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Effect of a shore-based sampling programme on *Notothenia coriiceps* populations

R.J. CASAUX[1]* AND E.R. BARRERA-ORO[1,2]

[1]*Instituto Antártico Argentino, Departamento de Ciencias Biológicas, Cerrito 1248, (1010 AAZ) Buenos Aires, Argentina*
[2]*Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", División Ictiología, Angel Gallardo 470, (C1405 AJR) Buenos Aires, Argentina*
**pipocasaux@infovia.com.ar*

Abstract: The effect of an intensive sampling programme on an inshore population of *Notothenia coriiceps* was studied at Potter Cove, South Shetland Islands, by comparing catch data taken in successive summers of 1992/93 to 1994/95 at one specific zone (site 1) with those taken in the 1994/95 summer at two close but not previously sampled zones (sites 2 and 3). The fish were caught with trammel nets under similar sampling conditions (depth, net measurements, bottom type). In site 1, a decline in length (TL) of the fish was observed throughout the whole period. The fish from sites 2 (mean = 32.4 cm) and 3 (mean = 31.8 cm) exhibited no significant differences in mean length. They were larger (P = 0.07) than those from site 1 caught in the summers of 1994/95 (mean = 28.8 cm) and 1993/94 (mean = 30.2 cm), but were similar in size to those sampled in the summer of 1992/93 (mean = 31.7 cm), just when the sampling programme started in site 1. Although alternative hypotheses to explain the results are discussed (e.g. random error, strong recruitment), it is suggested that the size variations of the fish sampled at site 1 are due to intensive sampling effort carried out throughout this study at that specific zone in Potter Cove.

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Key words: Antarctica, monitoring, *Notothenia coriiceps*, sampling effect

Introduction

The monitoring of coastal fish populations can be used to detect changes in inshore marine ecosystems. The necessity of implementing these studies in the Antarctica has been pointed out in the compass of international programmes such as BIOMASS (Biological Investigations On Marine Antarctic Systems and Stocks) and CS-EASIZ (Coastal Systems-Ecology of the Antarctic Sea Ice Zone Program) (Anon 1994). Trawling cannot be used due to the lack of areas of seafloor suitable for trawling in most of the Antarctic shallow water areas. The few shore-based studies aimed at monitoring variations in the abundance of Antarctic inshore demersal fish dealt with samples obtained by means of trammel/gill nets (Duhamel 1990, Barrera-Oro & Marschoff 1991, Barrera-Oro *et al*. 2000).

The effects of commercial exploitation of finfish on Antarctic fish populations is well known (Kock 1992). However, potential effects of scientific sampling programmes on fish communities are rarely documented. The advantages of using trammel/gill nets in comparison to other inshore sampling gear (hook and lines, traps) are the capture of a larger quantity of fish in a short time, no damage to benthos, negligible bycatch of benthic organisms and easy operation from rubber boats. This sampling method has been widely used in Antarctica mainly for coastal biological studies (Everson 1970, Burchett 1983, Linkowski *et al.* 1983, Barrera-Oro & Casaux 1990, Casaux *et al*. 1990, Vacchi & La Mesa 1995). However, there is very little information on how a long-term programme using this type of gear may affect the age and size structure of local fish populations.

Notothenia coriiceps (previously referred to as *Notothenia neglecta*) Richardson, 1844 is the dominant inshore demersal fish of the South Shetland Islands area and has a high degree of site fidelity (Barrera-Oro & Casaux 1996). It has been named a target species for the CS-EASIZ program. We have used time series information based on trammel net catches of this species at different sites in Potter Cove, King George Island, to analyse the effects of an intensive sampling programme on the size and age structure of the population.

Material and methods

Four hundred and ninety-three *N. coriiceps* specimens were caught from 19 December 1994–1 February 1995 using trammel nets set at Potter Cove (62°14'S, 58°40'W), King George Island, South Shetland Islands. The fish were measured for total length (TL) to the nearest 0.1 cm and a proportion of them (75%) were sexed. The nets were fixed to rocks in three specific zones of the cove. At site 1, mark-recapture, activity and monitoring studies of this species have also been carried out intensively since December 1992 (Barrera-Oro & Casaux 1996, Iken *et al*. 1997). Fish samples were also regularly taken generally at greater depths in a radius area of about 100 m including this site

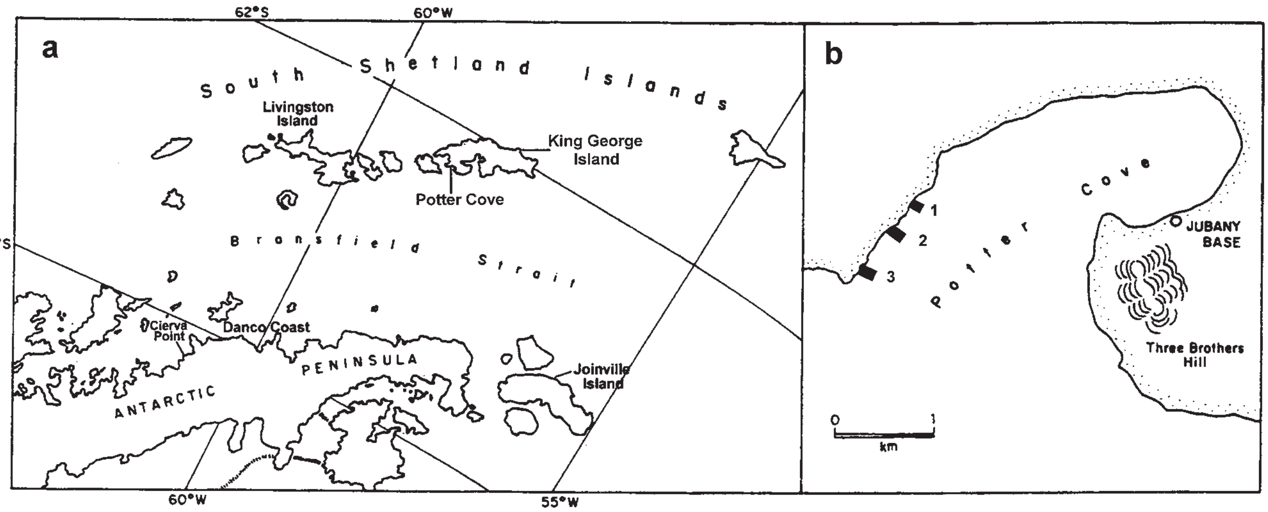

Fig. 1. a. The location of Potter Cove at the South Shetland Islands, and **b.** the sampling sites (squares) in the cove.

since 1983 (Barrera-Oro & Casaux 1998). Site 2 and site 3 were two previously unsampled areas, which are respectively 200 and 700 m from site 1 (Fig. 1). The sampling depths (5–10 m) and net measurements (length 17 m, height 1.5 m, inner mesh 2.5 cm, outer mesh 12 cm) were identical at the three sites. Duration of net sets varied from 6 to 96 hours, depending on sampling design and weather conditions. In this study, other fish species (*Notothenia rossii* and *Trematomus newnesi*) were scarcely represented in catches and therefore not considered. The seabed is uniform over the whole sampling area. The area belongs to the "mouth" of the cove and is characterized by a rocky bottom covered with red and brown macroalgae (Casaux *et al.* 1990).

In site 1, the total lengths of the fish caught in this study were compared with those obtained in the previous summer seasons (December–February) of 1992/93 and 1993/94. Likewise, the sizes of all these fish were compared with those from site 2 and site 3 using a nested ANOVA design with hauls nested within years and sites and contrasting the means of groups applying the Tukey-Kramer procedure. Values are expressed as means and their standard deviations were obtained from the ANOVA.

Table I. Detail of sampling stations for *Notothenia coriiceps*.

Summer season and site	Number of stations	Total number of fish	Number of fish per net	Length in cm range	Length in cm mean
1992/93 (site 1)	6	97	16.1	19.1–39.8	31.7
1993/94 (site 1)	19	306	16.1	17.1–44.2	30.2
1994/95 (site 1)	21	299	14.2	16.8–43.7	28.8
1994/95 (site 2)	9	129	14.3	17.7–58.0	32.4
1994/95 (site 3)	6	65	10.9	22.0–47.3	31.8

Table II. Differences among the mean total lengths (in cm ± SD) of *Notothenia coriiceps* caught in the 1992/93, 1993/94 and 1994/95 summer seasons in site 1.

Summer season	1992/93	1993/94	1994/95
1992/93	mean = 31.7 ± 4.8	–	–
1993/94	ns	mean = 30.2 ± 7.2	–
1994/95	$P < 0.001$	$P < 0.05$	mean = 28.8± 6.5

Results

Notothenia coriiceps was the dominant species in the samples, comprizing 95.1% of the fish captured. The other two fish species caught, *N. rossii* and *T. newnesi*, were scarcely represented (4.7% and 0.2% respectively). The catch data obtained at site 1 show that the number of *N. coriiceps* specimens caught per net was

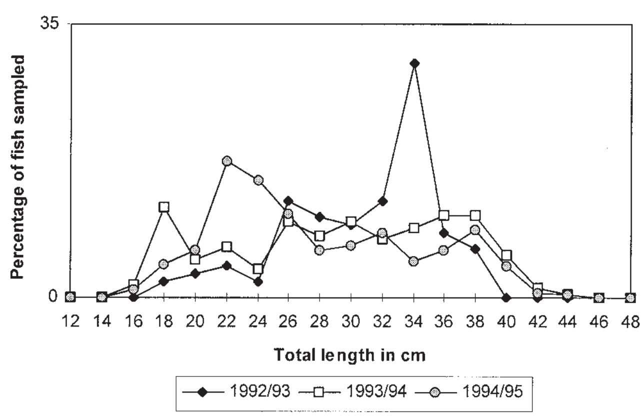

Fig. 2. Length frequency distribution of *Notothenia coriiceps* caught in the 1992/93, 1993/94 and 1994/95 summer seasons in site 1.

Table III. Differences among the total lengths (in cm ± SD) of *Notothenia coriiceps* caught in the 1994/95 summer season in the three sampling sites.

	Site 1	Site 2	Site 3
Site 1	mean = 28.8 ± 6.5	–	–
Site 2	$P < 0.01$	mean = 32.4 ± 6.3	–
Site 3	$P < 0.01$	ns	mean = 31.8± 6.0

similar in the summers of 1992/93 and 1993/94 and slightly decreased in the summer of 1994/95 (Table I).

The ratio between males and females in the overall sample resulted similar (1.06:1), as well as in different sites and years. Therefore sexes were combined.

At site 1, a diminution in length was observed in the specimens caught successively in the summer season since 1992/93 to 1994/95 (Table II, Fig. 2). The decline was of about 3 cm (nested ANOVA, F = 2.73, $P = 0.07$).

The size of the fish caught during summer 1994/95 at the three sampling sites differed significantly (nested ANOVA, F = 7.67, $P < 0.01$). The fish caught at site 1 were significantly smaller than those from site 2 (> 3.6 cm, $P < 0.01$) and 3 (> 3 cm, $P < 0.01$); whereas the difference in size between individuals from these last two sites (0.6 cm) was not significant (Table III, Fig. 3).

Discussion

The trammel net is a passive sampling device. Catches depend solely on fish activity. However, in the Antarctic, the use of this gear to analyse trends of a fish population by means of CPUE (catch per unit effort) is made very difficult by variable weather conditions, causing problems in keeping the unit of effort constant throughout the study. Likewise, the number of fish caught per net does not increase as a simple function with the length of setting. The catch rate depends on many other uncontrolled factors that may influence fish activity, such as water movements and water transparency (due to wind, tide, local water circulation), day light cycle (and so, period of the season) and prey availability. Therefore, we have used the mean size parameter instead of an abundance index.

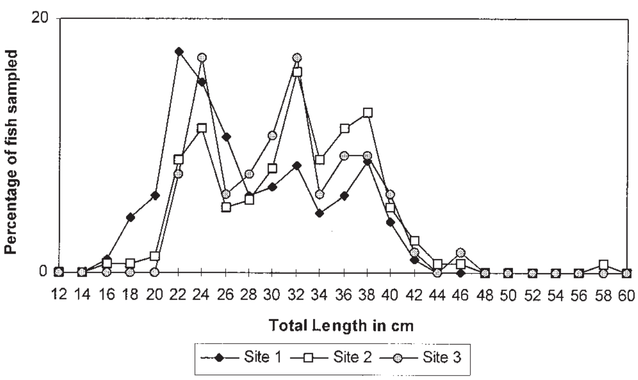

Fig. 3. Length frequency distribution of *Notothenia coriiceps* caught in the summer season of 1994/95 in sites 1, 2 and 3.

Table IV. Statistical significance of the comparison between total lengths of *Notothenia coriiceps* caught in the summer of 1994/95 in the three sampling sites and those caught in the 1992/93 and 1993/94 summer seasons in site 1.

	Site 1	
1994/95	1992/93	1993/94
Site 1	$P < 0.01$	$P < 0.05$
Site 2	ns	$P < 0.01$
Site 3	ns	ns

The main species of the inshore sampling programme conducted at Potter Cove from December 1992 to February 1995 was the dominant species in the area *N. coriiceps.* In addition to monitoring, our studies were focused on activity and mark-recapture experiments: 702 individuals of *N. coriiceps* were caught in summer 1992–95 in a specific zone of the Cove at site 1 by means of trammel nets (Table I). At this site, the number of fish per net obtained in summer of 1994/95 slightly decreased. This could be an artefact since we worked with different sampling intervals for the different kinds of studies: activity studies were done every six hours whereas for mark-recapture and monitoring studies the net remained in place for periods longer than 16 hours resulting in different catch effort rates.

At site 1, a decline in mean length of the fish was observed from summer of 1992/93 to that of 1994/95 (Table II, Fig. 2). This phenomenon could be related to:

1) a variation of the population due to a natural effect, such as a strong recruitment,
2) artificial effects attributed to human actions, such as a random error or an intensive sampling effort.

The additional sampling carried out at two near (200 and 700 m) but previously unsampled sites helped to clarify this question. The fish from sites 2 and 3 were significantly larger than those from site 1, all of them caught in the summer of 1994/95. Moreover, the fish from the new sites were also markedly larger than those sampled at site 1 in the summer of 1993/94, but were similar in size to those fish sampled during the summer of 1992/93, when the intensive sampling programme started at site 1 (Table IV). It is important to recall that sampling conditions such as depth, net parameters and bottom type were the same at all three sites, hence differences in the results due to random errors in the sampling design is unlikely.

It is evident that while the size range at site 1 does not change between years, the size range of specimens at site 3 was 3 cm larger at the minimum size and 7 cm larger at the maximum size (Table I). The regular sampling of fish since 1983, generally at greater depths in a larger area which includes site 1, may have some influence on the results. Differences attributed to sexual dimorphism in the size of *N. coriiceps* is unlikely, because the male-female ratio in this work was similar in all three years, as well as in previous studies carried out in similar seasons at Potter Cove (Barrera-Oro & Casaux 1990, Casaux *et al*. 1990).

The length frequency distribution of *N. coriiceps* in 1994/95 shows that the structure of the population in sites 2 and 3 was similar, whereas in site 1 there were higher numbers of smaller fish (from 22 cm downwards) and lower numbers of larger fish (from 32 cm upwards) (Fig. 3). It is important to recall that the three sampling sites are located in the same cove with only short distances between them (< 700 m, Fig. 1), therefore the effect of an hypothetical strong recruitment (as it could be presumed in site 1) should have been uniform in the whole sampling area. According to the total length range (except the upper limit of one individual of 58 cm in total length), fish of about 3–12 years of age were represented in the whole sample (Casaux *et al.* 1990). The peaks in Fig. 3 may represent the existence of strong age classes passing through the system, although these may be not consecutive; from age determination data in the studied area it is likely that several age classes are masked in the length distribution (Linkowski & Zukowski 1980, Barrera-Oro & Casaux 1996).

It is suggested that the decline in mean length of the fish sampled at site 1 is due to intensive sampling effort carried out over this study at that specific zone in Potter Cove.

This study provides additional evidence of the strong site fidelity of *N. coriiceps,* which was recently also demonstrated in a mark-recapture experiment carried out in Potter Cove. Several individuals of *N. coriiceps* were recovered at exactly the same place (site 1) 1–3 years after liberation (Barrera-Oro & Casaux 1996, and personal unpublished observations). Information on the site fidelity of *N. coriiceps* in other areas was previously given by Burchett (1983) at South Georgia and by Everson (1970) and recently North (1996) at Signy Island, South Orkney Islands. The last study provided direct evidence from a video camera positioned in the wild.

Present results indicate that the development of long-term programmes monitoring non-migratory inshore demersal fish species need to be planned carefully. The division of the sampling effort in homogeneous but different zones and the release of fish after monitoring procedures could help to avoid local variations of the size structure/abundance of the population caused by intensive sampling in specific sites.

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