

Inlet) areas in 1971. The Kachemak Bay quota was set at 5 million pounds annually; the quotas for the Kodiak area for 1971 and 1972 were 88 and 86.6 million pounds respectively, and 55 million pounds is proposed for 1973. The 1971 and 1972 Kodiak area catch quotas were not achieved because processing

had to be stopped because of water shortages. In addition, in 1972 a fisherman's strike for higher prices coupled with emergency orders of the Alaska Department of Fish and Game reduced fishing time.

Over the years, the techniques of processing and the type of the end product

have changed considerably. Early in the history of the industry, almost all of the shrimp were canned; for a short period frozen shrimp logs were made from the broken pieces. At present, the industry produces a mixture of high quality canned and frozen products, which have an almost unlimited market.

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*Beautiful Kachemak Bay in Alaska is the site of NMFS studies designed to further understanding of *Pandalus borealis*, the chief shrimp species in the Alaskan catch.*

Pandalid Shrimp Life History Research at Kachemak Bay, Alaska

JAMES C. OLSEN

Pandalid shrimp stocks in the Gulf of Alaska are a resource that currently requires short-term and long-term studies so that effective management models can be developed and the effects of potential environmental changes can be evaluated. The stocks are heavily exploited, but little is known about the effect that fishing has on the shrimp or about how fluctuations in environmental factors are related to year-class abundance. It is possible, for instance, that fluctuations in year-class strength rather than fishing effort may ultimately determine levels of yield. Many investigators have shown that marine invertebrates, particularly short-lived species, usually have widely fluctuating levels of year-class success. This is especially marked in species whose larval stages are planktonic and at the mercy of the vicissitudes of the oceanic environment. Pandalid shrimp are relatively short-lived (5-7 years), in comparison with some other kinds of shellfish, but have relatively long planktonic larval periods

(up to 3 months). It is likely, therefore, that the cyclical nature of most pandalid shrimp fisheries is closely related to year-class success.

Although pandalid shrimp are fished in many areas of the world and numerous life history studies have been done on *Pandalus borealis*, the most important commercial species, there have been limited studies to determine the effect of a fishery on a pandalid stock or the role of the environment in governing year-class strength.

This lack of information continues to hamper management in setting regulations to protect this valuable resource in Alaska. The growth of the fishery continues to outpace research, primarily because long-term studies are required to establish life history information that relates to determining how fishing affects the resource.

James C. Olsen is a member of the staff of NMFS Auke Bay Fisheries Laboratory, Auke Bay, Alaska.

The NMFS Auke Bay Fisheries Laboratory has responded to the need for research by studying the dynamics of shrimp stocks in Kachemak Bay, Alaska (Figure 1). Kachemak Bay, an arm of lower Cook Inlet, is 42 miles long and 21 miles wide at the mouth and 3.5 miles wide at a constriction formed by the intrusion of Homer Spit (Figure 2). The northwest shore consists of shallow



Figure 1.—Alaska, showing location of Kachemak Bay.

mudflats, which run up to cliffs of sand and clay of about 500 feet elevation (Figure 3). The southeast shoreline borders the deeper side of the bay and consists of mountainous glacially eroded hardrock indented by many sheltered passages, islands, and deep bays. The bay is relatively shallow; the average depth is 165 feet and the maximum is 545 feet. Mixing, due to tidal action, is a dominant feature and involves water transport from the Gulf of Alaska into the bay.

Kachemak Bay has been used by the Auke Bay Laboratory as a study area for shellfish research since 1957. A field station has been developed on the south shore of Kachemak Bay at Kasitsna Bay (Figure 4) and is managed by a resident biologist. Kachemak Bay was chosen



Figure 2.—Kachemak Bay viewed from the northwest shore. Homer Spit is in the foreground and the mountainous southeast shore in the background.

for field studies because of its accessibility to clean salt water for laboratory studies and because it has year-round commercial fisheries for king, tanner, and Dungeness crabs, shrimp, salmon, and halibut. Kachemak Bay has supported commercial fish and shellfish fisheries for many years and has recently gained importance as a recreational area for boating, clam digging, crabbing, and sport fishing. The existence of a variety of fish and shellfish stocks makes the bay valuable as a marine study area.

The total area of Kachemak Bay (250 square miles) is small enough to permit comprehensive sampling with limited amounts of equipment and personnel. Industrial developments are present and others are proposed for the area. One sawmill operates in the area and three fish-processing plants are present. Oil and natural gas reserves are present and may be developed in the near future.

The current shrimp research activities in Kachemak Bay will provide insight into the life history, population dynamics, and behavior of pandalid

shrimp in the Gulf of Alaska. The general objectives of the research on larval and postlarval shrimp are to (1) increase knowledge about pandalid shrimp life history stages, behavior, and population dynamics; (2) determine how fishing affects shrimp stocks; (3) determine the causes of annual fluctuations in shrimp stock abundance; (4) describe and quantify the characteristics and ecology of environments inhabited by shrimp; and (5) increase the understanding of the role pandalid shrimp have in the organic production system of the North Pacific.



Figure 3.—Northwest shore of Kachemak Bay viewed from the Kasitsna Bay field station.

Studies designed to answer these questions began in May 1970 with weekly sampling of the commercial shrimp catches. This sampling, which is continuing with participation by the Alaska Department of Fish and Game, provides estimates of the species, size, and sex-specific catch rates, along with life history data such as growth, onset of maturity, and hatching times. The first stock assessment was made in October 1970 by trawl survey; second and third assessments were made in May 1971 and 1972; and a fourth survey is planned for May 1973.

The data from stock assessment surveys and catch sampling are providing growth, recruitment, mortality, and other life history information primarily for *P. borealis* and *P. gonurus*. Similar data for other pandalid species are also obtained, but the information has not been as complete because of the difficulty in sampling rocky habitats. Results from our studies will be used to develop mathematical models of the dynamics of pandalid shrimp populations.

Studies of shrimp larvae are also underway at Kachemak Bay. These studies began in 1971 and have provided data on (1) time and place of larval hatching, (2) diurnal vertical distribution of larvae, (3) preliminary estimates of larval survival, and (4) annual larval production and number of females hatching larvae.

The work in progress includes creat-



Figure 4.—Kasitsna Bay field station. The four buildings in the foreground are laboratory work areas and storage facilities. The two large buildings in the background are permanent living quarters.

ing a reference collection of larvae representing various species and developmental stages. The identification and description of larval stages will be accomplished by using culture techniques and field collections.

The Auke Bay Laboratory's shrimp research program is conducted in close

cooperation with the Alaska Department of Fish and Game, and the results are assisting the State in making management decisions—particularly in defining the size of annual quotas. As the analyses are completed, the results are expected to find application to areas of Alaska other than Kachemak Bay.

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