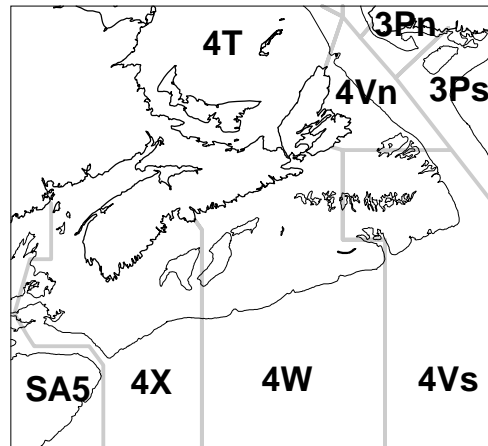


W.B.Scott & M.G.Scott

## Monkfish on the Scotian Shelf and Northeast Georges Bank (4VWX and 5Zc)



### Background

Monkfish, *Lophius americanus*, also called goosfish or angler ranges from the Grand Banks and Northern Gulf of St. Lawrence south to Cape Hatteras, North Carolina. Individuals have been collected from inshore areas to depths greater than 800m, although highest concentrations occur between 70-100m and in deeper waters of about 190m. They have been taken at temperatures from 0-24°C, but in Canadian waters, appear most abundant between 3-9°C.

The goosfish has been described as mostly mouth with a tail attached, and reports of monkfish eating prey almost as big as themselves are common. Growth appears to be fairly rapid and similar for both sexes up to age 4, (47-48cm). After this, females grow a bit more rapidly and seem to live somewhat longer, up to 12 years, reaching a size of over 100cm while the males have not been found older than age 9, at approximately 90cm.

Sexual maturity occurs between ages 3 and 4 and spawning may take place from spring through to autumn depending on latitude. Females lay a nonadhesive, buoyant mucoid veil that can be as large as 12m long and 1.5m wide. Incubation lasts from 7-22 days, after which the larvae spend several months in a pelagic phase, before settling to the bottom at a size of about 8 cm.

The stock structure of monkfish is unknown, but USA survey distributions suggest northern and southern components with the shallow waters of central Georges as a boundary zone. Canadian survey distributions do not suggest a discontinuity between the 4X, 4W and 5Zc components of this stock. The degree of mixing in both USA and Canadian waters is unknown and large scale migrations have not been reported. Spawning appears to take place in Canadian waters during the summer months, thus suggesting some degree of independence between the various components.

### Summary

- Abundance (in numbers) has improved from low levels in the 1990s to near average. However, the proportion of large fish (> 60 cm) has declined and biomass remains low.
- There is evidence of much improved recruitment since 1992.
- Condition factor is currently low.
- There is no reliable estimate of recent fishing mortality although there is an increasing trend in total mortality since the mid-1980s.
- Monkfish catches by the scallop fleet need to be documented in terms of size composition and catches.
- A continuation of the recent cautious approach to harvesting is appropriate.

## The Fishery

### Landings (tonnes)

Year	1994	1995	1996	1997	1998	1999**	2000
Allocation	-	200*	300*	300*	300*	300*	-
4VW	44	68	105	144	68	119	
4X	1159	935	1067	1249	748	1163	
5Zc	541	418	184	189	190	150	
Total	1744	1421	1356	1582	1006	1432	

\* experimental directed monkfish fishery

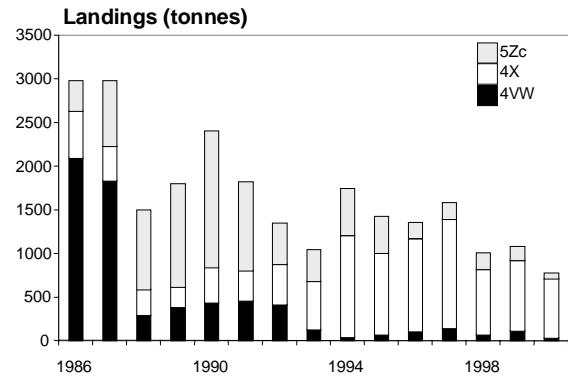
\*\* Allocation and landings refer to the 15 month period from January 1, 1999, to March 31, 2000

Detailed historical information on the monkfish fishery is contained in Beanlands and Annand (1996). The 2000 landings (April 1 to 31st August) are 31t, 576t, and 74t respectively, for 4VW, 4X, and 5Zc.

Prior to 1986, limited markets existed for monkfish. Therefore, monkfish landings by the scallop and mobile gear fleets may not be reflective of actual catches for that time due to potential discarding and misreporting. However, as new markets and higher prices in the early 1990s resulted in increased trips targeting monkfish, landings since then are more likely to reflect the catches. Increased effort on the resource was particularly evident by the mobile gear fleet less than 65 ft in 4X. This fleet was restricted to a 20% bycatch early in 1995 in order to maintain historic catch and effort levels for the duration of a proposed exploratory fishery. In September of that year, a 5 year co-operative science/industry study was established to assess the abundance and distribution of monkfish and its potential as a developing fishery.

The five vessels participating in this study were allocated 200 tonnes of monkfish in 4X for each of the 5 years of the study and an additional 100 tonnes was allocated in 1996 to extend the experimental area to 5Zc. The 4X allocation although fished every year, was not taken until 1999, due to declining markets and prices. In that year, good prices, markets and availability of fish all resulted in the total

allocation being met. Subsequent to 1996, the 5Zc allocation was not fished due to decreased markets and high bycatch of flounders. The landings for 1995 to 1999 include these allocations.



Large landings by the offshore scallop fleet in 5Zc throughout the late 1980s and early 1990s have steadily dropped to a low of 56 tonnes. However, landings by the inshore scallop fleet, predominantly in the Bay of Fundy area, have increased through the 1990s to a high of 322 tonnes in 1997. Div. 4VW landings have been minimal at less than 150 tonnes since 1993.

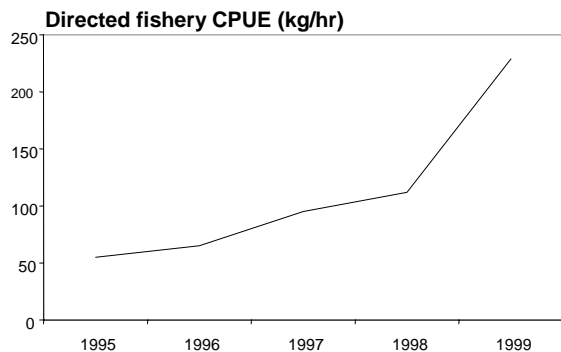
**The catch and effort data** for otter trawlers (OTB) TC 1-3 is confounded by the fact that through provisions in their Conservation Harvesting Plan (CHP), this fleet is permitted to direct for their 20 % bycatch and therefore does not represent a true incidental bycatch. For a more accurate reflection of catch rates (CPUE) in this fishery, further investigation is needed to extract this information on a set by set basis. A decline in effort in 1995 by this fleet is likely the effect of the bycatch limit established earlier in that year. Effort further declined due to limited markets and lower prices.

A comparison of the **size composition** of both the directed (203 mm) and bycatch (130 mm) landings showed little difference despite the larger mesh codend restriction in the directed

fishery. A slight decrease in mean length was detected for both fisheries between 1995 and 1996 but subsequently remained stable with a slight increase in 1999.

**Resource Status**

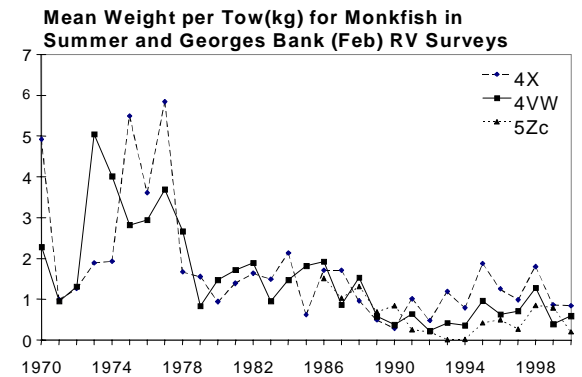
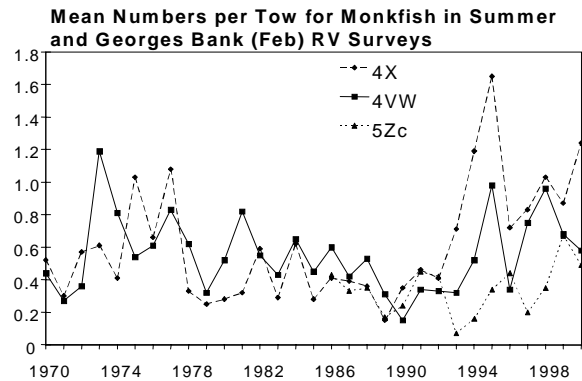
The **directed effort series** from the five vessels given an allocation in 1995 is derived entirely from an area in Crowell Basin known as the "monkfish hole". It is uncertain as to how this relates to the total population and should therefore not to be taken as a global indication of abundance. Despite a decline in effort to 1998 (thought to be the result of market and price limitations), catch rate has continued to increase gradually over the 5 years of the experimental fishery with a sharp increase in 1999. The increase in both catch and effort in that year is likely the result of increased market value and availability of fish.



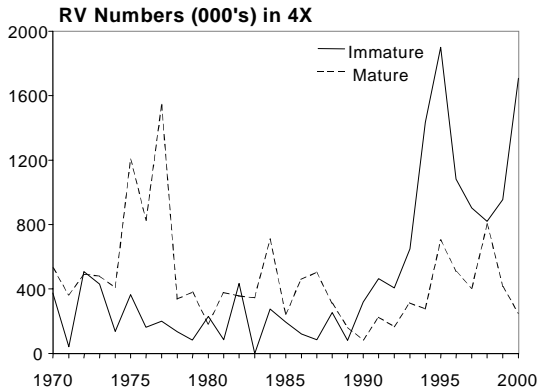
The **DFO summer research vessel (RV) survey** indices revealed similar trends in abundance and biomass in 4VW and 4X. A decreasing trend for both indices from the mid 1970s to the late 1980s is followed by an increasing trend particularly in abundance, through the 1990s. Biomass has increased to a lesser degree than abundance.

Stratified mean **numbers per tow** have been increasing in both 4VW and 4X with the 1995 and 2000 values the highest in the series

in 4X. Stratified mean **weights per tow** have increased slightly but remain at a historically low level in both areas. Stratified mean numbers and weights per tow from the February survey of Georges Bank, although more variable, revealed a steep decline from 1986 to 1993. Stratified mean numbers show a recent upward trend similar to 4VW and 4X.

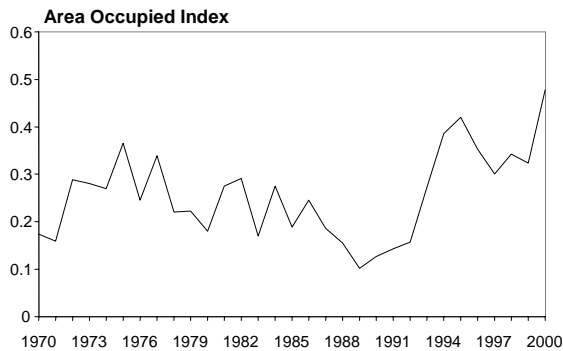


Using a length at 50 % maturity of 46 cm, the summer RV survey numbers were separated into immature and mature sizes. A strong increasing trend of immature fish (**recruitment**) since 1989 is found in both 4X and 4VW while mature fish gradually increased to 1997 and subsequently declined. It is likely that the influx of small fish is responsible for the increase in catch rates of the commercial fishery, particularly that of the directed fishery in 4X.



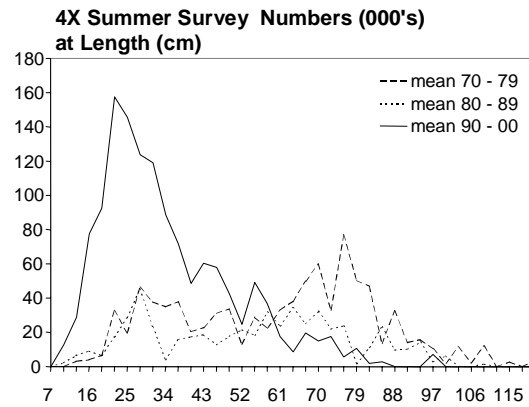
Annual spatial **distributions** and length frequencies from RV surveys are contained in Branton and Black (2000). Monkfish appear to be spread across the shelf with concentrations on the edges of the banks and in the basins. However, small fish (10 to 30 cm) were consistently found off LaHave Basin.

The proportion of the RV survey sets where monkfish occurs is a measure of **area occupied**. Monkfish has been increasingly occurring in survey sets in both 4VW and 4X since 1989 and is currently at a series high in 4X. This trend is more apparent for the immature monkfish.



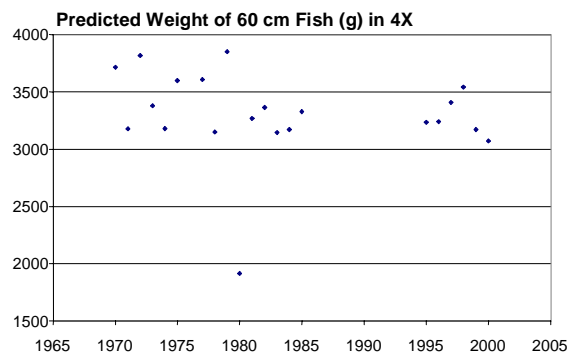
**Size composition** from stratified numbers at length indicates a major shift to small monkfish in recent years for both the 4VW and 4X areas. Large monkfish (> 70 cm), that were so prominent in the 1970s, have virtually disappeared. The cause for this

disappearance has not been determined and is worthy of note in 4VW where there is no fishery.



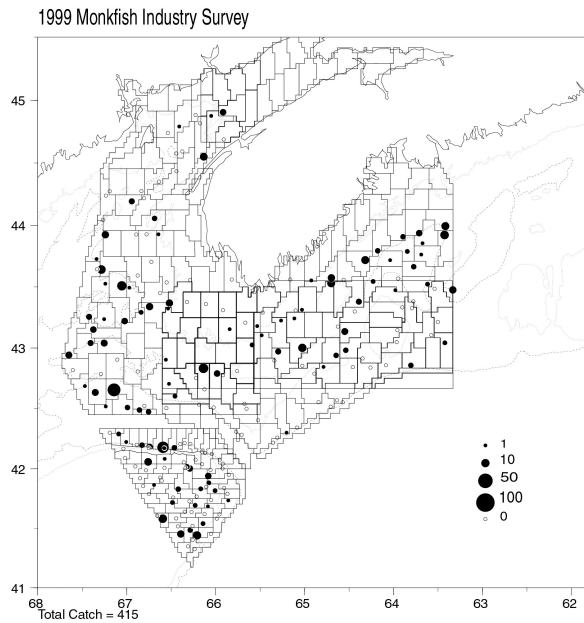
**Georges Bank** RV survey numbers at length are much more variable due to small numbers in the catch but is relatively consistent with 4X and 4VW.

**Condition**, the relative weight of a 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 60 cm (mature) monkfish in the last two years has averaged 3.1 kg, which is below the long term mean.

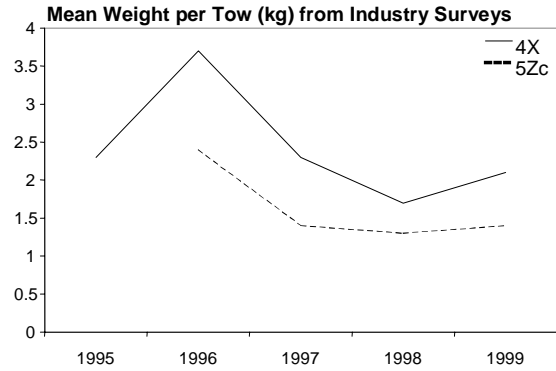
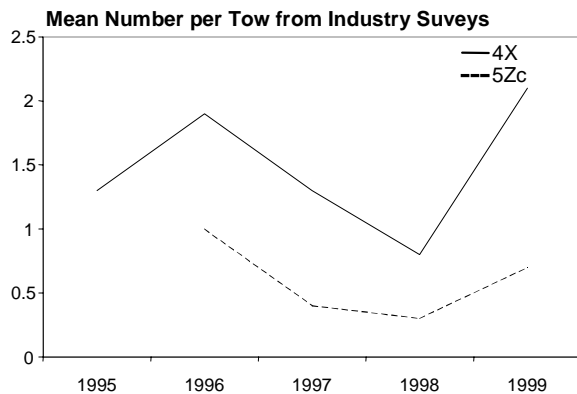


A **joint industry/DFO Science resource survey** of 4X was conducted in October 1995-1999 by 5 vessels from the mobile gear fleet less than 65 ft. In 1996, a survey of Georges Bank was included. The 4X survey showed similar distribution patterns to the RV survey including the area of small fish found near La Have Basin. The Georges

Bank survey indicated monkfish were distributed across the bank with concentrations along the northern edge.



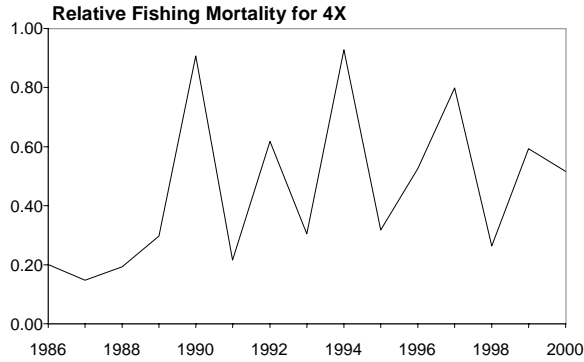
Mean number and weight per tow from industry surveys was used as a relative index of abundance. Both estimates from the 4X survey rose from the 1995 value and subsequently declined to 1998. The Georges Bank survey showed the same decreasing trend in mean numbers but mean weight seems to have stabilized in 1997. In 1999, both surveys showed an increase in number per tow.



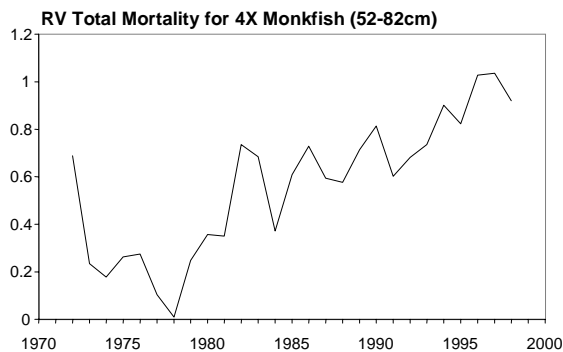
The industry survey size composition from 4X shows a mode of 35 to 40 cm in 1995. This mode shifted to 50 cm until 1998 when a second mode at 26 cm was evident. In 1999, only one mode at 26 cm was observed.

When the length frequency for the industry survey is compared with that of the bycatch fishery which uses the same 130 mm square mesh, the industry survey consistently catches a larger proportion of fish less than 40 cm. The absence of these small fish in the commercial (bycatch) fishery may be due to the distribution pattern of monkfish on the Scotian Shelf or influenced by the fact that small fish are often cut at sea for tails and, therefore, are not available for land based sampling.

Relative Fishing Mortality (F) was derived for 4X by dividing the catch by the RV survey biomass index for 1986 to 2000 only, due to concerns over the accuracy of catches prior to that date. The results are highly variable with no apparent trend.



Several options for estimating **total mortality (Z)** were examined. All indicate a strong increasing trend since the mid 1980s which is in keeping with the loss of large fish in the survey. The patterns of Z's available from catch curve analysis in both 4VW and 4X are based on the assumption of a stable age distribution. The recent strong abundance of young fish makes this assumption suspect and there will likely be biases associated with that. While accepting the trends in Z at face value is difficult, it is reasonable to interpret these estimates as indicating that the recent high numbers of young fish are not persisting at older ages as would have been expected in the past.

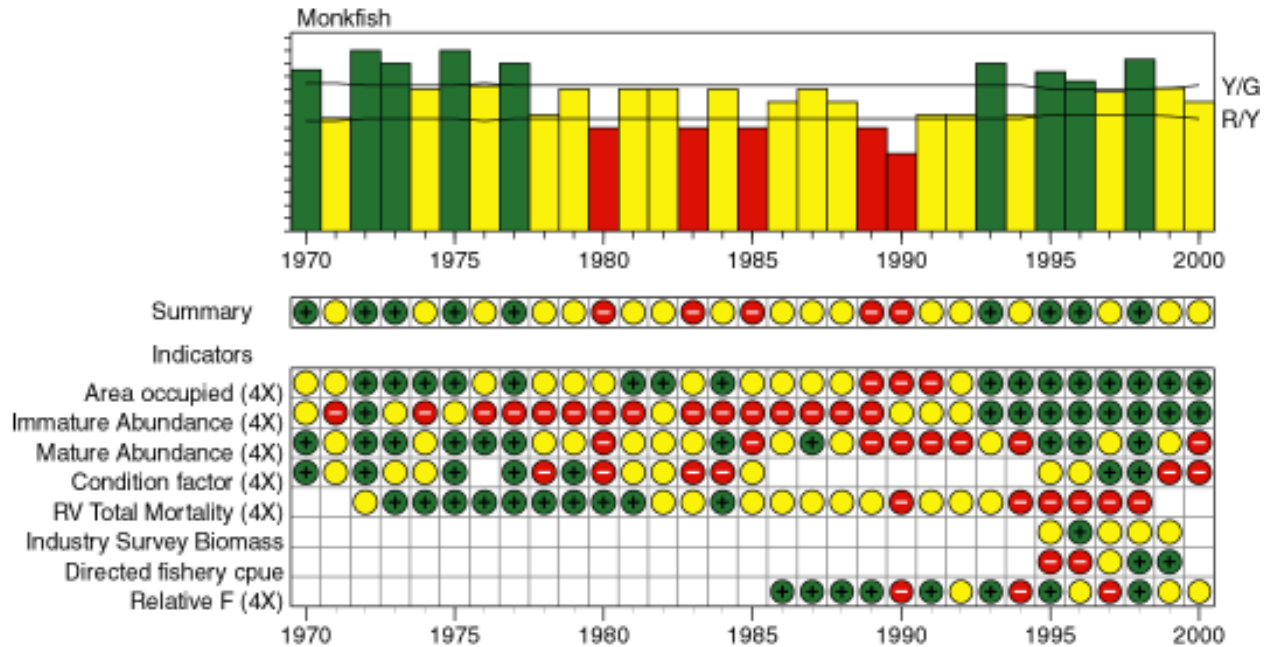


The **Traffic Light** table that follows summarizes the indicators of stock status

shown above. The current stock area includes all of 4VWX and 5Zc but in the last 5 years the exploratory fishery has been conducted almost entirely in 4X and most of the balance of the landings also come from that area. The relationship between 4X and the balance of the stock area is unknown. Because of the current fishery distribution, 4X will be given specific focus particularly with respect to the traffic light approach.

This table shows the annual values of each indicator as one of three lights depending on whether they are among the highest values observed for that indicator, among the lowest 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 are yellow ●.

The results for the indicators combined are shown in the summary line above the array of individual indicators. If most indicators in a particular year are red then the summary light for that year will be red, if most are green the summary light will be green, and so on. The actual summary scores from the range of indicators in the table are shown in the bar chart above the table. The height of the bar determines the colour for the corresponding year and the horizontal lines on the bar chart indicate the boundaries between the colours (red-yellow and yellow-green).



**Outlook**

Indicators of **abundance** (Area occupied, Mature Abundance, Industry Survey Biomass, Directed fishery CPUE) of the adult part of the monkfish population in 4X have improved from low levels in the early 1990s and is now near the long-term average. However, the proportion of large fish (> 60 cm) has declined and biomass remains low.

Indicators of **productivity** of the adult population have been poor in the 1990s. Condition factor (Condition factor) was in the low part of the historical range and the average size of fish in the adult population was and is low. The latter could result from either reduced growth, improved recruitment or increased mortality. Estimates of total mortality (RV Total Mortality) show an increasing trend since 1978. However, these total mortality estimates are difficult to interpret as they confound changes in mortality with changes in recruitment and growth. Alternatively, there is evidence of much improved recruitment (Immature Abundance) since 1992.

The evidence with regard to the absolute level of **fishing mortality** (Relative F) is weak, however relative changes should be indicative. It appears that fishing mortality was higher after 1989 but there is no basis to provide a more reliable estimate of recent fishing mortality.

The summary indicator for monkfish in 4X has fluctuated between green and yellow zones in recent years and is yellow in 2000. The population appears to have gone through a period of low productivity and abundance in the late 1980s to early 1990s and the factors causing this may still be affecting the present population. There are, however, signs of improved recruitment that is beginning to have a positive influence on the adult stock size. A continuation of the recent cautious approach to harvesting is appropriate until productivity trends and the effects of harvesting can be more accurately defined.

Available indicators for monkfish in 4VW show very similar trends to those for 4X, although fishery removals have been much

lower. This suggests that a cautious approach to exploitation should continue in the 4VW area. It also suggests that many of the changes observed in both areas may have been driven by changes in environmental conditions.

The increasing catches of monkfish by the inshore scallop fleet in the Bay of Fundy need to be documented in terms of size composition and verification of catches. Currently there is no sampling from this fleet. As fish are generally landed as tails only in this fishery, a conversion factor for tail length to total length must be developed.

If harvesting levels are to be set for monkfish, appropriate actions should be taken to ensure the very restricted areas being targeted by the directed fishing be monitored closely for signs of overfishing. The potential exists for large increases in effort as a reflection of market fluctuations.

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

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