

Silver Hake on the Scotian Shelf (Div. 4VWX)

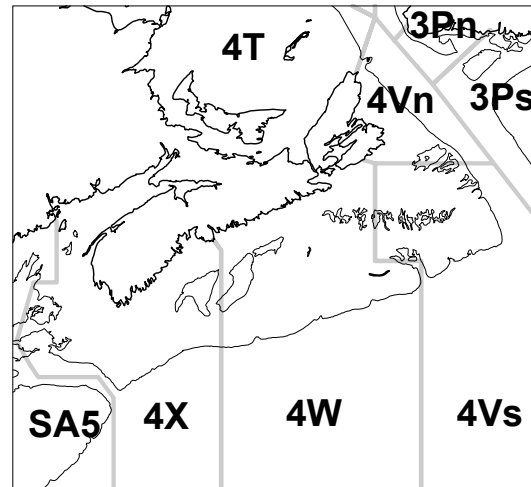
Background

Silver hake (*Merluccius bilinearis*) is a bottom dwelling member of the gadoid family, found from Cape Hatteras to the Grand Banks and the Gulf of St. Lawrence. A major concentration of silver hake occurs on the Scotian Shelf.

Scotian Shelf silver hake are generally found between 7 and 10° C, in deeper water on the shelf edge and in the Emerald and LaHave basins. Seasonal movements occur during the summer, as silver hake move into shallow water on Sable and Western banks to spawn. Scotian Shelf silver hake feed primarily on invertebrates, with krill the predominant prey item. Older fish are piscivorous and exhibit a high degree of cannibalism.

Silver hake exhibit relatively rapid growth with females growing faster than males. Maximum age is 12 years. Maturity is relatively early, with a majority maturing at age 2.

Prior to 1977, fishing on the Scotian Shelf was unrestricted in terms of area, mesh size and season. During this period fishing was conducted over the entire shelf, and the use of trawl mesh as small as 40 mm was common. In 1977, fishing for this species was restricted to the seaward side of the Small Mesh Gear Line (SMGL), west of 60° W longitude, with a minimum mesh size of 60 mm (offshore). In 1994, further restrictions were introduced to minimise incidental catches of cod, haddock and pollock in the silver hake fishery. These included a repositioning of the SMGL to prevent fishing in depths less than 190 m and the mandatory use of a separator grate in the lengthening piece of the trawl. Since 1995 a fishery has been conducted by the Canadian tonnage class 3 (<65') mobile gear fleet in and around Emerald and LaHave Basins (inshore).



Summary

- Survey estimates of abundance and biomass have declined since the early 1980s. Biomass is now near the lowest level observed.
- Condition and length-at-age are low relative to the long term average.
- Fish are maturing at smaller size, with a higher proportion maturing at age 1 and 2.
- Estimates of total mortality are high, suggesting exploitation is high and/or natural mortality has increased.
- Recruitment (2002 year class) is well above average.
- Ages caught in the fishery have changed, and now a significant proportion of the catch is immature fish.

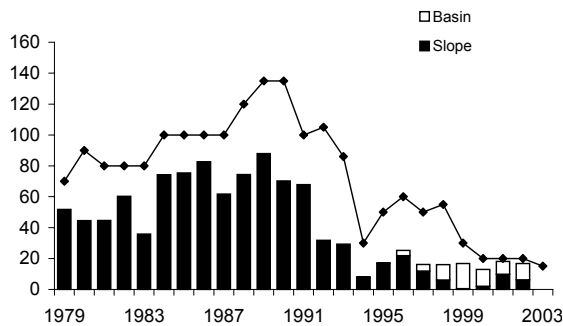
The Fishery

Landings (000s t)								
Year	1970-79	1980-89	1990-98	1999 ²	2000 ³	2001	2002	2003
TAC	90.2 ⁴	98.5	55.6	33	20	20	20	15
Canada ¹	0	0	2.3	16.7	12.9	18.0	16.7	
Foreign	115.6	64.2	30.9	0	0	0	0	
Total	115.6	64.2	33.2	16.7	12.9	18.0	16.7	

1. Includes developmental allocations.
2. Fishing year, landings and TAC refer to the 15-month period from January 1, 1999 to March 31, 2000.
3. Commencing in 2000, fishing year, landings and TAC refer to the period from April 1 of the current year to March 31 of the following year.
4. Average TAC for 1974-79 period.

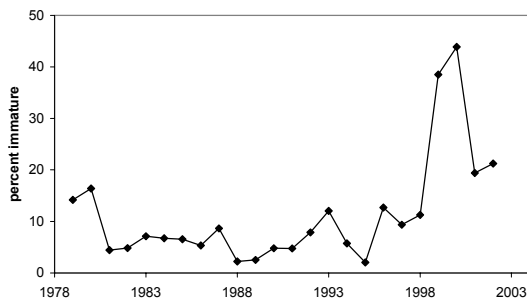
Landings for the 2003 fishing year (to November 10th) are 4,600t.

Landings, tonnes ('000)



In recent years the selection pattern of the commercial fishery has changed to smaller fish, and the proportion of the catch that is immature is very high.

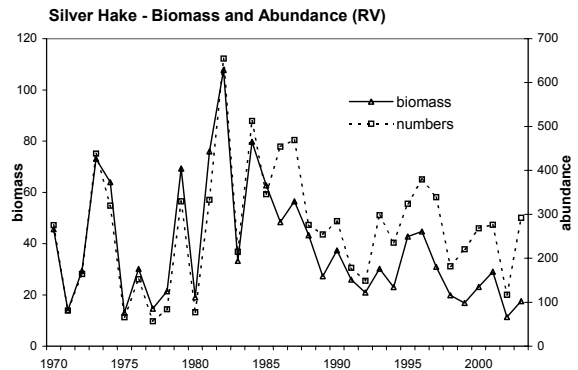
Immature (weight)



Resource Status

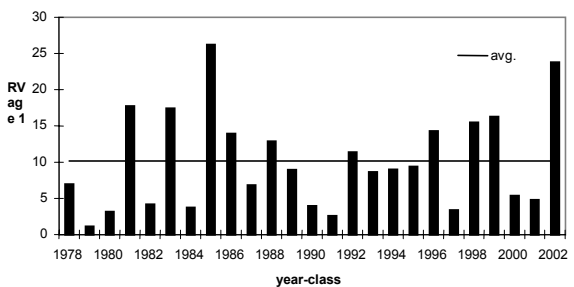
Information on the annual spatial distribution and size composition from the July research vessel surveys is contained in Branton and Black (2003).

Total biomass from the DFO **summer research vessel (RV) survey** increased slightly from 1998 to 2001, but has decreased subsequently and is now near the lowest levels in the time series.



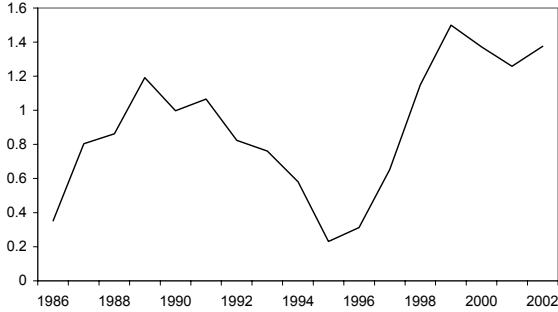
Recruitment to the 2003/2004 fishery is from the 2001 and 2002 year-classes. The 2001 year class is below average, but the 2002 year class is very large – more than twice average and the largest seen since 1985.

Recruitment (millions)



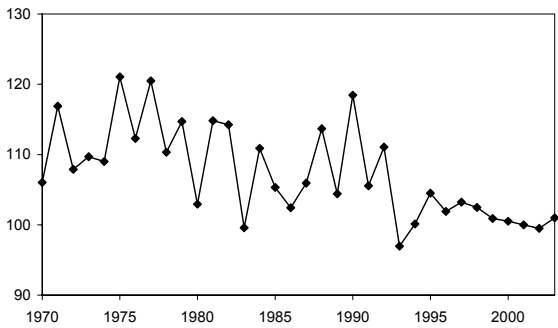
Total mortality over ages 2-4 from the summer survey shows an increasing trend since 1995. Total mortality for ages important to the fishery is above that expected with $F_{0.1} = 0.7$ (assuming natural mortality = 0.4), suggesting either exploitation is relatively high (despite moderate catches) or that natural mortality has increased. The magnitude of this increase may be confounded with a reduction in survey catchability due to a decrease in size at age.

Total mortality (ages 2-4)



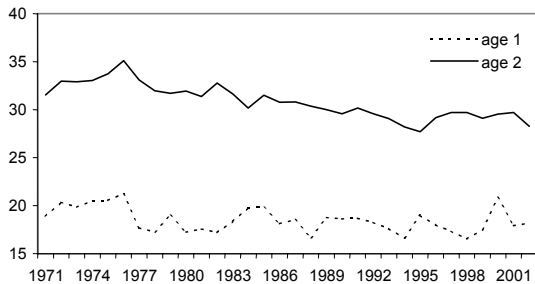
Condition (weight at 25cm), shows a general decline from 1975 to 1993. An increase was seen in 1995, but condition has declined subsequently to a low level relative to the long-term average.

Condition index



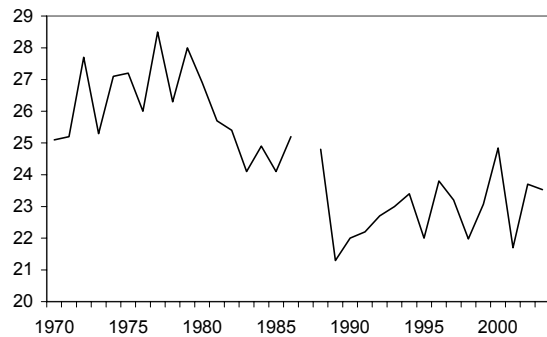
Lengths-at-age 2 and older have also shown a decline, from high levels in the early 1970s to a low in 1995. Length-at-age increased from 1995 to 1998, but declined subsequently and remains below the long-term mean. Length at age 1 shows no trend.

Length-at-age: female



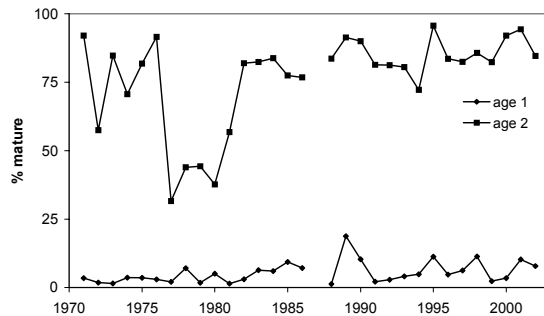
Length at 50% maturity was highest in the 1970s, but declined subsequently. Since 1993 it has remained stable at a lower level.

Length (cm) at 50% Maturity



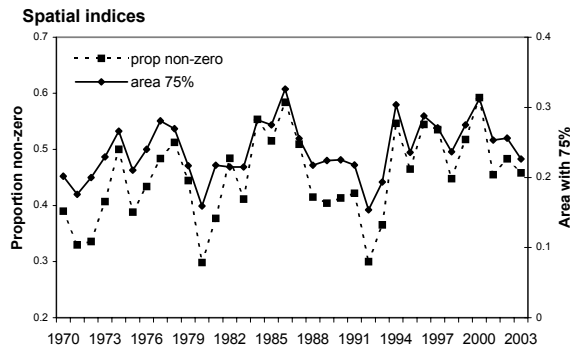
The **proportion mature** at age 1 and age 2 has shown an increasing trend since the early 1990s, and are now at or near the highest values in the times series.

Females



A measure of **resource concentration** is the proportion of the historical stock area encompassing 75% of the annually estimated survey biomass. For silver hake this index has been stable at a high level since 1992, indicating that the resource is widely distributed.

The proportion of annual survey sets where the species occurs (non-zero sets) is a measure of the **area occupied** by the species. This index has been increasing since 1992 and is presently at a high level.



Management Considerations

The current mesh size (55 mm square) was intended to ensure the release of small fish. This does not appear to be effective and requires investigation.

Sources of Uncertainty

A source of uncertainty is the potential change in catchability in the Summer RV survey due to the reduction in size at age and implications on total mortality.

Ecosystem Considerations

Marine species are exposed to interacting biophysical influences, such as temperature, currents and primary productivity that affect their growth, survival and reproductive success. Our current understanding of these effects on our estimates of fish populations and potential yield is poor. Fish species should be considered as living components of ecosystems, subject to changes in their environment. Reviews of comprehensive suites of biophysical data should be undertaken, to gain greater understanding of the relationship between fish and the environment in which they live.

There appears to have been a wide-spread reduction in the productivity of demersal fish species on the Scotian

Shelf. This is evident in the reduced growth for these species where it is measured and can be inferred from the accumulations of large numbers of small individuals for many other species where direct measures of growth are not available. Many of these species are also showing the onset of sexual maturity at smaller sizes. In a single-species context this implies a significant loss in potential yield relative to historical catches. Many of these species, including some that are subject to little or no fishing mortality, are showing similar patterns of change in productivity. This makes it likely that an environmental or ecological effect is responsible. What this may be is currently unknown.

All fisheries have the potential for discarding undersized specimens of targeted species or all size classes of non-target species, the mix of which is dependent on the gear used and the location of the fishery. The use of a separator grate in the silver hake fishery reduces bycatch of larger fish and larger invertebrates. The mix of species is generally well recorded, but the wider ecosystem effects of this fishery, in terms of total bycatch, have not been assessed.

Fishing gears can have negative physical impacts on the seafloor, reducing epi-fauna and flora and damaging or modifying fish and invertebrate habitat. For the silver hake trawl fishery these potential impacts have not been assessed.

Summary of Attributes of Stock Status

Attribute	Recent Trend	Current Status
Biomass RV age 1+ (1970-2003)	Decreasing since 1996	Low
Recruitment RV age 1 (1979-2003)	None	2002 year class very high
Total mortality RV ages 2-4 (1983-2001)	Increasing since 1995	High
Condition (1970-2003)	Declining since 1995	Low
Length-at-age (1971-2002)	Stable	Low
Length-at- maturity (1970- 2003)	Stable	Low
Proportion mature at age 1 and age 2 (1970- 2002)	Stable	High
Area occupied (1970-2003)	Stable	Widely distributed.
Resource concentration (1970-2003)	Stable	Not concentrated

Outlook

Survey biomass remains very low and total mortality is high. Growth at present is poor, with condition and length-at-age below long-term averages. Changes in maturation have occurred, with fish maturing at shorter length and a higher proportion maturing at age 1 and 2.

Changes have been seen in the catch at age of the commercial fishery, with age 1 fish now making up an important component of the catch.

The 2002 year class is thought to be very large. However, because of the high total mortality and reduced growth, this year class may not result in a significant increase in the spawning stock biomass.

The summer RV surveys have been the long-term, fishery-independent source of information on biomass, abundance and size-composition for many fish stocks including 4VWX silver hake. For a variety of reasons the assessments have become more and more dependent on the survey data. Consistency has been maintained by standardized sampling protocols and calibration of the gears. In the past, changes in the survey vessel have been made after calibration experiments have provided information on the expected effects of the change. Due to the recent fire on the '*Alfred Needler*', there is the possibility that an unplanned and uncalibrated vessel change may occur. This will create great uncertainty in any comparisons of subsequent survey results to the historical series for at least the next five years. It will also make it very difficult to determine how the stock may be responding to any particular management action.

This stock continues to be in poor condition, and a large proportion of the catch is now composed of 1 year olds. The implications of harvesting these young fish should be investigated.

For More Information

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References

Branton, R., and G. Black 2003. 2003 summer groundfish survey update for selected Scotia-Fundy groundfish stocks. DFO Can. Sci. Assess. Sec. Res. Doc. 2003/089.

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