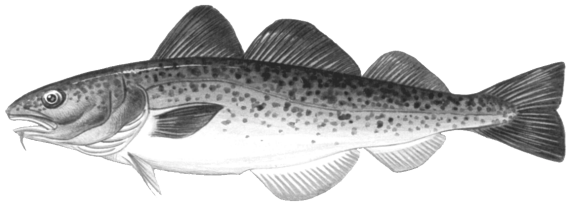
Fisheries and Oceans / Pêches et Océans
Gulf Region

DFO Science
Stock Status Report A3-01(2000)



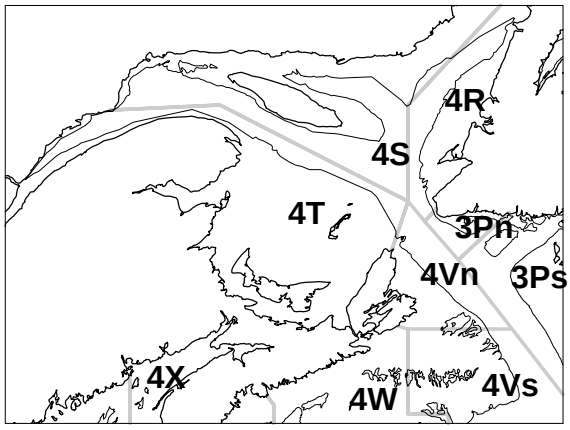
Cod in the Southern Gulf of St. Lawrence

Background

Southern Gulf of St. Lawrence cod are relatively long lived, and may reach ages of 20 or more when mortality is low. They begin to reach commercial size at age 4, and are fully available to the commercial fishery by age 7. They mature sexually at a size slightly below the commercial size of 41 cm (ages 4-5).

Southern Gulf cod are highly migratory. Spawning occurs in the Shediac Valley and around the Magdalen Islands from late April to early July. During the summer, the cod are widely distributed while they feed heavily on krill, shrimp, and small fish, primarily herring, Am. plaice, and capelin. The fall migration begins in late October and cod become concentrated off western Cape Breton in November as they move into 4Vn. The stock overwinters in 4Vn and northern 4Vs, along the edge of the Laurentian Channel. The return migration begins in mid-April, although in some years (1991-92), this was delayed by the late breakup of the winter ice. The management unit for this stock includes all of 4T and catches in 4Vn during November-April. In some years, catches in 4Vs in January-April are attributed to this stock. In recent years, the winter fishery has been closed in 4Vsb to avoid catches of southern Gulf cod.

Southern Gulf cod have been exploited since at least the 16th century. Landings varied between 20,000 - 40,000 t annually between 1917-1940, and then began to increase to a peak of over 100,000 t in 1958. The fishery was primarily prosecuted with hook and line until the late 1940s, when a ban on otter trawling was lifted. Landings remained relatively high in the 1960s and early 1970s, in the range of 60,000 t. TACs were first imposed in 1974, and these became restrictive as the stock declined in the mid-1970s. The stock recovered somewhat, and landings returned to the 60,000 t range during the 1980s. During the 1980s, the fixed gear fishery declined drastically, and the fishery was mainly prosecuted by mobile gear until it was closed in September 1993, due to low abundance. The fishery was re-opened in 1999.



Summary

- In 1999, the fishery for cod, which had been closed since 1993, re-opened with a TAC of 6,000 t.
- The abundance of the stock is low. Spawning stock biomass has remained stable in recent years.
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- The recruitment produced in the early 1990s has been 50 to 70% of the historical average. There are indications that recruitment is improving. The 1995, 1996 and 1997 year-classes, although more abundant than the 1993-1994 year-classes, are still below average.
- Estimates of total mortality from research and sentinel surveys indicate that the natural mortality rate of this stock remains higher than the historical estimate of 0.2. Natural mortality since 1986 is estimated to be approximately 0.4 but appears to be declining.
- With no fishing in 2000, the spawning stock biomass would be expected to increase by about 10%.
- Stock projections indicate about a 5% expected improvement in spawning stock biomass if the 2000 TAC is maintained at the 1999 level of 6,000 t.

- Catches of 6,000 t or lower in 2000 would result in a less than 1% probability of stock decline.

Summary of Stock Indicators

Indicators		Knowledge Status	Observation	Interpretation	Uncertainties
Type	**Index**				
Primary					
Population No.	Groundfish survey	High	Small increase from historical low	Little sign of stock recovery	Natural mortality
	Sentinel surveys	Medium	No trend	Little change since start of surveys	Short time series
Spawning stock biomass	Groundfish survey	High	Small increase from historical low	No major improvement since fishery closure	Natural mortality
Recruitment	Groundfish survey	High	Below average but improved	Very slow rebuilding	Uncertain about 1997, not estimated from 1998-99
Recruits/Spawner	Groundfish survey	High	Average and higher than recent past	Normal juvenile survival	Predators , e.g. herring, mackerel and seals
Mortality	Fishing (F)	High	Exploitation rate of 7% in 1999	Fishery closure effective in limiting fishing mortality	
	Natural (M)	Medium	Estimated to be 0.4	M currently above hist. mean	May be declining
Fishery	Catches	High	Low due to closures, low TAC	Low fishing mortality	
	Effort	Medium	Very low due to closures, low TAC	Low fishing mortality	
Stock production	Sequential population analysis	High	Low due to low weight at age, high M, and low recruitment	Very low rate of stock growth under current conditions	Future natural mortality
Industry preception	Questionnaires	Medium	Fishers indicate abundance above average	Increase in biomass	Factors included in appraisal
	Pre-assessment input	Medium	Positive and negative views	Biomass stable	
Secondary					
Age structure	Groundfish survey	High	Higher proportion of large spawners	More balanced age-structure	Uncertainty 1996-1997 year-classes
Maturity at age	Groundfish survey	Medium	No change evident	Normal conditions	Difficult to determine maturity during September
Growth	Condition factor	High	Average and unchanged		
	Weight at age	High	Low with slight increase	Improving growth conditions	
Spatial distribution	Fishing distribution	Medium	Absent from several traditional areas	Restricted distribution, low fishing effort	
	Groundfish survey	High	Restricted distribution	Consistent with low stock size	
Auxiliary					
Predators	Seal abundance	Medium	Grey and harp seal populations are currently very large	Possibly inhibiting survival of recruits	Juvenile cod survival rates are currently good
	Seal diet	Poor	Seal diet data limited for southern Gulf.	Seal diets in other areas contain age 2-3 cod	Diet in southern Gulf not well estimated
	Pelagic fish	High	Negative correlation between pelagic fish abundance and young cod survival.	Herring and mackerel abundance currently high	Limited direct observation of interactions
Prey abundance		Medium	Abundance high for some cod prey species	Food not limiting	Incomplete estimates for some prey species of cod
Oceanography	Water Temperature	High	Temperature increasing	Conditions closer to productive periods	
	Ice	High	Coverage less than average	Conditions closer to productive periods	
	North Atlantic Oscillation index	High	Above average	Normally indicative of cold conditions	Change in position of Icelandic low

The "Knowledge Status" refers to the amount of data available and its reliability

The Fishery

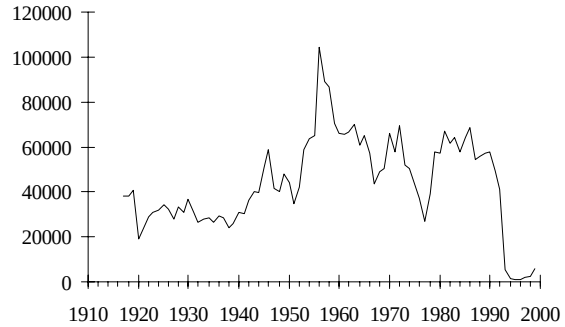
After having been closed since September 1993, the directed fishery for cod in the southern Gulf was re-opened at a TAC of 6,000 t in 1999, including 700 t for sentinel surveys. Cod were caught in cod-directed fisheries and as by-catch in fisheries directed at other species, mainly flatfish. The by-catch fisheries were closed if the catch of cod exceeded 25% by fishing trip in the mobile winter flounder, witch flounder and American plaice fisheries. The fixed gear fisheries were closed if the catch of cod exceeded 10% or 500 kg by weight in the shark fishery and 25% and 10% by fishing trip in the American plaice and winter flounder fisheries, respectively. A recreational fishery using hook and line gear was allowed with the same daily bag limit as 1998 of five fish.

Landings (thousands of tonnes)

	1980-89	1990-95	1996	1997	1998	1999
Year	Avg.	Avg.				
Landings	61	22	1	2	3	6
TAC	59	26	0	0	0	6

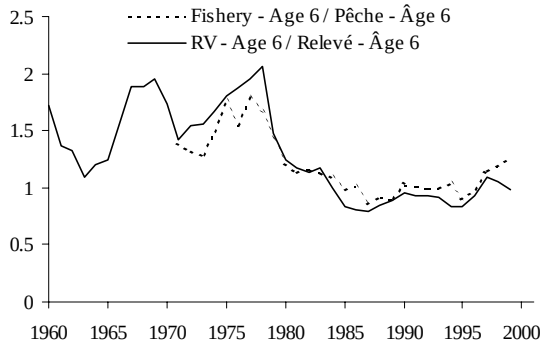
The total reported **landings** were 5878 t in 1999. This was higher than landings in 1998 (2588 t) but remained at historical low levels. The catches in the cod-directed and by-catch fisheries amounted to 5332 t. Sentinel surveys were conducted under a scientific protocol designed to obtain additional indices of abundance of the stock and caught 546 t. The fishery in 1999 was concentrated close to shore in the Miscou Bank – Shediac Valley, north shore of PEI , western shore of Cape Breton and the edge of the Laurentian Channel near 4Vn.

Landings (t)



Ages seven and eight were the most dominant age-groups in the 1999 landings but fish of five to ten years of age were also well represented. Overall, the **weights at age** of cod in the research vessel survey decreased slightly, and remain low relative to the period before 1980. Weights at age in the fishery showed an increase because of the higher proportion of fixed gear (particularly gillnets) catch in 1999 than in the past.

Weight (kg)



Resource Status

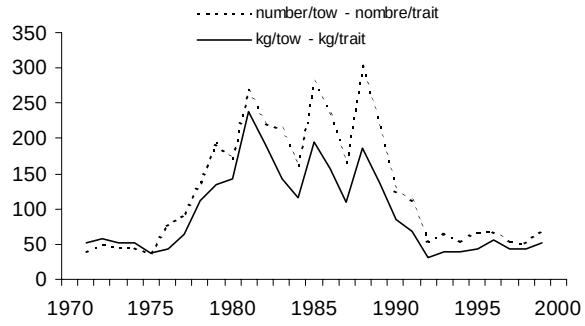
The information used in this assessment included the landings data from 1917-1999, the research vessel survey data from 1971-1999, sentinel survey data from 1994-1999, the otter trawl catch rate data from 1982-1993, and the commercial catch at age from 1971-1999.

The **views of fishers** on the state of the resource were obtained primarily through a telephone survey of active fishers in 1999. Of 103 fishers interviewed through the telephone survey, whose first priority was cod, 58% felt that the status of the stock was higher or much higher when compared to their past fishing experience. By contrast, 17% of respondents considered the 1999 cod abundance to be lower or much lower than in all the years they fished.

The **annual groundfish survey** has been conducted in September since 1971. The results of the 1999 survey indicate that the stock continues to be at low abundance.

The index of abundance (mean numbers per tow) of the population increased from 52 fish/tow to 69 fish/tow. Almost all of the increase was caused by higher abundance of fish < 45 cm. The abundance of cod aged two to four were the highest seen since the 1993 survey.

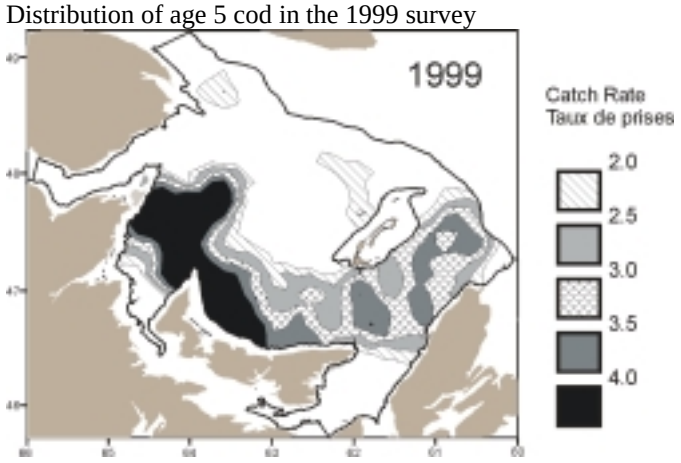
Survey Index (all ages)



Survey mean weight per tow, indicates that stock biomass has remained low and stable over the last few years.

Catch rates during the 1999 survey tended to be concentrated close to shore and in shallower waters, a distribution characteristic of periods of low abundance.

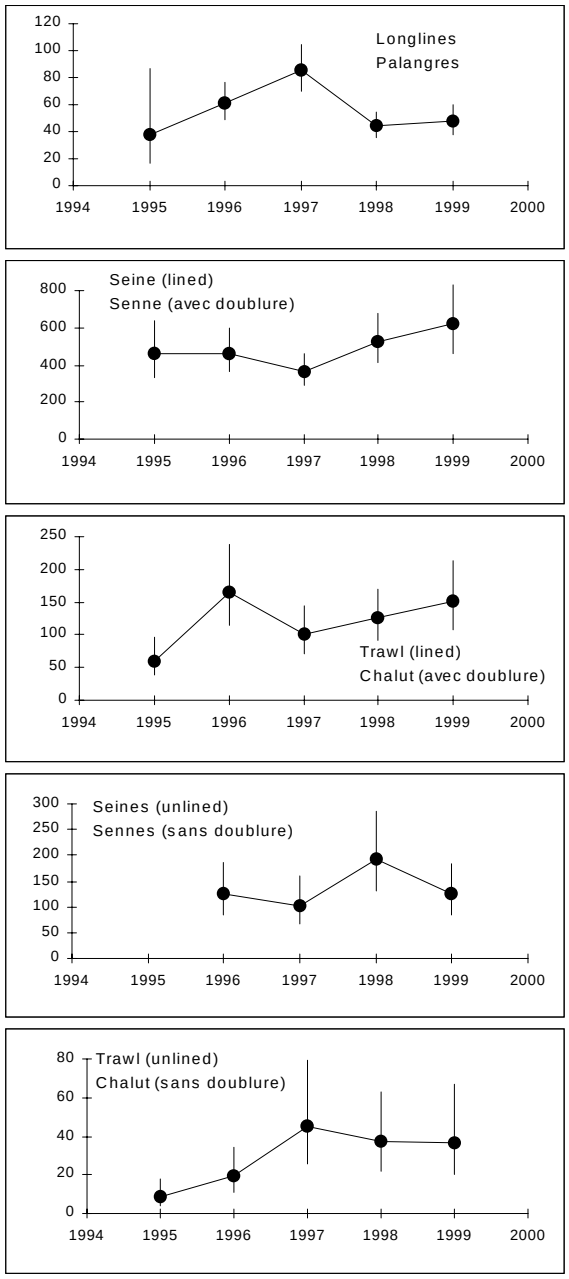
Distribution of age 5 cod in the 1999 survey



The shift in survey biomass distribution towards the east observed over the last few years was reversed in 1999.

The **sentinel survey** program was continued in 1999. Thirty-nine vessels fishing with fixed and mobile gears in various areas of the southern Gulf were used to monitor cod abundance. The catch rate index for longlines and unlined otter trawl remained stable between 1998 and 1999. Catch rates for the unlined seines declined. However, catch rates for sentinel surveys using lined mobile gears (seines and otter trawls) increased during the same period. Sentinel survey indices from lined otter trawls and seines are similar to the research vessel index (weight/tow) which sample the same portion of the population.

Sentinel Catch Rate Indices



Sentinel catch rates were higher off north-eastern New Brunswick (Shediac Valley) and near P.E.I.

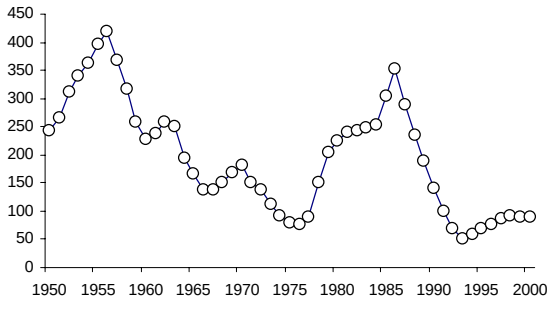
The previous assessments had indicated an increase in **natural mortality** rate (M) of this cod stock. Estimates of M calculated previously were updated and the new estimates continue to indicate values in the range of 0.4 in recent years, more than twice historical values. Analyses indicated that M may be declining but that it remains high, likely in the range of 0.3 to 0.4. Given the uncertainties as to the extent of the decline, the assessment model, which included an increase in M from 0.2 to 0.4 starting in 1986 for all age groups, was used in this assessment.

The exact causes of the recent high estimates of M are undetermined but would include all sources of unaccounted mortalities such as poor environmental conditions, predation, unreported catches and changes in life history characteristics such as growth rate.

Spawning stock biomass was high in the 1950s, but declined throughout the 1960s and reached a minimum in the mid-1970s. There was a sharp increase in spawning biomass with the recruitment of strong year-classes of 1974-75, and 1979-80.

Spawning biomass was relatively high in the early- to mid-1980s, but then declined rapidly, reaching a minimum in 1993. There has been a marginal increase since but spawning stock biomass has remained stable at a low level over the last four years, below one half of the average spawning biomass of about 200,000 t.

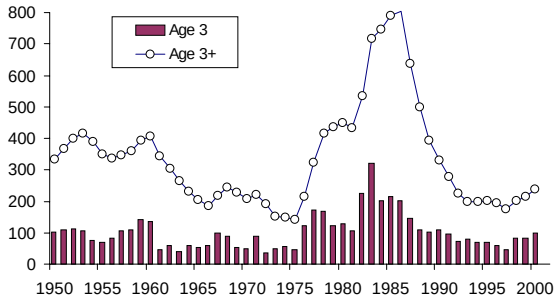
Spawning Biomass ('000 t)



The trend in total **abundance** is similar to that of spawning biomass, except that the relative heights of the peaks in the 1950s and 1980s are reversed. Spawning biomass was

lower in the 1980s than the 1950s due to lower weights at age. The increase in population abundance estimated in 2000 is due largely to the 1995 – 1997 year-classes, which do not yet contribute significantly to the spawning biomass.

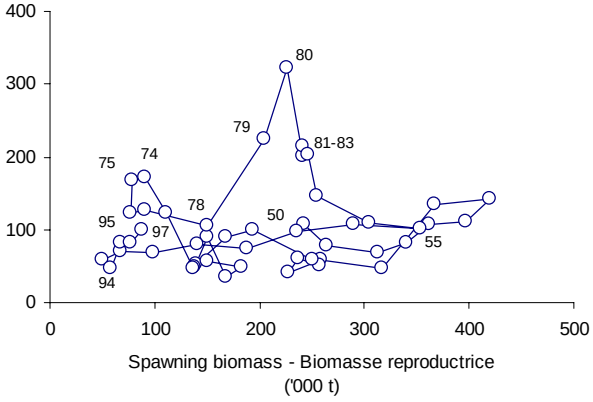
Abundance (millions)



Recruitment of year-classes produced in the late 1980s and early 1990s are below the long–term average of 103 million fish.

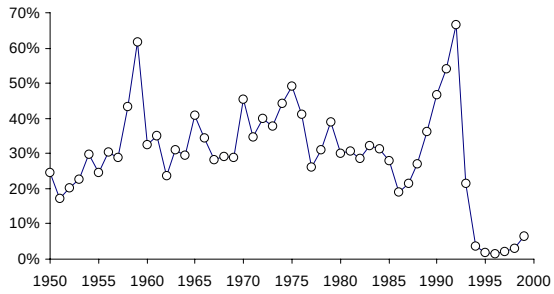
The 1994 year-class is estimated to be the lowest seen for this stock since the early 1970s. However, recent year-classes (1995-1997) are estimated to be more abundant, although still below the long-term average. The estimates of recruitment in recent years are consistent with low spawning stock biomass.

Recruits (‘000)



The **exploitation rate** increased from the early 1950s to the mid-1970s, with the exception of a high value in 1959. There was a decrease in 1977 and 1978 with the extension of fisheries jurisdiction. The exploitation rate increased again and averaged near 30% up to 1988. The exploitation rate then increased sharply and reached near 70% in 1992. Fishing effort was reduced markedly in 1993 with the closure of the fishery. Exploitation rates during the period of the moratorium have ranged between two and three percent. In 1999, exploitation rate was estimated at about 7%.

Exploitation rate (7+)



Sources of Uncertainty

The estimate of natural mortality in recent years is a source of **uncertainty** in the assessment. However, an analysis using a natural mortality rate of 0.3 in 1998 and 1999 gave similar population estimates for 2000. The analysis provides the first estimate of the 1997 year-class (age 3 in 2000) and typically these are more uncertain. It should be noted that this year-class will not contribute significantly to the fishery or the spawning biomass until age 5.

The increased proportion of larger fish in the population causes many fishermen to view the status of the stock favorably. Their views also vary according to the local abundance. The surveys indicate that cod were distributed closer to shore in recent years, that cod were rarely found in the central part of the survey area, contrary to

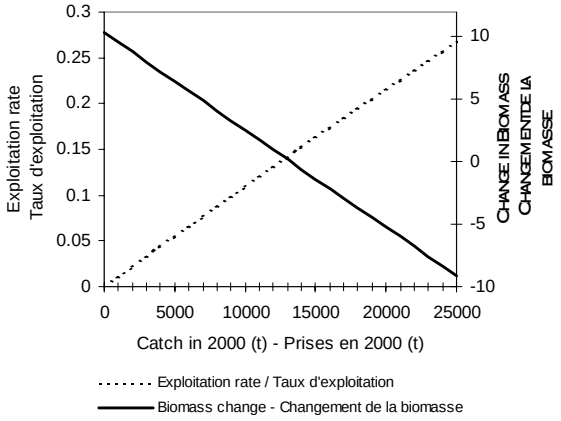
the early 1990s. The distribution has shifted to the west in 1999.

Outlook

The productivity of the stock has been low recently because of low recruitment, poor growth and high natural mortality. The situation appears to be improving marginally in terms of growth and incoming year-classes seem to be more abundant.

Catch projections at various levels of catch in 2000 are provided. The estimates referred to below were made using the best available point estimates of stock size. For any catch in 2000, the associated exploitation rate is determined by reading up to the dotted black line, then across to the left side.

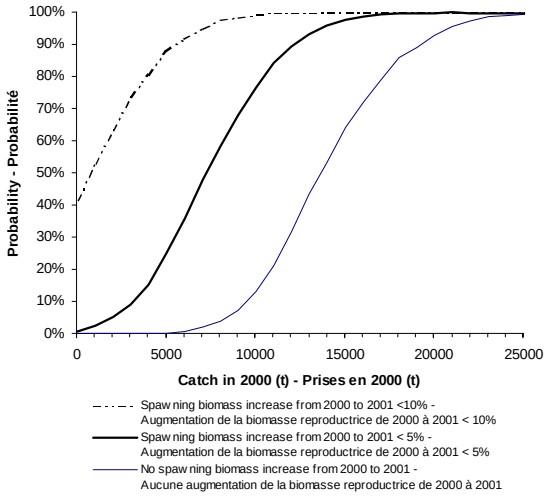
The percent change in spawning stock biomass can be determined by reading up to the solid line then across to the right side.



The spawning biomass is expected to increase by about 10% if there is no catch in 2000. Maintaining the TAC at 6,000 t in 2000 would result in about a 5% increase in spawning biomass.

It is also possible to estimate the uncertainties regarding stock size and then use these in **risk analysis**. The risk analyses considered were: a) the probability that the 2001 spawning biomass would be less than the 2000 biomass, b) the probability that the 2001 spawning biomass would increase by less than 5%, and c) the probability that the 2001 spawning biomass would increase by less than 10%.

There is a 42% probability that spawning biomass would not increase by 10% in 2000 with no catch. The chance that the spawning biomass would decline if the catch in 2000 would be the same as in 1999 (near 6000 t) is about 1%. Stock abundance is estimated to be low and rebuilding is highly desirable.



These risk analyses include uncertainties of the population estimates but not those associated with natural mortality, weight at age and partial recruitment. However, they do provide some guidelines for decision making.

In considering the TAC for the year 2000, it should be noted that risk was calculated for the calendar year, whereas TACs for this stock are set for the period 15 May to 14 May.

The mid-term outlook (three years) depends on the strength of the 1997 year-class and the trends in natural mortality. Recovery can

be expected to be slow even if removals are low.

For more Information

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