

Northwest Atlantic



Fisheries Organization

Serial No. N2735

NAFO SCR Doc. 96/59

SCIENTIFIC COUNCIL MEETING - JUNE 1996

Observations on Cod in the Inshore Environment of Eastern Newfoundland

by

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Abstract

Recent reports of large aggregations of cod in deep fjord-like inlets of eastern Newfoundland, and frequent observations of cod in unusually shallow water, contrast with very low catches during autumn research bottom-trawl surveys in offshore waters. To help resolve uncertainty regarding the stock affinities of the cod found in inshore waters in 1995-1996, information regarding distribution and spawning of cod around headland shelves, within major bays and within small fjord-like inlets prior to the 1990s is briefly reviewed. Cod are known to have been present in each of these environments during the winter, spawning cod have been reported in each environment during the spring, and a fishery occurred in Trinity Bay and Bonavista Bay, and possibly other bays, in the early spring before the arrival of cod from the offshore. Despite these observations, and evidence that some of the cod found in the small inlets in the early 1990s were genetically distinct from cod sampled offshore at the same time, there is as yet little evidence to support the hypothesis that each bay has one or more substocks which have historically contributed substantially to the fishery.

Introduction

Cod in Divisions 2J+3KL (the "northern cod") have historically migrated on a seasonal basis between an overwintering area near the shelf break and a summer-autumn feeding area in shallow water along the coast of southern Labrador and eastern Newfoundland (Templeman 1966; Akenhead et al. 1982). However, not all cod move offshore in the winter. Some remain near the coastal shelves in deep water below the Cold Intermediate Layer (CIL) of the Labrador Current, and some remain within the bays of eastern Newfoundland, often in narrow fjord-like environments. In recent years the quantity of cod caught during autumn research bottom-trawl surveys in offshore waters has been very low (Shelton et al. MS 1996), but there are numerous reports of cod in shallow coastal waters (Davis MS 1996; Neis MS 1996), and dense aggregations have been found and studied in deep inlets in the inner reaches of Trinity Bay (Bratley MS 1996; Rose MS 1996). There is much speculation and uncertainty regarding the stock affinities of the cod which are now found in inshore waters. The purpose of this paper is to provide a brief overview of the distribution of cod in inshore waters prior to the 1990s, in hope that this might help the interpretation of the patterns seen in the most recent year or two.

Cod in deep waters off headlands

The presence of cod in deep water off the coastal shelves of eastern Newfoundland has been recognized since exploratory longlining in the early 1950s (Templeman and Fleming 1956, 1963). Not all the cod in these areas, just below the depth at which the CIL impinges on the bottom, arrive from near the shelf break following spawning. In the 1980s the fishery in the deep water started each spring very soon after the disappearance of the ice, and often long before the sudden increase in landings toward the middle or end of June in adjacent shallow waters (unpubl. data). Good catches of cod were secured just below the CIL during experimental bottom-trawling off Cape Bonavista in early February, 1980, and early April, 1981 (unpubl. data). Two bottom-trawl sets at the mouth of Trinity Bay in March 1967 in 228 and 278 m yielded good catches of cod which had been feeding intensively on capelin (Lilly 1982). Thus, some cod are in this deep-water coastal environment months before the migration of cod from the offshore (Taggart MS 1996). Templeman (1962) presented several arguments in support of his hypothesis that each of the coastal shelves, such as the Bonavista Shelf, the Fogo Shelf and the St. Anthony Shelf, might support a local stock of cod.

As reported by Hutchings et al. (1993), there is evidence of spawning in the deep water off Cape Bonavista. Cod caught in the commercial gillnet fishery northeast of the Cape in 275-350 m were sampled weekly in 1983 and 1984. There were 20 collections in 1983 and 18 in 1984, with the number of fish in each collection varying from 13 to 86 (median = 25). Data collected included fish length, sex and gonad weight. In the absence of observations on state of maturity, I have employed a gonad-somatic index, calculated as $(\text{gonad weight}/\text{length}^3) \times 10^4$, where gonad weight is in g and length is fork length (cm). Only cod at least 60 cm in length are included. There were many cod with relatively large gonads when the first samples were collected each year (May 11 in 1983 and May 30 in 1984) (Fig. 1). The proportion of cod with elevated indices, and the maximum values of the indices, declined to a minimum by the middle or end of July. Notable outliers occurred on July 21, 1983 and August 7, 1984. The decline in gonad indices provides only circumstantial evidence that cod spawn in deep water off the Bonavista Shelf. The cod with low gonad indices could have spawned elsewhere before migrating into the area, and cod with large gonads may have moved elsewhere to spawn if they had survived.

Cod in eastern bays

Speculation regarding the existence of local stocks of cod in the bays of eastern Newfoundland dates back at least to the early 1890s (Nielsen 1895; Thompson 1943). However, the existence and size of any "bay" stocks has not until recently been an important concern for management. For example, when Lear (MS 1986) reviewed evidence for structure within the 2J+3KL cod stock complex, he described Templeman's (1962) postulate regarding the existence of local stocks associated with the coastal shelves, but did not mention "bay" stocks. One assumes that it was generally accepted that if inshore components did exist, then they would be small relative to those components which spent at least some of the year offshore.

There is no doubt, however, that cod do spawn in the bays. Cod from the inner reaches of Trinity Bay supported a cod hatchery at Dildo in the early and mid-1890s (eg. Nielsen 1895), and there have been additional observations regarding the presence of cod in spawning condition in the eastern bays (eg. Thompson 1943). The spawning time of these cod was not carefully studied, but Nielsen (1895, and other annual reports) was able to collect his first ova in late May or early June. He stated (quoted by Graham 1922) "that only during May and June can spawning cod be obtained except in a few rare cases, in Placentia, Trinity or Conception Bays". The rare cases included instances of cod in spawning condition in August and September.

Additional evidence of the presence of spawning cod within eastern bays may be found in unpublished trip reports (Marinus 67-1, 68-1, 68-2) which describe the maturity of cod caught during experimental gillnetting in the deep water of Trinity and Bonavista bays. These data have been summarized by Hutchings et al. (1993). Cod were caught with 6- and 7-inch mesh monofilament gillnets off Tickle Harbour Point and the Horse Chops in Trinity Bay and near Little Denier and Cabot Island in Bonavista Bay (Fig. 2) in April-June of 1967 and 1968 (Fleming MS 1967, MS 1968). All gillnet sets were made in deep water with the nets usually running from cold water into the underlying warmer water. In 1967 "many of the cod were in spawning condition or close to it" (Fleming 1967), and in 1968 "the cod were in maturity stages indicating spawning was soon to occur" (Fleming 1968). Fleming (1968) thought that the gillnet experiments were sampling "a segment of the stock which ... consists of large old cod which have escaped other gears, and which spawn in the coastal areas and bays in contrast to the younger fish being caught by traps and handlines which spawn before arriving in the coastal areas in the spring."

Cod in fjord-like environments

Cod have for many years been caught through holes cut in the ice in sheltered inlets of the major eastern bays. The only such areas which have been studied scientifically are the three fjord-like arms near Random Island on the western side of Trinity Bay. The Department of Fisheries and Oceans, Govt. of Canada, has conducted tagging and other experiments in these arms, and the Fisheries Oceanography Group at Memorial University, St. John's, Newfoundland, has conducted numerous studies on a year-round basis since 1990. Cod were found to remain in the arms throughout the winter, and evidently spent much of the time in cold (<0°C) water (Wroblewski et al. 1994). Some of these fish appear genetically dissimilar from those fish overwintering offshore (Ruzzante et al. 1996). These studies did not prepare investigators for the dense aggregations found in Smith Sound in the springs of 1995 and 1996, and the large quantities of cod in Northwest Arm and Southwest Arm in spring 1996 (Bratley MS 1996; Rose MS 1986).

Cod in the shallow-water fishery

Cod in shallow water along the coast of southern Labrador and eastern Newfoundland supported a fishery with hook and line for centuries. Since the late 19th century this fishery has been strongly augmented by the use of the cod trap, and since the 1960s by the use of synthetic gillnets. The best fishing areas have tended to be along exposed coasts, such as the Avalon Peninsula and the Great

Northern Peninsula, and near the headlands of the great bays along the east and northeast coasts. These areas have in common a closeness to the schools of cod migrating toward the coast from their offshore overwintering areas. If all cod caught in the inshore shallow-water fishery arrived from the offshore, then the earliest landings would be expected at the headlands. However, substantial landings occur in the inner parts of Bonavista and Trinity Bays several weeks prior to the big increase in landings at the tips of the headlands. To examine the timing of these landings on a broad spatial scale, I plotted daily landings from cod traps in Statistical Sections in the inner and outer parts of each of these two bays in 1983 and 1984 (Fig. 3,4). Section 11, in the inner part of Bonavista Bay, had two periods of high landings; one in May and the other in late June and early July. Section 13, in the outer part of Bonavista Bay, had only small landings in May but a large peak in June-July. Most of the early landings in Section 13 probably came from a few communities toward the inner part of the bay. Section 17, in the inner part of Trinity Bay, had substantial landings weeks before the dramatic increase in Section 19 in the outer part of Trinity Bay. The contrast between early landings at communities in the inner parts of the bays and a later start in the last third of June near the headlands is even more apparent if one focuses on individual communities, especially in Bonavista Bay in 1984 (Fig. 5).

The patterns described above appear to correspond to the descriptions of "herring fish" and "capelin fish" as reported by fishers (Neis et al. MS 1996). Additional research is required to determine if the early landings (prior to about mid-June) in the inner parts of Bonavista Bay and Trinity Bay were supported by cod which remained within the bays throughout the winter and the later landings were supported by cod which migrated into the coastal areas from farther offshore. There is a possibility that some cod which were offshore in the winter moved into the bays through the deep water before striking into the shallow water. One way of testing this possibility is to determine if any fish taken in the early fishery were tagged offshore earlier in the same year.

It is tempting to speculate that cod taken in the early landings belong to "bay stocks". It would be of interest to determine if cod taken in the early landings differed from cod taken from later landings with respect to length-at-age, relative year-class strength, otolith structure, and other biological characteristics. Unfortunately, it may be difficult to use data collected prior to the 1990s. Most routine sampling of inshore catch was conducted on the outer shores and headlands after mid-June. The early catch in the inner parts of the bays may have been rarely sampled.

Fish in spawning condition may be found both at headlands and within the bays, but the presence of spawning fish inshore is merely consistent with the hypothesis that bay stocks exist; it does not prove that they do. As noted above, some of the cod taken from fjord-like inlets in Trinity Bay do appear genetically distinct from cod sampled offshore, but the evidence in favour of coastal or bay stocks is not yet as strong as it is for cod along the coast of Norway (eg. Løken, et al. 1994, and references therein).

Inshore cod in 1995-1996

There are at least two surprising and poorly understood aspects of the occurrence of cod in the inshore waters of eastern Newfoundland in 1995-1996, a time when very few cod have been found during research bottom-trawl surveys offshore. The first is the finding of large aggregations of cod in the deep arms, most notably Smith Sound, on the western side of Trinity Bay. There is much evidence that cod have always overwintered in this area, but the present winter/spring aggregations appear to be much larger than observed in the past. There are several possible origins for these fish. First, the cod could belong to an inshore population that has been faring well since the moratorium on fishing was introduced in 1992. Second, there could always have been a tendency for some part of the stock, not genetically distinct from the migrating component, to remain inshore in the winter. The fish predisposed to remain inshore may be faring better than those which tend to move offshore in the winter. A third possibility, often voiced by G. Rose (Memorial University of Newfoundland, St. John's, Newfoundland, pers. comm.) and formally proposed by Taggart (MS 1996), is that there may have been a major change in migration patterns, so that cod which would normally move offshore in the autumn, possibly to the North Cape area, have stayed inshore. Rose has suggested that this may be related to the absence of older cod to lead migrations. Taggart (MS 1996) has proposed that genetic studies may help clarify the issue.

A second surprising aspect of the cod currently in coastal waters is the large number of reports of cod being seen near the surface (Neis et al. MS 1996; numerous personal communications to scientists; communications in public media, such as Evening Telegram, St. John's, Newfoundland, 25 May 1996, p.4) and cod being caught in shallow-water gear, including gillnets set for herring and black-back flounder. These observations give the impression that cod are in great abundance, at least in some areas, and contrast strikingly with the poor catches in offshore research surveys. An explanation for the quantity of cod in very shallow water is not immediately apparent. Perhaps there has always been a tendency for some cod to forage in very shallow water, but in the recent past most such cod would be caught. In the absence of a fishery, these cod accumulate and are often observed. A second explanation for the increase in sightings and shallow-water bycatch is that, as noted above, there are indeed more cod inshore, especially in the period from autumn through to the spring.

Resolving these questions regarding the abundance of cod inshore is critical to an understanding of the recent dynamics of the stock.

Acknowledgements

I thank Dr. J. R. Botta for providing the data from cod caught in the gillnet fishery off Cape Bonavista in 1983-1984.

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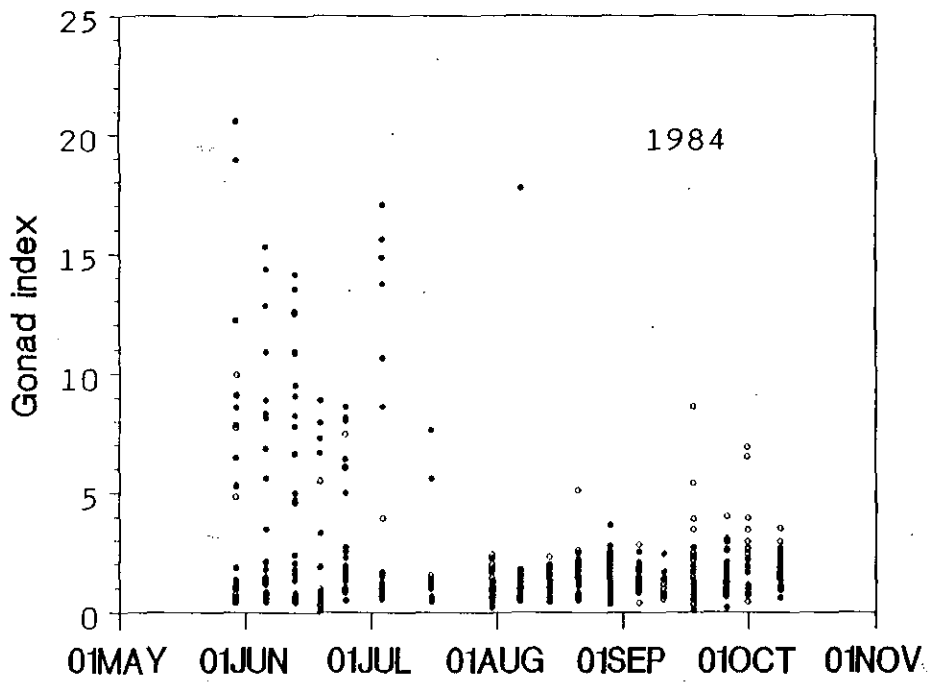
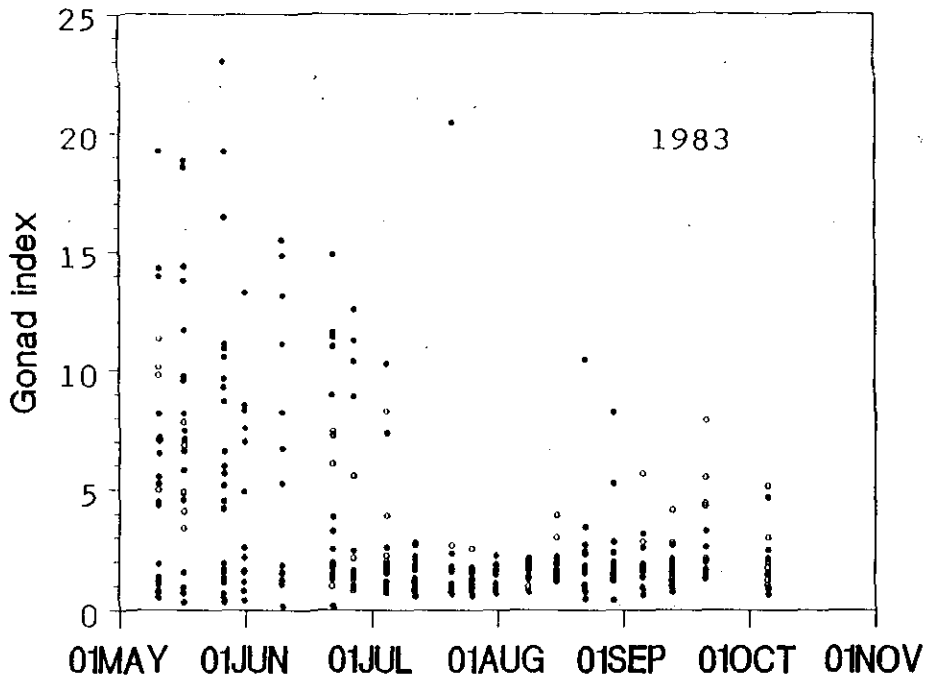


Fig. 1. Gonad indices of cod sampled from the deepwater gillnet fishery northeast of Cape Bonavista in 1983 and 1984.

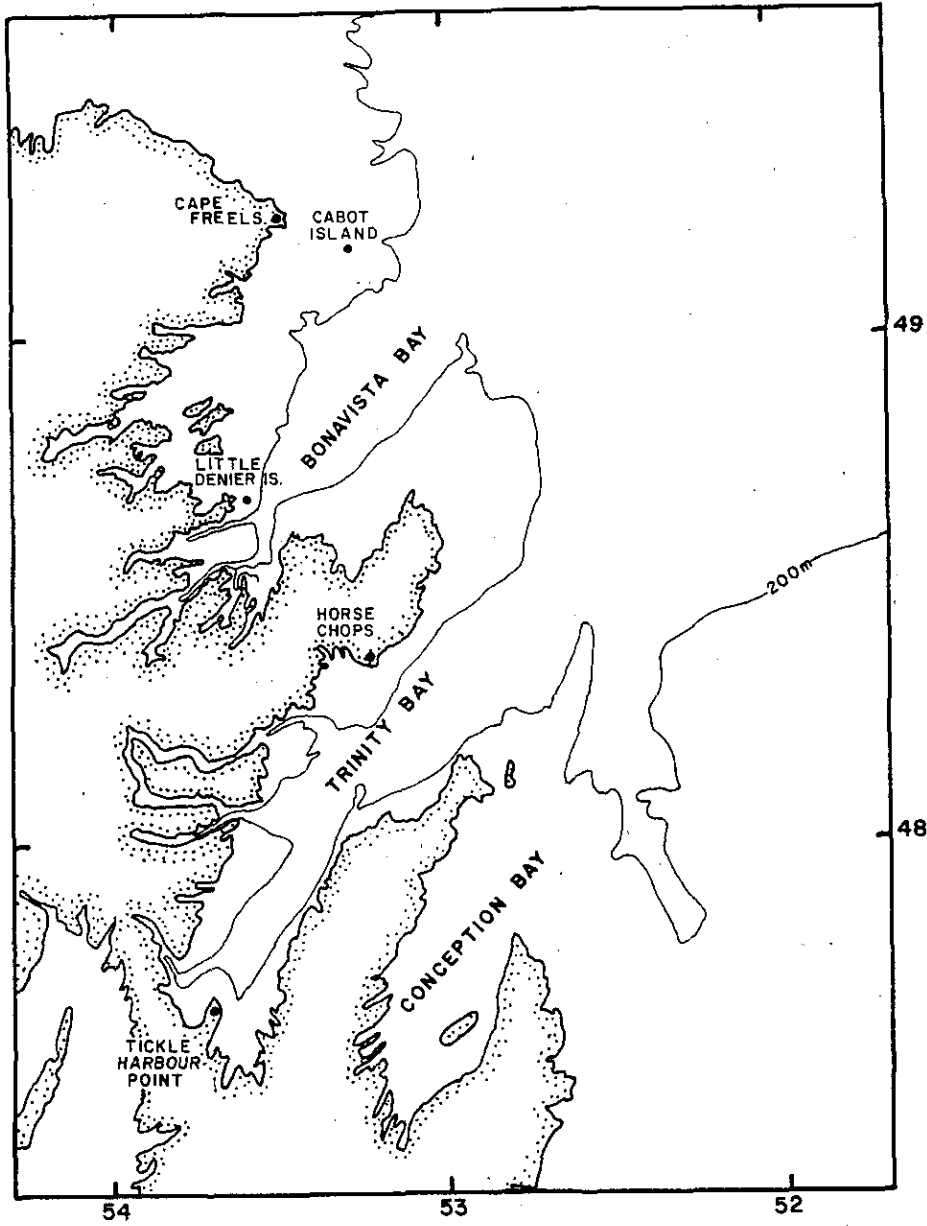


Fig. 2. Sampling locations during experimental gillnetting in Trinity and Bonavista Bays during the springs of 1967 and 1968.

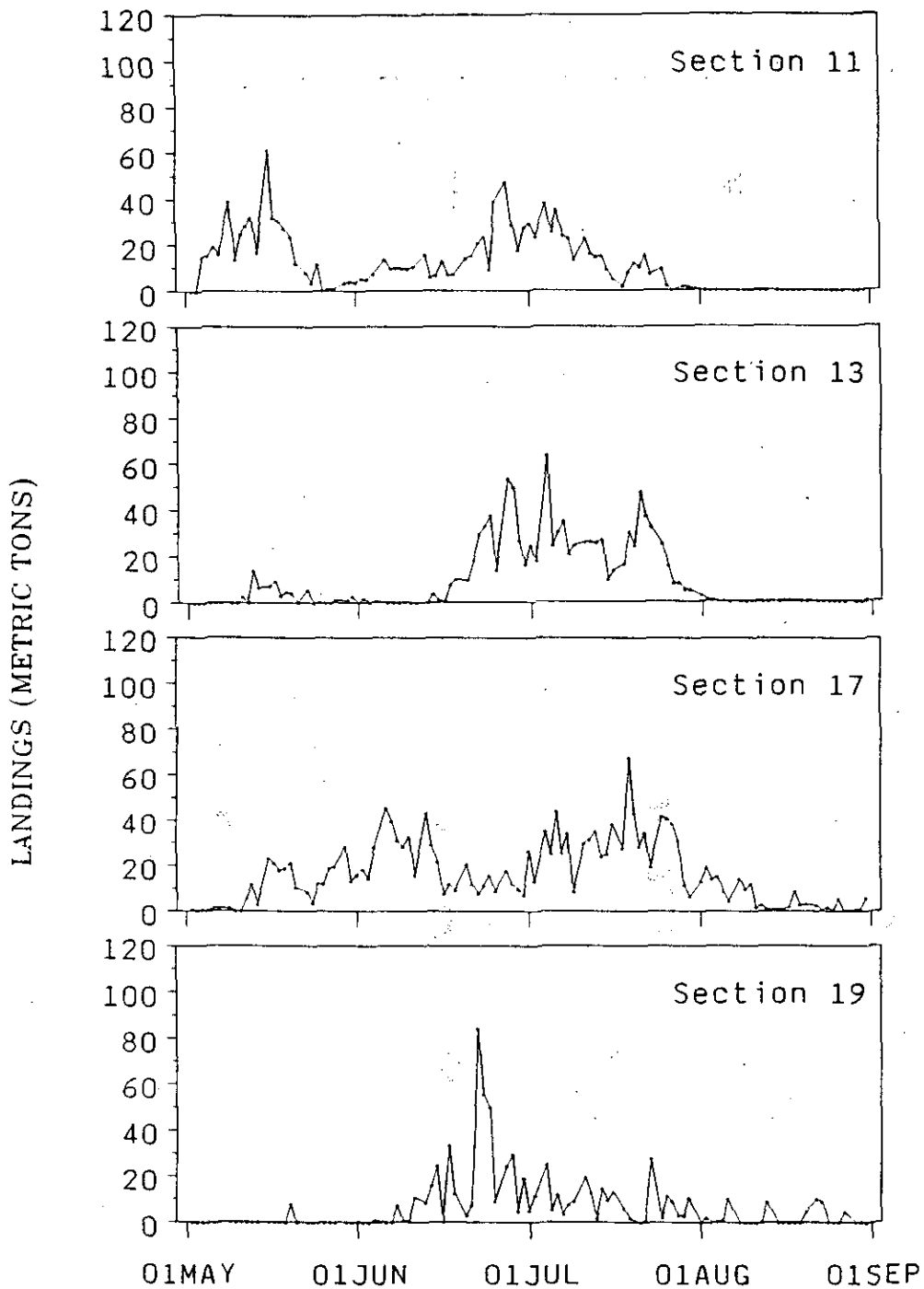


Fig. 3. Daily landings from cod traps in 4 Sections along the east coast of Newfoundland in 1983. Section 11 is in inner Bonavista Bay; 13 is in outer Bonavista Bay; 17 is in inner Trinity Bay; and 19 is in outer Trinity Bay. Sundays are not plotted.

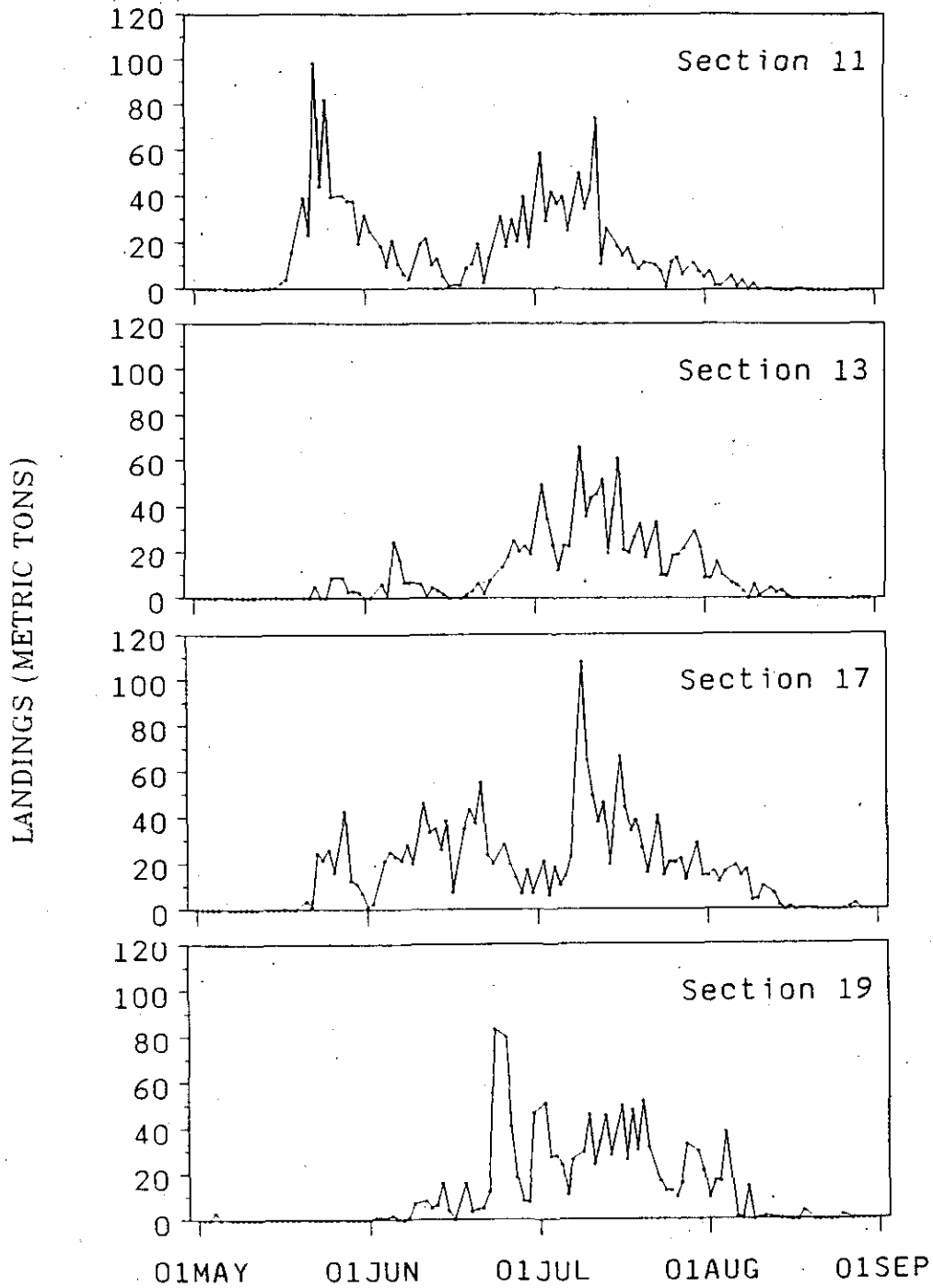


Fig. 4. Daily landings from cod traps in 4 Sections along the east coast of Newfoundland in 1984. Section 11 is in inner Bonavista Bay; 13 is in outer Bonavista Bay; 17 is in inner Trinity Bay; and 19 is in outer Trinity Bay. Sundays are not plotted.

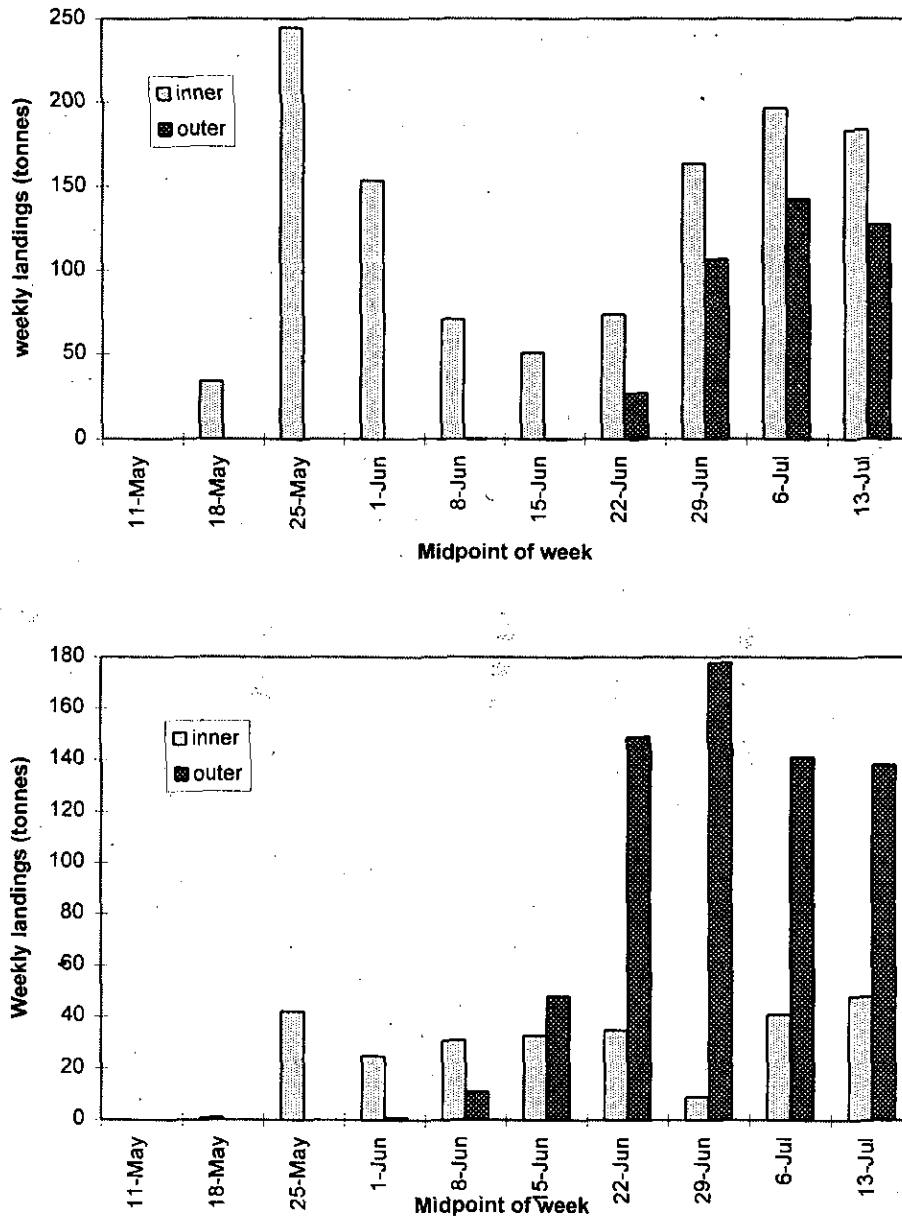


Fig. 5. Weekly landings for communities in the inner and outer areas of Bonavista Bay (upper) and Trinity Bay (lower) early in the 1984 season. In Bonavista Bay, the inner communities are St. Brendans and Salvage, and the outer community is Bonavista. In Trinity Bay, the inner communities are Chance Cove and Bellevue and the outer communities are Old Perican and Grates Cove.