The Snail Resource of the Eastern Bering Sea and Its Fishery

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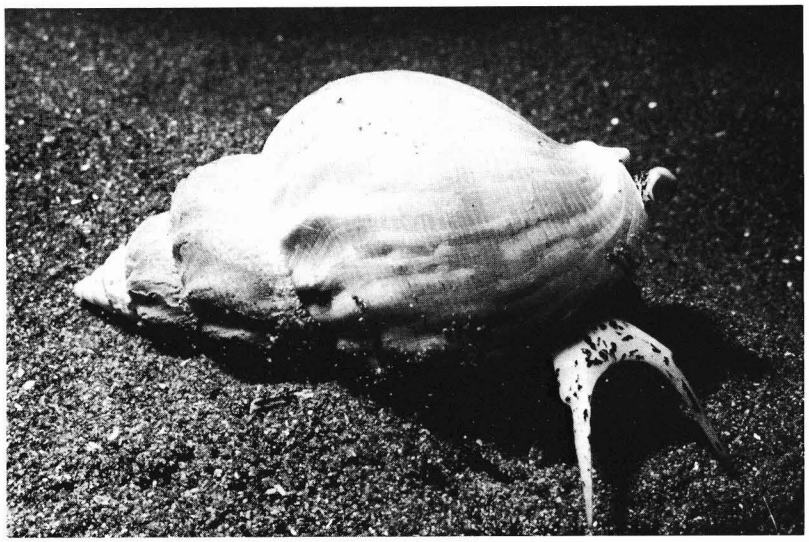

Buccinum sp., photographed in Alaska's Auke Bay by Lou Barr, then with the NMFS Auke Bay Fisheries Laboratory, Northwest and Alaska Fisheries Center, Auke Bay, AK 99821.

ABSTRACT–A trawl survey in the eastern Bering Sea outlined the distribution and relative abundance of several large snails of commercial importance. Snails made up 6.6 percent of the invertebrate biomass with members of the genus Neptunea *being most abundant. These snails lack a larval stage and are facultative predators and scavengers. Japan has harvested snails in the area since at least 1971. Reported catch rates in pots ranged from 0.9 to 4.0 kg/pot and total Japanese catch has varied from 404 to 3,574 t of edible meat per year. The United States has the vessel capacity to enter the fishery but probably will not do so until there is a large increase in the value of snail products.*

The Alaskan continental shelf is an area of vast fishery resources. Fish and crab resources are well known and have long been exploited by many fishing nations; potential resources, like eastern Bering Sea snails, are virtually unknown. Several species of large snails occur in relatively high abundance in Alaskan waters and offer considerable fisheries potential.

Japan has harvested snails in the eastern Bering Sea since the early 1970's and there is potential for the development of a U.S. domestic fishery as well. This report presents information about the Japanese fishery in the eastern Bering Sea, life history characteristics for the principal snail species, and discusses the potentiality for U.S. participation in the harvest of this unique shellfish resource.

The Snail Resource and Its Composition

During the summer and fall of 1975, the Northwest and Alaska Fisheries Center of the National Marine Fisheries Service (NMFS) conducted a comprehensive trawl survey over 566,000 km^2 (218,600 miles^2) of the eastern Bering Sea shelf and upper slope (Fig. 1). This survey was designed to identify principal demersal fish and shellfish communities of the eastern Bering Sea which could be affected by development of continental shelf energy sources. Data on fish and epibenthic invertebrates were gathered from several hundred locations with a modified 400-mesh eastern otter trawl. The resulting data offered significant insight into the population and biological characteristics of numerous species of snails.

Gastropods made up 1.7 percent of the total biomass and 6.6 percent of the invertebrate biomass in the survey area (Pereyra et al.[1]).

Distribution of snails throughout the area is patchy, with the areas of highest concentration also supporting a high biomass of fish and epibenthic invertebrates. Snail biomass in some areas exceeded 3,000 kg/km^2 (17,000 pounds/nmi^2); however, if the trawl is not effective at catching species of snails that sometimes burrow into the substrate, then the biomass may actually be much higher.

About 15 species of large (>5 cm) snails are common in the eastern Bering Sea (Table 1). Members of the genus *Neptunea* are by far the most abundant in terms of both numbers and biomass. The Pribilof neptune, *N. pribiloffensis*, (Fig. 2), is probably the most abundant *Neptunea; N. lyrata, N. ventricosa,* and *N. heros* (Fig. 2) are also very

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[1]Pereyra, W. T., J. E. Reeves, and R. G. Bakkala. 1976. Demersal fish and shellfish resources of the eastern Bering Sea in the baseline year 1975. Northwest and Alaska Fisheries Center, NMFS, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112. Processed rep., 619 p.

Table 1.—Scientific names of large snails taken in the eastern Bering Sea during the 1975 trawl survey of the NMFS Northwest and Alaska Fisheries Center.

Beringius beringii (Middendorf, 1849)
Buccinum angulossum Gray, 1839
B. plectrum Stimpson, 1865
B. polare Gray, 1839
B. scalariforme Möller, 1842
Clinopegma magna (Dall, 1875)
Fusitriton oregonensis (Redfield, 1848)
Neptunea heros (Gray, 1850)
N. lyrata (Gmelin, 1791)
N. pribiloffensis (Dall, 1919)
N. ventricosa (Gmelin, 1791)
Plicifusus kroeyeri Möller, 1842)
Pyrulofusus deformis (Reeve, 1847)
Volutopsius fragilis (Dall, 1891)
V. middendorffii (Dall, 1891)

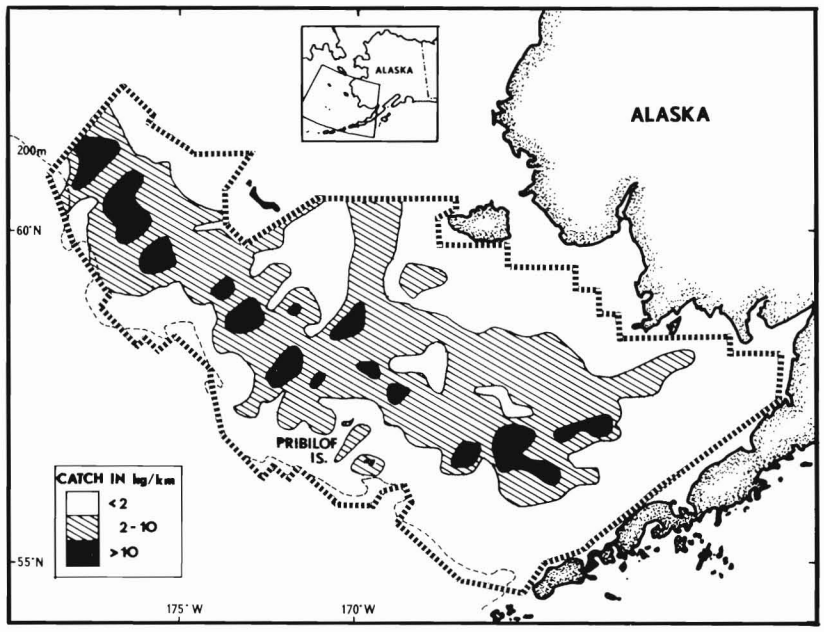

Figure 1.—Location of trawl survey area of the NMFS Northwest and Alaska Fisheries Center in 1975 (inside dashed line) and areas of high snail density (all species combined).

common. The mean shell lengths of *N. pribiloffensis, N. lyrata, N. ventricosa,* and *N. heros* were 100, 115, 102, and 121 mm, respectively (MacIntosh[2]).

The genus *Buccinum* is also well represented in the eastern Bering Sea. Six species of this genus were taken in the 1975 survey, of which four, *B. angulossum, B. plectrum, B. polare,* and *B. scalariforme*, were fairly abundant. Although quite numerous, these smaller snails (58-75 mm average shell length) contribute relatively little to total snail biomass in the eastern Bering Sea. *Buccinum angulossum* (Fig. 3) is representative of the size and general form of these snails.

Most species of eastern Bering Sea snails do not occur over the entire shelf but are retricted to specific depth and temperature regions. In general, those species that have continuous distributions into the Gulf of Alaska inhabit the warmer, deeper waters near the continental shelf edge, while those species having a more northerly distribution into Arctic waters inhabit the colder (at least seasonally), shallower, inshore waters. Basically, *N. pribiloffensis* and *N. lyrata* are temperate water snails and are characteristically found in deeper, warmer waters along the edge of the continental shelf. In contrast, *N. heros* and *N. ventricosa*, which range into the Arctic Ocean, inhabit shallower, seasonally cooler waters near the coast of western Alaska.

Numerous trawl surveys have been conducted in the Gulf of Alaska, but very little attention has been paid to the snail resources of the area. Although quantitative data are lacking, it is apparent that *N. pribiloffensis, N. lyrata,* and *Fusitriton oregonensis* make up the bulk of the snail biomass. *Fusitriton* reaches a length of 13 cm and ranges from the California coast to the Gulf of Alaska and the eastern Bering Sea. All three species occur at depths from at least 50 to 250 m with the latter also found inshore to the intertidal zone. Large catches of *N. pribiloffensis* and *N. lyrata* have been made by trawlers and pot fishermen of Ketchikan, Petersburg, Kodiak, and Cordova. Overall, species diversity appears to be less and distribution of snails appears to be more patchy in the Gulf of Alaska than in the eastern Bering Sea.

Life History

Most snails listed in Table 1 have similar life histories. The sexes are separate and fertilization is internal. Among the large *Neptunea*, sexual maturity occurs at a shell length of 90-110 mm (MacIntosh and Paul, 1977) which probably corresponds to an age of about 10 years. Definitive work on aging has not been completed.

A feature of the life histories of all but one[3] of the common large snails is the production of egg capsules from which crawling young are hatched. Thorson (1950) and Shuto (1974) have discussed this lack of a pelagic larval stage (termed lecithotrophic development) among some Prosobranch gastropods and the effect it has had on their evolution and distribution.

In the eastern Bering Sea, egg clusters are usually laid on the shells of large snails. Both living and dead shells are utilized as substrates, and there appears to be little correlation between the

[2]MacIntosh, R. A. 1976. A guide to the identification of some common eastern Bering Sea snails. Northwest and Alaska Fisheries Center, NMFS, 2725 Montlake Blvd. E., Seattle, WA 98112. Processed rep., 27 p.

[3]*Fusitriton oregonensis*, a member of the tropically oriented family *Cymatiidae*, apparently has pelagic larvae although no literature on the subject exists. Pers. commun. Alan J. Kohn, Univ. Washington, Seattle, WA 98195.

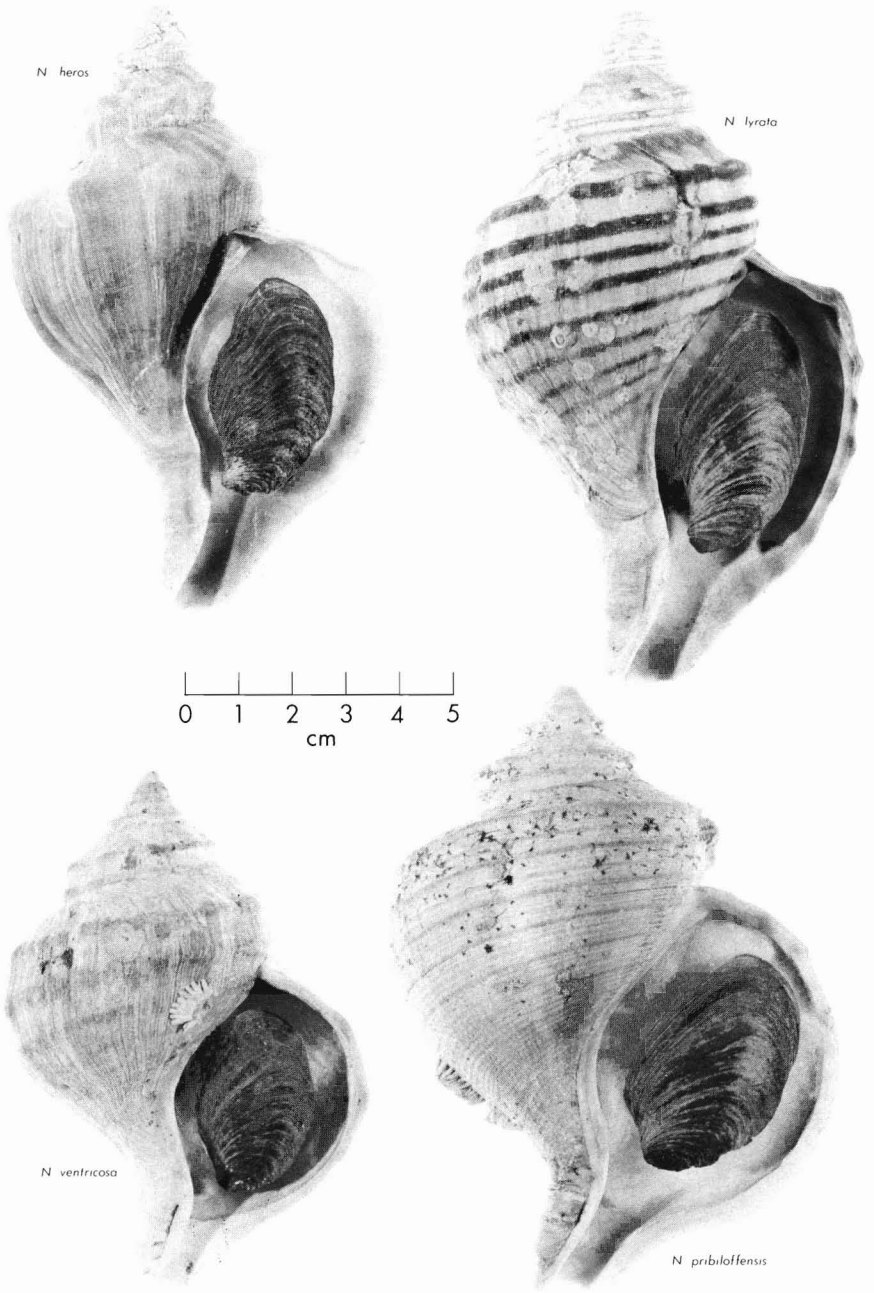

Figure 2.—The four large *Neptunea* from the eastern Bering Sea, clockwise from upper left, *N. heros, N. lyrata, N. pribiloffensis*, and *N. ventricosa*.

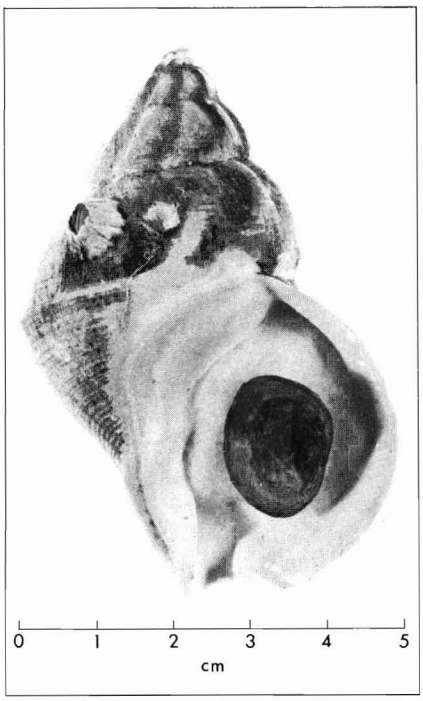

Figure 3.—*Buccinum angulossum*, one of four common *Buccinum* in the eastern Bering Sea.

species of snail depositing its eggs and the species the cases are deposited on. Egg clusters of the large eastern Bering Sea gastropods vary considerably in size, shape, color, and number of individual capsules contained. The capsules, clusters, and young of many species remain undescribed.

Very little is known about the feeding habits of Bering Sea snails. Laboratory studies (Avery[4]) have shown that *Fusitriton oregonesis, Neptunea lyrata*, and *Buccinum plectrum* respond to a variety of scents including those of freshly killed mussel, nereid worm, crab, mud shrimp, and fish. Eastern Bering Sea snails are probably facultative predators and scavengers.

Japanese Fishery

Japan has commercially harvested snails in the eastern Bering Sea since at least 1971. The fishery occurs east of long. 175°W on the continental shelf northwest of the Pribilof Islands. Aspects of the commercial fishery have been described, including gear, species captured, and size composition of the catch (Nagai, 1974); incidental catch

[4]Avery, J. 1961. Observation on certain aspects of the feeding habits of four species of carnivorous marine gastropods. Friday Harbor Laboratory Library, Friday Harbor, WA 98250. Unpubl. manuscr., 29 p.

(Nagai, 1975a); and catch-per-unit-effort (Nagai, 1975b). So little information is available for this fishery that only a fragmentary account of its history can be pieced together. Statistics available since 1972 indicated an annual harvest of about 3,000 metric tons (t) (11,000 t live weight) of edible snail meats through 1975 (Table 2). Data for both total weight and recovered meat weight of the 1974 harvest indicated an edible meat recovery of 27 percent. The value compares favorably with values of edible meat recoveries from 26.8 percent to 30.6 percent generated for four species of eastern Bering Sea *Neptunea* by MacIntosh and Paul (1977).

The most common gastropod in Japanese catches made northwest of the Pribilof Islands in 1973 was *N. pribilofensis* which composed about 70 percent of the catch by weight (Nagai, 1974). *Buccinum angulossum* and *B. scalariforme* accounted for an additional 23 percent of the catch.

Until 1977, the number of vessels involved in the fishery was unknown. In some years, the Fisheries Agency of Japan licensed 21 vessels but it is unlikely that all of these vessels actually took part in the fishery. Patrols of NMFS in the eastern Bering Sea observed ony 14, 5, 0, and 6 vessels fishing snails in the years 1971 through 1974, respectively, and no vessels in 1975 and 1976[5]. Records submitted for 1977 by the Japanese in compliance with the Fishery Conservation and Management Act of 1976 indicated that three vessels fished in the eastern Bering Sea (east of long. 175°W) during the year. These vessels were given an allocation of 3,000 t of meat by the North Pacific Fishery Management Council. Fishing began in June and terminated on 16 October, at which time the combined catch of the vessels was 404 t of edible meat—about 15 percent of Japan's allocation. The average catch rate in 1977 was 2.7 t of meats per vessel day.

The 1978 season began in May and ended in November. There was a considerable increase over 1977 in both effort and catch, with about 2,200 t of snail meats taken in about 760-vessel-days (average 2.9 t/day). Fishing effort peaked in August when nine vessels fished northwest of the Pribilof Islands along the edge of the continental shelf. Vessels licensed for this fishery range from 96 to 490 gross t and 25 to 50 m in length (Fig. 4) (unpublished data, U.S. Embassy, Tokyo, Japan). Similar vessels are used in the Japanese longline and crab fisheries in Alaska and, in fact, several vessels fished for crab before switching to the snail fishery in the 1978 season.

Table 2.—Catch and effort statistics of the Japanese snail fishery in the eastern Bering Sea, 1972-78.

Year	Catch (t) edible meat	Total weight[1]	Fishing effort (vessel days)
1972	[2]3,218	11,900	NA[3]
1973	[2]3,319	12,300	NA
1974	[2]3,574	13,237	NA
1975	[2]3,447	12,767	NA
1976	NA	NA	NA
1977	[4]404	1,500	152
1978	[4]2,184	8,100	749

[1]Values are estimates derived from the weight of edible meat and whole snails taken by the fishery in 1974.
[2]Data provided by the Japan Fisheries Agency through the U.S. Embassy, Tokyo, Japan.
[3]Not available.
[4]As reported to the United States under provisions of the Fishery Conservation and Management Act of 1976.

Fishing gear consists of pots fished at intervals on a groundline. The snail pots are truncated cones 88 cm in height (Fig. 5). The diameter of the tunnel in the top of the pot varies from 12 to 15 cm and webbing on the side of the pot is 6-cm mesh over the lower 23 cm of the side and 12-cm mesh on the remainder. Snails, being predators and scavengers, are strongly attracted to the fish bait in the pots.

Little is known about Japanese fishing techniques, but in 1973 one vessel fished about 6,000 pots on 12 groundlines (500 pots/groundline) and took 3 days to pick and re-bait the entire set of gear. An average catch rate of 4 kg/pot per 3-day soak was reported by that same vessel (Nagai, 1975a). In the 1977 fishery, the overall average catch rate was reported as 0.9 kg/pot per 33-hour soak (unpublished data, 1979. Alaska Regional Office, National Marine Fisheries Service, NOAA, Juneau, AK 99802).

All processing of the snail catch now occurs on board the catcher vessel. This consists of crushing the shells, briefly cooking the meats, and removing any soft parts and shell fragments. The meats are graded by size and quality and quick frozen in trays. Small snails in the catch may be frozen whole.

The only available figures on the

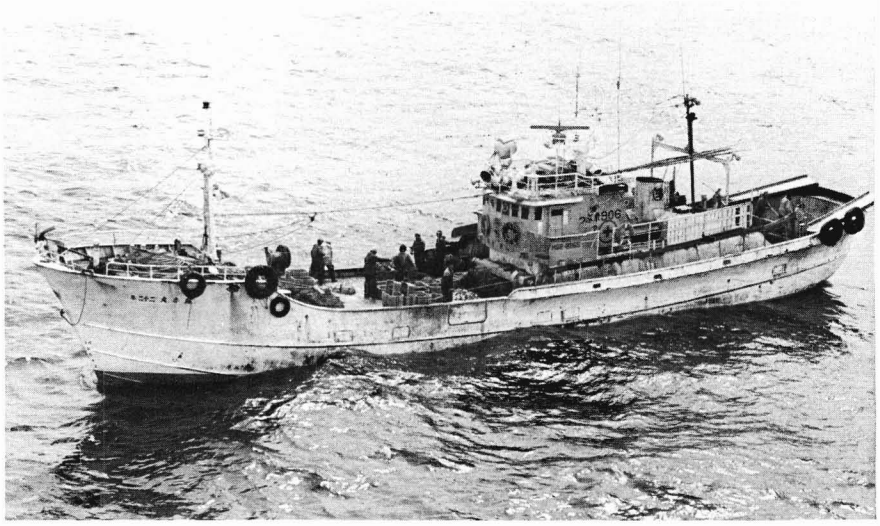

Figure 4.—A Japanese snail fishing vessel in the eastern Bering Sea.

[5]The 1974 total included one factoryship which processed snails from the five catcher vessels. This appears to be the only year in which fishing vessels did not process their own catch.

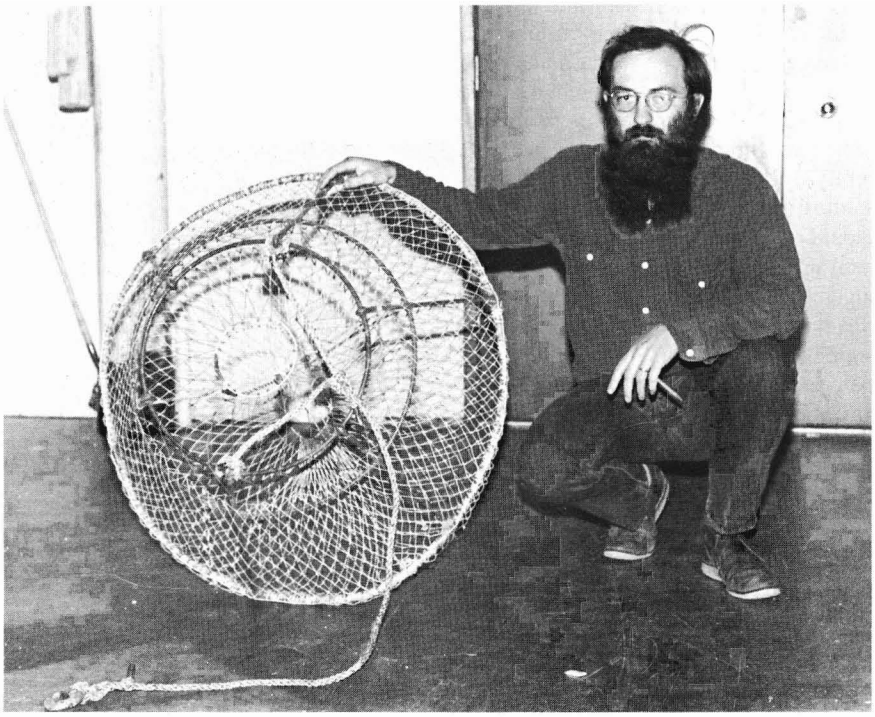

Figure 5.—Snail pot used by the Japanese fishery in the eastern Bering Sea.

value of the snail fishery are derived from estimates of the ex-vessel value of snail meats that are used by the United States as a base for calculating fee schedules for foreign vessels fishing within the extended jurisdiction zone. Fee schedules for the years 1977-79 were based on the ex-vessel snail meat value of $600, $600, and $1,657 per t for the years 1976-78, respectively. The ex-vessel value of snail meats in 1977 was probably higher than the reported $600. At these ex-vessel prices, the 1977 eastern Bering Sea catch was worth only $242,000 and the 1978 catch was worth $1.3 million. In 1979, if the total catch is similar to that made in 1978 (2,187 t of edible meats), its ex-vessel value will probably be in excess of $3.6 million.

Until recently, there was no U.S. regulation of the eastern Bering Sea snail fishery. Implementation of the Fishery Conservation and Management Act of 1976 gave the United States a tool to monitor and manage the snail fishery within the 200-mile conservation zone. At this time, a preliminary management plan developed by NMFS is being used by the North Pacific Fishery Management Council to manage the fishery.

Because there is currently no domestic fishery for snails in the eastern Bering Sea, the total allowable catch has been allocated to Japan, the only nation now involved in the fishery. So little data are available on the snail resource and fishery that Japan's 1977 and 1978 quotas were set at the same level as previous yearly catches, i.e., 3,000 t of edible meats. Changes in total allowable catch and Japan's harvest level will depend upon newly acquired biological and socioeconomic data.

Prospects for a U.S. Snail Fishery

United States fishermen have made little effort to initiate a domestic fishery for snails in the eastern Bering Sea. With only slight modifications, domestic crab vessels currently fishing for king and snow (Tanner) crab in the eastern Bering Sea could fish for snails.

Although there has been little progress toward a domestic snail fishery in the Bering Sea, seafood processors have made several recent attempts to initiate fisheries in other parts of Alaska. In Prince William Sound, as in many other areas of the Gulf of Alaska, snails are regularly taken in crab pots despite the large mesh used. New England Fish Company[6], Petersburg Fisheries, Inc., and others have had samples of Alaskan snails analyzed and have explored marketing possibilities. North Pacific Processors of Cordova, in an effort to build a broader based Prince William Sound pot fishery, installed a snail crushing machine and purchased snails from fishermen during the 1977-78 snow crab season. Only 5,000 pounds of snails were delivered during the season. Small deliveries were attributed to relatively good snow crab fishing, the low price (US$0.06-0.10/pound) paid to fishermen, and the unexpectedly low concentrations of snails encountered.

The current attempt to develop a snail fishery in Nova Scotia, Canada, should be of interest to Alaskan processors. The Nova Scotia Department of Fisheries has developed an escargot-like product that is produced from marine snails similar to those found in Alaska. It is attempting to develop a market for the marine snails *Buccinum undatum* and *Neptunea decemcostata* that are taken in the lobster pot fishery[7].

Discussion

Snails are an underutilized resource in Alaska. Although our knowledge of their distribution and relative abundance is increasing, a data base that provides estimates of stock size and condition is not yet available. Studies on distribution and abundance, species associations, age and growth, trophic

[6]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

[7]Ernest Cadegan, Nova Scotia Department of Fisheries, Box 2223, Halifax, Nova Scotia, Canada. Pers. commun.

relationships, and biochemical genetic relationships of four species of eastern Bering Sea *Neptunea* are now being conducted by NMFS.

The prospects for rapid development of Alaska's snail resources are uncertain. Snail stocks in the Gulf of Alaska are essentially unexploited and eastern Bering Sea stocks may well be underexploited. Recent fluctuations in snail catch and effort in the Japanese eastern Bering Sea fishery are probably a response to political and economic factors and not to the availability of snails. The increased cost of distant water fisheries and the remarkably low dockside value of snail meats (est. $1,700/t in 1978) would seem to limit the growth of the fishery. The recent reduction of Japanese snail allocations in the 200-mile fisheries zone of the U.S.S.R. and the strength of the Japanese yen in world money markets, however, might have the opposite effect.

Domestic fishermen and processors have expressed interest in the Alaskan snail resource, but their future involvement is more uncertain than the future involvement of Japan. The rapidly expanding and highly profitable king and snow crab fisheries are currently dominating domestic fishing activities in the area. While crab vessels would be well suited to snail pot fishing, most crab fishermen are looking at Gulf of Alaska and eastern Bering Sea bottomfish stocks as an alternate or supplemental activity. Attempts to initiate a snail fishery in the Gulf of Alaska have not been productive to date. They have been exploratory in nature but show promise as potential off-season operations in the next few years. As in the eastern Bering Sea, the resource and harvesting capacity now exists. Innovative processing and marketing techniques as well as continued increase in the value of the traditional frozen meat product will be necessary conditions for the initiation of a domestic snail fishery.

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