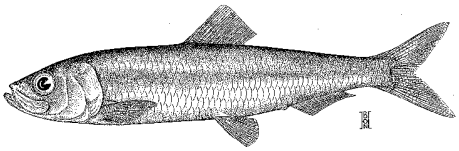
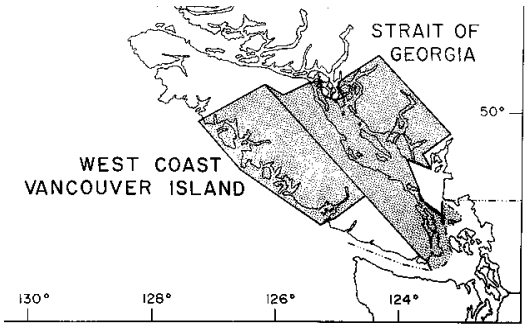




West Coast Vancouver Island Herring

Background

Pacific herring is a pelagic species which occurs in inshore and offshore waters on both sides of the North Pacific. In the eastern Pacific it ranges from California to the Beaufort Sea. Herring mature and recruit to the spawning stock predominantly between ages 2 and 5. Within this range, recruitment tends to occur at younger ages in southern waters, and older ages in the north.

The West Coast of Vancouver Island (WCVI) herring stock is one of five major B.C. herring stocks. Between 1918 and 1966 the catch from this stock averaged 18,000 t .The stock collapsed from overfishing in the early 1960s, and the commercial reduction fishery was closed in 1967. Following the advantageous combination of favourable environmental conditions and a low harvest rate, the stock recovered by the mid-1970s. The modern roe fishery began in 1972. The target harvest rate of roe herring is fixed at 20% of the forecast mature stock biomass. Unfavourable oceanic conditions returned in 1978, and the stock has been in a low productivity state since then. Recent assessments indicate that the mature herring biomass is 5 to 10 thousand tonnes above the stock conservation reference point (18,800 t), and under current environmental conditions can only sustain a small catch (less than 8,000 t).

The Fishery

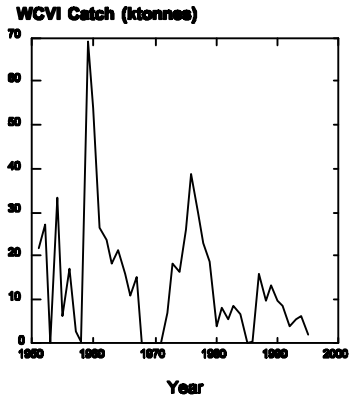
Average WCVI Catch (thousands of tonnes)

1951-60	1961-70	1971-80	1981-90
23.2	13.2	18.2	7.8

From the mid-1940s until the late 1960s, herring were harvested and processed (reduced) into relatively low value products such as fish meal and oil. Commercial harvest rates increased during this period and were unsustainable by the early 1960s. By 1965, most of the older fish had been removed from the spawning population by a combination of overfishing, and a sequence of weak year-classes, attributed to unfavourable environmental conditions and a low stock biomass. As a consequence, the commercial fishery collapsed in 1967, and was closed by the federal government to allow the stock to recover.

After a four year closure and a fortuitious return of favourable environmental conditions, the stock had rebuilt enough to sustain a new fishery. There was a growing interest to harvest roe herring for export to Japan. A small experimental roe harvest began in 1972, and the fishery expanded until 1983, when fixed quotas were introduced to

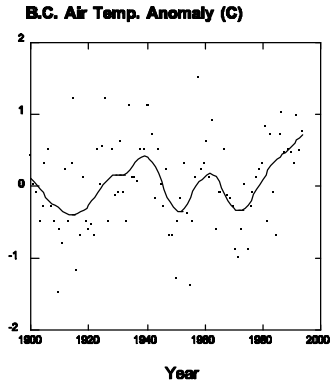
regulate the catch. Small quantities of WCVI herring are also utilized for spawn-on-kelp, and aboriginal food fish. The objective of the modern herring fishery is to obtain a low volume, high-quality product that is economically profitable and ecologically sustainable. The fishery is currently managed by setting a fixed target harvest rate of 20% of the forecast mature stock biomass. To meet conservation objectives, the management strategy also enforces a minimum spawning stock biomass . If the forecast biomass falls below the Cutoff threshold (18,800 t) the commercial fishery is closed until the stock rebuilds (Stocker 1993). In response to several years of poor recruitment, the WCVI fishery was closed in 1985 and 1986. Since then the stock has been in a low productivity state and has only been able to sustain an average catch of about 7,500 t (Schweigert et al 1996).



1

Climatic Factors

Fisheries and Oceans (Canada) research has shown that the growth and survival of WCVI herring are sensitive to natural variations in ocean climate. These recurring climatic changes, which last for a decade or two, cause significant shifts in the structure and productivity of the coastal ecosystem where the herring live. Specifically, the productivity of the WCVI herring stock is vulnerable to interannual and decadal time scale variations in the climate of the coastal ocean (indexed by water and air temperatures, which are highly correlated), and spawning biomass. Recruitment is the most important process determining the productivity of B.C. herring populations. Long-term research has shown that both recruitment and adult survival tend to be below average in warm years, particularly when migratory herring-predators (like Pacific hake and mackerel) are abundant off the west coast of Vancouver Island (Ware & McFarlane 1995). The coastal ocean has been in a protracted warm state since 1978. When this occurs the productivity of the copepod and krill populations appears to decline. Also, more Pacific hake migrate for the summer to the WCVI stock assessment area, where they eat a lot of herring. Pacific mackerel and hake are particularly abundant during warm El Niño summers.



2

Stock reconstructions (Schweigert et al 1996) indicate that herring cohorts born in cool years are twice as large, on average, as those born in warm years. Surplus production calculations indicate that the unfished carrying capacity of the WCVI population is about 111,000 t when the environment and ecosystem are in a cool climate state , but is less than half as large (about 49,000 t) during

a warm climate state. Since coastal water (and air) temperatures off the WCVI alternate between decadal-length warm and cool periods (Ware 1995), stock reconstructions spanning the last 40 years indicate that the WCVI population is more or less continually in transition between these two "equilibrium" biomass states.

Retrospective stock production analyses indicate that the WCVI stock can sustain catches exceeding 20 thousand tonnes during cool climate states. However, the sustainable catch is less than 8,000 t during warm climate states, as the following table of recent catches indicates.

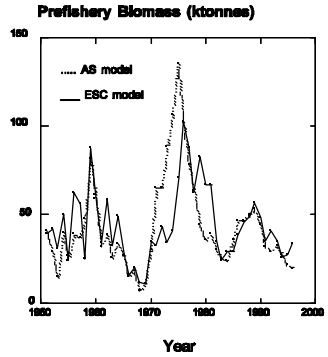
WCVI Catch (thousands of tonnes)

1992	1993	1994	1995	1996
3.4	5.6	6.4	2.0	1.4

Resource Status

Herring stock assessments are based on biological samples of the population age composition, average weight-at-age, historical catch data, and assessments of spawn distribution and intensity throughout the coast (Schweigert et al 1996).

The fishable stock biomass is estimated by two models: an age-structured model and an escapement model. The latter relies predominantly on the spawn estimates. The average of the estimates from both models is used to determine the current stock level, project future run size, and forecast an allowable catch. Retrospective estimates of the mature stock (age 2+ and older) biomass just prior to the fishery, indicate a peak in the mid-1970s in response to favourable environmentalconditions and low harvest rates.



As the stock approached its carrying capacity the net production rate fell, causing a decline in the late-1970s. The ocean climate shifted to a warm state in 1978 and has remained anomalously warm since then (with the exception of 1985 which was a cool year). This most recent series of warm years has caused low stock biomass and productivity. There was a minor increase in the biomass in 1988, when the above average 1985 year-class recruited. However, as this year-class aged and declined in abundance so has the stock biomass, because no new strong year-classes have recruited to the population.

Outlook

The pattern of below-average recruitment to the stock is not expected to improve until the current warm climate moderates, and returns to an average or cool state. The current size of the population (ca. 27,000 t) is near the level which produces maximum productivity during warm climate states. At this level the sustainable catch is less than 8,000 t.

The coastal ocean seems to have returned to a near-normal temperature state in the fall of 1996. If this condition persists for a few years, we anticipate an increase in recruitment, biomass and allowable catch from the WCVI stock.

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