— Shrimp —

Pandalus: borealis, goniurus, platyceros, hypsinotus, and dispar

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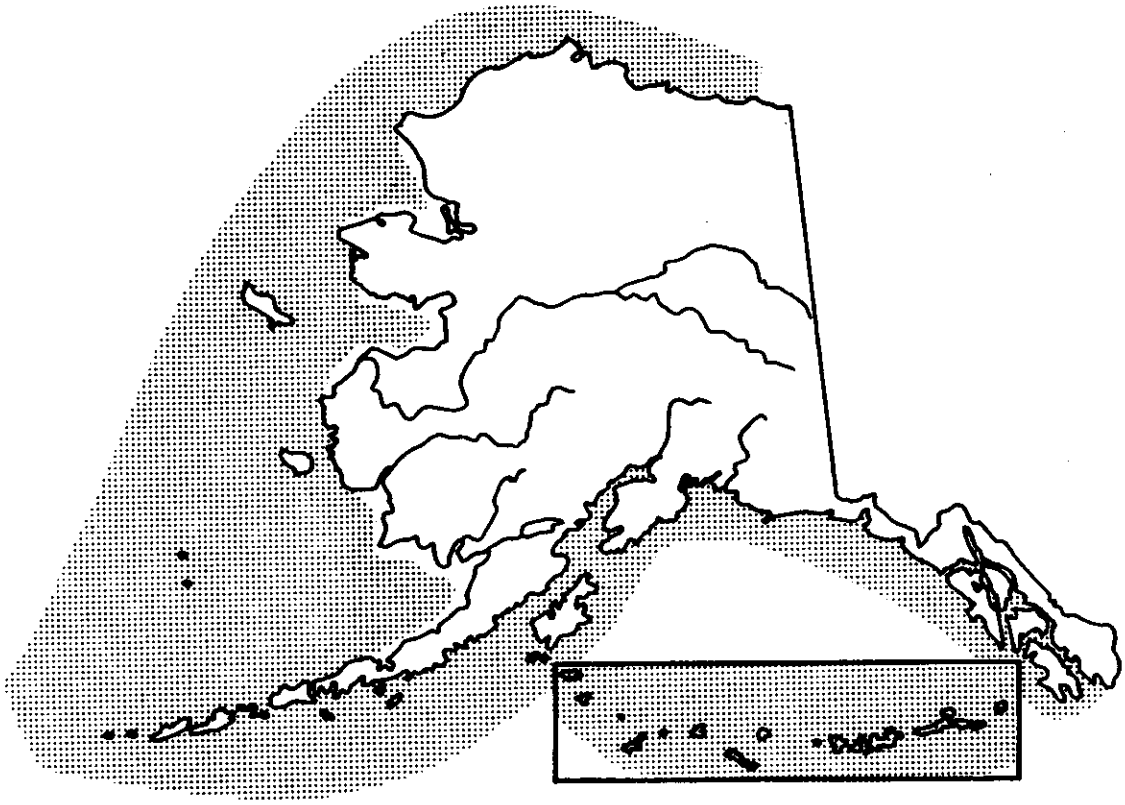
The following pages are excerpted from the *Alaska Habitat Management Guide, Southcentral Region, Volume 1: Life Histories and Habitat Requirements of Fish and Wildlife,* produced by the State of Alaska Department of Fish and Game, Division of Habitat, Juneau, Alaska, 1985.

Shrimp Life History and Habitat Requirements
Southwest and Southcentral Alaska



Map 1. Range of shrimp (ADF&G 1978)

I. NAME

A. Common and Scientific Names: Northern pink shrimp or deep sea prawn (Pandalus borealis Kroyer); humpy shrimp or flexed shrimp (Pandalus goniurus Stimpson); spot shrimp or spot prawn (Pandalus platyceros Brandt); coonstripe shrimp (Pandalus hypsinotus Brandt); sidestripe shrimp or giant red (Pandalopus dispar Brandt).

II. EXTENT TO WHICH SPECIES REPRESENTS GROUP

There are five important species of shrimp caught by commercial fisheries in Alaska, all of which belong to the family Pandalidae.

III. RANGE

A. North America

The range of the northern pink shrimp extends from the Bering Sea southward to the Columbia River mouth in Washington (Rathjen and Yesaki 1966).

Humpy shrimp have been found from the arctic coast of Alaska southward to Puget Sound.

Coonstripe shrimp have been reported from the Bering Sea to the Strait of Juan de Fuca.

The range of the spot shrimp extends from Unalaska Island, Alaska, southward to San Diego, California.

Sidestripe shrimp are distributed from the Bering Sea, west of the Pribilof Islands, southward to Manhattan Beach, Oregon (ADF&G 1978).

B. Statewide

Greatest concentrations of northern pink shrimp are located in lower Cook Inlet, Kodiak, Shumagin Islands, and along the southside of the Alaska Peninsula west to Unalaska Island. Pink shrimp are also found along eastern Kenai Peninsula, Prince William Sound, Yakutat Bay, throughout Southeast Alaska, and near the Pribilof Islands in the eastern Bering Sea (ADF&G 1978, McCrary 1984).

Greatest concentrations of humpy shrimp are found off southeastern Kodiak Island and the Shumagin Islands.

Coonstripe shrimp are primarily found in lower Cook Inlet, off Kodiak Island, and among the Shumagin Islands.

Spot shrimp have been reported in lower Cook Inlet, off Kodiak Island, and along the Alaska Peninsula.

Sidestripe shrimp concentrations have been located off Kodiak Island, the Shumagin Islands, and in Lower Cook Inlet (ADF&G 1978; Merritt, pers. comm.).

C. Regional Distribution Summary

To supplement the distribution information presented in the text, a series of bluelined reference maps has been prepared for each region. Most of the maps in this series are at 1:250,000 scale, but some are at 1:1,000,000 scale. These maps are available for review in ADF&G offices of the region or may be purchased from the contract vendor responsible for their reproduction. In addition, a set of colored 1:1,000,000-scale index maps of selected fish and wildlife species has been prepared and may be found in the Atlas that accompanies each regional guide.

1. Southwest. See the statewide summary above, and for more detailed narrative information, see volume 1 of the Alaska Habitat Management Guide for the Southwest Region.
2. Southcentral. See the statewide summary above, and for more detailed narrative information, see volume 2 of the Alaska Habitat Management Guide for the Southcentral Region.

IV. PHYSICAL HABITAT REQUIREMENTS

A. Water Quality

Distribution of pandalid shrimp is dependent upon the water's temperature and salinity. Immature shrimp are tolerant of a broad range of temperature and salinity and are often abundant in relatively shallow depths, where these two parmeters are variable, whereas older, sexually mature shrimp prefer greater depths, where these two parameters are more stable and less variable. With the exception of humpy shrimp, these pandalid species have been found in a temperature range of 7 to 11°C along the coast of British Columbia (Butler 1964). Humpy shrimp are apparently selective to colder water temperatures. In laboratory studies, pink shrimp were found to have narrow thermal requirements for larval production, with low temperatures (3-6°C) generally more favorable than high temperatures. Different thermal regimes resulted in differences in the time and duration of spawning and in the abundance of egg-bearing females. Larval production, larval survival, developmental and growth rates were enhanced by higher (9°C) rearing temperatures, regardless of feeding levels. Size and viability of newly hatched larvae are significantly influenced by the thermal history of females during the egg-bearing period (6-7 months). Low incubation (3°C) and higher rearing (9°C) temperatures tended to increase larval and survival growth rates (Nunes 1984). In the Bering Sea, concentrations of pink shrimp were located at 0.5°C (Ivanov 1964b). Tolerance to salinity appears to differ by species. The tolerance of pink shrimp to salinity in British Columbia waters has been reported to range from 23.4 to 30.8 parts per thousand (o/oo) (Butler 1964). Butler (1964) reported salinity tolerance ranges for coonstripe shrimp from 25.9 to 30.6 o/oo, for spot shrimp from 26.4 to 30.8 o/oo, and for sidestripe shrimp from 26.7 to 30.8 o/oo. During the winter, pink shrimp are generally absent from inner bay waters of less than 30 fathoms when bottom temperatures may be less than 2°C and ice cover may be present. At the same time, where northern shrimp are most concentrated, temperatures may range from 1 to 2°C warmer than those of innermost bays of comparable depth (ADF&G 1978).

ADF&G studies have shown that pandalid shrimp tend to be distributed in one of two ways: 1) Younger age groups are located in shallower areas, whereas older age groups are deeper; and 2) older age groups occur offshore, and younger age groups are inshore. Apparently, older, sexually mature shrimp, especially oviparous females, prefer deeper water, where temperature and salinity parameters are less variable. Younger shrimp, particularly those prior to first sexual maturity, are tolerant of a broader range of salinities and temperature and are therefore often abundant in nearshore or shallower areas, where these two parameters are generally more variable (ADF&G 1978).

B. Water Quantity

The depth at which pandalid shrimp are found depends upon the species and their stage of development. Shrimp larvae are found in shallower waters than adults, ranging from about 5 to 35 fathoms in depth. From ages one to two years, pink shrimp juveniles begin utilizing bottom habitats of from 20 to 40 fathoms, though dense aggregations may be found at 50 to 70 fathoms. Adult pink shrimp inhabit water depths of from 10 to 350 fathoms (Rathjen and Yesaki 1966). The depth at which coonstripe shrimp occur is similar to the depth range of humpy shrimp, which is 3 to 100 fathoms (Fox 1972). Spot shrimp have been found to occur in depths from 2 to 266 fathoms (ibid.), and sidestripe shrimp are commonly found in depths ranging from 20 to 351 fathoms (Ronholt 1963).

C. Substrate

Substrate preference appears to be species-specific. Pink and sidestripe shrimp appear to prefer smooth, mud seabottoms. Humpy shrimp primarily occur in areas with a substrate of smooth mud, sand, or organic debris. Coonstripe shrimp prefer areas of smooth mud, sand, or organic debris. Unlike the other species, spot shrimp are primarily found in rough, rocky areas (ADF&G 1978).

V. NUTRITIONAL REQUIREMENTS

A. Preferred Foods

Adult pandalid shrimp feed both by scavenging dead animal material and by preying on such living organisms as amphipods, euphausiids, annelids, and other shrimps (ibid.).

B. Feeding Locations

Larvae feed in the water column. Juveniles and adults are benthic feeders.

C. Factors Limiting the Availability of Food

No information available.

D. Feeding Behavior

Adults are carnivorous bottom feeders (ibid.). Pink shrimp larvae feeding rates increased with increasing temperatures. Among starved larvae, higher temperatures lowered the threshold concentrations of prey organisms required for successful first feeding. The amount of food required by larvae to complete development was significantly reduced at higher temperatures (Nunes 1984).

VI. REPRODUCTIVE CHARACTERISTICS

A. Breeding Habitat

The normal distribution of adults and breeding habitat covers a wide range of depths varying by area and species. Breeding habitat is not considered as vastly different from the normal annual distribution of adults, except that depths occupied in fall and winter tend to be deeper than in spring and summer for all species. Commercial fisheries commonly operate on concentrations of adults during the breeding season in areas and depths that produce adults all year ((McCrary 1984).

B. Breeding Seasonality

Timing of spawning differs by geographical range for pandalid shrimp, where temperature is the controlling factor. For pink shrimp at the northern extremities of its range, incubation of eggs is longer because of an earlier spawning and later hatching date (Rasmussen 1953, Allen 1959). Generally, eggs ripen in the ovaries of the females. Breeding and egg deposition occur from late September through mid November (ADF&G 1978).

C. Reproductive Behavior

Within 36 hours after the female molts into breeding dress, the male attaches a sperm mass to her underside between the last two pairs of pereiopods (walking legs) (Needler 1931). Fertilization and oviposition occur as eggs are released from the oviducts and onto the sperm masses. Eggs then become attached to the forward four pairs of pleopods (abdominal appendages) and abdominal segments (ADF&G 1978).

D. Age at Sexual Maturity

The age at which sexual maturity is reached differs by species and by geographical location within a species. Pink shrimp found in the Pribilof areas of the Bering Sea and in the Kodiak and Shumagin islands areas are estimated to reach maturity at 2.5 years (Ivanov 1964a, McCrary 1971). The same estimate is believed to hold true for sidestripe shrimp and, to a lesser extent, for coonstripe and humpy shrimp in Kodiak and Shumagin islands waters. Pink, humpy, coonstripe, and sidestripe shrimp species in Southeast Alaska waters have been found to mature at 1.5 years (McCrary 1971).

Pandalid shrimp may occur in one of three forms as they mature sexually. These include the hermophroditic male form, the "primary female" form, or the "secondary female" form. Hermaphroditic pandalid shrimp mature first as males, then later in their life cycle transform into females. The age at which the transition from male to female occurs also varies by species and by geographical location within species. Individuals of a given species mature less rapidly as they inhabit waters in a colder portion of their range. Generally, most shrimp function two years as a male before becoming female (ADF&G 1978). In British Columbia, humpy shrimp mature as males during their first autumn and again as females at 1.5 years of age (Butler 1964). Pink shrimp, coonstripe shrimp, spot shrimp, and sidestripe shrimp generally mature as males at 1.5 years (Butler 1964, Dahlstrom 1970). An individual that has become female remains so throughout its life.

"Primary females" are shrimp that mature directly as females and are never hermaphroditic. Though primary females have been documented in pink shrimp populations off the coast of British Columbia (Butler 1964), their occurrence in Alaskan waters is believed to be rare (ibid.).

"Secondary female" development entails the appearance of female

characteristics that are repressed before maturity is reached. When the secondary female attains sexual maturity it remains female for the rest of its life. Secondary females have been documented in Southeast Alaska populations of pink, humpy, and coonstripe shrimp but have not been documented in other Alaskan waters (ADF&G 1978).

E. Fecundity

Pandalid shrimp exhibit high fecundity. Eggs per clutch for pink shrimp have been found to range in number from 478 to 2,117. In Southeast Alaska, the fecundity range for pink shrimp was from 809 to 1,642; sidestripe shrimp ranged from 674 to 1,454; humpy shrimp from 971 to 3,383; coonstripe shrimp from 1,083 to 4,583; spot shrimp from 4,044 to 4,528. Fecundity is related to the size of the shrimp, with larger shrimp producing more eggs (Alaska OCS 1980).

F. Frequency of Breeding

Shrimp usually mature sexually as males. After spawning one or more times, they pass through a transitional phase and subsequently spawn as females. Transformation may occur so rapidly that an individual spawning one year as a male will spawn the following year as a female (Fox 1972).

G. Incubation Period/Emergence

Females carry eggs for five to six months prior to hatching. Hatching usually occurs from March through April for pink shrimp, and for sidestripe shrimp it may extend into June or July. For pink shrimp, the lengths of the spawning, carrying, and hatching periods vary inversely with the water temperatures (Haynes and Wigley 1969). Laboratory studies indicate that most eggs hatch at night during periods of vigorous pleopod movement by the female. Hatching of an entire clutch may require two days. Larvae are planktonic for about two to three months; they pass through six stages to become juveniles, at which time they become benthic (Berkeley 1930).

VII. MOVEMENTS ASSOCIATED WITH LIFE FUNCTIONS

A. Larvae

In British Columbia, freshly hatched larvae were found in the vicinity of the spawned adults. The larvae then move to shallower areas ranging from 9 to 64 m in depth, where they spend the first summer (ibid.).

B. Juvenile

In British Columbia, juvenile pink, coonstripe, sidestripe, and spot shrimp move to deeper water during their first winter to join the adult population (ibid.).

C. Adult

Pink shrimp have displayed fairly distinct seasonal onshore-offshore migrations. They use shallow, nearshore, and inner bays primarily from spring through fall. With the onset of winter and colder temperatures in nearshore and inner bays, pink shrimp migrate to warmer offshore areas (ADF&G 1978).

Female pink shrimp have been reported to move inshore as their eggs develop in late fall and early winter (Haynes and Wigly 1969). Pink shrimp have also engaged in diel vertical migrations, which appear to be related to feeding behavior because shrimp feed mainly on euphausiids and copepods, which make the same movements (ADF&G 1978).

Kachemak Bay studies have shown that pink shrimp leave the bottom in late afternoon or evening, returning to the same area about dawn. The period of time that the shrimp remained away from the sea bottom varied directly with the season's number of hours of darkness.

VIII. FACTORS INFLUENCING POPULATIONS

A. Natural

Pandalid shrimp are subject to a high level of predation, both as planktonic larvae and as benthic adults. Predators include Pacific hake, Pacific cod, sablefish, lingcod, sole, rockfish, spring dogfish, skates, rays, Pacific halibut, salmon, and harbor seals. Parasites and disease also cause mortality of shrimp populations. The black spot gill disease has been documented in shrimp from the Kodiak area. The gill lamellae of the shrimp are destroyed, and a chitinous growth covers the damaged area, creating a "black spot" (Fox 1972, Yevich and Rinaldo 1971).

Spot shrimp in the British Columbia area have been parasitized by a rhizocephalen (Sylon spp.) (Butler 1970). Bopyroid isopods (Bopyrus spp.) also parasitize most species of pandalid shrimp (Fox 1972).

It is apparent that the mechanism of stock recruitment for pink shrimp in Alaskan waters is markedly influenced by temperature. Temperature appears to control the reproductive process in pink shrimp, particularly during the period between egg formation and egg development (Nunes 1984).

B. Human-related

A summary of possible impacts from human-related activities includes the following:

- Alteration of preferred water temperatures, pH, dissolved oxygen, and chemical composition
- Alteration of preferred substrate
- Alteration of intertidal areas
- Increase in suspended organic or mineral material
- Reduction in food supply
- Reduction in protective cover (e.g., seaweed beds)
- Obstruction of migration routes
- Shock waves in aquatic environment
- Human harvest

(See Impacts of Land and Water Use of this series for additional impacts information.)

IX. LEGAL STATUS

A. Managerial Authority

Shrimp populations are managed by the Alaska Department of Fish and Game under policy regulations and management plans adopted by the Alaska Board of Fisheries.

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