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Stock enhancement of the Japanese scallop *Patinopecten yessoensis* in Hokkaido

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Abstract

Prior to the early 1940s, harvests of scallops from Japan fluctuated from ~10 to 80,000 tonnes per anum. However, the fishery collapsed in 1945 and production remained at chronically low levels (<100 tonnes p.a.) in key areas. A breakthrough in methods for catching juvenile scallops (spat) for grow-out in hanging culture paved the way for the restoration and eventual stock enhancement of the major scallop fisheries in Hokkaido Prefecture. Following this breakthrough, scallop fisheries were managed using a system based mainly on: (1) mass-release of cultured juveniles, (2) removal of predators, and (3) rotational fishing, i.e., partitioning fishing grounds into four areas, releasing 1-year-old juveniles into one area each year, then harvesting them 3 years later. This management system was pioneered largely by the fisheries cooperative at Sarufutsu, Hokkaido, and catches there improved from <100 tonnes to consistent harvests of 40,000 tonnes p.a. Similar management systems have been adopted by neighboring fisheries cooperatives, resulting in current total harvests of scallops from stock enhancement in Hokkaido of ~300,000 tonnes p.a. The success of scallop stock enhancement in Hokkaido is attributed to: a good supply of larvae, development of simple and effective methods for catching and rearing spat, ideal habitat for growth of scallops, removal of predators, and devolution of management to fisheries cooperatives. The management system developed in Hokkaido should be transferable to other locations where there is a good natural supply of spat, low levels of predation, currents that retain larvae, and incentives for fishermen to invest in the capture, rearing and release of spat and the implementation of rotational fishing.

Keywords: Scallops; Cultured juveniles; Removal of predators; Rotational fishing; Fisheries management; Fisheries cooperatives

1. Introduction

The coastline of the Sea of Okhotsk, Hokkaido, is ideal habitat for the scallop *Patinopecten yessoensis*, and has supported important fisheries for this species since the early 1900s. Maximum annual production was 80,000 tonnes in 1934 (Nishihama, 1994), although catch records dating back to 1920 show that there were 6–13-year cycles of good and poor harvests up to 1945. Over-fishing did occur prior to 1945, although the resource normally recovered due to recruitment of a strong year class. However, rampant harvesting in the postwar decade (1945–1955) reduced annual production to ~6000 tonnes, where it remained for the next 25 years. Efforts to restrict harvest areas and seasons, prohibit certain types of gear, and introduce size limits during this period did not succeed in restoring the fishery (Fig. 1).

The desperate condition of the scallop stocks was reversed by development of new methods for collecting, growing and releasing juveniles (spat). The breakthrough came from a simple modification to the traditional method for catching spat for grow-out in hanging culture (Ventilla, 1982). Previously, spat for hanging culture were collected by placing bunches of cedar leaves in the water. However, rates of collection were low because the spat cut their byssus and fell to the seabed at a size of 10–15 mm shell height (SH). The important innovation, developed by Yusaku Kudo, a fisherman from Mutsu Bay, Aomori Prefecture, in 1964 involved enclosing spat collectors with an 'onion' (mesh) bag. The mesh was large enough to allow swimming scallop larvae to pass through and settle on the collector inside, but small enough to retain them when they severed the bysuss.

Use of onion bag collectors increased the catch of spat enormously and created the opportunity for much greater production through hanging culture, and eventually through stock enhancement. However, an intermediate culture stage

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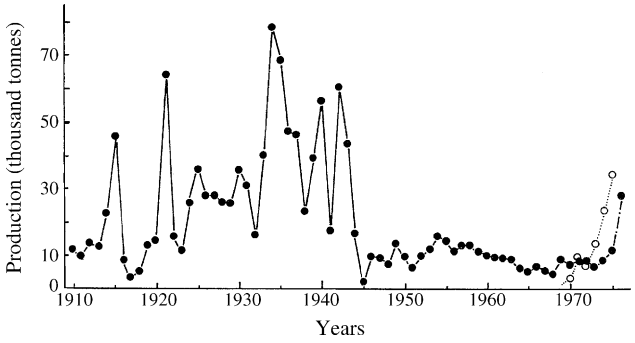

Fig. 1. Production of the scallop, *Pactinopecten yessoensis*, in Hokkaido before 1975 (after Nishihama, 1994). (●) and (◯) show production based on harvests of wild scallops and hanging culture, respectively.

was also needed—the retained spat had to be reared before they were large enough for hanging culture, or able to be released to the seabed with acceptable levels of survival (Ventilla, 1982).

Following the development of this technology, it became possible to culture scallop *en masse* in Mutsu Bay, Funka Bay, Sarufutsu and the Saroma Lake area (Fig. 2) using inexpensive and plentiful juveniles. The increases in production of scallops in hanging culture were astounding. In 1975, ~70,000 tonnes of scallops (worth ¥14.3 billion) were produced, of which 48% originated from Hokkaido. By 2002, production from hanging culture had expanded to 272,000 tonnes (worth ¥34.3 billion) (Fig. 3). The number of juveniles sold for culture and release rose from 600 million (worth ¥2.1 billion) in 1975 to 2.1 billion (worth ¥6.76 billion) in 2002. The shell height of juveniles sold also increased from 30–50 to 50–60 mm.

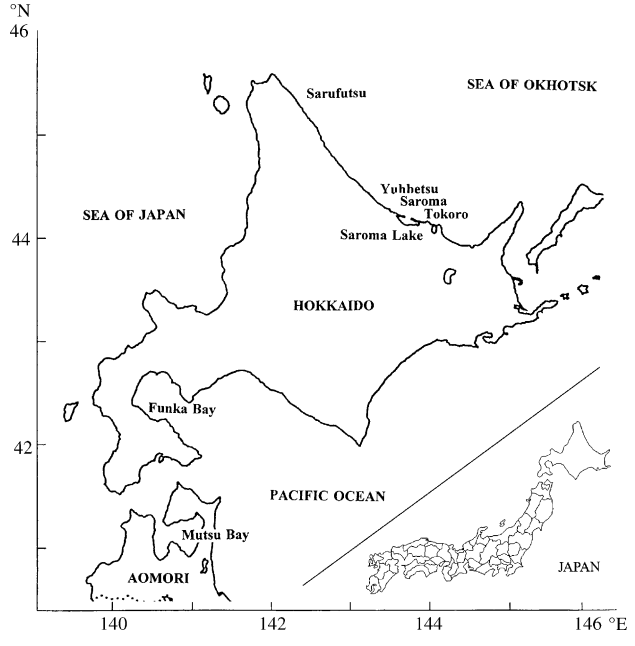

Fig. 2. The main locations in northern Japan for the production of scasllops: Mutsu Bay, Aomori Prefecture, Funka Bay, Sarufutsu Village, and Saroma Lake, along the coast of the Sea of Okhotsk coast, Hokkaido Prefecture.

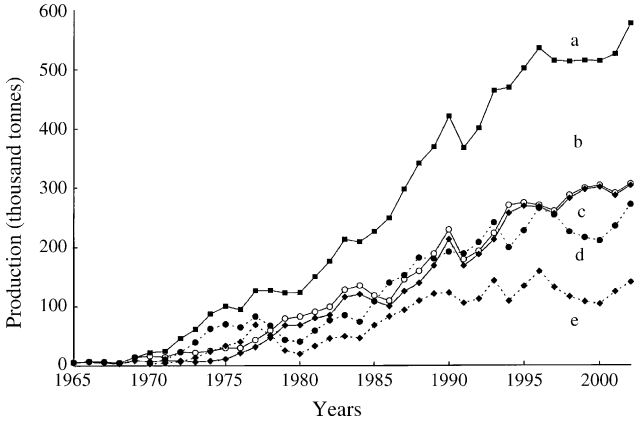

Fig. 3. Production of scallops in Japan as a whole, and in Hokkaido Prefecture, between 1965 and 2002. (a) Total production for Japan from combined harvests from hanging culture and management of the wild fishery by stock enhancement; (b) production from wild fishery managed by stock enhancement for all of Japan; (c) production from wild fishery managed by stock enhancement for Hokkaido Prefecture; (d) production from hanging culture for all of Japan; (e) production from hanging culture for Hokkaido Prefecture.

Here, I describe how the collection, rearing and release of scallop spat has been used in a stock enhancement management system to progressively increase production of the scallop fisheries in Sarufutsu and Saroma Lake to levels that far exceed historical maximum harvests.

2. Stock enhancement of the scallop fishery at Sarufutsu

Sarufutsu village is located on the northern coast of Hokkaido adjacent to the Sea of Okhotsk (Fig. 2). About 33 km of the coastline is under the control of the local fisheries cooperative. The 38,400 ha of productive scallop fishing grounds are at a depth of 20 m and extend up to 10 km offshore (Fig. 4). Prior to stock enhancement, production of scallops by the Sarufutsu cooperative peaked at 13,886 tonnes in 1942, but then gradually decreased to <100 tonnes p.a. Surveys in the early 1960s showed that the macrobenthic fauna on the fishing grounds consisted of 50% starfish, 35% non-edible sea urchins, and 10% scallops. Furthermore, >50% of the scallops were older adults; very few were juveniles (Tomita, 1979). Many of the fishermen could no longer make a living and left the village. To address this crisis, members of the cooperative agreed to a 10-year moratorium on fishing for scallops in 1964. However, the scallop resources did not recover.

At around that time, attempts were being made to restore scallop populations at Funka Bay by releasing cultured juveniles that had become available in great numbers at a low price. The fisheries cooperative at Funka Bay released three million juveniles in 1967, which resulted in a 10-fold increase in catch in 1970 (Nishihama, 1994). The Tokoro Fisheries