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Seasonality and reproductive parameters of the thorny skate (*Raja radiata* Donovan, 1808) in NAFO Division 3N

by

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Abstract

In this paper the seasonal and geographic pattern of the fishing effort distribution targeting thorny skate is described. The fishery is performed in fall and in a quite restricted area of Div. 3N, in shallow waters of less than 100 m. The results support that the fishery is largely based on a skate mating concentration. The estimated length at 50 % maturity in males and females is 51 and 55 cm respectively.

Introduction

The thorny skate was a traditional by-catch of the Grand Bank in groundfish fisheries (Durán et al. 1996). However, this species become a target for the Spanish trawler fleet in this area. The catches increased probably as a result of increased effort towards non-regulated species (Junquera and Paz, 1998).

The skate fishery in the Grand Bank and the Scotian Shelf is regulated inside Canadian waters since 1994 (Simon and Frank, 1996), though the fishery outside 200 miles is currently unregulated.

The first assessments on skate in NAFO were presented by Simon and Frank (1995) and Atkinson (1995). The last one (Kulka and Mowbray, 1998) shows differences in spring and fall distributions, and seasonal changes in the catch in NAFO Divisions 3LNOPs, with a period of concentration mainly in fall in shallow waters Division 3NO. Junquera and Paz (1998) also reported marked seasonal pattern of aggregation. According to the available information, it could be concluded that either a small scale seasonal migration or a dispersion over the shelf occur in this species.

In this paper, the seasonal pattern of distribution in thorny skate is analysed using data of fishing effort and total catches obtained in 1997, 1998 and 1999 by the observers on board the commercial fishing fleet. Data on sexual maturity recorded in the 1999 fall concentrations are also presented.

Material and Methods

Information on fishing effort distribution and catches per tow outside 200 miles for this study was obtained from NAFO Observers on board the commercial fleet (100% coverage). A total of 1800 hauls targeting thorny skate have been recorded from July to December 1997 and January to December 1998. Those are recognised because of the use of a codend mesh size larger than 200 mm, instead of the usual 130 mm one used when targeting for others species. Besides, in 1999 four Spanish trawlers were monitored by scientific observers.

Biological information regarding sexual maturity of thorny skate were obtained from the national scientific observers on board the same fleet in 1999 (Table 1). All specimens were sexed and total length to the lower cm was recorded. Sexual maturity of thorny skate was assessed using the maturity scale shown in ANNEX 1. Four stages of males and six stages of females were distinguished. Both males and females were classified as "immatures" when they are in stage 1 and as "matures" (meaning adults) in either of the further stages. The length at 50% maturity (L_{50}) was calculated from the proportion of adults by length-classes.

The method of Ashton (1972) for turning proportions of mature individuals into so-called logits and then fitting a straight line have been used. The proportion of mature individuals at length was adjusted to a logistic function as described by Ashton:

$$\hat{P} = \frac{e^{a+bL}}{1+e^{a+bL}} \qquad (1)$$

and the logaritmic transformation:

$$\ln \frac{\hat{P}}{1-\hat{P}} = a + bL \qquad (2)$$

where $\hat{P}$ = predicted mature proportion
and are the coefficients of the logistic equation
L is the length

Statistica for Windows (StatSoft, Inc., 1995) was used to calculate the predicted values and the coefficients.

The size at maturity is obtained as minus the coefficients ratio (- /) by substituting $\hat{P}$ = 0.5 in equation (2). Two maturity curves, one for males and other for females were generated.

Results

According to the results on the fleet activity, hauls targeting thorny skate were conducted in a rather restricted area (43º02´ - 44º20´N and 49º20´ - 50º30´W) at depths less than 100 m. The great majority of this fishing area belong to Division 3N, with only a few hauls straddling into Division 3O.

In order to analyse the catches seasonal pattern of occurrence, the total catch of the years 1997, 1998 and 1999 was converted into respective monthly percentages. In Fig. 1 is observed than the whole year skate catches are taken exclusively in the period from Sept. to Nov., and are negligible out of this season. Peak catches occurred in October in the three year analysed, accounting every time for over 45% of the total catch of the respective years.

A total of 216 males ranging from 31 total length cm to 89 cm total length and 222 females from 21 cm total length to 78 cm total length were examined (Table 2). A 62% of the males and 47% of the females sampled were mature (adults). The percentage of mature males in this year was higher than that of females.

The maturity curves obtained by length class are shown in Fig. 2. The estimated length at 50% maturity was 51.5 cm in males and 55.2 cm in females Table 3 shows the coefficients of the logistic function and the parameters of maturity curves. A large proportion of the adult males (57%) were at stages fully mature and active, while in females a great diversity of stages was observed.

Discussion

The seasonal pattern of distribution of the fishing effort targeting skate in shallow waters of Division 3N is highly concentrated in the fall months, in agreement with previous observations (Kulka and Mowbray, 1998). Also catches are taken in a rather small geographic range. Tagging studies on Grand Bank (Templeman, 1984) indicate that thorny skate is primarily a sedentary species and generally not undergo long migrations. Kulka and Mowbray

(1998) indicated differences in biomass estimates and distributions between seasons what could indicate some degree of seasonal migration. However distances involved are probably less than 100 km per year. Further fall survey biomass and abundance estimates were usually higher than those in spring due to a change in availability, attributable to a seasonal movement of skate outside 200 miles.

The maturity results obtained in this study support that the fishing activity of the fleet is based on a mating concentration of the thorny skate, as the majority of males were ripe whereas females were at earlier maturity stages, as already printed by (Junquera and Paz, 1998). Having into account this is a viviparous specie it is likely that the mating moment would produce the more dense concentration of individuals, while spawning will occur later when the population is more disperse to avoid competence for the progeny. Also the time of females spawning could be spread over time, as Atkinson (1995) suggest that reproduction occurs year round on the Grand Banks.

The length at 50% maturity is larger in females (55 cm) than in males (51 cm). On the contrary Templeman (1987) found that male skate in this same area mature at larger size than females, and in both cases at fairly larger lengths than the ones obtained in this study (68 – 83 cm and 65 – 74 in males and females respectively). We cannot interpret the reason of this difference, as the diagnostic method of maturity in Templeman paper is not stated. He also pointed the existence of large differences between areas in length at sexual maturity and concluded that no large scale migrations of thorny skate occurred between areas.

Acknowledgements

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Table 1.- Characteristics of maturity sampling in thorny skate in 1999.

Date	Positions	Division	Depth (m)	Nº individuals
18/10/99	43º28´N – 50º14´W	3N	51	100
21/10/99	43º57´N – 50º05´W	3N	53	97
21/10/99	43º50´N – 50º25´W	3N	54	64
5/11/99	43º36´N – 50º05´W	3N	49	85
7/11/99	43º20´N – 50º11´W	3N	55	92

Table 2. Number of adult and immature individuals by lenght.

MALES

Length	Immature	Mature	Total	%
<30	-	-	-	-
30 - 32	2	0	2	0
33 - 35	1	0	1	0
36 - 38	3	0	3	0
39 - 41	16	0	16	0
42 - 44	17	2	19	11
45 - 47	13	8	21	30
48 - 50	18	5	23	22
51 - 53	3	7	10	70
54 - 56	4	10	14	71
57 - 59	4	10	14	71
60 - 62	1	9	10	90
63 - 65	1	17	18	94
66 - 68	0	7	7	100
69 - 71	0	20	20	100
72 - 74	0	13	13	100
75 - 77	0	7	7	100
78 - 80	0	8	8	100
81 - 83	0	4	4	100
84	0	6	6	100
Total	83	133	216	62

FEMALES

Length	Immature	Mature	Total	%
<30	-	-	-	-
30 - 32	2	0	2	0
33 - 35	5	0	5	0
36 - 38	5	0	5	0
39 - 41	13	0	13	0
42 - 44	21	0	21	0
45 - 47	17	0	17	0
48 - 50	25	2	27	7
51 - 53	15	8	23	35
54 - 56	10	3	13	23
57 - 59	1	10	11	91
60 - 62	1	13	14	93
63 - 65	0	29	29	100
66 - 68	1	11	12	92
69 - 71	0	12	12	100
72 - 74	1	14	15	93
75 - 77	0	2	2	100
78 - 80	0	1	1	100
81 - 83	-	-	-	-
84	-	-	-	-
Total	117	105	222	47

Table 3.- Parameters of the thorny skate maturity curves by sexes in 3 N Regulatory Area.

FEMALES

	α	β
Estimate	- 21.56	0.39
Std. Error	2.69	0.05
t (220)	- 8.02	7.98
p - level	0.000	0.000

Number of females = 222
Variance explained = 75 %
R = 0.86

$\mathbf{L_{50}}$ $(-\alpha/\beta)$ = **55.2**

MALES

	α	β
Estimate	- 11.39	0.22
Std. Error	1.67	0.03
t (216)	- 6.82	6.73
p - level	0.000	0.000

Number of males = 216
Variance explained = 57 %
R = 0.75

$\mathbf{L_{50}}$ $(-\alpha/\beta)$ = **51.5**

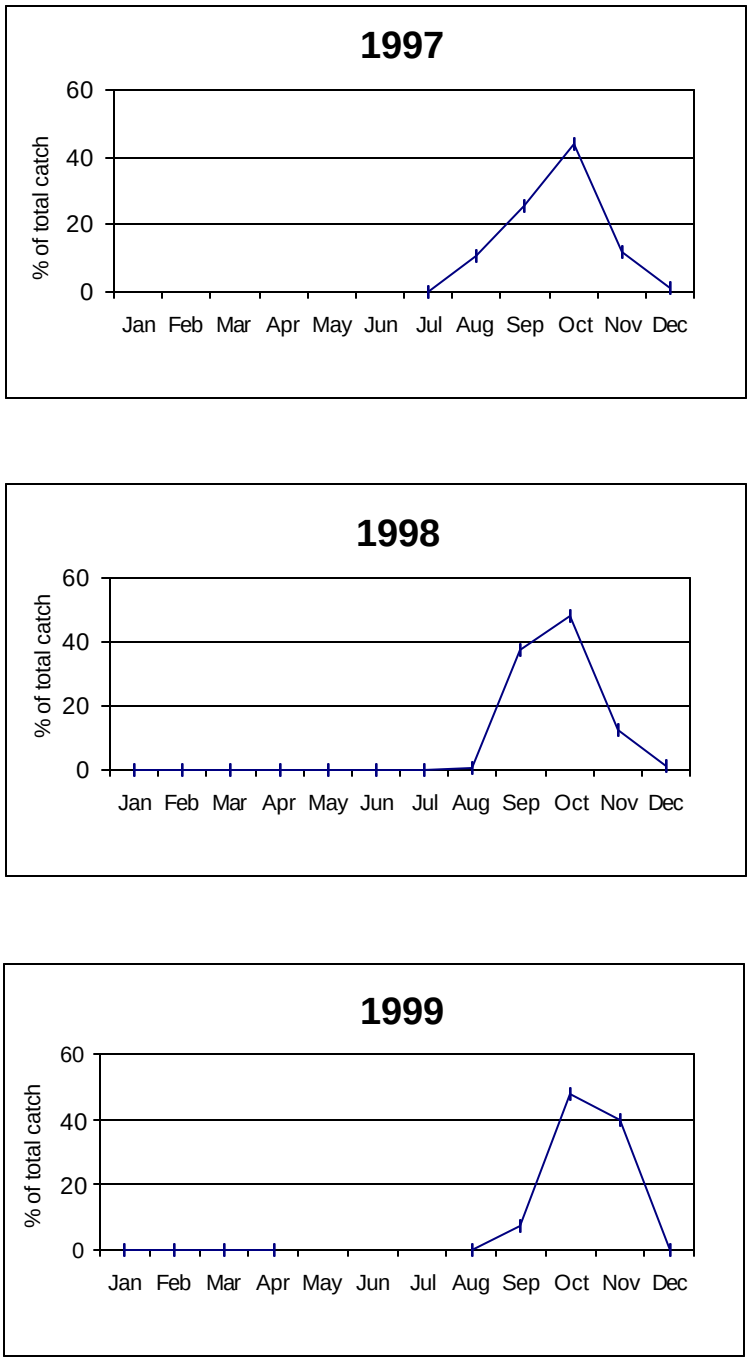
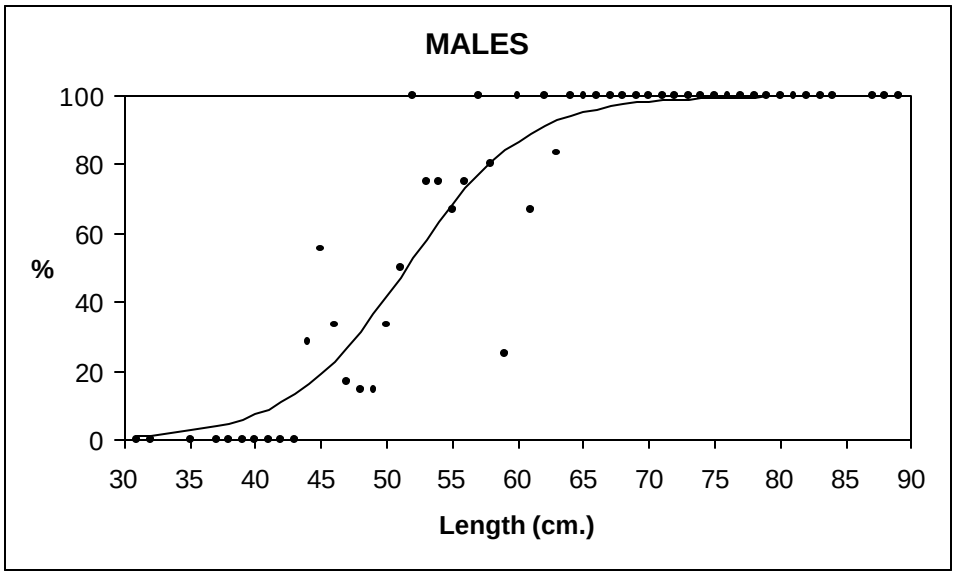


Figure 1.- Percent total catch for thorny skate in Div. 3N.



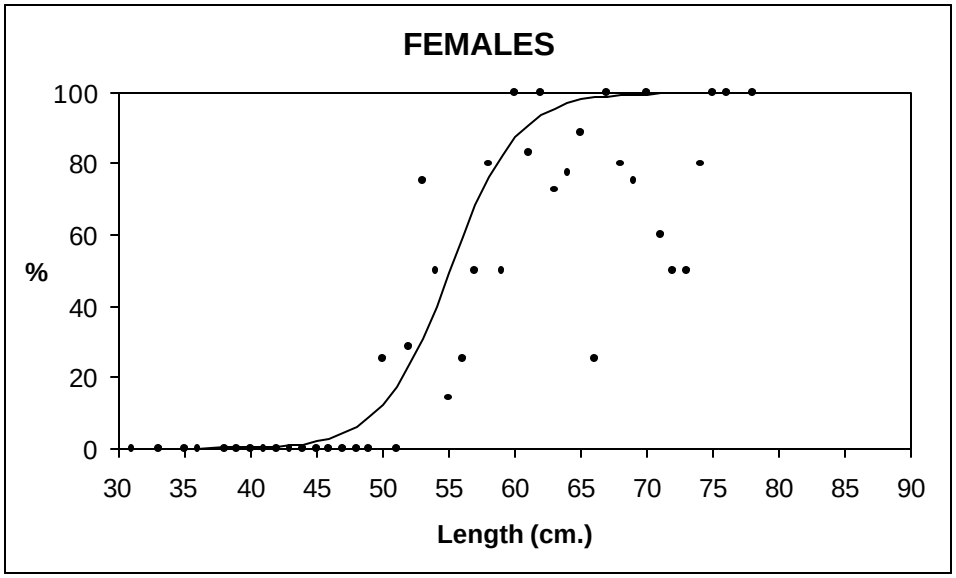


Figure 2.- Maturity ogives of thorny skate in Division 3N in the year 1999.

ANNEX 1. **Maturity scale for thorny skate.**

MALES

1.- Immature. Claspers undeveloped as small, flexible sticks being shorter than extreme tips of posterior pelvic fin lobes.

2.- Maturing. Claspers becoming extended, longer than tips of posterior pelvic lobes, their tips (glans) becoming structured, but skeleton still soft and flexible.

3.- Mature. Claspers full length, external and internal glans structures fully formed, skeleton hardened so that claspers stiff and free glans components sharp.

4.- Active. Glans clasper often dilated, its structures reddish and swollen. Sperm flowing on pressure from cloaca and/or present in claspers groove or glans. Sperm ducts largely as stage 3 but may be less tightly filled, whereas seminal vesicle may be well filled.

FEMALES- ovarian stages

1.- Immature. Ovaries small, their internal structure gelatinous or granulated. No oocytes differentiated or all uniformly small, granular. Oviducts (uteri) narrow, thread-like.

2.- Maturing. Ovaries somewhat enlarged, walls more transparent. Oocytes becoming differentiated to various small sizes. Uteri largely as stage 1 but may become widened posteriorly.

3.- Mature. Ovaries large and tight. Oocytes enlarged, with some being very large. Uteri enlarged and widening over nearly their entire length.

FEMALES- uterine stages

4.- Active. A distinctly large yolk-egg present in one or both Fallopian tubes. No egg capsule yet visible in shell gland, or beginning formation of eggs capsule at most.

5.- Advanced. Large yolk-eggs in Fallopian tubes, or already passing through into egg capsules. Egg capsules about fully formed in one or both oviducts but still soft at upper end and located very close to Fallopian tubes.

6.- Extruding. Completed, hardened egg capsules in one or both oviducts, more or less separated from Fallopian tubes. Capsule surface covered with dense silky fibres. If oviducts empty but still much enlarged and wide, capsules have probably just been extruded.