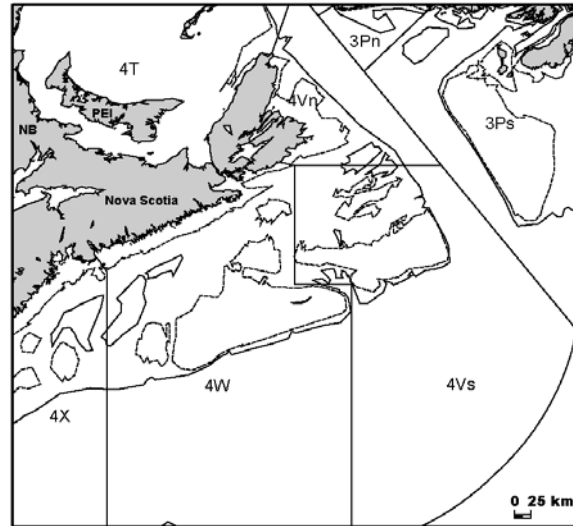


## Winter Skate on the Eastern Scotian Shelf (4VsW)



### Background

Most elasmobranch fisheries have followed a general pattern of high initial exploitation followed by a rapid collapse. The intention has been that the 'developing' skate fishery on the eastern Scotian Shelf not follow this course. Our knowledge of skate on the Scotian Shelf is limited, however recent research is increasing our information base.

Winter skate (*Leucoraja ocelatta*) occur in the southern waters of Georges Bank, inner Bay of Fundy and are near their northern limit of distribution on the offshore banks of the eastern Scotian Shelf. This latter area is unique because it is the only region where thorny skate overlaps with winter skate, the former being more abundant in northern waters. Winter skate are the primary focus of the commercial fishery and constitute greater than 90% of the catch. Thorny skate occur as a bycatch in this fishery and only the largest individuals are retained.

Like other elasmobranchs, skates are slow growing, produce very few young each year and thus are slow to increase in population numbers. Length at 50% maturity for female winter skate occurs around 75cm. Preliminary ageing of winter skate suggests that the age at 50% maturity is about 7-8 years old. Historical information shows that skates consume considerable quantities of sand lance. Skate predators have yet to be identified.

### Summary

- Landings in the directed fishery have declined from 2152t in 1994 to 200t in 2002 reflecting progressive reductions in TAC.
- Skate biomass has been declining since mid 1970's. Since mid 1990's, abundance has been low and stable.
- Production has been low since 1995.
- Since mid 1990's, fishing mortality has declined, consistent with decreases in catch.
- Given current low biomass, fishing should be kept at current low levels.
- Skates are elasmobranchs with low fecundity and late maturity, life history characteristics which make them susceptible to over-exploitation.

## The Fishery

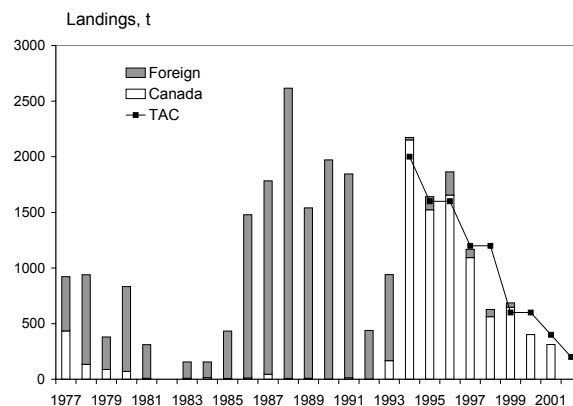
### Landings (000s t)

Year	1970-79 Avg	1980-89 Avg	1990-99 Avg	2000 <sup>4</sup>	2001	2002
TAC <sup>1</sup>			1367	600	400	200
Canada <sup>2</sup>	153	19	776	401	313	
Foreign <sup>3</sup>	6734	913	540			
TOTAL	6887	932	1314	401	313	

1. For directed fishery only (all skate species). The TAC for 1990-1999 is the average TAC for 1994-1999.
2. Reported landings of all skate species by Canadian vessels.
3. Reported bycatch of winter skate by foreign vessels.
4. Commencing in 2000, fishing year, landings and TAC refer to the period April 1<sup>st</sup> of the current year to March 31<sup>st</sup> of the following year.

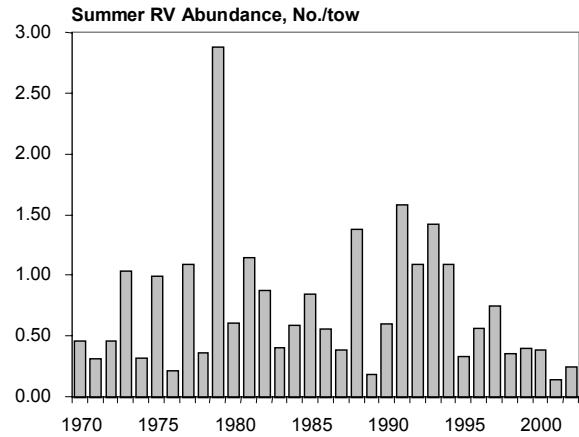
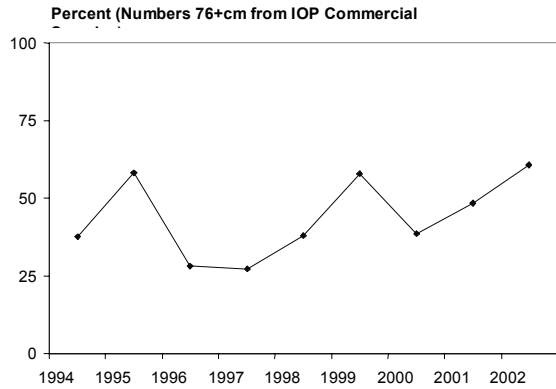
A developmental directed fishery for skates in Div. 4VsW by Canada began in 1994, with a TAC of 2000t limited to four otter trawlers. Landings by the directed fishery have declined from 2152t in 1994 to less than 400t in 2001, reflecting progressive reductions in TAC. Reported catches (to October 24, 2002) were 145t in the Canadian directed fishery, which was taken entirely in Div. 4Vs. The reductions in TAC have reflected increasing concerns about the impact of the directed fishery on stock status and has resulted in a reduction in the number of vessels prosecuting the fishery to three in 2001 and one in 2002.

Discards of winter skate by groundfish fisheries prior to their closures in 1994 had been estimated to be greater than 1000t. Since 1994, discards were estimated to have been generally less than 100t. The recording of skate discards by species needs to be a priority to understand the total removals by all fisheries in the area.



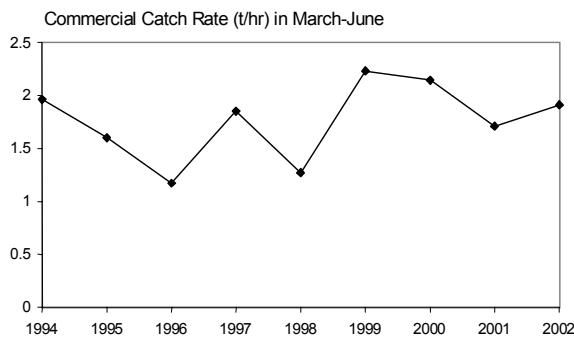
**Commercial sampling** of winter skates began in 1995. The length frequency in 1995 peaked at 76cm and included many fish up to and greater than 100cm. In 1996, the peak shifted to 71cm and has remained there since. This is slightly below the 50% maturity of 75cm. The percentage of fish greater than 90cm declined from 25% in 1995 to 6% in 1996 and less than 4% since 1997. The number of commercial samples in the last two years were not considered sufficient to make inferences on the length composition of the population.

Length frequency observations by the International Observer Program (IOP) from the commercial phase of the directed fishery were therefore examined. They showed a similar pattern of loss of larger individuals as the commercial sampling, but there was some indication of improvement in the percentage of numbers of fish greater than 76cm. The percentage of fish greater than 90cm decreased from 22% in 1995 to less than 3% from 1996 to 2000. In 2001 and 2002, the percentage increased to 4% and 5%, respectively.

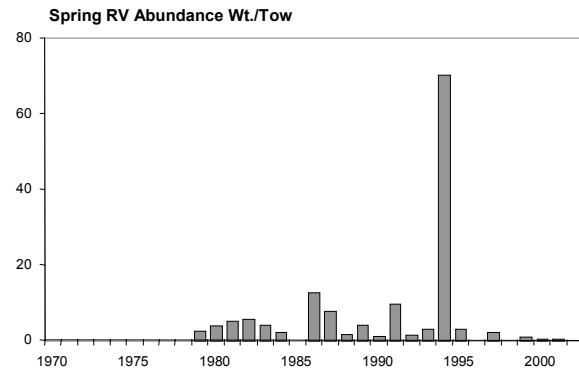


**Resource Status**

An examination of **commercial catch rates** of winter skate in spring revealed no significant changes since the beginning of the directed fishery. In 2002, the spring catch rate of 1.9t/hr was slightly above average.

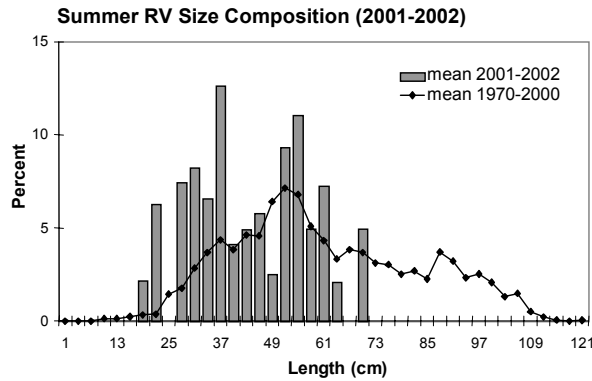


Abundance from the spring RV survey was variable with no patterns evident, until 1997. The 1994 estimate was biased by a single tow of 1500kg. Since 1999 the values have been among the lowest in the series.

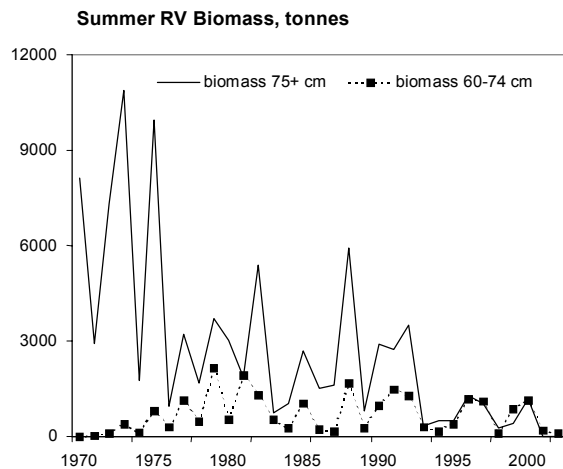


The **abundance** estimate from the summer research vessel (RV) survey in Div. 4VsW indicates a decreasing trend since 1991. The 1998-2002 values have all been below the long-term mean.

**Length composition** relative to the long-term mean has changed. During the last two years of the survey, there was a greater proportion of fish less than 40cm compared to the long-term mean and very few fish greater than 60cm were captured.

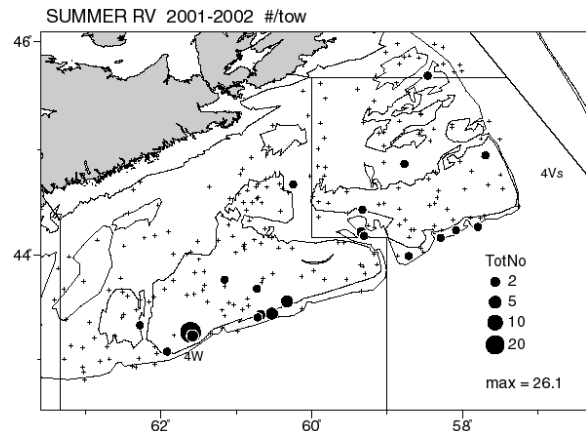


Annual estimates of **biomass** were made from the summer RV survey for 60-74cm and 75+cm fish. The fishery generally exploits fish greater than 60cm. Since size at 50% maturity of females is 75cm, the RV survey was broken into immature (60-74cm) and mature (75+cm) fishable biomass. The immature fishable biomass was lowest in the early 1970's and peaked in 1979 with no trend evident. The mature fishable biomass declined progressively from the beginning of the series. In 2001 and 2002 the immature estimates were very low and no fish greater than 75cm were caught.

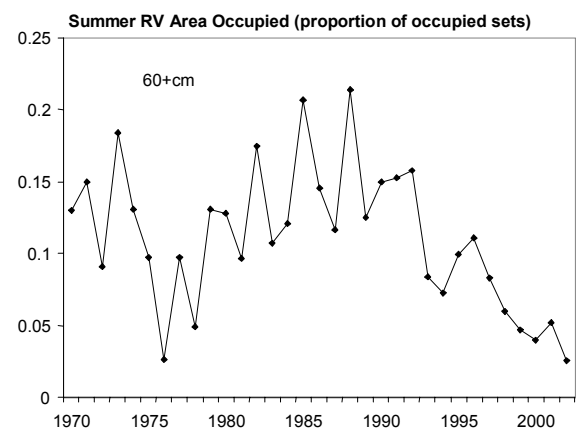


The **distribution** of winter skate from the summer RV survey prior to the directed fishery revealed that winter skate were concentrated on the eastern banks and adjoining slope waters of the Scotian

Shelf. Beginning in 1986, there was an overall reduction in abundance on the eastern Scotian Shelf with a possible shift in distribution towards the slope waters. As well, in the last two years, the majority of fish have been caught in Div. 4W.

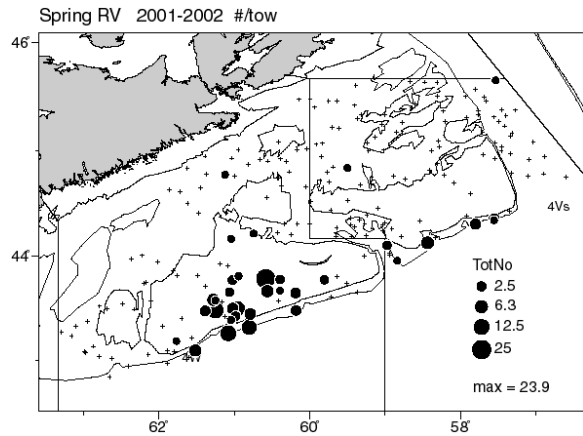


The **area occupied** (as indicated by proportion of RV sets in which winter skate greater than 60cm occur) in Div. 4VsW in the summer RV survey was examined. In general, there was an increasing trend in the area occupied by the stock from 1976 until 1988 with a subsequent decline. The 2002 estimate is the lowest in the time series.

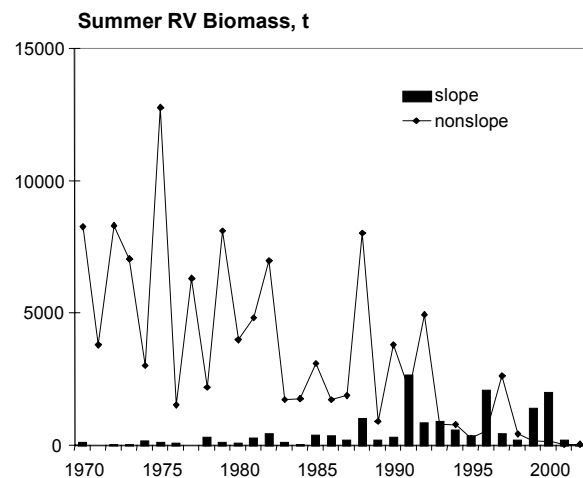


The distribution of winter skate in the **spring RV** in 2001 and 2002 was similar to that seen in the summer RV with most of the fish caught on Sable and

Western banks or the slopes south of the banks.

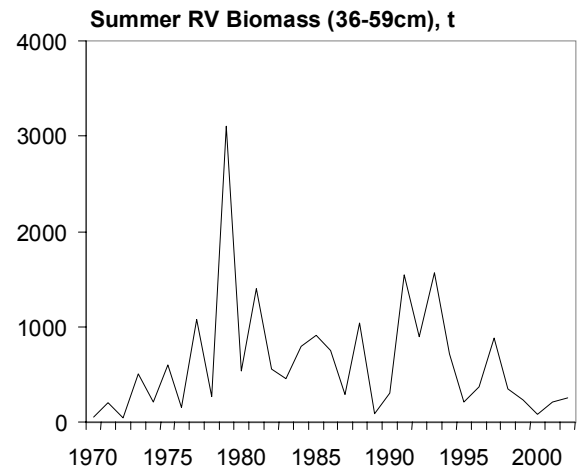


The summer RV survey biomass trends in Div. 4VsW were divided into **slope and non-slope** RV strata to examine this apparent shift. In general, there had been an increasing trend in biomass in the slope strata, but in 2001 and 2002 very few fish were caught. In the non-slope strata, biomass has shown a steady decline since the beginning of the summer RV survey series to almost zero in 2001 and 2002.

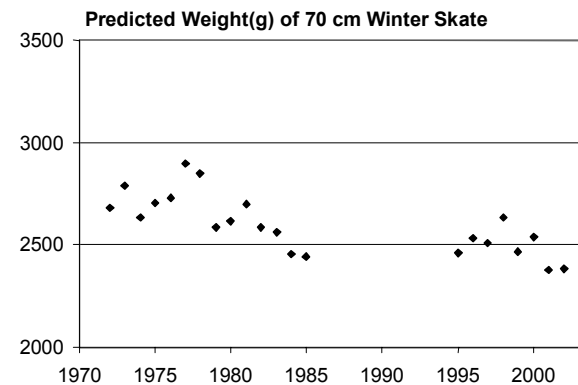


**Recruitment** into the fishery was approximated by the biomass of 36-59cm fish from the summer RV. This index is variable, with some indication of increased recruitment between 1991-

1994, although recent values have been low.

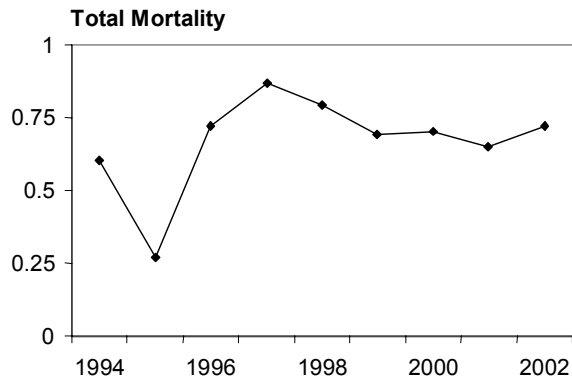


**Condition**, the relative weight of the fish at a given length from the summer RV survey was used as an indicator of the health of the fish. The predicted weight of a 70cm (adult) winter skate during the last 8 years has averaged 2.4 kg., which is below the long-term mean. The 2001 and 2002 estimates are the lowest in the series.



Estimates of **total mortality (Z)** were derived from an analysis of IOP length frequencies from the commercial fishery, using an unvalidated growth model from an ageing study of winter skate on the Scotian Shelf to convert lengths to ages. These estimates peaked in 1997 and have remained high. This reflects the loss of larger fish from the fishery, though little

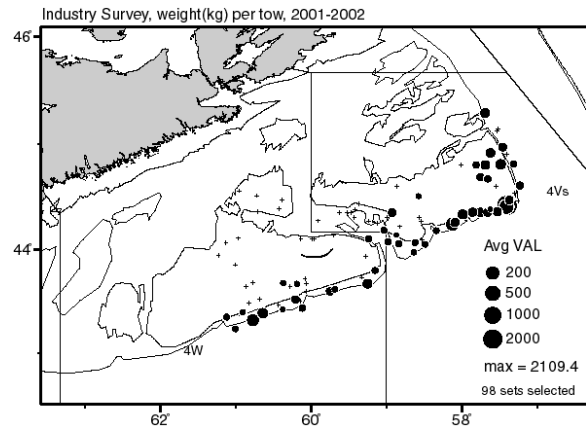
change is evident in the last 4 years. It may be indicative of mortality, a change in the way the fish are exploited, or movement of larger fish out of the area.



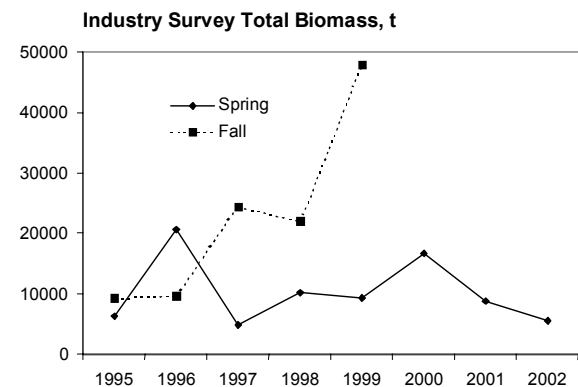
As part of the Conservation Harvesting Plan for skates established in 1994, industry agreed to conduct two **industry/science skate surveys** per year (spring and fall) in Div. 4VsW. In 1994, an exploratory skate survey was initiated, with science designating the fishing locations and the use of 155mm mesh gear. In 1995, a stratified random survey design was used with 255mm mesh gear. In 1996, the survey gear reverted back to 155mm mesh in order to provide more complete sampling of the size range of the population. In 1999, both surveys ended after the initial 5 year evaluation period. The 2000 stock assessment determined that continued monitoring was required. The 2001 Harvesting Plan required that only the spring survey be continued. The economic realities of the fishery (reduced TAC and low prices) would not support two surveys.

The **distribution** of winter skate from the spring industry/science surveys in 2001 and 2002 showed some inconsistencies with the spring and summer RV surveys. Most of the fish were found on the eastern shoal of Banquereau Bank and

the slope waters of Div. 4Vs with a lesser amount on the slope waters of Div. 4W.

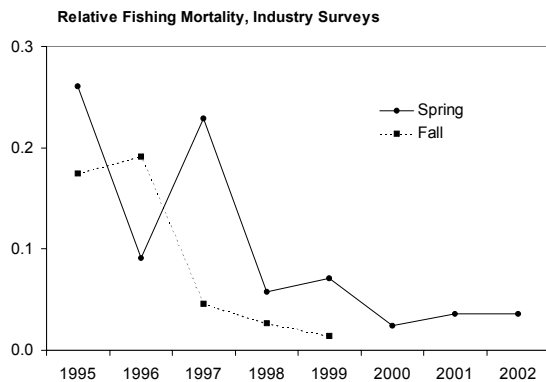


Winter skate **total biomass estimates** from the spring industry survey ranged from a low of 4900t in 1997 to a high of 20,500t in 1996. The 2002 estimate was 5600t. The fall industry survey biomass estimate ranged from a low of 9400t in 1995 to a high of 47,800t in 1999. These estimates are in the order of 6-12 times greater than the summer RV biomass reflecting the increased catchability of the rockhopper gear used. The industry survey suggests stability in the population and indicates that there has been little change in biomass since 1996.

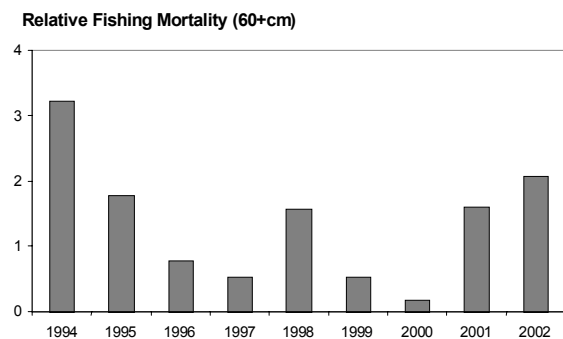


**Relative fishing mortality (F)** (based on total, not fishable biomass) was calculated for the spring and fall industry surveys. The spring estimates were highest in 1995 and 1997 and have been

much lower for the last 5 years, while the fall estimates were high in 1995 and 1996 and were much lower from 1997-1999.

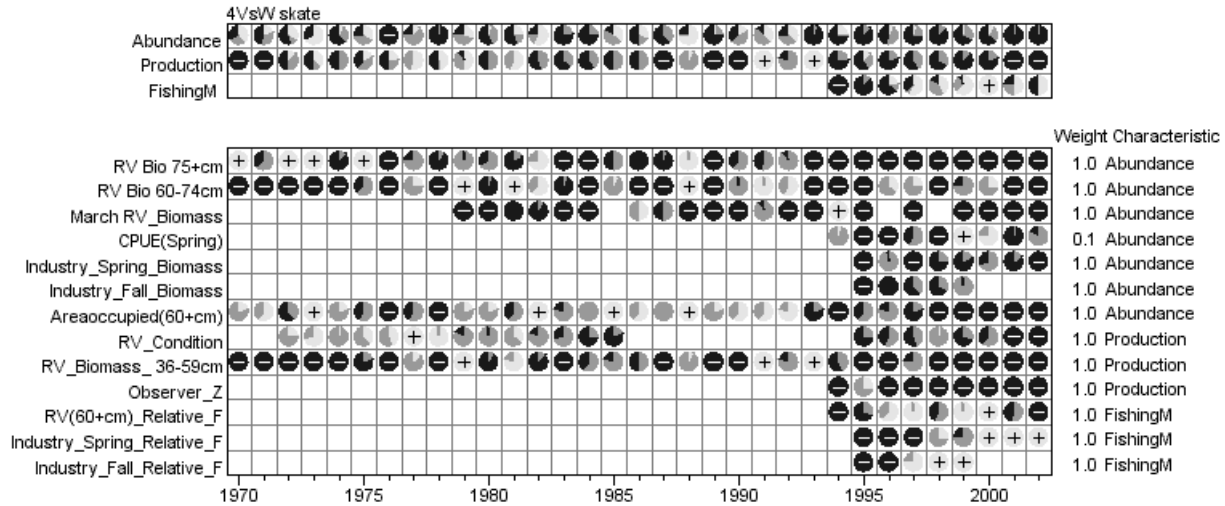


Relative Fishing Mortality, F (the ratio of catch divided by the summer RV biomass > 60cm of winter skate) based on the summer RV survey was calculated from 1994 to 2002. The period preceding the directed fishery is not comparable due to the extensive unreported discarding of skate during open fisheries. Relative F's were highest at the beginning of the directed fishery and fell to a low in 2000 as TAC's were reduced. The relative F has increased slightly in the last two years as RV biomass has fallen.



The **Traffic Light** table summarises the indicators of stock status shown above. This table shows the annual values of each indicator as a combination of three lights depending on whether they are among the best values for that indicator, among the worst or in between. For indicators such as stock biomass and recruitment, high values are good and have a green light and low values are bad and have a red light. However, for indicators such as mortality, high values are bad and are assigned a red light (●) whereas low values are good and receive a green light (+). Intermediate values (midpoint between red and green) are yellow (●). A value between red and yellow is expressed as a pie with increasing amounts of red in the pie as the value approaches the red threshold or cut point. Similarly, a value between the midpoint and the green cut point becomes increasingly green in the pie as the green cut point is approached. Empty cells in the table indicate no observation for that year. Uncertainties about the appropriate cut point resulted in a broad yellow zone.

In the traffic light analysis, indicators are summarised into groups, which emphasise specific aspects of the resource. These groupings are called characteristics. The following outlook is cast in terms of these characteristics and each is shown in bold.



\* See Appendix 1 for description of traffic light indicators, boundary points, weights and rationale.

**Outlook**

Indicators of **abundance** show that the fishable component of the winter skate population has been at very low levels in recent years. Spawning stock biomass (RV Biomass 75+cm) has been consistently low since 1993, whereas the immature fishable biomass (RV Biomass 60-74cm) which had been above average in the late 1990's was below average the last two years. Area occupied (Area occupied, 60+cm) has been declining steadily since 1988, is currently near an historical low and now occupies only 2% of the survey area compared to 15-20% in the mid 1980's. The March RV Biomass indicator has also been extremely low in recent years. Indicators based on the directed fishery and industry/science surveys (CPUE, Industry Spring Biomass) have been stable since they were initiated in 1995.

Several indicators suggest that **production** has been low since 1995. Condition factor (RV Condition 70 cm) was high throughout the 1970s and has been in

the low since the mid-1990s. Recent recruitment (RV Biomass 36-59cm) has also tended to be low. Total mortality (Observer Z), estimated from the directed fishery has been high (approximately 0.7) since 1996.

There are three indicators associated with fishing **mortality** based on catch of skate in 4VsW. The fishing mortality indicator based on RV survey biomass estimates (RV Relative F, 60+cm) was highest at the beginning of the directed fishery, declined to a low in 2000 and has increased again in the last two years as RV Biomass (60+cm) has dropped to near zero. The indicator based on biomass estimate from the industry survey (Industry Spring Relative F) suggests a recent reduction in exploitation that is consistent with falling TAC's in that period.

In summary, long-term data from the RV survey suggests that current levels of abundance (especially larger individuals) and productivity are very low. Industry and fisheries data, available only since 1994,



suggests that recent abundance has been stable and that fishing mortality has declined. There was a continual decline in this resource prior to the commencement of the directed fishery thus it is unlikely that the current low abundance has been caused by removals by the directed fishery.

Skates are elasmobranchs with low fecundity and late maturity, life history characteristics which make them susceptible to over-exploitation. Most skate fisheries have been unsustainable and associated fishing mortalities have been difficult to quantify. The uncertainty whether the current level of harvesting has caused the decline in abundance does not change the fact that Div. 4VsW abundance is low and fishing mortality (directed and by-catch) should be kept at current low levels. The industry survey on this stock provides valuable biological and abundance information and should be maintained.

### ***For More Information***

Contact:

Jim Simon  
Marine Fish Division  
Bedford Institute of Oceanography  
P.O. Box 1006, Dartmouth  
Nova Scotia, B2Y 4A2

TEL: (902) 426-4136  
FAX: (902) 426-1506  
E-mail: [simonj@mar.dfo-mpo.gc.ca](mailto:simonj@mar.dfo-mpo.gc.ca)

### ***References***

DFO, 2000. Winter Skate on the Eastern Scotian shelf (4VsW). DFO Sci. Stock Status Rep. A3-29 (2000).

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Fax number: 902-426-5435  
e-mail address: [myrav@mar.dfo-mpo.gc.ca](mailto:myrav@mar.dfo-mpo.gc.ca)  
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Appendix 1. Description of traffic light of indicators, boundary points, weights and rationale for Div. 4VsW skate.

The traffic light approach provides a framework that allows us to incorporate multiple indices of stock status and other relevant indicators. Colour boundaries corresponding to good and bad periods can be established qualitatively for some indicators, but remain problematic for others. For most indicators, the history of the index is short relative to the ecological and evolutionary history of the fish populations or of the ecosystems within which they occur. In the absence of quantitative information to specify colour boundaries they have been established by a process of deliberation, where the weight of expert opinion is used to determine the most reasonable estimates. These represent the best available estimates; however all are subject to improvement through ongoing research.

The low catchability of the survey gear has hindered own ability to track population changes in the winter skate stock. Unrestricted and unreported discarding, has resulted in an unknown amount of skate not entering the commercial record. As well, skate are not reported to the species level in catch statistics. Nevertheless, it was felt that skate abundance was much higher in the 1970's, has been low at least since the mid-1990's and colour boundaries were set to correspond to these general trends.

Indicator	Green (+)	Red (-)	Characteristic	Weighting
Summer RV biomass (75+cm)	6000 – Top four estimates observed	2000 – Low values observed (1993-2002)	Abundance	1
Summer RV biomass (60-74cm)	1500 – Top three estimates during late 70's and 80's	600 – Lowest values	Abundance	1
March RV biomass	15 – Contains top observation in 1994	5 – Encompasses lowest observations	Abundance	1
CPUE(Spring)	2.2 – Contains highest observations	1.7– Contains 3 lowest estimates. May not be responsive to changes in biomass	Abundance	0.1
Industry Spring Biomass	35600 – Above highest value, short time series	6600 -- Contains lowest observed values	Abundance	1
Industry Fall Biomass	47500 – Peak(1999) near midpoint of limits	9500 – Near lowest 2 estimates, short time series	Abundance	1
Area Occupied (60+cm)	.17 – Four highest observed values in survey	.07 – Near to lowest catch rates recorded in past few years	Abundance	1
RV condition	2850 – Peak values in late 1970's, uncertain of effect	2400 – Associated with low values in last 2 years	Production	1
Summer RV biomass (36-59cm)	1500 – Contains three highest estimates	500 – Among lowest observed	Production	1
Observer Z	.2 – Estimated to be twice natural mortality	.4 – Twice the green boundary	Production	1
Summer RV (60+cm) Relative F	.5 – Associated with lowest values	2 – Contains highest values	Fishing M	1
Industry Spring Relative F	.04 – Low values with reduction of quota	.09 – Peak values at beginning of fishery	Fishing M	1
Industry Fall Relative F	.04 – Low values with reduction of quota	.09 – Peak values at beginning of fishery	Fishing M	1