

## CHANGES IN THE BLUEFIN TUNA STOCK IN THE GULF OF ST. LAWRENCE IN 1980 AND THEIR IMPLICATIONS

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## SUMMARY

Size composition and CPUE data from the Gulf of St. Lawrence rod and reel fishery indicate that up to 1979, this fishery was exploiting a "relict stock", receiving little or no recruitment from younger year-classes and that stock abundance was decreasing. This was in agreement with a recent population analysis. However, data collected in 1980 indicate a change in the size composition and abundance of bluefin entering the Gulf of St. Lawrence in that year. It is postulated that these changes are due to the reappearance of abundant "medium-size" bluefin, in the form of the strong 1973 year-class, in the northwest Atlantic.

## RESUME

Les données de composition par taille et de CPUE de la pêche à la canne et au moulinet du golfe du Saint-Laurent indiquent que, jusqu'en 1979, cette pêche exploitait un "stock résiduel", au recrutement en jeunes classes minime ou inexistant, et dont l'abondance décroissait. Ceci concorde avec une analyse de population récemment effectuée. Cependant, les données réunies en 1980 signalent un changement de la composition par taille et

de l'abondance en ce qui concerne le thon rouge qui a pénétré cette même année dans le golfe du Saint-Laurent. On avance que ces changements seraient dûs à la réapparition dans l'Atlantique nord-ouest de thon rouge de taille moyenne, sous forme d'une classe annuelle fournie, celle de 1973.

## RESUMEN

Los datos de composición por talla y CPUE de la pesquería de caña-liña del Golfo de St. Lawrence indican que hasta 1979 esta pesquería explotaba un "stock residual" que recibía escaso o ningún reclutamiento de las clases anuales más jóvenes, y que la abundancia del stock estaba decreciendo. Esta conclusión coincidía con los resultados obtenidos de un análisis de población recientemente llevado a cabo. Sin embargo, los datos recogidos durante 1980 indicaban cambios en la composición por talla y abundancia del atún rojo que entró ese año en el Golfo de St. Lawrence. Se presupone que estos cambios se deben a la reaparición de abundante atún rojo de "tamaño medio", en la forma de la fuerte clase anual de 1973, en el Atlántico Noroeste.

## INTRODUCTION

Canadian Atlantic bluefin tuna fisheries can be divided into three major gear types: rod and reel (sport), trap net and purse seine. Incidental catches are also taken by longline, harpoon and gill-net, although these are relatively small. The purse-seine fishery has been executed sporadically from 1963 to present off the east coast of the United States and is directed towards juvenile bluefin. The other fisheries are all executed within Canadian inshore waters and take only "giant" bluefin tuna (>121 kg), which occur seasonally in Canadian inshore waters from June to November. The following analysis deals only with the rod and reel fishery.

## HISTORICAL REVIEW

Historic records show that the earliest experiments in sport angling for bluefin tuna in Canadian Atlantic waters date back to 1817 in St. Ann's Bay, Nova Scotia (Fig. 1). Other successful attempts were made in this area and off Chester and Liverpool in 1908-11. In the mid-1930's, sport angling spread to other areas in Nova Scotia, Shelburne, Lunenburg and Wedgeport, in particular. Wedgeport became the site of the International Tuna Cup Match, first held in 1937, and most of the sport fishing activity was centered around the Wedgeport area after the Second World War.

Catches off the Atlantic coast of Nova Scotia reached a peak of 203 MT in 1949 but declined subsequently. The Tuna Match off Wedgeport was cancelled between 1958 and 1965 due to lack of fish and has not been held since 1976. No bluefin have been taken by rod and reel off southwest Nova Scotia since 1977.

A bluefin sport fishery was started along the east coast of Newfoundland in Conception Bay in 1957 and later spread to Notre Dame Bay. Catches reached a peak of 637 fish in 1968 but declined sharply thereafter. No bluefin have been taken by rod and reel in Newfoundland waters since 1978 and effort has dropped virtually to zero.

Sport fishing began in the Gulf of St. Lawrence off the north shore of Prince Edward Island (P.E.I.) in 1967. The number of boats involved increased rapidly after 1970 and catches reached a peak of 1,048 fish in 1974 (Fig. 2). This fishery spread to New Brunswick and Quebec in the Chaleur Bay area in 1973 and catches reached a peak of 291 fish in 1977. Two to three boats also fished in the St. George's Bay area off the Nova Scotia coast in the mid-1970's.

Commercial interests entered the Canadian bluefin sport fishery in the early 1970's and the Gulf of St. Lawrence fishery, although still using rod and reel gear, is now almost entirely a commercially oriented fishery. The principle market is the Japanese "sashimi" market and fresh fish are air-freighted into Japan.

A 9- to 14-m boat is typically used in the Gulf of St. Lawrence rod and reel fishery. These boats often fish inshore for lobster or groundfish during the remainder of the year. A crew of two, plus one to four anglers, usually comprise the fishing party and a fishing day may entail all the daylight hours but is no longer than one day. The boats are equipped with fighting chairs and two rods are usually fished simultaneously. Hooks are baited with mackerel, herring or squid, depending upon local availability. Both chumming from a drifting boat and trolling are practiced. Fishing is carried out within 30 km of shore.

In the early 1970's concern for the Atlantic bluefin tuna stocks was expressed. The International Commission for the Conservation of Atlantic Tunas (ICCAT) recommended in 1974 that "parties ..... take the necessary measures to limit the fishing mortality of bluefin tuna to recent levels." As a result, Canada adopted regulations for the rod and reel fishery in 1975 which restricted effort levels. Fishing areas were delineated and 10-wk seasons were established for each area. The number of licenses to be issued was fixed and each boat was limited to a maximum catch of two fish per day. No fish less than 136 kg were to be taken. Fishing line breaking-strength was limited to 59 kg and night fishing was prohibited. Logbooks were issued to all license holders and weekly submission was required.

Regulations for this fishery remained relatively unchanged from 1975 to 1978, but changes were introduced in 1979 that relaxed effort restrictions. A quota of 2,200 bluefin was established and the freeze on licensing was removed. As a result, the number of licenses issued in the Gulf of St. Lawrence increased from approximately 200 in 1975-78 to almost 450 in 1979. The most substantial increase in licenses occurred in the St. George's Bay area off Nova Scotia where only four licenses had previously been issued. Despite the increase in licenses in 1979, the rod and reel catch in the Gulf of St. Lawrence did not increase (Fig. 2). Further changes were made in regulations in 1980 that lengthened the fishing season, reduced area restrictions and increased the maximum fishing line breaking-strength to 82 kg. The number of licenses issued increased to almost 750 in 1980 but estimates made by fishery officers indicated only approximately two-thirds of the licenses were active in the fishery. The bluefin catch in the Gulf of St. Lawrence in 1980 increased by 29% over 1979.

Logbook coverage had always been above 95% in this fishery prior to 1979; however with the increase in new licenses in 1979, logbook coverage fell to 75%. A further decrease in coverage to 70% in 1980 was accompanied by a substantial decrease in the quality of information reported in logbooks, due to the large number of new participants in the fishery.

#### SIZE AND AGE COMPOSITION

In recent years, the Canadian bluefin fishery has exhibited a trend of increasing annual mean weight (Fig. 3, Table 1). Similar trends have been observed in other bluefin fisheries in both the northwest and northeast Atlantic (Beardsley 1975). The trend in the Canadian fishery has been interpreted as indicating that this fishery has been exploiting a "relict stock" of older year-classes that pre-date the beginning of the US-Canadian juvenile bluefin purse seine fishery in the early 1960's (Caddy and Butler 1976). Very low escapement through the purse seine fishery has resulted in little or no recruitment into the "giant" size category exploited by the Canadian rod and reel fishery. The size composition of bluefin taken in the

Gulf of St. Lawrence from 1971 to 1980 is shown in Figure 4 and the estimated age composition, based upon examination of the otoliths of 1,137 bluefin collected from 1975 to 1979 is shown in Figure 5. The range of ages extends from 5- to 30-yr-old but is principally composed of the 11+ year-classes and is predominated by 16- to 26-yr-old fish.

#### CPUE ANALYSIS

Detailed fishing logs were collected from Canadian bluefin rod and reel fishermen during the 6-yr-period 1975-80 and catch-per-unit-effort as mean number of fish landed per 10 days on fishing grounds was calculated (Fig. 6). Since regulations limited entry in this fishery from 1975 to 1978, a significant increase in experience would be expected to have occurred over this period. Experience leading to the successful landing of a fish using angling gear can be broken into two distinct factors; that required to hook a fish and that required to boat a hooked fish. While it was not possible to estimate the first factor from the data available, the ratio of number of strikes to number of fish boated (Fig. 7) estimates the second factor. This ratio showed the expected increase during the period of limited entry and a subsequent decrease in both 1979 and 1980 when new participants entered the fishery. St. George's Bay was not included since data were available for the last three years only. An experience index was produced from this ratio for each area and each year and the CPUE estimates were adjusted accordingly. The resulting adjusted CPUE trends (Fig. 8) showed a continuous decline from 1975 to 1979, but a slight increase in 1980 for both Prince Edward Island and the total Gulf of St. Lawrence. Bluefin abundance was unusually low in Chaleur Bay in 1978 and if the Chaleur Bay CPUE estimate for that year is not included, the resulting trend is comparable to the others.

To examine the usefulness of the CPUE estimates as stock abundance indices, the adjusted CPUE estimates were compared to stock abundance estimates from a recent Virtual Population Analysis (Parrack 1981). Only the 11+ year-classes were used in this analysis since they are the principal year-classes taken in this fishery over this period. Simple linear

regression correlations were calculated (Table 2), using both the two-stock hypothesis western Atlantic stock abundance estimates and the one-stock hypothesis total Atlantic stock abundance estimates produced by Parrack (1981).

High correlations were obtained using the 1975-79 abundance estimates, under both stock hypotheses. If the 1978 Chaleur Bay CPUE estimate is dropped from this analysis, the correlation for this area increases to compare with the others.

When the 1980 CPUE estimates were included in the analysis, lower but still significant correlations were obtained. The VPA stock abundance estimates showed a decrease in 11+ year-class abundance in 1980. If an age-specific migration is occurring and the age composition of the Canadian fishery remains the same, then the 1980 age composition of the stock, as calculated from the VPA, suggests that 11+ year-class abundance will continue to decline for at least another five years until the 1973 year-class recruits into the fishery (Fig. 9).

It was suspected that the increase in CPUE observed in 1980 was a result of either the decrease in logbook coverage or the deterioration in quality of data reported; however the trend of increasing annual mean weight observed in this fishery in recent years (Fig. 3) was also reversed in 1980, when a significant ( $p < 0.05$ ) decrease in mean weight occurred. This decrease was a result of a predominance of smaller size-classes in the 1980 fishery and could reflect new recruitment into the "relict stock" exploited by the Canadian fishery, suggesting a change in age-specific migration patterns. The VPA by Parrack (1981) estimated total stock abundance and would not reflect changes in abundance in the Gulf of St. Lawrence if a change in the age composition occurred in that portion of the stock entering the Gulf of St. Lawrence.

An occurrence in the east Atlantic described by Tiews (1978) may be relevant to this situation. Tiews examined the size composition of bluefin tuna taken off the Norwegian west coast and in the central North Sea from 1956 to 1973. He observed that prior to 1963, there were two groups of fish

of different size compositions, of which the older group migrated into the North Sea after a few weeks stay on the Norwegian coast. In 1963 and subsequently, the younger group did not appear on the Norwegian coast and consequently the older group did not move into the North Sea, resulting in the collapse of the North Sea fishery.

Present knowledge of the migration patterns of bluefin tuna in the west Atlantic indicates a progressive northward extension of the summer feeding range with increasing age (Mather 1980). The reappearance of abundant "medium" size-classes (40-120 kg) in the northwest Atlantic may produce a situation similar to the pre-1963 migration patterns observed by Tiews (1978) in the northeast Atlantic. Smaller size-classes that do not usually enter the Gulf of St. Lawrence in large numbers may be displaced into this area by the appearance of the 1973 year-class in areas outside the Gulf of St. Lawrence. This would account for the predominance of smaller size-classes in the size composition and decrease in mean weight observed in the Gulf of St. Lawrence in 1980 and may explain the increase in abundance indicated by the CPUE estimates but not indicated by the VPA by Parrack (1981).

Although the 1973 year-class has not recruited into the Gulf of St. Lawrence rod and reel fishery, it first appeared in the Japanese longline fishery in the west Atlantic in 1977 (Shingu and Hisada 1981) and several bluefin ranging in size from 70 to 100 kg, tentatively identified as individuals of the 1973 year-class, were taken in the St. Margaret's Bay trap net fishery in 1980. Historic records indicate that up until the mid-1950's, "medium" size bluefin were common in the Nova Scotia sport and St. Margaret's Bay trap net catches. Unfortunately, records are not available from the Gulf of St. Lawrence for the same period.

While this explanation is speculative, it is consistent with the changes observed in the Gulf of St. Lawrence fishery in 1980. It remains to be seen whether data from this fishery in 1981 support this hypothesis. In addition to indicating an increase in bluefin abundance in the Gulf of St. Lawrence several years in advance of recruitment into the fishery of the 1973 year-class, the implication is that "giant" bluefin fisheries in other areas in the northwest Atlantic may show corresponding changes in age composition and abundance.

REFERENCES

- Beardsley, G. L. 1975. A review of the status of the stocks of Atlantic bluefin tuna. ICCAT Col. Vol. Sci. Pap. IV: 161-172.
- Caddy, J. F., and M. J. A. Butler. 1976. Recent catch trends and age composition in Canadian coastal fisheries for giant bluefin tuna (*Thunnus thynnus*) and their relevance to assessment of the northwest Atlantic large fish stocks. ICCAT Col. Vol. Sci. Pap. V(2): 244-257.
- Mather, F. J., III. 1980. A preliminary note on migratory tendencies and distributional patterns of Atlantic bluefin tuna based on recently acquired and cumulative tagging results. ICCAT Col. Vol. Sci. Pap. IX(2): 478-490.
- Parrack, M. L. 1981. An assessment of the Atlantic bluefin tuna resource. ICCAT Col. Vol. Sci. Pap XV(2): 259-272.
- Shingu, C., and K. Hisada. 1981. Analysis on the Atlantic bluefin tuna stock caught by longline fishery. ICCAT Col. Vol. Sci. Pap. XV(2): 320-326.
- Tiews, K. 1978. On the disappearance of bluefin tuna in the North Sea and its ecological implications for herring and mackerel. Rapp. P.-v. Reun. Cons. int. Explor. Mer 172: 301-309.

Table 1. Catch and annual mean weight of bluefin tuna taken in the Gulf of St. Lawrence rod and reel fishery.

Year	P.E.I.		Chaleur Bay		St. Georges Bay		Gulf of St. Lawrence	
	n	$\bar{w}$	n	$\bar{w}$	n	$\bar{w}$	n	$\bar{w}$
1967	5	na					5	na
68	14	na					14	na
69	31	339					31	339
70	99	336					99	336
71	201	330					201	330
72	478	324					478	324
73	724	344	3	352			727	344
74	1048	338	99	367			1147	341
75	343	388	154	392	6	391	503	390
76	650	388	206	402	0	-	856	397
77	448	394	291	397	10	357	749	396
78	437	406	46	418	16	464	499	409
79	317	406	75	398	111	493	503	424
80	389	400	208	407	50	396	647	402

n = catch in number of fish

$\bar{w}$  = mean round weight in kg

Table 2. r-values for adjusted CPUE vs VPA estimated abundance of 11+ year-classes (western Atlantic stock).

	1975-79	1975-80
Gulf of St. Lawrence	.9771**	.8905*
P.E.I.	.9575*	.9178**
Chaleur Bay*	.9153*(.9870)**	.8181*(.9412)**

r-values for adjusted CPUE vs VPA estimated abundance of 11+ year-classes (total Atlantic stock).

	1975-79	1975-80
Gulf of St. Lawrence	.9728**	.8949*
P.E.I.	.9574*	.9212**
Chaleur Bay*	.9171*(.9741)**	.8275*(.9352)**

\*value in brackets calculated by dropping the 1978 point - exceptionally low catch in Chaleur Bay in that year.

Significance level \*  $p < 0.05$

\*\*  $p < 0.01$

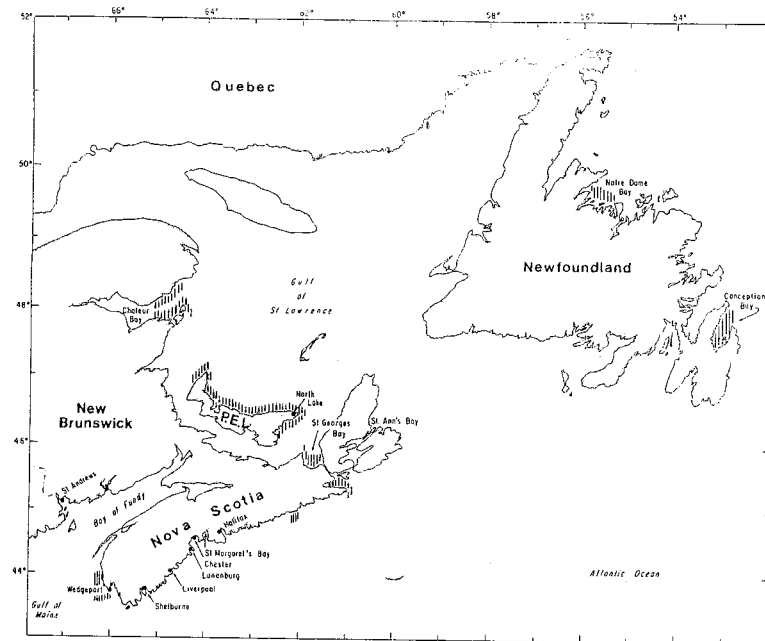


Figure 1. Fishing locations of the Canadian bluefin tuna rod and reel fishery.

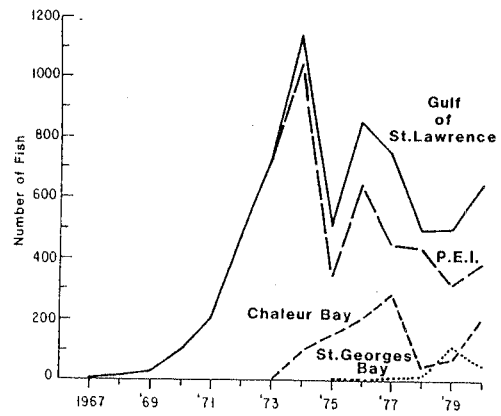


Figure 2. Catch trends from the Gulf of St. Lawrence bluefin tuna rod and reel fishery, 1967-80.

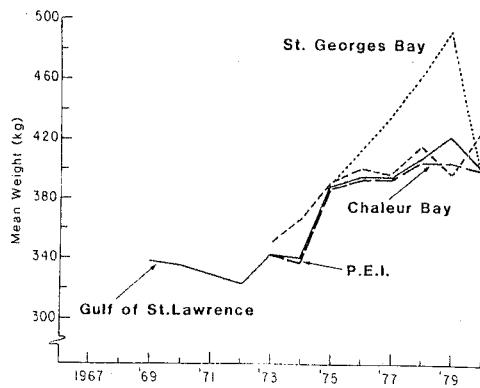


Figure 3. Annual mean weight trends from the Gulf of St. Lawrence bluefin tuna rod and reel fishery, 1967-80.

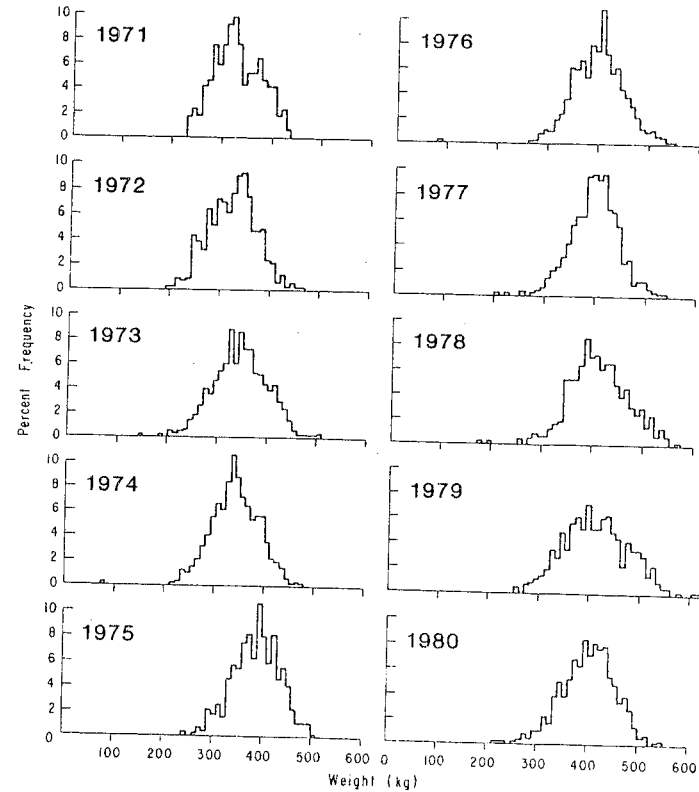


Figure 4. Relative size composition of the bluefin tuna rod and reel catch in the Gulf of St. Lawrence, 1971-80.

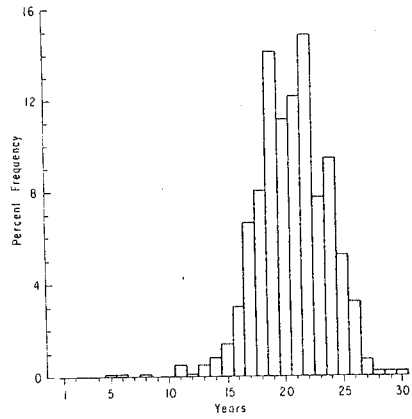


Figure 5. Age composition of Atlantic bluefin tuna in Canadian waters estimated by analysis of otoliths collected from 1975-79.

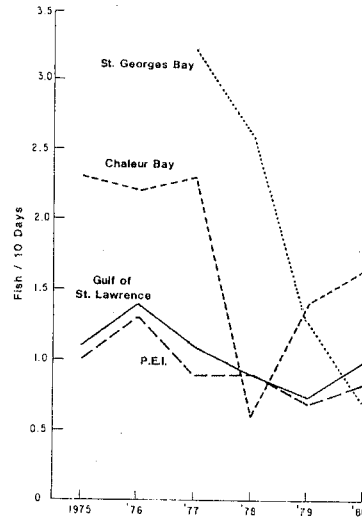


Figure 6. Catch per unit effort trends from the Gulf of St. Lawrence bluefin tuna rod and reel fishery, 1975-80.

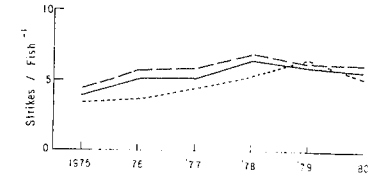


Figure 7. Experience estimates from the Gulf of St. Lawrence bluefin tuna rod and reel fishery, 1975-80.

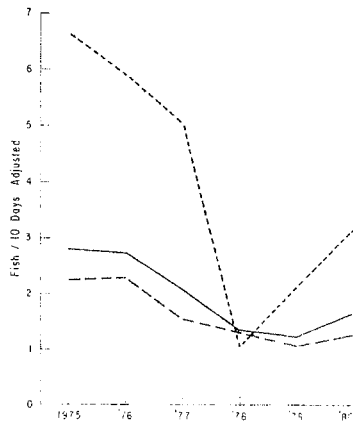


Figure 8. Catch per unit effort trends, adjusted for experience, from the Gulf of St. Lawrence bluefin tuna rod and reel fishery, 1975-80.

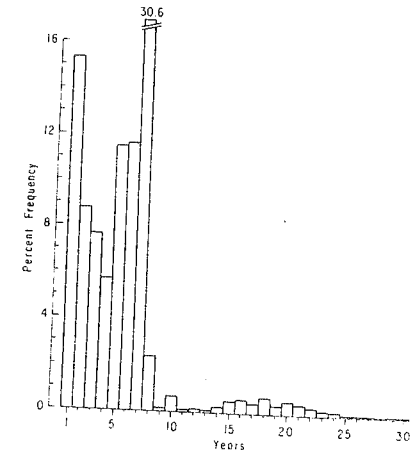


Figure 9. 1980 age composition of Atlantic bluefin tuna stock (western Atlantic stock) calculated from VPA by Parrack (1980).