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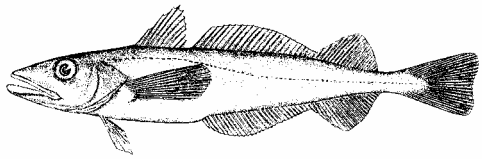
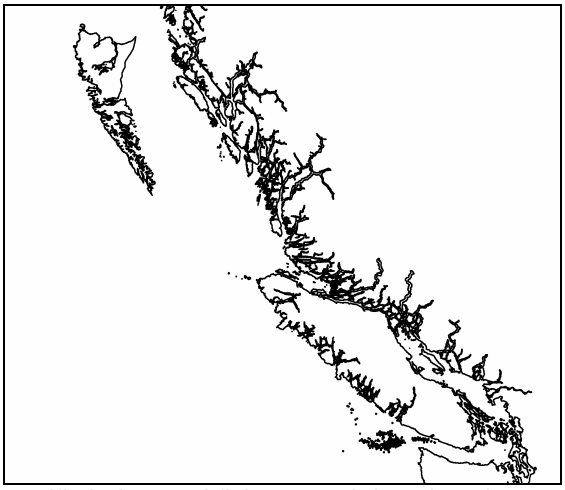
Pacific Region **Stock Status Report 2003/032**



Pacific hake (offshore)

Background

There are two stocks of Pacific hake (Merluccius productus) off the west coast of Canada, one offshore and one in the Strait of Georgia. The offshore stock is distinguished by larger size-at-age and seasonal migratory behavior. The stock is mainly pelagic and spends the May to September period feeding on krill along the shelf break from Baja California to northern BC. During the winter, Pacific hake move well offshore and to the south to California, with spawning occurring from December to March. Pacific hake mature at about age 3+ and live up to 20 years of age. An average hake weighs 600 g and is 48 cm in length. During the summer older, larger and mostly female fish are found further north. The stock is characterized by low median recruitment punctuated by very strong year classes in 1980 and 1984. Weight-at-age declined from the late 1980s to the mid 1990s, with an increase in weight-at-age to former levels in recent years. Winter spawning distribution is largely unknown, but the summer distribution is well understood through at-sea and dockside observer monitoring and hydro-acoustic surveys conducted triennially by DFO and the U.S. National Marine Fisheries Service. During the 1970s and 1980s, the summer northern boundary of the stock was Queen Charlotte Sound and the biomass was centered from Oregon to southern B.C., with about 20% of the biomass in Canadian waters. By the late 1990s, the centre of summer feeding and winter spawning distributions shifted north. In 1998, about 50% of the stock was in Canadian waters during the summer months and fish were found as far north as 59 deg. N in the Gulf of Alaska. Over the long-term, about 30% of the mature biomass is in Canadian waters during the summer months.



Pacific hake trawl fishery catch locations in 2002.

Summary

- Stock size was relatively stable from 1972-1982 at between 2 to 3 million t. Stock size then increased to a maximum of 6 million t in 1987.
- Stock size declined steadily after 1987, and reached its lowest point of about 0.7 million t in 2001.
- The exploitation rate increased from below 10% prior to 1993, to 31% in 2001.
- The stock in 2002 was projected to be composed predominately (63% by weight) of age 3 fish that are about 66% mature.
- Mature female biomass was projected to rise gradually over the three years after 2001 as an above average 1999 year-class enters the mature biomass of the stock.
- The projected increase in biomass over the three years after 2001 depends heavily on the estimated strength of the 1999 year-class, persistence in the recent increase in

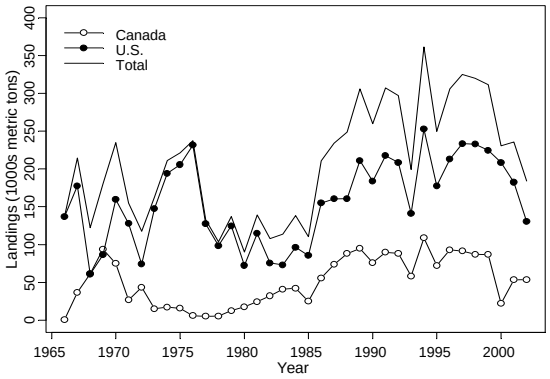
weight-at-age, and the selected harvest policy over the projection period.

The Fishery

Average Canadian and U.S. landings (1000s t)

	1960-1969	1970-1979	1980-1989	1990-1999	2000-2002
CAN	48	22	49	85	43
U.S.	115	149	120	209	173

Pacific hake are caught using large mid-water trawls. Total landings varied between 100 and 235 thousand t from 1966 to 1987. There has been a decline in landings during the 1997 to 2002 period from 325 to 185 thousand t. Canadian landings averaged 51 thousand t annually over the period 1966 to 2002 and 75 thousand t since 1990. In both Canada and the U.S., foreign fisheries were eliminated by the early 1990s. The U.S. eliminated foreign joint-venture (JV) fishing in 1991. In Canada, JV fisheries continued until 2001 and represented about 40% of the Canadian catch. Landings have exceeded the coastwide total allowable catch by an average of 10% since 1993 due to disagreement on the allocation between Canadian and U.S fisheries. The fishery is worth approximately CAN $15 million and supports domestic processing plants in Ucluelet and Port Alberni that mainly produce surimi. An enzyme associated with a parasite in offshore Pacific hake causes the flesh to begin breaking down within hours of being caught. For this reason, processing must be done on, or as close to, the fishing grounds as possible. Hence, despite the present wide range in Pacific hake distribution, fishing continues to be concentrated off the southwest coast of Vancouver Island.



Pacific hake annual landings (1000s t).

Resource Status

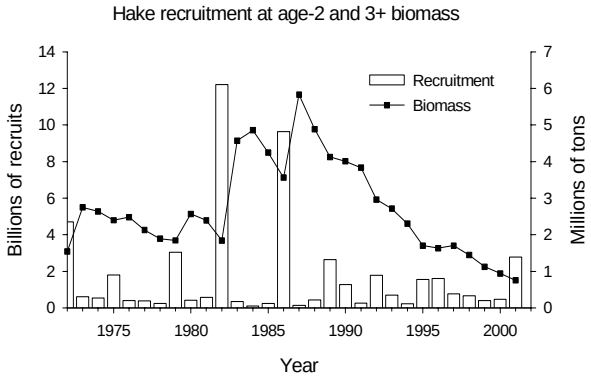
This trans-boundary stock is jointly surveyed and assessed by Canada and the United States. The stock is assessed using a catch-at-age population dynamics model that incorporates four stock indices and a recruitment index. The primary index is a biomass times series derived from the triennial hydro-acoustic survey that began in 1977.

The 2001 stock reconstruction suggested that biomass peaked in 1987 at an historical high of about 6 million t as a result of exceptional 1980 and 1984 year-classes. Stock biomass declined continuously after 1987, with a stable period from 1995 to 1997, followed by a continuous decline to its lowest point of about 0.7 million t in 2001. The 2002 stock was projected to be composed predominately (63% by weight) of the 1999 year-class of age 3 fish, which are about 66% mature. The female spawning stock biomass was estimated to be about 0.4 million t at that time. The exploitation rate increased from below 10% prior to 1993, to 31% in 2001. Mature female spawning biomass in 2001 was estimated to be 20% of an unfished stock.

The target fishing mortality rate has been set at $F_{40\%}$, with a 40-10 adjustment, for the past 3 years. The $F_{40\%}$ reference point is the fishing mortality rate that would reduce the spawning biomass per recruit to 40% of its unfished level. The target fishing mortality is applied when the stock size is greater than 40% of the unexploited stock size. The fishing mortality rate is reduced by the 40-10 adjustment when the stock size is below 40% of the unfished level. The reduction is a linear decline in harvest to zero when the stock size is 10% or less of its unfished level. The actual harvests have exceeded the targets since 1998.

Based on evaluation of a number of harvest strategies, a coast wide yield range of 96 to 133 thousand t was recommended by a joint Canada/U.S. review panel for the 2002 fishing year.

A major source of model uncertainty is the accuracy of the abundance index derived from the hydro-acoustic survey time series. Because the stock is highly variable in distribution along the coast, the survey may not have encompassed the entire stock distribution in some years. Also, assumptions of the model are that the acoustic measurement detects all hake in the path of the acoustic beam and that the reference target strength estimate, based on a small number of observations, is correct.



Recruitment at age 2 and age 3+ (adult) biomass.

Outlook

The offshore Pacific hake stock is estimated to be at a low level of abundance. In the U.S., Pacific hake was declared over-fished in April 2002 by virtue of the female spawning biomass falling below 25% of the unfished level. Mature female biomass is projected to rise gradually over the next three years due to the influence of the 1999 year-class as it enters the mature component of the stock. However, the projected increase in stock biomass, and hence the future yield trajectory, depends heavily on the estimated strength of the 1999 year-class, persistence in the recent increase in weight-at-age, and the selected harvest rate. Consequently, the joint Canada/U.S. review panel recommended against adopting the 2003 stock projections until another assessment is conducted.

Unusual patterns of distribution and recruitment have been observed in recent years and appear to be related to changes in the west coast ecosystem in the early 1990s. Juvenile Pacific hake (ages 1-3) had spread northwards during the 1994 to 1999 period in association with El Niño conditions. It is unclear how stock productivity was

affected by large numbers of juvenile fish in the Canadian zone. In contrast, low abundance of Pacific hake was experienced in Canadian waters in 2000 and 2001, when the TAC was not fully utilized. In 2002, relatively few 3-year-old fish were found in the Canadian commercial fishery, which represented a more typical distributional pattern.

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