# Seafood Assessment

SeaChoice
healthy choices, healthy oceans

## Pacific Herring

*Clupea pallasii*

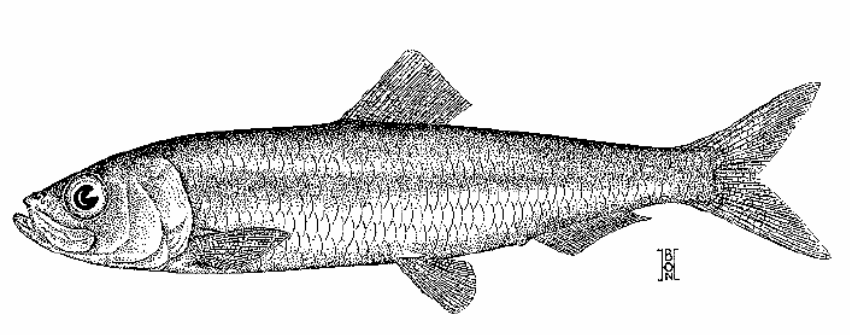

Image: Hart 1973.

## British Columbia

April 2006

Scott Wallace
Blue Planet Research and Education

## About SeaChoice ® and Seafood Assessments

The SeaChoice® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the Canadian marketplace. SeaChoice® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. SeaChoice® makes its science-based recommendations available to the public in the form of a pocket guide, Canada's Seafood Guide, that can be downloaded from the Internet (www.seachoice.org) or obtained from the SeaChoice® program directly by emailing a request to us. The program's goals are to raise awareness of important ocean conservation issues and empower Canadian seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on Canada's Seafood Guide is supported by a Seafood Assessment by SeaChoice or a Seafood Report by Monterey Bay Aquarium; both groups use the same assessment criteria. Each assessment synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic/sustainability criteria to arrive at a recommendation of "Best Choice", "Some Concerns" or "Avoid". The detailed evaluation methodology is available on our website at www.seachoice.org. In producing Seafood Assessments, SeaChoice® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and scientific reviews of ecological sustainability. Information used to evaluate fisheries and aquaculture practices for assessments regularly comes from ecologists, fisheries and aquaculture scientists, members of industry and conservation organizations. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, SeaChoice's sustainability recommendations and the underlying Seafood Assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Assessments in any way they find useful, with acknowledgement. For more information about SeaChoice® and Seafood Assessments, please contact the SeaChoice® program via e-mail and telephone information available at www.seachoice.org

SeaChoice® and Seafood Assessments are made possible through a grant from the David and Lucile Packard Foundation.

## Executive Summary

Pacific herring captured in Canada's roe herring fishery are given an overall seafood recommendation of 'best choice'. Herring have a low inherent vulnerability to fishing due to a low age at first maturity and fast growth rate. The status of the population as a whole is stable; however in 2006 abundance in two of the five management areas was forecasted to be below the established *cutoff* threshold to allow a fishery opening. The herring roe fishery targets large spawning aggregations and catches very few other species in the process. There is likely some habitat impact from gillnets and to a lesser degree purse seines but this has not been well documented. The management system is quite robust with regular stock assessments, monitoring and enforced catch controls.

## Table of Sustainability Ranks

| | Conservation Concern | | | |
|---|---|---|---|---|
| **Sustainability Criteria** | **Low** | **Moderate** | **High** | **Critical** |
| Inherent Vulnerability | √ | | | |
| Status of Stocks | | √ | | |
| Nature of Bycatch | √ | | | |
| Habitat Effects | | √ | | |
| Management Effectiveness | √ | | | |

**About the Overall Seafood Recommendation:**

- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.
- A seafood product is ranked **Good Alternative** if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.

## Overall Seafood Recommendation:

**Best Choice** Good Alternative Avoid

# Introduction

*Biology*[1]

Pacific herring are a wide-ranging pelagic species found throughout the North Pacific occurring as far west as Japan and Korea, north to Russia and the Arctic Ocean, and south along the coast of North America to northern Baja California (Mecklenburg et al. 2002). They are found in near shore coastal environments to well off shore. This species form schools at the surface to depths of 250 m but typically at depths less than 150 m.

In British Columbia, spawning occurs in the spring in shallow inshore waters. Eggs are deposited on kelps or other vertical relief structure or on rocks. Incubation of the eggs is typically 10-21 days at which time the larvae enter the plankton. Herring are relatively fast growing maturing between ages 2 and 5 and are typically short lived (≤ 7 years). Maximum recorded age is 15 years. After spawning, adult herring typically return to offshore waters.

The current stock structure of Pacific herring in British Columbia is not completely understood. Based on recent genetic and tagging studies the current belief is that all British Columbia herring belong to a single metapopulation comprised of five major migratory subpopulations (Beacham et. al. 2001, Ware and Schweigert 2001). These five subpopulations form the basis of the fishery management system and quota allocation is derived at this level. Based on research, the metapopulation viewpoint is widely believed by stock assessment scientists to be the best theory to account for the observed behaviour and genetic structure of herring. The metapopulation theory contrasts the 'discrete population' theory which suggests that Pacific herring in British Columbia are comprised of several discrete populations. The chasm between viewpoints has implications for how herring are currently managed and for explaining the disappearance of local spawning populations. One important consequence of the metapopulation viewpoint is that some local populations can be expected to disappear even in the absence of fishing (Schweigert 2003).

From an ecosystem perspective, herring are one of the most important fish species in Canada's Pacific waters. At all stages of their life cycle herring are consumed by several species in the ecosystem from jellyfish to baleen whales (Environment Canada 1994).

*Fishery*

Herring have been harvested for their roe and flesh by BC's coastal aboriginal peoples for at least 7000 years (Carlson and Dalla Bona 1996). Commercial catch records for herring exist as far back as 1877 in British Columbia. Herring were first sold as a dried salted product in the early 1900s which evolved into a reduction fishery for their flesh and oils in the 1930s (Schweigert 2005). An enormous quantity of herring was removed during the reduction fishery resulting in an eventual collapse of the fishery by the late 1960s. The peak year for herring landings was 1963 when over 250 000 t was landed (Figure 1). The herring population collapsed in the late 1960s. The fishery for herring reopened in 1972 with a focus on herring roe using seines and gillnets to capture the fish. Since 1983 the roe fishery has been managed with a fixed harvest rate policy and a quota system. This system requires that a preseason forecasted biomass

is estimated of which 20% is allocated to the fishery. In recent years the coastwide harvest of roe herring is approximately 20-30 000 t (Figure 1) taken from five different management areas (Figure 2). If the preseason biomass estimate is below a preset 'cutoff' level in a given management area then no fishery is carried out in that region (DFO 2006). The fishery is for the roe which is exported primarily to Japan.

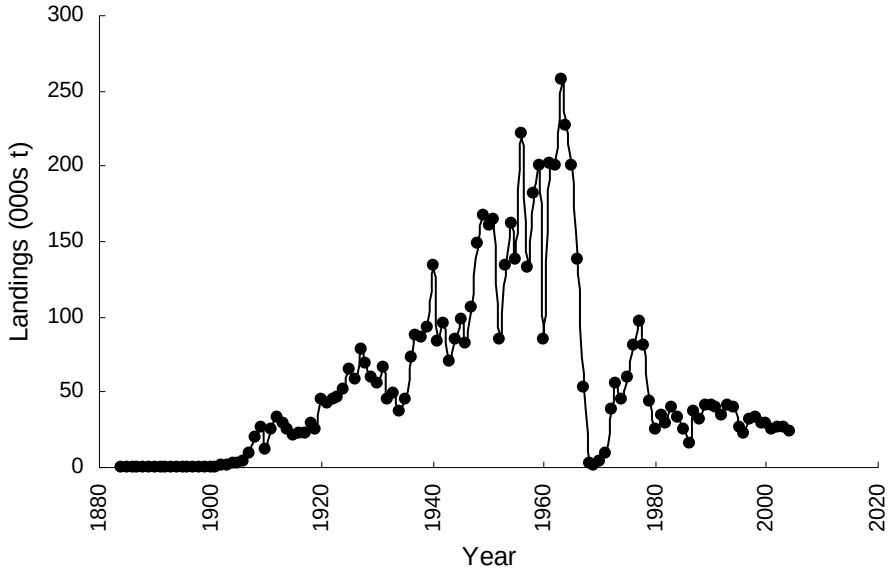


Figure 1. Coastwide commercial catch of herring from 1873 to 2004. Source: DFO catch statistics.

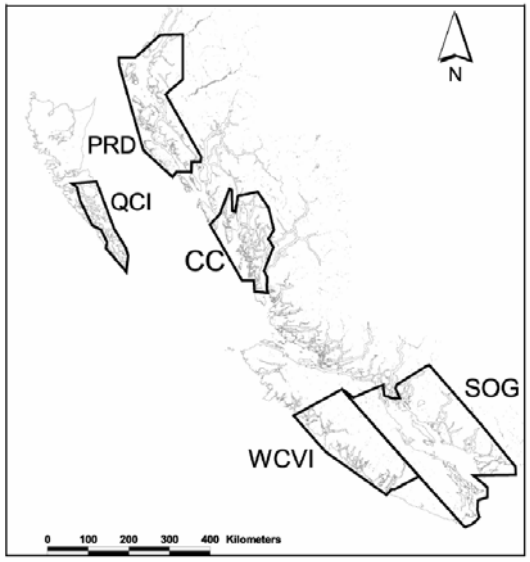


Figure 2. Five main Pacific herring management areas; Prince Rupert District (PRD), Queen Charlotte Islands (QCI), Central Coast (CC), West Coast Vancouver Island (WCVI), Strait of Georgia (SOG). Source: Schweigert 2005.

**Scope of the analysis and the ensuing recommendation:**

The recommendation from this analysis is limited to the Pacific roe-herring fishery in Canada's Pacific waters.

## Availability of Science

Scientific information required to carry out this seafood assessment is relatively complete and accessible. Pacific herring receive annual assessments involving information collected by juvenile surveys and spawning surveys. In recent years there have been several tagging initiatives as well as genetic studies to help understand the population structure.

## Market Availability

**Common and market names:** Pacific herring. Roe is referred to as *kazunoko* in Japanese (Froese and Pauly 2006).

**Seasonal availability:** Herring roe is not readily available in the Canadian market place.

**Product forms:** Herring is primarily harvested for the roe which is salted and frozen. Whole fresh fish, fillets, and pickled herring is also produced in small quantities.
(See: http://www.bcseafoodonline.com/herring_1.asp)

**Import and export sources and statistics:** Canadian import and export statistics are not categorized by species and therefore all herring, including those caught in the Atlantic Ocean are reported in a single category.[2]

# Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

## Criterion 1: Inherent Vulnerability to Fishing Pressure

Pacific herring are a relatively short lived species living to a maximum age of 15 but are typically found to be 3-6 years (Schweigert 2005). First maturity can be as low as two years with full maturity by age five (DFO 2002). The growth rate or von Bertalanfy growth coefficient (*K*), is a measure of the rate at which the asymptotic length is approached and it is often used as indicator of a species resilience to fishing pressure. For Pacific herring, *K* is approximately 0.3 which is in the low range of vulnerability (Froese and Pauly 2005). Fecundity varies by size but is reported by Hart (1973) to be on average 19 000 per female. Overall this species is considered to be resilient to fishing pressure and therefore receives a green ranking for this criterion.

**Table 1**. Life history characteristics of Pacific herring.

| Growth Rate | Age at Maturity | Maximum Age | Fecundity | Species Range | Special Behaviors | Sources |
|---|---|---|---|---|---|---|
| K=0.3 | First maturity-2 years. | 15 years | 9-38000; average 19 000 | North Pacific | Dense breeding aggregations | DFO 2002 Hart 1973 |

| Criterion 1: Inherent Vulnerability to Fishing Pressure | |
|---|---|
| **Primary Factors to Evaluate** | **Ranking** |
| Intrinsic rate of increase 'r' | Not found |
| Age at first maturity |  |
| von Bertalanfy growth coefficient 'k' |  |
| Maximum Age |  |
| Reproductive potential (fecundity) |  |
| **Secondary Factors to Evaluate** | |
| Species range |  |
| Special behaviours or requirements |  |
| Quality of habitat | None |
| **Overall Inherent Vulnerability to Fishing Pressure Rank** |  |

## Criterion 2: Status of Wild Stocks

For management purposes Pacific herring are managed as five separate units: Prince Rupert District (PRD), Queen Charlotte Islands (QCI), Central Coast (CC), West Coast Vancouver Island (WCVI), Strait of Georgia (SOG) (see Figure 2).

Factor 1: Management classification status

The population of Pacific herring as a whole in British Columbia waters can be considered *fully fished*. All major aggregations are subject to a commercial harvest. The population as a whole has recovered from the extensive overfishing that occurred in the 1960s. This factor receives a yellow ranking.

Factor 2: Abundance thresholds

If a forecasted biomass for a given management region is below a preset 'cutoff' then no fishery is permitted in that area. Management regions with populations below the cutoff are considered to be in poor shape. For the 2006 fishing year the forecasted biomass in the QCI and WCVI management areas was below the cutoff and therefore no fishery took place in these regions (Figure 3). This factor is given a yellow ranking due to low abundance in two of the five assessment regions.

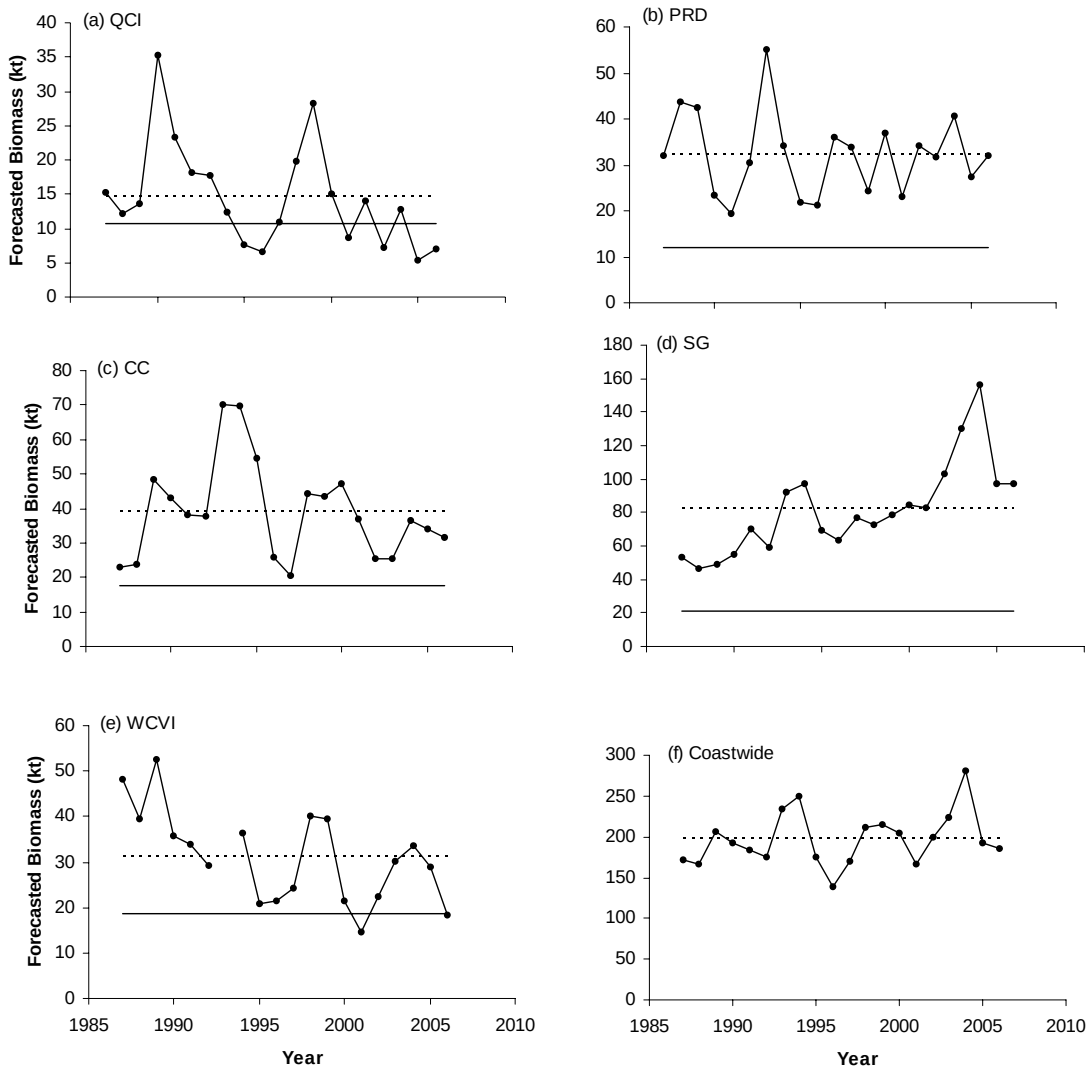


Figure 3. Forecasted biomass estimates (kilotonnes) of Pacific herring in the five management areas and coastwide: Prince Rupert District (PRD), Queen Charlotte Islands (QCI), Central Coast (CC), West Coast Vancouver Island (WCVI), Strait of Georgia (SG). Solid lower line is the 'cutoff' level and dashed line is the series average.

Factor 3: Occurrence of overfishing

There is no indication that the aggregations exposed to fishing pressure are being overfished. The cutoff policy combined with the fixed harvest rate ensures that the population is not overfished. This factor receives a green ranking.

Factor 4: Overall degree of uncertainty in status of stock

Pacific herring, relative to most marine fish receive, considerable research attention including spawning surveys (dive and aerial), juvenile surveys, in season biomass estimates and biological data analysis (i.e., size and sex information). While the stock fluctuates, the overall degree of

uncertainty around the stock size and associated quotas is relatively low. This factor receives a green ranking.

Factor 5: Long-term trend

The long term trend is variable due to extreme natural fluctuations in the population but overall the coastwide population can best be described as stable (Figure 3). There is some concern regarding the recent declines in abundance in the QCI and WCVI management areas (Figure 3a,e). Overall this factor is given a yellow ranking.

Factor 6: Short term trend

The 2006 forecasted spawning biomass (186 000 t) is about equal to the long term average (197 000 t) and therefore this factor is given a yellow ranking.

Factor 7: Current age, size, or sex distribution

The age and size distribution of Pacific herring fluctuates based on environmental conditions (Schweigert et al. 2002, Schweigert 2004; Figure 4). Although the mean weight-at-age has decreased over the long term (Figure 4) the cause is not precisely known but thought to be due to a complex interaction between density dependent growth, food supply and environmental variation (Schweigert et al. 2002). Fishing is not considered a proximate cause for this trend. It is uncertain as to what this trend means in the long term for stock productivity and therefore this trend is cause for some concern. The biological indicators suggest that the biological parameters are presently skewed and therefore this factor receives a red ranking.

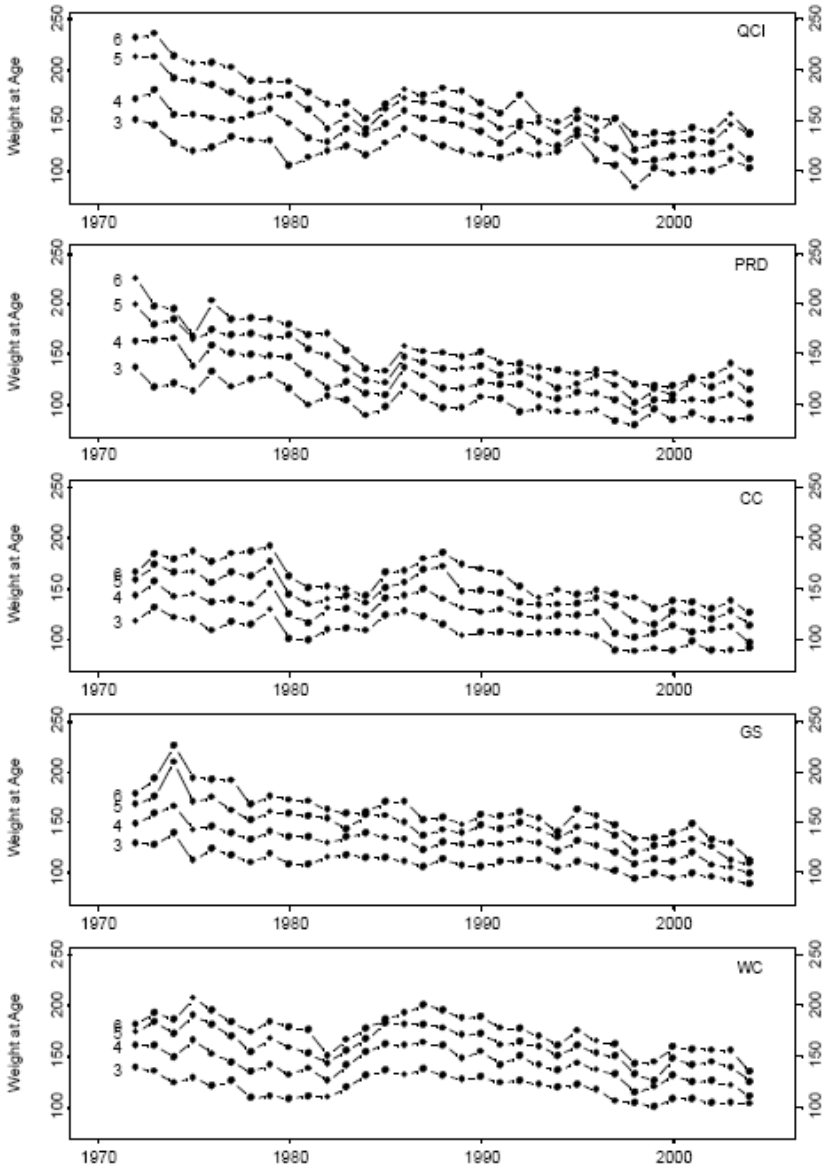


Figure 4. Estimates of weight-at-age (g) for 3-6 year old herring from 1951-2004 for the five assessment regions. Schweigert 2004.

## Synthesis

| Criterion 2: Status of Wild Stocks | |
|---|---|
| **Primary Factors to Evaluate** | **Ranking** |
| Management classification status | |
| Current population abundance | |
| Occurrence of overfishing | |
| Overall degree of uncertainty in status of stock | |
| Long term trend in abundance | |
| Short term trend in abundance | |
| Current age, size, or sex distribution | |
| **Overall Status of Wild Stocks Rank** | |

## Criterion 3: Nature and Extent of Bycatch

*Seafood Watch® defines sustainable wild-caught seafood as marine life captured using fishing techniques that successfully minimize the catch of unwanted and/or unmarketable species (i.e., bycatch). Bycatch is defined as species that are caught but subsequently discarded (injured or dead) for any reason. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, accounted for and/or managed in some way.*

Factor 1: Quantity of Bycatch

The fishery for Pacific herring targets spawning aggregations using purse seines and gillnets. Because the aggregations are comprised predominantly of herring, the ratio of bycatch to directed catch is low (i.e., <1%) (Boyes, pers. comm. 2006, Schweigert pers. comm. 2006). This factor receives a green ranking.

Factor 2: Population Consequence of the Bycatch

At present time there is no license condition to report catch of non-herring species. The catch of non-herring species is therefore not well known and limited to anecdotal information from fishers themselves. Anecdotal information indicates that very few species are caught as bycatch and in very small quantities so there is not likely any population consequences of the bycatch. Coastal water birds are vulnerable to gillnet technologies but are not captured with any regularity by herring gillnets (Boyes, pers. comm. 2006). Overall, there is no documented information on the extent, nature and consequences of the bycatch in this fishery and therefore this factor receives a yellow (unknown) ranking.

Factor 3: Trends in Bycatch Rates-Not applicable as bycatch rate is low.

Secondary Factor: Ecosystem Impacts of Bycatch- Not applicable as bycatch rate is low.

**Synthesis**

| Criterion 3: Bycatch | |
|---|---|
| **Primary Factors to Evaluate** | **Ranking** |
| Quantity of bycatch | |
| Population consequence of bycatch | |
| Trends in bycatch rates | NA |
| **Secondary Factors** | |
| Ecosystem Impacts | NA |
| **Overall Rank** | |

## Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

### Primary Habitat Factors

Factor 1: Impacts of Fishing Gear on Habitat.

There has been no research on habitat impacts from the herring fishery. Herring are captured by gillnets and purse seines. For 2006, the available harvest was allocated between seines and gill nets on a 55:45 coast-wide basis (DFO 2006). Both of these technologies have potential to moderately impact bottom habitats. Purse seines, however, are often set in deep waters and therefore often contact with the bottom. The percentage of seine sets that contact the bottom is unknown but is likely low (Schweigert pers. comm. 2006). Gillnets are typically set overtop of spawning events which occur in a variety of habitats ranging from rock to soft bottom habitat. The coastwide extent of the damage is unknown but is not considered to be a problem (Schweigert pers. comm. 2006). Based on this assessment methodology, any gear type that contacts the bottom is given a minimum of a yellow ranking.

Factor 2: Resilience of the Habitat Fished

Herring gillnets are set over a variety of near shore shallow (<10 m) habitats depending on the spawning location of the herring. Habitat types include rocky shorelines where the herring spawn on attached seaweeds, encrusting algae and on the rock itself; soft bottom habitats with eelgrass; and boulder bottoms (Schweigert 2004). Rocky habitats are generally considered to have a low resilience to gear as are eelgrass habitats (Chuenpagdee et al. 2003). The degree of habitat damage caused by the gillnet fleet depends on the relative amount of fishing occurring in each type of habitat which is presently unknown. The seine fleet likely has less impact as the sets are often mid-water. In the event where the bottom line of a seine net contacts the substrate it is usually on sandy bottoms considered to be somewhat more resilient to impact (Chuenpagdee et al. 2003). The relative amount of fishing pressure occurring over various habitats is unknown and therefore it is not possible to characterize the fleet. This factor receives an *unknown* yellow ranking.

Factor 3: Spatial Extent of the Impact.

The herring fishery takes place at moderate spatial over a time period of typically less than a week. It is confined to areas of spawning aggregations of herring which on the scale of the entire province occupies a small area. Overall the spatial extent of this fishery is considered to be small and therefore this factor receives a green ranking.

### Primary Ecosystem Factors

Factor 1: Disruption of food webs.

Herring are one of the most important species to the marine ecosystem of Canada's Pacific coast. The dynamic nature of marine ecosystems (and the lack of understanding of how these systems work) precludes the opportunity for a precise scientific answer to the question of

how much herring needs to be left for ecosystem functioning. Herring populations exhibit substantial inter-annual natural fluctuations which ripple through marine ecosystems regardless of human harvest.

The Department of Fisheries and Oceans has not yet addressed the role that herring play in the ecosystem into the management plans. The 2006 management plan states (DFO 2006):

"At this time there is no information available on the appropriate conservation limits for the ecosystem as it pertains to the herring stocks. It is recognized that herring play a critical role in the ecosystem and are a food source for a variety of species. The precautionary harvest rate of 20 percent of the mature biomass ensures that 80 percent of the adult population is available to predator species and to protect for future production. Additionally, since no harvest occurs on immature herring all of these fish are available to support ecosystem processes. Research is ongoing to better understand these ecosystem processes and the role herring plays in maintaining the integrity and functioning of the ecosystem."

Overall this factor receives an *unknown* yellow ranking.

Factor 2: Changes in ecosystem state.

There is no indication that the fishery as currently executed has resulted in any change of ecosystem state but this has not been adequately studied. This factor receives an unknown yellow ranking.

**Synthesis**

It is unlikely that the fishing gears used to capture herring are having any large scale impacts on habitats and ecosystems but this is unknown. The main concern regarding this fishery is the appropriate fishery yield of herring in the context of ecosystem requirements.

| **Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems** | |
|---|---|
| **Factors to Evaluate** | **Ranking** |
| Impacts of Fishing Gear on Habitat | |
| Resilience of the Habitat | |
| Spatial Extent of the Impact | |
| Disruption of food webs | |
| Changes in ecosystem state | |
| **Overall Effect of Fishing Practices on Habitats and Ecosystems Rank** | |

## Criterion 5: Effectiveness of the Management Regime

Factor 1: Stock Assessments

Herring populations in each major management area are assessed on an annual basis using an age structured model (Schweigert 2004). The model is parameterized by spawn indices and biological data indicating age and size composition. The current stock assessment age-structured model has been utilized since 1984 (Fournier and Archibald 1982) with aspects of the herring database in existence for over 50 years. The model is in a state of continual revision to reflect increased information on the life history of herring and the conduct of the fishery itself. Overall, the model performance is considered to be reliable within an acceptable determined error. Similar age-structured models have been proven effective in other jurisdictions to manage herring fisheries. This factor receives a green ranking.

Factor 2: Scientific Monitoring

Management of the herring fishery involves regular collection and analysis of both fishery dependent and independent data. One concern is the ability to make accurate inseason adjustments in the event that the forecast is incorrect. The quotas are assigned based on the forecast; however there is no way of determining the accuracy of the forecast until after the fishery has been executed. There have been some attempts to estimate inseason abundance using echo-sounding but they are considered to be less accurate than modeled stock assessments for the purpose of reevaluating quotas (Tanasichuk, 1999). Relative to most fisheries, the BC herring fishery receives considerable scientific monitoring and therefore this factor is given a green ranking.

Factor 3: Scientific Advice

The advice put forward by the stock assessment scientists has invariably been accepted by managers and adopted into the management plans (see review in Schweigert 2005). This factor receives a green ranking.

Factor 4: Bycatch

Not applicable because fishing method produces very little bycatch.

Factor 5: Fishing Practices

Management has not evaluated the impacts of fishing gear on habitat and has not explicitly incorporated the ecosystem role of herring into their management plans. This factor receives a yellow ranking.

Factor 6: Catch Monitoring and Enforcement

Overall this fishery is well-monitored and enforced with dockside monitoring of the landings. Despite the comprehensive monitoring, the quota is still often exceeded but has

generally decreased in recent years (Figure 4). In 1998, fisheries managers implemented two major reforms to facilitate accurate and timely catch monitoring. First was the pooling of licenses, which effectively decreased the number of boats participating in the fishery; the second was an individual quota system, which eliminated the race for fish and consequently the potential for going over the total allowable catch. Since 1998, overages have averaged 5% in total, but in some assessment areas overages are still unacceptably high (Figure 5). In 2004 the overall catch was for the first time less than the quota but in some areas the quota was exceeded. Management has recognized the need for timely catch information as one of the key management objectives (DFO 2006). This factor receives a yellow ranking.

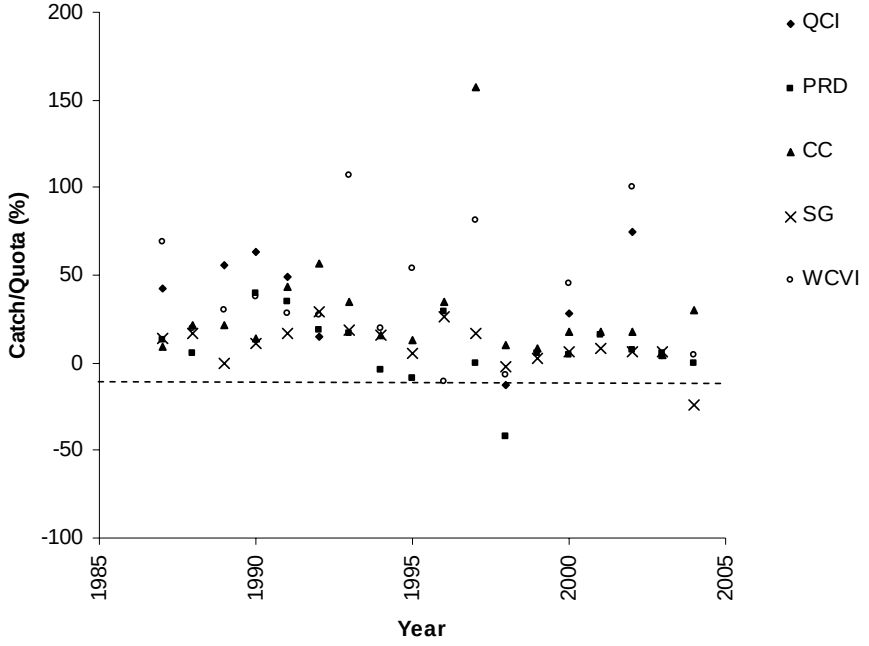


Figure 5. Roe herring catch compared to the quota set by management from 1985-2004. Data used for graphs from Schweigert (2005).

Factor 7: Management Track Record

Management has been able to restore and maintain the stock productivity by significant changes in management over the last three decades. This factor receives a green ranking.

**Synthesis**

| **Criterion 5: Effectiveness of the Management Regime** | |
|---|---|
| **Factors to Evaluate** | **Ranking** |
| Stock Assessments | |
| Scientific Monitoring | |
| Scientific Advice | |
| Bycatch | NA |
| Fishing Practices | |
| Catch Monitoring and Enforcement | |
| Management Track Record | |
| **Overall Effectiveness of the Management Regime** | |

## Overall Evaluation and Seafood Recommendation

Pacific herring captured in Canada's roe herring fishery are given an overall seafood recommendation of 'best choice'. Herring have a low inherent vulnerability to fishing due to a low age at first maturity and fast growth rate. The status of the population as a whole is stable; however in 2006 abundance in two of the five management areas was forecasted to be below the established *cutoff* threshold to allow a fishery opening. The herring roe fishery targets large spawning aggregations and catches very few other species in the process. There is likely some habitat impact from gillnets and to a lesser degree purse seines but this has not been well documented. The management system is quite robust with regular stock assessments, monitoring and enforced catch controls.

## Table of Sustainability Ranks

| | Conservation Concern | | | |
|---|---|---|---|---|
| **Sustainability Criteria** | **Low** | **Moderate** | **High** | **Critical** |
| Inherent Vulnerability | √ | | | |
| Status of Stocks | | √ | | |
| Nature of Bycatch | √ | | | |
| Habitat Effects | | √ | | |
| Management Effectiveness | √ | | | |

## Overall Seafood Recommendation:

**Best Choice** Good Alternative Avoid

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