002	1812	1342	1812	1133
2003	1064		1064	
2004	1257		1257	
2005	1372	44	1372	
2006	774		774	
2007	826		826	
2008	208		208	
MEAN:				
25 year	1805	1729	1826	
5 year	887	44	887	





2008 BIOMASS AGE COMPOSITION

no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
decreasing

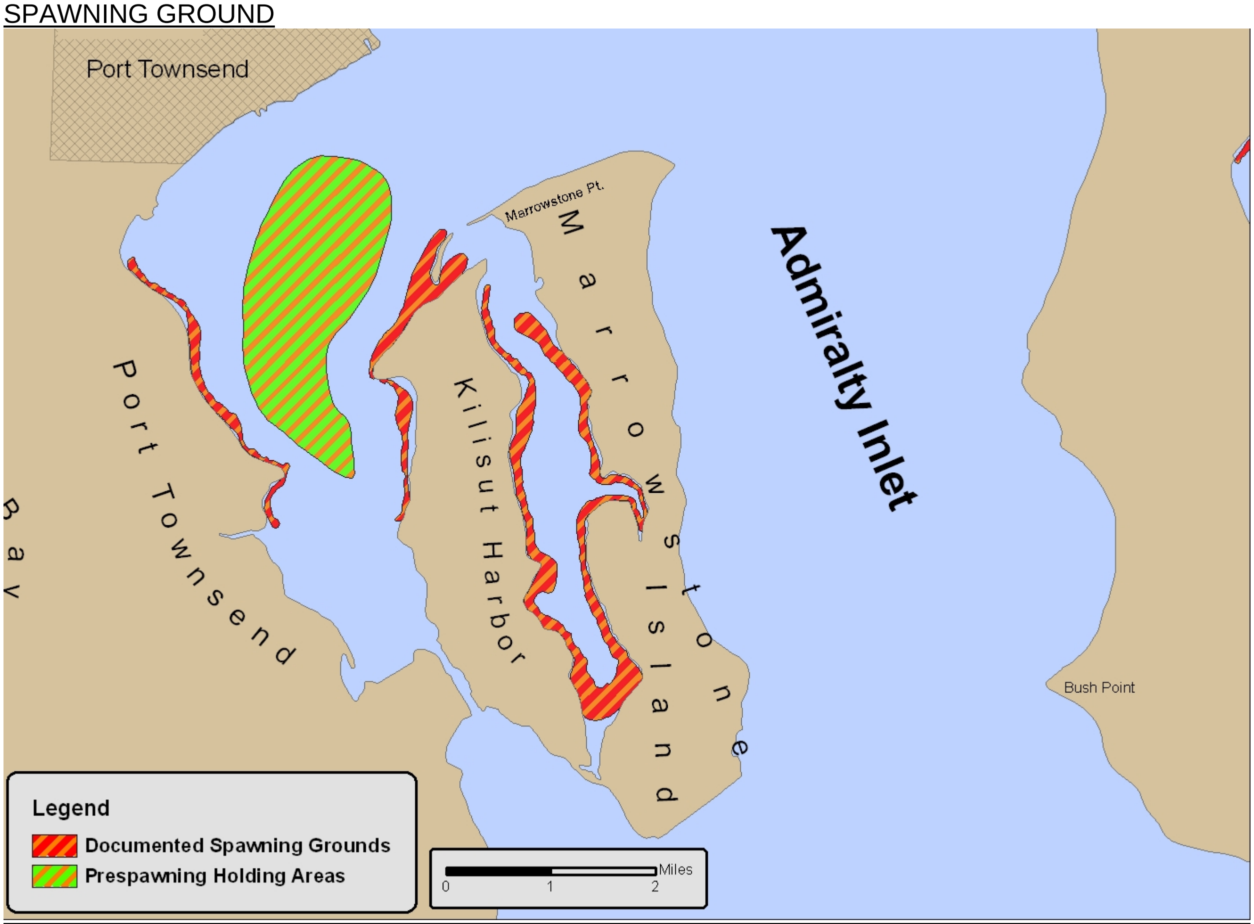
STOCK STATUS (2 year)
depressed: 28% of 25 yr mean spawning biomass

Kilisut Harbor Herring Stock

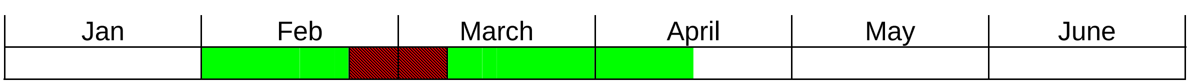
OVERVIEW

The Kilisut Harbor herring stock is a small south/central Puget Sound stock with recent years' observed spawning activity entirely within Kilisut Harbor. Spawning activity usually begins in early February with peak spawning in March. Growth characteristics are average for Puget Sound. Estimated spawning biomass for this stock has steadily decreased since 2002 and no spawn deposition was observed in 2008. The recent five year trend is a significant decrease and the individual stock is considered depressed. A sample from this stock was included in a recent genetic study (Beacham et al. 2008) and significant genetic differentiation was observed between this stock and the Cherry Point stock with no significant difference compared to the Skagit Bay stock. This finding suggests gene flow between this stock and others in Puget Sound.

SPAWNING GROUND



SPAWNING TIMING



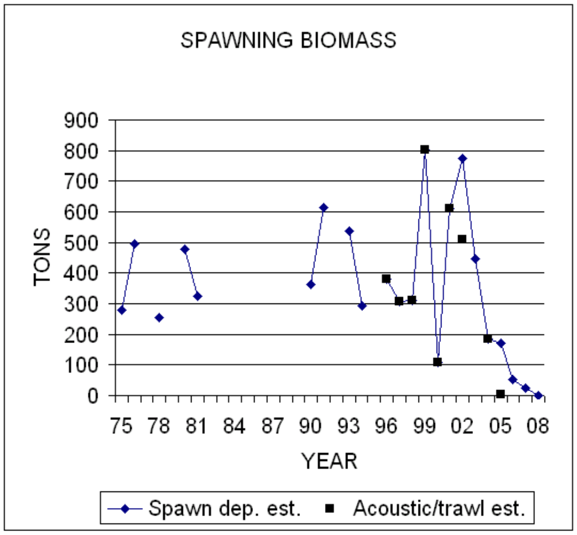
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

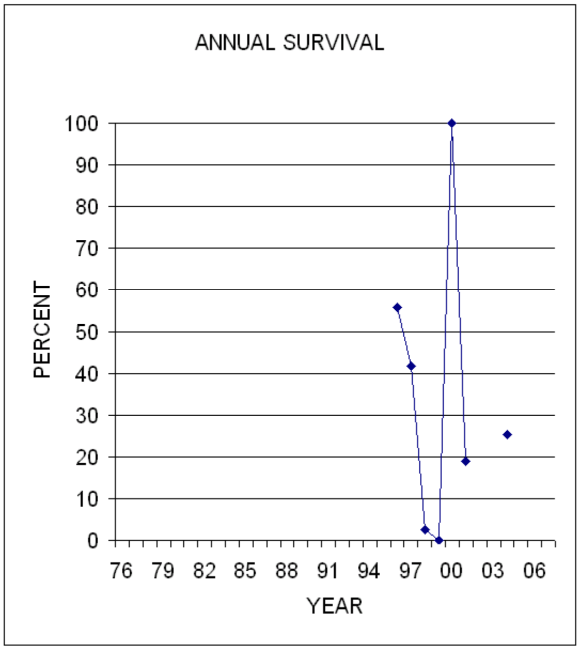
142mm/152mm/163mm/180mm (2008)

STOCK STATUS PROFILE for Kilisut Harbor Herring Stock

STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75	279		279	
76	495		495	
77				
78	254		254	
79				
80	477		477	
81	324		324	
82				
83				
84				
85				
86				
87				
88				
89				
90	364		364	
91	613		613	
92				
93	538		538	
94	292		292	
95				
96		380	380	
97		307	307	0
98		311	311	170
99		802	802	792
2000		107	107	107
2001		612	612	393
2002	774	510	774	629
2003	448		448	
2004		184	184	
2005	170	5	170	120
2006	54		54	
2007	24		24	
2008	0		0	
MEAN:				
25 year	328	358	352	
5 year	62	95	86	





2008 BIOMASS AGE COMPOSITION

no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY

no fishery

DATA QUALITY

fair/poor

RECENT TREND (5 year)

decreasing

STOCK STATUS (2 year)

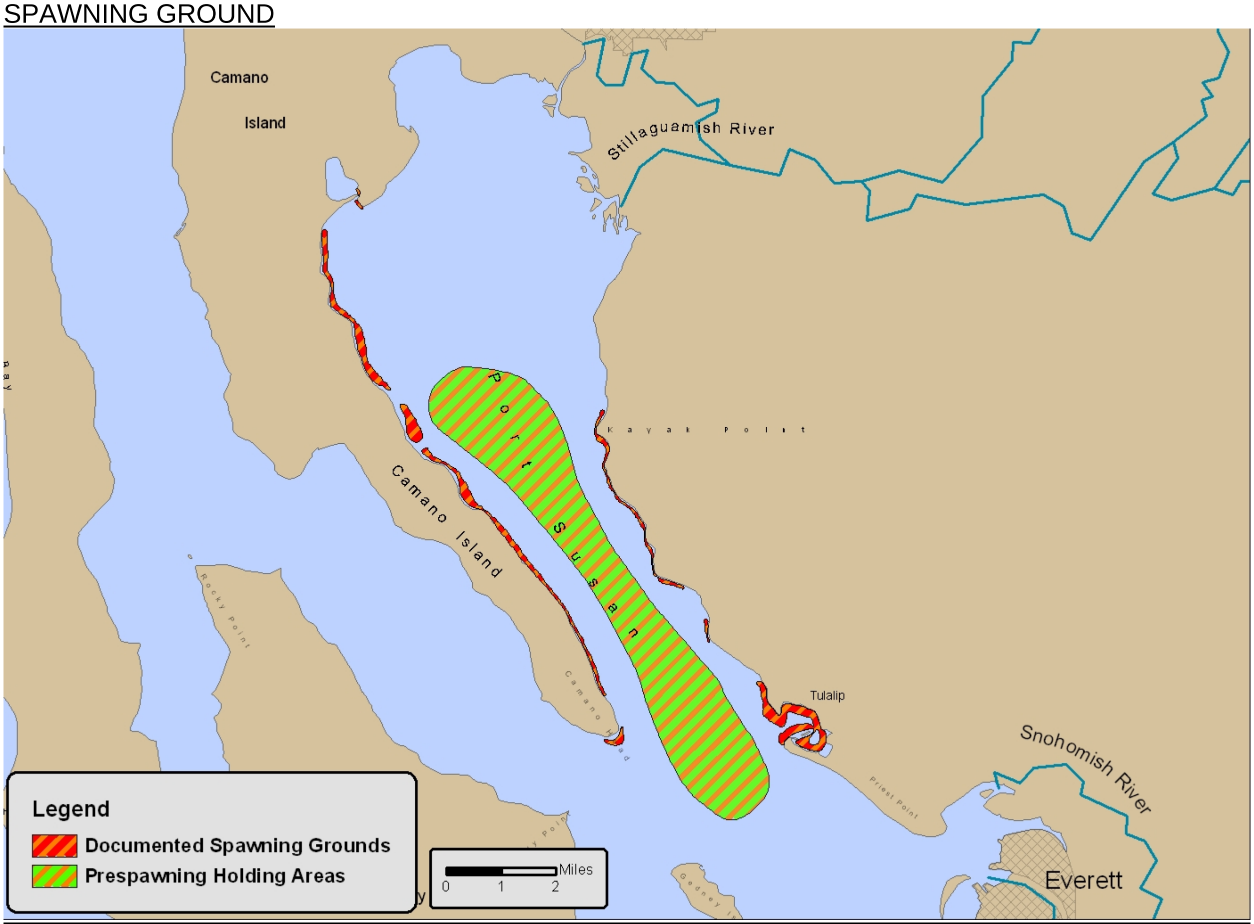
depressed: 3% of 25 yr mean spawning biomass

Port Susan Herring Stock

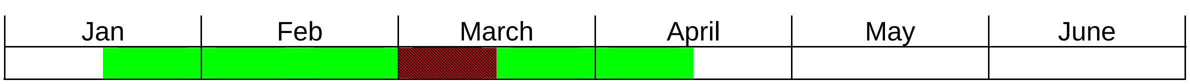
OVERVIEW

The Port Susan herring stock often deposits significant spawn on rocks and gravel. Outside of Tulalip Bay, where most observed spawn deposition has been located, marine algae normally used by herring as spawning substrate are sparse in the Port Susan area. This behavior makes acoustic/trawl survey assessment the method of choice for this stock, although successful location of prespawner aggregations has been sporadic. Spawning biomass has hovered around 500 tons since a peak of over 2,000 tons in 1998. Additional spawning ground was documented in 2008 in the northwest portion of Port Susan on intertidal salt marsh vegetation, an occurrence not previously reported inside Puget Sound.

SPAWNING GROUND



SPAWNING TIMING



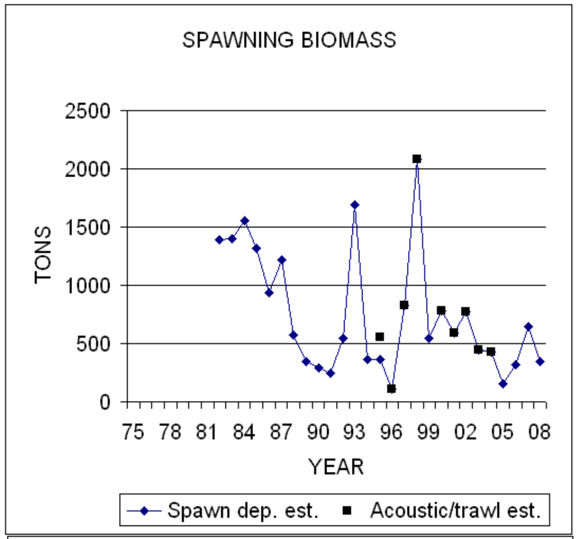
MEAN LENGTH OF 2/3/4/5/6 YEAR OLDS

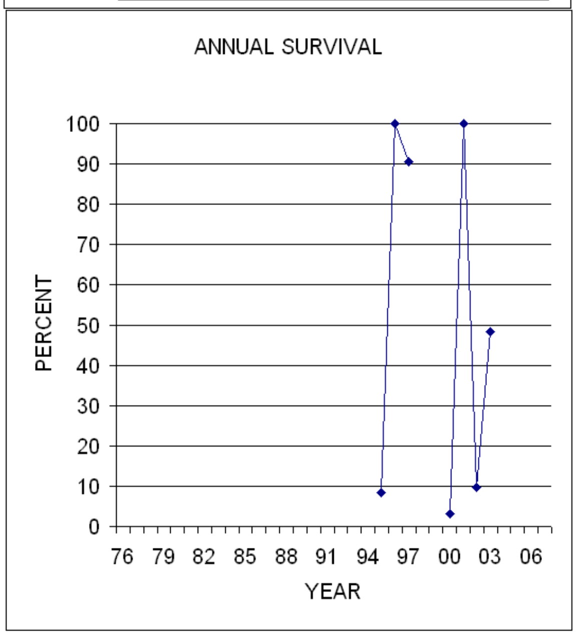
161mm/168mm/179mm/182mm/185mm (2007)

STOCK STATUS PROFILE for Port Susan Herring Stock

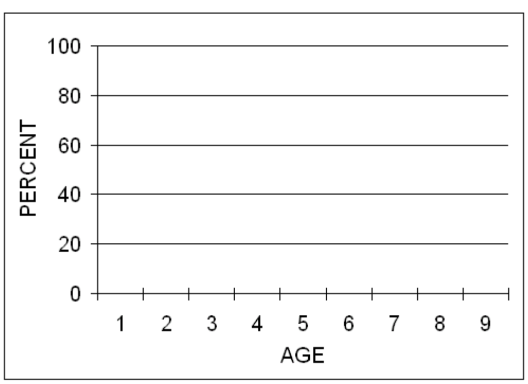
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76				
77				
78				
79				
80				
81				
82	1391		1391	
83	1398		1398	
84	1555		1555	
85	1321		1321	
86	934		934	
87	1216		1216	
88	570		570	
89	345		345	
90	291		291	
91	245		245	
92	545		545	
93	1693		1693	
94	365		365	
95	363	557	363	
96		110	110	75
97		828	828	670
98		2084	2084	1276
99	545		545	
2000		785	785	
2001		587	587	557
2002		775	775	72
2003		450	450	374
2004		429	429	154
2005	157		157	
2006	321		321	
2007	643		643	
2008	345		345	
MEAN:				
25 year	674	734	700	
5 year	367	429	379	





2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
stable

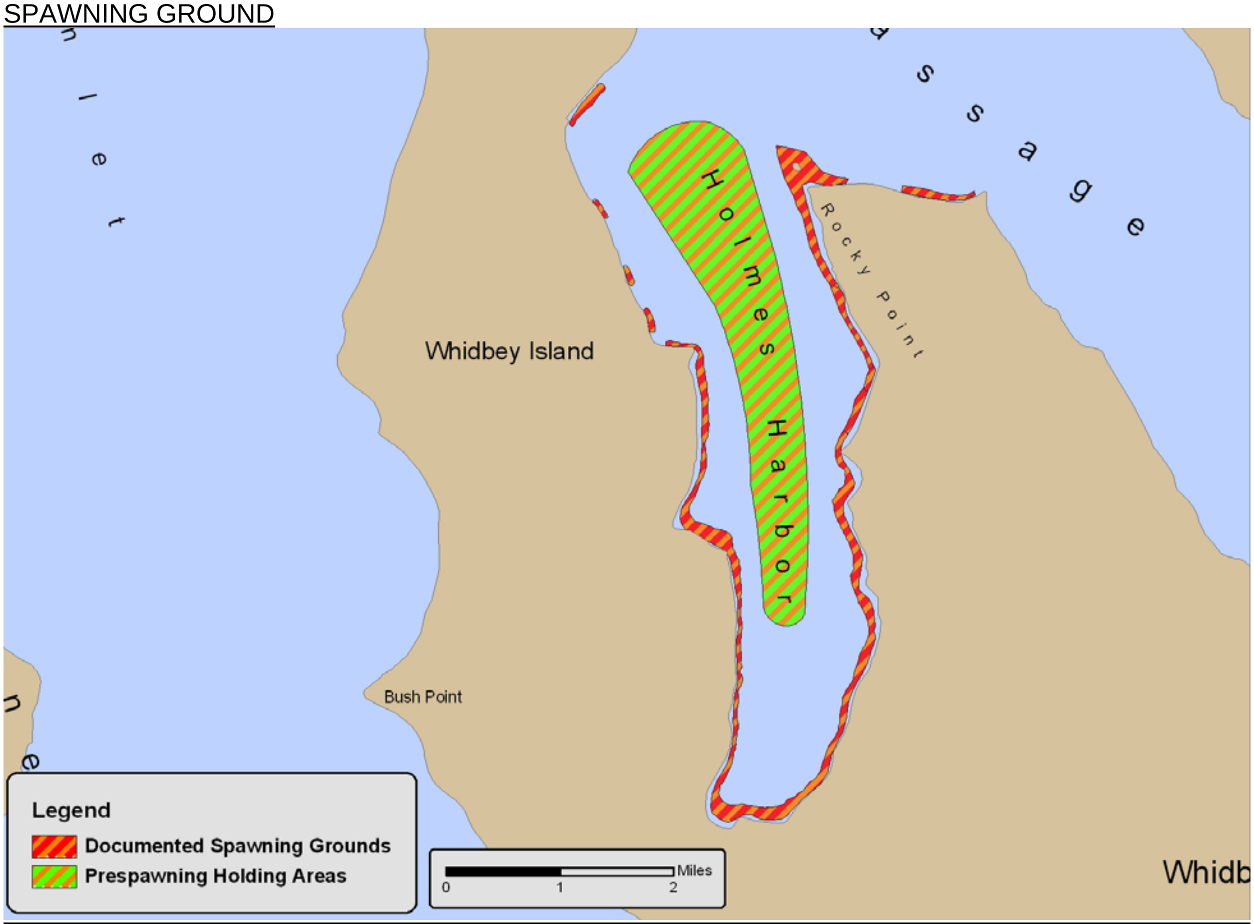
STOCK STATUS (2 year)
moderately healthy: 71% of 25 yr mean spawning biomass

Holmes Harbor Herring Stock

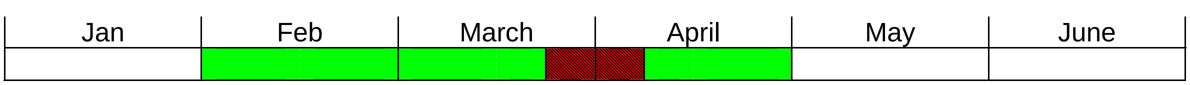
OVERVIEW

Spawning timing for the Holmes Harbor herring stock is later than most Puget Sound stocks, with most activity from early March to early April. Recent spawning biomass is relatively high with a previous five year mean (2004-2008) of 745 tons, compared to a mean spawning biomass of less than 400 tons between 1976 and 2003. Along with the Quilcene Bay stock, this stock was considered to be the largest in Washington waters prior to the start of quantitative surveys in the 1970's, as reported by Chapman et al. (1941), Cleaver and Franett (1946), and Williams (1959). This conclusion was based mainly on fishery observations and landings (brush weir/trap) that reached as high as 358 tons in 1937. Tagging operations on spawning grounds conducted in the 1950's documented recovery of at least one tagged adult fish at Swiftsure Bank off the southwest tip of Vancouver Island in the summer and in early winter reduction fisheries in the southeast Vancouver Island region, suggesting that the Holmes Harbor stock is a migratory stock.

SPAWNING GROUND



SPAWNING TIMING



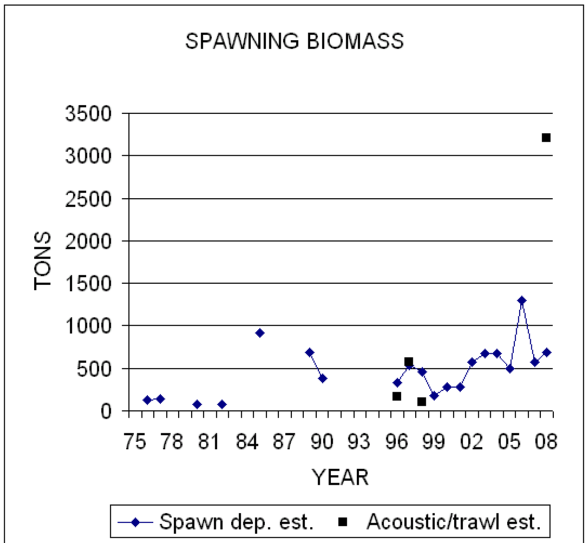
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

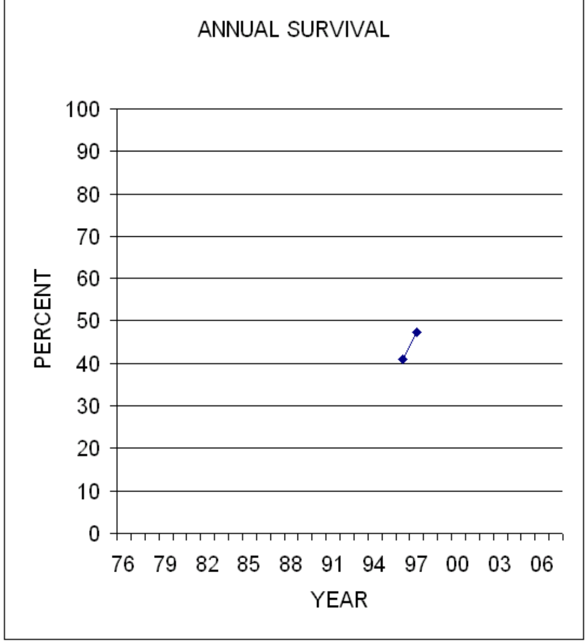
137mm/170mm/176mm/190mm (2008)

STOCK STATUS PROFILE for Holmes Harbor Herring Stock

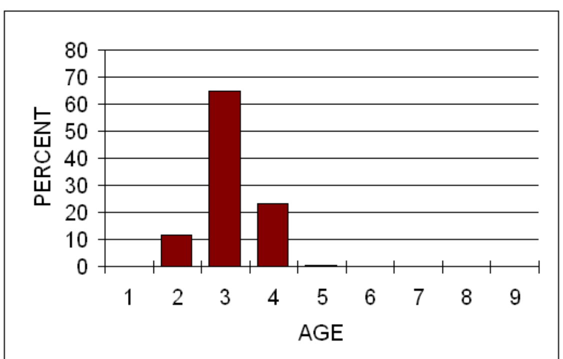
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76	126		126	
77	135		135	
78				
79				
80	78		78	
81				
82	78		78	
83				
84				
85	914		914	
86				
87				
88				
89	693		693	
90	380		380	
91				
92				
93				
94				
95				
96	336	160	336	
97	530	571	530	328
98	464	97	464	141
99	175		175	
2000	281		281	
2001	275		275	
2002	573		573	
2003	678		678	
2004	673		673	
2005	498			
2006	1297			
2007	572		572	
2008	686	3213	686	
MEAN:				
25 year	564	1010	516	
5 year	745	3213	644	





2008 BIOMASS AGE COMPOSITION



STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
stable

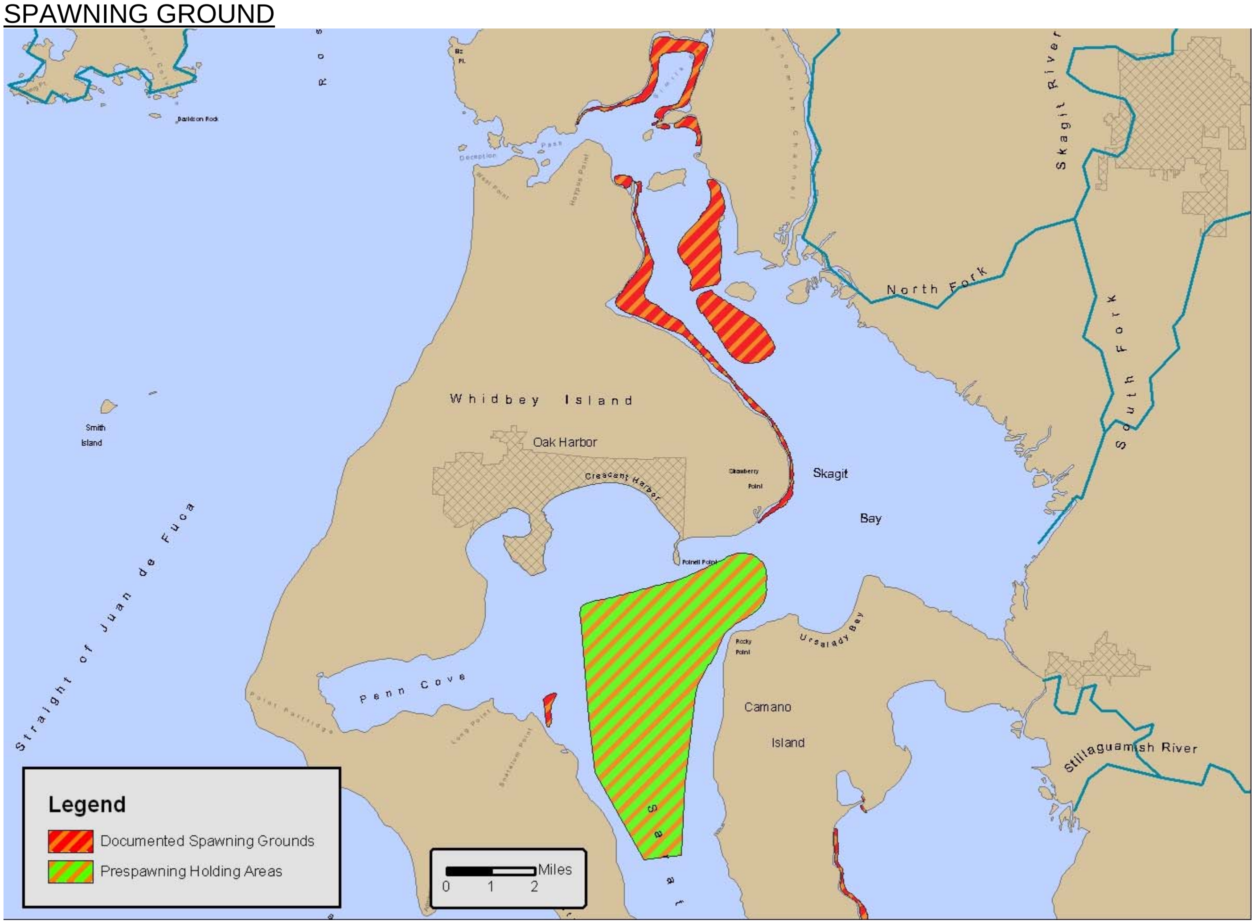
STOCK STATUS (2 year)
healthy: 112% of 25 yr mean spawning biomass

Skagit Bay Herring Stock

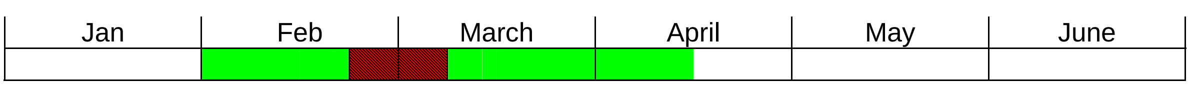
OVERVIEW

The Skagit Bay herring stock is currently one of the larger stocks in Puget Sound. Acoustic/trawl surveys have observed large prespawner herring concentrations in the north end of Saratoga Passage. Observed spawn deposition in recent years has primarily been in and near Similk Bay. A recent genetic study (Beacham et al. 2008) demonstrated genetic differentiation between this stock and the Cherry Point stock and a lack of differentiation compared to a sample from the Kilisut Harbor stock. The close proximity to the prespawner holding area and spawning grounds and reasonably similar spawn timing for the Holmes Harbor stock make it likely that intermixing of these two stocks occurs, although spawn timing is typically earlier for the Skagit Bay stock.

SPAWNING GROUND



SPAWNING TIMING



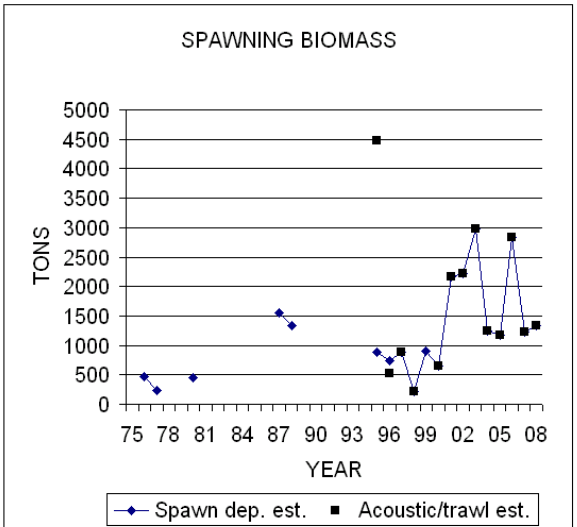
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

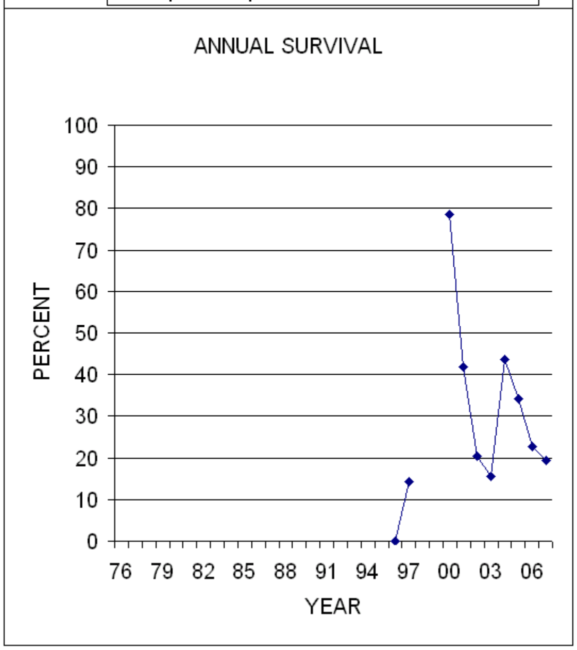
141mm/167mm/176mm/183mm (2008)

STOCK STATUS PROFILE for Skagit Bay Herring Stock

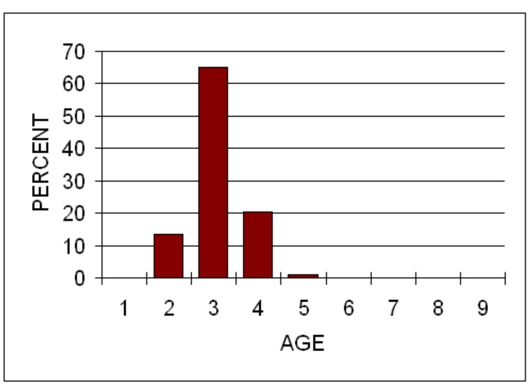
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons): SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76			478	
77			227	
78				
79				
80	453		453	
81				
82				
83				
84				
85				
86				
87	1552		1552	
88	1340		1340	
89				
90				
91				
92				
93				
94				
95	891	4480	891	
96	736	521	736	736
97		893	893	892
98		209	209	31
99	905		905	
2000		646	646	
2001		2170	2170	1309
2002		2215	2215	1212
2003		2983	2983	2517
2004		1245	1245	692
2005		1169	1169	462
2006		2826	2826	2275
2007		1236	1236	556
2008		1342	1342	1047
MEAN:				
25 year	1085	1687	1397	
5 year		1564	1564	





2008 BIOMASS AGE COMPOSITION



STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
stable

STOCK STATUS (2 year)
healthy: 92% of 25 yr mean spawning biomass

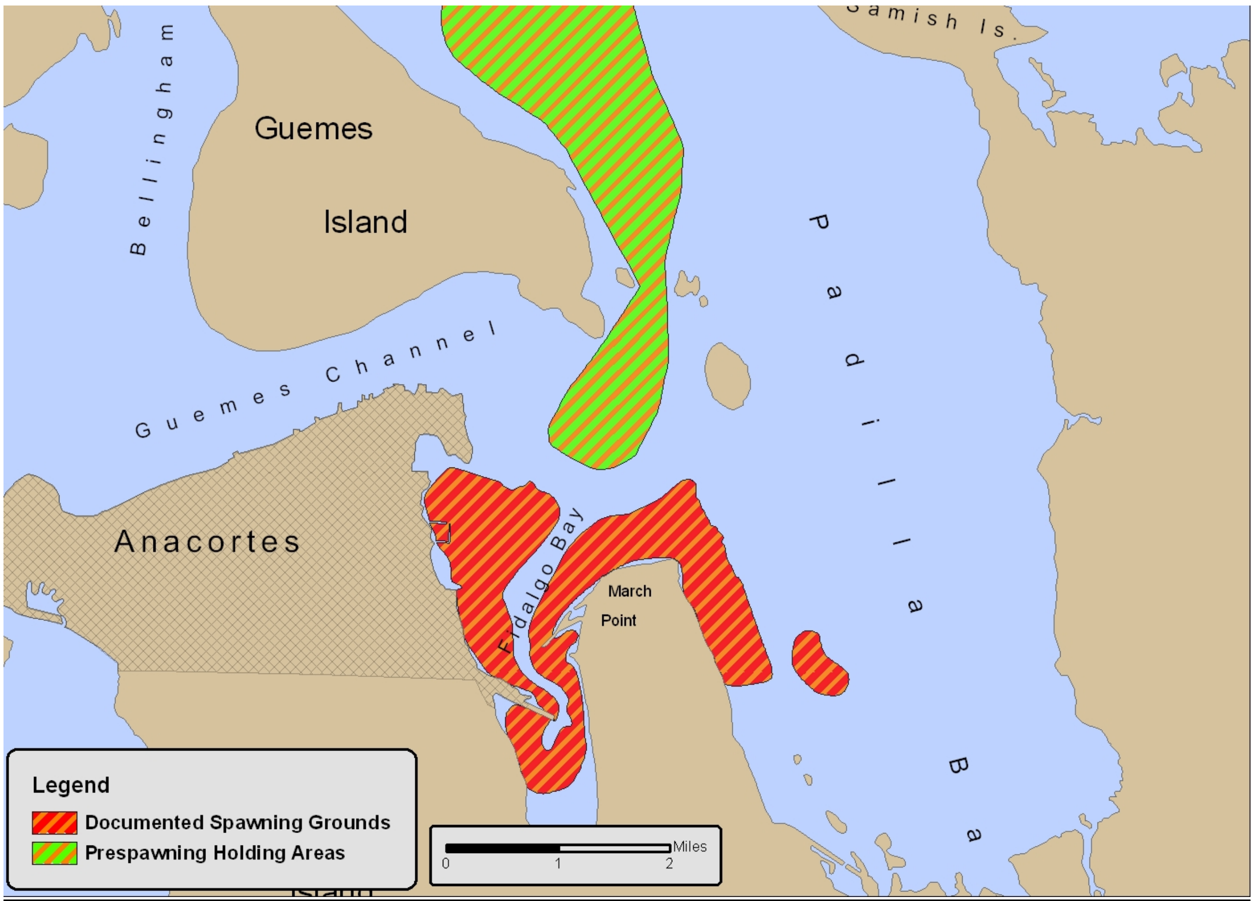
North Puget Sound Herring Stock Profiles

Fidalgo Bay Herring Stock

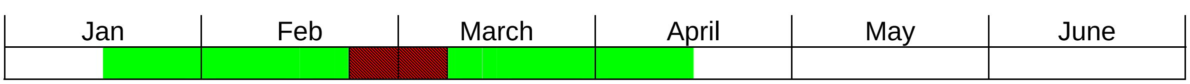
OVERVIEW

Formerly considered to be a medium-sized north Puget Sound herring stock, the Fidalgo Bay stock has decreased in recent years. Annual spawning biomass estimates have decreased each year since 2001, although the trend for the most recent five years (2004-2008) is not statistically significant (95% confidence level). Compared to the previous 25 year mean spawning biomass, the 2008 status is considered depressed. The proximity of its spawning grounds to oil refinery activities at March Point make its status of particular interest. Spawn deposition takes place at very low densities over the large shallow eelgrass flats that encompass most of the bay. One sample from 1999 was not genetically differentiated from other Puget Sound stocks, except the Cherry Point and Squaxin Pass stocks (Small 2005).

SPAWNING GROUND



SPAWNING TIMING



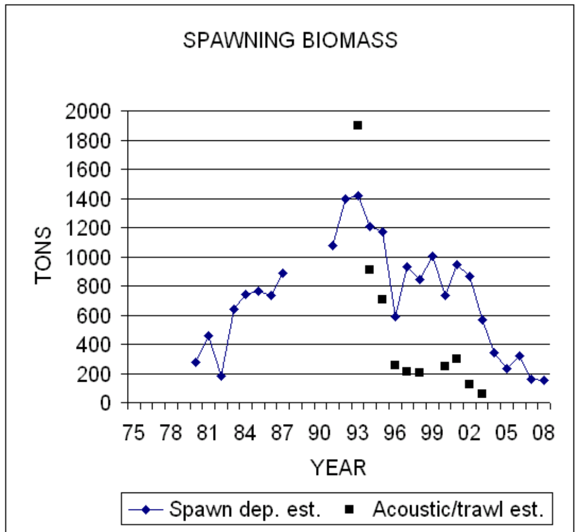
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

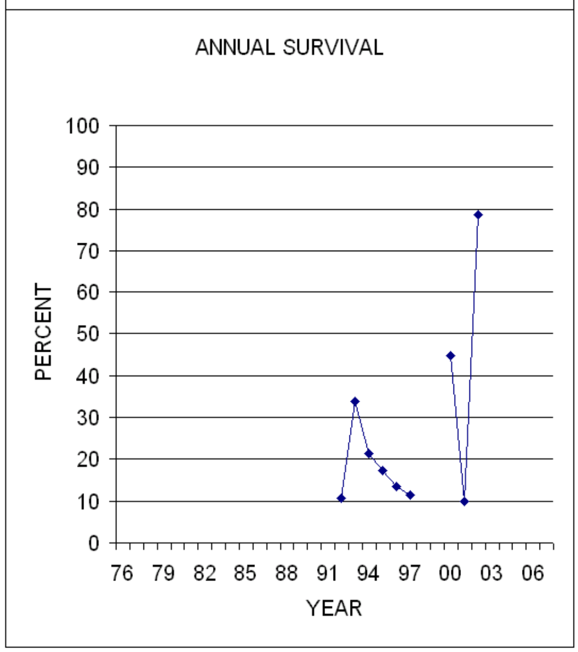
148mm/157mm/177mm/204mm (2003)

STOCK STATUS PROFILE for Fidalgo Bay Herring Stock

STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76				
77				
78				
79				
80	276		276	
81	456		456	
82	182		182	
83	640		640	
84	742		742	
85	761		761	
86	731		731	
87	887		887	
88				
89				
90				
91	1079		1079	
92	1399		1399	
93	1417	1896	1417	1206
94	1207	912	1207	590
95	1173	702	1173	882
96	590	255	590	273
97	929	208	929	800
98	844	206	844	680
99	1005		1005	
2000	737	246	737	
2001	944	296	944	500
2002	865	124	865	737
2003	569	55	569	49
2004	339		339	
2005	231		231	
2006	323		323	
2007	159		159	
2008	156		156	
MEAN:				
25 year	777	490	777	
5 year	242		242	





2008 BIOMASS AGE COMPOSITION

no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
stable

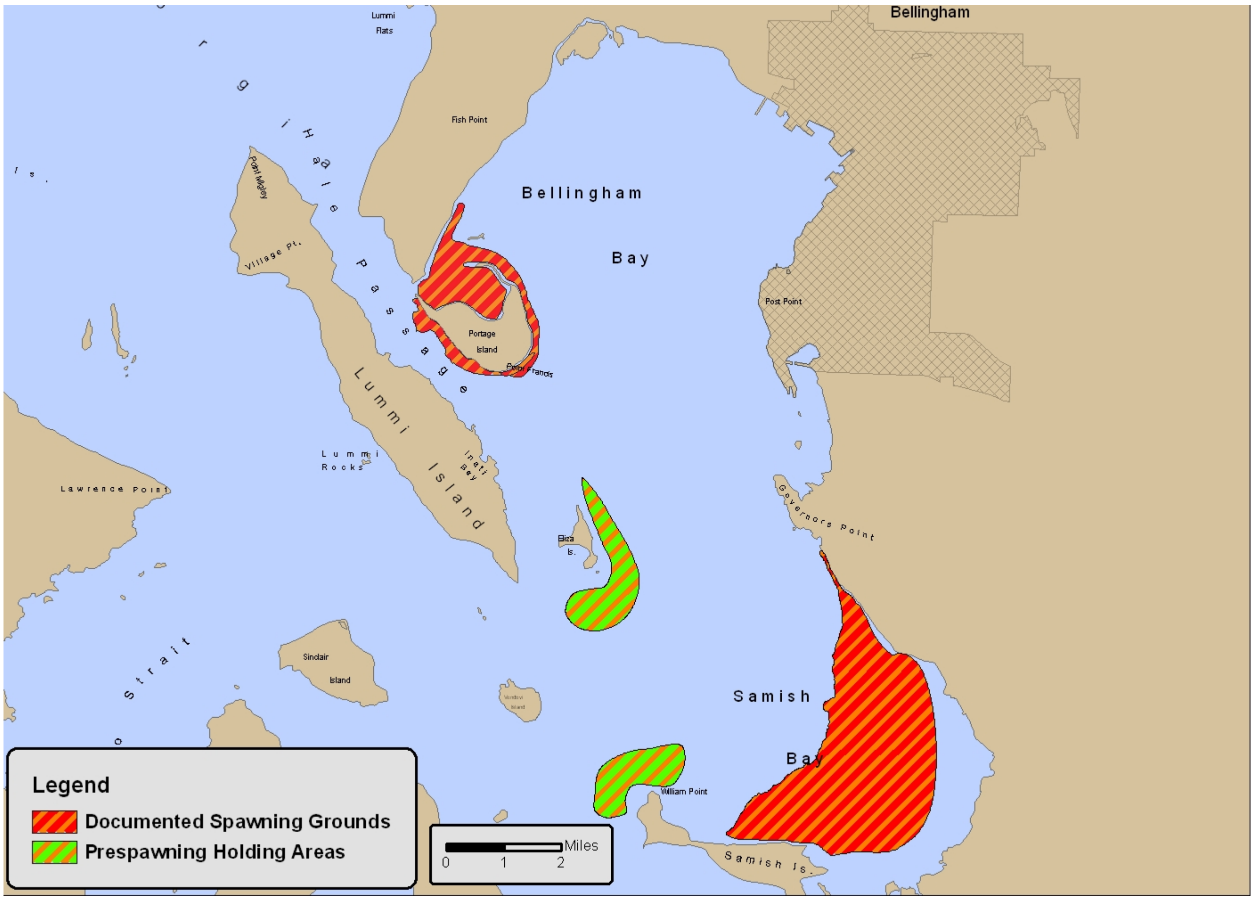
STOCK STATUS (2 year)
depressed: 20% of previous 25 yr mean spawning biomass

Samish/Portage Bay Herring Stock

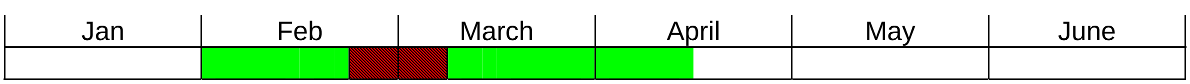
<u>OVERVIEW</u>

Spawning by this small north Puget Sound stock occurs in both Samish Bay and Portage Bay. The majority of spawning activity in recent years has been observed in Portage Bay. Spawning activity typically occurs from early February to late March. Some of this stock's spawning grounds overlap with those of the later spawning Cherry Point stock on the east side of Hale Passage. It is the only north Puget Sound stock classified as healthy as of 2008.

<u>SPAWNING GROUND</u>



<u>SPAWNING TIMING</u>



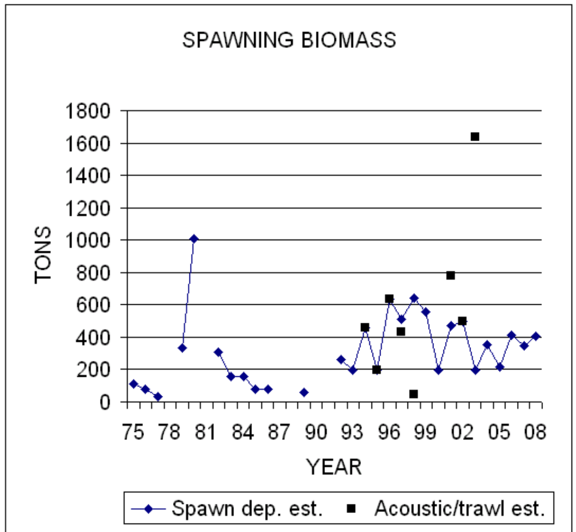
<u>MEAN LENGTH OF 2/3/4/5 YEAR OLDS</u>

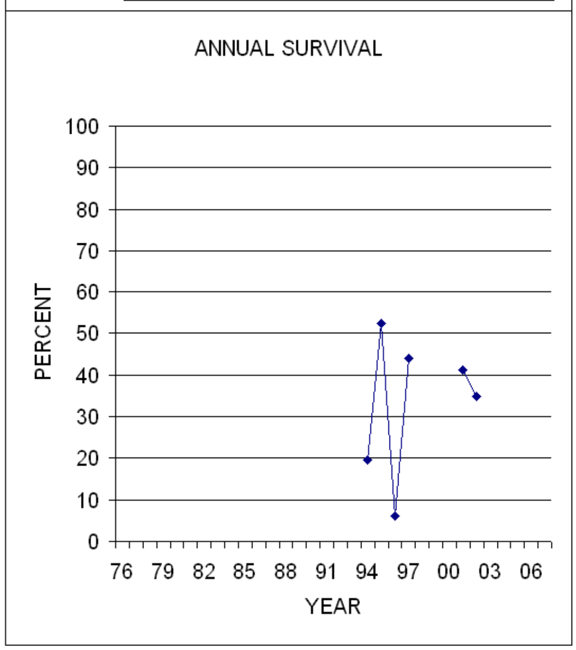
146mm/166mm/185mm/192mm (2003)

STOCK STATUS PROFILE for Samish/Portage Bay Herring Stock

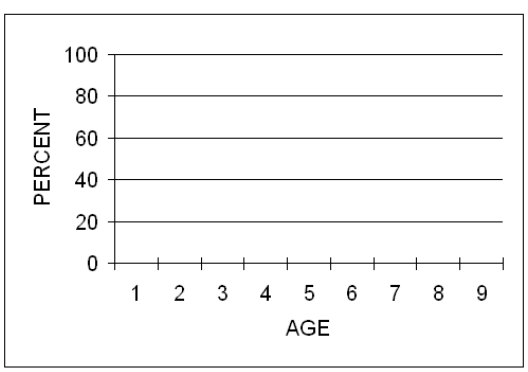
STOCK ASSESSMENT

	SPAWNING BIOMASS (tons)			
YEAR	SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75	109		109	
76	77		77	
77	32		32	
78				
79	333		333	
80	1008		1008	
81				
82	310		310	
83	159		159	
84	160		160	
85	78		78	
86	79		79	
87				
88				
89	58		58	
90				
91				
92	262		262	
93	198		198	
94		459	459	
95		194	194	66
96		636	636	487
97	509	431	509	452
98	643	48	643	419
99	555		555	
2000	196		196	
2001	470	778	470	
2002	496	497	496	283
2003	299	1638	199	20
2004	351		351	
2005	218		218	
2006	412		412	
2007	348		348	
2008	409		409	
MEAN:				
25 year	319	585	330	
5 year	348		348	





2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
poor

RECENT TREND (5 year)
stable

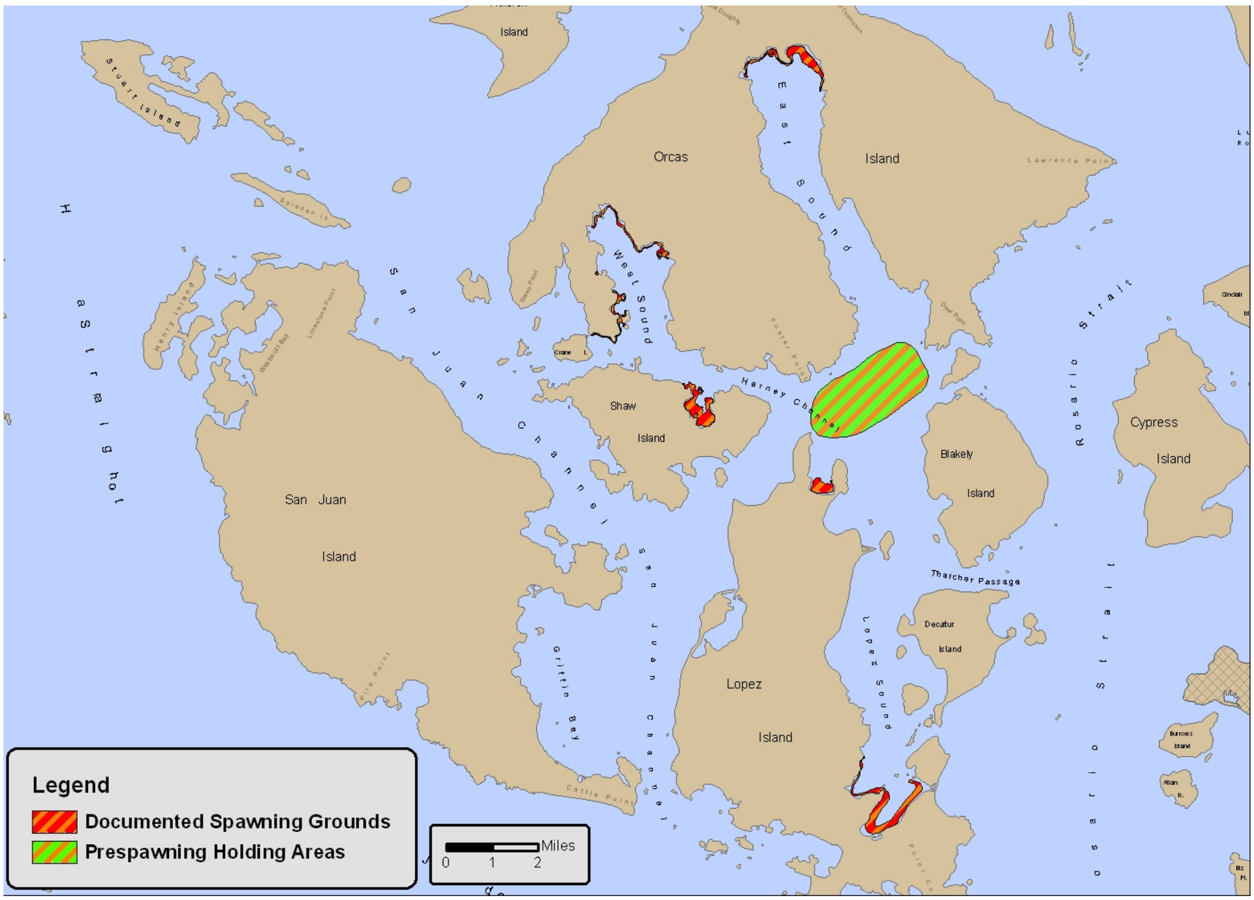
STOCK STATUS (2 year)
healthy: 115% of 25 yr mean spawning biomass

Interior San Juan Islands Herring Stock

OVERVIEW

The Interior San Juan Islands herring stock is small with spawning grounds in several separate areas and one known prespawner holding area near Harney Channel. Observed spawn deposition has been mostly in Mud Bay (Lopez Island) and East Sound (Orcas Island) in the last few years. Significant portions of eelgrass beds in Blind Bay previously used for spawning have disappeared. Spawning activity has been documented into late April. Current spawning biomass currently appears to be low, although it should be noted that sampling effort has been sporadic for this stock's spawning grounds.

SPAWNING GROUND



SPAWNING TIMING

Jan	Feb	March	April	May	June

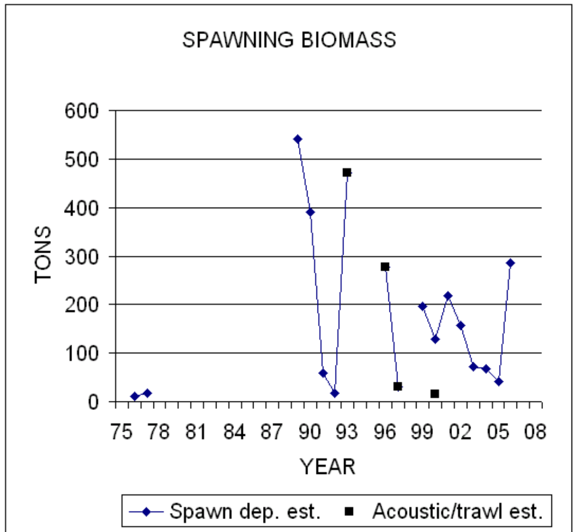
MEAN LENGTH OF 2/3 YEAR OLDS

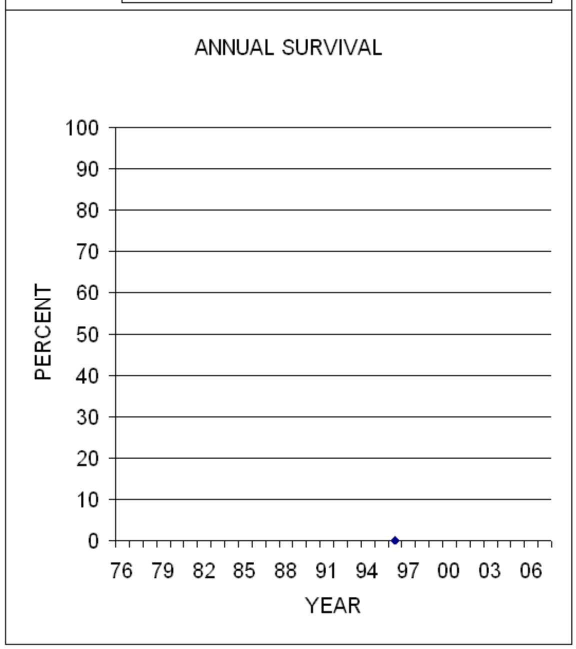
140mm/154mm (2000)

STOCK STATUS PROFILE for Interior San Juan Islands Herring Stock

STOCK ASSESSMENT

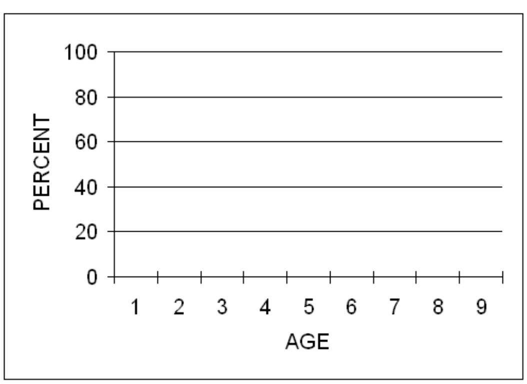
YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76	10		10	
77	18		18	
78				
79				
80				
81				
82				
83				
84				
85				
86				
87				
88				
89	541		541	
90	391		391	
91	60		60	
92	17		17	
93		472	472	
94				
95				
96		277	277	
97		30	30	30
98				
99	197		197	
2000	128	16	128	
2001	218		219	
2002	158		158	
2003	72		72	
2004	67		67	
2005	41		41	
2006	285		285	
2007	33		33	
2008	60		60	
MEAN:				
25 year	162	199	179	
5 year	97		97	





no data

2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
poor

RECENT TREND (5 year)
insufficient data

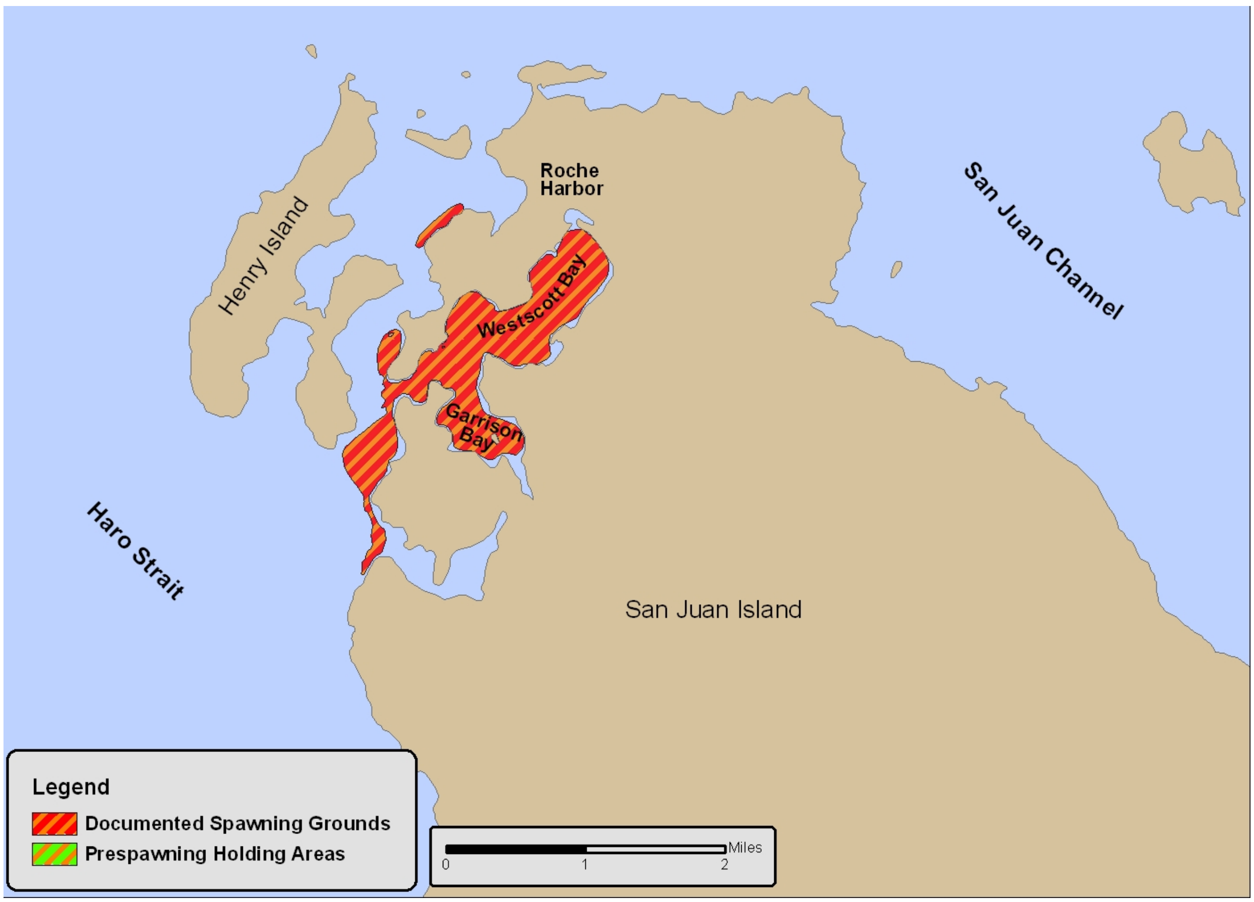
STOCK STATUS (2 year)
depressed: 26% of 25 yr mean spawning biomass

Northwest San Juan Island Herring Stock

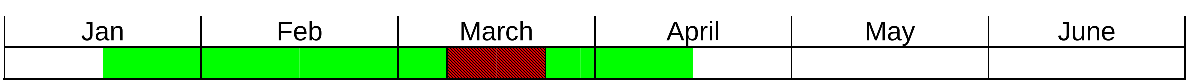
OVERVIEW

Historically, the Northwest San Juan Island stock is a small stock with spawning grounds primarily in Westcott Bay and Garrison Bay on San Juan Island. Stock distinction from the Interior San Juan Islands stock is based only on geographical separation. A virtually complete disappearance of extensive eelgrass beds for unknown reasons in Westcott and Garrison Bay that was first reported in 2001 has not improved. A shift in spawning location to other eelgrass beds in the vicinity (outside of Westcott and Garrison Bays) has not been documented. Limited spawn deposition survey effort has not documented any spawning activity here since 2003, causing this stock's status as "disappeared". It is possible this stock's spawners have strayed to other spawning populations with similar spawn timing and better spawning habitat as suggested for British Columbia herring (Ware and Tovey 2004).

SPAWNING GROUND



SPAWNING TIMING



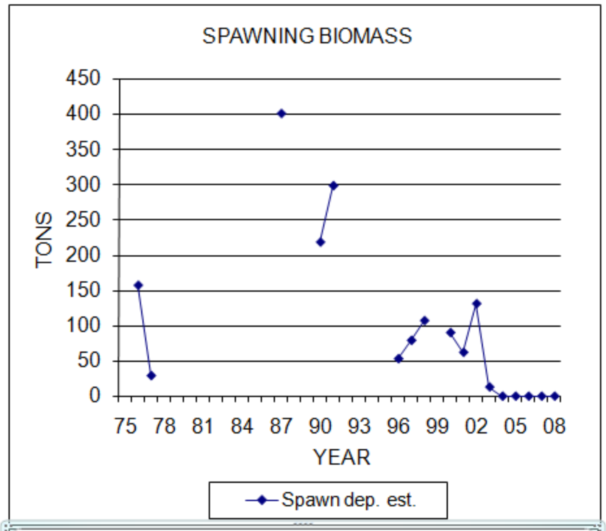
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

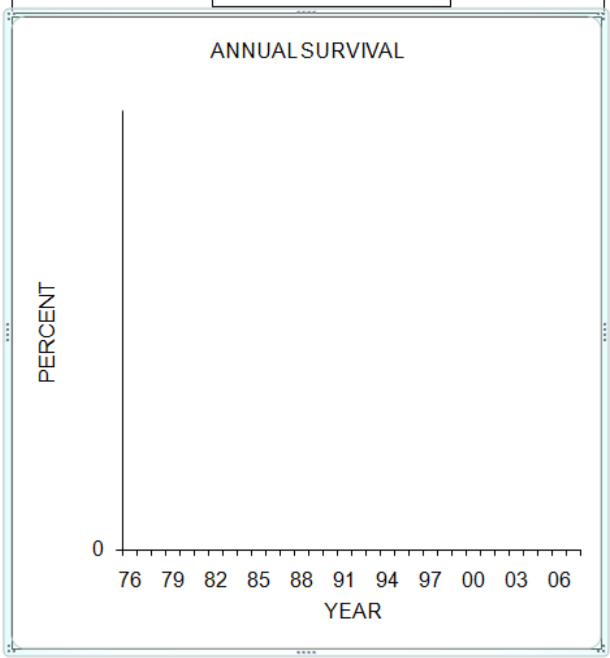
No data

STOCK STATUS PROFILE for NW San Juan Island Herring Stock

STOCK ASSESSMENT

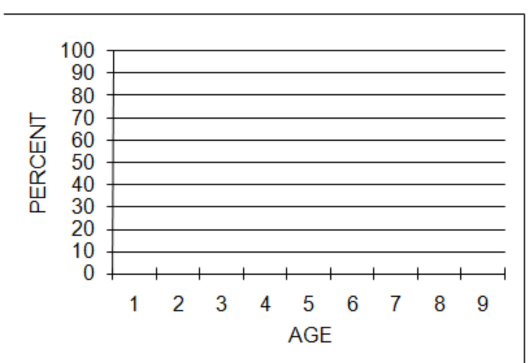
YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76	157		157	
77	29		29	
78				
79				
80				
81				
82				
83				
84				
85				
86				
87	400		400	
88				
89				
90	218		218	
91	298		298	
92				
93				
94				
95				
96	53		53	
97	79		79	
98	107		107	
99				
2000	90		90	
2001	62		62	
2002	131		131	
2003	13		13	
2004	0		0	
2005	0		0	
2006	0		0	
2007	0		0	
2008	0		0	
MEAN:				
25 year	97		97	
5 year	0		0	





no data

2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
poor

RECENT TREND (5 year)
no estimated spawning escapement

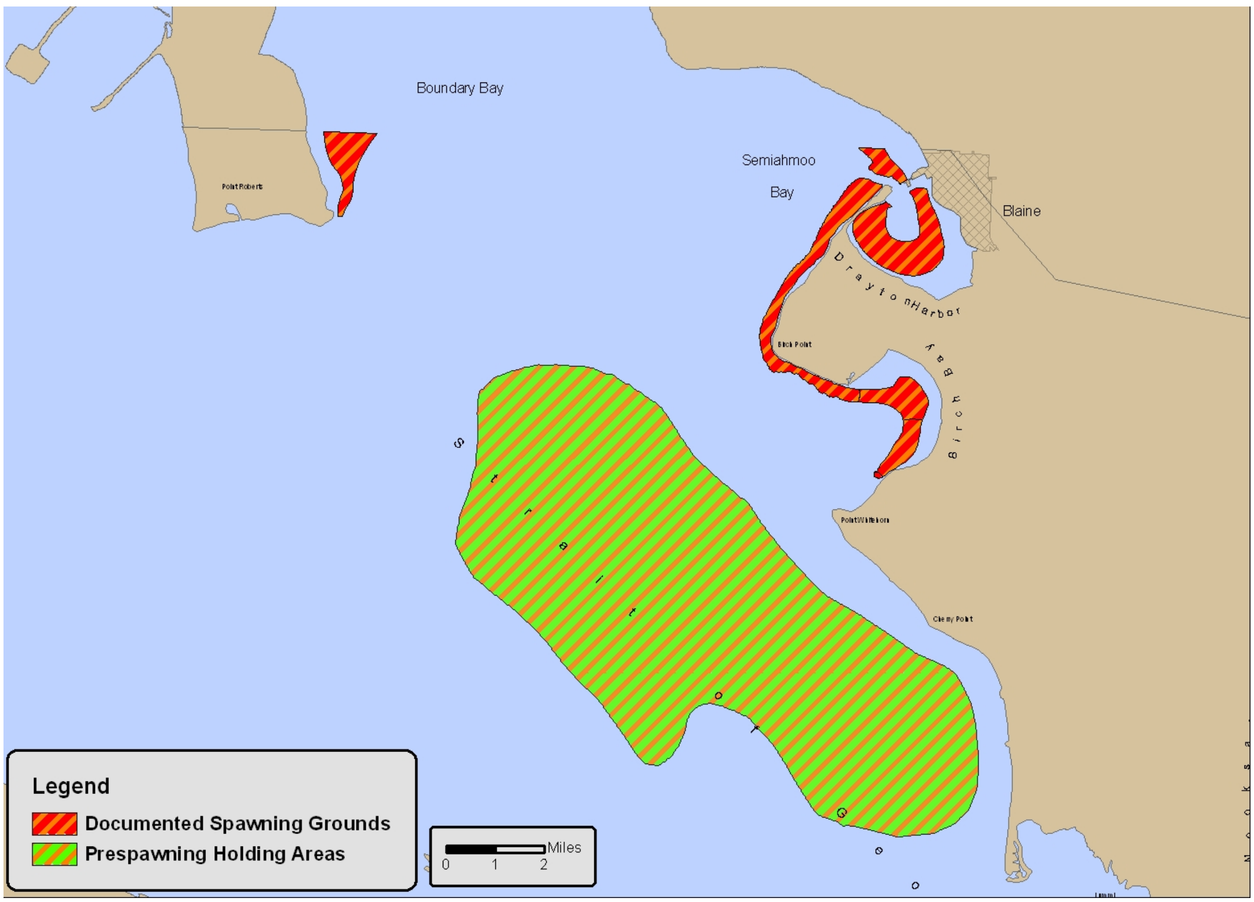
STOCK STATUS (2 year)
disappearance: 0% of 25 yr mean spawning biomass

Semiahmoo Bay Herring Stock

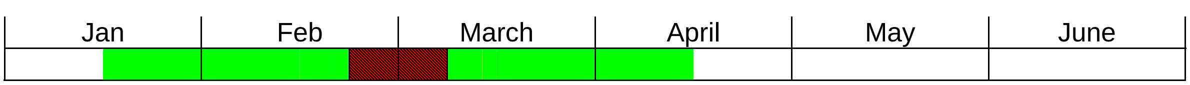
OVERVIEW

The Semiahmoo Bay herring stock is the northernmost stock in Washington. The stock's documented spawning grounds overlap with those of the spring spawning Cherry Point stock. Biological characteristics such as growth rates, and spawning behavior such as time of spawning, differ markedly between the two stocks on a consistent basis. Additionally, two studies (Small et al. 2005, Mitchell 2006) examining DNA microsatellites concluded this stock to be genetically differentiated from Cherry Point herring without significant observed genetic divergence from other sampled Puget Sound stocks. Spawning biomass for the last years has averaged 912 tons and the stock is considered to be moderately healthy.

SPAWNING GROUND



SPAWNING TIMING



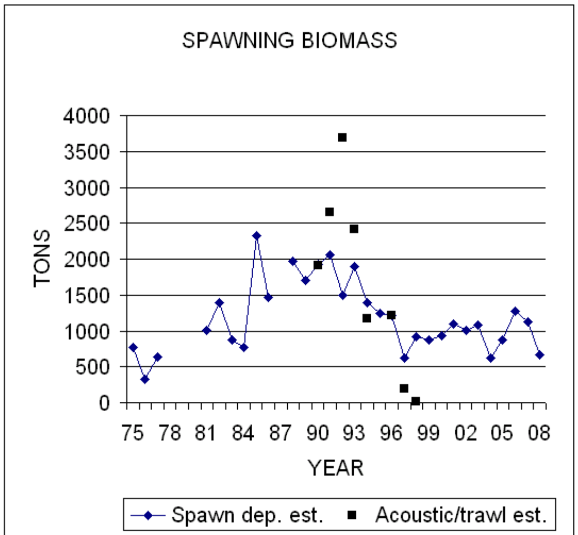
MEAN LENGTH OF 2/3/4/5/6 YEAR OLDS

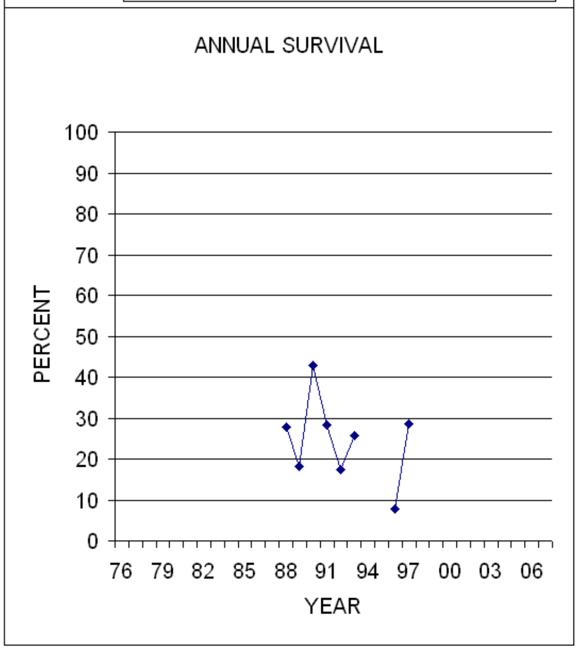
142mm/161mm/172mm/191mm/187mm (2005)

STOCK STATUS PROFILE for Semiahmoo Bay Herring Stock

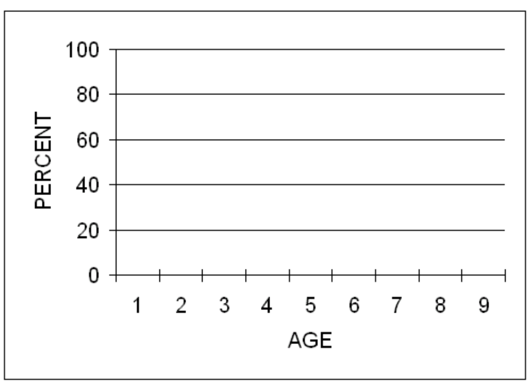
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75	772		772	
76	321		321	
77	634		634	
78				
79				
80				
81	1008		1008	
82	1389		1389	
83	874		874	
84	772		772	
85	2325		2325	
86	1464		1464	
87				
88	1965		1965	
89	1701		1701	978
90	1930	1909	1930	1573
91	2061	2655	2061	860
92	1501	3689	1501	636
93	1902	2416	1902	1554
94	1389	1166	1389	676
95	1245		1245	
96		1219	1219	
97	621	196	621	465
98	919	12	919	731
99	868		868	
2000	926		926	
2001	1098		1098	
2002	1012		1012	
2003	1087		1087	
2004	629		629	
2005	870		870	
2006	1277		1277	
2007	1124		1124	
2008	662		662	
MEAN:				
25 year	1276	1658	1274	
5 year	912		912	





2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
stable

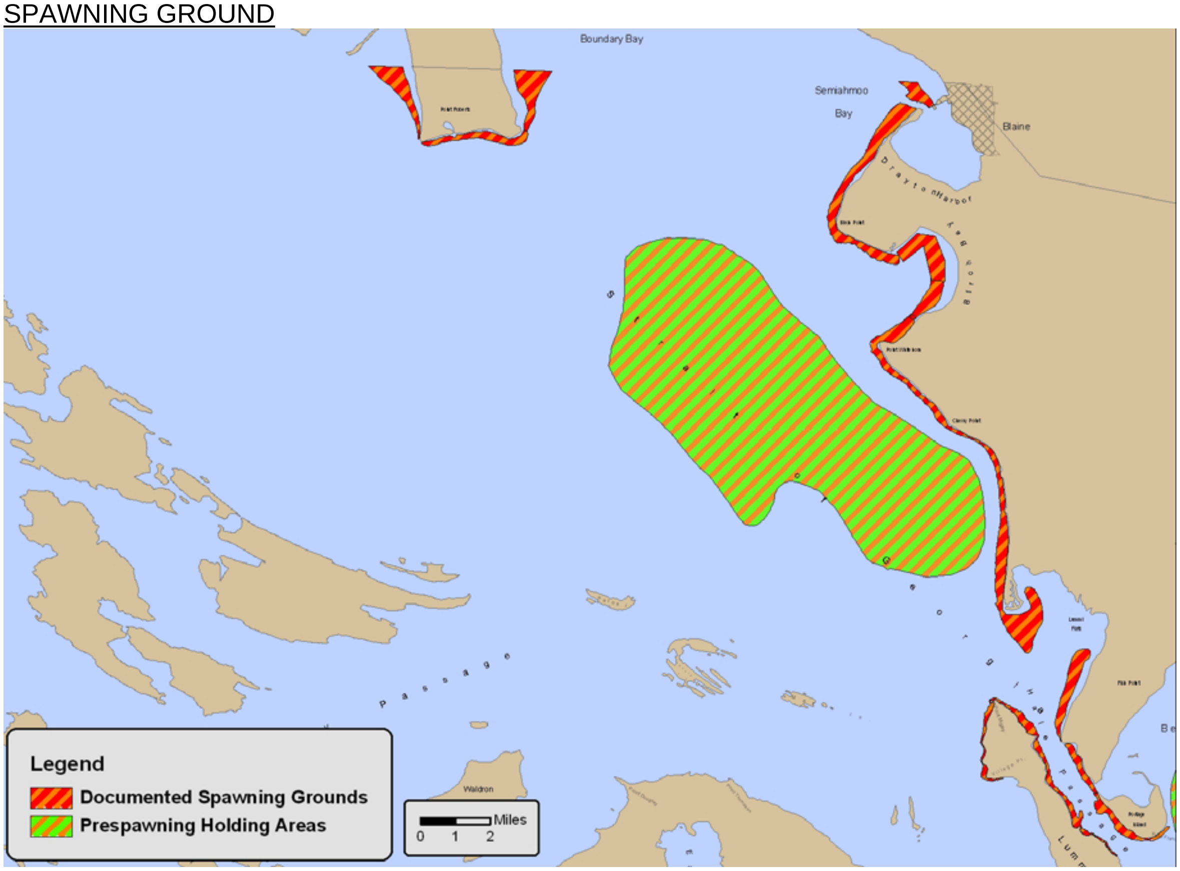
STOCK STATUS (2 year)
moderately healthy: 70% of 25 yr mean spawning biomass

Cherry Point Herring Stock

OVERVIEW

The Cherry Point herring stock is unique in Washington State because of its exceptionally late spawning timing. Cherry Point fish also exhibit relatively rapid growth rate after age 1 and are generally considered to be a “migratory” stock, probably moving to summer offshore feeding areas off of the continental shelf. Washington’s largest herring stock from the 1970s until the mid-1990s, its abundance has decreased dramatically and it continues to be in critical condition. Two status reviews by the federal government (Stout et al. 2001, Gustafson et al. 2006) concluded that the Cherry Point stock did not meet Endangered Species Act criteria to be considered a distinct population segment and it was not listed as endangered or threatened; it was considered to be part of a metapopulation that includes all herring populations in the Strait of Georgia and Puget Sound. However, as discussed in a previous section of this report, several recent genetic studies examining DNA microsatellites have demonstrated the Cherry Point stock to be genetically distinct from British Columbia and other Puget Sound stocks sampled to date, justifying its management as a discrete stock. A decrease in available spawning habitat has not been documented for this stock’s spawning grounds.

SPAWNING GROUND



SPAWNING TIMING

Jan	Feb	March	April	May	June

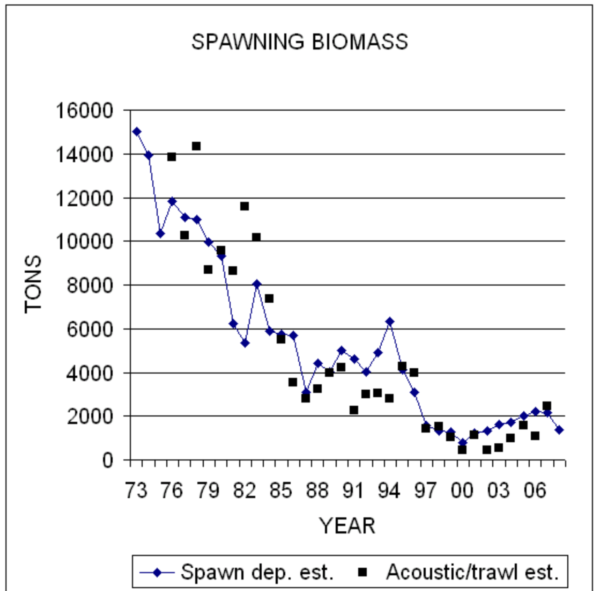
MEAN LENGTH OF 3/4 YEAR OLDS

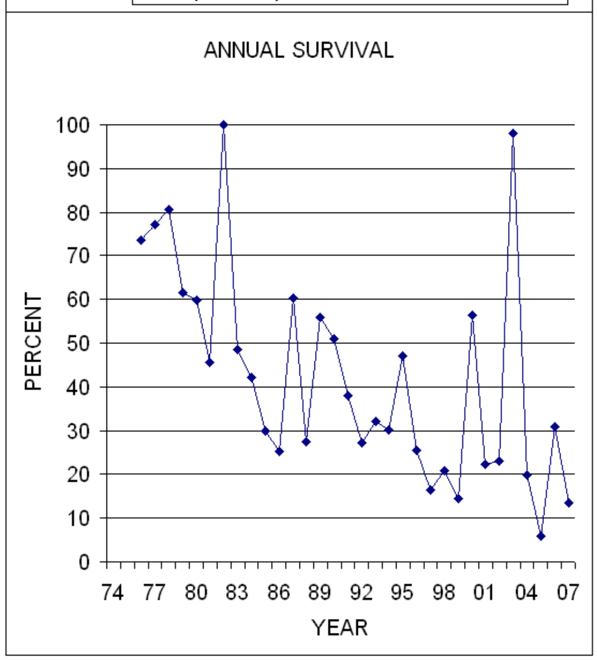
173mm/183mm (2008)

STOCK STATUS PROFILE for Cherry Point Herring Stock

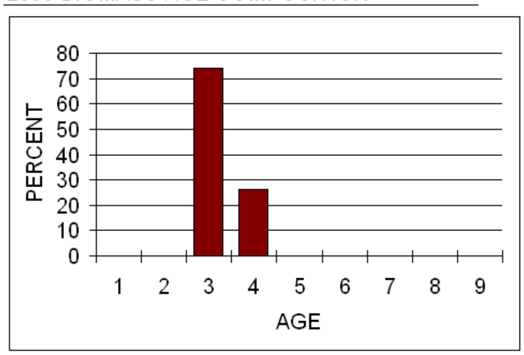
STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
73	14998		14998	
74	13963		13963	
75	10337		10337	1910
76	11844	13832	11844	1159
77	11097	10270	11097	3009
78	10973	14314	10973	3541
79	9957	8684	9957	1129
80	9329	9589	9329	3675
81	6219	8637	6219	397
82	5342	11562	5342	2043
83	8063	10142	8063	1385
84	5901	7347	5901	1001
85	5760	5519	5760	2928
86	5671	3528	5671	3295
87	3108	2775	3108	1155
88	4428	3236	4428	2080
89	4003	3963	4003	2497
90	4998	4215	4998	1901
91	4624	2278	4624	1141
92	4009	2998	4009	1991
93	4894	3055	4894	3434
94	6324	2777	6324	4076
95	4105	4251	4105	1204
96	3095	3971	3095	772
97	1574	1400	1574	645
98	1322	1502	1322	984
99	1266	1052	1266	890
2000	808	436	808	560
2001	1241	1146	1241	680
2002	1330	450	1330	974
2003	1611	555	1611	998
2004	1734	981	1734	22
2005	2010	1565	2010	1784
2006	2216	1102	2216	2029
2007	2169	2434	2169	1515
2008	1352		1352	952
MEAN:				
25 year	3182	2606	3182	
5 year	1896	1521	1896	





2008 BIOMASS AGE COMPOSITION



STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
good

RECENT TREND (5 year)
increasing

STOCK STATUS (2 year)
critical: 55% of 25 yr mean spawning biomass

Strait of Juan De Fuca Herring Stock Profiles

Discovery Bay Herring Stock

OVERVIEW

The Discovery Bay herring stock is traditionally the major Strait of Juan de Fuca stock. Its abundance has fluctuated dramatically since the early 1900's, when significant fishery landings suggested sizable spawning biomass; followed by decreased fishery activity and assumed abundance decline in the 1930's; a return to "relatively high" abundance levels during the 1940's and 1950's (Williams 1959); documented high abundance (peak of 3,220 tons in 1980) in the early 1980's; and generally very low abundance since 1990. The stock has no known fishery interceptions and its spawning grounds are presumed to be among the most pristine in Washington. Increased pinniped predation and/or movement to other spawning grounds with similar spawn timing are potential causes for biomass decline. Primarily due to the proximity of its spawning grounds to offshore feeding grounds, this stock has been suggested to be migratory.

SPAWNING GROUND

SPAWNING TIMING

Jan	Feb	March	April	May	June

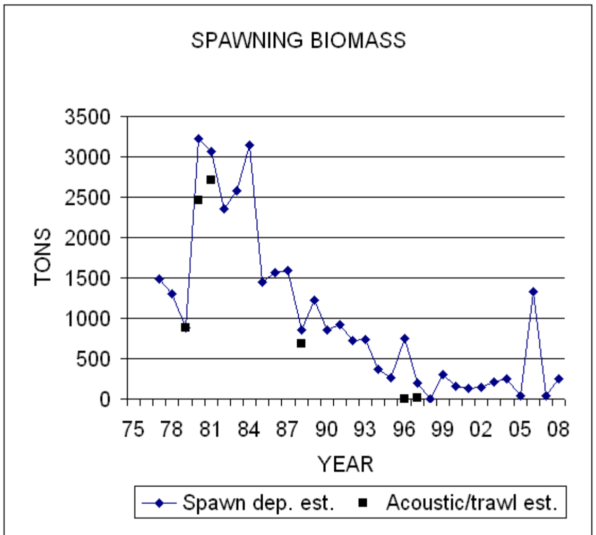
MEAN LENGTH OF 2/3/4 YEAR OLDS

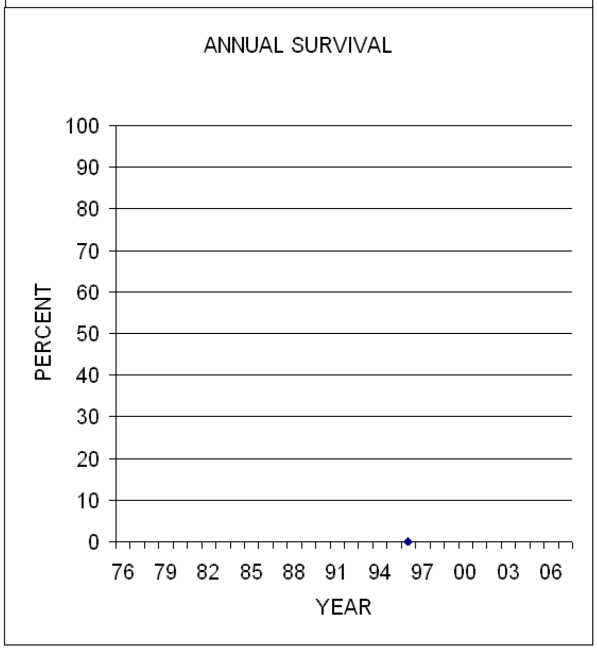
143mm/168mm/204mm (1997)

STOCK STATUS PROFILE for Discovery Bay Herring Stock

STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76	697			
77	1488		1488	
78	1305		1305	
79		882	882	
80	3220	2458	3220	
81	3070	2712	3070	
82	2356		2356	
83	2578		2578	
84	3144		3144	
85	1447		1447	
86	1566		1566	
87	1593		1593	
88	853	687	853	
89	1225		1225	
90	855		855	
91	925		925	
92	727		727	
93	737		737	
94	375		375	
95	261		261	
96	747	5	747	
97	199	19	199	
98	0		0	
99	307		307	
2000	159		159	
2001	137		137	
2002	148		148	
2003	207		207	
2004	252		252	
2005	33		33	
2006	1325		1325	
2007	42		42	
2008	248		248	
MEAN:				
25 year	700	237	700	
5 year	380		380	





no data

2008 BIOMASS AGE COMPOSITION

no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
fair

RECENT TREND (5 year)
stable

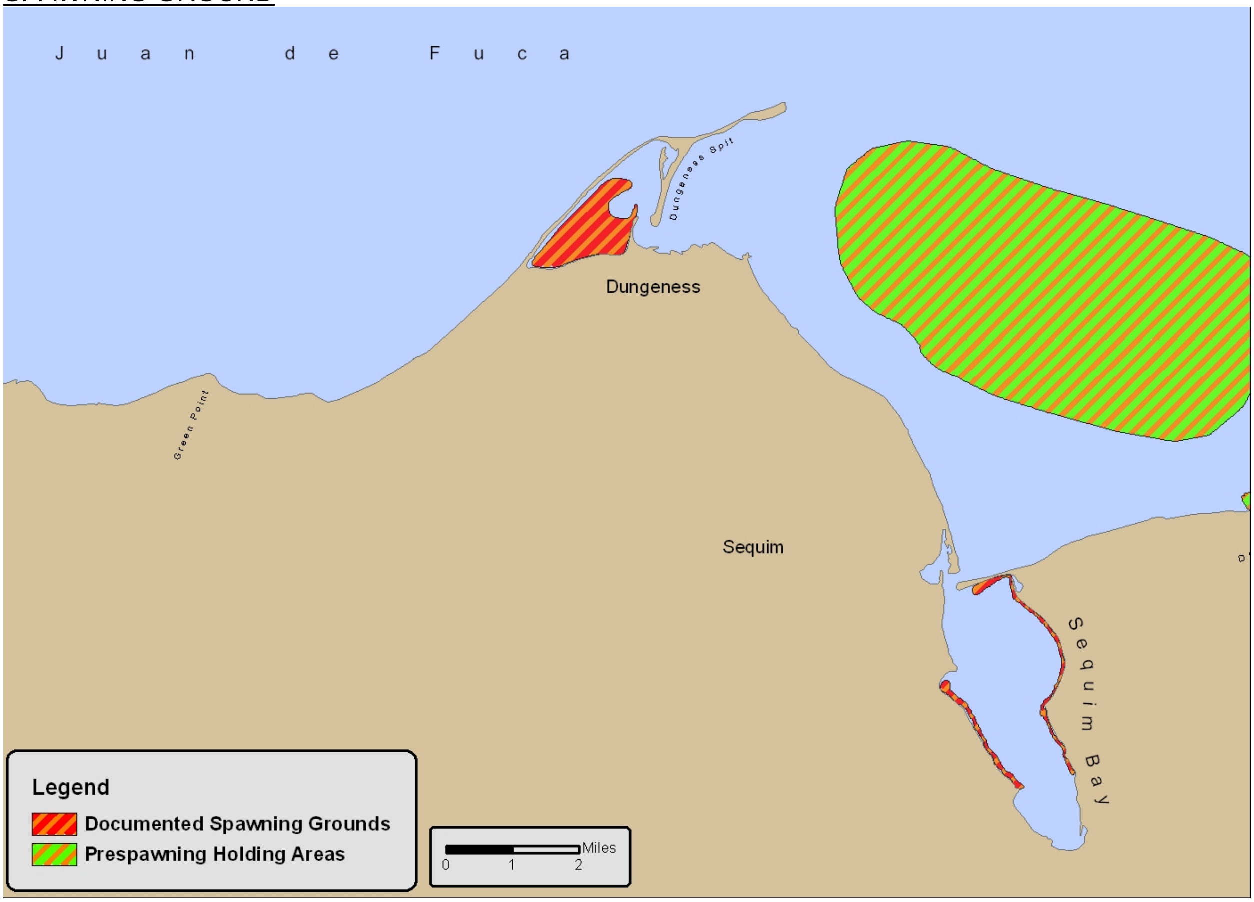
STOCK STATUS (2 year)
critical: 21% of 25 yr mean spawning biomass

Dungeness/Sequim Bay Herring Stock

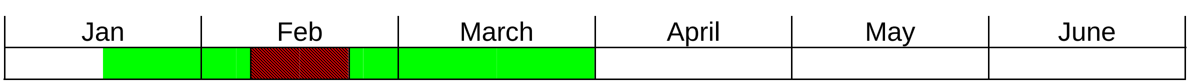
OVERVIEW

The Dungeness Bay portion of this small stock's spawning grounds hosts most, if not all, of its spawning activity. These spawning grounds are the westernmost documented grounds used by any Puget Sound stock. Despite the presence of abundant marine vegetation preferred for spawning in Sequim Bay, only one small spawning event has been documented there since 1994. Observed spawning activity in Sequim Bay was highest in the early 1980's when peak spawning biomass was documented for the nearby Discovery Bay stock, suggesting a "spillover" effect to Sequim Bay when the Discovery Bay population is at a high level of abundance. Documented spawn timing is slightly earlier for Dungeness Bay compared to Sequim Bay and Discovery Bay, again suggesting a link between those two spawning grounds. A decrease in available spawning substrate has been observed in parts of Dungeness Bay in recent years, but is not considered to be limiting abundance.

SPAWNING GROUND



SPAWNING TIMING



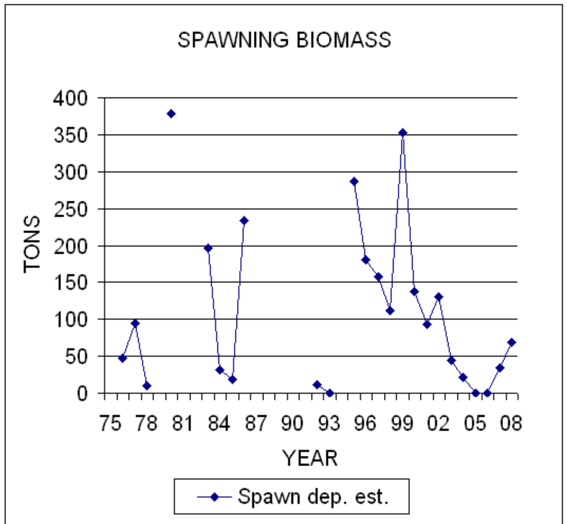
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

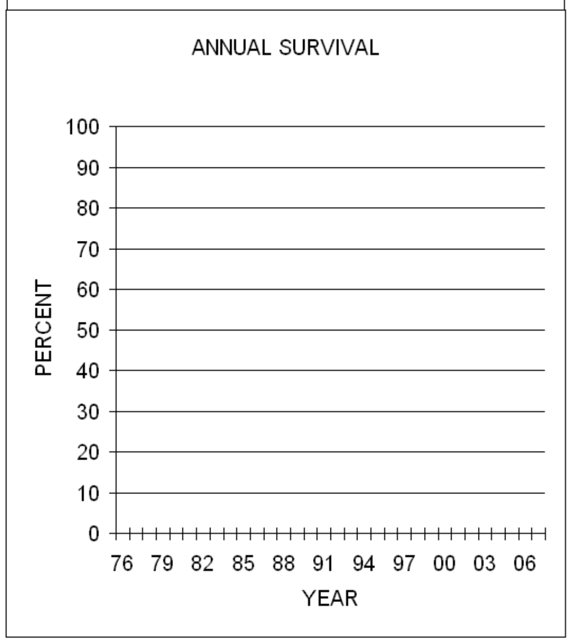
No data

STOCK STATUS PROFILE for Dungeness/Sequim Bay Herring Stock

STOCK ASSESSMENT

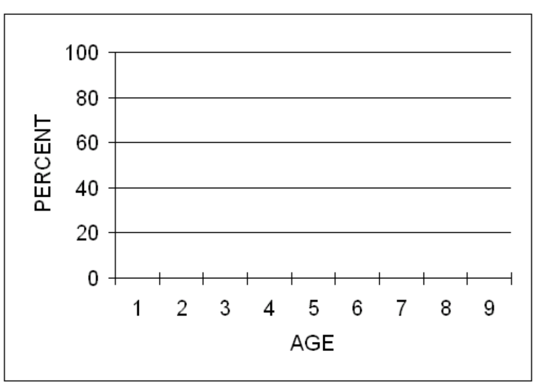
YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76	47		47	
77	94		94	
78	10		10	
79				
80	378		378	
81				
82				
83	197		197	
84	31		31	
85	18		18	
86	234		234	
87				
88				
89				
90				
91				
92	11		11	
93	0	(partial survey	0	
94		coverage)		
95	287		287	
96	180		180	
97	158		158	
98	112		112	
99	352		352	
2000	138		138	
2001	93		93	
2002	131		131	
2003	44		44	
2004	22		22	
2005	0		0	
2006	0		0	
2007	34		34	
2008	69		69	
MEAN:				
25 year	101		101	
5 year	25		25	





no data

2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
poor

RECENT TREND (5 year)
decreasing

STOCK STATUS (2 year)
depressed: 51% of 25 yr mean spawning biomass

Puget Sound Herring Stock Status Summary

The table on the next page includes individual, regional, and Puget Sound cumulative stock status summaries since 1994 based on two year mean spawning biomass estimates and status classification criteria described on page 11 of this report. Obviously, the value of a stock-by-stock evaluation is affected greatly by stock discreteness.

The discreteness of the Cherry Point herring stock has been repeatedly demonstrated by recent genetic studies detailed previously in this report. Evaluating abundance trends of the Squaxin Pass stock individually is also generally supported by these studies, although not as clearly as for the Cherry Point stock. The discreteness of other Puget Sound herring stocks is less certain. However, the lack of definitive genetic evidence does not preclude the existence of additional individual stock discreteness among Puget Sound herring. Further genetic studies are recommended to attempt to elucidate the stock structure of Puget Sound herring.

Therefore, if considerable intermixing/gene flow with numerous other "stocks" occurs, the individual stock statuses presented below may be of limited importance. It may be more useful to examine abundance levels and trends on a regional or sub-regional basis and also to consider genetic findings to date (e.g. separate the Cherry Point and Squaxin Pass stocks from their respective regions).

For the 2007-08 period, less than half (47%) of Puget Sound herring stocks are classified as healthy or moderately healthy. This is the lowest percentage of stocks meeting these criteria since development of the stock status summary in 1994, although very similar to the status breakdown for the previous two-year periods (2003-04 and 2005-06). No spawning activity has been documented for the N.W. San Juan Island stock for five consecutive seasons and it is classified as "disappearance". If possible, sampling effort should be continued to determine if/when a "recolonization" of spawning herring similar as that described in British Columbia areas (Ware and Tovey 2004) occurs there. Quilcene Bay, Holmes Harbor, and Skagit Bay currently appear to be in the healthiest condition of individual Puget Sound herring stocks.

The Cherry Point herring stock status continues to be considered critical. After a low estimated spawning biomass of 808 tons in 2000, followed by a steady, although moderate, increase through 2006, spawning biomass decreased for both 2007 and 2008. A lack of older spawning fish sampled from acoustic/trawl surveys of the Cherry Point stock continues to be a concern.

The spawning biomass for all Puget Sound stocks combined, excluding the Cherry Point stock, would be considered moderately healthy compared to the previous 25-year sum of mean spawning biomasses; the 2007-08 mean cumulative spawning biomass for those stocks is 11,656 tons and the previous 25-year sum of means is 16,263 tons. For the 2005-06 period, this grouping of stocks was also considered to be moderately healthy.

The other Puget Sound herring stock that appears to be genetically differentiated, Squaxin Pass, is considered to be healthy at this time. The relationship of the spawning fish in Carr Inlet observed in 2008 to the prespawning aggregation in Case Inlet is not known. Increased assessment surveys and further genetic sampling will hopefully clarify this issue and improve assessment of the Squaxin Pass stock.

The spawning biomass for all Puget Sound stocks combined, excluding both the Cherry Point and Squaxin Pass stocks, would be considered moderately healthy compared to the previous 25-year sum of mean spawning biomasses for 2007-08 after a healthy status classification for 2005-06. Regionally, south/central Puget Sound stocks combined, excluding Squaxin Pass, are considered healthy for 2005-06 and moderately healthy for 2007-08, reflecting a general high level of spawning biomass for this grouping in 2006.

The regional status for North Puget Sound herring stocks, excluding the Cherry Point stock, is depressed. Spawning biomass for the Fidalgo Bay stock, in particular, has declined significantly since 1999. The Portage/Samish Bay stock is the only North Puget Sound stock currently classified as healthy.

The Strait of Juan de Fuca region's status has been generally classified as critical since 1994, primarily due to the estimated spawning biomass of the Discovery Bay stock. An unexplained one-year significant increase in abundance was observed in 2006, followed by a dramatic decrease in 2007 and 2008. Such large year-to-year fluctuation brings into question the discreteness of this stock.

STOCK STATUS - Describes a stock's current condition based primarily on recent (previous 2 year mean) abundance compared to long-term (previous 25 year mean) abundance.

Stock criteria such as survival, recruitment, age composition, and spawning ground habitat condition are also considered.

HEALTHY - A stock with recent two year mean abundance above or within 10% of the 25 year mean.

MODERATELY HEALTHY - A stock with recent two year mean abundance within 30% of the 25 year mean, and/or with high dependence on recruitment.

DEPRESSED - A stock with recent abundance well below the long term mean, but not so low that permanent damage to the stock is likely (i.e., recruitment failure).

CRITICAL - A stock with recent abundance so low that permanent damage to the stock is likely or has already occurred (i.e., recruitment failure).

DISAPPEARANCE - A stock which can no longer be found in a formerly consistently utilized spawning ground.

UNKNOWN - Insufficient assessment data to identify stock status with confidence.

Region / Stock	2008	2006	2004	2002	2000	1998	1996	1994
South-Central Puget Sound	HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY
Squaxin Pass	HEALTHY	MOD. HEALTHY	HEALTHY	HEALTHY	HEALTHY	MOD. HEALTHY	MOD. HEALTHY	MOD. HEALTHY
Wollochet Bay	UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN				
Quartermaster Harbor	DEPRESSED	MOD. HEALTHY	MOD. HEALTHY	MOD. HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY
Port Orchard-Madison	HEALTHY	HEALTHY	MOD. HEALTHY	HEALTHY	HEALTHY	DEPRESSED	DEPRESSED	DEPRESSED
South Hood Canal	MOD. HEALTHY	HEALTHY	MOD. HEALTHY	MOD. HEALTHY	HEALTHY	MOD. HEALTHY	UNKNOWN	UNKNOWN
Quilcene Bay	HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY	UNKNOWN
Port Gamble	DEPRESSED	DEPRESSED	DEPRESSED	MOD. HEALTHY	HEALTHY	DEPRESSED	HEALTHY	HEALTHY
Kilisut Harbor	DEPRESSED	DEPRESSED	MOD. HEALTHY	HEALTHY	HEALTHY	MOD. HEALTHY	UNKNOWN	HEALTHY
Port Susan	MOD. HEALTHY	DEPRESSED	DEPRESSED	MOD. HEALTHY	MOD. HEALTHY	HEALTHY	DEPRESSED	MOD. HEALTHY
Holmes Harbor	HEALTHY	HEALTHY	HEALTHY	HEALTHY	DEPRESSED	HEALTHY	UNKNOWN	UNKNOWN
Skagit Bay	HEALTHY	HEALTHY	HEALTHY	HEALTHY	MOD. HEALTHY	MOD. HEALTHY	HEALTHY	UNKNOWN
North Puget Sound	DEPRESSED	DEPRESSED	DEPRESSED	DEPRESSED	DEPRESSED	DEPRESSED	MOD. HEALTHY	HEALTHY
Fidalgo Bay	DEPRESSED	DEPRESSED	DEPRESSED	HEALTHY	HEALTHY	HEALTHY	MOD. HEALTHY	MOD. HEALTHY
Samish/Portage Bay	HEALTHY	HEALTHY	MOD. HEALTHY	HEALTHY	HEALTHY	HEALTHY	HEALTHY	MOD. HEALTHY
Interior San Juan Is.	DEPRESSED	MOD. HEALTHY	DEPRESSED	MOD. HEALTHY	DEPRESSED	UNKNOWN	UNKNOWN	UNKNOWN
N.W. San Juan Is.	DISAPPEARANCE	DEPRESSED	CRITICAL	DEPRESSED	UNKNOWN	DEPRESSED	UNKNOWN	UNKNOWN
Semiahmoo Bay	MOD. HEALTHY	MOD. HEALTHY	DEPRESSED	MOD. HEALTHY	DEPRESSED	DEPRESSED	HEALTHY	HEALTHY
Cherry Point	CRITICAL	CRITICAL	CRITICAL	CRITICAL	CRITICAL	CRITICAL	DEPRESSED	MOD. HEALTHY
Strait of Juan de Fuca	CRITICAL	DEPRESSED	CRITICAL	CRITICAL	CRITICAL	CRITICAL	CRITICAL	CRITICAL
Discovery Bay	CRITICAL	DEPRESSED	CRITICAL	CRITICAL	CRITICAL	CRITICAL	CRITICAL	CRITICAL
Dungeness/Sequim Bay	DEPRESSED	DEPRESSED	DEPRESSED	MOD. HEALTHY	HEALTHY	HEALTHY	HEALTHY	UNKNOWN
Puget Sound Combined	MOD. HEALTHY	HEALTHY	MOD. HEALTHY	HEALTHY	MOD. HEALTHY	MOD. HEALTHY	MOD. HEALTHY	HEALTHY

Individual Stock Comparison	2008	2006	2004	2002	2000	1998	1996	1994
HEALTHY	6 stocks	6 stocks	4 stocks	8 stocks	10 stocks	7 stocks	7 stocks	4 stocks
MOD. HEALTHY	3 stocks	4 stocks	5 stocks	7 stocks	2 stocks	3 stocks	2 stocks	5 stocks
DEPRESSED	6 stocks	7 stocks	6 stocks	1 stock	3 stocks	5 stocks	3 stocks	1 stock
CRITICAL	2 stocks	1 stock	3 stocks	2 stocks	2 stocks	2 stocks	1 stock	1 stock
DISAPPEARANCE	1 stock	0 stocks	0 stocks	0 stocks	0 stocks	0 stocks	0 stocks	0 stocks
UNKNOWN	1 stock	1 stock	1 stock	1 stock	1 stock	1 stock	5 stocks	7 stocks
	47% Healthy or Mod. Healthy	56% Healthy or Mod. Healthy	50% Healthy or Mod. Healthy	83% Healthy or Mod. Healthy	71% Healthy or Mod. Healthy	59% Healthy or Mod. Healthy	69% Healthy or Mod. Healthy	82% Healthy or Mod. Healthy

Puget Sound Herring Spawning Biomass Estimates, 1973-2008

The herring spawning biomass estimates for individual stocks previously presented in the individual stock profiles demonstrate the large annual fluctuations indicated from assessment surveys conducted since 1973. Pacific herring abundance, as well as for other forage fishes, has a tendency to fluctuate greatly (Bargmann 1998). As discussed in previous sections, it is likely that there is considerable gene flow between various Puget Sound herring stocks. Therefore, grouping stocks by region that have not demonstrated genetic divergence (e.g. Cherry Point and Squaxin Pass stocks) may be the most meaningful way to attempt to determine abundance trends and comparisons for the Puget Sound herring resource.

The precipitous decline of the Cherry Point herring stock has been obvious and well documented (Fig. 1-3). The genetic divergence of this stock has been repeatedly demonstrated and any analysis of abundance trends should consider other Puget Sound herring stocks to be discrete from the Cherry Point stock. The cumulative spawning biomass of all other Puget Sound herring stocks has not exhibited a decrease similar to the Cherry Point stock, fluctuating between about 10,000 and 16,000 tons (Fig. 3).

The south/central Puget Sound combined stock spawning biomass has exhibited a general increasing trend since 1997 (Fig. 1). However, between 1976 and 1996, only the spawning biomass for the 10-12 larger Puget Sound stocks was estimated annually, with the remaining smaller stocks surveyed on a rotational basis. Other than the Cherry Point stock, very few Puget Sound herring stocks were assessed prior to 1976. The increased sampling effort since 1996 suggests an exaggeratedly high level of cumulative spawning abundance for the south/central Puget Sound region in particular.

To account for the lack of sampling effort in a given year the historical (1973-2008) mean estimated spawning biomass for a stock can be assumed. Figure 2-4 assume the historical mean if a stock was not sampled. The south/central Puget Sound region’s cumulative spawning biomass has been relatively high (approx. 10,000 tons) since the late 1990’s and is comparable to estimated abundance in the late 1970’s and 1980’s.

The North Puget Sound region herring spawning biomass, excluding the Cherry Point stock, is currently at a low level of abundance, following a cumulative peak observed in the 1990’s (Fig. 1, 2 and 4). The Portage Bay/Samish Bay stock is the only stock in this region whose abundance higher than the historical average in recent years.

The cumulative estimated herring spawning biomass for the herring stocks in the Strait of Juan de Fuca region continues to be very low compared to the peak period observed in the early 1980’s. The Discovery Bay stock had an unexplained significant one-year increase in 2006, casting doubt on the amount of natal homing and fidelity for this stock.

Although not as obvious as for the Cherry Point stock, it appears possible that the Squaxin Pass herring stock is also genetically discrete from other populations. The reported estimated spawning biomass for the Squaxin Pass stock has fluctuated drastically and recent spawning biomass is relatively high for this stock (Fig. 4). The years of extremely low reported spawning biomass (e.g. less than 150 tons in 1977-79 and 1997-98) were generally based on spawn deposition surveys, which likely underestimated abundance for this stock as described previously in its stock profile.

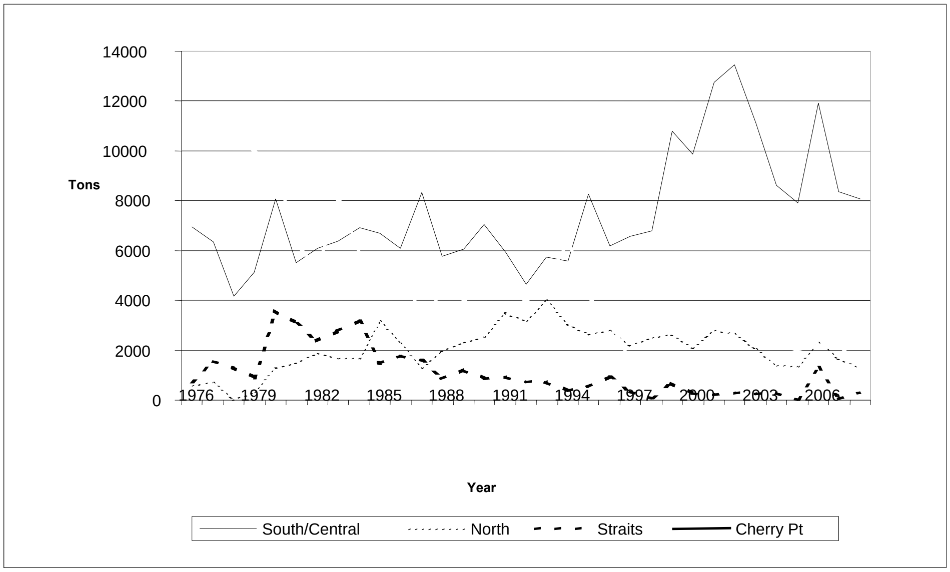


Figure 1. Puget Sound Herring Cumulative Spawning Biomass Estimates by Region and Cherry Point stock, 1976-2008 (Sampled stocks only included in figure).

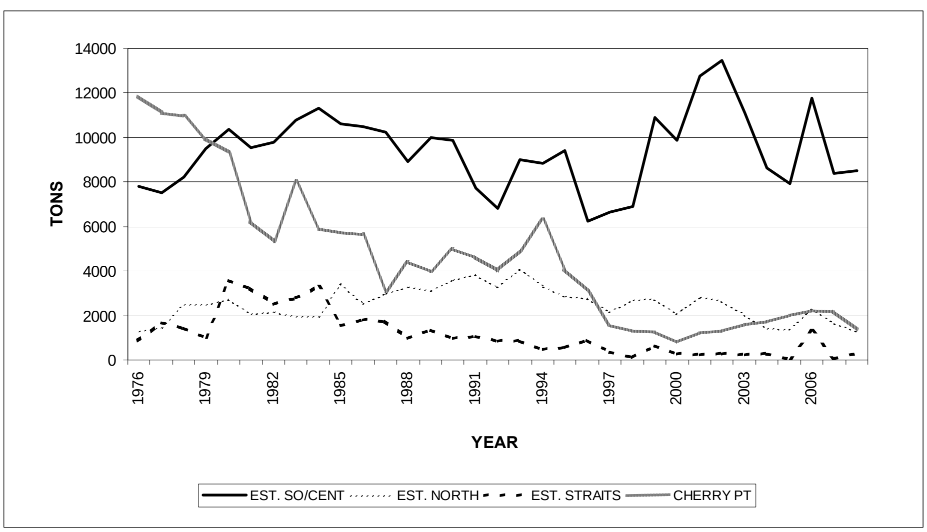


Figure 2. Puget Sound Herring Cumulative Spawning Biomass Estimates by Region and Cherry Point stock, 1976-2008 (historical mean assumed if stock not sampled).

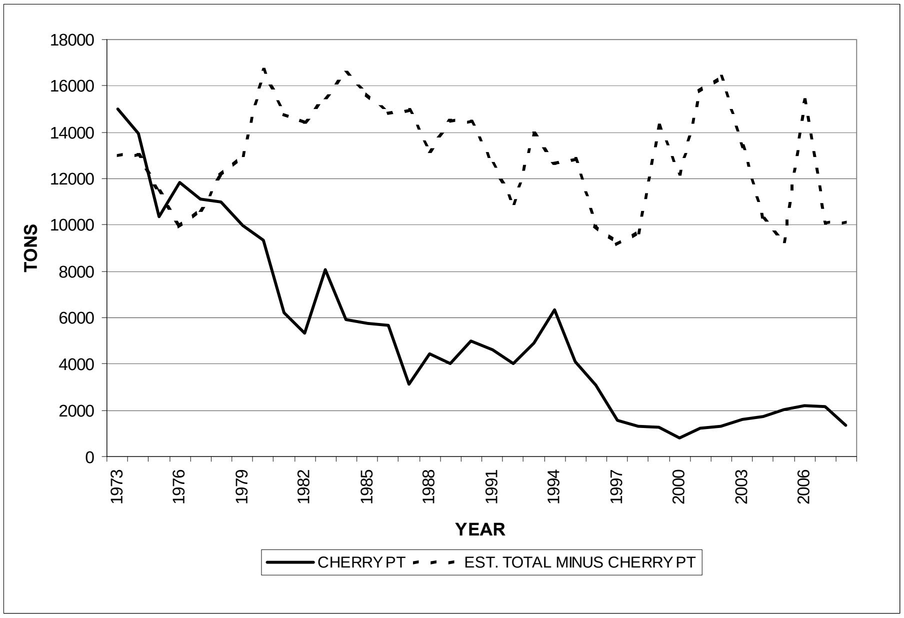


Figure 3. Puget Sound Herring Cumulative Spawning Biomass Estimates, Cherry Point stock compared to all other stocks combined, 1973-2008 (historical mean assumed if stock not sampled).

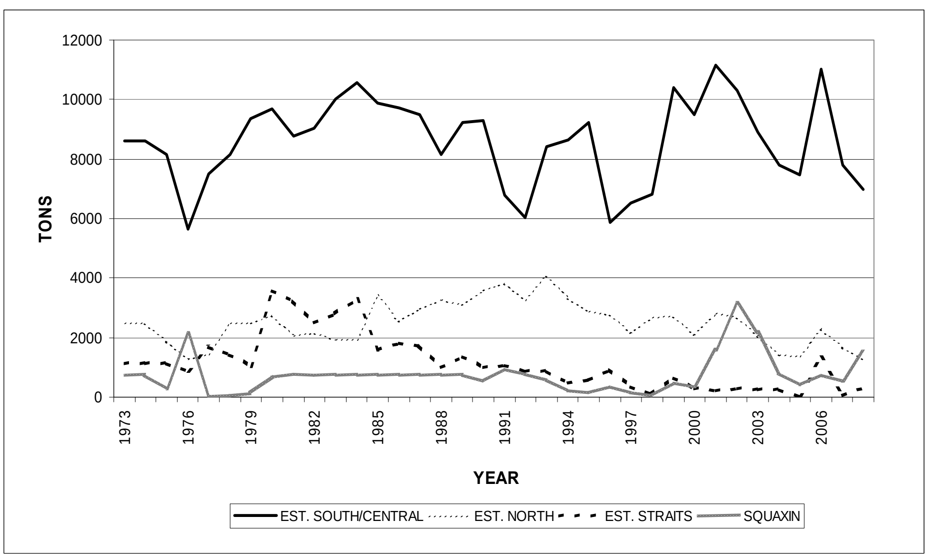


Figure 4. Puget Sound Herring Cumulative Spawning Biomass Estimates by Region and Squaxin Pass stock, 1973-2008 (historical mean assumed if stock not sampled).

Summary of Puget Sound Herring Fisheries

Commercial herring fisheries in Puget Sound have experienced several major shifts since the start of the last century as described in detail by Trumble (1983) and Williams (1959).

Commercial herring fisheries in the early 1900s harvested herring mainly for export , a market that collapsed soon after World War I. During this time purse seines, drag seines, and traps targeted herring with most of the catch coming from Hale Pass (north Puget Sound), Holmes Harbor, Birch Bay, Poulsbo, and Discovery Bay.

From the 1920s through the 1940s the major portion of herring landings were used as bait for commercial halibut, crab, and shark fisheries. Herring traps accounted for much of the landings beginning in the 1920s. Traps were typically located adjacent to or near spawning grounds to intercept adult fish migrating to and from spawning areas. The most successful trap sites were the southwest shore of Holmes Harbor and at Point Whitney near Quilcene Bay in Hood Canal. Total reported herring landings through the 1940s ranged from a low of 36 tons in 1942 to a high of 1,311 tons in 1926 (Chapman et al. 1941 and Williams 1959).

By the early 1950s, commercial herring fishing emphasis in Puget Sound shifted again to primarily supply bait to growing recreational salmon fisheries. Changing market conditions and trap location restrictions in 1937 decreased the number of operational herring traps to one (in Holmes Harbor) by 1947 and led to a gradual reduction in trap landings, the last of which occurred in 1971.

The next shift in the Puget Sound herring fishery happened in 1957 when the reduction of herring to oil and meal was authorized. This led to a sizable fishery in north Puget Sound, with landings from 1,500 to 3,500 tons. This fishery was phased out in the early 1980s due to concerns about potential effects on local herring stock abundance.

In 1972, a sac-roe fishery targeting the Cherry Point stock began. Landings in this treaty and non-treaty fishery topped 4,000 tons in 1974. Declines in the north Puget Sound herring stocks, particularly the Cherry Point stock, led to the closure of both the reduction and sac-roe fisheries by the mid-1980s. In 1988, a non-tribal spawn-on-kelp and treaty sac-roe fisheries were resumed on the Cherry Point stock. Another decline in Cherry Point stock abundance in the mid-1990s again closed this fishery and has remained closed to date. A minimum spawning biomass of 3,200 tons for the Cherry Point stock is currently required before harvest is considered.

The only current commercial herring fishery operating in Puget Sound provides bait for sport salmon and groundfish fisheries. Fishing activity is primarily in south and central Puget Sound and mostly targets juvenile herring assumed to be an aggregate of stocks within the region. Most of the harvest is taken by non-tribal fishers using relatively small (maximum length of 200 feet) lampara seines. The size of annual landings by this fishery are generally determined by market conditions, which are heavily influenced by the length of recreational salmon seasons. Similarly, Williams (1959) and Chapman et al. (1941) reported that herring landings are affected most by variability of fishing effort and that annual catch figures are not a reliable indicator of herring abundance. It is also likely that periodic reports of a lack of “plug” herring (i.e. age 1+ or older) by commercial fishers inside Puget Sound is often an indication of out-migration to offshore feeding grounds.

Annual landings by the herring sport bait fishery for the last ten years (1998-2007) have averaged 387 tons, ranging from a low of 222 tons in 2006 to a high of 592 tons in 2002. Preliminary reported landings for 2008 are approximately 330 tons. The annual maximum harvest guideline is set at 10% of average adult biomass in the south/central Puget Sound region, which has averaged more than 10,000 tons for the last ten years. Landings for 1998-2007 were well below the harvest guideline, ranging from 2% to 6% of the sum of mean adult spawning biomass estimates for south/central Puget Sound stocks for the same time period.

In general, the results of genetic studies to date also support current management of the commercial herring bait fishery, which operates on a maximum harvest guideline based on regional cumulative spawning biomass estimates. Bait fishery harvest is primarily of juvenile fish that are presumed to consist of mixed stocks (Trumble 1983).

Seasonal gear closures of documented spawning grounds are in place to protect spawning adult herring from harvest by the commercial bait fishery. Additionally, fishing is not allowed in north Puget Sound or near Discovery Bay to prevent the harvest of Cherry Point and Discovery Bay herring, respectively. Hood Canal has also been closed since 2004 to all commercial herring fishing due to concerns of the impacts of low dissolved oxygen on herring abundance, although this closure was not based on observed changes in adult spawning biomass estimates of Hood Canal area herring stocks.

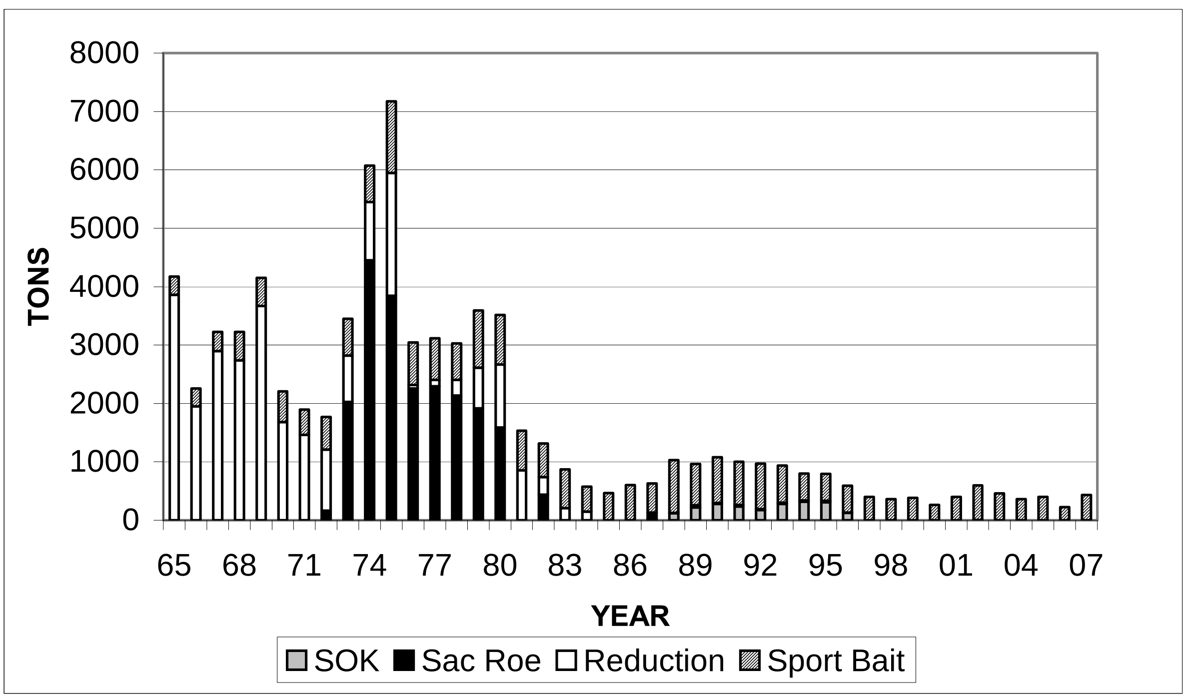


Figure 5. Puget Sound Herring Landings by Fishery Type, 1965-2007.

Natural Mortality

The abundance of Puget Sound herring stocks is impacted significantly by mortality rates. Mortality can be attributed to two types: fishing and natural mortality (all causes other than human harvest).

Fish survival and mortality are often expressed in terms of rates or percentages. The survival rate is the number of fish alive after a specified time (usually yearly), divided by the initial number. The mortality rate, based on the number of fish not surviving, is equal to 1 minus the survival rate (e.g., an annual survival rate of 35% would produce an annual mortality rate of 65%). Adult herring mortality rates of 30-40% are considered typical for herring worldwide (Lemberg et al. 1997).

Adult herring mortality and survival has been estimated for the Cherry Point stock since 1976. Additional stocks were included in mortality estimates beginning in 1987 when acoustic/trawl survey effort was increased. Figure 6 shows estimates of annual tonnages of herring in Puget Sound determined by natural mortality/survival rates, fishery harvest, and cumulative spawning biomass. The mortality rate estimate used includes all available results for that year (Cherry Point stock only prior to 1987; as many as 14 individual stock estimates since 1987). It is assumed that the cumulative spawner biomass estimate is reflective of total spawner biomass and that complete discreteness exists between sampled stocks. However, as mentioned in previous sections, this assumption may be flawed.

The annual mortality rate estimate for the Cherry Point herring stock has increased from a range of 20-40% in the late 1970s to an average of 68% since 1990. The mean estimated annual natural mortality rate for other sampled stocks since 1990 has averaged 72%; again, high for herring populations. Fishing mortality since 1997 has averaged about 4% of estimated natural mortality.

While significant gene flow between different stocks would affect the accuracy of calculated mortality rates, there is no question that there has been a decrease in the mean and median age (and size) of sampled adult herring in Puget Sound. Relatively good recruitment has sustained most stocks despite the high natural mortality observed.

Potential causes of increased natural mortality include predation, disease, and climatic changes. NMFS (1997) estimated that the harbor seal (*Phoca vitulina*) population in all Washington waters increased 7.7% annually between 1978 and 1993 and the harbor seal population in inland waters of Washington more than doubled from 7,380 in 1983 to 15,634 in 1993 (WDFW and National Marine Mammal Laboratory data reported by West 1997). Herring are among the primary pinniped prey species in Washington (Schmitt et al. 1995, Lance and Jeffries 2007) and southern B.C. waters (Olesiuk 1990).

Herring in Puget Sound and throughout the eastern North Pacific are impacted by at least three pathogens (*Ichthyophonus hoferi*, viral hemorrhagic septicemia virus, and erythrocytic necrosis virus) that exert population-level effects through different epizootiological mechanisms.

Ichthyophonus hoferi is an internal Mesomycetozoan parasite (Mendoza et al. 2002) that currently occurs in high prevalences in herring populations throughout the eastern North Pacific. Recurring large scale epizootics of ichthyophoniasis occur in Atlantic herring populations, often resulting in massive mortalities, population crashes, and unmarketable herring product (reviewed in McVicar 1999). *Ichthyophonus* surveillances in prespawner Puget Sound herring have been performed annually since 2000, and annual infection prevalence is typically 20-55% (Hershberger et al. 2002, Hershberger and Stick unpublished data). An interesting outlier has consistently occurred in the Squaxin Pass herring stock, where prevalence is typically around 5%, supporting the hypothesis that this population is likely the most resident of all the Puget Sound herring populations because *Ichthyophonus* exposures and subsequent infections likely occur in the Straits or coastal shelf. Among the metapopulation of herring in Puget Sound, *Ichthyophonus* prevalence increases with herring age, ranging from 12% among juveniles to 55% among the oldest adults (Hershberger et al. 2002). Recent studies indicate that *Ichthyophonus*-infected fish demonstrate decreased swimming performance (Kocan et al. 2006) and infected herring are preferentially selected by salmonid and cottid predators (Vollset et al. in preparation). These epidemiological data indicate that direct and indirect mortality from ichthyophoniasis may contribute to the disappearance of the older herring age cohorts in Puget Sound and account for observed age structure truncation among the Puget Sound herring stocks.

Viral hemorrhagic septicemia virus (VHSV) is a highly virulent rhabdovirus of marine forage fishes in the eastern North Pacific including herring (Kocan et al. 1997). Capture and confinement of wild Puget Sound herring into laboratory tanks or net pens used for a SOK fishery often results in initiation of VHS epizootics among the confined cohorts (Hershberger et al. 1999). Additionally, large scale VHS epizootics repeatedly occur among wild, free-ranging herring in British Columbia and Alaska. A combination of disease from VHS and *Ichthyophonus* represents a leading hypothesis accounting for the crash and failed recovery of Pacific herring populations in Prince William Sound, AK. In Puget Sound, impacts of VHS are typically most severe among the youngest herring age cohorts because naïve juveniles are highly susceptible to the disease and resulting mortality, but the cohorts that survive exposure develop strong adaptive resistance to the disease (Hershberger et al. 2007).

Viral erythrocytic necrosis (VEN), a condition characterized by the presence of cytoplasmic inclusion bodies within affected erythrocytes occurs in marine fishes throughout Puget Sound, the most susceptible of which include Pacific herring (Hershberger et al. 2006), pink salmon (*Oncorhynchus gorbushcha)*, and chum salmon (*O. keta)* (Evelyn and Traxler 1978, MacMillan & Mulcahy 1979). VEN epizootics in juvenile Pacific herring repeatedly occur throughout southeast Alaska (Meyers et al. 1986, Meyers, unpublished accession case reports) and are characterized by mass mortalities or fish demonstrating signs of morbidity. Recurring VEN epizootics also occur among juvenile herring in Puget Sound (Hershberger et al. 2009). The persistence and recurrence of VEN epizootics in Puget Sound herring indicates that the disease is likely common among juvenile herring, and although population-level impacts likely occur, they are typically covert and not easily detected.

Changes in sea temperatures can have direct and indirect impacts on herring survival. The observed decline of the Cherry Point stock since the mid-1970s coincided with warmer/dryer than average conditions in the Pacific Northwest (Stout et al. 2001). Chapman et al. (1941) considered Cherry Point and Discovery Bay populations to be at low levels in the 1930s when similar climatic conditions occurred. Conditions shifted back to cold/wet or average during the 1940s and 1950s. Williams (1959) reported that among others, the Cherry Point and Discovery Bay populations had returned to relatively high levels of abundance during those decades.

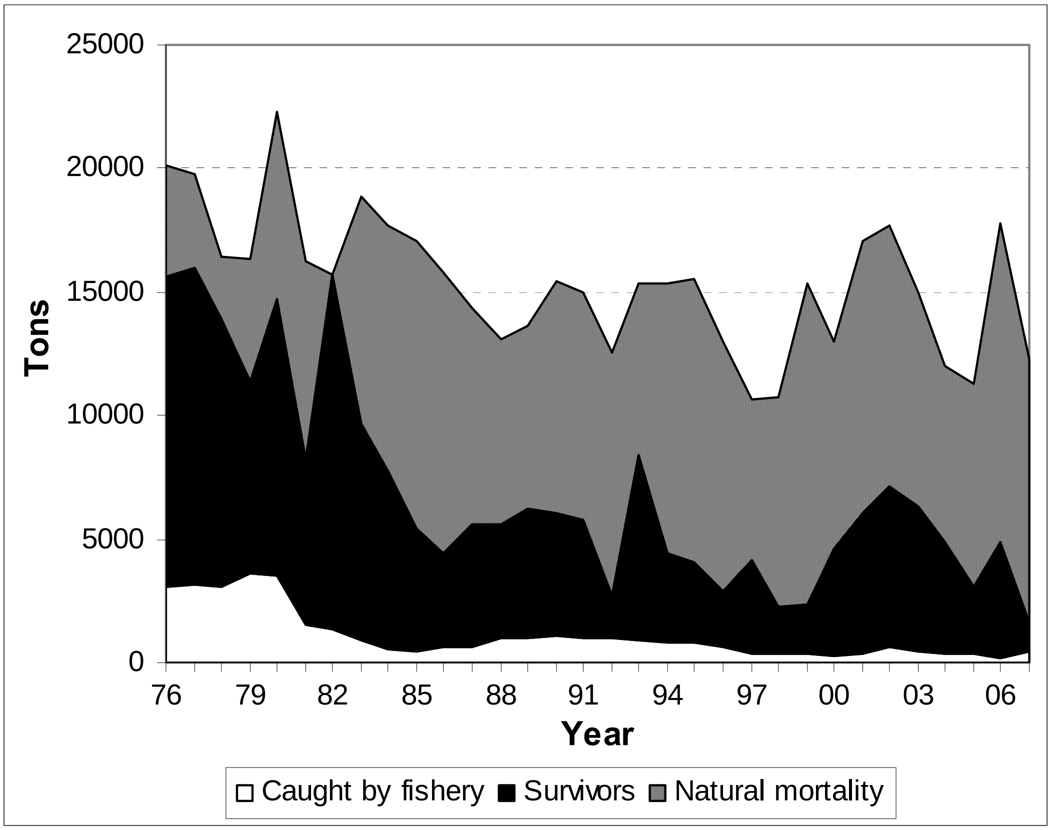


Figure 6. Natural and Fishery Mortality of Puget Sound Herring Stocks, 1976-2007.

Coastal Herring Stock Profiles

Coastal Herring Summary

Introduction

Spawning populations of Pacific herring are documented in the coastal embayments of Willapa Bay and Grays Harbor. Initial documentation of spawning activity for Grays Harbor occurred in 1998 and has been observed intermittently since that time. Herring stock assessment by WDFW has traditionally been focused on presumed larger Puget Sound stocks and limited assessment of coastal herring stocks currently takes place.

Spawning Timing/Grounds

Herring spawning activity has been observed in February and March in Willapa Bay and February through March in Grays Harbor. Most of the spawn deposition in Grays Harbor appears to occur in the South Bay/Elk River estuary area of south Grays Harbor with some also documented in the Ocean Shores/Point Damon area.

Lassuy (1989) indicated that Pacific herring spawn in the Columbia River estuary; limited sampling by WDFW has not confirmed spawning activity there.

Stock Identification

Little is known about the coastal herring populations. However, due to the geographical separation of their spawning grounds, the Willapa Bay and Grays Harbor spawning populations are considered to be discrete for the purposes of this report.

Herring spawned in coastal locations are likely components of large summer herring aggregations that concentrate in coastal offshore areas including the western end of the Strait of Juan de Fuca and the west coast of Vancouver Island.

Stock Status

The limited information available and current sampling effort for the coastal herring populations does not provide adequate basis for evaluation of the status of these stocks. Abundance of these stocks is considered to relatively small compared to Puget Sound herring stocks. The cumulative spawning biomass estimate for these areas has ranged from 0 to 694 tons annually.

Fisheries

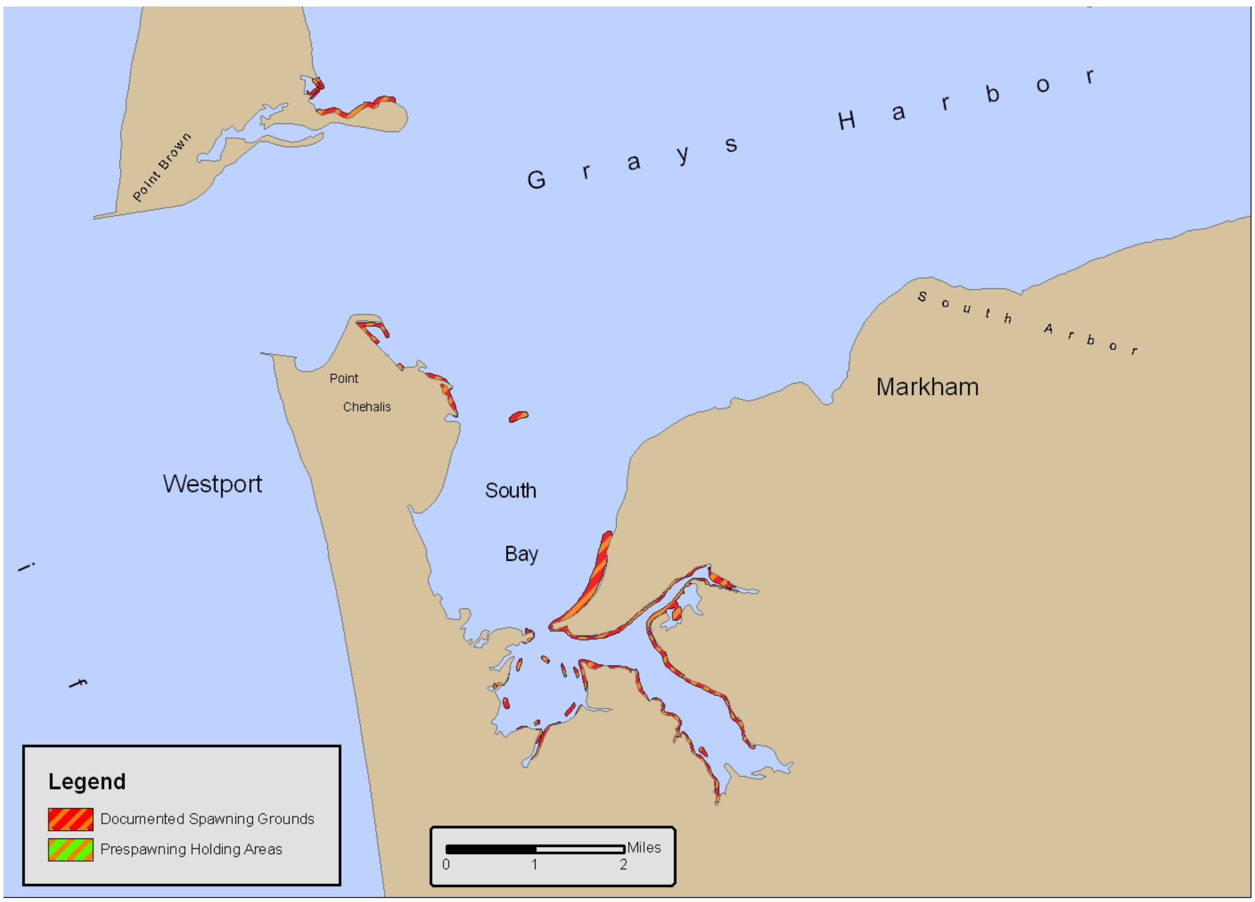
Reported fishery landings of seven tons or less have occurred since 1999 for bait herring caught Grays Harbor, with no reported landings from Willapa Bay in recent years. No directed herring fishery harvest is allowed in Washington’s coastal waters.

Grays Harbor Herring Stock

OVERVIEW

Herring spawn deposition was first documented in Grays Harbor in 1998 and was observed annually until 2005. A limited amount of spawning activity has been confirmed in the Point Damon area of north Grays Harbor, but most of the stock's spawn deposition has been observed in the South Bay/Elk River estuary vicinity. Much of the spawn deposition is deposited relatively high along the intertidal salt marsh edges on a mix of vascular plants and marine algae.

SPAWNING GROUND



SPAWNING TIMING

Jan	Feb	March	April	May	June

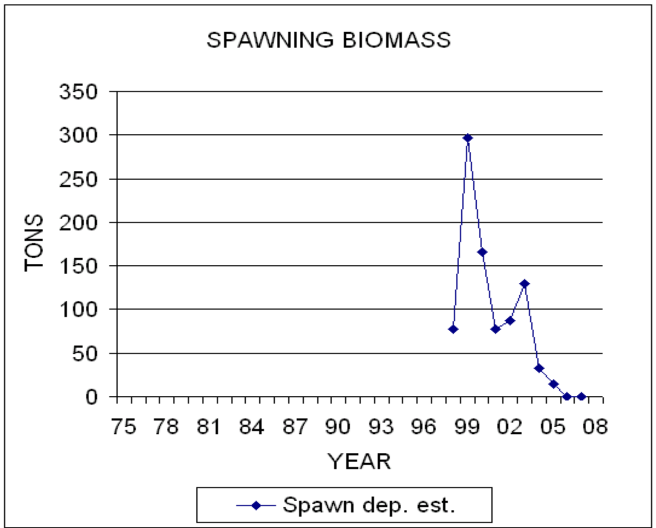
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

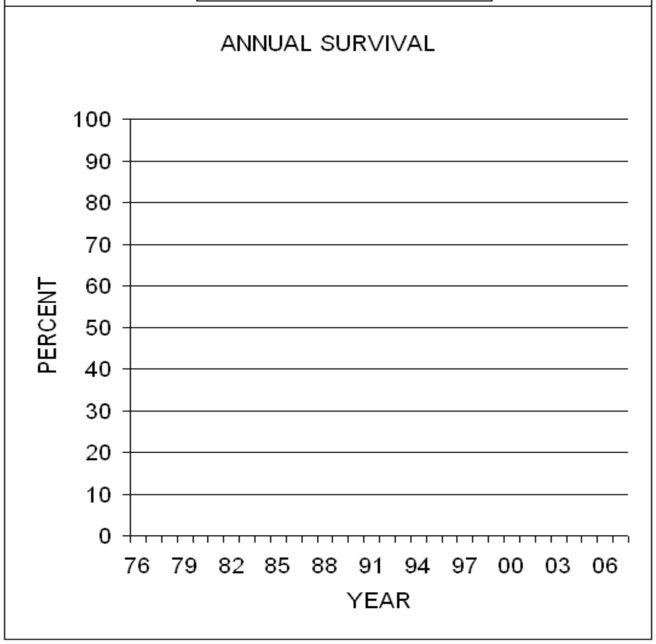
No data

STOCK STATUS PROFILE for South Grays Harbor Herring Stock

STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
75				
76				
77				
78				
79				
80				
81				
82				
83				
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				
95				
96				
97				
98	77		77	
99	297		297	
2000	166		166	
2001	77		77	
2002	87		87	
2003	129		129	
2004	33	(partial survey	33	
2005	15	coverage)	15	
2006	0		0	
2007	0		0	
2008				
MEAN:				
25 year	88		88	
5 year	35		35	





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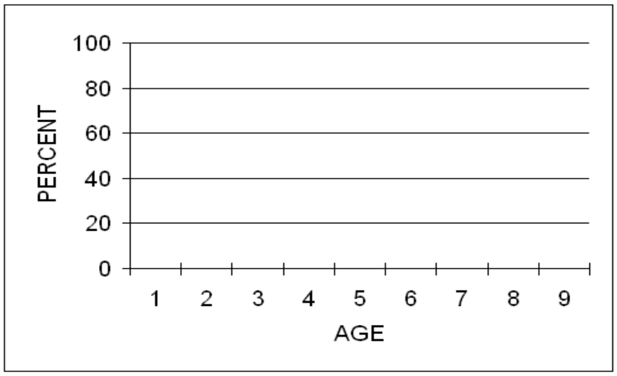
2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2004 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
poor

RECENT TREND (5 year)
insufficient data

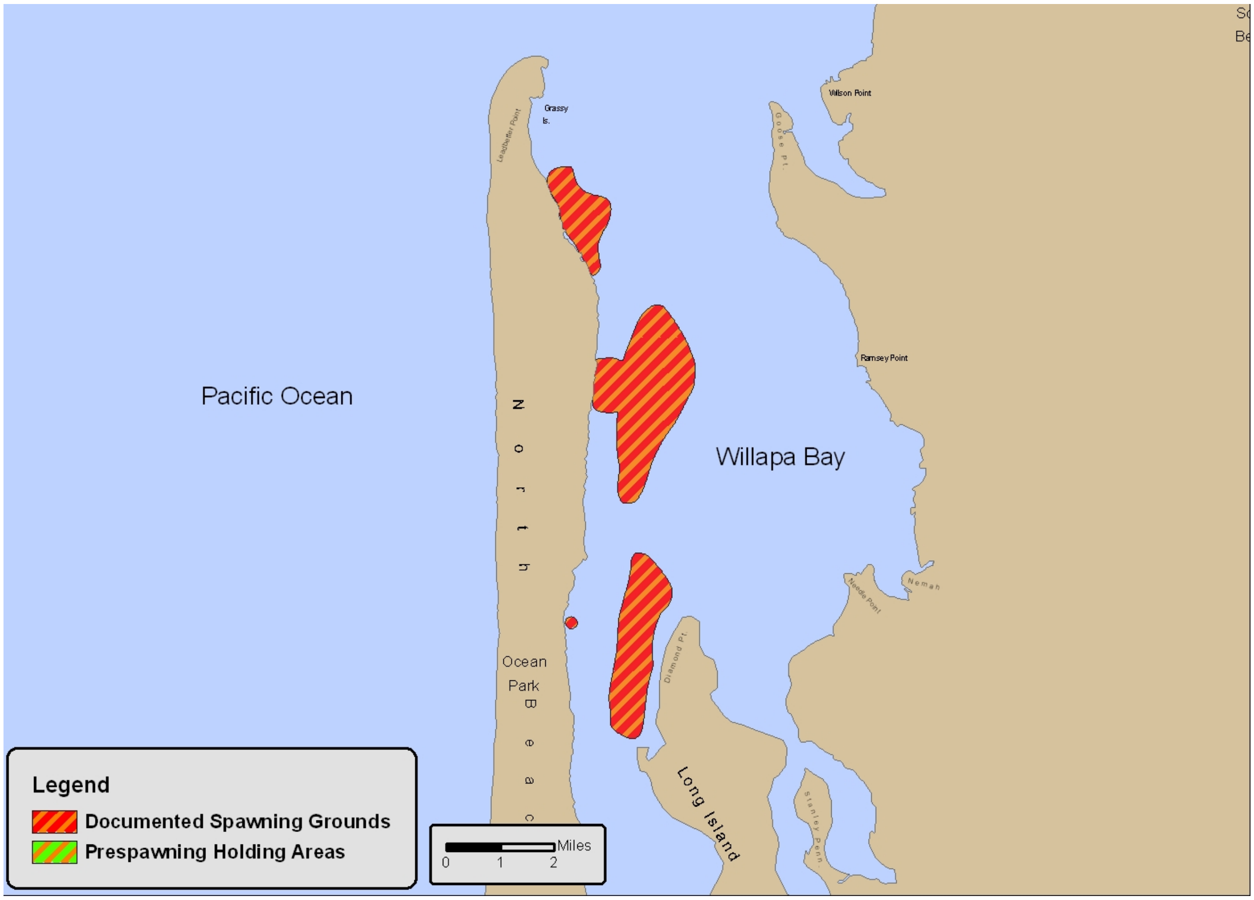
STOCK STATUS (2 year)
insufficient data

Willapa Bay Herring Stock

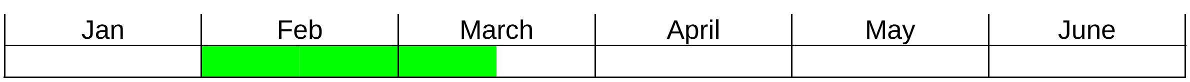
OVERVIEW

Limited survey effort suggests a decrease in spawning biomass for the Willapa Bay herring stock since 2004. Documented spawning grounds are limited to the southern portion of the bay. Little is known about this stock's life history, although it is likely that these fish spend significant time in ocean waters.

SPAWNING GROUND



SPAWNING TIMING



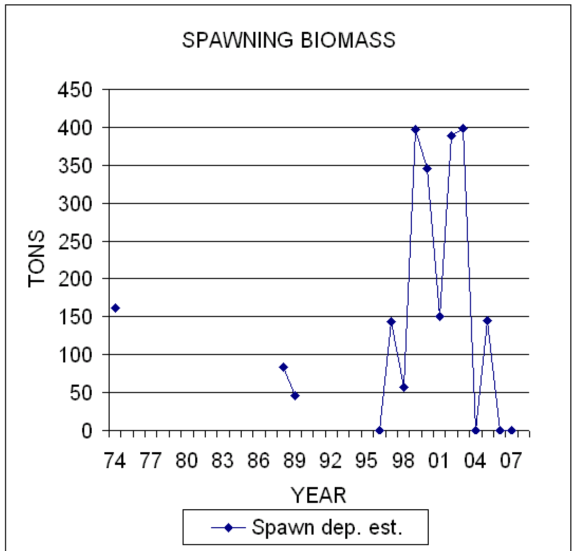
MEAN LENGTH OF 2/3/4/5 YEAR OLDS

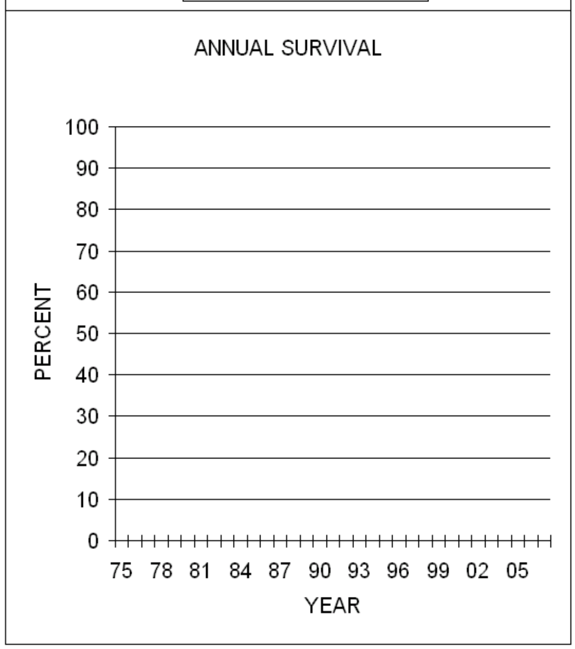
No data

STOCK STATUS PROFILE for Willapa Bay Herring Stock

STOCK ASSESSMENT

YEAR	SPAWNING BIOMASS (tons) SPAWN DEPOSITION SURVEYS	ACOUSTIC/ TRAWL SURVEYS	FINAL BIOMASS ESTIMATE	RECRUITMENT (tons)
74	162		162	
75				
76				
77				
78				
79				
80				
81				
82				
83				
84				
85				
86				
87				
88	83		83	
89	46		46	
90				
91				
92				
93				
94				
95				
96	0	(partial survey	0	
97	144	coverage)	144	
98	57		57	
99	397		397	
2000	345		345	
2001	150		150	
2002	389		389	
2003	398		398	
2004	0	(partial survey	0	
2005	145	coverage)	145	
2006	0		0	
2007	0		0	
2008				
MEAN:				
25 year	154		154	
5 year	256		256	





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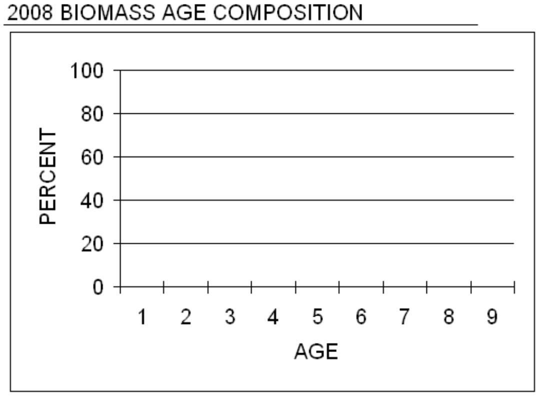
2008 BIOMASS AGE COMPOSITION



no data

STOCK SUMMARY

2008 SPAWNER FISHERY SUMMARY
no fishery

DATA QUALITY
poor

RECENT TREND (5 year)
insufficient data

STOCK STATUS (2 year)
insufficient data

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Appendix A. Estimated biomass in short tons (2000 lbs/ton) and number (millions of fish) at age of spawner herring by stock by year (N caught includes only spawner fishery catches).

SQUAXIN PASS

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1975	Tons at Age	1	4	14	45	145	52	30	3	298
	N at Age	0.031	0.050	0.151	0.480	1.350	0.469	0.220	0.031	2.790
	N Caught	0	0	0	0	0	0	0	0	
1976	no age data									2138
1977	Tons at Age	9	10	0	0	0	0	0	0	20
	N at Age	0.001	0.081	0.032	0.049	0.071	0.038	0.010	0.001	0.282
	N Caught	0	0	0	0	0	0	0	0	
1978	Tons at Age	12	11	26	2	3	1	1	2	58
	N at Age	0.241	0.124	0.208	0.011	0.016	0.010	0.007	0.009	0.625
	N Caught	0	0	0	0	0	0	0	0	
1981	Tons at Age	118	478	85	12	47	16	0	13	772
	N at Age	2.366	6.109	0.542	0.067	0.266	0.067	0.000	0.067	9.500
	N Caught	0	0	0	0	0	0	0	0	
1990	Tons at Age	58	497	11	0	0	0	0	0	566
	N at Age	1.233	9.339	0.159	0	0	0	0	0	10.731
	N Caught	0	0	0	0	0	0	0	0	
1991	Tons at Age	439	409	94	0	0	0	0	0	943
	N at Age	12.459	7.706	1.485	0	0	0	0	0	21.65
	N Caught	0	0	0	0	0	0	0	0	
1992	Tons at Age	70	227	381	89	5	0	0	0	771
	N at Age	1.583	3.858	5.342	1.060	0.036	0	0	0	11.879
	N Caught	0	0	0	0	0	0	0	0	
1995	Tons at Age	62	79	14	2	1	0	0	0	157
	N at Age	1.205	1.0048	0.157	0.023	0.008	0	0	0	2.3978
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	129	212	33	0	0	0	0	0	374
	N at Age	2.598	3.107	0.368	0.000	0.000	0	0	0	6.073
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	107	37	5	0	0	0	0	0	149
	N at Age	2.156	0.482	0.051	0.000	0.000	0	0	0	2.689
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	22	36	10	0	0	0	0	0	68
	N at Age	0.437	0.502	0.115	0.000	0.000	0	0	0	1.054
	N Caught	0	0	0	0	0	0	0	0	
1999	Tons at Age	338	114	21	0	0	0	0	0	474
	N at Age	7.188	1.651	0.226	0.000	0.000	0	0	0	9.065
	N Caught	0	0	0	0	0	0	0	0	
2000	Tons at Age	220	149	3	0	0	0	0	0	371
	N at Age	4.333	2.792	0.045	0.000	0.000	0	0	0	7.17
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

SQUAXIN PASS

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
2001	Tons at Age	1119	439	38	0	0	0	0	0	1597
	N at Age	31.545	8.301	0.535	0.000	0.000	0	0	0	40.381
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	189	2498	466	0	0	0	0	0	3150
	N at Age	4.278	49.350	7.660	0.000	0.000	0	0	0	61.288
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	70	1127	850	119	35	0	0	0	2201
	N at Age	1.743	21.802	13.167	1.623	0.374	0	0	0	38.709
	N Caught	0	0	0	0	0	0	0	0	
2004	Tons at Age	95	346	322	59	2	3	0	0	828
	N at Age	2.161	6.319	5.322	0.861	0.038	0	0	0	14.743
	N Caught	0	0	0	0	0	0	0	0	
2005	Tons at Age	180	102	94	38	22	0	0	0	436
	N at Age	4.286	1.679	1.375	0.538	0.245	0	0	0	8.123
	N Caught	0	0	0	0	0	0	0	0	
2006	Tons at Age	361	228	146	14	7	0	0	0	755
	N at Age	6.856	3.179	1.728	0.149	0.065	0	0	0	11.977
	N Caught	0	0	0	0	0	0	0	0	
2007	Tons at Age	40	379	102	32	4	0	0	0	557
	N at Age	0.701	5.472	1.279	0.391	0.041	0	0	0	7.884
	N Caught	0	0	0	0	0	0	0	0	
2008	Tons at Age	1008	18	0	0	0	0	0	0	1026
	N at Age	31.12	0.232	0	0	0	0	0	0	31.352
	N Caught	0	0	0	0	0	0	0	0	

WOLLOCHET BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
2000	Tons at Age	45	82	10	3	2	0	0	0	142
	N at Age	0.851	1.226	0.102	0.023	0.011	0	0	0	2.213
	N Caught	0	0	0	0	0	0	0	0	
2001	Tons at Age	59	52	22	0	0	0	0	0	133
	N at Age	1.528	0.719	0.225	0.000	0.000	0	0	0	2.472
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	23	56	19	5	3	0	0	0	106
	N at Age	0.564	1.073	0.200	0.036	0.018	0	0	0	1.891
	N Caught	0	0	0	0	0	0	0	0	
2003	no age data									152
2004	no age data									52
2005	no age data									67

Appendix A. (cont)

WOLLOCHET BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
2006	no age data									27
2007	no age data									35
2008	no age data									45

QUARTERMASTER HARBOR

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1995	Tons at Age	1433	410	146	10	0	0	0	0	2001
	N at Age	26.259	4.952	1.497	0.115	0	0	0	0	32.823
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	477	315	12	0	0	0	0	0	805
	N at Age	8.921	4.401	0.122	0.000	0.000	0	0	0	13.444
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	1147	231	24	0	0	0	0	0	1402
	N at Age	23.909	3.094	0.281	0.000	0.000	0	0	0	27.284
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	287	457	184	19	0	0	0	0	947
	N at Age	4.970	4.970	1.621	0.162	0.000	0	0	0	11.723
	N Caught	0	0	0	0	0	0	0	0	
1999	Tons at Age	1115	106	38	0	0	0	0	0	1257
	N at Age	22.289	1.454	0.363	0.000	0.000	0	0	0	24.106
	N Caught	0	0	0	0	0	0	0	0	
2000	Tons at Age	171	556	16	0	0	0	0	0	743
	N at Age	2.884	8.254	0.199	0.000	0.000	0	0	0	11.337
	N Caught	0	0	0	0	0	0	0	0	
2001	Tons at Age	198	1044	78	0	0	0	0	0	1320
	N at Age	3.888	14.176	0.729	0.000	0.000	0	0	0	18.793
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	41	206	167	2	0	0	0	0	416
	N at Age	0.933	2.736	1.741	0.031	0.000	0	0	0	5.441
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	150	541	179	60	0	0	0	0	930
	N at Age	3.809	10.093	2.666	0.667	0.000	0	0	0	17.235
	N Caught	0	0	0	0	0	0	0	0	
2004	Tons at Age	40	186	252	189	32	27	0	0	727
	N at Age	1.003	3.364	3.186	2.006	0.295	0	0	0	10.090
	N Caught	0	0	0	0	0	0	0	0	
2005	Tons at Age	250	278	110	65	45	9	0	0	756
	N at Age	5.93	4.983	1.577	0.82	0.378	0.063	0	0	13.751
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

QUARTERMASTER HARBOR

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
2006	Tons at Age	659	241	63	0	16	8	0	0	987
	N at Age	12.854	3.613	0.829	0	0.177	0.059	0	0	17.532
	N Caught	0	0	0	0	0	0	0	0	
2007	no age data									441
2008	Tons at Age	403	33	28	27	0	0	0	0	491
	N at Age	11.317	0.458	0.285	0.228	0	0	0	0	12.288
	N Caught	0	0	0	0	0	0	0	0	

PORT ORCHARD/MADISON

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1988	Tons at Age	431	839	358	36	29	12	0	0	1705
	N at Age	6.807	8.95	2.906	0.293	0.208	0.061	0	0	19.225
	N Caught	0	0	0	0	0	0	0	0	
1989	Tons at Age	670	466	496	108	0	0	0	0	1739
	N at Age	12.009	4.945	4.588	0.782	0.05	0.05	0	0	
	N Caught	0.609	0.251	0.233	0.4	0	0	0	0	
1990	Tons at Age	766	648	174	127	59	22	0	0	1795
	N at Age	15.137	7.943	1.494	0.997	0.409	0.119	0	0	26.099
	N Caught	0	0	0	0	0	0	0	0	
1991	Tons at Age	380	146	118	18	47	12	1	0	722
	N at Age	8.013	2.054	1.231	0.152	0.416	0.078	0.015	0	11.959
	N Caught	0	0	0	0	0	0	0	0	
1992	Tons at Age	156	116	30	9	2	1	0	0	314
	N at Age	3.343	1.679	0.294	0.058	0.011	0.005	0	0	5.390
	N Caught	0	0	0	0	0	0	0	0	
1993	Tons at Age	266	16	15	3	4	0	0	0	304
	N at Age	4.988	0.19	0.148	0.025	0.019	0	0	0	5.370
	N Caught	0	0	0	0	0	0	0	0	
1994	Tons at Age	198	192	22	11	0	0	0	0	424
	N at Age	3.249	2.284	0.182	0.079	0	0	0	0	5.794
	N Caught	0	0	0	0	0	0	0	0	
1995	Tons at Age	619	165	79	0	0	0	0	0	863
	N at Age	11.988	1.87	0.683	0	0	0	0	0	14.541
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	429	310	63	4	0	0	0	0	806
	N at Age	8.27	4.297	0.631	0.025	0	0	0	0	13.223
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	214	130	14	2	0	0	0	0	360
	N at Age	4.226	1.645	0.126	0.012	0	0	0	0	6.009
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

PORT ORCHARD/MADISON

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1998	Tons at Age	381	87	16	5	0	0	0	0	489
	N at Age	8.156	1.304	0.146	0.04	0	0	0	0	9.646
	N Caught	0	0	0	0	0	0	0	0	
1999	Tons at Age	1765	187	32	22	0	0	0	0	2006
	N at Age	37.913	2.542	0.339	0.017	0	0	0	0	40.811
	N Caught	0	0	0	0	0	0	0	0	
2000	Tons at Age	592	1110	53	2	0	0	0	0	1756
	N at Age	11.406	17.808	0.673	0.017	0	0	0	0	29.904
	N Caught	0	0	0	0	0	0	0	0	
2001	Tons at Age	1158	682	157	10	0	0	0	0	2007
	N at Age	27.825	9.793	1.587	0.075	0	0	0	0	39.280
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	268	525	56	15	14	0	0	0	878
	N at Age	6.632	8.733	0.745	0.149	0.108	0	0	0	16.367
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	283	522	228	48	4	1	0	0	1085
	N at Age	7.031	9.783	3.095	0.486	0.040	0.010	0	0	20.445
	N Caught	0	0	0	0	0	0	0	0	
2004	Tons at Age	116	366	169	48	0	0	0	0	700
	N at Age	2.616	5.948	2.078	0.509	0.006	0.003	0	0	11.160
	N Caught	0	0	0	0	0	0	0	0	
2005	Tons at Age	499	826	492	101	39	2	0	0	1958
	N at Age	11.26	13.541	6.481	1.036	0.386	0.022	0	0	32.726
	N Caught	0	0	0	0	0	0	0	0	
2006	Tons at Age	1038	752	288	29	5	0	0	0	2112
	N at Age	19.325	11.094	3.699	0.268	0.038	0	0	0	34.424
	N Caught	0	0	0	0	0	0	0	0	
2007	Tons at Age	155	1187	191	47	7	3	0	0	1589
	N at Age	2.787	16.939	2.261	0.484	0.06	0.015	0	0	22.546
	N Caught	0	0	0	0	0	0	0	0	
2008	Tons at Age	881	193	101	11	0	0	0	0	1186
	N at Age	20.392	2.774	1.176	0.115	0	0	0	0	24.457
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

PORT GAMBLE

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1976	Tons at Age	58	453	381	86	71	65	13	15	1142
	N at Age	0.866	4.425	2.809	0.548	0.414	0.404	0.058	0.096	9.62
	N Caught									
1977	no age data									2525
1978	Tons at Age	87	270	389	421	403	252	103	60	1984
	N at Age	1.170	2.352	2.465	2.415	2.201	1.220	0.491	0.264	12.578
	N Caught									
1979	Tons at Age	0	548	360	523	179	181	0	0	1790
	N at Age	0.000	4.460	2.286	2.779	0.840	0.840	0.000	0.000	11.206
	N Caught									
1980	no age data									2309
1981	Tons at Age	221	633	380	307	138	47	28	0	1753
	N at Age	2.897	5.409	2.419	1.595	0.598	0.226	0.133	0.000	13.290
	N Caught									
1987	Tons at Age	935	820	256	35	0	0	0	0	2046
	N at Age	14.535	8.479	2.2	2.33	0	0	0	0	27.544
	N Caught	0.078	0.046	0.012	0.001	0	0	0	0	0.137
1988	Tons at Age	461	713	178	36	0	0	0	0	1390
	N at Age	6.159	6.644	1.319	0.243	0	0	0	0	14.365
	N Caught	0.142	0.153	0.03	0.006	0	0	0	0	0.331
1989	Tons at Age	1339	532	371	153	0	0	0	0	2395
	N at Age	22.302	5.582	3.122	1.119	0	0	0	0	32.125
	N Caught	0.133	0.033	0.019	0.007	0	0	0	0	0.192
1990	Tons at Age	965	1155	606	178	65	0	0	0	2969
	N at Age	15.678	11.974	4.457	1.127	0.376	0	0	0	33.612
	N Caught	0.454	0.347	0.129	0.033	0.011	0	0	0	0.974
1991	Tons at Age	380	915	630	194	104	36	0	0	2259
	N at Age	6.695	10.226	5.677	1.482	0.751	0.22	0	0	25.051
	N Caught	0.265	0.404	0.224	0.059	0.03	0.009	0	0	0.991
1992	Tons at Age	454	1251	454	79	30	0	0	0	2270
	N at Age	6.693	13.44	3.882	0.615	0.2	0	0	0	24.83
	N Caught	0.007	0.013	0.004	0.001	0	0	0	0	0.025
1993	Tons at Age	922	365	183	35	15	0	0	0	1521
	N at Age	18.052	4.107	1.7	0.263	0.098	0	0	0	24.22
	N Caught	0.012	0.003	0.001	0	0	0	0	0	0.016
1994	Tons at Age	1054	986	569	206	40	0	0	0	2857
	N at Age	15.975	10.981	4.834	1.46	0.236	0	0	0	33.486
	N Caught	0	0	0	0	0	0	0	0	0
1995	Tons at Age	1964	742	344	92	13	0	0	0	3158
	N at Age	35.324	8.22	2.968	0.692	0	0.057	0	0	47.261
	N Caught	0	0	0	0	0	0	0	0	0

Appendix A. (cont)

PORT GAMBLE		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
YEAR										
1996	Tons at Age	805	903	315	37	0	0	0	0	2058
	N at Age	13.915	11.325	2.932	0.289	0	0	0	0	28.461
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	844	473	77	26	0	0	0	0	1419
	N at Age	13.555	4.741	0.578	0.127	0	0	0	0	19.001
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	257	486	208	7	13	0	0	0	971
	N at Age	5.013	6.61	2.044	0.05	0.073	0	0	0	13.79
	N Caught	0	0	0	0	0	0	0	0	
1999	Tons at Age	917	582	148	17	0	0	0	0	1664
	N at Age	17.476	7.909	1.531	0.128	0	0	0	0	27.044
	N Caught	0	0	0	0	0	0	0	0	
2000	Tons at Age	890	1338	182	34	12	0	0	0	2459
	N at Age	17.448	20.304	2.091	0.377	0.121	0	0	0	40.341
	N Caught	0	0	0	0	0	0	0	0	
2001	Tons at Age	585	1035	148	11	0	0	0	0	1779
	N at Age	9.328	11.749	1.353	0.071	0	0	0	0	22.501
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	313	1058	393	49	0	0	0	0	1812
	N at Age	5.91	13.557	3.939	0.348	0	0	0	0	23.754
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	184	621	231	29	0	0	0	0	1064
	N at Age	5.91	13.557	3.939	0.348	0	0	0	0	23.754
	N Caught	0	0	0	0	0	0	0	0	
2003	no age data									1064
2004	no age data									1257
2005	Tons at Age	361	320	351	216	106	9	0	9	1372
	N at Age	7.528	5.141	4.499	2.295	1.102	0.092	0	0.092	20.749
	N Caught	0	0	0	0	0	0	0	0	
2006	no age data									774
2007	no age data									826
2008	no age data									208

Appendix A. (cont)

KILISUT HARBOR

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1994	Tons at Age	81	149	17	46	0	0	0	0	292
	N at Age	1.176	1.554	0.126	0.252	0	0	0	0	3.108
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	279	83	18	0	0	0	0	0	380
	N at Age	4.73	0.898	0.132	0	0	0	0	0	5.76
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	123	103	64	17	0	0	0	0	307
	N at Age	1.688	1.019	0.478	0.096	0.000	0	0	0	3.281
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	97	133	72	6	3	0	0	0	311
	N at Age	1.683	1.557	0.609	0.054	0.018	0	0	0	3.921
	N Caught	0	0	0	0	0	0	0	0	
1999	Tons at Age	768	26	7	0	0	0	0	0	802
	N at Age	16.939	0.434	0.059	0.000	0.000	0	0	0	17.432
	N Caught	0	0	0	0	0	0	0	0	
2000	Tons at Age	90	17	0	0	0	0	0	0	107
	N at Age	2.084	0.250	0.000	0.000	0.000	0	0	0	2.334
	N Caught	0	0	0	0	0	0	0	0	
2001	Tons at Age	214	348	43	7	0	0	0	0	612
	N at Age	4.065	4.286	0.385	0.050	0.000	0	0	0	8.786
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	165	527	75	7	0	0	0	0	774
	N at Age	2.428	6.555	0.810	0.081	0.000	0	0	0	9.874
	N Caught	0	0	0	0	0	0	0	0	
2003	no age data									448
2004	Tons at Age	39	125	18	2	0	0	0	0	184
	N at Age	1.925	0.578	0.252	0.252	0.074	0.015	0	0	3.096
	N Caught	0	0	0	0	0	0	0	0	
2005	Tons at Age	87	59	11	13	0	0	0	0	170
	N at Age	2	1.114	0.164	0.131	0	0	0	0	3.409
	N Caught	0	0	0	0	0	0	0	0	
2006	no age data									54
2007	no age data									24
2008	no age data									0

Appendix A. (cont)

PORT SUSAN

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1995	Tons at Age	176	122	60	5	0	0	0	0	363
	N at Age	2.643	1.144	0.483	0.025	0	0	0	0	4.295
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	36	58	16	0	0	0	0	0	110
	N at Age	0.548	0.644	0.137	0.000	0.000	0	0	0	1.329
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	198	524	96	10	0	0	0	0	828
	N at Age	2.884	5.438	0.824	0.082	0.000	0	0	0	9.228
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	279	1202	565	38	0	0	0	0	2084
	N at Age	5.127	15.227	5.438	0.311	0.000	0	0	0	26.103
	N Caught	0	0	0	0	0	0	0	0	
1999	no age data									545
2000	Tons at Age	166	428	184	6	0	0	0	0	785
	N at Age	2.665	5.552	1.926	0.051	0.000	0	0	0	10.194
	N Caught	0	0	0	0	0	0	0	0	
2001	Tons at Age	357	207	23	0	0	0	0	0	587
	N at Age	6.839	2.550	0.232	0.000	0.000	0	0	0	9.621
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	71	353	310	41	0	0	0	0	775
	N at Age	1.384	5.015	3.517	0.404	0.000	0	0	0	10.32
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	85	298	53	14	0	0	0	0	450
	N at Age	2.219	4.851	0.721	0.155	0.000	0	0	0	7.946
	N Caught	0	0	0	0	0	0	0	0	
2004	Tons at Age	74	144	152	51	7	0	0	0	429
	N at Age	1.556	2.413	2.063	0.623	0.078	0	0	0	6.733
	N Caught	0	0	0	0	0	0	0	0	
2005	no age data									157
2006	no age data									321
2007	Tons at Age	10	295	254	69	15	0	0	0	643
	N at Age	0.142	4.248	2.832	0.708	0.142	0	0	0	8.072
	N Caught	0	0	0	0	0	0	0	0	
2008	no age data									345

Appendix A. (cont)

HOLMES HARBOR

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1996	Tons at Age	230	68	38	0	0	0	0	0	336
	N at Age	4.479	0.817	0.328	0	0	0	0	0	5.624
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	277	200	52	0	0	0	0	0	530
	N at Age	5.256	2.471	0.470	0.000	0.000	0	0	0	8.197
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	134	166	128	26	12	0	0	0	464
	N at Age	3.052	2.616	1.134	0.174	0.087	0	0	0	7.063
	N Caught	0	0	0	0	0	0	0	0	
1999	no age data									175
2000	no age data									281
2001	no age data									275
2002	no age data									573
2003	no age data									678
2004	no age data									673
2005	no age data									498
2006	no age data									1297
2007	no age data									572
2008	Tons at Age	80	444	159	3	0	0	0	0	686
	N at Age	2.077	6.153	1.951	0.025	0.000	0	0	0	10.206
	N Caught	0	0	0	0	0	0	0	0	

SKAGIT BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1995	Tons at Age	257	366	267	0	0	0	0	0	891
	N at Age	3.739	3.49	2.243	0	0	0	0	0	9.472
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	629	107	0	0	0	0	0	0	736
	N at Age	13.718	1.407	0.000	0.000	0.000	0	0	0	15.125
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	791	101	0	0	0	0	0	0	892
	N at Age	18.055	1.509	0.000	0.000	0.000	0	0	0	19.564
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	127	62	20	0	0	0	0	0	209
	N at Age	3.031	1.023	0.218	0.000	0.000	0	0	0	4.272
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

SKAGIT BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1999	no age data									905
2000	Tons at Age	464	161	21	0	0	0	0	0	646
	N at Age	10.040	2.584	0.262	0.000	0.000	0	0	0	12.886
	N Caught	0	0	0	0	0	0	0	0	
2001	Tons at Age	688	1243	226	13	0	0	0	0	2170
	N at Age	12.820	15.768	2.143	0.095	0.000	0	0	0	30.826
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	465	1108	576	66	0	0	0	0	2215
	N at Age	9.403	16.494	6.937	0.616	0.000	0	0	0	33.45
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	1199	1426	331	27	0	0	0	0	2983
	N at Age	30.342	24.875	4.641	0.236	0.000	0	0	0	60.094
	N Caught	0	0	0	0	0	0	0	0	
2004	Tons at Age	300	646	238	47	7	6	0	0	1245
	N at Age	6.915	11.927	3.742	0.702	0.081	0	0	0	23.448
	N Caught	0	0	0	0	0	0	0	0	
2005	Tons at Age	234	419	408	93	15	0	0	0	1169
	N at Age	4.94	6.642	5.967	1.111	0.147	0	0	0	18.807
	N Caught	0	0	0	0	0	0	0	0	
2006	Tons at Age	1421.503	979.3465	397.1405	28.00991	0	0	0	0	2826
	N at Age	25.258	13.165	4.439	0.306	0	0	0	0	43.168
	N Caught	0	0	0	0	0	0	0	0	
2007	Tons at Age	35.9709	893.2773	268.7825	37.96928	0	0	0	0	1236
	N at Age	0.703	13.786	3.63	0.453	0	0	0	0	18.572
	N Caught	0	0	0	0	0	0	0	0	
2008	Tons at Age	181	874	273	14	0	0	0	0	1342
	N at Age	4.216	12.227	3.318	0.128	0	0	0	0	19.889
	N Caught	0	0	0	0	0	0	0	0	

FIDALGO BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1992	Tons at Age	270	767	269	81	13	0	0	0	1399
	N at Age	6.987	13.581	3.641	1.083	0.197	0	0	0	25.489
	N Caught	0	0	0	0	0	0	0	0	
1993	Tons at Age	894	356	128	26	14	0	0	0	1417
	N at Age	19.706	6.031	1.699	0.17	0.085	0	0	0	27.691
	N Caught	0	0	0	0	0	0	0	0	
1994	Tons at Age	548	454	153	45	6	0	0	0	1207
	N at Age	10.43	7.327	2.111	0.487	0.103	0	0	0	20.458
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

FIDALGO BAY

		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1995	Tons at Age	772	240	106	27	28	0	0	0	1173
	N at Age	19.078	4.101	1.426	0.357	0.357	0	0	0	25.319
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	210	291	74	15	0	0	0	0	590
	N at Age	4.792	4.250	0.995	0.090	0.000	0	0	0	10.127
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	543	301	85	0	0	0	0	0	929
	N at Age	14.166	4.481	0.723	0.000	0.000	0	0	0	19.370
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	500	284	43	18	0	0	0	0	844
	N at Age	11.006	4.442	0.464	0.133	0.000	0	0	0	16.045
	N Caught	0	0	0	0	0	0	0	0	
1999	no age data									1005
2000	Tons at Age	404	300	18	15	0	0	0	0	737
	N at Age	8.320	4.530	0.277	0.185	0.000	0	0	0	13.312
	N Caught	0	0	0	0	0	0	0	0	
2001	Tons at Age	169	569	171	35	0	0	0	0	944
	N at Age	3.310	8.851	1.924	0.308	0.000	0	0	0	14.393
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	593	165	91	15	0	0	0	0	865
	N at Age	14.214	2.496	0.977	0.109	0.000	0	0	0	17.796
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	48	254	164	94	8	0	0	0	569
	N at Age	1.004	4.319	2.008	0.703	0.100	0	0	0	8.134
	N Caught	0	0	0	0	0	0	0	0	
2004	no age data									339
2005	no age data									231
2006	no age data									323
2007	no age data									159
2008	no age data									156

Appendix A. (cont)

SAMISH/PORTAGE BAY		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
YEAR										
1994	Tons at Age	348	88	18	4	0	0	0	0	459
	N at Age	6.599	1.245	0.244	0.032	0	0	0	0	8.120
	N Caught	0	0	0	0	0	0	0	0	
1995	Tons at Age	128	39	21	6	0	0	0	0	194
	N at Age	2.611	0.5	0.231	0.067	0	0	0	0	3.409
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	259	333	44	0	0	0	0	0	636
	N at Age	4.336	4.336	0.417	0.000	0.000	0	0	0	9.089
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	310	165	30	4	0	0	0	0	509
	N at Age	6.203	1.948	0.253	0.035	0.000	0	0	0	8.439
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	284	286	72	0	0	0	0	0	643
	N at Age	6.525	5.171	0.985	0.000	0.000	0	0	0	12.681
	N Caught	0	0	0	0	0	0	0	0	
1999	no age data									555
2000	no age data									196
2001	Tons at Age	255	173	41	0	0	0	0	0	470
	N at Age	4.871	2.389	0.375	0.000	0.000	0	0	0	7.635
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	194	203	71	22	5	0	0	0	496
	N at Age	4.591	3.549	0.899	0.190	0.047	0	0	0	9.276
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	20	109	98	56	12	0	5	0	299
	N at Age	0.437	1.598	1.046	0.513	0.076	0.000	0.038	0.000	3.708
	N Caught	0	0	0	0	0	0	0	0	
2004	no age data									351
2005	no age data									218
2006	no age data									412
2007	no age data									348
2008	no age data									409

Appendix A. (cont)

INTERIOR SAN JUAN ISLANDS

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1993	Tons at Age	343	107	23	0	0	0	0	0	472
	N at Age	6.438	1.231	0.189	0	0	0	0	0	7.858
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	113	137	23	4	0	0	0	0	277
	N at Age	2.378	2.201	0.276	0.031	0	0	0	0	4.886
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	30	0	0	0	0	0	0	0	30
	N at Age	0.677	0.000	0.000	0.000	0.000	0	0	0	0.677
	N Caught	0	0	0	0	0	0	0	0	
1998	no age data									
1999	no age data									197
2000	Tons at Age	112	16	0	0	0	0	0	0	128
	N at Age	2.798	0.289	0.000	0.000	0.000	0	0	0	3.087
	N Caught	0	0	0	0	0	0	0	0	
2001	no age data									219
2002	no age data									158
2003	no age data									72
2004	no age data									67
2005	no age data									41
2006	no age data									285
2007	no age data									33
2008	no age data									60

SEMIAHMOO BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1988	Tons at Age	664	1063	189	49	0	0	0	0	1965
	N at Age	9.508	10.914	1.406	0.335	0	0	0	0	22.163
	N Caught	0	0	0	0	0	0	0	0	
1989	Tons at Age	655	583	396	48	19	0	0	0	1701
	N at Age	10.89	5.954	3.081	0.32	0.134	0	0	0	20.379
	N Caught	0	0	0	0	0	0	0	0	
1990	Tons at Age	1330	380	116	75	29	0	0	0	1930
	N at Age	25.239	5.013	0.994	0.54	0.195	0	0	0	31.981
	N Caught	0	0	0	0	0	0	0	0	
1991	Tons at Age	1164	536	155	136	70	0	0	0	2061
	N at Age	21.772	6.887	1.555	0.889	0.444	0	0	0	31.547
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

SEMIAHMOO BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1992	Tons at Age	417	729	207	81	41	14	12	0	1501
	N at Age	7.716	8.901	1.819	0.56	0.251	0.063	0.063	0	19.373
	N Caught	0	0	0	0	0	0	0	0	
1993	Tons at Age	1390	268	164	63	10	6	0	0	1902
	N at Age	25.266	3.201	1.485	0.439	0.061	0.045	0	0	30.497
	N Caught	0	0	0	0	0	0	0	0	
1994	Tons at Age	870	367	119	18	14	0	0	0	1389
	N at Age	14.375	4.231	1.114	0.15	0.077	0	0	0	19.947
	N Caught	0.0000	0.0001	0.0010	0.0003	0.0008	0	0	0	
1996	Tons at Age	688	423	87	17	5	0	0	0	1219
	N at Age	12.746	4.869	0.654	0.123	0	0.033	0	0	18.425
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	297	260	50	13	0	0	0	0	621
	N at Age	5.88	2.973	0.387	0	0.062	0	0	0	9.302
	N Caught	0	0	0	0	0	0	0	0	
1998	Tons at Age	601	230	74	16	0	0	0	0	919
	N at Age	14.121	3.896	0.852	0.122	0	0	0	0	18.991
	N Caught	0	0	0	0	0	0	0	0	
1999	no age data									868
2000	Tons at Age	793	126	7	0	0	0	0	0	926
	N at Age	16.063	1.866	0.08	0	0	0	0	0	18.009
	N Caught	0	0	0	0	0	0	0	0	
2001	no age data									1098
2002	no age data									1012
2003	no age data									1087
2004	no age data									629
2005	no age data									870
2006	no age data									1277
2007	no age data									1124
2008	no age data									662

Appendix A. (cont)

CHERRY POINT

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1973	Tons at Age	15	765	5864	4649	2880	645	90	0	14998
	N at Age	0.163	7.562	35.128	22.768	12.523	2.765	0.407	0.000	81.315
	N Caught	0.022	1.013	4.816	3.249	1.566	0.321	0.053	0	
1974	Tons at Age	42	1690	2430	4761	3281	1466	251	28	13963
	N at Age	0.542	23.213	16.619	26.284	15.897	6.594	0.994	0.090	90.322
	N Caught	0.025	1.331	3.593	9.236	6.773	2.715	0.34	0.084	
1975	Tons at Age	10	1954	1003	1923	3039	1819	538	52	10337
	N at Age	0.162	15.416	6.091	9.271	13.584	7.277	1.994	0.162	53.903
	N Caught	0.027	2.847	2.141	4.206	5.949	2.937	0.742	0.049	
1976	Tons at Age	379	794	2854	1587	2132	2653	1137	308	11844
	N at Age	5.528	10.169	18.087	8.327	9.828	11.057	4.368	1.229	68.251
	N Caught	0.535	1.014	3.415	1.922	2.136	2.173	0.703	0.195	
1977	Tons at Age	932	2486	843	1409	1065	1609	1665	1088	11097
	N at Age	13.912	22.406	6.151	7.908	5.199	6.810	6.663	4.100	73.221
	N Caught	0.826	1.568	2.394	2.003	2.052	1.768	0.965	0.429	
1978	Tons at Age	77	4521	1920	878	944	636	834	1174	10973
	N at Age	1.237	41.753	14.150	5.026	4.717	2.784	3.402	4.253	77.320
	N Caught	0.117	4.969	2.655	1.343	1.534	0.836	0.817	0.869	
1979	Tons at Age	269	976	3983	1872	747	996	438	687	9957
	N at Age	3.824	8.066	25.751	10.038	3.525	4.242	1.733	2.629	59.748
	N Caught	0.579	1.265	4.45	2.095	1.014	0.909	0.392	0.533	
1980	Tons at Age	3209	690	793	1847	1549	494	345	308	9329
	N at Age	40.156	6.217	5.047	9.948	7.241	2.121	1.317	1.097	73.144
	N Caught	4.897	1.041	1.736	1.822	0.965	0.338	0.154	0.161	
1981	Tons at Age	448	2631	740	647	1188	348	87	131	6219
	N at Age	5.991	20.715	4.894	3.164	5.274	1.392	0.338	0.422	42.189
	N Caught	0	0	0	0	0	0	0	0	
1982	Tons at Age	1261	1122	1747	614	299	230	64	0	5342
	N at Age	16.415	8.957	10.665	3.166	1.292	0.958	0.250	0.000	41.662
	N Caught	0.275	0.764	0.405	0.146	0.127	0.053	0.015	0.001	
1983	Tons at Age	1846	1580	1451	2185	597	161	202	40	8063
	N at Age	24.702	12.504	8.661	10.918	2.623	0.671	0.793	0.183	60.993
	N Caught	0	0	0	0	0	0	0	0	
1984	Tons at Age	1664	779	926	1151	985	242	71	77	5901
	N at Age	23.954	6.494	5.868	5.724	4.425	1.010	0.289	0.289	48.100
	N Caught	0	0	0	0	0	0	0	0	
1985	Tons at Age	1659	2385	1020	271	207	150	40	29	5760
	N at Age	23.895	21.667	6.907	1.448	0.947	0.613	0.167	0.000	55.700
	N Caught	0	0	0	0	0	0	0	0	
1986	Tons at Age	2393	1718	754	414	250	74	51	11	5671
	N at Age	30.802	14.959	5.465	2.208	1.214	0.276	0.221	0.055	55.200
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

CHERRY POINT										TOTAL
									GTE	SPAWNER
		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	BIOMASS
YEAR										
1987	Tons at Age	814	1287	622	199	90	37	22	37	3108
	N at Age	12.576	11.026	4.261	1.103	0.447	0.149	0.089	0.119	29.800
	N Caught	0.578	0.523	0.232	0.074	0.03	0.012	0.004	0.008	
1988	Tons at Age	1089	1793	1014	385	111	35	0	4	4428
	N at Age	14.794	16.120	6.593	2.010	0.523	0.161	0.000	0.000	40.200
	N Caught	0.408	0.448	0.194	0.063	0.017	0.004	0	0.001	
1989	Tons at Age	2086	809	745	348	12	8	0	0	4003
	N at Age	34.104	7.889	4.998	1.911	0.049	0.049	0.000	0.000	49.000
	N Caught	1.86	0.441	0.38	0.196	0.003	0.004	0	0	
1990	Tons at Age	1864	1769	450	605	265	25	20	0	4998
	N at Age	27.183	18.389	3.091	3.198	1.279	0.107	0.107	0.000	53.300
	N Caught	1.509	1.024	0.188	0.22	0.091	0.007	0.005	0	
1991	Tons at Age	754	1766	1151	499	398	46	14	0	4624
	N at Age	10.613	16.758	7.820	2.673	1.796	0.200	0.040	0.000	39.900
	N Caught	0.545	0.871	0.451	0.175	0.121	0.013	0.004	0	
1992	Tons at Age	1527	850	1119	349	88	60	8	0	4009
	N at Age	23.758	8.288	7.820	1.955	0.383	0.255	0.043	0.000	42.500
	N Caught	1.05	0.369	0.382	0.109	0.022	0.015	0.002	0	
1993	Tons at Age	3475	626	299	240	171	69	10	0	4894
	N at Age	55.342	6.767	2.211	1.407	0.871	0.268	0.067	0.000	67.000
	N Caught	3.179	0.392	0.152	0.121	0.092	0.029	0.006	0	
1994	Tons at Age	4876	873	304	133	114	19	6	0	6324
	N at Age	73.725	9.248	2.161	0.691	0.519	0.086	0.000	0.000	86.430
	N Caught	3.695	0.47	0.156	0.076	0.049	0.007	0.003	0	
1995	Tons at Age	1519	1942	320	99	189	33	4	0	4105
	N at Age	20.262	18.080	2.223	0.503	0.713	0.126	0.000	0.000	41.950
	N Caught	1.514	1.362	0.204	0.069	0.094	0.014	0.002	0	
1996	Tons at Age	573	1111	1083	204	53	68	6	0	3095
	N at Age	8.654	10.789	7.789	1.125	0.202	0.288	0.029	0.000	28.847
	N Caught	0.359	0.45	0.343	0.059	0.009	0.013	0.001	0	
1997	Tons at Age	236	630	595	82	33	0	0	0	1574
	N at Age	3.856	6.051	4.360	0.445	0.133	0.000	0.000	0.000	14.830
	N Caught	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1998	Tons at Age	841	205	196	59	21	0	0	0	1322
	N at Age	13.064	2.143	1.361	0.323	0.119	0.000	0.000	0.000	17.010
	N Caught	0	0	0	0	0	0	0	0	
1999	Tons at Age	267	884	82	29	4	0	0	0	1266
	N at Age	4.183	9.129	0.650	0.155	0.014	0.000	0.000	0.000	14.131
	N Caught	0	0	0	0	0	0	0	0	
2000	Tons at Age	370	249	185	3	0	0	0	0	808
	N at Age	5.221	2.514	1.413	0.018	0.000	0.000	0.000	0.000	9.175
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

CHERRY POINT

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
2001	Tons at Age	374	565	247	56	0	0	0	0	1241
	N at Age	5.592	6.434	1.897	0.328	0.000	0.000	0.000	0.000	14.265
	N Caught	0	0	0	0	0	0	0	0	
2002	Tons at Age	646	430	174	37	43	0	0	0	1330
	N at Age	11.173	5.202	1.520	0.220	0.220	0.000	0.000	0.000	18.317
	N Caught	0	0	0	0	0	0	0	0	
2003	Tons at Age	838	596	122	42	13	0	0	0	1611
	N at Age	14.411	7.876	1.245	0.311	0.072	0.000	0.000	0.000	23.939
	N Caught	0	0	0	0	0	0	0	0	
2004	Tons at Age	23	388	740	406	101	54	23	0	1734
	N at Age	0.375	4.168	5.717	2.668	0.584	0.264	0.107	0.000	13.894
	N Caught	0	0	0	0	0	0	0	0	
2005	Tons at Age	267	1522	169	36	16	0	0	0	2010
	N at Age	5.196	26.045	2.236	0.328	0.109	0	0	0	33.914
	N Caught	0	0	0	0	0	0	0	0	0
2006	Tons at Age	541	1491	129	55	0	0	0	0	2216
	N at Age	6.252	16.721	1.145	0.519	0	0	0	0	24.637
	N Caught	0	0	0	0	0	0	0	0	0
2007	Tons at Age	241	1411	503	14	0	0	0	0	2169
	N at Age	3.886	19.932	5.253	0.072	0	0	0	0	29.143
	N Caught	0	0	0	0	0	0	0	0	0
2008	Tons at Age	0	999	353	0	0	0	0	0	1352
	N at Age	0	11.424	3.36	0	0	0	0	0	14.784
	N Caught	0	0	0	0	0	0	0	0	0

DISCOVERY BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1976	Tons at Age	1	59	270	100	86	123	38	21	697
	N at Age	0.014	0.602	2.113	0.579	0.466	0.635	0.184	0.108	4.706
	N Caught	0	0	0	0	0	0	0	0	
1977	Tons at Age	88	312	268	317	149	192	97	67	1488
	N at Age	1.165	3.088	2.058	2.070	0.939	1.108	0.532	0.339	11.310
	N Caught	0	0	0	0	0	0	0	0	
1978	Tons at Age	0	0	0	0	0	0	0	0	1305
	N at Age	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	N Caught	0	0	0	0	0	0	0	0	
1979	Tons at Age	71	116	132	159	89	173	102	42	882
	N at Age	0.891	1.102	0.972	1.009	0.551	0.922	0.539	0.210	6.190
	N Caught	0	0	0	0	0	0	0	0	
1980	Tons at Age	1877	763	274	71	119	52	58	0	3220
	N at Age	25.405	7.703	2.111	0.518	0.778	0.259	0.259	0.000	37.034
	N Caught	0	0	0	0	0	0	0	0	

Appendix A. (cont)

DISCOVERY BAY

YEAR		Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	GTE Age 9	TOTAL SPAWNER BIOMASS
1981	Tons at Age	61	1243	614	328	347	316	101	61	3070
	N at Age	0.975	10.866	4.333	2.155	1.951	1.701	0.476	0.250	22.685
	N Caught	0	0	0	0	0	0	0	0	
1988	Tons at Age	536	263	55	0	0	0	0	0	853
	N at Age	7.640	2.670	0.400	0.000	0.000	0	0	0	
	N Caught	0	0	0	0	0	0	0	0	
1996	Tons at Age	431	290	28	5	0	0	0	0	752
	N at Age	6.65	3.172	0.191	0.038	0	0	0	0	10.051
	N Caught	0	0	0	0	0	0	0	0	
1997	Tons at Age	176	23	0	0	0	0	0	0	199
	N at Age	4.335	0.360	0.003	0.000	0.000	0	0	0	4.698
	N Caught	0	0	0	0	0	0	0	0	
1998	no age data									0
1999	no age data									307
2000	no age data									159
2001	no age data									137
2002	no age data									148
2003	no age data									207
2004	no age data									252
2005	no age data									33
2006	no age data									1325
2007	no age data									42
2008	no age data									248