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BIOLOGICAL STUDIES ON BLUEFIN TUNA (THUNNUS THYNNUS, L.) IN CANADIAN WATERS DURING 1982 AND 1983, WITH A PRELIMINARY LOOK AT SOME 1984 STATISTICS

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SUMMARY

Canadian landings (1983) of bluefin were the highest since 1978 and nearly all were caught on tended-line gear in the Gulf of St. Lawrence. Bluefin tuna from the Gulf show definite seasonal (weekly) gain in weight; however, there is no comparable increase in weekly mean length, implying that this gain is due to seasonal fattening.

A regression of length on weight shows no sexual dimorphism in body form. The relationships for the years 1974 to 1983 combined are:

Males $W = 2.80 \times 10^{-5} L^{2.950}$; $n = 1164$; $r^2 = 0.97$,

Females $W = 1.67 \times 10^{-5} L^{3.039}$; $n = 463$; $r^2 = 0.98$,

where W is the round weight in kg and L is the fork length in cm.

The sex ratio of adult bluefin in the Gulf of St. Lawrence shows an increasing proportion of males at lengths over 230 cm with only males occurring over 281 cm. The reverse proportions are however observed by age, with females predominating at ages over 29 years.

The Canadian rod and reel catch per unit effort indicates a relatively stable catch rate ranging from 0.7 to 1.3 fish per 10 fishing days. Tended-line gear has dominated the fishery since 1981 and appears to have a catch rate double that of the sport rod and reel gear.

A preliminary investigation of the parasites from the gut of giant bluefin recorded 7 species, 5 of which may be new host records (two of these may be from remains of prey species).

RESUME

Les débarquements canadiens (1983) de thon rouge ont été les plus importants depuis 1978, et correspondent presque tous à des captures effectuées à la ligne à main dans le golfe du Saint-Laurent. Le thon rouge du golfe montre un gain saisonnier (hebdomadaire) de poids, que n'accompagne cependant pas d'augmentation hebdomadaire comparable de la taille, ce qui tendrait à indiquer qu'il s'agit d'un engraissement saisonnier.

Une régression taille-poids n'indique pas de dimorphisme sexuel de la silhouette. Le rapport pour les années 1974 à 1983 combinées est:

Mâles $W = 2.80 \times 10^{-5} L^{2.950}$; $n = 1164$; $r^2 = 0.97$

Femelles $W = 1.67 \times 10^{-5} L^{3.039}$; $n = 463$; $r^2 = 0.98$

dans lequel W est le poids vif en kg et L la longueur fourche en cm.

Le sex-ratio du thon rouge adulte dans le golfe du Saint-Laurent montre un pourcentage croissant de mâles pour les tailles au-dessus de 230 cm, et leur présence exclusive au-delà de 281 cm. L'âge présente néanmoins un pourcentage inverse, les femelles prédominant au-delà de 29 ans.

La CPUE de la pêche canadienne à la cannne et moulinet montre un taux de capture relativement stable de 0,7 à 1,3 poissons par dizaine de jours de pêche. La ligne à main prédomine dans la pêcherie depuis 1981 et son taux de capture semble être le double de celui de la canne avec moulinet.

Une enquête préliminaire des parasites intestinaux du thon rouge géant a permis de noter 7 espèces, dont 5 pourraient avoir été observées pour la première fois (2 d'entre elles proviennent peut-être d'espèces-proies).

RESUMEN

Los desembarques canadienses de atún rojo en 1983 fueron los mas importantes desde 1978 y en su casi totalidad se obtuvieron por arte de "tended-line" en el Golfo de San Lorenzo. El atún rojo de dicho Golfo muestra un claro aumento temporal (semanal) de peso. Sin embargo, no existe un aumento semanal comparable en talla, lo cual implica que este aumento se debe a un engorde temporal.

Una regresión de talla sobre el peso no muestra dimorfismo sexual en la forma del cuerpo. Las relaciones de los años 1974 a 1983 combinadas son:

Machos $W=2.80 \times 10^{-5} \; L^{2.950}$ $n=1164;\ r^2=0.97$

Hembras $W=1.67 \times 10^{-5} \; L^{3.039}$ $n=463;\ r^2=0.98$

donde W es el peso vivo en kg y L es la longitud-horquilla en cm.

La proporción de sexos del atún rojo adulto en el Golfo de San Lorenzo muestra una proporción en aumento de machos con tallas superiores a los 230 cm, y por encima de los 281 cm,solo se encuentran machos. Sin embargo se observan proporciones inversas por edad, ya que las hembras predominan por encima de los 29 años.

La captura por unidad de esfuerzo de la caña-liña canadiense muestra una tasa de captura relativamente estable, desde 0.7 hasta 1.3 peces por 10 dias de pesca. El arte del "tended-line" ha dominado la pesquería desde 1981 y parece tener una tasa de captura doble de la conseguida por la caña-liña.

Una investigación preliminar de los parásitos realizada en visceras de atún rojo gigante, registró siete especies, 5 de las cuales podrían ser primeros descubrimientos de este parásito en el atún rojo (es posible que dos de ellas procediesen de restos de presas ingeridas).

INTRODUCTION

Atlantic bluefin tuna (Thunnus thynnus, L.) are presently harvested in Canadian waters by three major gear types: tended line, rod and reel, and trap net. The Canadian fishery exploits giant bluefin (ie. fish over 120 kg.) which migrate for summer feeding to the continental shelf off Nova Scotia and as far north as Newfoundland and the waters of the southern Gulf of St. Lawrence.

Over the last decade shifts in the gear mix have occurred. The major shifts have been from a purse seine fishery off New England to a successful commercial trap net fishery in the mid to late 1970's in St. Margaret's Bay, Nova Scotia; to the present commercial tended line fishery in the Gulf of St. Lawrence. A relatively stable sport rod and reel fishery along the coast of Nova Scotia and in the Gulf of St. Lawrence has persisted throughout this period. Canadian large fish landings have remained relatively constant over the past decade (Table 1), however the proportion of the total bluefin tuna landings by Canada has varied considerably.

A historical review of the Canadian fishery was presented by Hurley and Iles (1981) and a description of the tended line fishery by Metuzals and Hurley (1982).

CATCH

Landings in 1982 and 1983 were under strict quota control with surplus quota being re-allocated from regions of low catch to regions having more successful fisheries. The total landings in 1983 were 1007 (Table 2) fish weighing 432.7 tonnes (Table 3). This was up considerably from recent years, however, the catch to date (as of 19/09/84) for 1984 appears to be down to 50% of the catch at the same time in 1983.

The St. Margaret's Bay trap fishery appears to have failed again in 1984 as it did in 1983. The only areas presently sustaining the Canadian fishery are Prince Edward Island (P.E.I) and Baie de Chaleur, both in the southern Gulf of St. Lawrence.

The distribution of landings since the 1970's (Table 2) indicates that the overall distribution of bluefin tuna has changed somewhat. The St. Margaret's Bay, St. Georges Bay and Newfoundland fisheries have all but collapsed. This can be taken as an indication of a change in migratory patterns, possibly due to environmental conditions.

SEASONAL WEIGHT CHANGE

The mean weight of wild ★ bluefin caught off P.E.I. during 1983 was 433.1 kg. This continues the previously documented (Metuzals and Hurley, 1982; Hurlbut and Maguire, 1983) trend of increasing mean weight of wild tuna caught since 1974 (Fig 1).

★ In this paper wild tuna refer to those fish caught and landed in the same day as opposed to fish caught and fattened in the trap nets of St. Margaret's Bay, Nova Scotia.

In addition, there appears to be an intra-seasonal trend of increasing weekly mean weight in past seasons (Fig 2). This may indicate an earlier movement of smaller tuna on their northward feeding migration or seasonal fattening while in northern waters. Examination of the change in weekly mean fork legth of bluefin within a season does not validate the former hypothesis (Fig 3). This indicates little if any intra-seasonal growth in length, therefore the growth in weight must be assumed to be mainly the result of seasonal fattening.

The week during which the 50% point in the landings by numbers was reached was most often the second week of September (Fig 2). There have been two years (1982 and 1975) when this point occurred one to two weeks earlier. These data are estimated from the sampling programs which may not cover the entire fishing season, however, it is felt to be representative of the general catch and should give a reasonable estimate of this date.

SIZE OF FISH

The length-weight relationship for bluefin tuna shows no sexual dimorphism in body form. The length-weight regressions for wild fish (caught off P.E.I. between 1974 and 1983) are :-

$$\text{Males} \quad W = 2.80 \times 10^{-5} L^{2.950} \quad ;n=1164 \; ;r^2=0.97,$$

$$\text{Females} \quad W = 1.67 \times 10^{-5} L^{3.039} \quad ;n=463 \; ;r^2=0.98,$$

where W is the round weight in kg and L is the fork length in cm.

The length weight relationship of fish trapped in St Margaret's Bay and then fattened in pens until the end of the season does not show any significant difference from those above, although the variance appears to be less.

SEX RATIO

The proportion by sex in the Canadian bluefin catch has shown a systematic divergence by length from the expected 50:50 ratio (Maguire and Hurlbut, 1983). The data sets are not large enough to study sex ratios by length by year, therefore the data are combined for all years (1974 to 1983). The sex ratio by length (Fig. 4) indicates a decreasing proportion of females amongst the larger fish (ie. over 231 cm in length). This relationship is not the same when the sex ratio is investigated by age (Fig. 5); there is a significant increase in the number of females with age.

These differences in observed sex ratios are probably the result of the divergent growth rates reported for bluefin (Butler et al.,1977; Hurley et al.,1980). Male bluefin grow faster and to a larger size than females, thus resulting in more males at greater lengths, however, they may also have a higher natural mortality associated with this increased growth.

More significant than the changing sex ratio by length or by age is the gross sex ratio in each year. The great preponderance of males appears due to the large size of fish available for exploitation by this fishery (assuming no size selection on the basis of hook size for these giant tuna). This may be the result of a size-migration behavioural pattern.

STOMACH CONTENTS AND PARASITES

Port samplers enumerated and recorded the stomach contents of bluefin tuna landed on P.E.I. during 1983. These data have not yet been analysed, however the most prevalent food items were herring and mackerel with many stomachs containing cod, white hake and occasionaly squid. One stomach sampled this year contained fifty-two (52) mature herring, five mature mackerel and one cod.

Stomachs from a sample of seventeen (17) length stratified bluefin were collected and frozen for subsequent parasitological examination. The results of this examination are presented in Table 4.

Five of the species of parasites recovered from the samples would appear to represent new host records for bluefin tuna. However, it is likely that only the occurrence of three of these species (ie H. reliquens, G. atlantica and R. camura) represent legitimate, new host records. It is felt that the occurrence of H. adunca, A. simplex and D. varicans in the samples, represent accidental infections acquired from prey (ie. herring).

CATCH PER UNIT EFFORT IN 1982 AND 1983

Compulsory submission of log records has been a license requirement since 1975 when measures were introduced to restrict fishing mortality in compliance with ICCAT advice. Unfortunately, this regulation has not been adequately enforced and hence log record coverage in 1982 and 1983 was only about 50% by numbers of fish caught. The degree of coverage of this fishery by log records is down considerably from the 95+% reported by Hurley et al. (1979) for the period from 1975 to 1979. The decreasing trend in quality and coverage of log record information as reported by Hurley and Iles (1981) has continued. The accuracy and/or representativeness of this coverage can not be ascertained at this time. There may be an under estimated bias in these logs due to a regulated limit of 1 and in some areas 2 bluefin per boat per day.

The log records for 1982 and 1983 were not used to ascertain fleet distribution, however, from interviews with vessel owners it seems that the fishing distribution patterns have not changed significantly from that reported for the 1975 to 1978 period (Hurley and Iles, ibid).

To standardize the quality of the data, only vessels that reported 40+ log days of fishing for the season were utilised. This choice was based upon the assumption that fishermen recording 40+ log days of effort are active tuna fishermen and conscientious about submitting complete log records.

The returns from this analysis indicate the catch per unit effort (CPUE) for the rod and reel fishery has not changed from that reported by Hurley and Iles (1981) (Fig 6). During 1982 and 1983 the first large scale commercial use of tended line gear occurred in the Gulf of St. Lawrence. The CPUE for this gear appears to be twice that of sport rod and reel (Fig 6). In 1982 and 1983 P.E.I. fishermen using tended line caught 2.47 and 1.67 times the number of tuna per day (= trip) as those using rod and reel.

ACKNOWLEDGEMENTS

We would like to thank the Scotia Fundy region of D.F.O. Canada for permitting use of the historic bluefin tuna sampling data collected between 1974 and 1981.

Mr. W.E. Hogans of the Atlantic Reference Centre, St. Andrews, N.B. conducted the parasitological examination of the tuna stomachs.

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TABLE 1. Landings of bluefin tuna from the the ICCAT area in thousands of tonnes.

YEAR	WEST ATLANTIC OCEAN						EAST ATLANTIC & MEDITERRANEAN	TOTAL
	CANADA		U.S.A.	JAPAN	OTHER	TOTAL		
	small	large						
1970	1.2	0.5	3.8	0.1	0.3	5.7	10.4	16.1
1971	0.9	0.2	4.1	1.4	0.2	6.9	10.8	17.7
1972	0.3	0.2	3.1	0.3	0.1	4.1	11.3	15.4
1973	0.6	0.3	1.6	1.1	0.2	4.1	10.7	14.7
1974	0.1	0.7	1.6	0.9	0.2	3.5	18.2	21.4
1975	0.3	0.3	2.9	1.5	0.2	5.2	21.1	26.3
1976	0.3	0.5	1.9	2.9	0.4	6.0	22.3	28.3
1977	0.3	0.7	3.1	3.7	0.2	6.8	18.8	25.6
1978	0.2	0.4	1.9	3.1	0.3	5.9	14.6	20.5
1979	0.0	0.2	2.3	3.6	0.3	6.5	12.1	18.5
1980	0.0	0.4	1.5	3.9	0.1	5.9	13.0	18.9
1981	0.1	0.3	1.4	3.8	0.3	5.9	13.2	19.1
1982	0.0	0.3	0.6	0.3	0.2	1.4	20.8	22.2

(after SCRS Vol XX No. 3, Table 10, pg 679)

TABLE 2. Landings of Atlantic bluefin tuna by numbers of fish from Canadian waters. These are broken down by province. The trap net fishery is from St. Margaret's Bay, Nova Scotia; the Nova Scotia (N.S.) catch is from the rest of the province. These statistics do not include the Canadian purse seine fishery off the New England coast.

YEAR::PROV	TRAP NET	P.E.I.	N.B.	QUE.	N.S.	NFLD	TOTAL
1970		99	0	0	15	418	532
1971		173	0	0	9	76	258
1972		482	0	0	12	104	598
1973		650	3	0	16	37	706
1974	865	1048	93	6	0	30	2042
1975	452	343	148	6	0	33	982
1976	474	650	180	26	0	6	1336
1977	948	448	196	95	13	5	1705
1978	530	437	35	11	17	2	1032
1979	72	317	55	20	111	1	576
1980	129	389	118	90	50	1	777
1981	93	515	26	29	81	3	747
1982	157	392	53	43	61	7	713
1983	17	789	125	54	19	3	1007
AVERAGE	266	480	73	27	28	51	929
PERCENT	28	51	7	2	3	5	

TABLE 3. Landings of Atlantic bluefin tuna by weight (tonnes) from Canadian waters. These are broken down by province. The trap net fishery is from St. Margaret's Bay, Nova Scotia; the Nova Scotia (N.S.) catch is from the rest of the province. These statistics do not include the Canadian purse seine fishery off the New England coast.

YEAR::PROV	TRAP NET	P.E.I.	N.B.	QUE.	N.S.	NFLD	TOTAL
1970							-
1971							-
1972							-
1973							-
1974	255.7	355.0	33.8	1.9	0.0	8.8	655.2
1975	144.0	133.5	57.3	2.1	0.0	10.4	347.3
1976	172.1	256.9	71.8	10.5	0.0	1.8	513.1
1977	367.9	178.2	77.9	37.9	5.4	1.5	668.8
1978	221.3	180.0	14.7	4.9	8.1	0.6	429.6
1979	30.6	128.6	21.8	8.1	54.7	0.4	244.2
1980	46.6	155.0	47.3	36.1	20.6	0.3	305.9
1981	40.7	219.2	10.9	11.6	36.4	0.9	319.7
1982	68.3	157.9	21.1	16.1	25.8	2.3	291.5
1983	6.6	341.7	52.4	22.1	8.9	1.0	432.7
AVERAGE	135.3	210.6	40.9	15.1	15.9	2.8	300.5
PERCENT	45.0	70.0	13.6	5.0	5.3	0.9	

TABLE 4. Results of parasitological examinations on 17 stomachs of bluefin tuna from the Gulf of St. Lawrence. These data have been prepared by Mr.W.E.Hogans of the Atlantic Reference Center, St. Andrews, N.B., Canada.

Species	Prevalence [1]	Intensity [2]
Hirudinella ventricosa (Pallas,1794)	94.1 (16)	5.6
*Hysterothylacium aduncа (Deardorff and Overstreet, 1981).	35.2 (6)	1.0
*Hysterothylacium reliquens (Deardorff and Overstreet, 1981)	11.7 (2)	1.5
Anisakis simplex (Rudolphi,1802)	52.9 (9)	3.1
*Genitocotyle atlantica (Linton, 1901)	11.7 (2)	1.0
*Derogenes varicans (Rudolphi,1809)	5.8 (1)	2.0
*Rhapidascaris camura (Overstreet,1978)	5.8 (1)	1.0

1. Percent infected, the number in brackets is the number of fish.
2. Mean intensity (numbers of parasites per infected fish).
*. New host record.

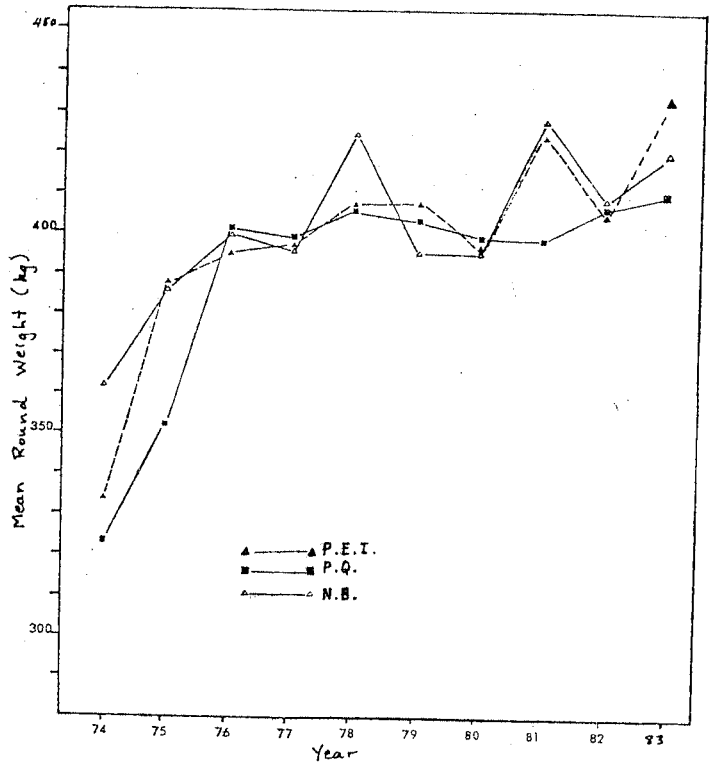

Figure 1. Annual mean round weight (kg) of Atlantic bluefin tuna landed in Prince Edward Island, Quebec, and New Brunswick between 1974 and 1982). (after Metuzals and Hurley, 1982)

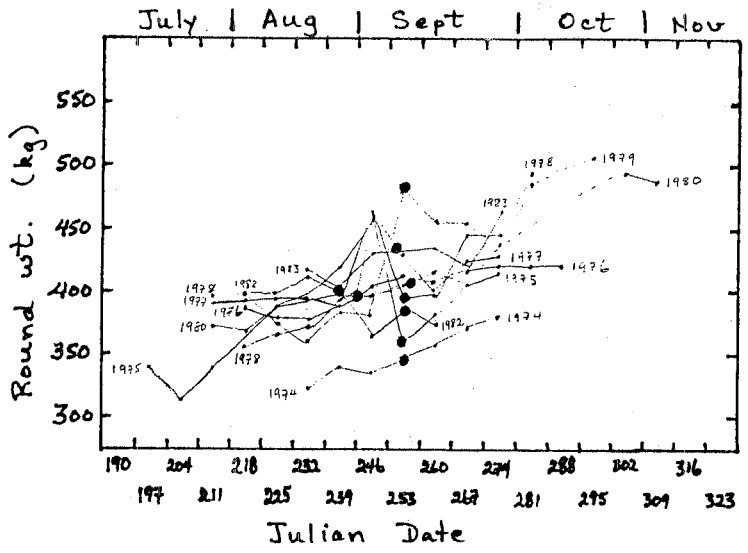

Figure 2. Weekly mean round weight (kg) by individual year of wild Atlantic bluefin tuna caught and landed on the same day. The large dot represents the approximate date at which 50% of the landings were achieved.

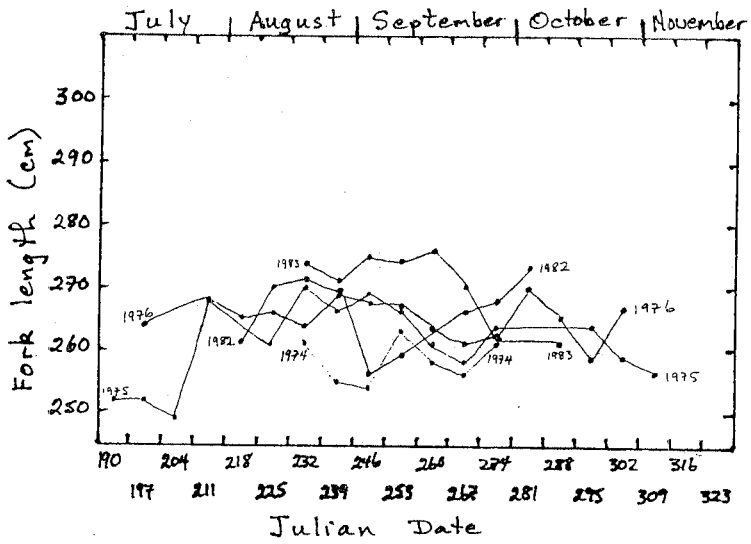

Figure 3. Weekly mean fork length (cm) by individual year of wild Atlantic bluefin tuna caught and landed on the same day.

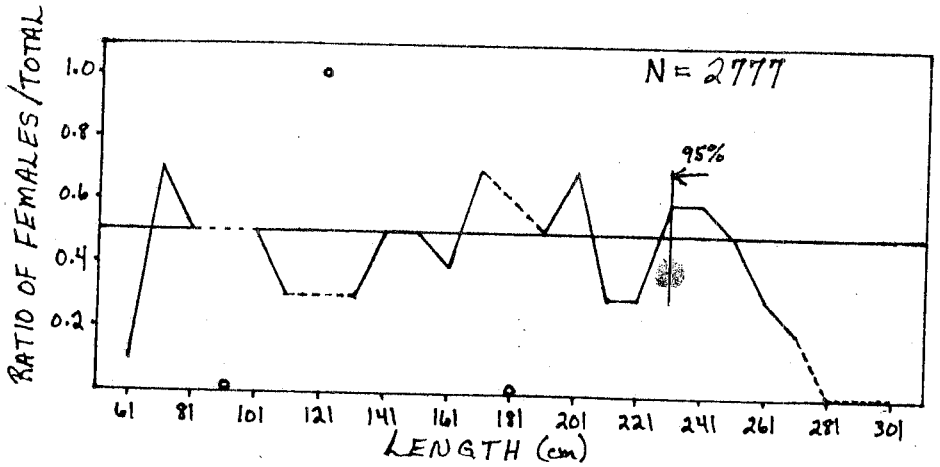

Figure 4. Ratio, by 10 cm length grouping, of female Atlantic bluefin tuna to total number of sexed tuna landed. Data for all years 1974 to 1983 combined. Broken lines indicate an observation with only one fish. Note: 95% of the landings occur at lengths over 231 cm, ie. to the right of the vertical bar.

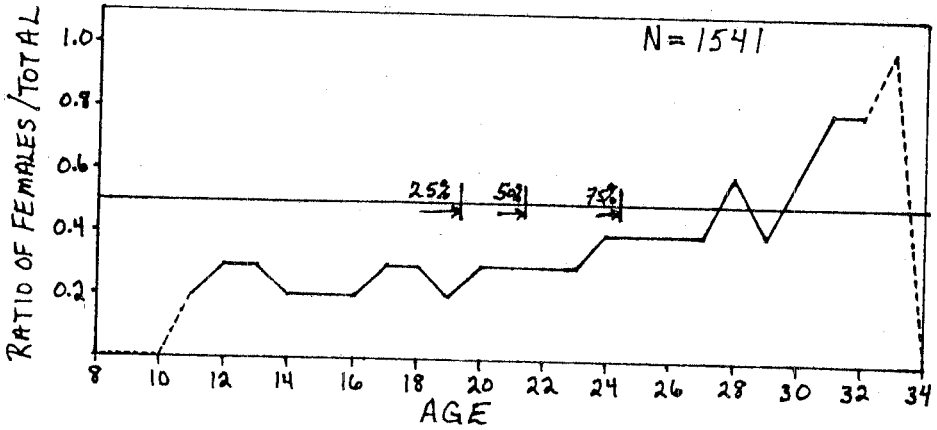

Figure 5. Ratio, by age group, of female Atlantic bluefin tuna to total number of sexed tuna landed. Data for all years 1974 to 1981 and 1983 combined. The samples from 1982 have not been aged to date. Broken lines indicate observations with only one fish. The vertical bars indicate the distribution of landings by age (ie. 25% of landings are tuna less than 20 years old, 50% are greater than 21 years old).

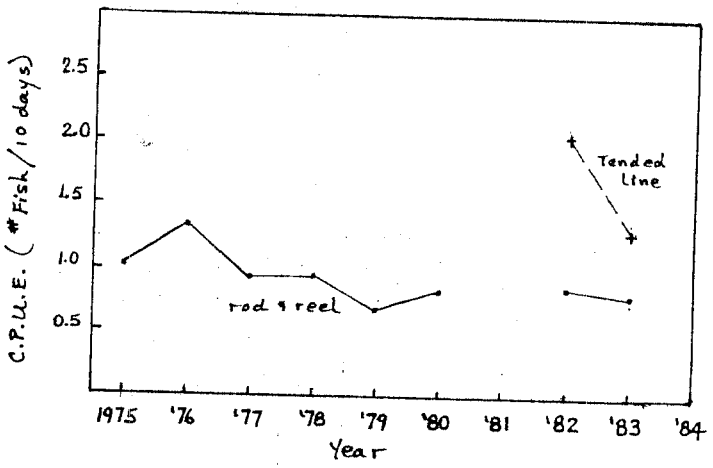

Figure 6. Catch per unit of effort of Atlantic bluefin tuna by year for sport rod and reel gear and commercial tended line gear landed in P.E.I. CPUE is expressed in numbers of fish per 10 days fishing.