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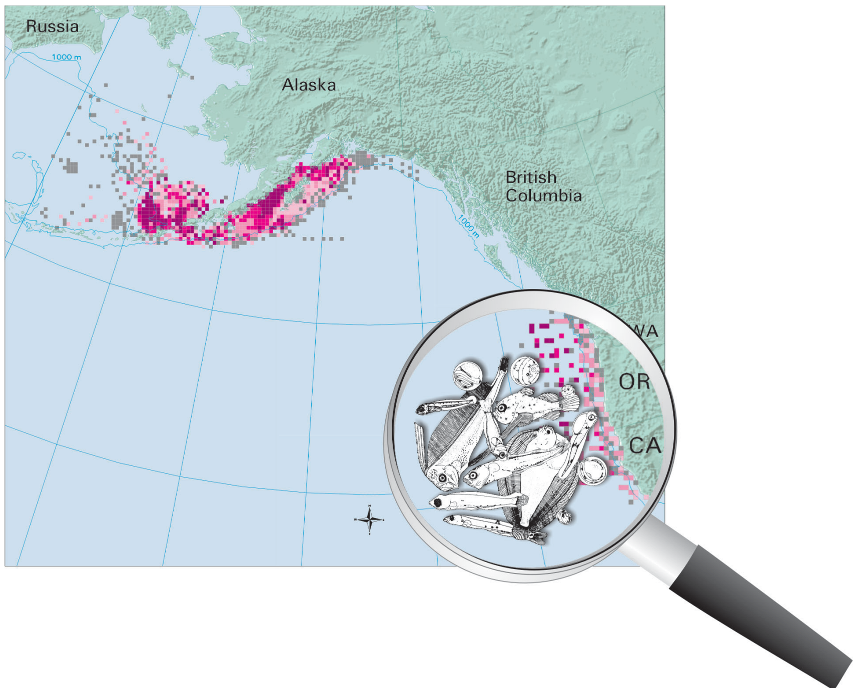

Atlas of Abundance and Distribution Patterns of Ichthyoplankton from the Northeast Pacific Ocean and Bering Sea Ecosystems Based on Research Conducted by the Alaska Fisheries Science Center (1972–1996)

Ann C. Matarese
Deborah M. Blood
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Jan L. Benson

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Abstract—This regional atlas summarizes and illustrates the distribution and abundance patterns of fish eggs and larvae of 102 taxa within 34 families found in the Northeast Pacific Ocean including the Bering Sea, Gulf of Alaska, and U.S. west coast ecosystems. Data were collected over a 20+ year period (1972–1996) by the Recruitment Processes Program of the Alaska Fisheries Science Center (AFSC). Ichthyoplankton catch records used in this atlas were generated from 11,379 tows taken during 100 cruises.

For each taxon, general life history data are briefly summarized from the literature. Published information on distribution patterns of eggs and larvae are reviewed for the study area. Data from AFSC ichthyoplankton collections were combined to produce an average spatial distribution for each taxon. These data were also used to estimate mean abundance and percent occurrence by year and month, and relative abundance by larval length and season. Abundance from each tow was measured as catch per 10 m^2 surface area. A larval distribution and abundance map was produced with a geographic information system using ArcInfo software. For taxa with identifiable pelagic eggs, distribution maps showing presence or absence of eggs are presented. Presence or absence of adults in the study area is mapped based on recent literature and data from AFSC groundfish surveys. Distributional records for adults and early life history stages revealed several new range extensions.

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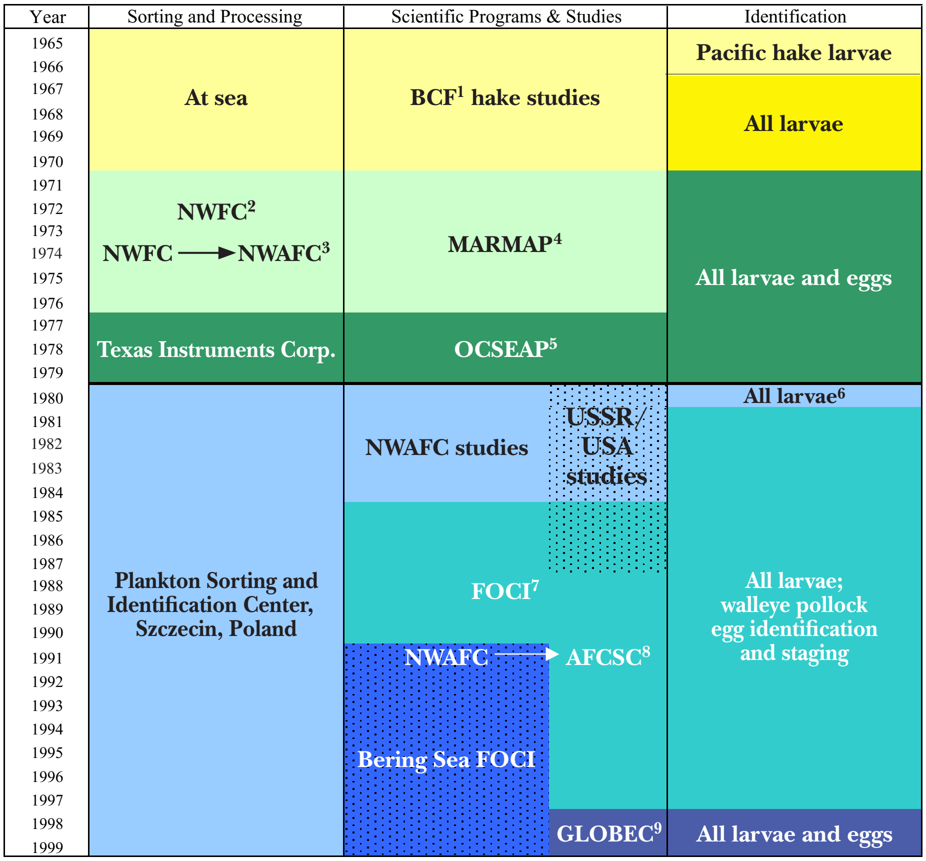
Introduction

Ichthyoplankton surveys have been conducted in many large marine ecosystems (e.g., California Current, Gulf of Alaska, Bering Sea, Georges Bank, Baltic Sea) to generate fishery-independent stock estimates, explain variations in recruitment, and identify marine species assemblages. As a result, ichthyoplankton surveys have played a key role in understanding how marine ecosystems function and change over time. The Recruitment Processes Program (initially named Resource Ecology) of the Alaska Fisheries Science Center (AFSC) has been conducting ichthyoplankton surveys in the Northeast Pacific Ocean and Bering Sea since 1965. During the early years, many projects and research studies focused on various taxa and geographic regions, but a major emphasis for the past 15 years has been the Fisheries Oceanography Coordinated Investigations (FOCI) Program which has sought to understand conditions leading to variation in recruitment among important commercial fish of the Northeast Pacific, with most effort concentrated on *Theragra chalcogramma* (walleye pollock). More recent Northeast Pacific Global Ocean Ecosystems Dynamics (GLOBEC) studies at AFSC have investigated the hypothesis that spawning in Northeast Pacific Ocean and Bering Sea marine fish populations has evolved along with oceanographic conditions to give rise to distinct groups or assemblages of fish larvae. Our approach is to study these ichthyoplankton assemblages within the framework of their ecosystems. Ongoing investigations continue to focus on interannual variations in distribution and abundance of eggs and larvae in relation to the environment, particularly regime shifts. This atlas describes the distribution and abundance of eggs and larvae of most of the numerically dominant taxa present in



[1]Bureau of Commercial Fisheries.
[2]Northwest Fisheries Center.
[3]Northwest and Alaska Fisheries Center.
[4]Marine Resources Monitoring, Assessment, and Prediction.
[5]Outer Continental Shelf Environmental Assessment Program.
[6]Eggs identified and larvae verified by Recruitment Processes Program.
[7]Fisheries-Oceanography Coordinated Investigations.
[8]Alaska Fisheries Science Center.
[9]Global Ocean Ecosystems Dynamics.

Figure 1

Ichthyoplankton protocols and level of identification for sampling programs conducted by the Recruitment Processes Program, 1965–1999.

the diverse ecosystems of the Northeast Pacific Ocean and Bering Sea, and provides a framework for future studies to define assemblages of larvae and how their occurrences reflect spatial and temporal patterns.

Background and historical review

Recruitment Processes Program ichthyoplankton sampling studies

The Recruitment Processes Program has been collecting and analyzing ichthyoplankton for more than 30 years (Fig. 1). Beginning in 1965, AFSC, then known as the Bureau of Commercial Fisheries (BCF) Seattle Technological Laboratory, started an ichthyoplankton program off the Northeast Pacific coast to determine the northernmost extent of *Merluccius productus* (Pacific hake) spawning. Only data on Pacific hake were kept and analyzed. The Marine Resources Monitoring, Assessment, and Prediction Program (MARMAP) began in 1971, sampling in the eastern Bering Sea, off Kodiak Island, Alaska, and off Vancouver Island, British Columbia. Samples were collected using MARMAP standard protocol (Jossi and Marak, 1983) and all taxa were sorted, counted, and identified by larval taxonomists at the Seattle Laboratory, at that time known as the Northwest Fisheries Center (NWFC). The Outer Continental Shelf Environmental Assessment Program (OCSEAP) supported five cruises conducted 1977–1979 in the shelf waters east of Kodiak Island in the Gulf of Alaska. These studies were developed to assess the spatial and temporal distribution of plankton which might be affected by oil exploration and development. In 1980, the Plankton Sorting and Identification Center in Szczecin, Poland, began processing ichthyoplankton samples collected by our Center, which had been renamed the Northwest and Alaska Fisheries Center (NWAFC) in 1974. For most of the early 1980s, sampling was conducted along the Washington, Oregon, and northern California coasts in cooperation with the Soviet Union (USSR/USA cruises, 1980–1987). As the first large-scale ichthyoplankton surveys to be done in this region, this work sought to document patterns in occurrence, distribution, and abundance of ichthyoplankton in coastal waters of the Northeast Pacific. FOCI began in 1985 and was centered on physical and biological factors affecting survival of early life history stages of walleye pollock in the Gulf of Alaska. Bering Sea FOCI was established in 1991 (after the NWAFC was split into two centers, the Northwest Fisheries Science Center (NWFSC) and the AFSC) under the auspices of NOAA's Coastal Ocean Program (COP) to address similar research in the eastern Bering Sea shelf region. Bering Sea FOCI ended in 1996, but was immediately followed in 1997 by the Southeast Bering Sea Carrying Capacity Program (SEBSCC), also sponsored by COP. This program seeks to document the role of juvenile walleye pollock in the eastern Bering Sea ecosystem, to examine the factors affecting their survival, and to develop and test annual indices of pre-recruitment abundance. The Northeast Pacific Global Ocean Ecosystems Dynamics Program (GLOBEC) was added to the Recruitment Processes Program in 1998. The GLOBEC research, in addition to distribution and abundance studies, includes the comparison of dominant multi-species ichthyoplankton assemblages from the Gulf of Alaska, Bering Sea, and U.S. west coast (Doyle et al., 2002) and larval flatfish transport studies concentrating on the influence of El Niño in the Gulf of Alaska (Bailey and Picquelle, 2002). These investigations continue to provide insight into the spawning strategies of the fish populations in these regions and how they relate to oceanographic conditions.

Current recruitment studies at AFSC focus on continuing ichthyoplankton surveys and analyzing data from historical time series. In particular, emphasis is on investigations of interannual trends among dominant taxa, especially in the Gulf of Alaska. We continue to investigate whether changes in spawning patterns and larval abundance and distribution can be studied in relation to ecosystem and environmental changes such as regime shifts. It is increasingly important to look at longer time scales (i.e., regime shifts and climate change) as we continue to plan new studies in the Northeast Pacific. This will require research that is long term, community focused, and includes multiple trophic levels. Such studies are underway to investigate interannual trends in the distribution and abundance of larval forage species (e.g., *Mallotus villosus*, capelin). Fluctuations in forage fish population abundance and community structure can have consequences on the health and survival of top predator species (e.g., salmon, sea birds, and marine mammals such as Steller sea lions) through changes in the amount, distribution, and variety or quality of food available to them.

Geographic and temporal coverage (Fig. 2)

Most data for the initial BCF Pacific hake and MARMAP studies in the mid-1960s and early 1970s were not entered into a permanent database. Our database became more consistent in 1977 with OCSEAP, the first broad-scale program offering NWAFC scientists the opportunity to study seasonal occurrences of eggs and larvae in the Northeast Pacific Ocean. During the 1970s, sampling intensity was highest in the Gulf of Alaska east of Kodiak Island (Map 1; for description of grid structure used in these maps, see section in this atlas titled "Maps and Data Layers"). The OCSEAP Program offered broad monthly coverage (February–November), but overall, only 16 cruises were conducted between 1972 and 1979 (no cruises from 1973 to 1976). The graphs adjacent to Maps 1–3 show that the sampling effort over the months of the year varied by decade and by region. In the 1970s, few samples were collected, but most of the cruises (81%) were conducted in the Gulf of Alaska with the remainder in the Bering Sea (Map 1).

By the mid-1980s, there was a dramatic increase in the number of surveys due to the U.S. west coast cruises (USSR/USA, 1980–1987) and the initiation of the FOCI Program (Map 2 and adjacent graph). Sampling was greatest in the Gulf of Alaska in Shelikof Strait and southwest of Kodiak Island. The number of cruises increased from 16 during the 1970s to 49 during the 1980s. January was included in the monthly coverage, but 88% of cruises occurred from March to May, which is the peak period of walleye pollock spawning in Shelikof Strait. Only four cruises were conducted in the Bering Sea, but coverage was expanded with nine cruises conducted along the U.S. west coast. Sampling distribution along the west coast was highest along the continental shelf region from Washington to northern California, while sampling was limited nearshore and in the deeper offshore waters.

Coverage in the 1990s was expanded to include more sampling in the Bering Sea with the onset of the

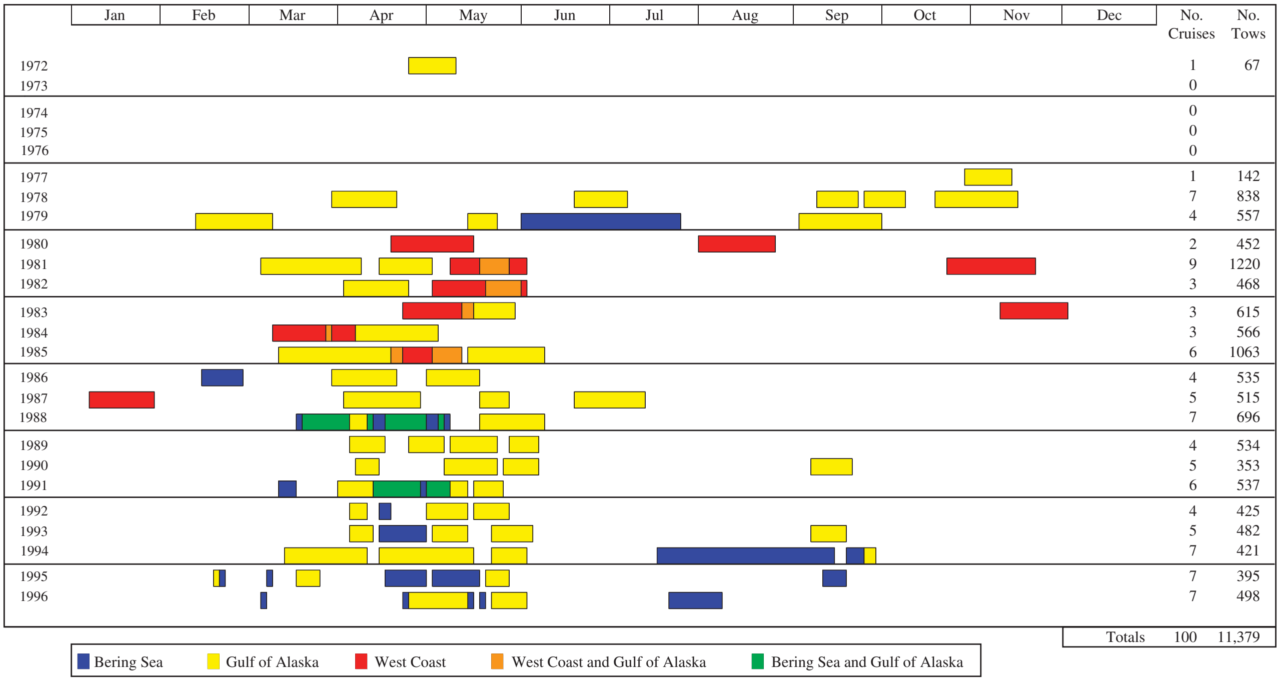
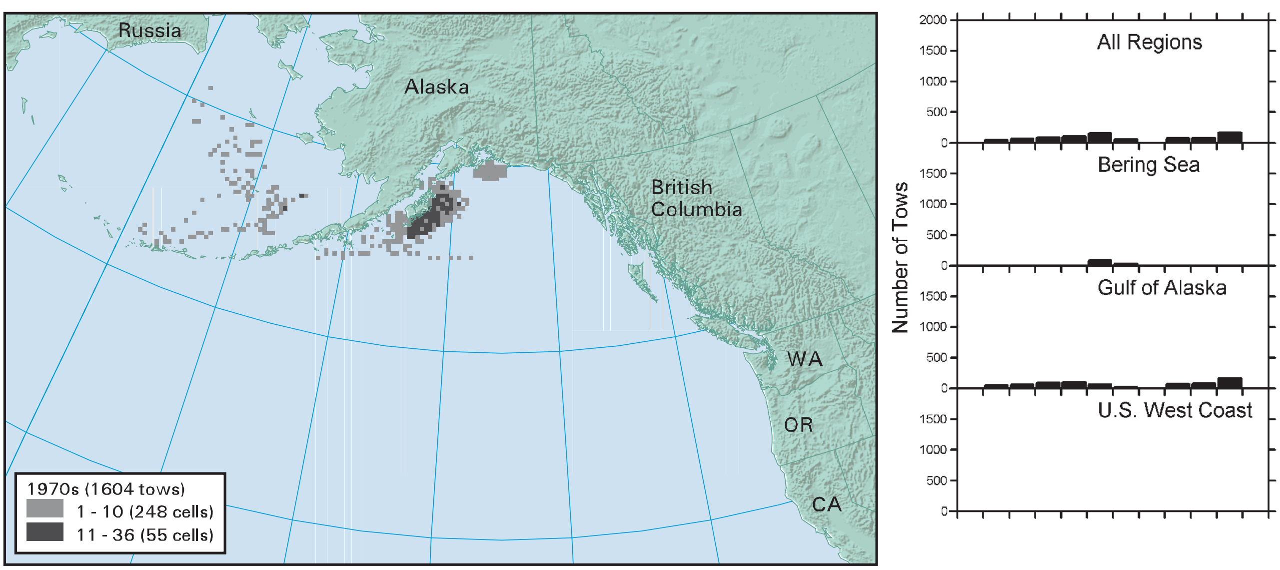


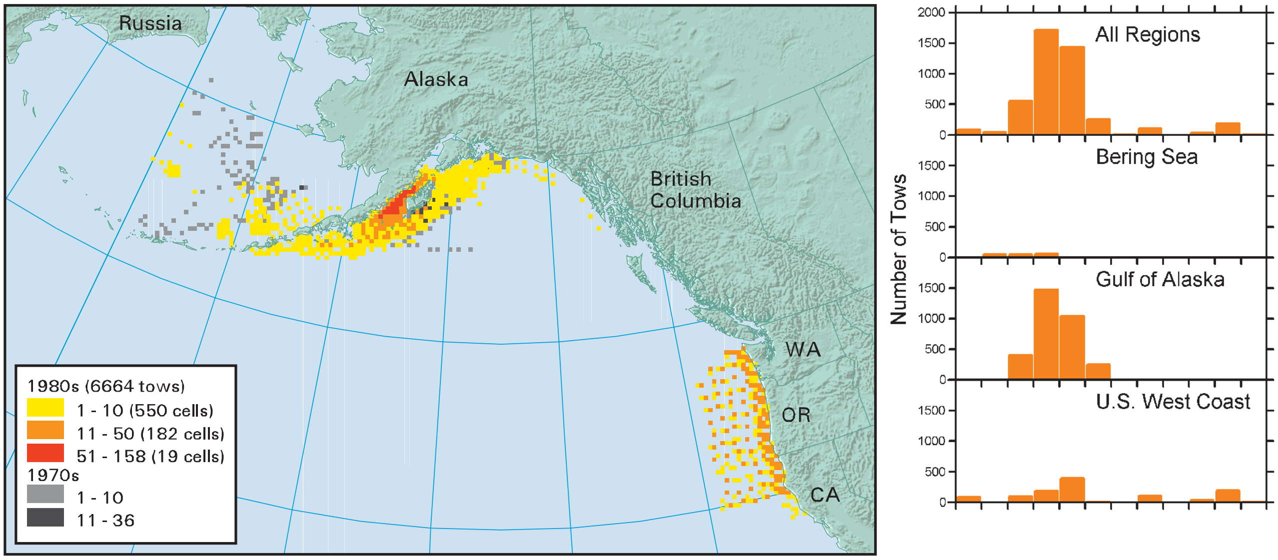
Figure 2

Geographic and temporal coverage of Recruitment Processes Program ichthyoplankton survey data 1972–1996 used in this atlas and available in the larval fish database (ICHBASE).



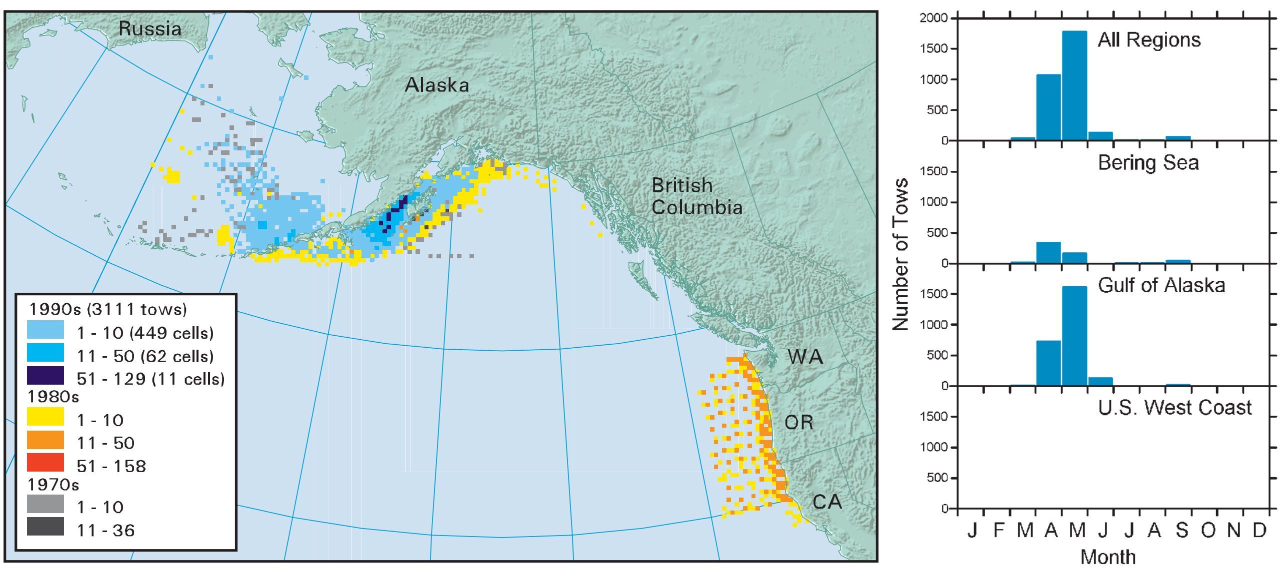
Map 1

Geographic distribution and sampling frequency of cruises conducted by the Recruitment Processes Program 1972–1979. Area sampled is divided into 625 km^2 cells. Gray cells were each sampled 1–10 times; black cells were each sampled 11–36 times. Graph at right shows monthly distribution and number of tows in the Bering Sea, Gulf of Alaska, and the two regions combined for the 1970s.



Map 2

Geographic distribution and sampling frequency of cruises conducted by Recruitment Processes Program 1972–1979 and 1980–1989. Area sampled is divided into 625 km^2 cells; 1970s data overlaid by 1980s data. For 1980s data, yellow cells were each sampled 1–10 times, orange cells were each sampled 11–50 times, and red cells were each sampled 51–158 times. Graph at right shows monthly distribution and number of tows in the Bering Sea, Gulf of Alaska, and off the U.S. west coast, and the three regions combined for the 1980s.



Map 3

Geographic distribution and sampling frequency of cruises conducted by Recruitment Processes Program 1972–1979, 1980–1989, and 1990–1996. Area sampled is divided into 625 km^2 cells; 1970s and 1980s data overlaid by 1990s data. For 1990s data, light blue cells were each sampled 1–10 times, medium blue cells were each sampled 11–50 times, and dark blue cells were each sampled 51–129 times. Graph at right shows monthly distribution and number of tows in the Bering Sea, Gulf of Alaska, and the two regions combined for the 1990s.

Bering Sea FOCI and SEBSCC Programs (Map 3 and adjacent graph). More cruises were conducted than in the 1980s (58 versus 49) and a much higher percentage of Bering Sea cruises were conducted than ever before (46%). Summer coverage (27%) was also more extensive. Sampling gear other than bongo and neuston nets and Tucker trawls was now used (e.g., MOCNESS nets to assess fine-scale vertical distribution) and cruises using Methot nets were designed to collect early juveniles; however, these special purpose gears were not included in the data presented here.

Ichthyoplankton distributional studies

Information on the patterns of distribution and abundance of early life history stages in Northeast Pacific fishes has changed dramatically over the 30 years from the 1970s to the present. In 1985, Kendall and Dunn summarized the difficulty of comparing earlier studies conducted prior to the Center's initial MARMAP Program: "The diversity of objectives, study methods, and lack of taxonomic resolution make it difficult to compare earlier studies or provide a comprehensive picture of ichthyoplankton distribution." Comparing the various ichthyoplankton programs over the years since MARMAP is still a formidable challenge. Program goals have varied from large-scale baseline studies to site-specific diel studies on feeding strategies. Despite these differences in geographic and seasonal coverage, the AFSC larval fish database (ICHBASE) now offers researchers the opportunity to examine changes in the distribution and abundance patterns of the dominant taxa found within our study area over time.

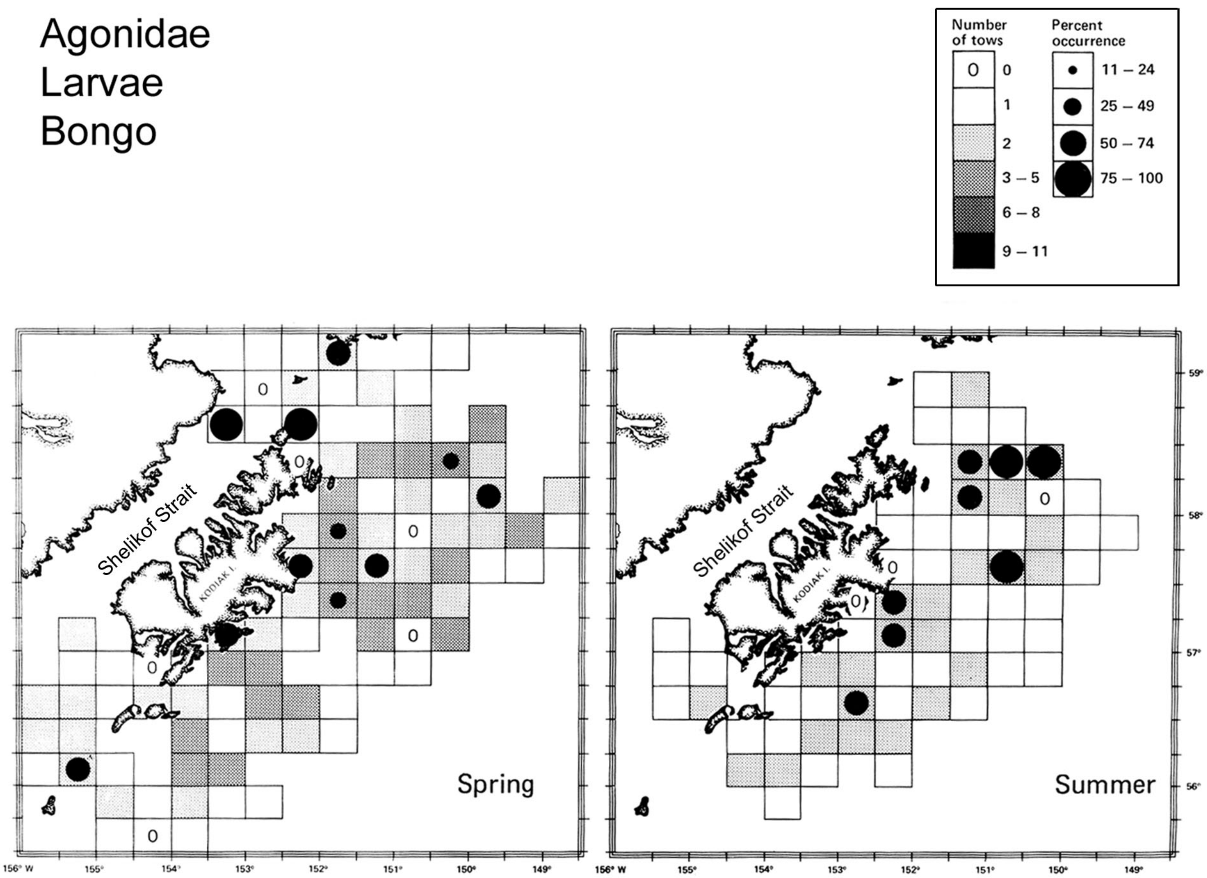
Kendall and Dunn (1985) reviewed ichthyoplankton studies off the continental shelf east of Kodiak Island, Alaska. Based on 11 cruises conducted during the 1970s (1972, 1977–1979), their objectives were to describe seasonal cycles of occurrence of larvae and geographical and seasonal distribution of the more abundant taxa. At that time, many larvae could be identified only to the family level. Taxa of some of the more speciose families (e.g., the family Agonidae representing about 25 species) were lumped and mapped together (Map 4). Seasonal distributional maps of families with many taxa are difficult to interpret since multiple taxa may spawn in different seasons or throughout the year. The five OCSEAP cruises were very limited in coverage, occupying a similar grid of stations along the east coast of Kodiak Island. For many taxa our knowledge of geographic distribution in the Northeast Pacific Ocean was limited to east of Kodiak Island. For example, the distributional map of larvae of *Anoplopoma fimbria* (sablefish) from Kendall and Dunn (1985) shows the extent of information we had by 1979 and how distributional data were mapped in the 1980s (Map 5).

Kendall and Dunn (1985) found walleye pollock larvae in spring and summer throughout the slope and shelf area around Kodiak Island (Map 6). In 1980, one year after the time period covered in that publication, a large spawning concentration of walleye pollock was discovered in Shelikof Strait. Throughout the following decade, we continued our studies in the Gulf of Alaska, but focused primarily on walleye pollock larvae spawned in Shelikof Strait. Large numbers of walleye pollock larvae were collected in the early 1980s from areas in and around Shelikof Strait (13,700/10 m^2; highest mean value in the 1980s as reported in Kendall and Picquelle, 1989) that were more than an order of magnitude higher than the mean number of larvae obtained from cruises during the 1970s outside of Shelikof Strait (228/10 m^2; highest mean value as reported in Kendall and Dunn, 1985). With the publication of a larval identification key (Matarese et al., 1981), we were able to routinely separate walleye pollock larvae from those of other gadids, particularly *Gadus macrocephalus* (Pacific cod), and, as a result, our knowledge of the early life history of walleye pollock in the Gulf of Alaska increased dramatically in the mid-1980s.

In 1989, Kendall and Picquelle summarized available data on distribution and abundance of walleye pollock in and around Shelikof Strait as a "backdrop for detailed FOCI studies investigating biological and physical factors influencing the annual survival of eggs and larvae." Based on 32 cruises (1972–1986), they determined overall patterns and centers of distribution for early life history stages of walleye pollock over five time intervals as the season progressed from early March through early June (Map 7). Geographic distributions of walleye pollock were further summarized by mapping their center of mass as centroids which were computed for total larvae by time interval, regardless of year (Map 8). Centroids were computed by stratifying the data into a regular grid and then computing the weighted average of the grid cell locations where the weights were the number of larvae in the grid cell.

Continuing the emphasis of our ichthyoplankton studies on identifying factors contributing to observed variations in recruitment of walleye pollock, Rugen[1] examined the larval fish community in the western Gulf of Alaska and identified what species co-occur with walleye pollock. He also examined seasonal changes in the ichthyoplankton community and updated the earlier work of Kendall and Dunn (1985). The data examined in his study were based on 30 cruises conducted 1972–1986

[1] Rugen, W. C. 1990. Spatial and temporal distribution of larval fish in the western Gulf of Alaska, with emphasis on the period of peak abundance of walleye pollock (*Theragra chalcogramma*). AFSC Proc. Rep. 90-01, 162 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE, Seattle WA 98115.



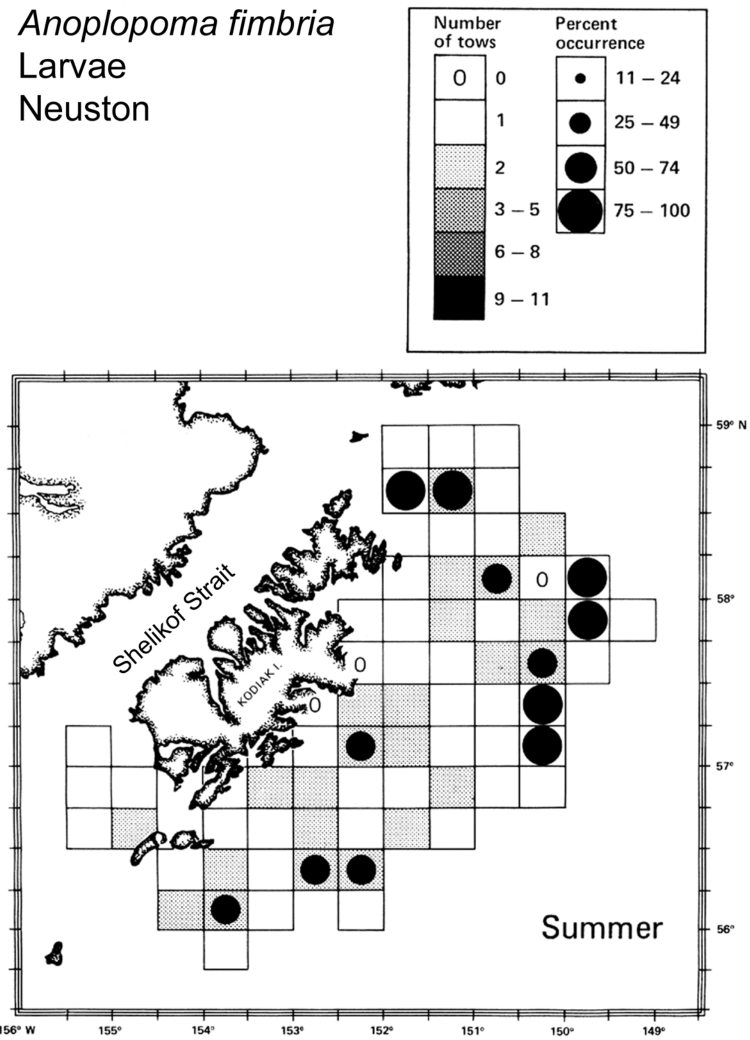
Map 4

Extent of knowledge of the geographic and seasonal distribution of Agonidae larvae collected in bongo nets covering 11 cruises near Kodiak Island, Alaska, 1972–1979 (after Fig. 52; Kendall and Dunn, 1985). Maps show sampling frequency and percent occurrence of larvae over area divided into rectangular cells, 0.25° latitude × 0.50° longitude. Left map shows distribution of larvae in the spring; right map shows distribution of larvae in the summer.

and included abundance maps showing changes in the extent of distributional data with an increased area of geographic coverage for various taxa collected with bongo gear. A comparison of the increase in our knowledge of the distribution patterns of *Ammodytes hexapterus* (Pacific sand lance) visually illustrates the increasing levels of understanding. In the 1970s Pacific sand lance appeared to be most abundant north, south, and east of Kodiak Island (Map 9, top map; Kendall and Dunn, 1985), but during the 1980s the extensive sampling in Shelikof Strait revealed that they were more abundant along the Alaska Peninsula (Map 9, bottom map; Rugen[1]). Distribution and abundance patterns for the entire data set (1972–1996) indicate that Pacific sand lance are ubiquitous in the Gulf of Alaska (see pages 218–219). Additional studies of the Gulf of Alaska springtime ichthyoplankton community based on data sets from the 1980s include Brodeur and Rugen (1994), who reported on the diel vertical distribution, and Doyle et al. (1995), who identified and described the neuston assemblage.

Doyle[2] examined data collected on 10 research cruises conducted jointly with the Soviet Pacific Research Institute (TINRO) in Vladivostok, Russia, 1980–1987, to determine seasonal and spatial distribution of ichthyoplankton from northern Washington to northern California (U.S. west coast). Relative abundance was summarized for the dominant taxa based on gear type and presented as maps for individual cruises along with a map of mean distribution (i.e., abundance summed over 10 cruises within a grid of 74 squares). Her objectives were to document occurrence, distribution, and abundance of ichthyoplank-

[2] Doyle, M. J. 1992. Patterns in distribution and abundance of ichthyoplankton off Washington, Oregon, and northern California (1980–1987). AFSC Proc. Rep. 92-14, 344 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE, Seattle WA 98115.

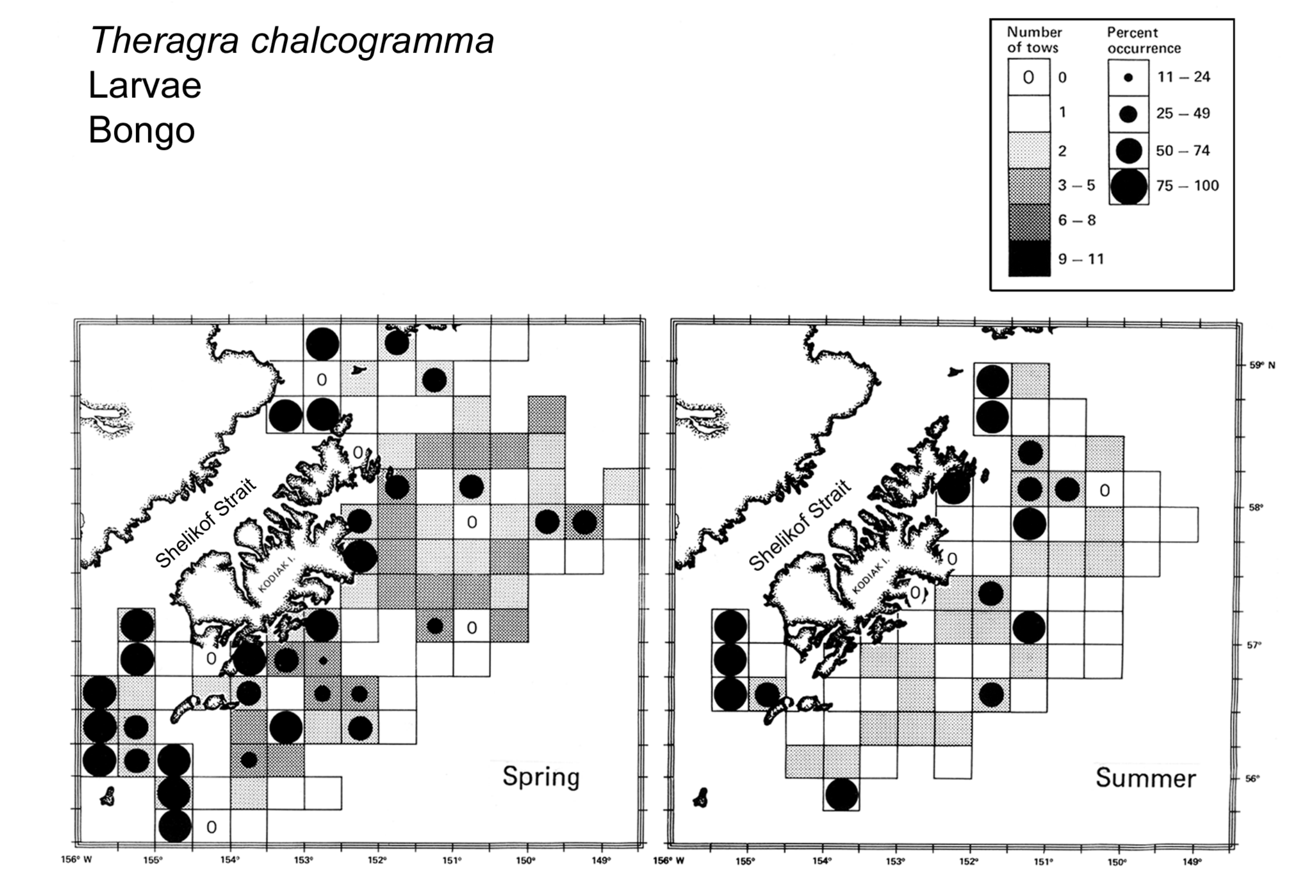


Map 5

Extent of knowledge of the geographic and seasonal distribution of *Anoplopoma fimbria* larvae collected in neuston nets covering 11 cruises near Kodiak Island, Alaska, 1972–1979 (after Fig. 30; Kendall and Dunn, 1985). Map shows sampling frequency and percent occurrence of larvae over area divided into rectangular cells, 0.25° latitude × 0.50° longitude.

ton from the surface and water column; identify and describe the occurrence and distribution of multi-species assemblages; and relate spatial and temporal patterns in the ichthyoplankton to the oceanographic patterns of the region. These were the first large-scale ichthyoplankton surveys conducted in this region and provided baseline distribution and abundance data and maps for many taxa (e.g., mean distribution of *Stenobrachius leucopsarus* (northern lampfish) (Doyle[2], Map 10). Based on these surveys, the occurrence of ichthyoplankton species in the neuston of this region is described in Doyle (1992), the effect of El Niño on ichthyoplankton abundance and distribution patterns off the U.S. west coast is investigated in Doyle et al. (1995), and the occurrence and distribution of larval fish assemblages off the U.S. west coast is compared with the occurrence and distribution of larval fish assemblages in the temperate zone of the Northwest Atlantic in Doyle et al. (1993).

In the 1990s, the majority of ichthyoplankton studies continued to focus on special studies to assist in the explanation and understanding of factors affecting the recruitment of walleye pollock. In 1996, FOCI biological and physical scientists collaborated on a synthesis volume that summarized our collective knowledge of the general



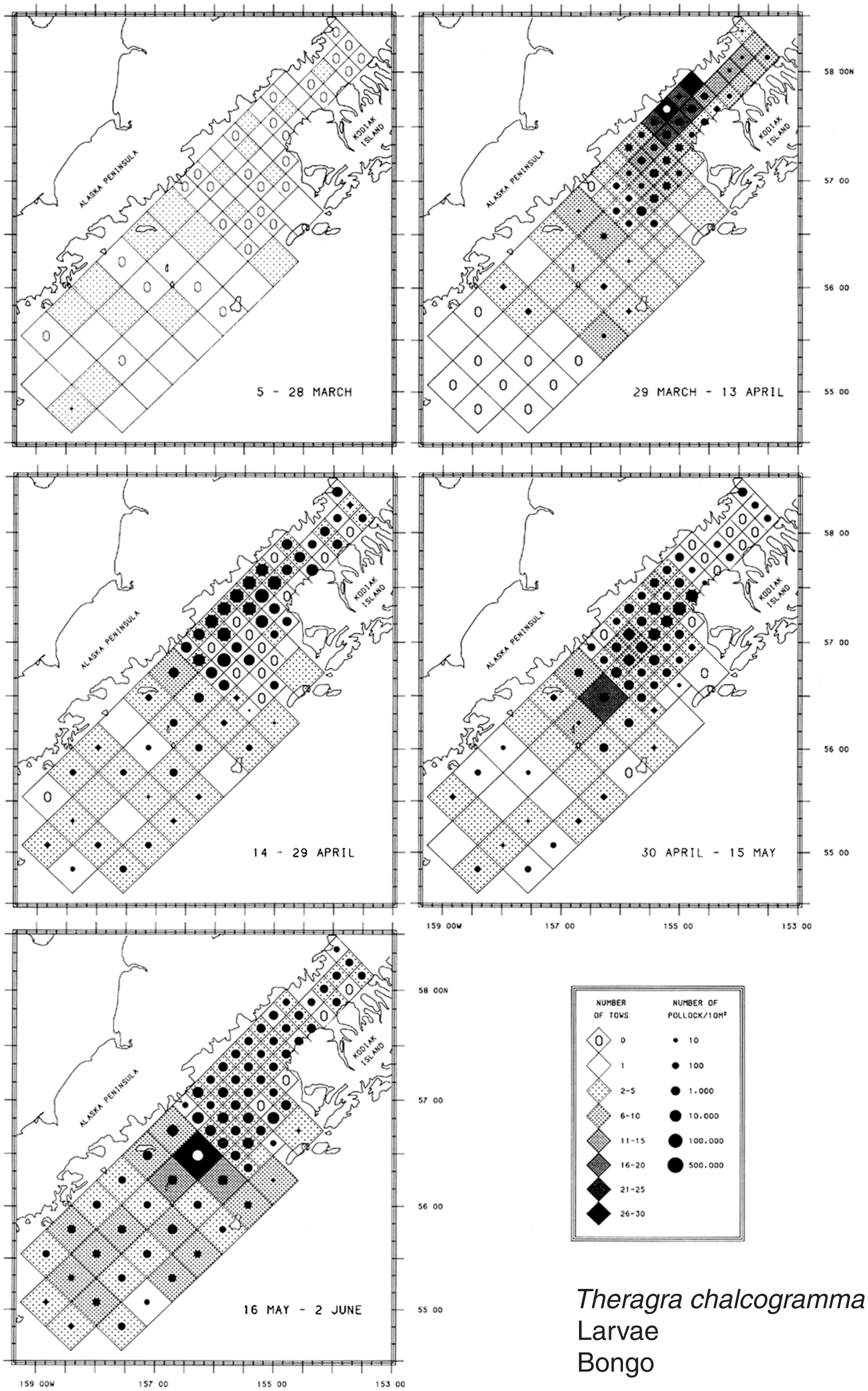
Map 6

Extent of knowledge of the geographic and seasonal distribution of *Theragra chalcogramma* larvae collected in bongo nets covering 11 cruises near Kodiak Island, Alaska, 1972–1979 (after Fig. 26; Kendall and Dunn, 1985). Maps show sampling frequency and percent occurrence of larvae over area divided into rectangular cells, 0.25° latitude × 0.50° longitude. Left map shows distribution of larvae in the spring; right map shows distribution of larvae in the summer.

life history of walleye pollock in the Gulf of Alaska (Kendall et al., 1996a). In late March and early April, adult walleye pollock spawn pelagic eggs that are about 1.4 mm in diameter at depths of 150–250 m. These eggs hatch in about 2 weeks at 5°C; the young larvae, about 4.5 mm standard length (SL), quickly rise to the upper 50 m of the water column where they drift during April and May to the south and west in the currents. Most of the larvae take one of two routes as they leave Shelikof Strait: along the Alaska Peninsula in the relatively slow-moving coastal waters or over the sea valley[3] in the more rapidly moving Alaska Coastal Current (ACC) (Kendall et al., 1996b). By late May, larvae have been transported to around Sutwik Island and by mid-summer they are distributed in patches both on the shelf and in near-shore regions along the Alaska Peninsula. FOCI has documented the life history pattern of walleye pollock in the Gulf of Alaska between the time of spawning migration and the development of the early juvenile stage (Map 11). The estimates of abundance and the studies of horizontal, vertical, and temporal distribution from the egg and larval surveys, as well as the collected knowledge from other FOCI researchers (i.e., estimates of the spawning adult population from hydroacoustic observations, identifications of processes that affect life stages, descriptions of the oceanic and atmospheric environment), have enabled FOCI to develop a conceptual model of walleye pollock survival that is useful in selecting variables to forecast recruitment (Megrey et al., 1996).

Although FOCI research covers every major life stage of walleye pollock, much emphasis has been on the

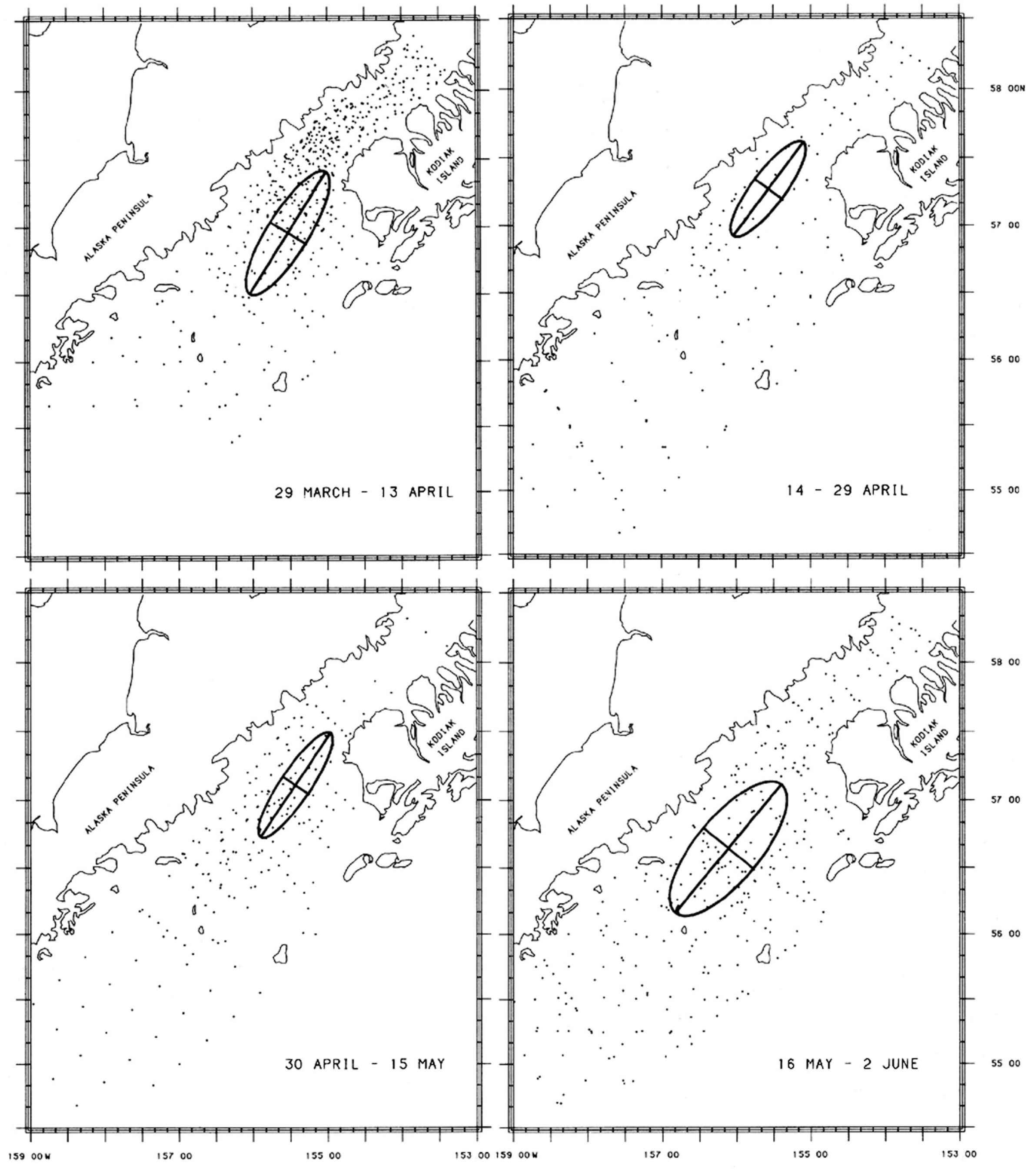
[3] Sea valley - On a continental shelf, a relatively shallow, wide depression with gentle slopes, the bottom of which grade continuously downward (Baker et al., 1966); a submarine valley; e.g., Shelikof sea valley, Gulf of Alaska; MacKay sea valley, Ross Sea. Allen Macklin. Personal commun. 2002. Office of Oceanic and Atmospheric Research, Pacific Marine Environmental Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115-6439.



Map 7

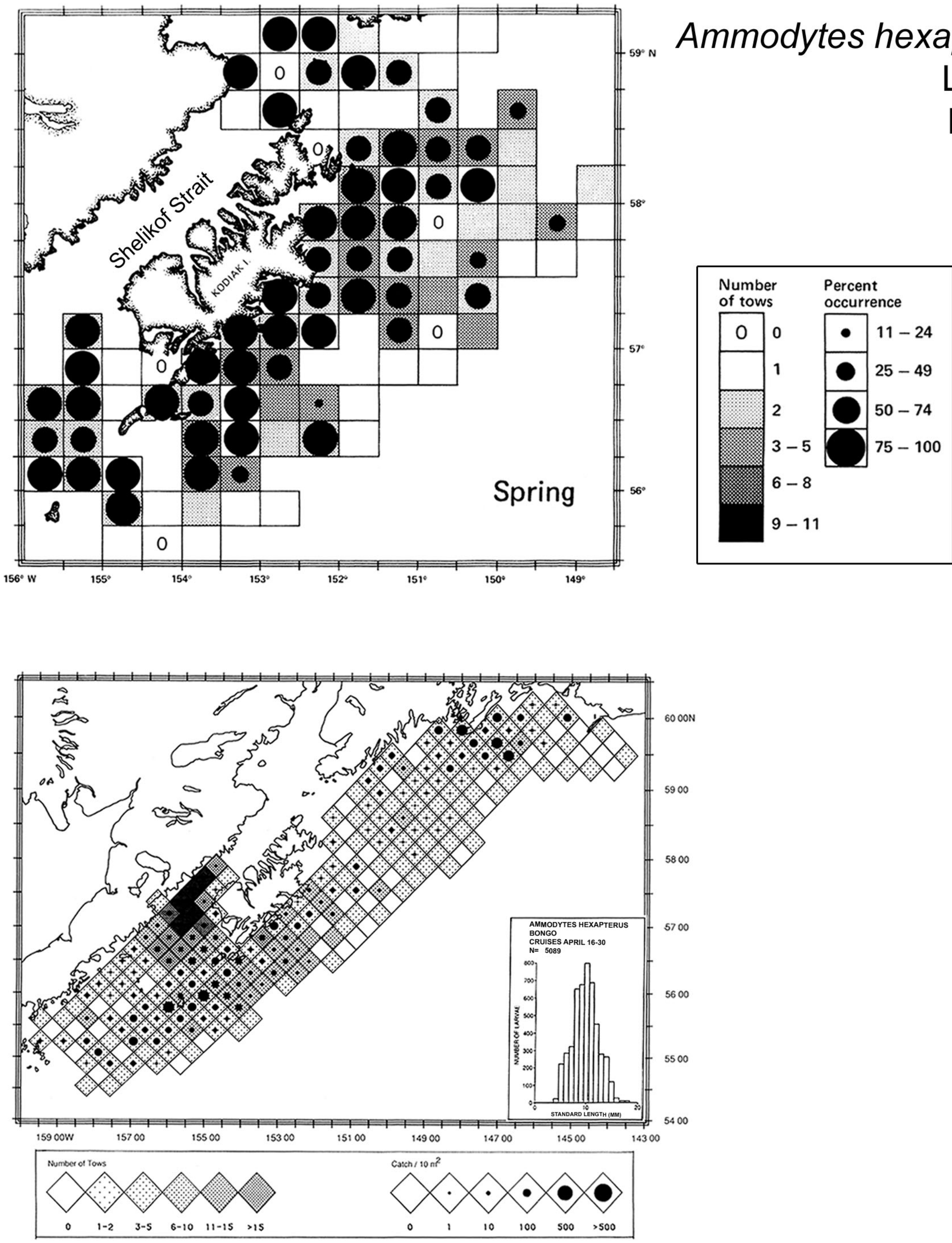
Geographic distribution of *Theragra chalcogramma* larvae collected in bongo nets covering 32 cruises in and around Shelikof Strait, Alaska, 1972–1986 (after Fig. 6; Kendall and Picquelle, 1989). Maps show sampling frequency and number of larvae occurring over five time intervals from early March through early June in sectors 10 × 10 nautical miles in Shelikof Strait and 20 × 20 nautical miles outside Shelikof Strait.

Theragra chalcogramma
Larvae
Bongo



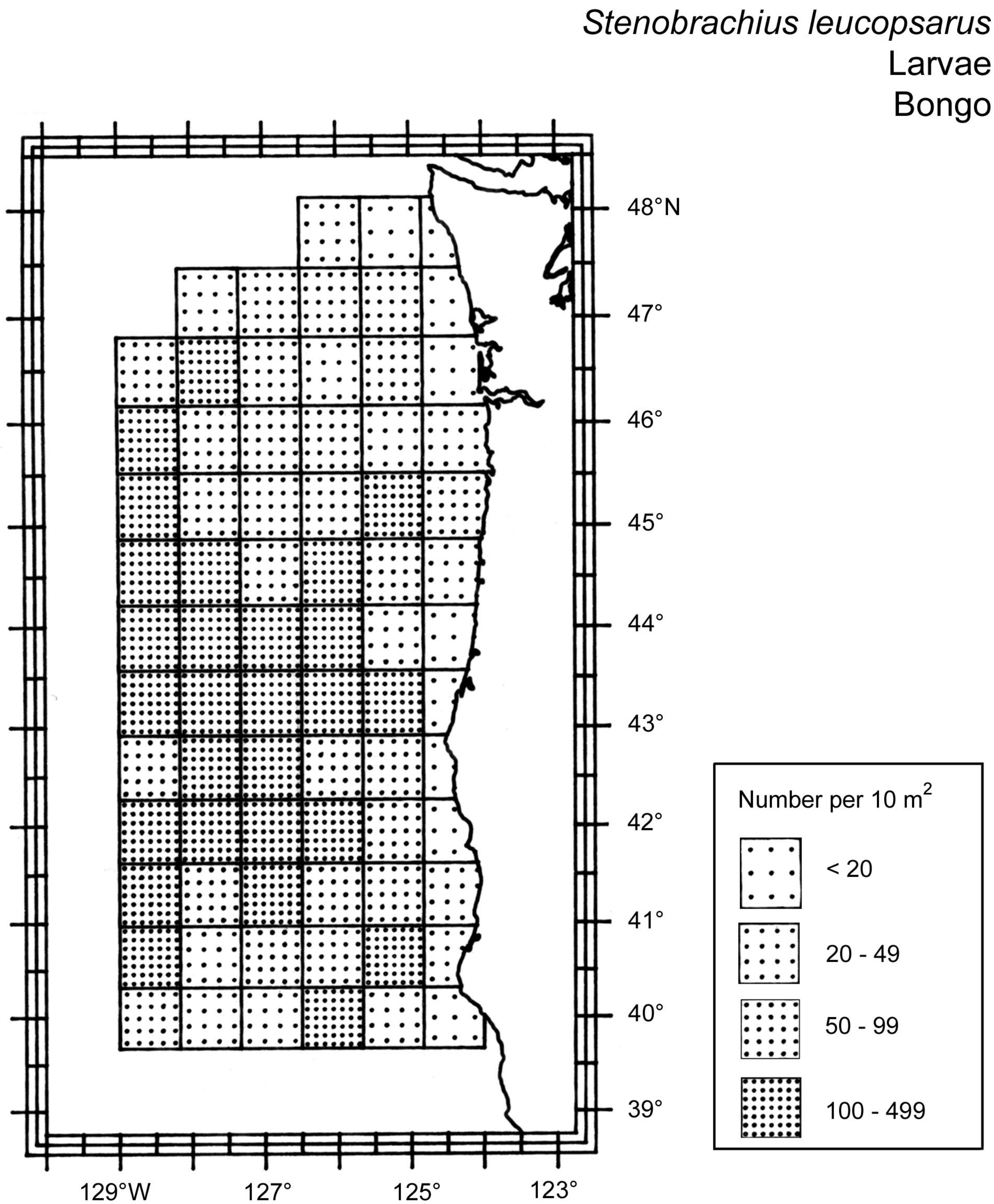
Map 8

Centers of geographic distribution of *Theragra chalcogramma* larvae collected in bongo nets covering 32 cruises in and around Shelikof Strait, Alaska, 1972–1986 (after Fig. 7; Kendall and Picquelle, 1989). Maps show center of mass of larvae over four time intervals from late March through early June; perimeter of centroid equals one standard deviation from the center of mass.



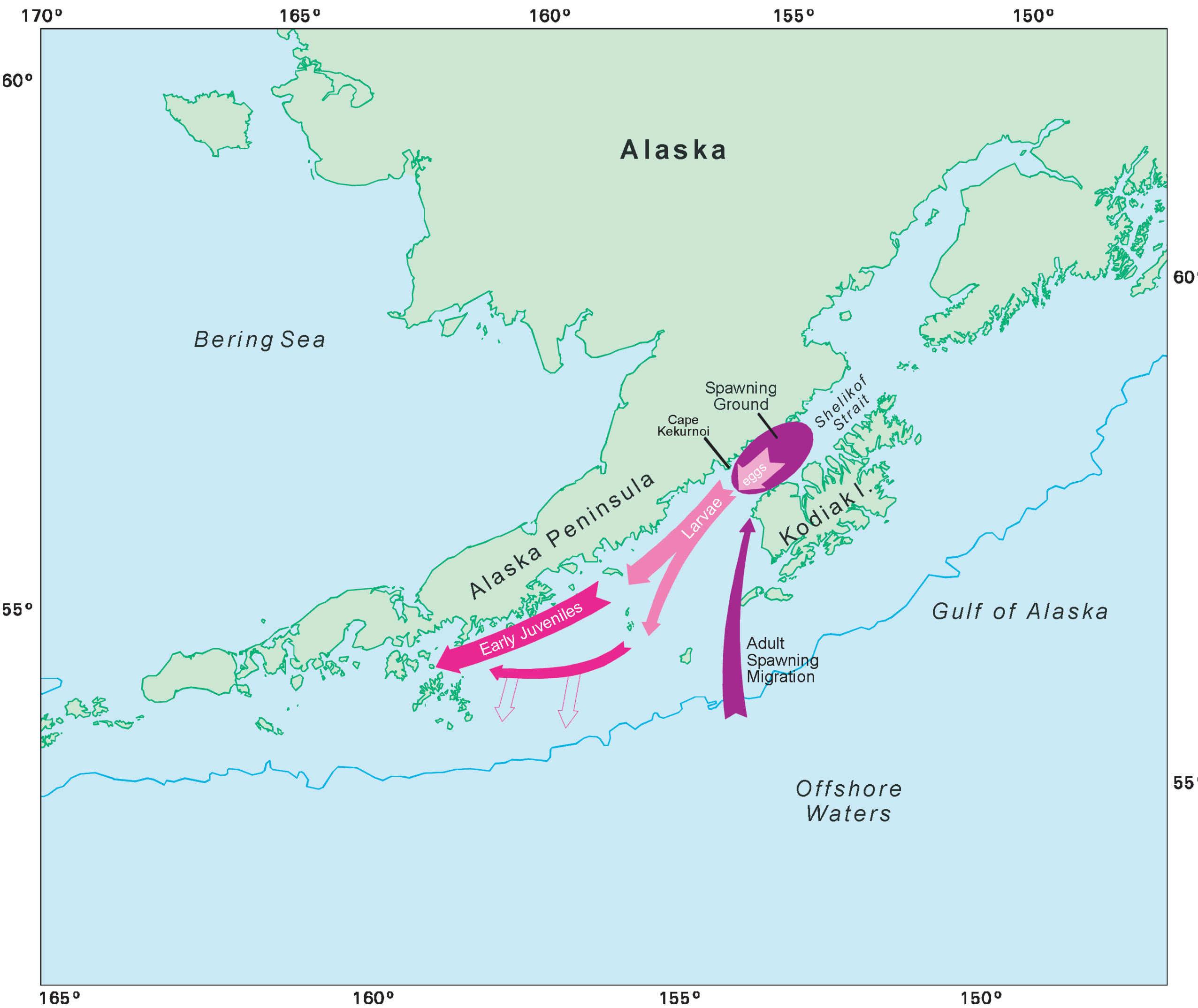
Map 9

Changes in extent of larval distributional data with increased area of geographic coverage. Top map: *Ammodytes hexapterus* larvae collected in spring in bongo nets covering 11 cruises near Kodiak Island, Alaska, 1972–1979 (after Fig. 65; Kendall and Dunn, 1985). Map shows sampling frequency and percent occurrence of larvae over area divided into rectangular cells, 0.25° latitude × 0.50° longitude. Bottom map: *Ammodytes hexapterus* larvae collected April 16–30 in the northern Gulf of Alaska (after Fig. 44b; Rugen text footnote 1). Map shows sampling frequency and catch/10 m^2 within 215 mi^2 sectors and length distribution for the two-week period.



Map 10

Mean distribution of *Stenobrachius leucopsarus* larvae collected in bongo nets covering 10 cruises off the U.S. west coast, 1980–1987 (after Fig. 74a; Doyle text footnote 2).



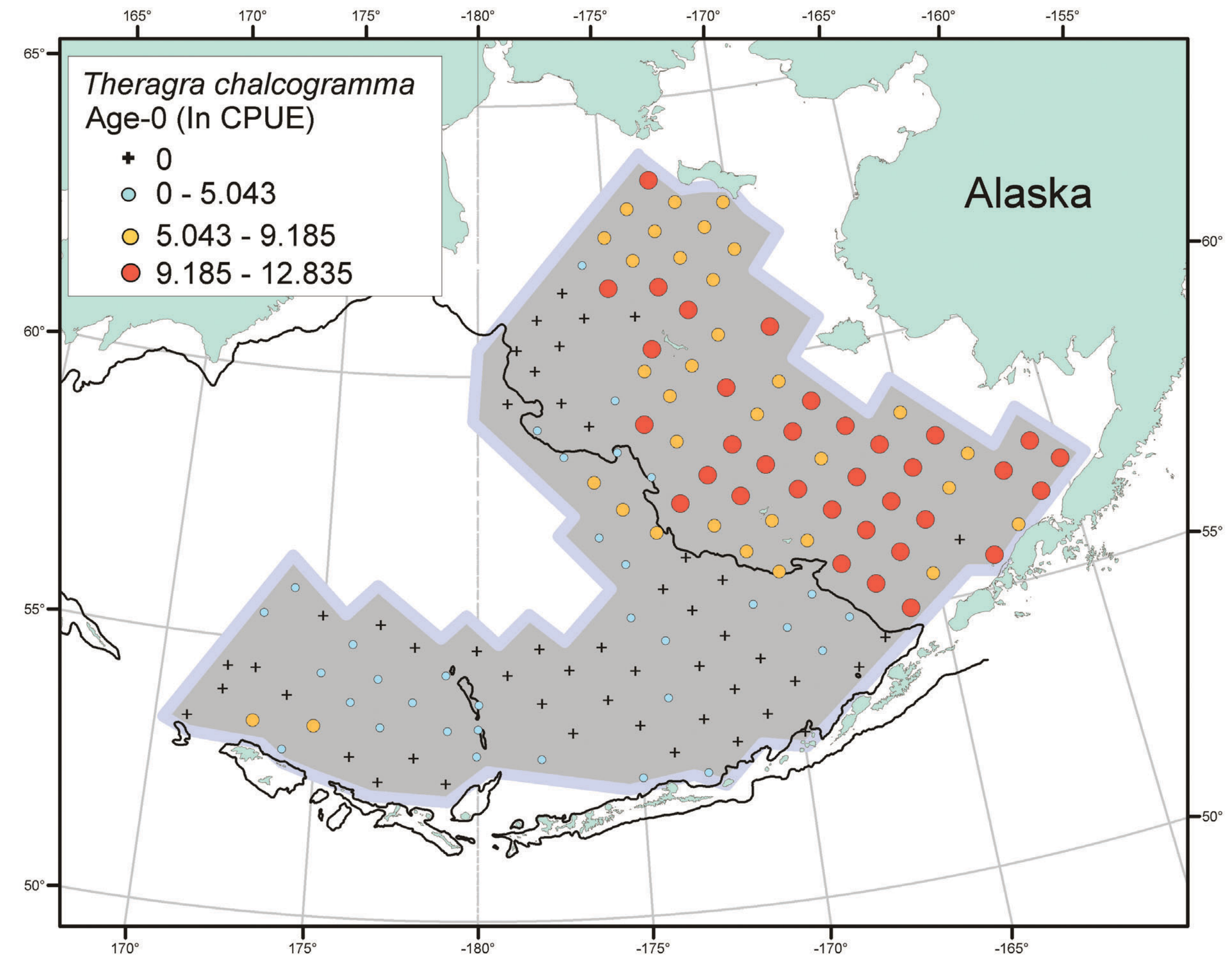
Map 11

General features of early life history of *Theragra chalcogramma* (walleye pollock) in Shelikof Strait, Alaska (after Fig. 1b; Kendall et al., 1996b).

first year of life. More recently, studies have expanded to include later stages of development. For example, research in the eastern Bering Sea has focused on the age-0 juveniles to ascertain distribution and abundance patterns along the slope and shelf regions during late summer. Brodeur et al. (1999) found that the distribution of age-0 walleye pollock biomass was skewed toward the shelf region (Map 12).

Taxonomic knowledge

The increase in our taxonomic knowledge over the last 30 years has allowed our basic knowledge of the zoogeography of species to be expanded and fine-tuned. Of the 635 known fish species that occur in the Northeast Pacific Ocean, we can currently identify early life history stages for 291 (Busby et al., 2000). Instead of mapping geographic distribution patterns for families, we can now map and analyze specific distribution patterns for individual species. Based on Busby (1998), we can update the distribution patterns of several members of the family Agonidae from earlier publications (e.g., *Bathyagonus alascanus* = Agonidae (Map 4) and *Podothecus acipenserinus* = Agonidae A (Map 13) from Kendall and Dunn (1985); see pages 162–163 and 176–177 for updated distributions). Generic distribution patterns from previous studies can also be updated to include individual species (e.g., *Hemilepidotus* spp. updated to

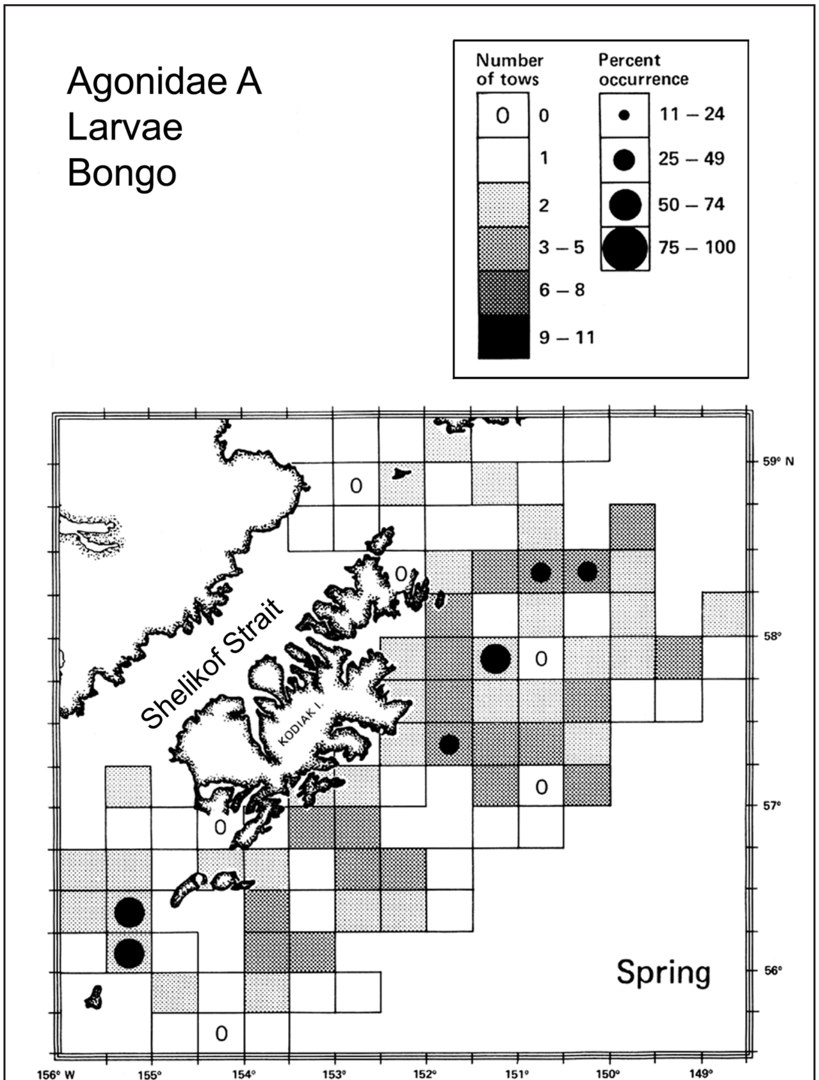


Map 12

Distribution and abundance of juvenile *Theragra chalcogramma* in late summer, 1987, in the eastern Bering Sea (after Fig. 3a; Brodeur et al., 1999; gray background equals area of coverage).

Hemilepidotus hemilepidotus; Map 14; see pages 142–143). When new species are described (e.g., *Lepidopsetta polyxystra* recently described by Orr and Matarese (2000)), previously published species distributions that we now know include data representing distribution patterns of two species can be re-evaluated (e.g., *Lepidopsetta bilineata* distribution from Kendall and Dunn (1985); Map 15). Larvae collected prior to the publication of Orr and Matarese (2000) were re-identified and new maps of each species were generated (see pages 240–241 and 242–243). Since re-identification is not possible for the adult data set, the updated larval map of *Lepidopsetta polyxystra* provides the most complete historical distributional data set for the newly described species.

Changes in the sampled species composition and dominant taxa of the Northeast Pacific ichthyoplankton community have occurred during the 30-year period as taxonomic knowledge increased, geographic coverage was expanded, and different gear types were used (Table 1). The dominant taxa collected in the bongo net based on rank abundance as reported in Kendall and Dunn (1985) were Osmeridae, *Hexagrammos* spp., *Theragra chalcogramma*, *Hemilepidotus* spp., *Mallotus villosus*, and *Bathymaster* spp. With the 1980s Gulf of Alaska data from Rugen[1] added, the dominant taxa in the bongo net changed significantly to *Theragra chalcogramma*, *Ammodytes hexapterus*, *Bathymaster* spp., Osmeridae, *Sebastes* spp., and *Hemilepidotus* spp., with several new taxa added to the list (*Hippoglossoides elassodon*, *Gadus macrocephalus*, *Lepidopsetta bilineata,* and *Atheresthes stomias)*. Based on Doyle[2], the dominant taxa collected from the bongo net off the U.S. west coast included, among others, *Stenobrachius leucopsarus*, *Diaphus theta*, *Sebastes* spp., and *Engraulis mordax*. Combining all years and geographic



Map 13

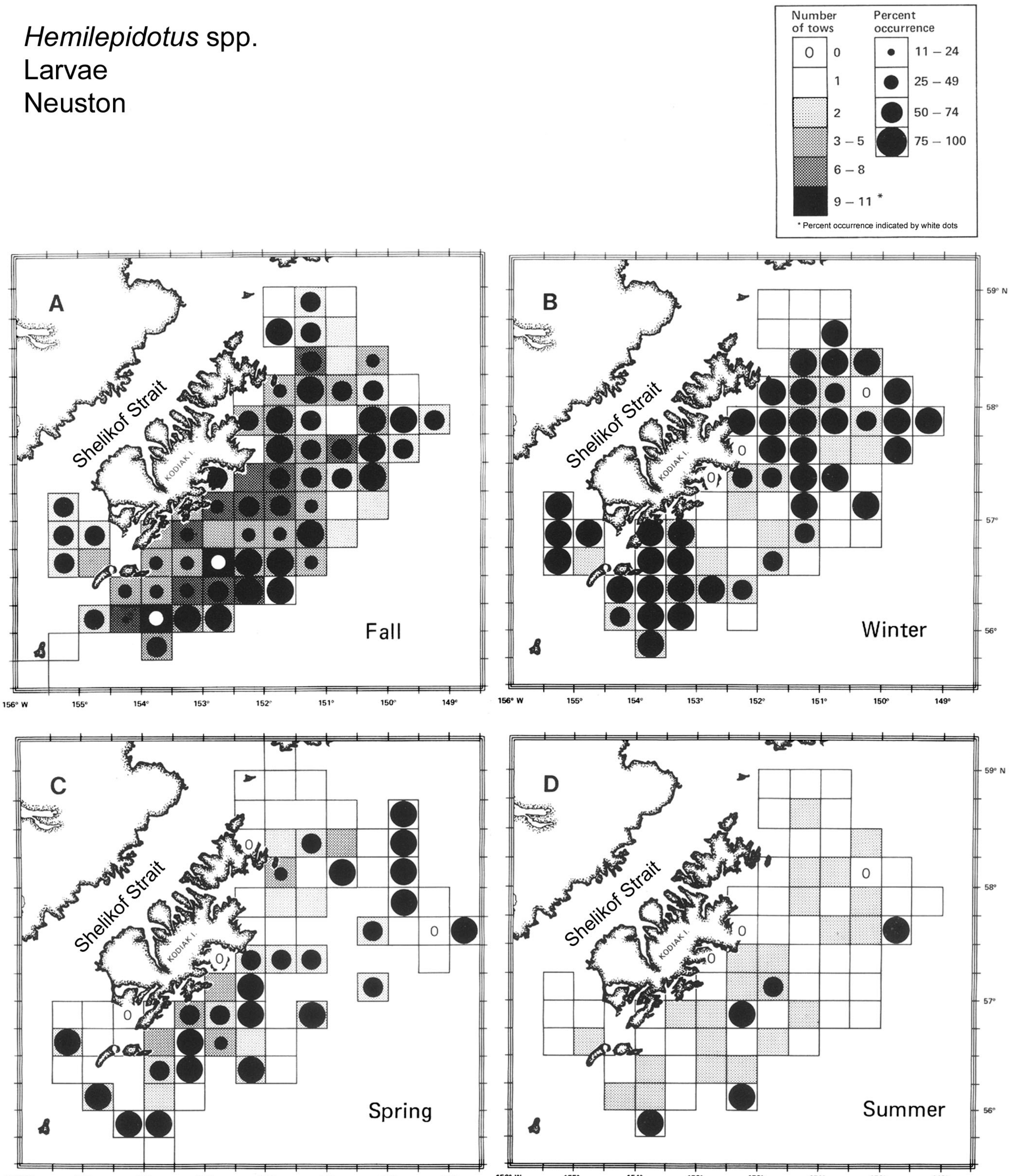
Extent of knowledge of the geographic and seasonal distribution of larvae of the family Agonidae A (= *Podothecus acipenserinus*) collected in bongo nets covering 11 cruises near Kodiak Island, Alaska, 1972–1979 (after Fig. 53; Kendall and Dunn, 1985). Map shows sampling frequency and percent occurrence of larvae over area divided into rectangular cells, 0.25° latitude × 0.50° longitude.

regions with sampling conducted during the 1990s, only one new species (*Lepidopsetta polyxystra)* was added to the group of taxa that had been previously dominant.

Overview of the physical oceanographic environment

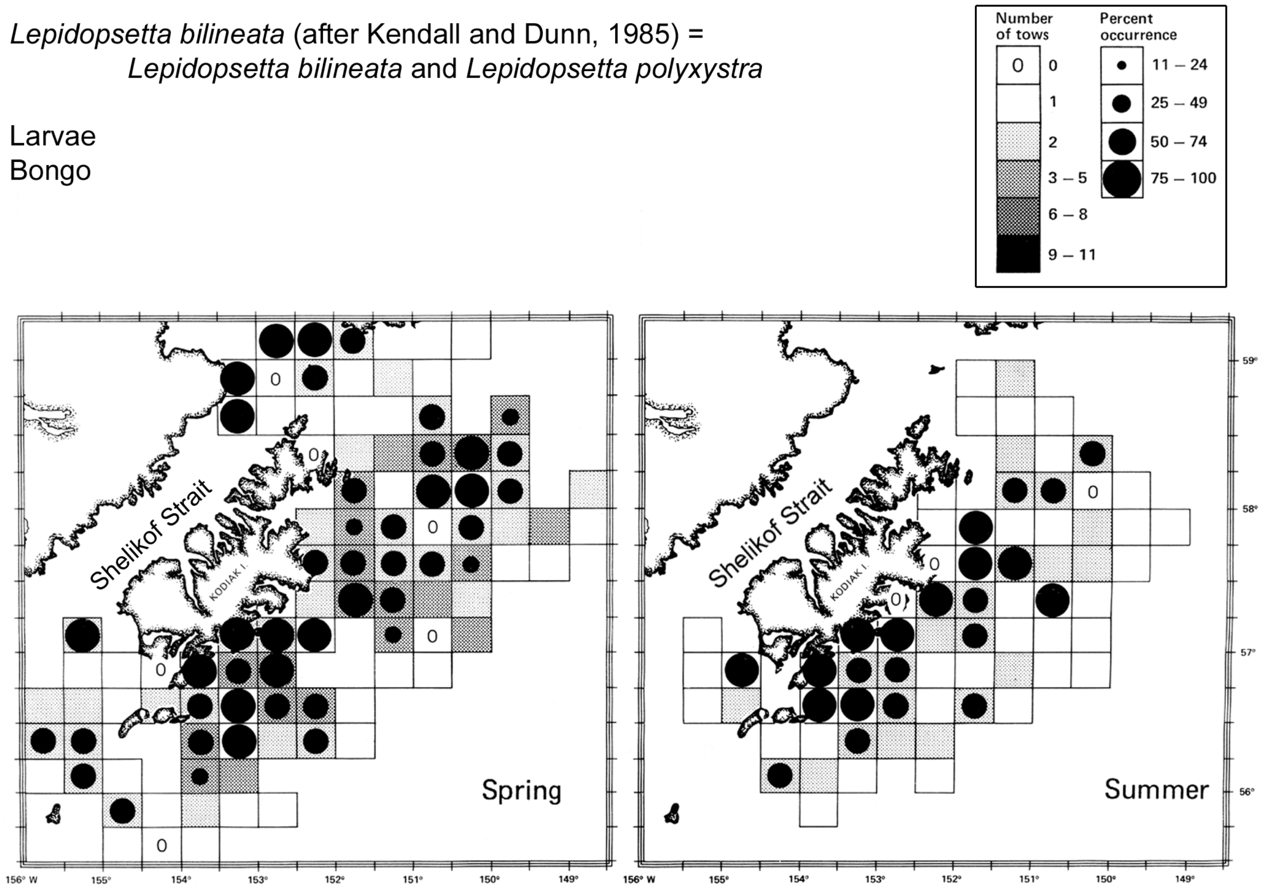
The abundance patterns of ichthyoplankton for three major ecosystems are summarized: the eastern Bering Sea (EBS), western Gulf of Alaska (GOA), and the U.S. west coast. An overall description of the physical and oceanographic characteristics of these three ecosystems is summarized below (Doyle et al., 2002).

The eastern Bering Sea is characterized by an exceptionally broad (>500 km) shelf region with a narrow continental slope adjoining an extensive Aleutian Basin (Map 16). The EBS shelf is one of the most productive regions in the world and sustains a high biomass of higher trophic level organisms (Loughlin et al., 1999). Circulation in the basin is generally cyclonic and is fed by inflow from the Alaskan Stream through the Aleutian Islands (Schumacher and Stabeno, 1998) (Map



Map 14

Extent of knowledge of the geographic and seasonal distribution of *Hemilepidotus* spp. (= *Hemilepidotus hemilepidotus*) larvae collected in neuston nets covering 11 cruises near Kodiak Island, Alaska, 1972–1979 (after Fig. 45; Kendall and Dunn, 1985). Maps show sampling frequency and percent occurrence of larvae over area divided into rectangular cells, 0.25° latitude × 0.50° longitude.

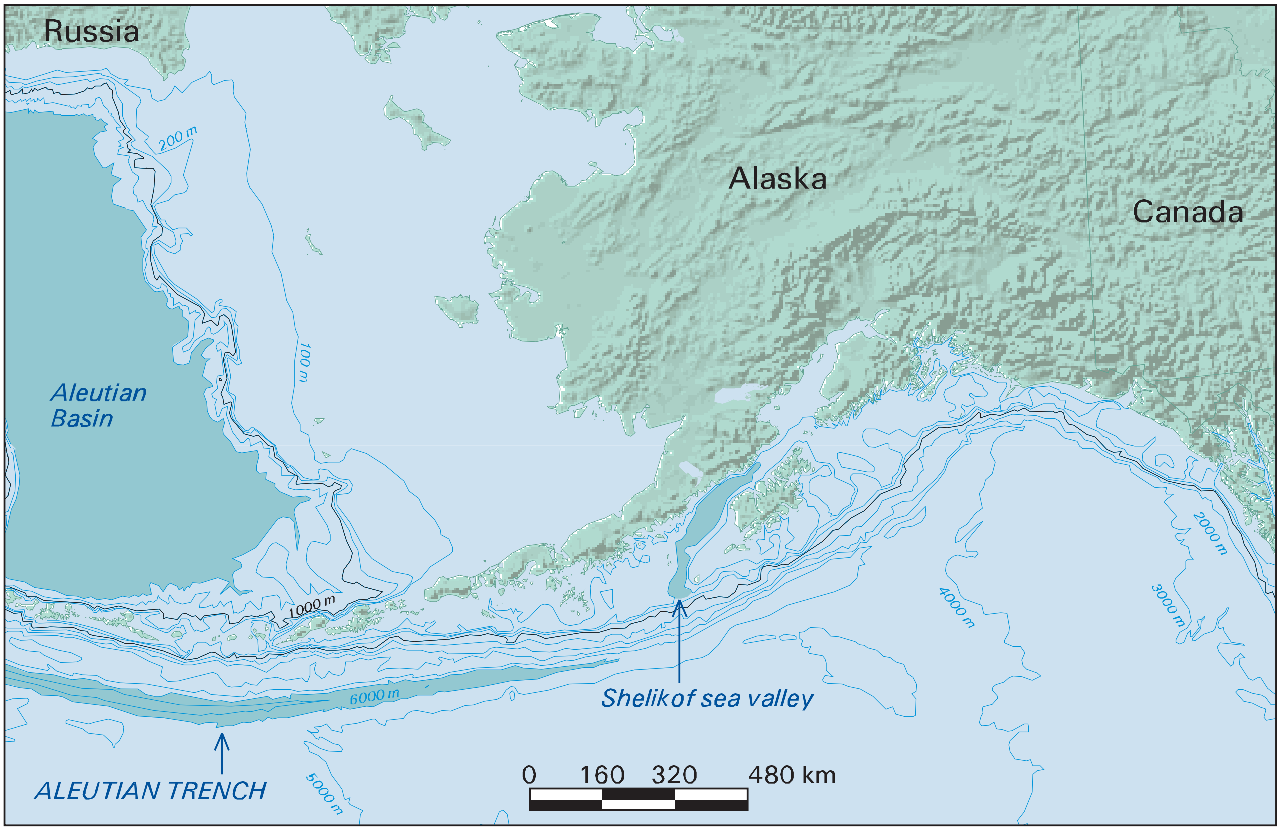


Map 15

Extent of knowledge of the geographic and seasonal distribution of *Lepidopsetta bilineata* (= *L. bilineata* and *L. polyxystra*) larvae collected in bongo nets covering 11 cruises near Kodiak Island, Alaska, 1972–1979 (after Fig. 77; Kendall and Dunn, 1985). Maps show sampling frequency and percent occurrence of larvae over area divided into rectangular cells, 0.25° latitude × 0.50° longitude. Left map shows distribution of larvae in the spring; right map shows distribution of larvae in the summer.

17). Flow is greatest in the Bering Slope Current, which transports nutrients onto the outer shelf. Flow over the shelf itself is generally weak and large eddies are a common feature. Ice covers a substantial portion of the EBS each winter and spring, although there is considerable interannual variation in the duration and extent of ice coverage. There are three recognized biophysical domains on the shelf, separated by frontal boundaries at roughly the 50 m, 100 m, and 200 m isobaths, which differ hydrographically depending on the degree of stratification and mixing. Productivity appears to be highest at the shelf-break front and phytoplankton blooms there can begin in May and last throughout the summer (Springer et al., 1996). Zooplankton production is estimated to be highest along the shelf edge and outer shelf where the mesozooplankton consists primarily of large oceanic copepod species.

Numerous troughs and shallow banks characterize the topography of the western Gulf of Alaska. The Aleutian shelf area, as defined by the 200 m isobath, is narrower than the EBS shelf (65–175 km) and drops abruptly to depths of 5000–6000 m in the Aleutian Trench, which parallels the shelf edge (Map 16). The Alaskan Stream, which flows southwesterly and roughly parallel to the shelf break at 50–100 cm/sec, dominates offshore, near-surface circulation (Map 17). Nearshore, the Alaska Coastal Current (ACC) is the dominant feature (Reed and Schumacher, 1986). The upper layer flows in a southwesterly direction. With surface speeds of 25–100 cm/sec, the ACC in the vicinity of Shelikof Strait is one of the most vigorous and dynamic coastal currents in the world (Stabeno et al., 1995). Temperatures follow a clear seasonal pattern, with the coldest values occurring in March and the warmest values in August (Reed and



Map 16

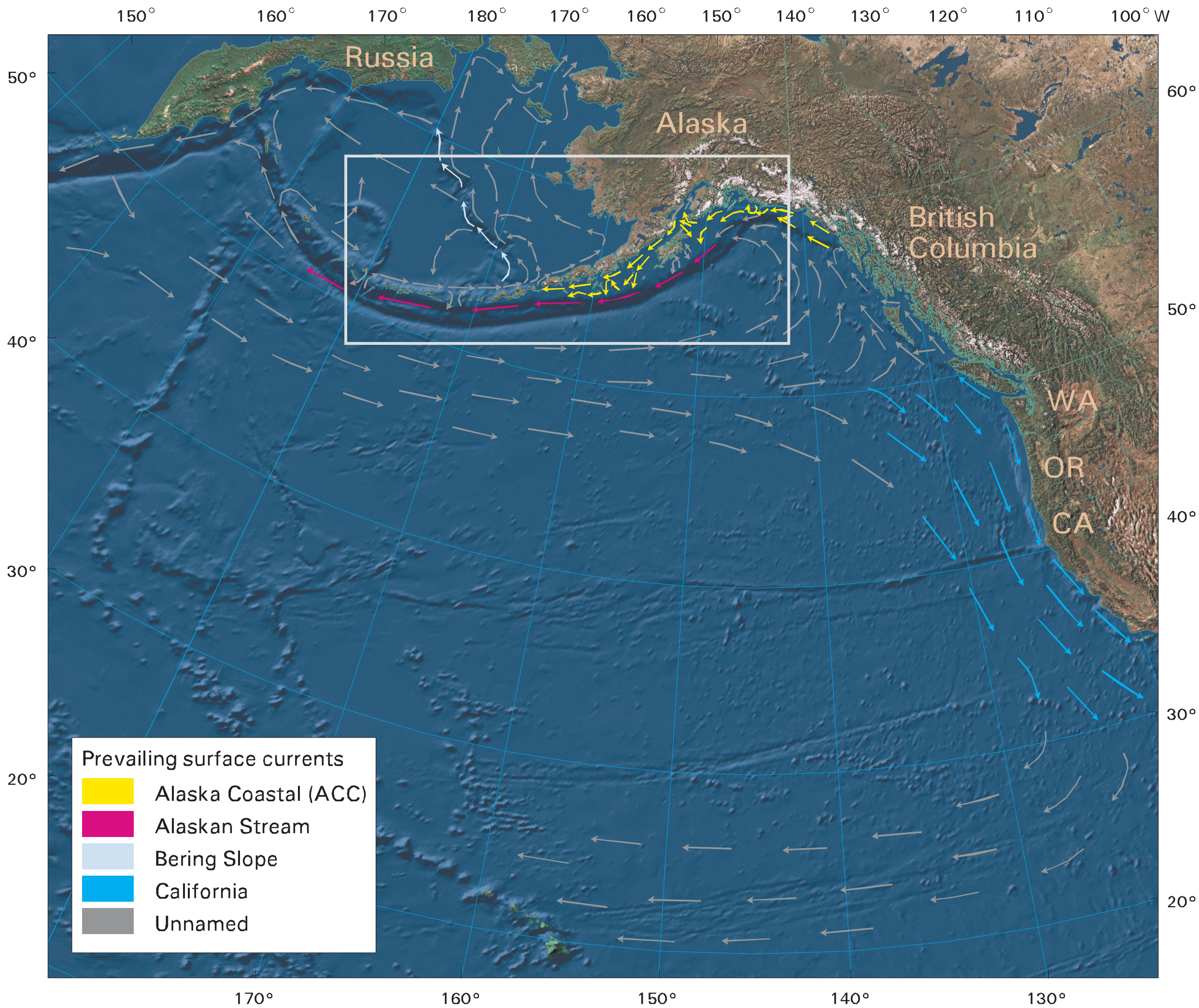
Bathymetry of the eastern Bering Sea and Gulf of Alaska. Aleutian Basin, Aleutian Trench, and Shelikof sea valley are shaded; 1000 m bathymetry contour line is black.

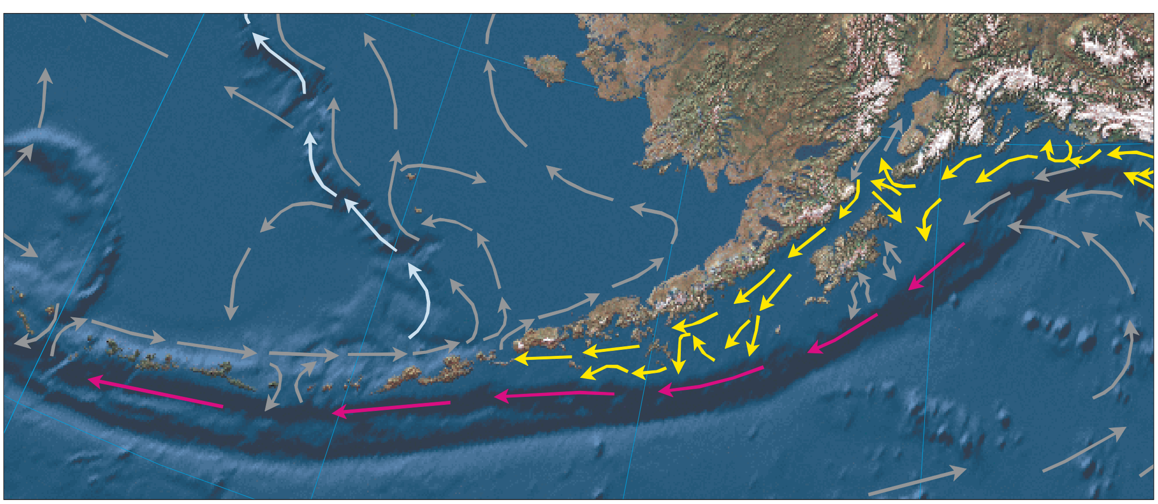
Table 1

Ichthyoplankton rank abundance (average catch per 10 m^2) for taxa collected by bongo nets for the 1970s (Gulf of Alaska), 1980s (Gulf of Alaska and U.S. west coast), and cumulative years 1972–1996 (all areas combined). With 1970s–Gulf Alaska as a baseline, bolded entries in each column indicate first occurrence on list of dominant taxa.

1970s—Gulf of Alaska[1]	1980s—Gulf of Alaska[2]	1980s—U.S. West Coast[3]	Cumulative, 1972–1996—all areas
Osmeridae	*Theragra chalcogramma*	*Stenobrachius leucopsarus*	*Theragra chalcogramma*
Hexagrammos spp.	*Ammodytes hexapterus*	***Diaphus theta***	*Ammodytes hexapterus*
Theragra chalcogramma	*Bathymaster* spp.	*Sebastes* spp.	Gadidae
Hemilepidotus spp.	Osmeridae	***Engraulis mordax***	*Bathymaster* spp.
Mallotus villosus	*Sebastes* spp.	***Bathylagus ochotensis***	*Stenobrachius leucopsarus*
Bathymaster spp.	*Hemilepidotus* spp.	***Tarletonbeania crenularis***	*Hippoglossoides elassodon*
Leuroglossus schmidti	***Hippoglossoides elassodon***	Osmeridae	*Gadus macrocephalus*
Stenobrachius leucopsarus	***Gadus macrocephalus***	***Lyopsetta exilis***	***Lepidopsetta polyxystra***
Sebastes spp.	***Lepidopsetta bilineata***[4]	***Protomyctophum crockeri***	*Sebastes* spp.
Stenobrachius spp.	*Mallotus villosus*	**Myctophidae**	Osmeridae
Ammodytes hexapterus	***Atheresthes stomias***	***Citharichthys* spp.**	*Atheresthes stomias*
Hexagrammos stelleri	*Stenobrachius leucopsarus*	***Bathylagus pacificus***	*Diaphus theta*

1 Based on Kendall and Dunn (1985).
2 Based on Rugen (text footnote 1).
3 Based on Doyle (text footnote 2).
4 *Lepidopsetta bilineata* (after Kendall and Dunn, 1985) = *Lepidopsetta bilineata* and *Lepidopsetta polyxystra*.



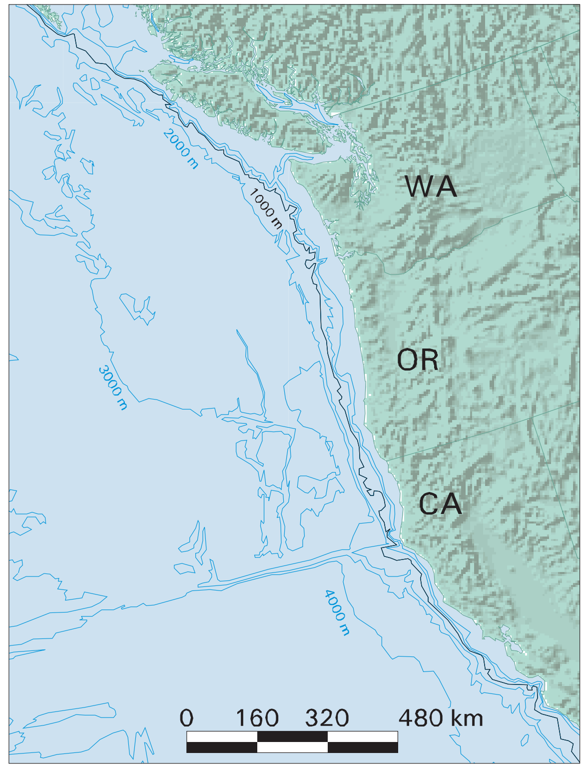


Map 17

Prevailing surface currents in the Bering Sea, Gulf of Alaska, and eastern North Pacific Ocean. Inset shows enlargement of surface currents in Alaskan waters.

Schumacher, 1986). Freshwater discharge into coastal waters peaks in the fall and strongly affects the circulation (Royer, 1998). This region has been referred to as the Coastal Downwelling Domain and is characterized by mainly onshore flow at the surface (Ware and McFarlane, 1989). A seasonal peak in phytoplankton production occurs first in the ACC and then in the adjacent shelf area during the first week in May (Napp et al., 1996). Production of copepod nauplii and other zooplankton usually accelerates significantly at this time, but, because of low temperatures and low concentrations of gravid adults, does not reach a maximum until mid-summer (Cooney, 1987).

In contrast to the EBS and the western GOA, the continental shelf is narrow off the U.S. west coast (Map 18). Off Washington and northern Oregon, the shelf width is less than 70 km, whereas off southern Oregon and northern California it narrows to less than 30 km, reaching a minimum of about 10 km off Cape Mendocino. A series of submarine canyons transect the shelf and slope off Washington and California. These canyons are absent off Oregon where rocky submarine banks are found along the shelf. The U.S. west coast is part of an extensive Coastal Upwelling Domain extending from Baja California to southern British Columbia (Ware and McFarlane, 1989). The oceanography of this region is characterized by the California Current system, a typical eastern boundary current regime (Hickey, 1989; 1998) (Map 17). The main California Current proceeds southwards along the U.S. west coast and is slow, meandering, broad, and indistinct. Prevailing winds cause downwelling close to the coast in winter and upwelling of cold, nutrient-laden, oceanic water close to the coast in summer. The intensity of Ekman transport and associated upwelling is variable along the coast and tends to increase from north to south with a local maximum at Cape Mendocino off northern California (Parrish et al., 1981). Annual sea-surface temperature minimums and salinity maximums generally occur in summer after sustained upwelling-favorable winds. Phytoplankton blooms occur during relaxed upwelling conditions between peak upwelling periods during spring and fall (Small and Menzies, 1981). A zone of high zooplankton standing stock is generally observed 10–30 km offshore in summer and the community is dominated by copepods (Landry and Lorenzen, 1989).



Map 18

Bathymetry of the North Pacific Ocean off the U.S. west coast; 1000 m bathymetry contour line is black.

Special studies

During the 30-year history of the Recruitment Processes Program, many ichthyoplankton surveys were planned to investigate specific questions, especially those pertaining to walleye pollock recruitment. Often station patterns designed to answer specific scientific questions (e.g., 24-hr diel sampling to investigate changes in diet or sampling around a drifter to follow a larval patch) were followed in lieu of a baseline grid pattern over a large-scale area. Some of these special investigations required gear other than the standard 60-cm bongo array (e.g., discrete depth sampling was accomplished using 1-m Tucker trawls or MOCNESS gear, and planktonic fish eggs were collected with a 20-cm bongo array). Generally, those studies using bongo gear were more effective in describing interannual differences in abundance and distribution of fish eggs and larvae.

Many surveys in the early 1980s were designed to sample and quantify walleye pollock eggs. Eggs were subsequently identified and staged, leading to studies on egg mortality, distribution, abundance, development, and adult spawning biomass using the egg production method (Kendall and Kim, 1989; Kim and Kendall, 1989; Picquelle and Megrey, 1993; Blood et al., 1994; Brodeur et al., 1996). As knowledge of the larval stage increased, specific studies were conducted to investigate larval feeding, predation, condition, growth, and hatch date distributions (see Kendall et al., 1996a, for more detailed information on special studies). Other studies in the Gulf of Alaska and Bering Sea Shelf were added to investigate late larvae and juvenile walleye pollock in summer (Hinckley et al., 1991; Brodeur et al., 1995; Brodeur et al., 1999). These special studies targeting specific research questions were not always useful in describing large-scale distribution and abundance patterns.

Ongoing investigations

FOCI studies on walleye pollock and their ecosystem continue in the Gulf of Alaska and the eastern Bering Sea. For the Gulf of Alaska, FOCI conducts process studies and annual larval surveys and incorporates these data into recruitment estimates for walleye pollock (Megrey et al., 1996). Correlation modeling methods have been developed to analyze hydroacoustic survey results of spawning aggregations, ichthyoplankton surveys of larvae, estimates of spawning biomass and recruitment from annual stock assessment, measurements of ocean temperature, winds, rainfall, sea-level pressure gradient, and other biological and physical factors (Megrey et al., 1995). Present studies in the Bering Sea seek to document the role of walleye pollock in the eastern Bering Sea ecosystem, including their interaction with seabirds and marine mammals. Goals are to examine the factors that affect juvenile walleye pollock survival and develop and test annual indices of pre-recruitment abundance. The Northeast Pacific Global Ocean Ecosystems Dynamics Program (GLOBEC) was added to the Recruitment Processes Program in 1998. Goals for the GLOBEC-supported investigations included a retrospective study to identify dominant taxa and multispecies assemblages in the ichthyoplankton, describe their horizontal distribution patterns, and relate these patterns to the oceanographic variables (Doyle et al., 2002). These assemblages are being further investigated as to temporal variation in their composition, distribution, and abundance. In addition, we are examining temporal variability in the occurrence, abundance, and distribution of many numerically dominant (e.g., *Atheresthes stomias,* arrowtooth flounder) and ecologically important (e.g., *Mallotus villosus*, capelin) ichthyoplankton species. Other studies are also investigating advective processes associated with onshore transport of ichthyoplankton, developing cross-shelf exchange tracers composed of offshore ichthyoplankton assemblages, and identifying key species that may be indicators of changes in oceanographic conditions or cross-shelf flow. Early in the development of these studies we undertook the challenge to produce a comprehensive atlas of the distribution and abundance patterns of dominant fish species that are important components of the ichthyoplankton assemblage. This atlas will provide baseline data as a reference for the above work and will serve as a companion to our laboratory guide (Matarese et al., 1989).

Information and data sources

Sampling protocol

The data used in this study were collected during ichthyoplankton surveys conducted from 1972 to 1996 by the Recruitment Processes Program (see Appendix Table 1). Sampling conducted during the years 1973–1976 was not incorporated. Collection data for cruises conducted up to 1988 can be found in Dunn and Rugen[4], and for those cruises conducted from 1989 to 1996, in the AFSC ichthyoplankton cruise database (Rugen[5]). The majority of the data are from samples collected using a MARMAP bongo sampler (Posgay and Marak, 1980) with an inside diameter of 60 cm and a 0.333 or 0.505- mm mesh net. Before 1985, standard MARMAP oblique tows were made to 200 m following MARMAP sampling procedures (Smith and Richardson, 1977). In 1985, sampling depth in the Gulf of Alaska was changed to near bottom in order to accurately determine the abundance of walleye pollock eggs and early larvae. Beginning in the early 1990s, annual larval surveys in the Gulf of Alaska in late May sampled to 100 m because that is where the larvae are found in the water column. Flowmeters suspended in the mouths of the nets of all ichthyoplankton gear were used to determine the volume of water filtered by each net. Data from 1-m Tucker trawls were used only for cruises where Tucker trawls were the primary gear (6 cruises, 312 tows; see Appendix Table 1).

A Sameoto neuston sampler (Sameoto and Jaroszynski, 1969), with a mouth opening 0.3 m high × 0.5 m wide and a 0.505-mm mesh net, was used sporadically throughout the time series to collect eggs and larvae that reside in the upper surface waters. A partial summary and analysis of our spring neuston collections from the Gulf of Alaska (1981–1986) are presented in Doyle et al. (1995). A summary and analysis of our neuston collections off the U.S. west coast are presented in Doyle (1992). In comparison to bongo collections presented here (Appendix Table 1), Table 2 presents an overall summary, based on the standard data set for 1972–1996, of the 20 most common taxa collected with neuston gear and arranged by percent frequency of occurrence. Some taxa were much more abundant in one geographic area over another (e.g., *Cololabis saira* and *Scorpaenichthys marmoratus* were more abundant in the U. S. west coast surveys than in the Gulf of Alaska). Data from the neuston were selected for

[4] Dunn, J. R., and W. C. Rugen. 1989. A catalog of Northwest and Alaska Fisheries Center ichthyoplankton cruises 1965–1988. AFSC Proc. Rep. 89-04, 87 p. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE, Seattle WA 98115.

[5] Rugen, W. C. 2000. Alaska Fisheries Science Center Ichthyoplankton Cruise Database [Online]. Available: URL: http://161.55.120.17/icc/openframe.cfm (access date – June 2001)

Table 2

Ranked frequency of occurrence (FO) of the 20 most common larval fish taxa collected in neuston nets from Recruitment Processes Program survey cruises 1972–1996. Abundance (per 10 m^2 of sea surface) is included. Total number of Sameoto neuston tows = 3011.

Taxon	No. positive hauls	Percent FO	Sum of catch/10 m^2	Avg. catch/10 m^2
Hexagrammos decagrammus	1385	46.00	637.652	0.212
Hexagrammos stelleri	384	12.75	75.230	0.025
Anoplopoma fimbria	382	12.69	74.945	0.025
Cryptacanthodes aleutensis	341	11.33	142.190	0.047
Hemilepidotus spp.	341	11.33	267.906	0.089
Cololabis saira	325	10.79	24.615	0.008
Hemilepidotus hemilepidotus	322	10.69	99.288	0.033
Bathymaster spp.	306	10.16	830.176	0.276
Hexagrammos lagocephalus	266	8.83	152.912	0.051
Sebastes spp.	263	8.73	42.836	0.014
Ammodytes hexapterus	257	8.54	236.692	0.079
Hexagrammos octogrammus	238	7.90	56.265	0.019
Pleurogrammus monopterygius	212	7.04	109.330	0.036
Hemilepidotus spinosus	211	7.01	73.237	0.024
Scorpaenichthys marmoratus	177	5.88	13.273	0.004
Mallotus villosus	160	5.31	30.691	0.010
Hemilepidotus jordani	103	3.42	8.203	0.003
Hexagrammos spp.	102	3.39	15.344	0.005
Theragra chalcogramma	100	3.32	24.469	0.008
Stichaeidae	90	2.99	4.870	0.002

some taxa for which the best geographic distribution pattern was described using surface gear (e.g., *Anoplopoma fimbria*, hexagrammids, and *Hemilepidotus* spp.). When the best distribution pattern and catch information for a particular taxon was not described by either gear, both bongo and neuston data were used. For nine taxa, only neuston data were used and for five taxa, data from both neuston and bongo gear were used to generate maps and graphs (Table 3).

The sampled population is defined as fish in the size range that is effectively caught by the sampling gear, and may include both larvae and juveniles because the transformation point between these two stages is unknown for many species and fish were staged inconsistently over the years. The number of individuals caught in each of the three sampling gears (i.e., bongo, neuston, and Tucker) was standardized to number caught per 10 m^2 of surface area. Catches from bongo and Tucker gear were standardized based on net mouth area and tow depth and length (Smith and Richardson, 1977). We assumed that bongo and Tucker gear sample essentially the same population and thus we allow data from these two gears to be combined. This assumption is supported by Shima and Bailey (1994), who concluded that the fish-length-specific sampling effectiveness of these two gears is not significantly different. This is contrary to Pepin and Shears (1997), who concluded that, in general, bongo nets catch more small larvae and fewer large larvae than Tucker trawls. However, they used a larger mesh size than we did, hence their results do not directly apply to our

Table 3

Taxa collected by neuston nets covered in this atlas.

Family	Taxon
Scomberosocidae	*Cololabis saira**
Anoplopomatidae	*Anoplopoma fimbria*
Hexagrammidae	*Hexagrammos decagrammus**
	Hexagrammos lagocephalus
	Hexagrammos octogrammus
	Hexagrammos stelleri
	Ophiodon elongatus
	*Pleurogrammus monopterygius**
Cottidae	*Hemilepidotus hemilepidotus**
	Hemilepidotus jordani
	Hemilepidotus spinosus
	*Scorpaenichthys marmoratus**
Cryptacanthodidae	*Cryptacanthodes aleutensis*
	Cryptacanthodes gigantea

* An atlas page based on larval distribution in bongo nets is also presented for this species (see Bongo Collections by Family section).

data. Both gears were fished at similar depth ranges and it was assumed that no individuals occurred below the depth sampled by the gear, thus the number caught per 10 m^2 of surface area represents the total number of individuals in the water column below a surface area of 10 m^2. Some of the Tucker tows were depth stratified; that is, the two nets sampled two contiguous depth intervals. In these cases, the catch per 10 m^2 from both nets was summed to integrate over the depths sampled by both nets. Samples collected by neuston gear were standardized to number caught per 10 m^2 of surface area based on net mouth width and tow length. Neuston data are usually represented as number per 1000 m^3, but we chose to scale the data to surface area because that describes the number of animals in a specified area of the neuston layer. In comparing neuston catches and bongo catches per unit area, the neuston catches are much smaller because the volume of water filtered is much smaller. The neuston net effectively samples the top 15 cm of the surface layer, hence animals occurring below this depth are not sampled. It was assumed that most individuals of neustonic species occur in the top 15 cm, although many species migrate vertically in and out of the neuston.

Plankton samples were preserved in the field using a 5% formalin-seawater solution buffered with calcium carbonate chips or sodium borate; after 1983, fish larvae were transferred to 70% alcohol after formalin fixation. All fish eggs, larvae, and juveniles have been removed and identified to the lowest possible taxon since 1980 at the Plankton Sorting and Identification Center in Szczecin, Poland (Fig. 1). Identifications are verified by the taxonomic team at AFSC using information found in Matarese et al. (1989) and supplemented by a number of more recent publications including Moser (1996a), Busby (1998), and Orr and Matarese (2000). Up to 50 individuals per species per tow are measured to the nearest 0.1 mm SL. Prior to 1980, only species that were routinely abundant or economically important were measured.

Geographic coverage

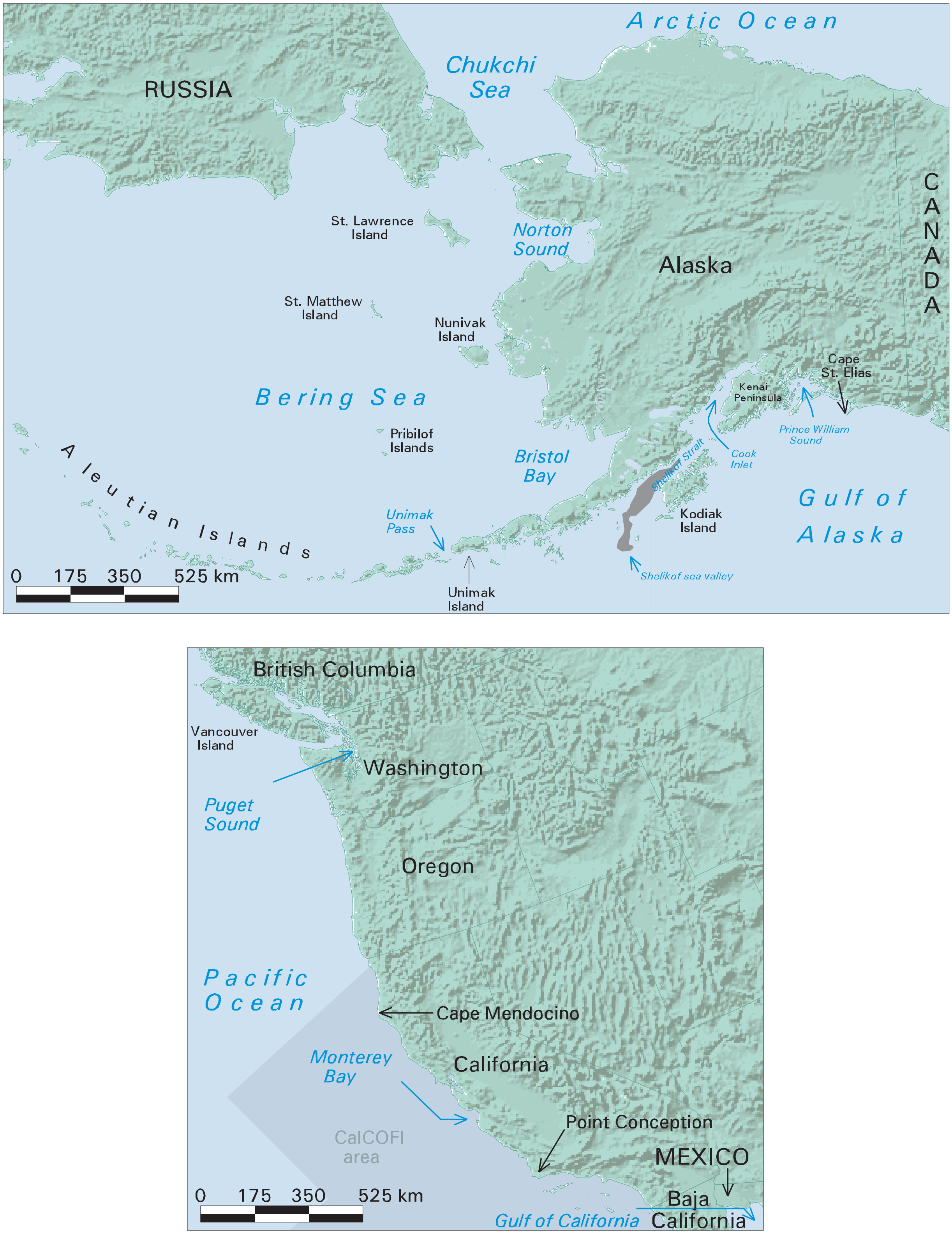
The study area extends from the Bering Sea, into the Gulf of Alaska, and along the U.S. west coast (Map 19). Most of the sampling throughout the time series occurred in Shelikof Strait and west toward the sea valley (Map 20). Repeated sampling was more extensive with bongo/Tucker gear than with neuston gear (Maps 21 and 22). Coverage is most complete in the Gulf of Alaska (except for 1980 when no sampling occurred there; Fig. 2) and less extensive in the Bering Sea and off the U.S. west coast. Coverage is also more complete along shelf regions and less extensive in deeper ocean waters where mesopelagic and deepwater flatfishes spawn. No ichthyoplankton sampling occurred in the Northeast Pacific in Canadian waters. Most of the 625 km^2 grid cells were sampled 1–10 times.

Most of the data used in this study were obtained from bongo tows taken during April and May. Combined bongo tows and Tucker trawls during these two months account for 52–79% of the yearly total, depending on geographic region (Fig. 3a). Data from neuston tows were more evenly distributed throughout the year, with tows made during April and May accounting for 0–54% of the yearly total in each region (Fig. 3b). The distribution of combined bongo tows/Tucker trawls and neuston tows by year and geographic region further illustrates the extensive coverage in the Gulf of Alaska and the 11-yr period (1977–1987) of routine use of neuston gear (Figs. 4a and b).

The degree to which our knowledge of occurrence and distribution patterns of larvae of key species has increased over the past three decades is best illustrated by viewing maps generated using presence/absence data for walleye pollock. During the 1970s, our knowledge of distribution patterns for walleye pollock larvae indicated that they were sporadically present east of Kodiak Island, along the Shelikof sea valley, and widely distributed in the Bering Sea (Map 23, top map and adjacent graph). The discovery of a large springtime spawning population in Shelikof Strait in 1980 dramatically altered our sampling strategy. The sampling distribution map and graph for the 1970s (Map 1) show how our knowledge was hampered by insufficient sampling in the season and area of peak abundance. Sampling in the 1980s was in the northern Gulf of Alaska, especially in Shelikof Strait. Increased sampling demonstrated that larvae were present throughout the western Gulf of Alaska around Kodiak Island and into the Southeast Bering Sea (Map 23, center map and adjacent graph). Sampling off the U.S. west coast showed a presence of walleye pollock off the Washington and Oregon coast. Our increased sampling in the Bering Sea in the 1990s was demonstrated by the wide presence of walleye pollock larvae in the Southeast Bering Sea over the slope and shelf areas (Map 23, bottom map and adjacent graph).

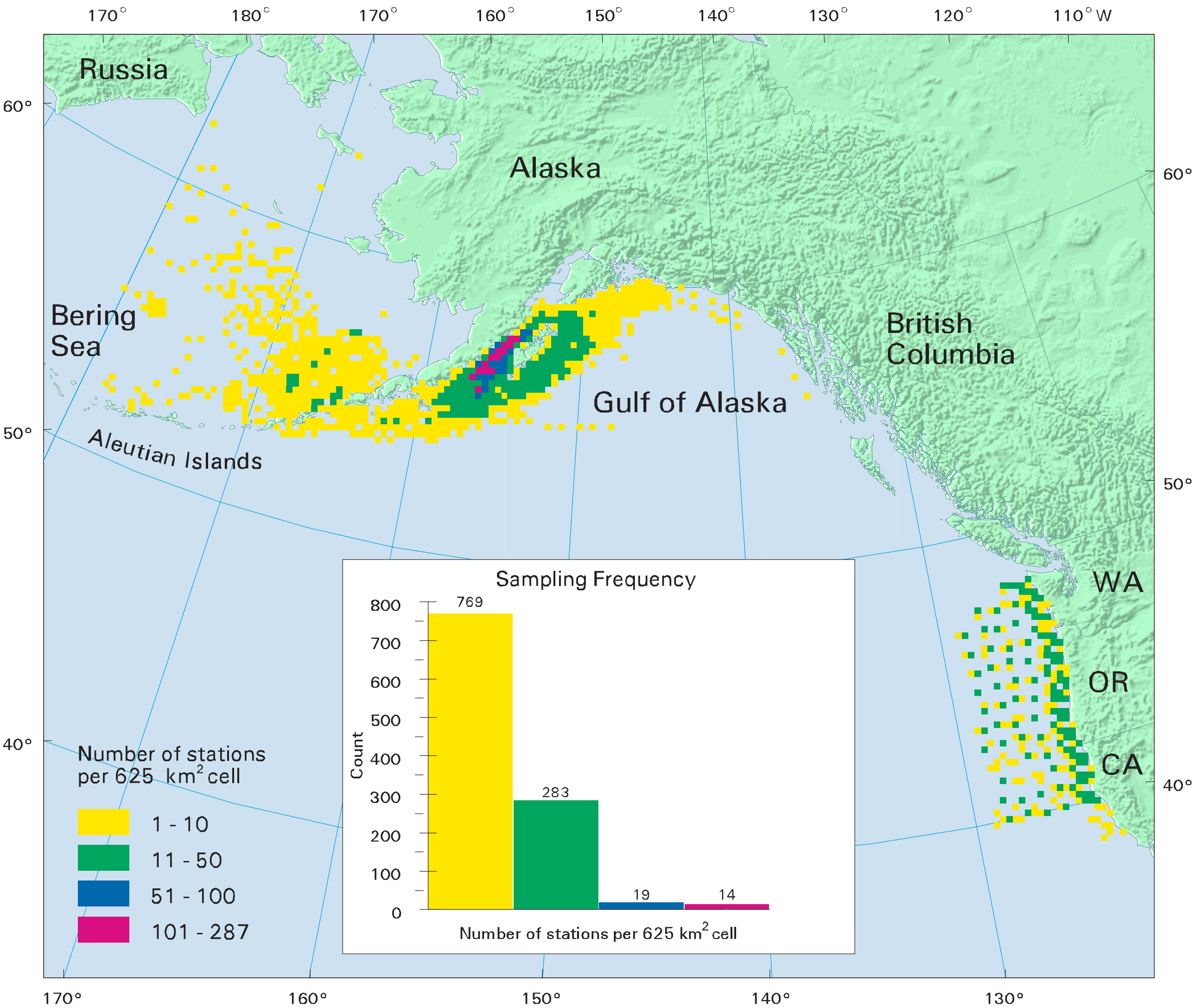
Taxonomic coverage

Larvae The complete list of larval fish taxa collected from Recruitment Processes Program cruises 1972 through 1996 used for initial consideration in the atlas is presented in Appendix Table 2. A total of 225 taxa was identified from the study area. Of these, taxa were selected for inclusion based on careful consideration of several criteria. Initially, taxa were ranked according to overall frequency of occurrence and then ranked by average abundance per 10 m^2. All taxa with an average abundance >5/10 m^2 and a frequency of occurrence >1% were further considered. This list was further refined by eliminating some above-species-level categories, such as



Map 19

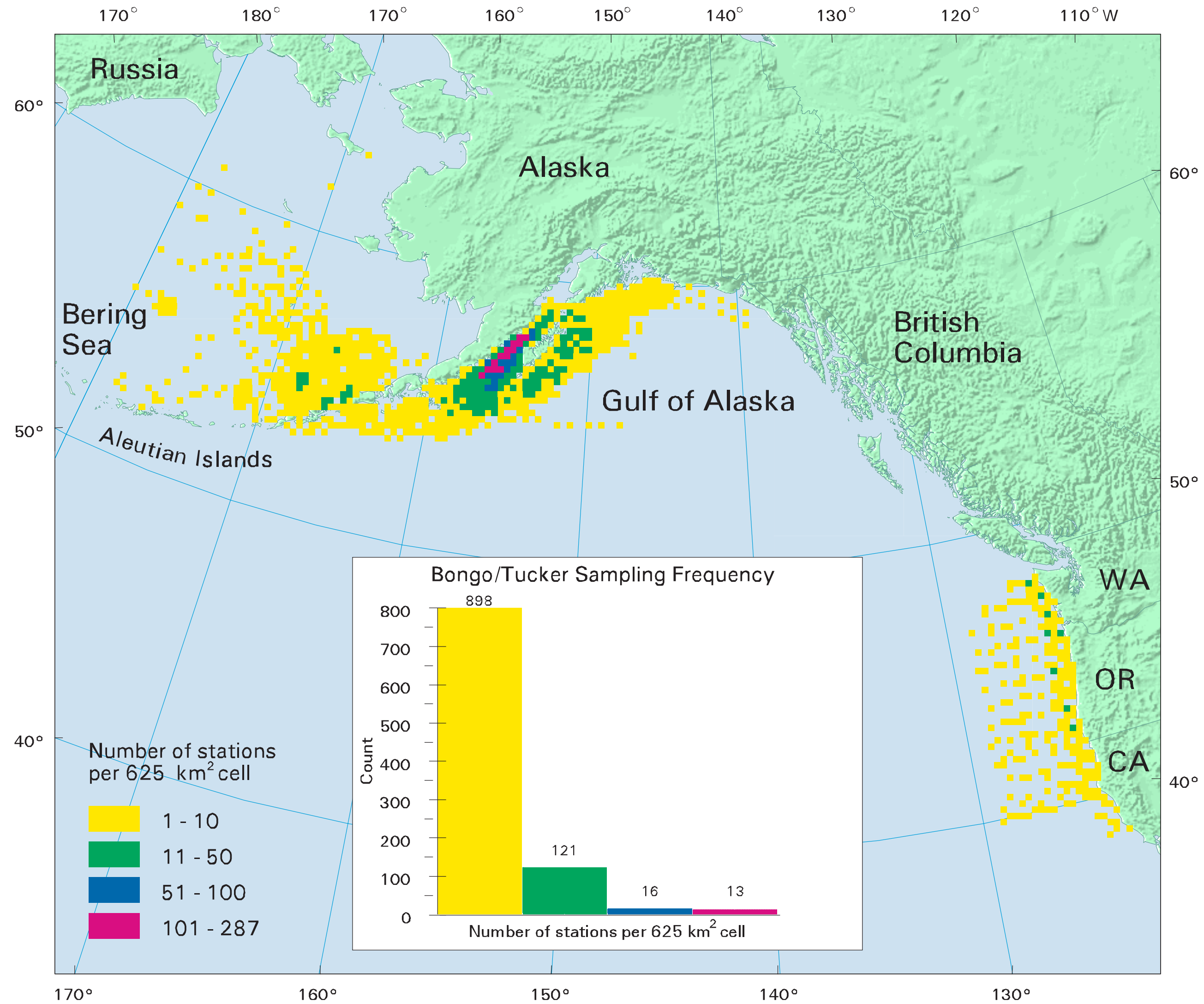
Study area showing geographic features described in species accounts for Alaska (top map) and U.S. west coast (bottom map).



Map 20

Geographic distribution and frequency of sampling during Recruitment Processes Program ichthyoplankton surveys for time period covered in this atlas (1972–1996). Area sampled is divided into 625 km^2 cells. Numbers over bars in histogram equal number of cells that contain 1–10 stations (yellow), 11–50 stations (green), 51–100 stations (blue), and 101–287 stations (red).

family and generic identifications, that did not provide significant new information. For example, although abundant and frequently occurring, the family taxon Gadidae usually contains damaged larvae not readily identifiable to species. Therefore, data and maps presented for individual species contained within the family, such as *Gadus macrocephalus* and *Theragra chalcogramma*, provide the best source of information. Despite all the recent advancements in our ability to identify early life history stages of northeastern Pacific fishes, major gaps exist in our knowledge of several numerically important taxa (Busby et al., 2000). Since many taxa remain poorly known (Table 4), some taxa were combined to provide more complete information. For families where no complete developmental series were known (e.g., Zoarcidae), data were pooled, and in cases where some developmental series were known (e.g., Stichaeidae), individual taxon pages were included. Although we can separate several unidentified morphological types within many genera and families, often their distributions overlapped or numbers were too low, so types were combined to provide generic or familial data (e.g., *Myoxocephalus* A, *Myoxocephalus* G, and *Myoxocephalus* spp. were combined). After some taxa were eliminated or combined,

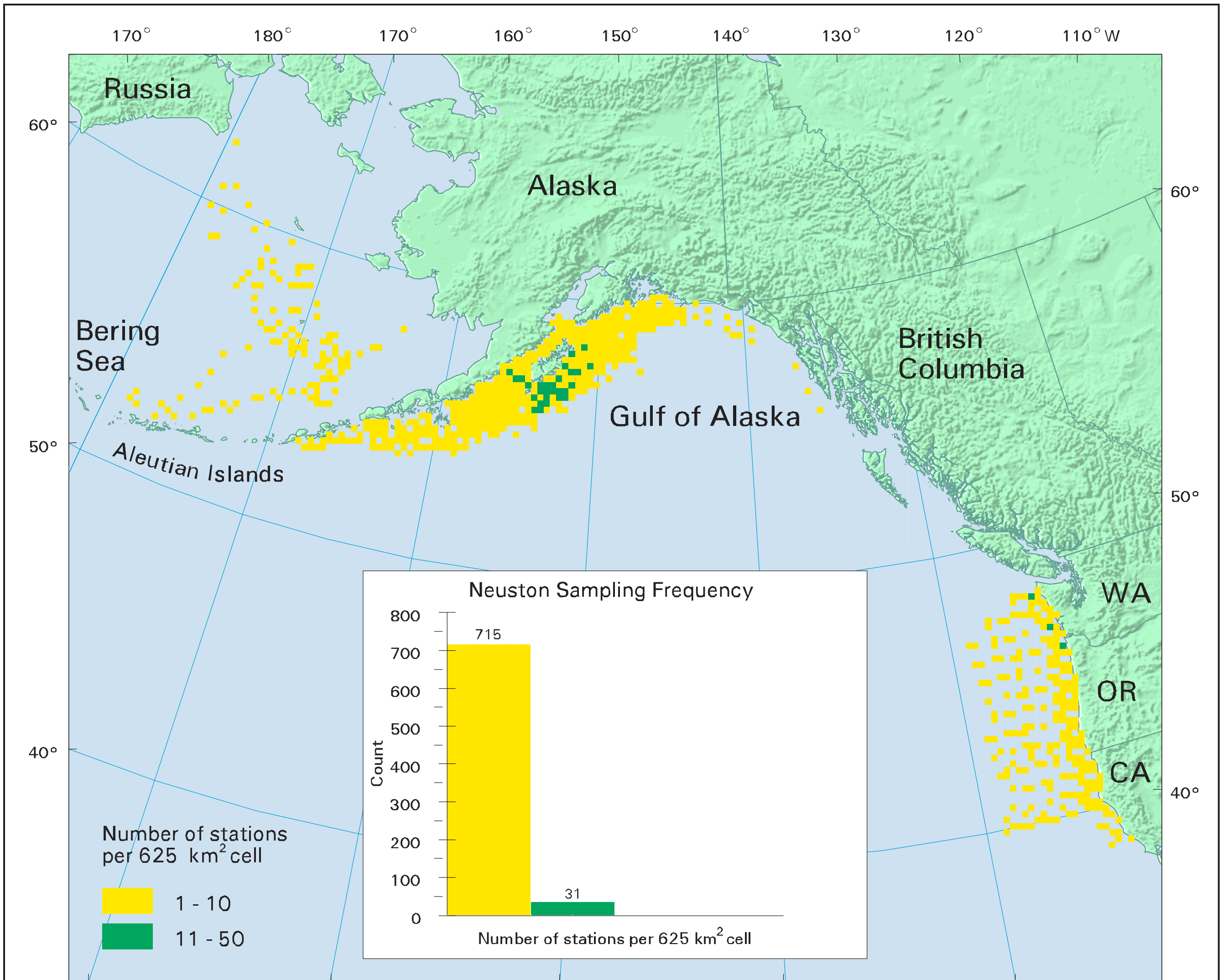


Map 21

Geographic distribution and frequency of sampling with bongo/Tucker gear during Recruitment Processes Program ichthyoplankton surveys for time period covered in this atlas (1972–1996). Area sampled is divided into 625 km^2 cells. Numbers over bars in histogram equal number of cells that contain 1–10 stations (yellow), 11–50 stations (green), 51–100 stations (blue), and 101–287 stations (red).

the reduced list was further examined. All taxa with less than 10 total occurrences of larvae overall were not considered except for a few cases where taxa were retained for taxonomic considerations (e.g., liparids), offshore species examined as part of ongoing El Niño and transport studies (e.g., *Embassichthys bathybius*), or pelagic egg abundance or frequency of occurrence was high (e.g., *Cololabis saira*). Other exceptions included many agonids, for even though they are rarely collected, recent identifications provided by Busby (1998) made new distributional information available at the species level. The selection process resulted in a total of 102 taxa included in 34 families (Table 5). For each taxon in the final list, a detailed map of abundance and distribution patterns is presented in the section of this atlas titled "Abundance and Distribution Patterns of Ichthyoplankton." Phylogenetic order and scientific names generally follow Nelson (1994) and Robins et al. (1991), respectively. Although several taxonomic papers resulting in nomenclatural changes have been published since Nelson (1994) and Robins et al. (1991), they are not used here.

Eggs The complete list of fish egg taxa collected from Recruitment Processes Program cruises 1972–1996 used



Map 22

Geographic distribution and frequency of sampling with neuston gear during Recruitment Processes Program ichthyoplankton surveys for time period covered in this atlas (1972–1996). Area sampled is divided into 625 km^2 cells. Numbers over bars in histogram equal number of cells that contain 1–10 stations (yellow) and 11–50 stations (green).

for initial consideration in the atlas is presented in Appendix Table 3. Data were restricted to pelagic fish eggs due to sampling strategies and gear limitations. A total of 58 taxa was identified from the study area. Of these, fish egg taxa were selected for inclusion based on careful consideration of several criteria. Initially, taxa were ranked according to overall frequency of occurrence of fish eggs and then ranked by average abundance per 10 m^2. Fish eggs were summed over the bongo data set (including the six cruises where Tucker trawls represented the primary gear). All taxa with an average abundance >5/10 m^2 and a frequency of occurrence >1% were further considered. This list was further refined by comparing results to the larval data and eliminating some higher level taxonomic categories, such as family and generic identifications, that did not provide significant new information or did not coincide with larval data. Based on frequency of occurrence, Pleuronectidae eggs ranked fifth, but these eggs represent the early stages of several species as well as disintegrated and unidentified eggs, so this taxon was not considered (see also Bathylagidae, Paralichthyidae, etc.). The selection process resulted in a total of 30 taxa included in 14 families (Table 6). For each taxon in the final list, distributional maps depicting presence/absence are presented in the section of this

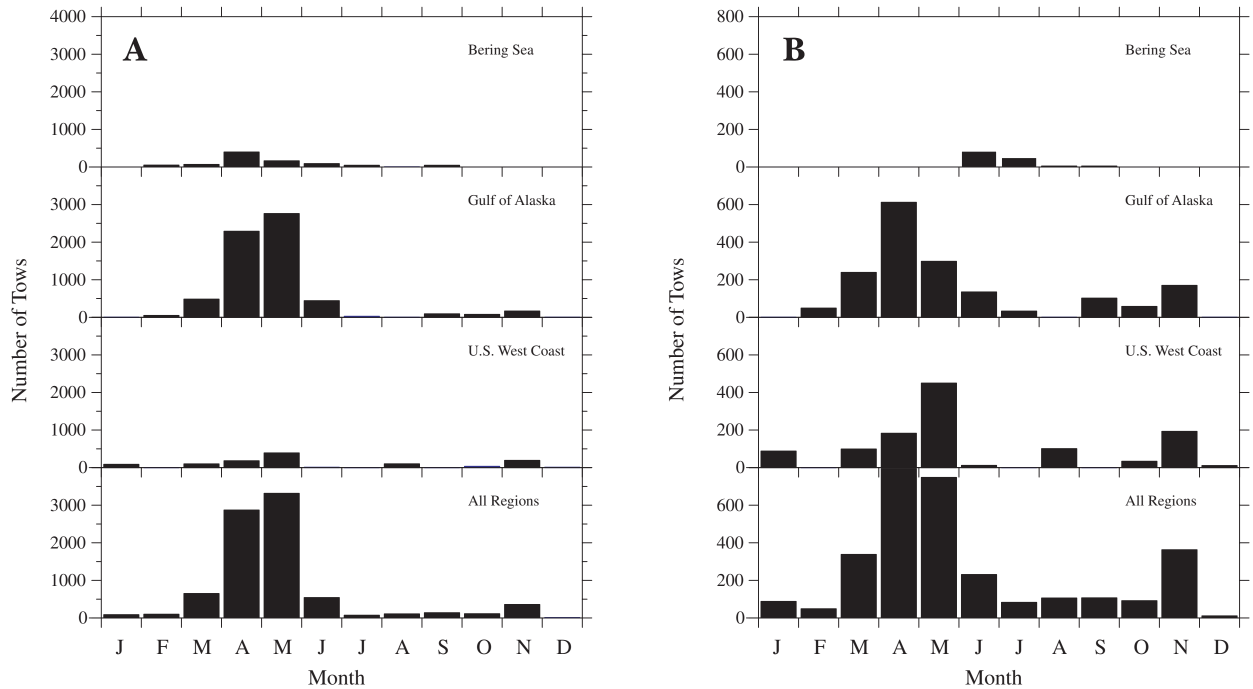


Figure 3

Monthly distribution and number of (**A**) combined bongo and Tucker tows (number of tows scaled to 4000) and (**B**) neuston tows (number of tows scaled to 800) by region used for this atlas.

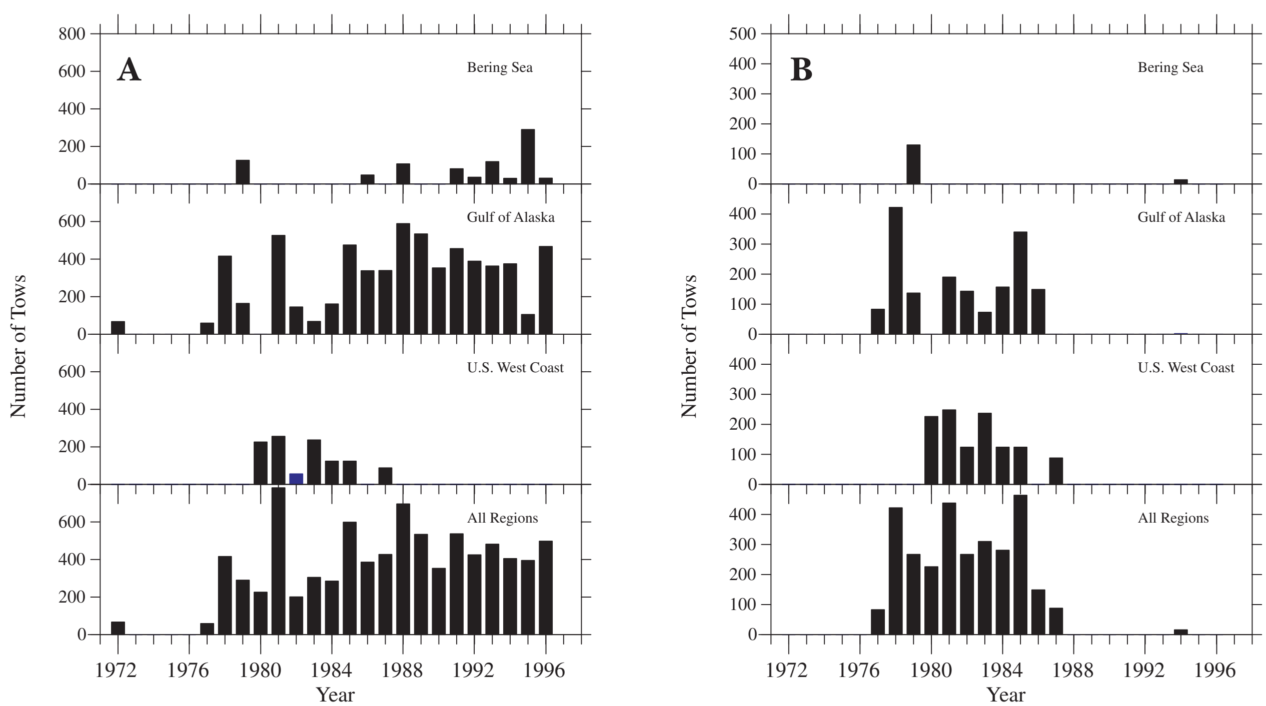
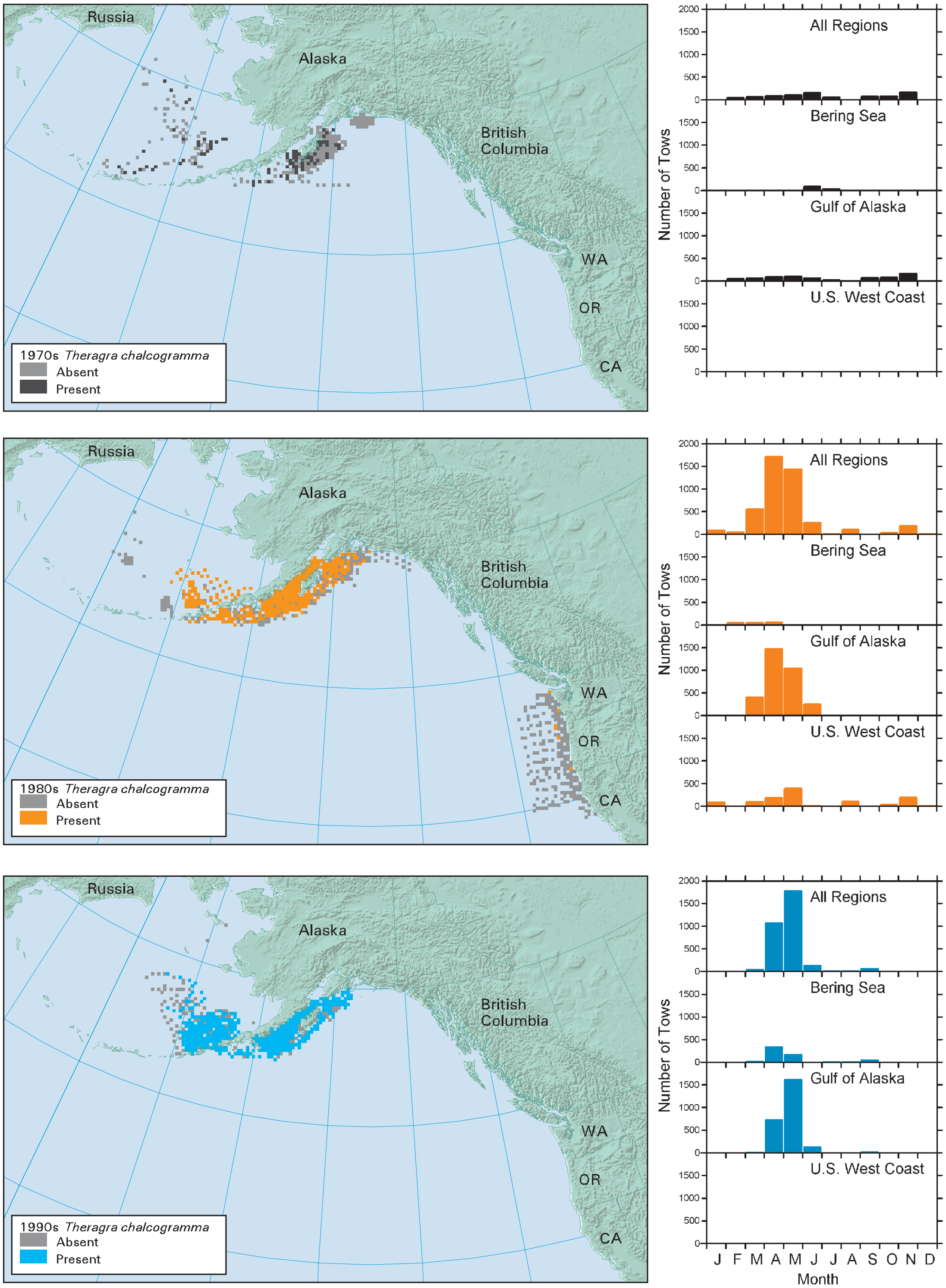


Figure 4

Yearly distribution and number of (**A**) combined bongo and Tucker tows (number of tows scaled to 800) and (**B**) neuston tows (number of tows scaled to 500) by region used for this atlas.



Map 23

Change in knowledge of occurrence and distribution pattern of *Theragra chalcogramma* (walleye pollock) larvae for the 1970s, the 1980s, and the 1990s. Area sampled is divided into 625 km^2 cells. Gray cells denote where sampling occurred during each time period but no larvae were found; colored cells show the presence of larvae. Graphs at right show monthly distribution and number of tows off the U.S. west coast, in the Gulf of Alaska, Bering Sea, and the three regions combined for the 1970s (top), 1980s (center), and 1990s (bottom).

atlas entitled "Abundance and Distribution Patterns of Ichthyoplankton."

Format and methods

Statistical overview

The data described in the Information and Data Sources section were combined to produce an average spatial distribution as presented in the maps on individual taxon pages. These data were also used to estimate mean abundance and percent occurrence by year and month and relative abundance by larval length and season, as shown in the graphs on the taxon pages. Abundance from each station was measured as catch per 10 m^2 surface area.

The data summarized by the maps and graphs were collected on cruises using many different survey designs to answer various research questions. Some of the surveys were intended to describe the spatial distribution of one or a few species, but most were designed for other purposes. Combining data from these cruises to estimate an average distribution is problematic. Space and time trends in larval abundance can be confounded with spatial and temporal variations in sampling effort. The greatest danger from uneven sampling effort in space and time is bias. For example, suppose for a particular species, a year of average abundance had more samples taken in the season of highest abundance while samples taken during other years occurred in the off-season. This would give the appearance of high abundance for that year, even though it was average. Similarly, if stations were distributed in a limited area in a year of especially high abundance, then that area would appear to be a hot spot in the map, when in fact the hot spot is due to high abundance in a particular year, not a particular area, and also due to uneven sampling in space. Many other scenarios could also produce bias. The potential for sampling bias is greatest for data from the U.S. west coast because this area was only sampled in the 1980s.

To minimize bias, two methods of combining cruise data to compute average abundance were considered. The first method was to interpolate abundance for each cruise over areas where no sampling occurred in that cruise, which would correct for uneven sampling in space. However, this approach was rejected because the areas of missing data were often very large and could lead to unreliable interpolations. Further, the missing areas were often not bounded by stations, which would result in extrapolation instead of interpolation. We decided not to try to correct for uneven sampling over space and instead we advise the reader of this atlas to refer to the map showing the sampling effort (Map 21 or 22), as well as the individual overall catch-by-month and catch-by-year graphs, when interpreting the maps for each taxon. Areas of little sampling effort are likely to produce inaccurate estimates of abundance.

Table 4

Major gaps in knowledge of early life history stages of northeastern Pacific fishes. Includes all new species described or reported from the area since Matarese et al. (1989) and presently unpublished larval data from AFSC (after Busby et al., 2000, in part). Only taxa with more than two larval stages known are included in count. Bolded entries denote taxa not covered at the family level in this atlas.

Taxon	Number of species	Number of larvae described	Percent known
Osmeridae[1]	7	2	29
Macrouridae[1]	10	5	50
Scorpaenidae	45	29	64
Cottidae	110	67	61
Liparidae	78	10	13
Liparis spp.[1]	18	5	28
Bathymasteridae	4	2	50
Bathymaster spp.[2]	3	1	33
Zoarcidae[1]	48	0	0
Stichaeidae	27	16	59
Pholidae	9	2	22

[1] List of species appears in Appendix Table 2.
[2] List of species appears on taxon page.

The second method, which we adopted, was to stratify the data into equal-sized time intervals (e.g., years), which partially controls the bias due to uneven sampling effort in time. This does not completely correct the bias because some time interval strata have no data at all, and stratification does not help in these cases. Bias for the strata that do have data is corrected by giving each stratum equal weight regardless of the number of stations. For the maps, the data within each 625 km^2 grid cell were stratified by year. This removes bias due to uneven sampling between years within each cell, but only for those years for which each cell was sampled; this does not correct for uneven sampling for those years where the cell was not sampled at all. The graphs of abundance and percent occurrence by month were also calculated by stratifying by year, that is, the data within each month were stratified by year. The bias due to uneven sampling over years was best corrected for those months when most years were present; that is, April and May (see overall catch-by-month graph on individual taxon pages). Similarly, stratifying by month reduced bias in the graphs of annual abundance and annual percent occurrence. Formulas for these computations are given in the Appendix.

Table 5
Larval distributions covered in this atlas.

Family	Taxon	Common name	Page(s)
Engraulidae	*Engraulis mordax*	Northern anchovy	74
Clupeidae	*Clupea pallasi*	Pacific herring	76
Microstomatidae	*Nansenia candida*	Bluethroat argentine	78
Bathylagidae	*Bathylagus milleri*	Robust blacksmelt	80
	Bathylagus ochotensis	Popeye blacksmelt	82
	Bathylagus pacificus	Pacific blacksmelt	84
	Leuroglossus schmidti	Northern smoothtongue	86
Osmeridae	Osmeridae	Smelts	88
	Mallotus villosus	Capelin	90
Stomiidae	*Chauliodus macouni*	Pacific viperfish	92
	Tactostoma macropus	Longfin dragonfish	94
Paralepidae	*Lestidiops ringens*	Slender barracudina	96
Myctophidae	*Diaphus theta*	California headlightfish	98
	Lampanyctus regalis	Pinpoint lampfish	100
	Lampanyctus ritteri	Broadfin lampfish	102
	Protomyctophum crockeri	California flashlightfish	104
	Protomyctophum thompsoni	Northern flashlightfish	106
	Stenobrachius leucopsarus	Northern lampfish	108
	Tarletonbeania crenularis	Blue lanternfish	110
Trachipteridae	*Trachipterus altivelis*	King-of-the-salmon	112
Macrouridae	Macrouridae	Grenadiers	114
Merlucciidae	*Merluccius productus*	Pacific hake	116
Gadidae	*Gadus macrocephalus*	Pacific cod	118
	Microgadus proximus	Pacific tomcod	120
	Theragra chalcogramma	Walleye pollock	122
Scomberesocidae	*Cololabis saira*	Pacific saury	44, 124
Melamphaidae	Melamphaidae	Bigscales	126
Scorpaenidae	*Sebastes* spp.	Rockfishes	128
	Sebastolobus spp.	Thornyheads	130
Anoplopomatidae	*Anoplopoma fimbria*	Sablefish	46
Hexagrammidae	*Hexagrammos decagrammus*	Kelp greenling	48, 132
	Hexagrammos lagocephalus	Rock greenling	50
	Hexagrammos octogrammus	Masked greenling	52
	Hexagrammos stelleri	Whitespotted greenling	54
	Ophiodon elongatus	Lingcod	56
	Pleurogrammus monopterygius	Atka mackerel	58, 134
Cottidae	*Artedius fenestralis*	Padded sculpin	136
	Artedius harringtoni	Scalyhead sculpin	138
	Gymnocanthus spp.		140
	Hemilepidotus hemilepidotus	Red Irish lord	60, 142
	Hemilepidotus jordani	Yellow Irish lord	62
	Hemilepidotus spinosus	Brown Irish lord	64
	Hemilepidotus zapus	Longfin Irish lord	144
	Icelinus spp.		146
	Leptocottus armatus	Pacific staghorn sculpin	148
	Myoxocephalus spp.		150
	Radulinus asprellus	Slim sculpin	152
	Ruscarius meanyi	Puget Sound sculpin	154
	Scorpaenichthys marmoratus	Cabezon	66, 156

continued

Table 5 (continued)

Family	Taxon	Common name	Page(s)
Agonidae	*Anoplagonus inermis*	Smooth alligatorfish	158
	Aspidophoroides monopterygius	Alligatorfish	160
	Bathyagonus alascanus	Gray starsnout	162
	Bathyagonus infraspinatus	Spinycheek starsnout	164
	Bathyagonus nigripinnis	Blackfin poacher	166
	Bathyagonus pentacanthus	Bigeye poacher	168
	Hypsagonus mozinoi	Kelp poacher	170
	Hypsagonus quadricornis	Fourhorn poacher	172
	Leptagonus frenatus	Sawback poacher	174
	Podothecus acipenserinus	Sturgeon poacher	176
	Xeneretmus latifrons	Blacktip poacher	178
Psychrolutidae	*Dasycottus setiger*	Spinyhead sculpin	180
	Psychrolutes paradoxus	Tadpole sculpin	182
	Psychrolutes sigalutes	Soft sculpin	184
Cyclopteridae	*Aptocyclus ventricosus*	Smooth lumpsucker	186
Liparidae	*Liparis* spp.	Snailfishes	188
	Nectoliparis pelagicus	Tadpole snailfish	190
Bathymasteridae	*Bathymaster* spp.		192
	Ronquilus jordani	Northern ronquil	194
Zoarcidae	Zoarcidae	Eelpouts	196
Stichaeidae	*Anoplarchus* spp.	Cockscombs	198
	Chirolophis spp.	Warbonnets	200
	Lumpenella longirostris	Longsnout prickleback	202
	Lumpenus spp.		204
	Lumpenus sagitta	Snake prickleback	206
	Poroclinus rothrocki	Whitebarred prickleback	208
	Stichaeus punctatus	Arctic shanny	210
Cryptacanthodidae	*Cryptacanthodes aleutensis*	Dwarf wrymouth	68
	Cryptacanthodes gigantea	Giant wrymouth	70
Pholidae	*Pholis* spp.	Gunnels	212
Ptilichthyidae	*Ptilichthys goodei*	Quillfish	214
Zaproridae	*Zaprora silenus*	Prowfish	216
Ammodytidae	*Ammodytes hexapterus*	Pacific sand lance	218
Icosteidae	*Icosteus aenigmaticus*	Ragfish	220
Centrolophidae	*Icichthys lockingtoni*	Medusafish	222
Paralichthyidae	*Citharichthys sordidus*	Pacific sanddab	224
	Citharichthys stigmaeus	Speckled sanddab	226
Pleuronectidae	*Atheresthes stomias*	Arrowtooth flounder	228
	Embassichthys bathybius	Deepsea sole	230
	Glyptocephalus zachirus	Rex sole	232
	Hippoglossoides elassodon	Flathead sole	234
	Hippoglossus stenolepis	Pacific halibut	236
	Isopsetta isolepis	Butter sole	238
	Lepidopsetta bilineata	Southern rock sole	240
	Lepidopsetta polyxystra	Northern rock sole	242
	Limanda aspera	Yellowfin sole	244
	Lyopsetta exilis	Slender sole	246
	Microstomus pacificus	Dover sole	248
	Parophrys vetulus	English sole	250
	Platichthys stellatus	Starry flounder	252
	Pleuronectes quadrituberculatus	Alaska plaice	254
	Psettichthys melanostictus	Sand sole	256
	Reinhardtius hippoglossoides	Greenland halibut	258

The graphs of relative abundance by larval length interval for each season were also computed by stratifying by year. The bias in length distribution due to uneven sampling over years is probably much less than the bias in mean abundance. However, yearly strata were again employed to keep the estimation procedure consistent. The reader should keep in mind that those time intervals that have little sampling effort will lead to less accurate estimates of abundance, hence the reader should refer to Figures 3 and 4 that show the number of stations by time interval for each gear and region (Bering Sea, Gulf of Alaska, and U.S. west coast). From these figures it is clear that the data from April and May in the Gulf of Alaska are the most reliable.

Maps and data layers

The maps in this atlas were produced with a geographic information system (GIS) using ArcInfo software (ArcInfo[6]), a product of Environmental Systems Research Institute (ESRI). Generic base data such as land extents were derived from a combination of Global Land One-kilometer Base Elevation (GLOBE) (GLOBE Task Team[7]) and Digital Chart of the World (DCW) data. To produce the land relief, GLOBE data were hill-shaded to show relief, missing data values were filled in, and data were clipped to the extent shown with the DCW data and converted to image format. Bathymetry data are from in-house and the General Bathymetric Chart of the Oceans digital atlas (GEBCO) (IOC, IHO, and BODC[8]).

The projection of the data is an Albers Equal-Area Conic projection and was chosen because area is preserved, thereby minimizing error in the display of the data. The parameters of the projection are

- 1st Standard parallel: 37
- 2nd Standard parallel: 59
- Central meridian: –145
- Latitude of projections origin: 45.

Fish density data (catch per 10 m^2) were introduced into the GIS through ASCII text files in comma-separated-value (csv) format. The text files were read into the ArcInfo software, where they were converted into ArcInfo coverages (data layers) for use in a GIS. Coordinate precision of the location of each sample was set to double so that up to 15 significant digits could be stored in the GIS.

The fish density data layer shows all the sample locations referenced geographically. However, samples were often taken at the same location resulting in points plotting on top of each other. Because we wanted to show the quantity and distribution of the samples, a different symbology was needed. Fish density is continuous in space even though the density may be zero at some locations. So, point locations were aggregated into a surface by overlaying the points onto a regular grid and assigning a mean value to each grid cell. The cell size of the grid is 25 km × 25 km (625 km^2), or roughly 15.5 miles × 15.5 miles. Though a smaller grid cell size may have been more desirable, the result would be too noisy, causing a loss of observable general trends in the data. The mean

Table 6

Pelagic fish egg occurrences covered in this atlas.

Family	Taxon
Engraulidae	*Engraulis mordax*
Microstomatidae	*Nansenia candida*
Bathylagidae	*Bathylagus milleri*
	Bathylagus ochotensis
	Leuroglossus schmidti
Stomiidae	*Chauliodus macouni*
	Tactostoma macropus
Trachipteridae	*Trachipterus altivelis*
Macrouridae	Macrouridae
Merlucciidae	*Merluccius productus*
Gadidae	*Gadus macrocephalus*
	Theragra chalcogramma
Scomberesocidae	*Cololabis saira*
Scorpaenidae	*Sebastolobus* spp.
Anoplopomatidae	*Anoplopoma fimbria*
Icosteidae	*Icosteus aenigmaticus*
Centrolophidae	*Icichthys lockingtoni*
Pleuronectidae	*Embassichthys bathybius*
	Glyptocephalus zachirus
	Hippoglossoides elassodon
	Hippoglossus stenolepis
	Isopsetta isolepis
	Limanda aspera
	Lyopsetta exilis
	Microstomus pacificus
	Parophrys vetulus
	Platichthys stellatus
	Pleuronectes quadrituberculatus
	Psettichthys melanostictus
	Reinhardtius hippoglossoides

[6] ArcInfo Version 8.1.2 [Computer software]. 2001. ESRI, Inc., Redlands, CA.

[7] Global Land One-kilometer Base Elevation Task Team (GLOBE) Digital Elevation Model. 1999. Version 1.0. NOAA, National Geophysical Data Center, 325 Broadway, Boulder, CO 80303, U.S.A. [Online] Available: URL: http://www. ngdc.noaa.gov/seg/topo/globe.shtml (access date – Dec. 1999).

[8] IOC, IHO, and BODC. 1997. GEBCO-97: 1997 ed. of GEBCO digital atlas, published on behalf of Intergovernmental Oceanographic Commission (of UNESCO) and International Hydrographic Organization as part of General Bathymetric Chart of the Oceans (GEBCO); British Oceanographic Data Center, Birkenhead, Merseyside L43 7RA, U.K.

value at each grid cell was derived in two stages. First, the mean catch per 10 m^2 was calculated per cell per year, then the mean catch per 10 m^2 was calculated per cell averaged over the years. This equalized the contribution of any single year since some years may have had a greater number of samples. The resulting data layer was a polygon showing all cells where samples were taken and their associated abundance based on catch per 10 m^2.

A chloropleth map design was chosen to depict abundance. The purpose of the map is to show the general spatial extent of the data and the general trend of average larval abundance over space. Chloropleth maps shade statistical units with intensity proportional to the data values. There are two main limitations with this type of map. First, variation within the statistical unit (cell) is not displayed. Second, the boundaries of the statistical unit (cell) are arbitrary, that is, discontinuities in the data are unlikely to be associated with the grid cell boundaries. Thus, if the original gridded polygon is created from a different start location, the map will look a little different.

All cells that were sampled, but contained no individuals of a taxon, are symbolized as gray, indicating absence. The remaining data were classified using quantiles: data were ranked, ordered, and divided into four categories, each containing an equal number of observations. Thus, each non-zero class size has approximately the same map area. The legend shows the range for each class and may show numbers for values that do not exist. Extreme values were grouped within a single class, so the distribution of data within a class can vary considerably. Five classes (zero and four quantiles) were chosen to maximize information content and readability while minimizing map complexity. The legend colors in the larval map are hierarchical in that lighter colors connote lower levels of abundance and darker colors connote higher levels.

Adult occurrence map

The occurrences of adults were derived for the most part from unpublished AFSC data residing in an Oracle database, named RACEBASE. RACEBASE was developed by the Resource Assessment and Conservation Engineering Division (RACE) and comprises data from assessment, hydroacoustic, and foreign surveys conducted by federal fishery scientists from 1948 to the present. The geographic extent of RACEBASE data covers the continental shelf and slope of western North America and northeastern Asia from the Arctic Ocean (72°14′N, 167°52′W) south through the eastern half of the Chukchi Sea, throughout the Bering Sea (including the continental shelf of northeast Siberia), the Aleutian Basin and eastward along the Aleutian Islands, and along the U.S. Pacific coast from the Gulf of Alaska to the southern border of California (32°28′N, 119°18′W). Our adult coverage was based on frequency of occurrence and abundance of larval distribution data and a review of adult distributions in RACEBASE provided in Allen and Smith (1988); our goal was to map the distribution of adults for every taxon in this atlas where verified point data were available. We selected a subset of adult occurrence records from 1975 through 1998 since the identifications from those years represented the most accurate data set. Our evaluation of the accuracy and completeness of RACEBASE data is based on collaborative discussions with James Orr[9] who personally assigned a confidence value on data requested for taxa included in this atlas (the assignment of confidence levels was subjective and relatively broad). Each taxon was assigned a confidence level 0–100% based on the 1975–1998 data. Only data with confidence levels of at least 70% (72 of 102 taxa) were used to generate maps. Since voucher specimens were not always collected over the years, a voucher program having only recently been implemented, occurrence records for some taxa are more complete and accurate than others. The verification process revealed that some taxa have had identification problems over the years and their records are suspect, hence they received a lower confidence score. In some cases, as taxonomic issues have been resolved, identification has improved over time. In cases where a taxonomic expert was on staff, identification was more accurate than in years when a taxonomist was not available. In general, targeted taxa and commercially important taxa are known; uncommon and commercially unimportant taxa are not as well known, even if they are very abundant or ecologically important. Adult occurrence data for the remaining 30 taxa where standard RACEBASE data were insufficient were obtained from the literature and unpublished sources, including subsets of RACEBASE.

The RACEBASE data were limited to the years 1975 through 1998, then extracted from the database and exported in ASCII text format. ArcInfo was used to create a data layer with the data, which was then overlaid with a polygon grid having a 25 km × 25 km cell size to produce the final data layer showing presence or absence of the species. The result was a layout design consistent with the larval abundance map, which overcame the issue of stacked points. Gray squares denote where samples were taken, but no individuals of that taxon were found; blue squares show the presence of the taxon. Cell sizes appear smaller than those in the average larval abundance map because of the change in map scale.

[9] Orr, James Wilder. Personal commun. 1998 (initial list of taxa); 2000 (final list revised). National Marine Fisheries Service, Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115-6349.

Table 7

Taxa with alternative data sources for adult occurrence (denoted with asterisk on adult occurrence maps). Standard RACEBASE data set (1975–1998) was not used if confidence was <60% or a specific taxon was not present.

Taxon	Percent confidence in standard RACEBASE dataset	Other sources
Nansenia candida	no records	Kawaguchi and Butler (1984), point data
Bathylagus milleri	60 (for genus)	subset of RACEBASE (2000), Willis et al. (1988)
Bathylagus ochotensis	0[1]	subset of RACEBASE (1975–2000), Willis et al. (1988)
Bathylagus pacificus	60 (for genus)	subset of RACEBASE (2000), Willis et al. (1988)
Tactostoma macropus	30	subset of RACEBASE (1996–2000), Willis et al. (1988)
Diaphus theta	30–40	subset of RACEBASE (1996–2000), Willis et al. (1988)
Lampanyctus regalis	50 (for genus)	subset of RACEBASE (1996–2000), Willis et al. (1988)
Lampanyctus ritteri	20–30	subset of RACEBASE (1996–2000), Shinohara et al. (1994), Willis et al. (1988)
Protomyctophum crockeri	5 (for genus)	Willis et al. (1988)
Protomyctophum thompsoni	5 (for genus)	Willis et al. (1988)
Stenobrachius leucopsarus	10	subset of RACEBASE (1996–2000), Willis et al. (1988)
Artedius fenestralis	10	Mecklenburg et al. (2002), Peden and Wilson (1976), Froese and Pauly (1996)
Artedius harringtoni	10	Mecklenburg et al. (2002), Peden and Wilson (1976), Froese and Pauly (1996)
Hemilepidotus zapus	20	subset of RACEBASE (1997–2000)
Radulinus asprellus	40	subset of RACEBASE (1996–2000)
Ruscarius meanyi	no records	Peden and Wilson (1976), Froese and Pauly (1996)
Anoplagonus inermis	50	Lea (1973), Froese and Pauly (2000)
Bathyagonus alascanus	40 (for genus)	Sheiko (1991), Froese and Pauly (1996, 2000)
Bathyagonus infraspinatus	40 (for genus)	Sheiko (1991), Froese and Pauly (1996, 2000)
Bathyagonus nigripinnis	40 (for genus)	Fitch (1973), Snytko (1987), Sheiko (1991), Froese and Pauly (1996, 2000)
Bathyagonus pentacanthus	40 (for genus)	Sheiko (1991), Froese and Pauly (1996, 2000)
Hypsagonus mozinoi	0	Wilimovsky and Peden (1979), Froese and Pauly (1996, 2000)
Aptocyclus ventricosus	50	subset of RACEBASE (1975–1998)[2]
Liparis spp.	60	Froese and Pauly (1996)
Nectoliparis pelagicus	0	Froese and Pauly (1996, 2000)
Ronquilus jordani	20–30	subset of RACEBASE (1997–2000); AFSC unpubl.,[3] point data
Anoplarchus spp.	0	Mecklenburg et al. (2002), Barton (1986), Coleman (1992), Froese and Pauly (1996)
Pholis spp.	50	Mecklenburg et al. (2002), Peden and Wilson (1976), Barton (1986), Froese and Pauly (1996)
Ptilichthys goodei	0	Mecklenburg et al. (2002), Richardson and Dehart (1975), Froese and Pauly (1996, 2000)
Icichthys lockingtoni	40	Mecklenburg et al. (2002), Ahlstrom et al. (1976), Froese and Pauly (1996, 2000)

[1] Three records from the standard RACEBASE dataset (1975–1998) were re-identified and upgraded to *Bathylagus ochotensis*. In addition, data from 1998–2000 were added.

[2] Same years as standard RACEBASE dataset, but only fish >0.5 kg considered.

[3] Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle WA 98115-0070.

When data were incomplete or unavailable, other methods were used to obtain the data. For several taxa, recent data added to our analyses in RACEBASE were more reliable since taxonomic upgrades had taken place; gray squares on these maps reflect sampling effort in the subset of years considered (Table 7). Adult occurrences for some of the midwater fishes in the Subarctic Pacific were adapted from data in Willis et al. (1988), which provided maps showing locations where adults had been collected. The exact position of these locations was not available, nor were the projection parameters of the maps known. Attempts to recreate the published maps using geo-referencing techniques gave distorted, inaccurate results. Consequently, a sample grid extrapolation process was conducted to manually record position data from the maps and create new digital files. To estimate position data, a decimal-degree grid was created by overlaying and securing a transparent Mylar™ sheet to one of the maps. Using the longitude and latitude scales of the map as a guide, a 1° × 1° cell grid was carefully drawn on the transparent sheet. With this grid, station position data from each map was estimated to a tenth of a degree, manually recorded with a corresponding record number, and entered into a digital worksheet for GIS formatting. These data were then binned into the same 25 km × 25 km grid cells as were used in the other adult and larval maps. Position data on each map west of the 180° longitude were not transcribed.

Other sources of adult occurrences are presented in Table 7. Adult occurrence maps generated with alternative data as described above are identified with an asterisk in the legend on individual taxon pages. Adult occurrence maps generated with alternative data other than RACEBASE show presence only; for these maps the survey area was not defined, therefore no gray area appears on the map.

Egg occurrence map

The data for the egg occurrence map was processed similarly to the adult occurrence map. Data was extracted from ICHBASE and exported in ASCII text format. A data layer was created with the data using ArcInfo, which was then overlaid with a polygon grid having a 25 km × 25 km cell size to produce the final data layer showing presence or absence of eggs of the taxon. The result was a layout design consistent with the larval abundance map, which overcame the issue of stacked data points. Gray squares denote where samples were taken, but no eggs were found. Black squares show the presence of the taxon. Cell sizes appear smaller than those in the average larval abundance map because of the change in map scale.

Using this atlas

This atlas is designed primarily to assist in identifying the basic distribution and abundance patterns of the dominant fish larvae collected in ichthyoplankton samples from the Northeast Pacific and Bering Sea, and is intended as a companion to our laboratory guide (Matarese et al., 1989). Maps are designed for graphic display and general reference purposes. While care has been made to ensure accuracy, neither the researchers nor any entity that has supplied information for use in these maps accepts any responsibility for any error or omission. Interested persons should contact the appropriate author/entity for verification or further information. Following are specific details regarding the format of the pages in the "Abundance and Distribution Patterns of Ichthyoplankton" section.

Left page

Heading The upper left corner of the page includes the name of the family in which the taxon occurs. The upper right corner includes the scientific name (see Nelson, 1994), followed by one or more personal names called the authority. The authority is an abbreviated bibliographic reference including the author and date when the taxon was first described. These references are not included in the literature cited, but can be found in Nelson (1994) or Eschmeyer (1998). If a species-group taxon first described in one genus is later transferred to another, the original citation is placed in parentheses when the new name is cited.

Life history A brief summary of the life history of the taxon is provided based primarily on previously published literature; some unpublished AFSC data was used. Data on adult distributions and life histories of Northeast Pacific fishes were obtained from sources including Miller and Lea (1972), Hart (1973), Eschmeyer et al. (1983), Matarese et al. (1989), and Mecklenburg et al. (2002). Adult lengths are reported as SL (standard length) or TL (total length), depending on the source of information. Primary sources of data on larval distribution patterns and development are Moser (1996a) (CalCOFI laboratory guide) and Matarese et al. (1989) (Northeast Pacific laboratory guide). Moser et al. (1993, 1994, and 2001) (CalCOFI atlases) were used for comparison only, since they are the only other published atlases covering larvae that occur within our study area. All published sources are listed in brackets at the bottom of this section. Although some literature on larval distributions based on portions of the data set presented here (e.g., Kendall and Dunn, 1985; Doyle, 1992; Doyle et al., 1993, 1995, 2002; Rugen[1]; Doyle[2]) are included, this atlas is not intended to be a comprehensive review of the literature on larval distributions in the Northeast Pacific Ocean and Bering Sea. For a review of the historical literature (e.g., LeBrasseur, 1970; Mattson and Wing, 1978), see Garrison and Miller (1982).

Larval distribution A descriptive overview of the distribution and abundance patterns is presented for each taxon based on new material from this study as depicted in the larval distribution and abundance map (right page). Larval distributions are compared to updated adult distributions shown on the adult distribution map (right page). Geographic distributions of most taxa coincide with published information. However, the northern geographic extent of seven taxa is newly described in this atlas. Northern range extensions are described by larval distributions for three taxa, by both larval and adult distributions for three taxa, and by adult distributions for one taxon (Table 8). Seasonal and monthly occurrences (overall catch-by-month graph) and seasonal larval length distributions (length distribution of larvae graph) are discussed. If available, egg occurrence, shown on the egg occurrence map on the right page, is presented. In summary, general trends in

Table 8

Northerly range extensions for species covered in this atlas.

Species	Described by larval or adult distribution	Previous geographic extent	Geographic extent in this atlas	Source
Hemilepidotus spinosus	larval, adult	Southeast Alaska	southern Bering Sea	ICHBASE, RACEBASE
Radulinus asprellus	larval, adult	Kodiak Island	Aleutian Islands	ICHBASE, RACEBASE
Ruscarius meanyi	larval	Southeast Alaska	Bering Sea	ICHBASE
Scorpaenichthys marmoratus	larval	Southeast Alaska	Kodiak Island	ICHBASE
Xeneretmus latifrons	larval	British Columbia	Aleutian Islands	ICHBASE
Citharichthys stigmaeus	larval, adult	Southeast Alaska	Alaska Peninsula	ICHBASE, RACEBASE
Pleuronectes quadrituberculatus	adult	Chukchi Sea	Arctic Ocean	RACEBASE

overall larval catch by year are explained (overall catch-by-year graph).

Overall catch by month

Top panel Mean abundance (catch per 10 m^2) in positive tows, with standard error bars. Means and standard errors are estimated by stratifying by year.

Bottom panel Percent of tows where the taxa occurred, with standard error bars. Mean percents and standard errors are estimated by stratifying by year. For ease of comparison, the y-axis always runs from 0% to 100% for every taxon. For rare taxa with occurrences <5%, it is sometimes difficult to see month-to-month differences. The black line indicates relative sampling effort. These are the same data as shown in the bar graphs in the bottom panels of Figures 3a and 3b (All Regions) for bongo and neuston tows, respectively. This information is repeated here on the overall catch-by-month graph to assist the reader with inferring the reliability of the data for the taxon. A scale for the sampling effort data was not included in order to reduce distraction from the main focus of the graph, i.e., the distribution of the taxon over months.

Length distribution of larvae

Both panels Standard length is binned to the nearest millimeter. The length range on the x-axis may be truncated to exclude lengths where the percent frequency is less than 0.5%. The observed length frequency distributions are a function of the relative abundance of larvae by length interval in the water column and their length-specific catchability, which varies with species and gear. Prior to 1980, only species that were abundant or economically important were measured. After 1980, all species were measured except for the occasional special-purpose tow. For all years, up to 50 larvae per sample were measured unless specimens were in poor condition (e.g., newly hatched larvae). Specimens >100 mm SL (total=21) were omitted from the length graphs to decrease the need to compress data along the x-axis. These specimens, representing 4 taxa, are noted in the figure captions.

Top panel Estimated percent of fish in 1-mm length intervals, with standard error bars, in winter–spring season (January–June). Mean percents and standard errors are estimated by stratifying by year. For finer seasonal resolution, the six-month interval is divided into two intervals of three months, and the two colors indicate the proportion of the larvae of that length interval that was sampled in the two time intervals. The black color represents the cooler months January–March; the green color represents the warmer months April–June. For ease of comparison, the y-axis always runs from 0% to 100%.

Lower panel Estimated percent of fish in 1-mm length intervals, with standard error bars, in summer–fall season (July–December). Mean percents and standard errors are estimated by stratifying by year. For finer seasonal resolution, the six-month interval is divided into two intervals of three months, and the two colors indicate the proportion of the larvae of that length interval that was sampled in the two time intervals. The green color represents the warmer months July–September; the black color represents the cooler months October–December. For ease of comparison, the y-axis always runs from 0% to 100%.

Overall catch by year

Top panel Mean abundance (catch/10 m^2) in positive tows, with standard error bars. Means and standard errors are estimated by stratifying by month.

Bottom panel Percent of tows where the taxa occurred, with standard error bars. Mean percents and standard errors are estimated by stratifying by month. For ease of comparison, the y-axis always runs from 0% to 100%. For rare taxa with occurrences <5%, it is sometimes difficult to see year-to-year differences. The black line indicates relative sampling effort. These are the same data as shown in the bar graphs in the bottom panels of Figures 4a and 4b (All Regions) for bongo and neuston tows, respectively. This information is repeated here on the overall catch-by-year graph to help the reader infer the reliability of the data for the taxon. A scale for the sampling effort data was not included in order to reduce distraction from the main focus of the graph, i.e., the distribution of the taxon over years.

Right page

This page is composed of three maps for each taxon: a larval distribution and abundance map, an egg occurrence map, and an adult occurrence map. Gray squares show where samples occurred, but no individuals of a taxon were found. The sampling distribution is different among the three maps. The square grid cell is the same size on all three maps, but appears smaller on the egg and adult occurrence maps due to scale changes.

Heading The upper left corner of the page includes the common name of the taxon (see Robins et al., 1991). A blank indicates that no common name is available for that taxon. The upper right corner includes the name of the family in which the taxon occurs.

Larval distribution and abundance map This map shows the quantity of larvae from combined bongo and Tucker trawl data in the mapped areas. The data are classified such that sampling location information and abundance are provided. Sampling location is represented by the small squares on the map. Gray squares show where sampling occurred but no individuals of a taxon were found; colored squares show the average abundance of larvae found in the sampled area. The quantity is color coded with lighter color depicting less and darker color depicting more. The color codes function to show general trends in the quantity of the larvae. The map is designed to show the overall abundance of the larvae, rather than the specific values of individual samples. The individual range values in the legend include the lowest value, but not the highest; the highest number marks the end of the range and is not inclusive. The reader should also keep in mind that the number of samples varies greatly among the squares. The frequency of sampling, which is the same for all taxa but differs with gear, is shown in Maps 21 and 22. Likewise, the black line on the bottom panels of the overall catch-by-month and catch-by-year graphs (same as bottom panels in Figs. 3 and 4) on the left page of each taxon layout indicate relative sampling effort and are intended to help the reader infer the reliability of the data.

Larval illustration Examples of flexion stage larvae for each taxon covered in this atlas are depicted in the upper right hand corner of the larval distribution and abundance maps. Sources for these illustrations include those previously published and originals drawn from specimens in our collections (Appendix Table 4); collection data are provided for original illustrations. For taxa that are reported at the generic or family level, representative larvae are identified. Original measurements of larvae are in millimeters and given in standard length (SL). Some measurements taken from the literature were expressed as head length (HL) (Macrouridae), body length (BL), notochord length (NL), or total length (TL).

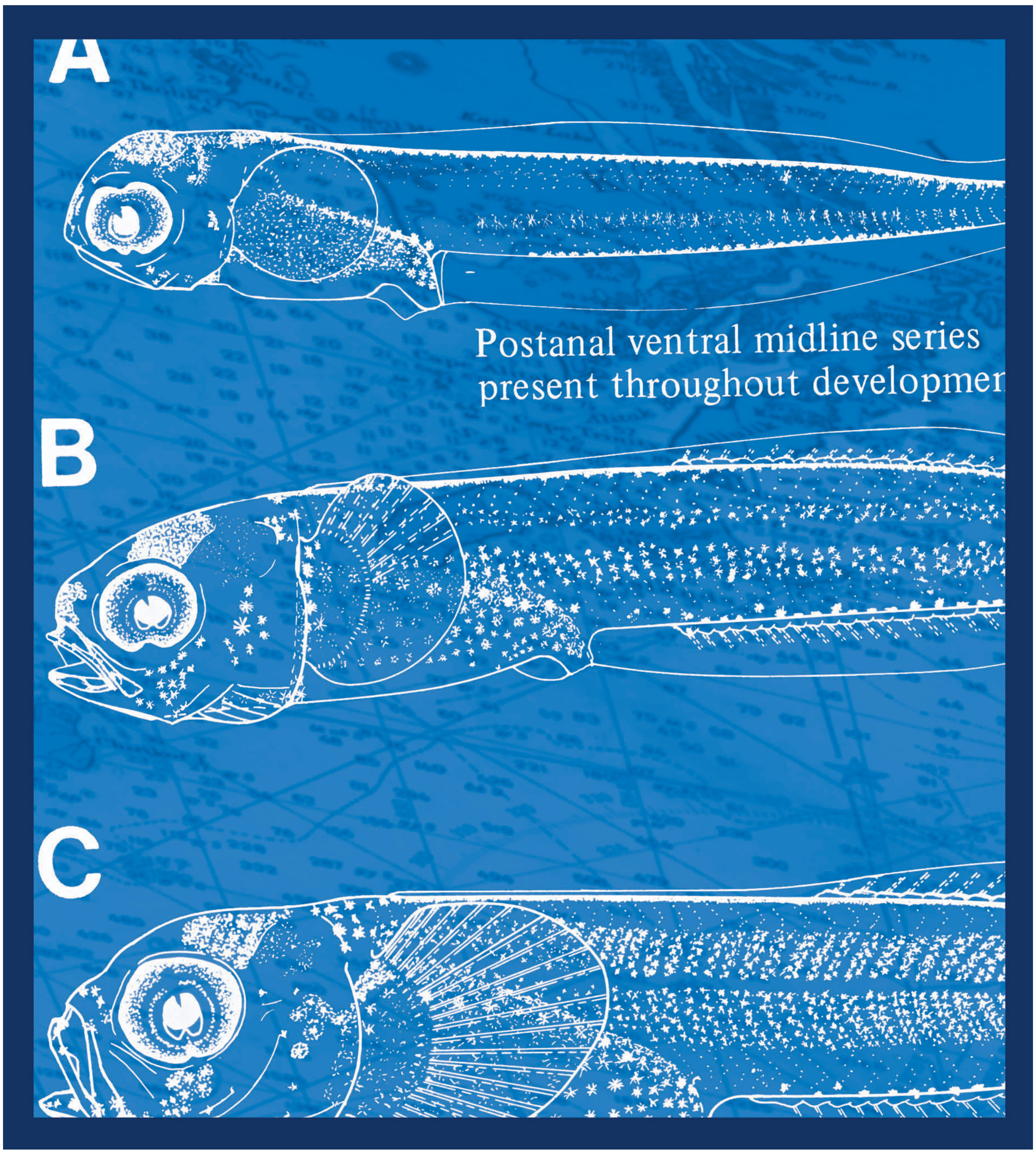
Egg occurrence map Egg identification or abundance data is available for less than 17% of those fish species for which larvae are identified in the Northeast Pacific Ocean and Bering Sea (Kendall and Matarese, 1994). Gear which is used for collecting fish eggs is biased toward planktonic individuals; demersal eggs are severely under-represented or entirely absent from our database. Egg occurrence in this map is displayed as presence only. Black squares show where eggs were present when sampled. For those taxa whose eggs are demersal or unknown, the legend within the map states that eggs are not collected.

Adult occurrence map RACEBASE is a database based on adult groundfish assessment, hydroacoustic, and foreign surveys conducted by federal fishery scientists. Standard adult occurrence maps were generated with RACEBASE data that was limited to the years 1975–1998. Range extensions based on this data set are noted in the text (Table 8). Blue squares show where adults were found when sampled. Gray squares denote where samples were taken, but no individuals of that taxon were found. Adult occurrence maps generated with alternative data as described on pages 35–36 and listed in Table 7 are identified with an asterisk in the legend on individual taxon pages. Adult occurrence maps generated with alternative data other than RACEBASE show presence only because the geographic extent of individual surveys was unknown (no gray area appears on the map).

Abundance and Distribution Patterns of Ichthyoplankton

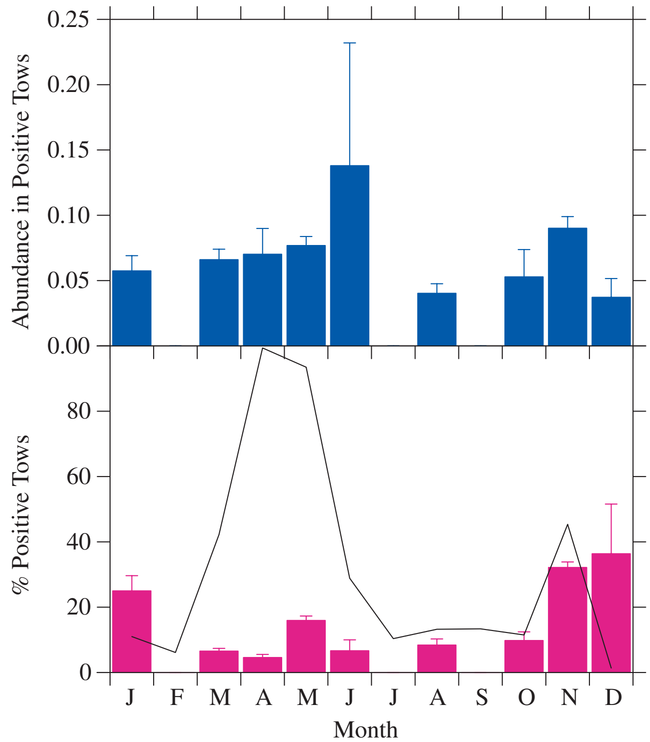
Neuston collections by family

Scomberesocidae
Anoplopomatidae
Hexagrammidae
Cottidae
Cryptacanthodidae

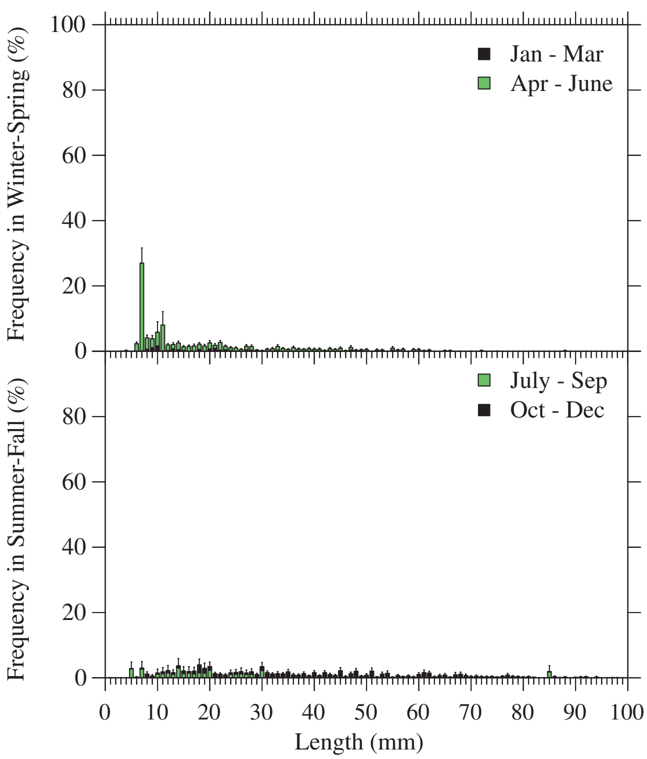


Life history *Cololabis saira* are found throughout the North Pacific Ocean, and in the eastern Pacific from the Gulf of Alaska to Mexico. Pacific saury adults are primarily epipelagic, occurring near the surface, but occasionally to depths of 200 m. Spawning takes place year-round with various peaks (spring in the CalCOFI area) within their range. Eggs are pelagic and attach via adhesive filaments to one another and to floating objects like kelp. Eggs are slightly ovoid, 1.5–1.8 × 1.6–1.9 mm in diameter, with a cluster of 12–20 filaments at one pole. Larvae are neustonic and hatch at sizes between 5 and 7 mm SL with a well-developed tail. Transformation occurs at sizes between 21 and 30 mm SL.
[Sources include: Matarese et al. (1989), Watson (1996a)]

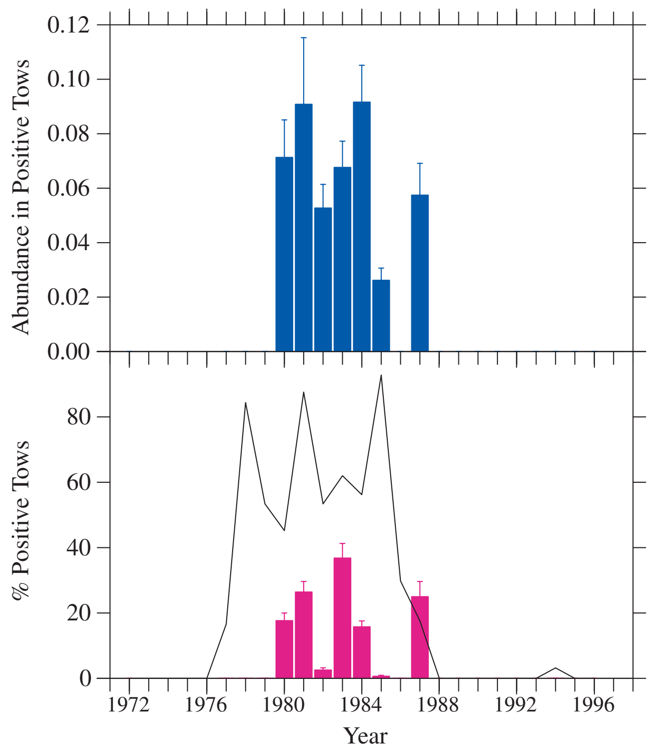
Larval distribution Pacific saury larvae and juveniles are found in neuston samples collected throughout the study area off the U.S. west coast off Washington, Oregon, and California. Larvae are most abundant in deeper slope and oceanic waters and are found most of the year except February, July, and September. Although adults are present in AFSC Gulf of Alaska surveys, eggs and larvae have not been collected. Larvae <25 mm SL are most abundant in winter–spring, but larvae and pelagic juveniles occur throughout the year. Eggs are present mostly in oceanic waters throughout the AFSC U.S. west coast survey area. Overall catch by year indicates larvae were present in more tows in the 1980s when neuston tows were more frequent during AFSC U.S. west coast surveys.



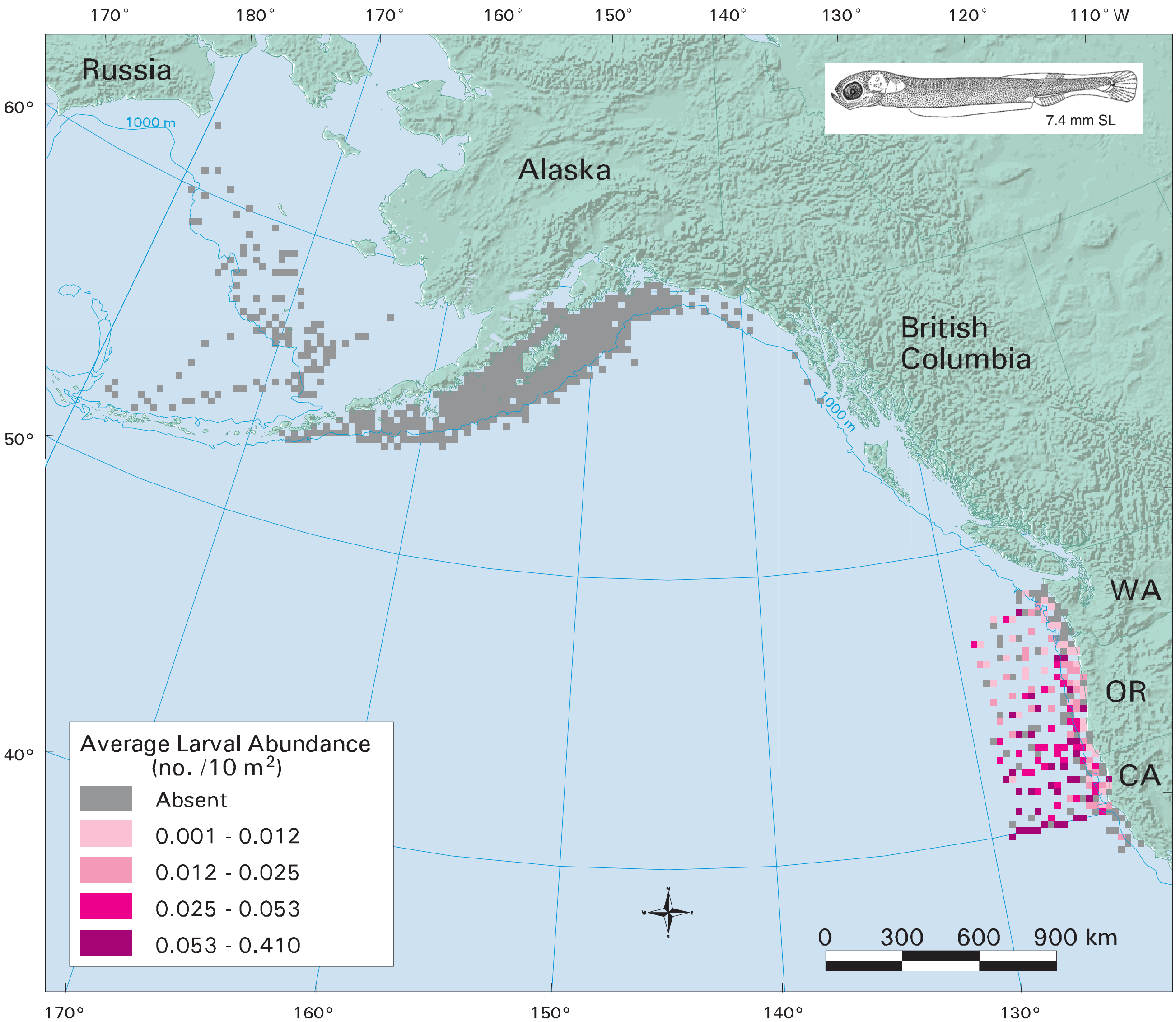
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

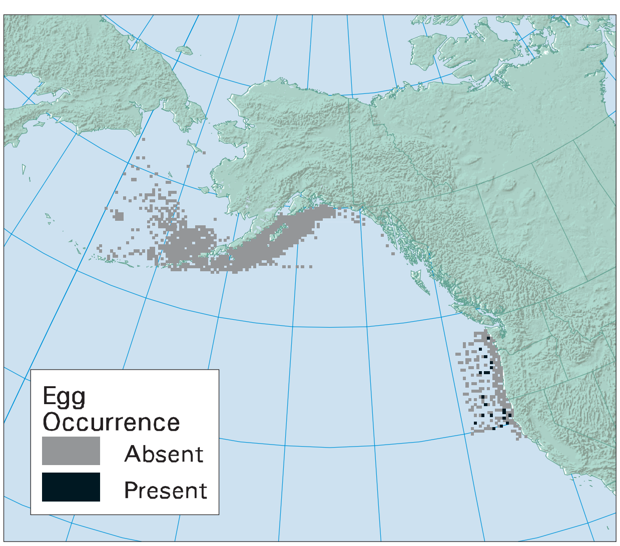


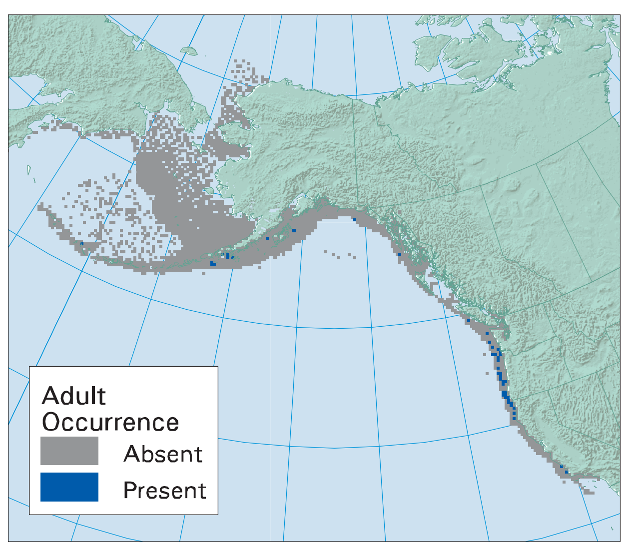
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 667 for winter–spring (Jan–June), 537 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

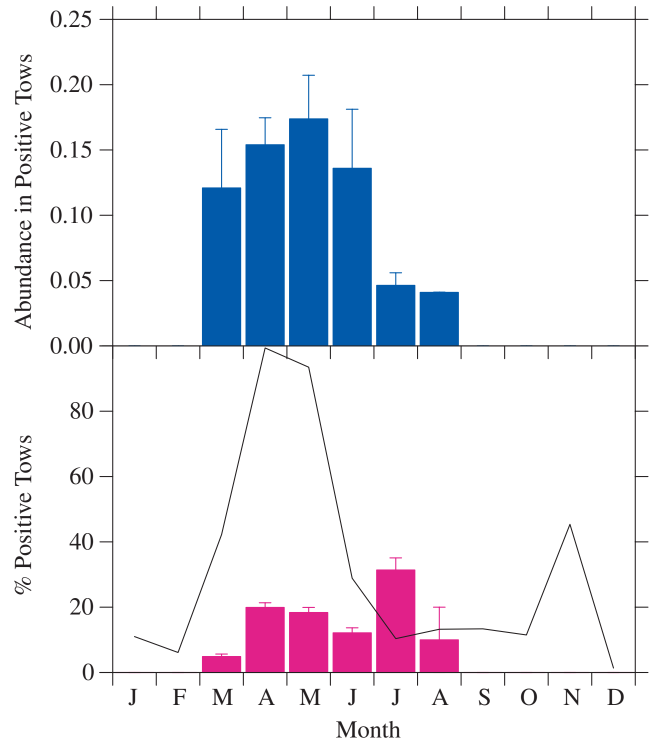

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
7.4 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.012
0.012 - 0.025
0.025 - 0.053
0.053 - 0.410
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

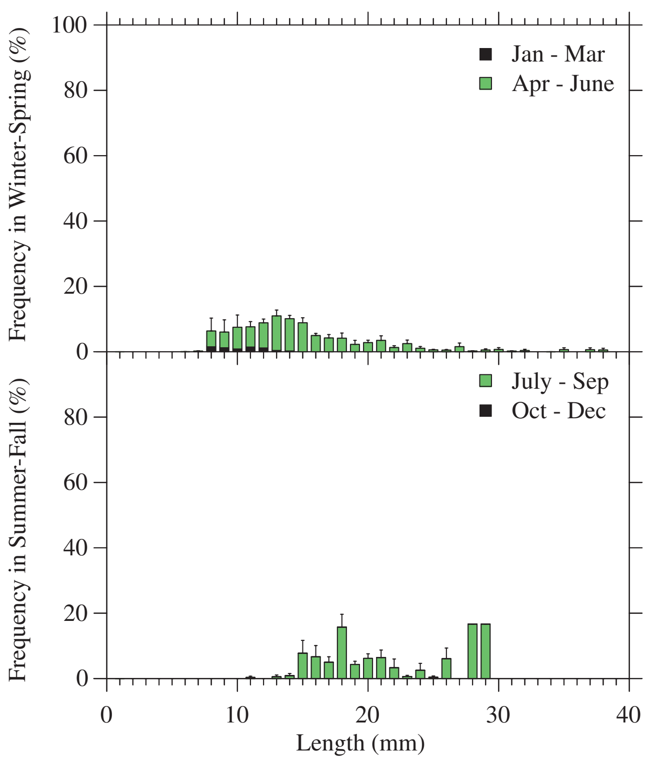

Adult Occurrence
Absent
Present

Life history *Anoplopoma fimbria* occur from the Bering Sea to Baja California. Adult sablefish are benthic and most abundant in waters deeper than 350 m along the continental slope. Fish mature at 5–7 years and may live to 55 years. Spawning occurs December–April in the southern extent of the range and becomes more protracted to the north, lasting from fall to summer in the Bering Sea. Females produce up to 1.3 million pelagic eggs (1.8–2.1 mm), which are found at depths greater than 200 m. Unpigmented larvae hatch at about 6 mm SL and quickly rise to the surface where they remain until the end of an extended pelagic juvenile tranformation stage (30–70 mm SL).
[Sources include: Hart (1973), Kendall and Matarese (1987), Matarese et al. (1989), Shaw and McFarlane (1997)]

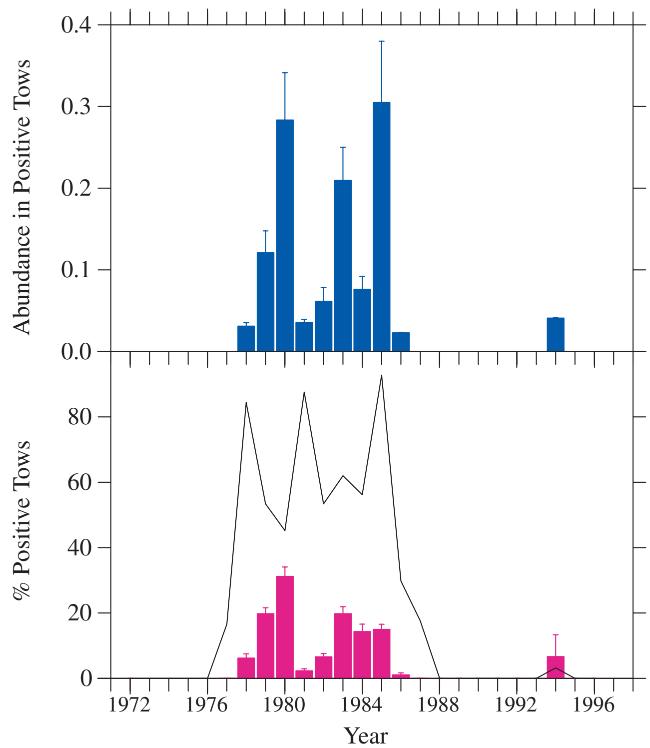
Larval distribution Sablefish larvae collected in neuston samples are widely distributed over deep water in the Bering Sea, Gulf of Alaska, and along the U.S. west coast. Larvae are most abundant along shelf edges in the Bering Sea, Gulf of Alaska south and east of Kodiak Island, and along the U.S. west coast off Washington and Oregon. Larvae are collected March–August with highest abundances in spring. Small larvae (<10 mm SL) are found in winter–spring; most larvae collected during this time are <20 mm SL. Larvae 11–29 mm SL are collected in summer–fall. Eggs are collected in deeper waters along the shelf edge near Unimak Pass, Gulf of Alaska, and along the U.S. west coast. Overall catches were highest in the 1980s when neuston gear was used more frequently and when AFSC conducted U.S. west coast surveys.



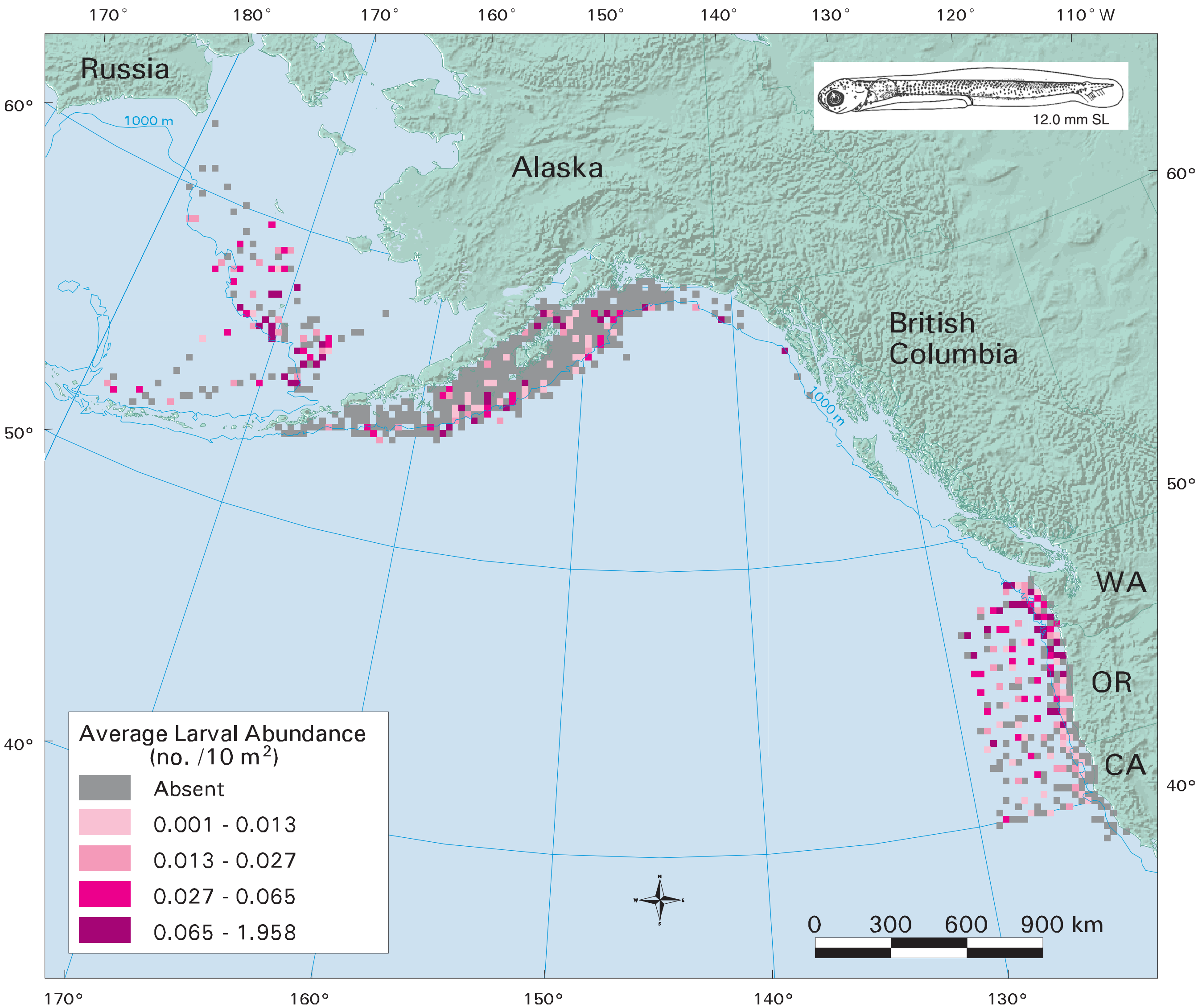
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

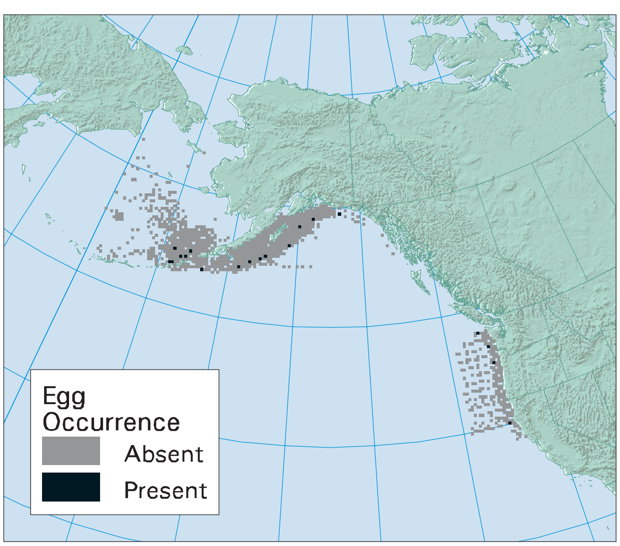


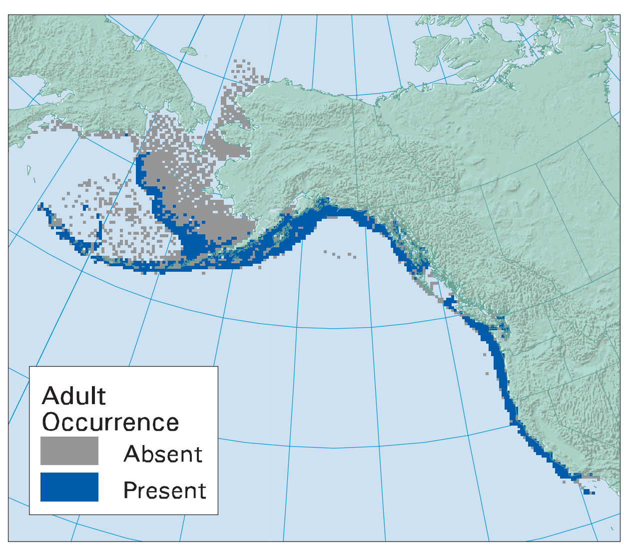
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 2361 for winter–spring (Jan–June), 100 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

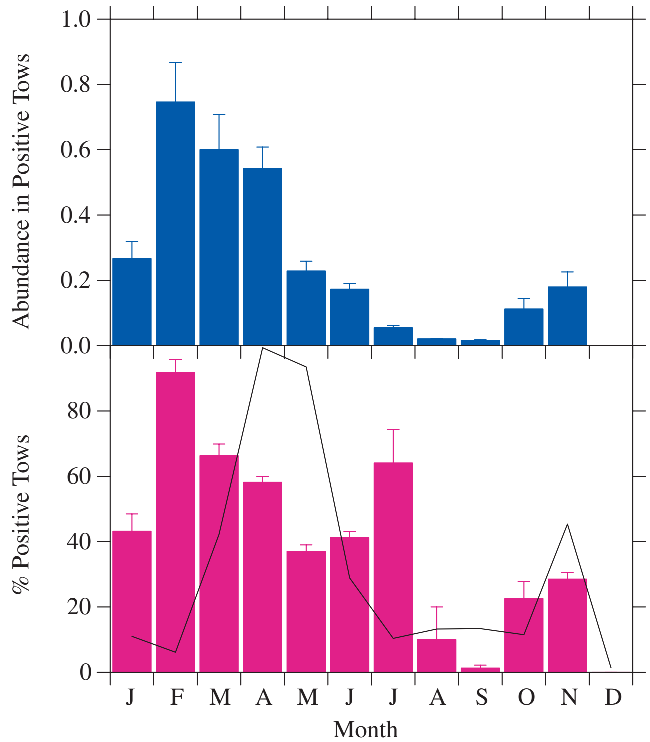

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
12.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.013
0.013 - 0.027
0.027 - 0.065
0.065 - 1.958
0 300 600 900 km
160°
150°
140°
130°


Egg Occurrence
Absent
Present

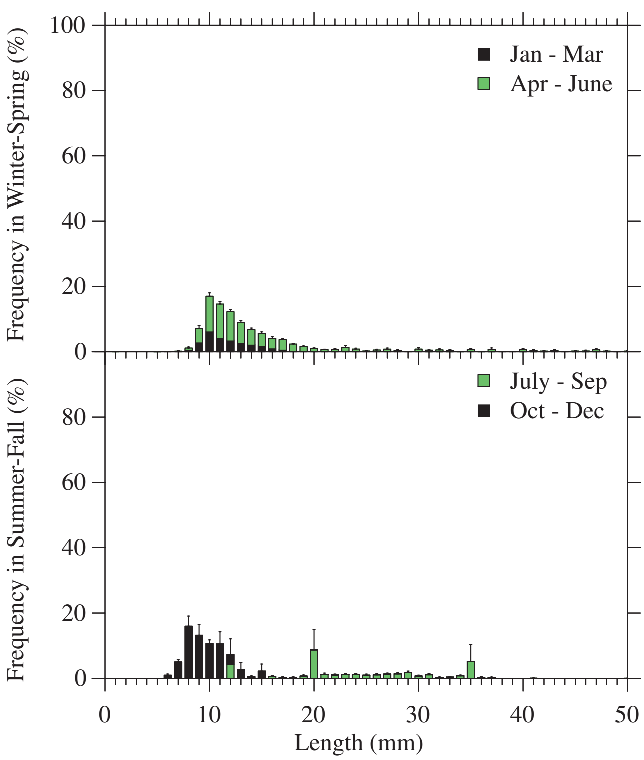

Adult Occurrence
Absent
Present

Life history *Hexagrammos decagrammus* are found from the Bering Sea to southern California, although occurrences off southern California are rare. Kelp greenling adults inhabit intertidal and nearshore areas to depths of 46 m and are commonly found in kelp beds. Demersal, adhesive eggs are pale blue and laid in masses on rocks during October and November. Larvae hatch at 7–9 mm SL and reside in the neuston until completion of an extended juvenile transformation stage (about 70 mm SL).
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

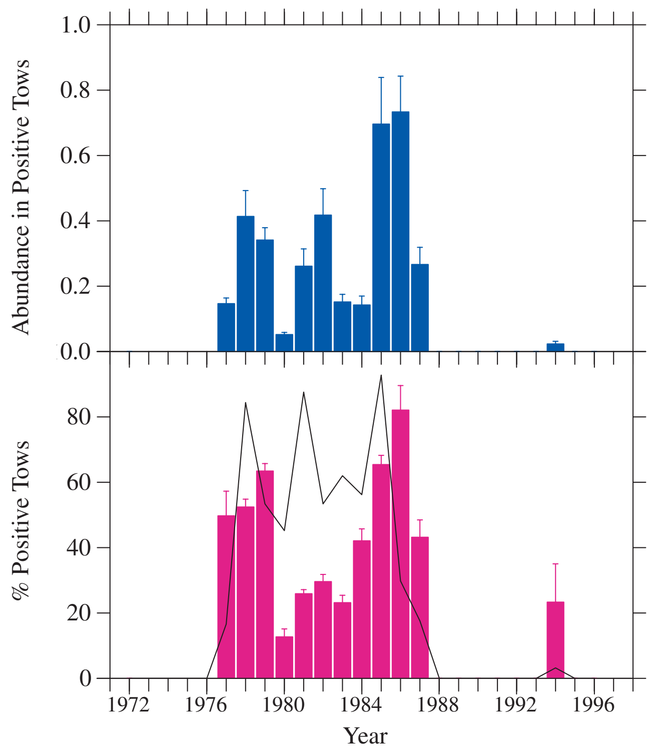
Larval distribution Kelp greenling larvae are found in neuston samples throughout the study area from the Bering Sea to off the U.S. west coast. They are abundant along the shelf edge in the Bering Sea, Shelikof sea valley, and in the Gulf of Alaska around Kodiak Island. Larvae are more routinely collected off the U.S. west coast than adults. Larvae have been collected in every month except December; highest catches are in winter–spring. Although the majority of larvae collected in winter–spring are <20 mm SL, a large size range is represented (7–48 mm SL). Newly hatched larvae, as well as pelagic postflexion juveniles, are collected in summer–fall. Overall catch by year indicates larvae were present in more tows in the late 1970s and early 1980s when neuston tows were more frequent.



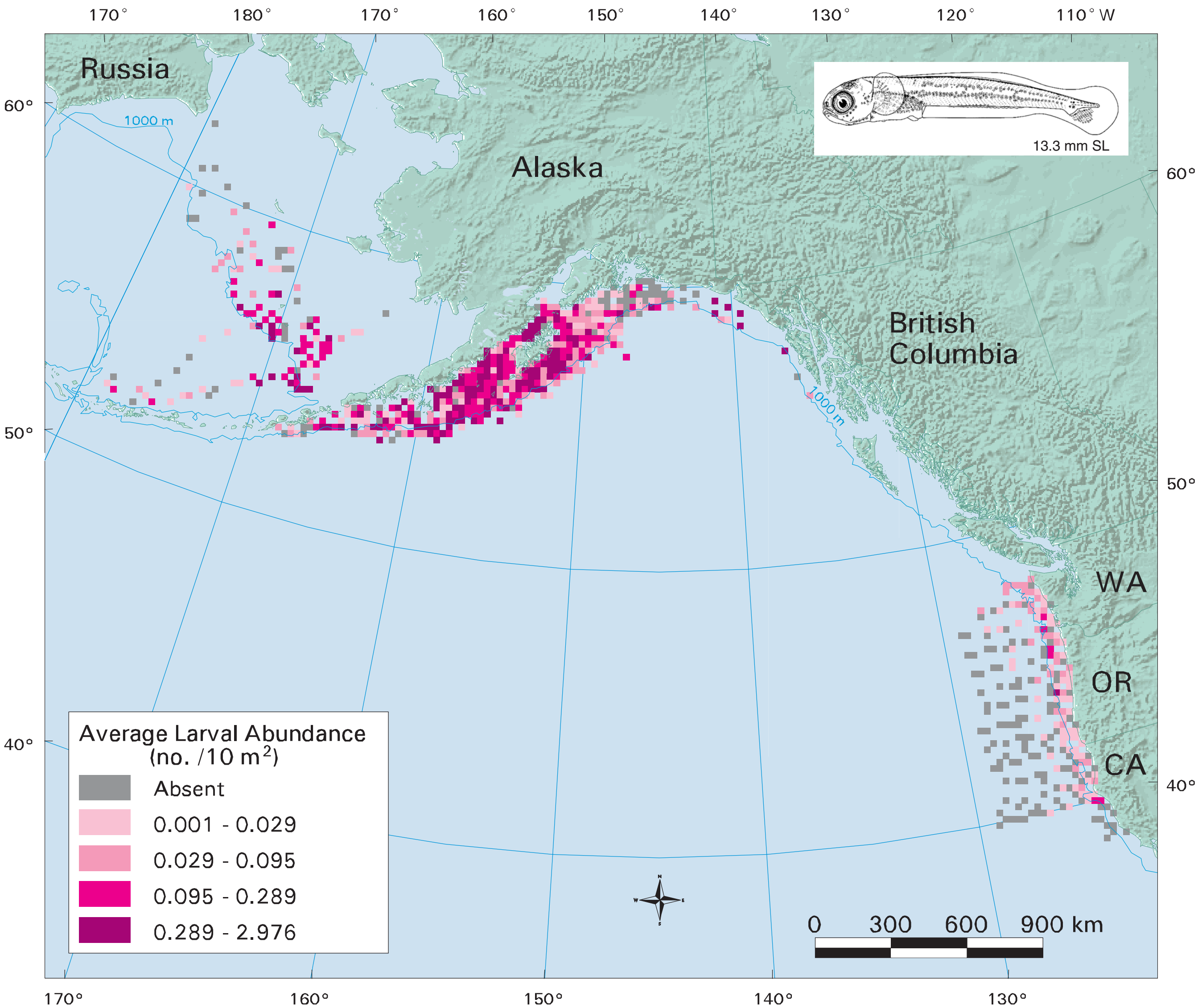
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



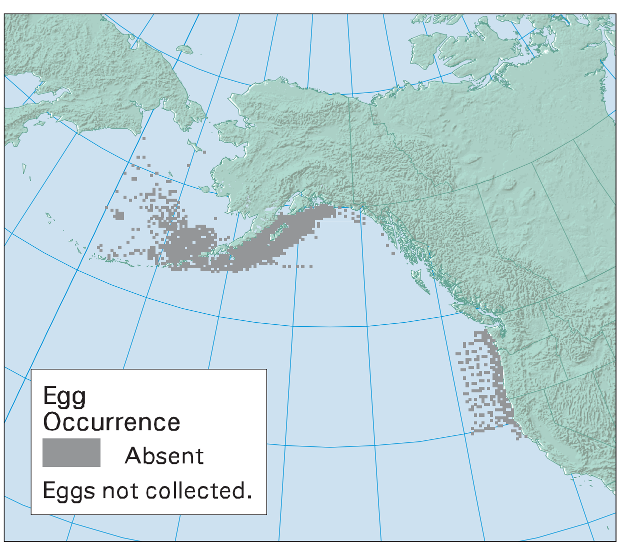
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 14,661 for winter–spring (Jan–June), 1044 for summer–fall (July–Dec).



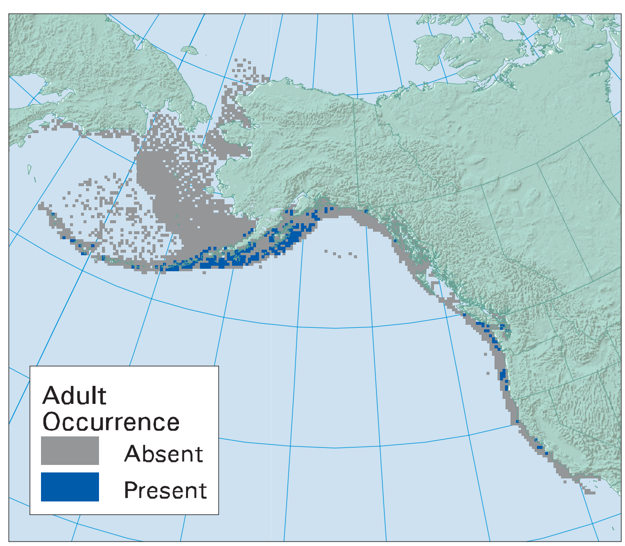
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
13.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.029
0.029 - 0.095
0.095 - 0.289
0.289 - 2.976
0 300 600 900 km
170° 160° 150° 140° 130°



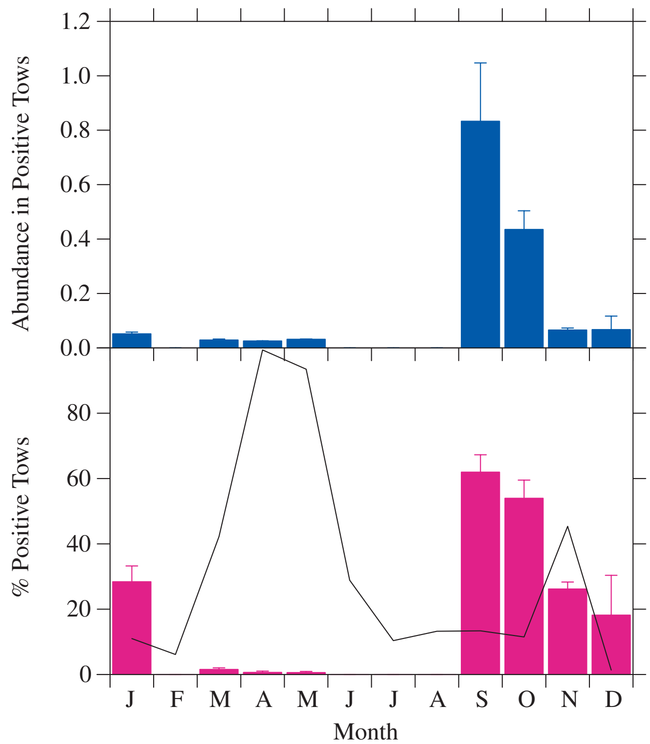
Egg Occurrence
Absent
Eggs not collected.



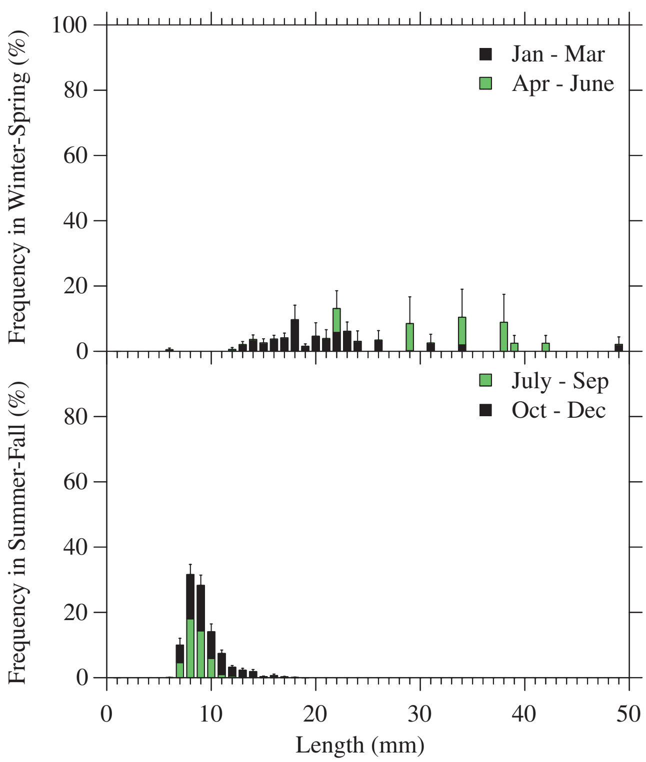
Adult Occurrence
Absent
Present

Life history *Hexagrammos lagocephalus* range from the Bering Sea to central California, generally inhabiting intertidal and nearshore areas. Rock greenling mature at 3–4 years; spawning is June–August in the Aleutian Islands and until September in the western Pacific. Spawning occurs at intervals with males guarding the nest. During the season females produce 14,000–103,000 demersal, adhesive eggs that are attached to rocks or algal holdfasts in areas of strong currents. Incubation lasts 30 days at 6–10°C, after which larvae hatch at 7–9 mm SL. Larvae reside in the neuston and remain there until about 49 mm SL.
[Sources include: Matarese et al. (1989)]

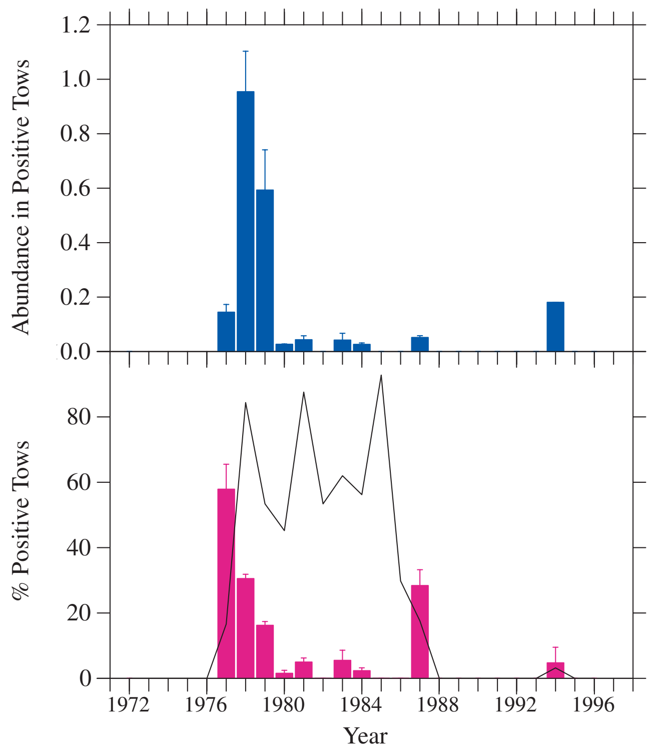
Larval distribution Rock greenling are collected in neuston samples from the Bering Sea, southeast Kodiak Island shelf eastward to Cape St. Elias, and off the U.S. west coast. Although adults are infrequently collected in AFSC surveys, larvae are common. Highest abundances occur on the shelf south and east of Kodiak Island and southwest of Cape St. Elias. Larvae are collected September–May. Small and newly hatched larvae (<20 mm SL) are taken in summer–fall, whereas larger larvae and pelagic prejuveniles (up to 50 mm SL) are collected in winter–spring. Overall catch by year indicates larvae were sporadically present in the time series, but more abundant during the late 1970s when sampling east of Kodiak Island in the fall was more frequent.



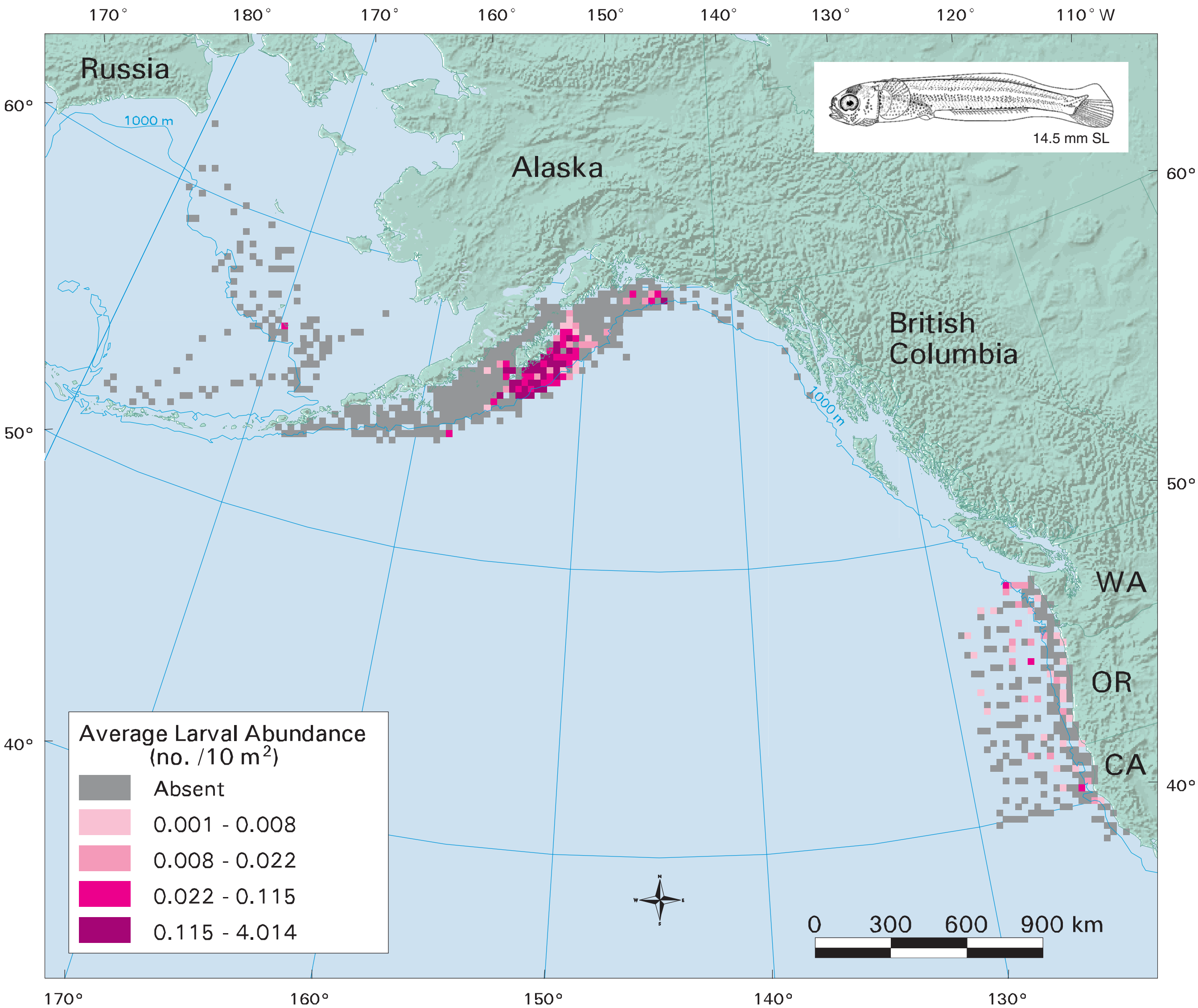
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

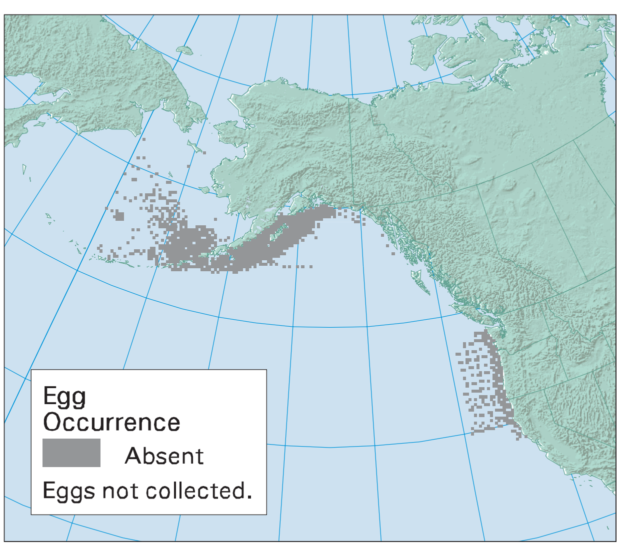


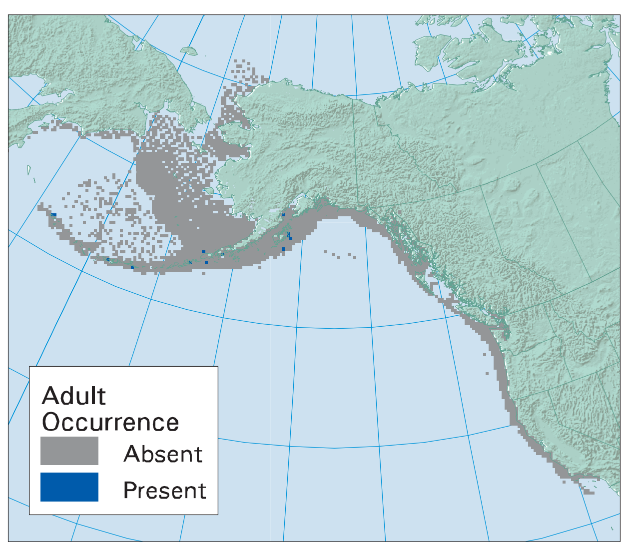
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 68 for winter–spring (Jan–June), 2549 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

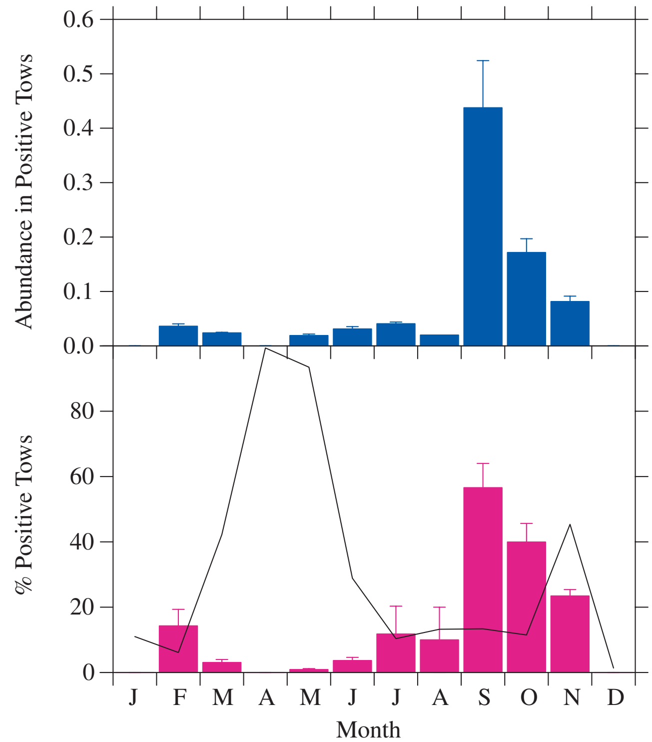

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
170°
160°
150°
140°
130°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
14.5 mm SL
Average Larval Abundance
(no. /10 m2)
Absent
0.001 - 0.008
0.008 - 0.022
0.022 - 0.115
0.115 - 4.014
0 300 600 900 km


Egg
Occurrence
Absent
Eggs not collected.

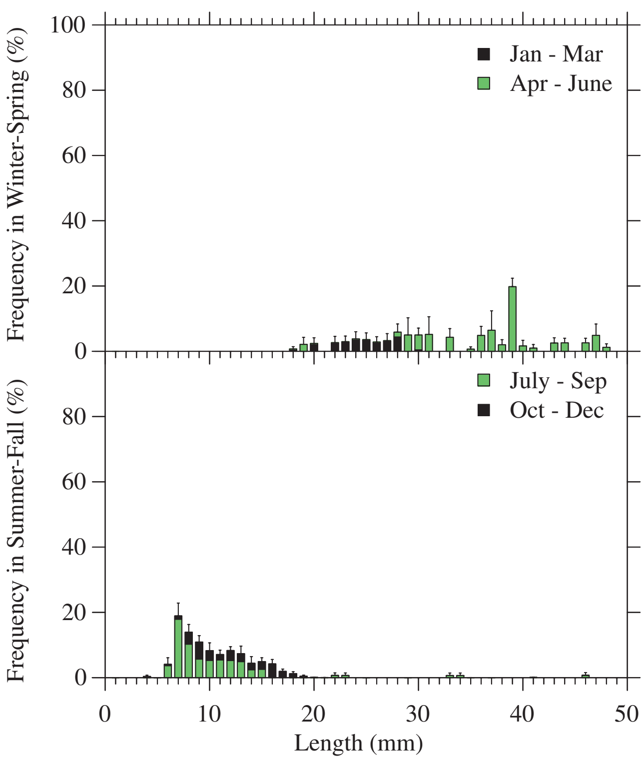

Adult
Occurrence
Absent
Present

Life history *Hexagrammos octogrammus* are collected from the Bering Sea to British Columbia. Masked greenling are the smallest members of the genus, reaching full size at 28 cm TL. Adults are collected in shallow rocky areas; females spawn demersal adhesive eggs (1.75–2.10 mm) into nests that the males guard. Larvae, which hatch at 7–9 mm SL, are neustonic and remain in the plankton until about 47 mm SL.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

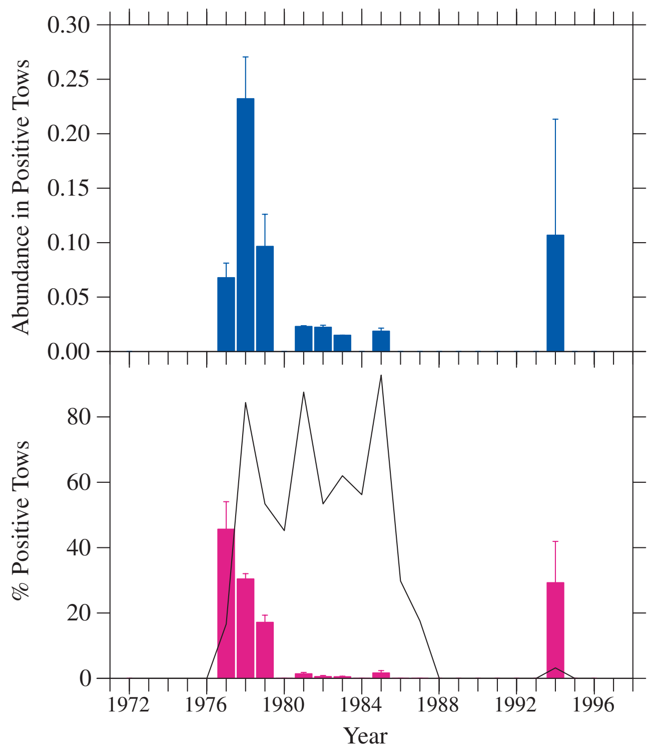
Larval distribution Masked greenling larvae are collected in neuston samples from the Bering Sea, southeast Kodiak Island shelf, and Gulf of Alaska. Although adults are infrequently collected in AFSC surveys, larvae are common. Larvae are widely distributed in the Bering Sea, but highest concentrations of larvae are found on the shelf south and east of Kodiak Island. Larvae are collected during most months February–November, with highest abundances in late summer and fall. Small and newly hatched larvae (<20 mm SL) are more common in summer–fall, whereas larger larvae and pelagic prejuveniles (18–48 mm SL) are taken in winter–spring. Larvae have been collected sporadically, occurring in fewer than half the years of sampling; highest abundances occurred during the late 1970s when sampling east of Kodiak Island in the fall was more frequent.



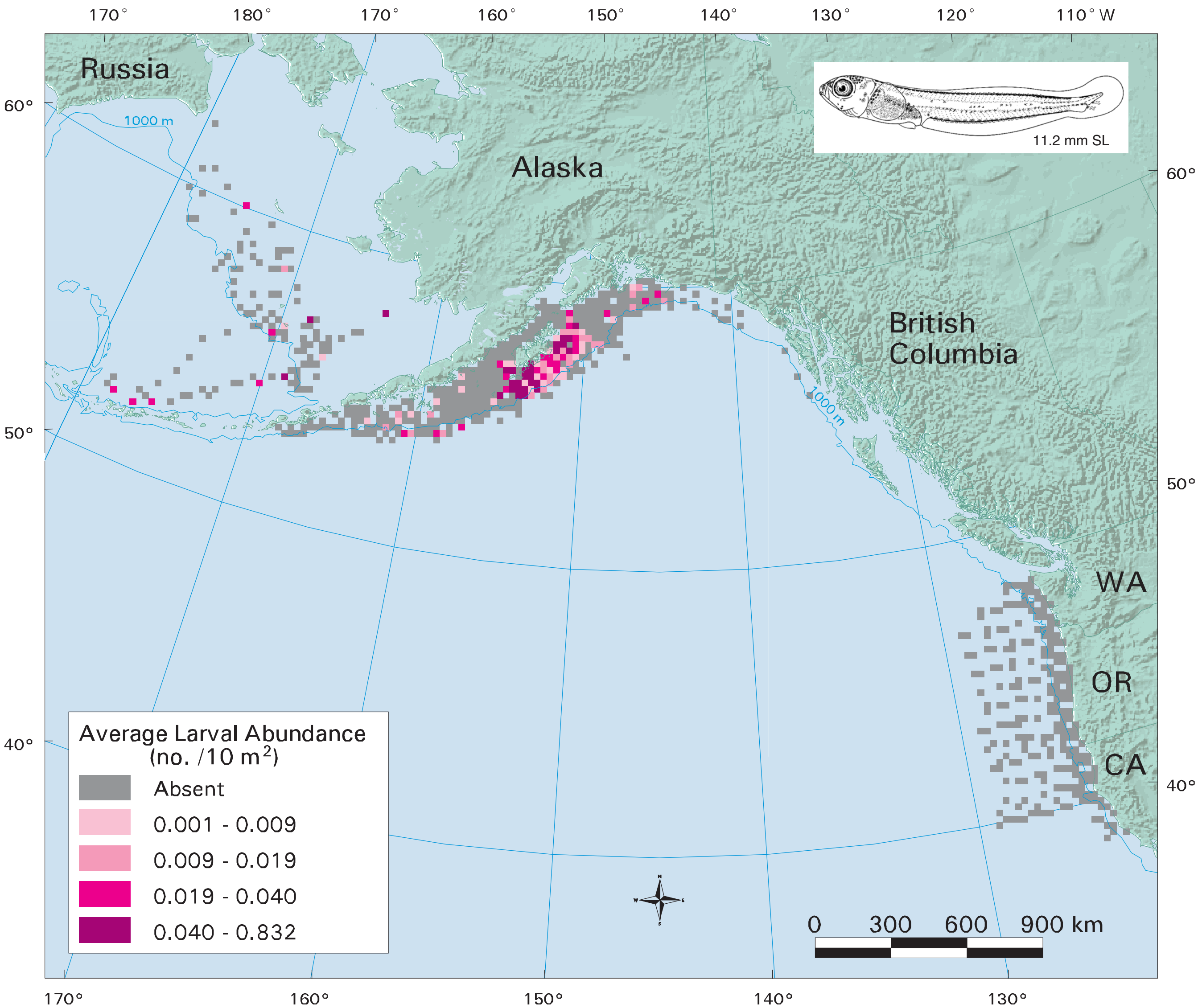
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

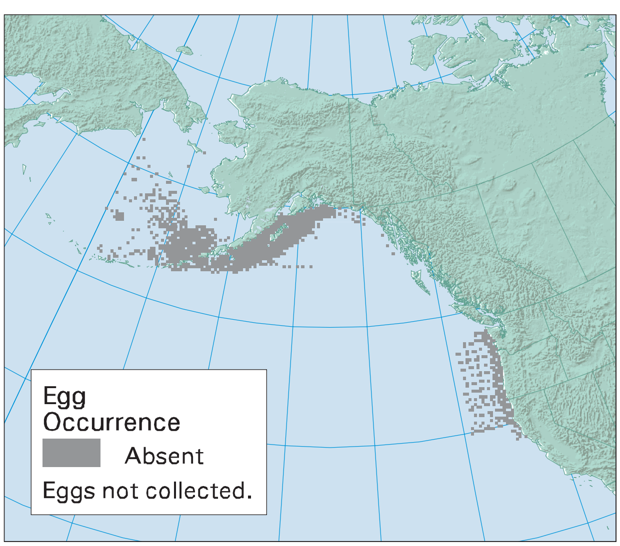


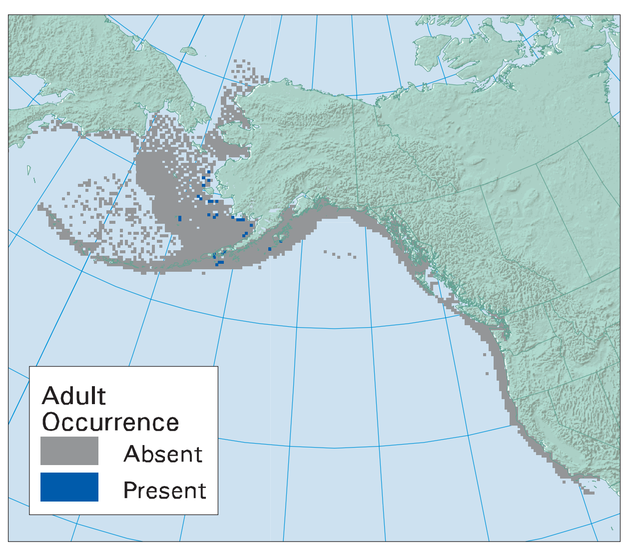
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 58 for winter–spring (Jan–June), 1452 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

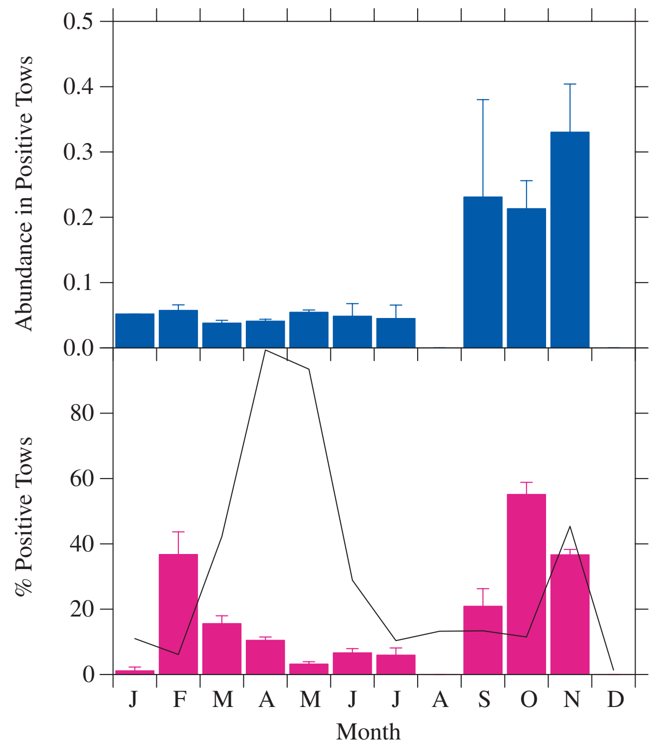

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
11.2 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.009
0.009 - 0.019
0.019 - 0.040
0.040 - 0.832
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

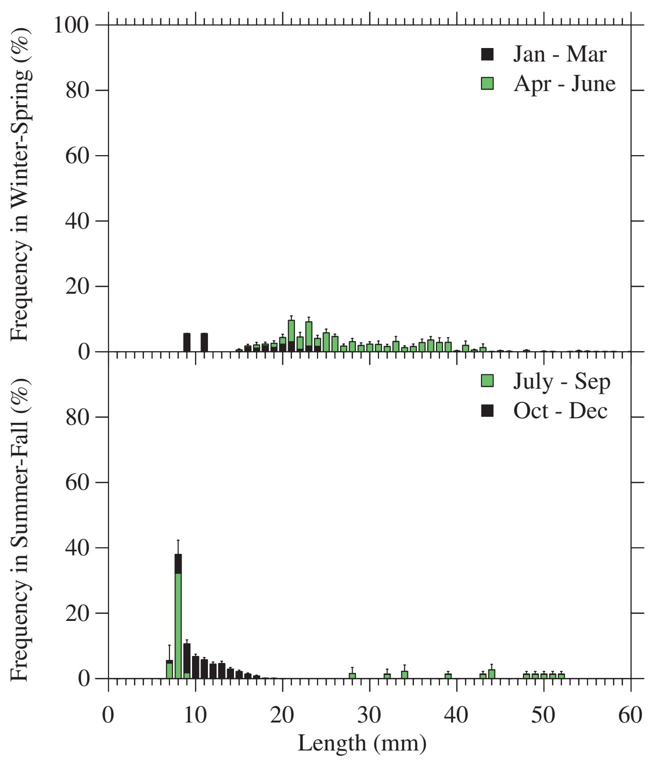

Adult Occurrence
Absent
Present

Life history *Hexagrammos stelleri* occur from the Chukchi Sea to the coast of Oregon. Whitespotted greenling are a nearshore demersal species that live from intertidal areas to depths of 175 m. Adults can reach 48 cm TL. Spawning has been reported in February and April and also in summer and fall at the extremes of their range. Demersal, attached eggs are blue in color and may be deposited on rocks; pelagic larvae hatch at 7–9 mm SL. [Sources include: Hart (1973), Eschmeyer et al. (1983), Matarese et al. (1989)]

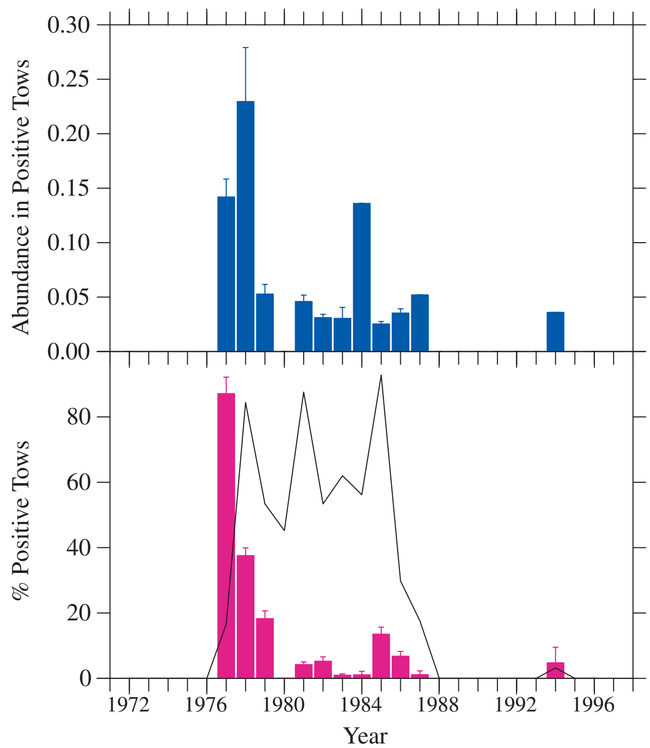
Larval distribution Whitespotted greenling larvae are found in neuston samples from the northern Bering Sea Shelf, along the continental shelf in the Gulf of Alaska around Kodiak Island, and off Washington along the U.S. west coast. Larvae are abundant in the Gulf of Alaska on the shelf south and east of Kodiak Island, but are uncommon in the AFSC U.S. west coast survey area. Found throughout the year, larvae are more abundant in summer–fall collections with highest catches in the fall. Although larvae and pelagic prejuveniles (about 10–50 mm SL) are collected year-round, most newly hatched (<10 mm SL) and young larvae occur in summer–fall. Overall catch by year indicates larvae were more common in collections during the late 1970s and 1980s when neuston sampling was conducted more frequently east of Kodiak Island. Highest abundances occurred 1977–1978 when fall cruises were conducted on the shelf east of Kodiak.



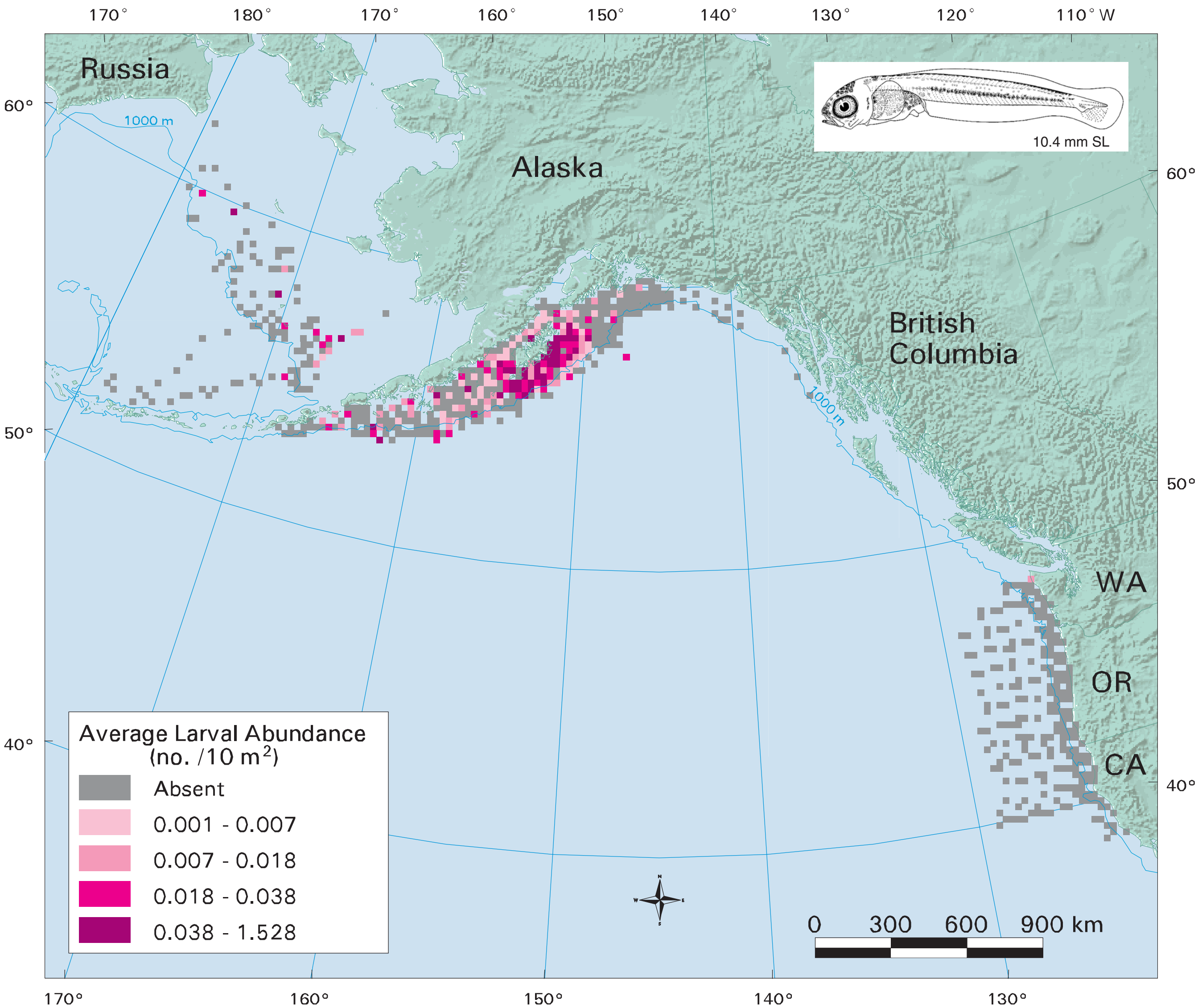
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

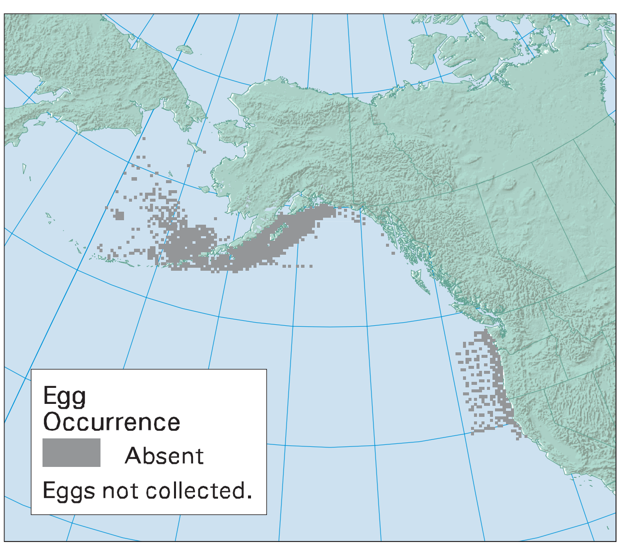


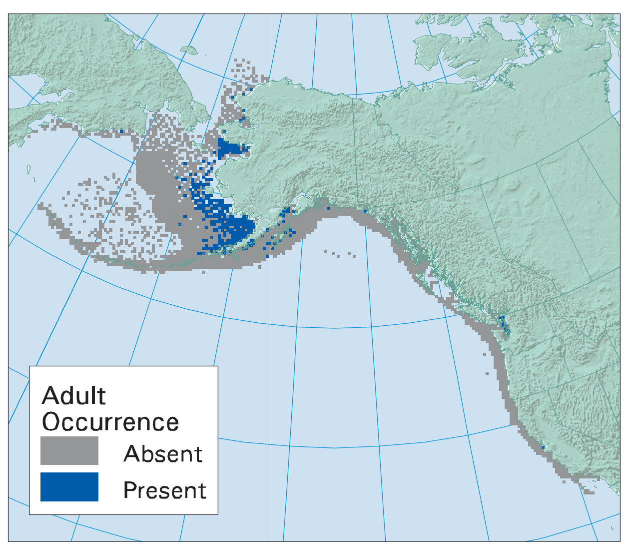
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 378 for winter–spring (Jan–June), 1701 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

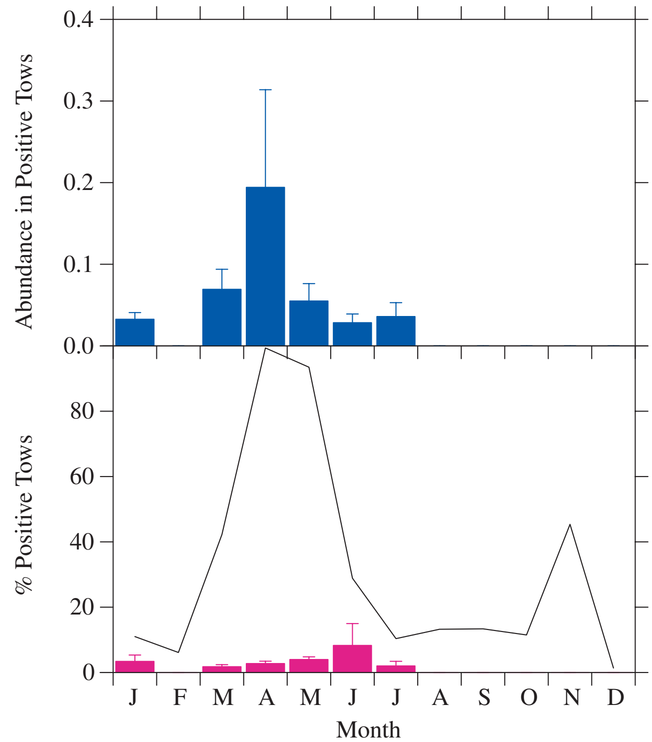

170° 180° 170° 160° 150° 140° 130° 120° 110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
60°
50°
40°
10.4 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.007
0.007 - 0.018
0.018 - 0.038
0.038 - 1.528
0 300 600 900 km
170° 160° 150° 140° 130°


Egg Occurrence
Absent
Eggs not collected.

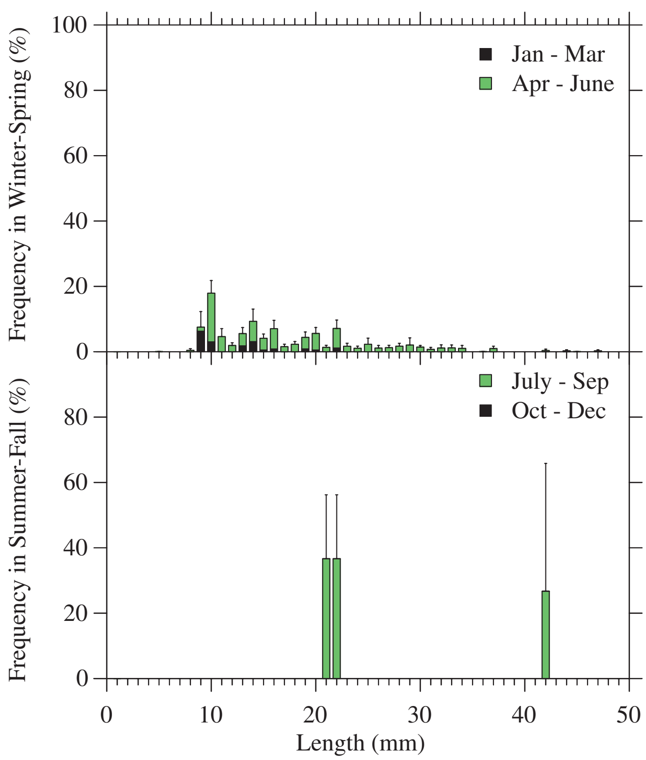

Adult Occurrence
Absent
Present

Life history *Ophiodon elongatus* range from the Gulf of Alaska along the U.S. west coast to northern Baja California. Adults are epi- and mesobenthic, found from intertidal areas to depths of 475 m. Lingcod are among the largest greenlings; adults can reach up to 152 cm TL. Spawning usually occurs in winter–spring in inter- and subtidal areas where adults nest in rocky areas with high currents. Eggs, which are 2.2–3.2 mm in diameter, opaque, and have a single oil globule, are demersal and guarded by males. Larvae hatch at about 7–10 mm SL with pigmented eyes and a well-developed mouth. Transformation occurs at approximately 30 mm SL, but juveniles remain pelagic until about 52 mm SL. Larvae are collected in the CalCOFI region, but are not as abundant as other co-occurring greenlings.
[Sources include: Matarese et al. (1989), Ambrose (1996a)]

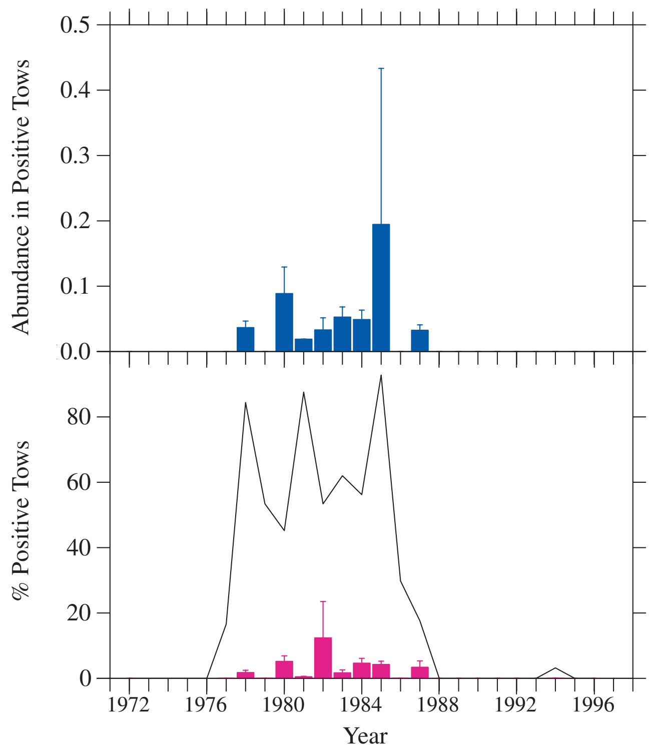
Larval distribution Lingcod larvae are collected in neuston samples taken in the Gulf of Alaska along the outer shelf from the Shumagin Islands eastward to off British Columbia, around Kodiak Island, and on the inner shelf off the U.S. west coast. Larvae are abundant in various areas throughout their range. Larvae and juveniles are found January–July with most collected in winter–spring (8–47 mm SL). Larvae were more abundant in neuston collections during the 1980s when AFSC conducted U.S. west coast surveys and when Gulf of Alaska surveys were conducted outside of Shelikof Strait southwest and northeast of Kodiak Island.



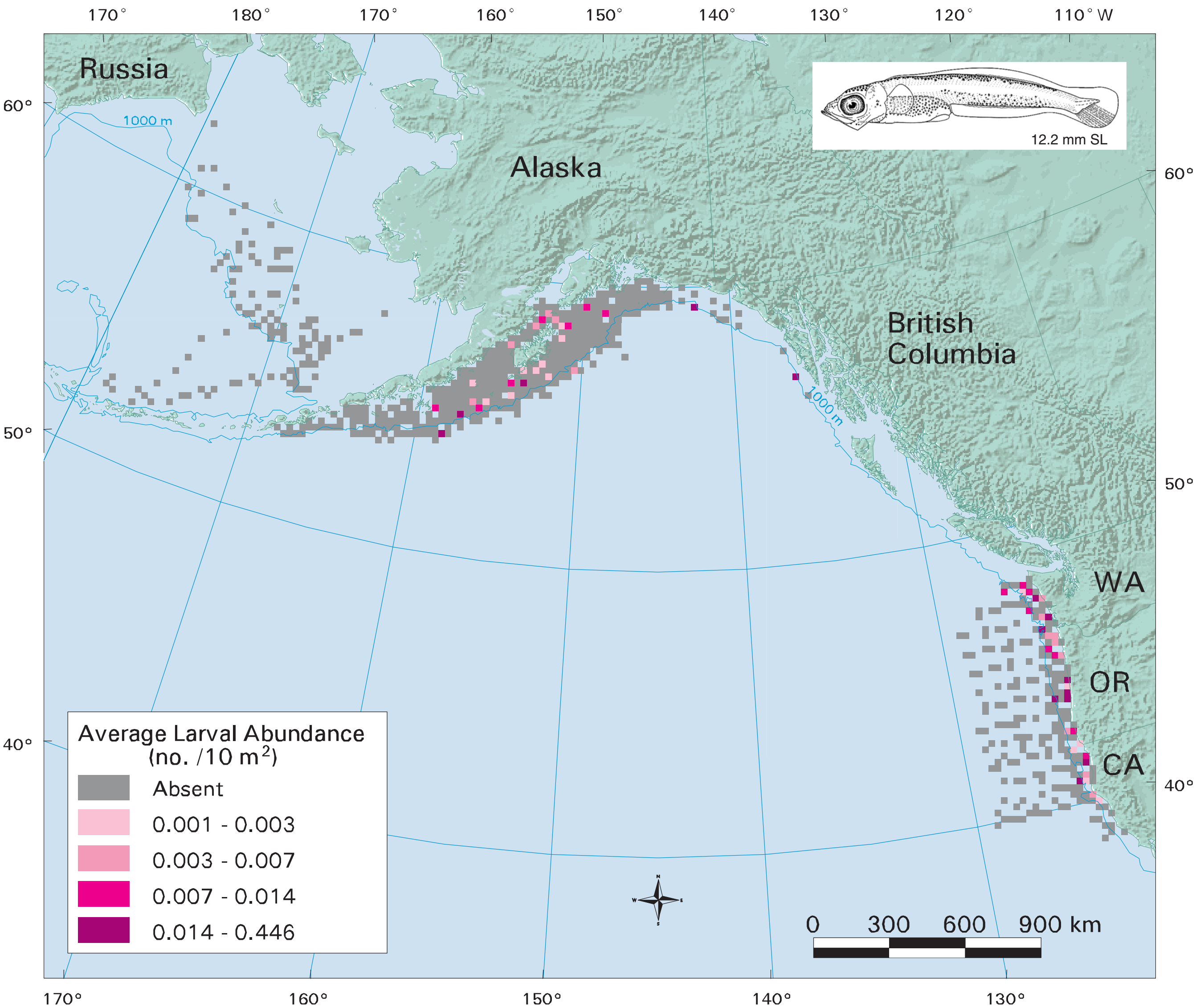
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



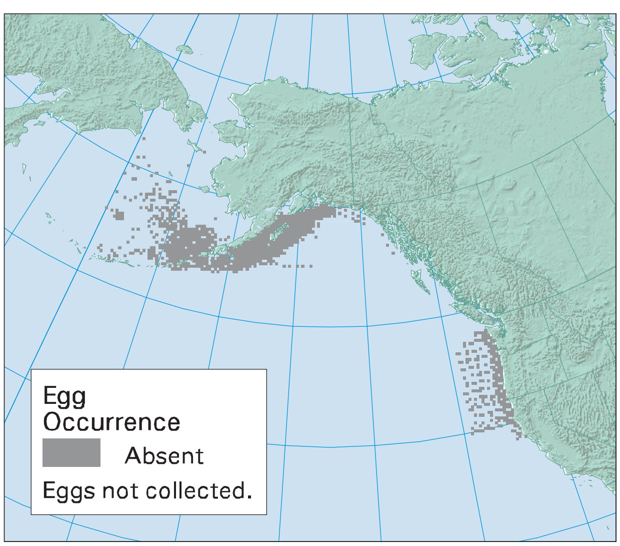
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 222 for winter–spring (Jan–June), 3 for summer–fall (July–Dec).



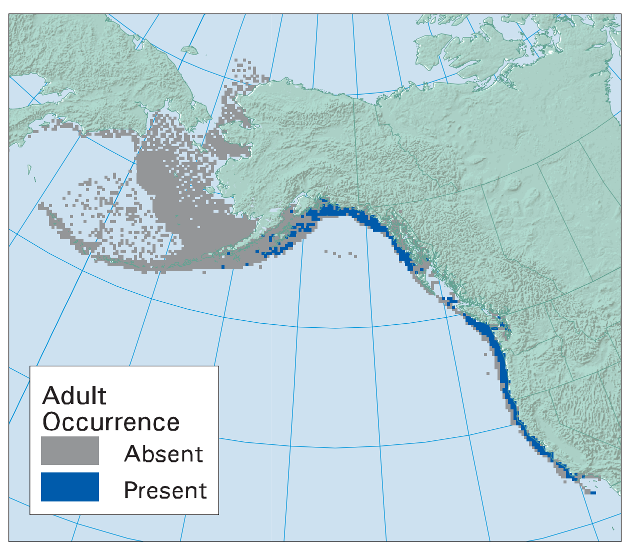
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
12.2 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.003
0.003 - 0.007
0.007 - 0.014
0.014 - 0.446
0 300 600 900 km



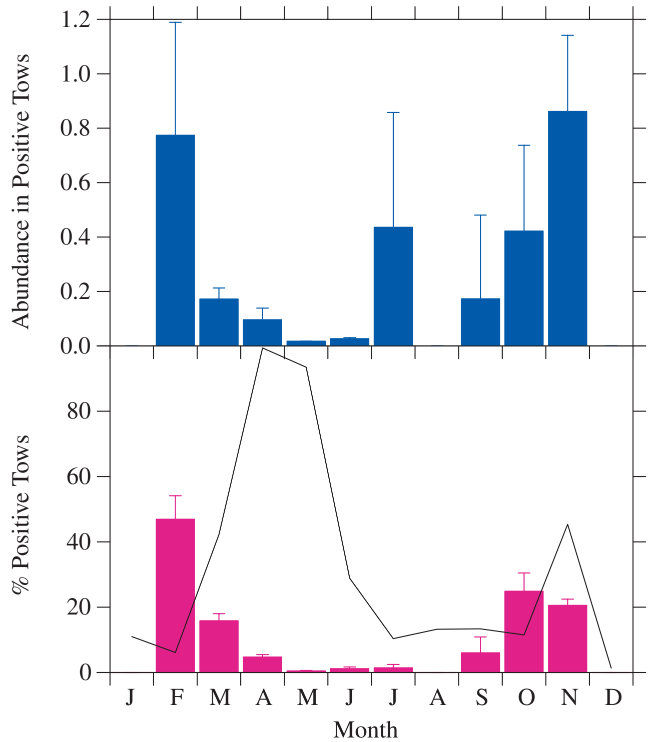
Egg Occurrence
Absent
Eggs not collected.



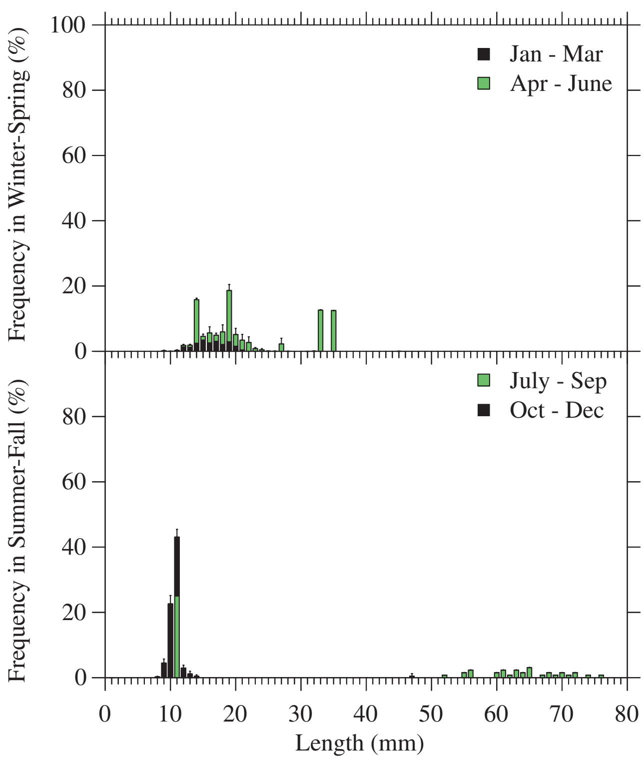
Adult Occurrence
Absent
Present

Life history *Pleurogrammus monopterygius* have been reported from the Bering Sea to southern California, although occurrences south of Alaska are rare. Atka mackerel are a schooling, semi-demersal species found from intertidal areas to depths of 575 m. Adults mature at 3–4 years and may live up to 11 years. In summer, adults move shoreward where males establish nesting areas. Females deposit 3,600–18,694 demersal, attached eggs (2.5–2.8 mm) in nests guarded by males. Larvae hatch at about 8 mm SL and reside in the neuston until completion of an extended transformation stage (about 75 mm SL).
[Sources include: Gorbunova (1962), Matarese et al. (1989)]

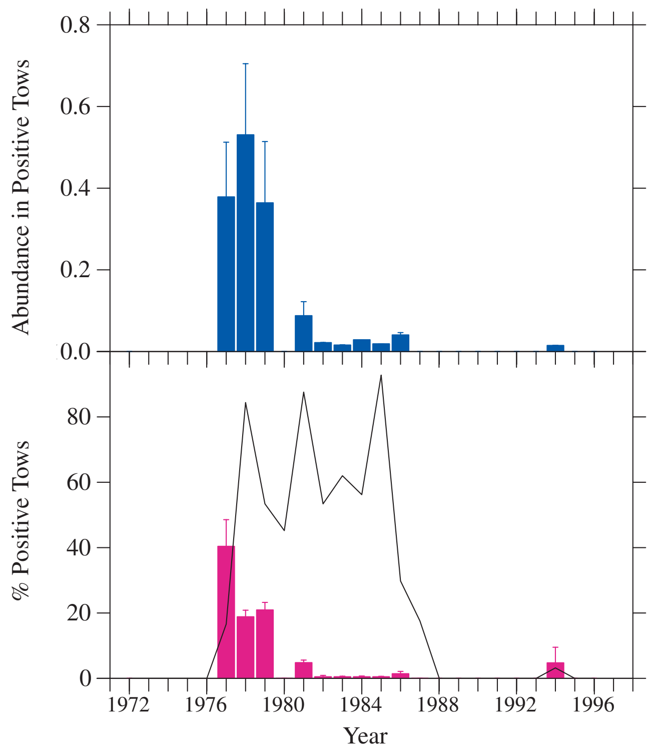
Larval distribution Atka mackerel larvae are collected in neuston samples from the Bering Sea and Gulf of Alaska. Although adults are reported to occur along the U.S. west coast to southern California, neither adults nor larvae have been collected during AFSC surveys in those areas. Larvae are abundant in the Gulf of Alaska, east of Kodiak Island. They are found in most months February–November with highest abundances during fall and winter. Size distribution of larvae in summer–fall is bimodal, reflecting the presence of small larvae (9–14 mm SL) in the fall and larger prejuveniles (47–76 mm SL) in summer. Small larvae and early juveniles (9–35 mm SL) are present in winter–spring. Overall catch by year indicates the presence of larvae was sporadic, but they were more abundant during the late 1970s when sampling east of Kodiak Island, specifically during fall, was more frequent.



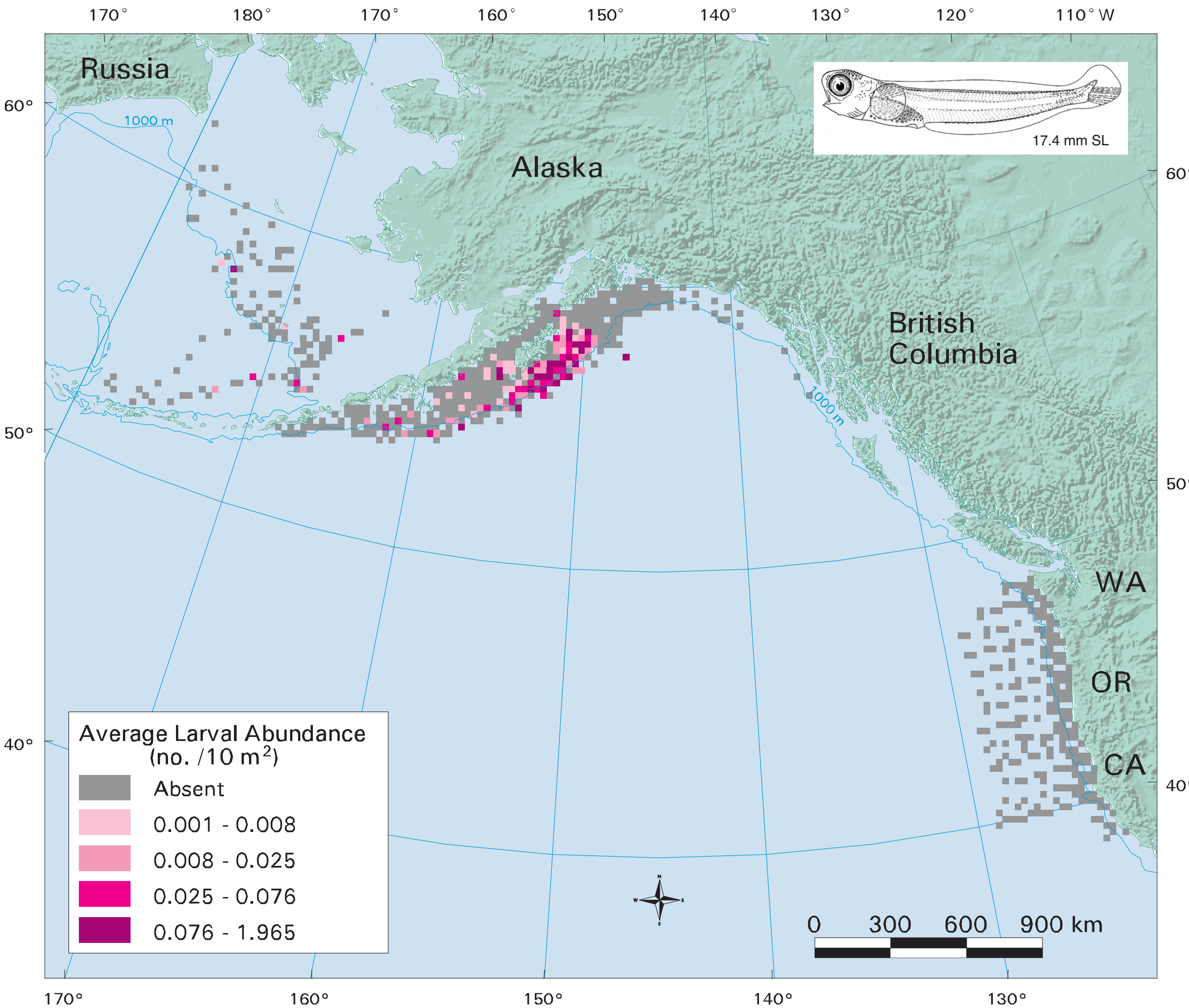
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

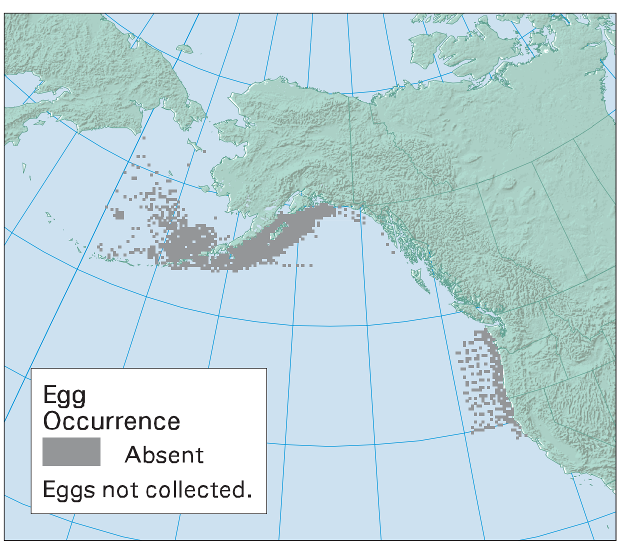


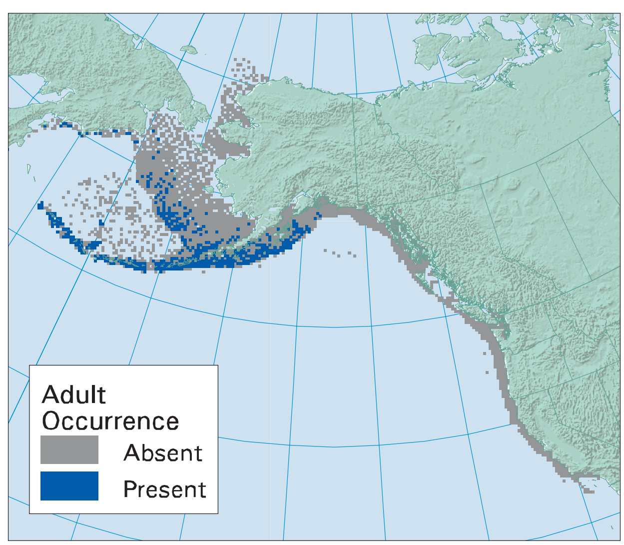
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 678 for winter–spring (Jan–June), 953 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

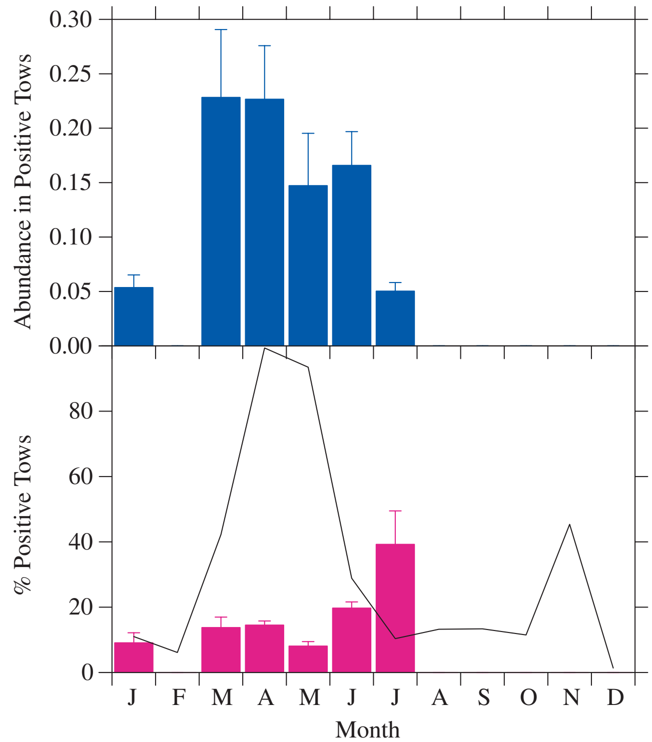

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
WA
OR
CA
17.4 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.008
0.008 - 0.025
0.025 - 0.076
0.076 - 1.965
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

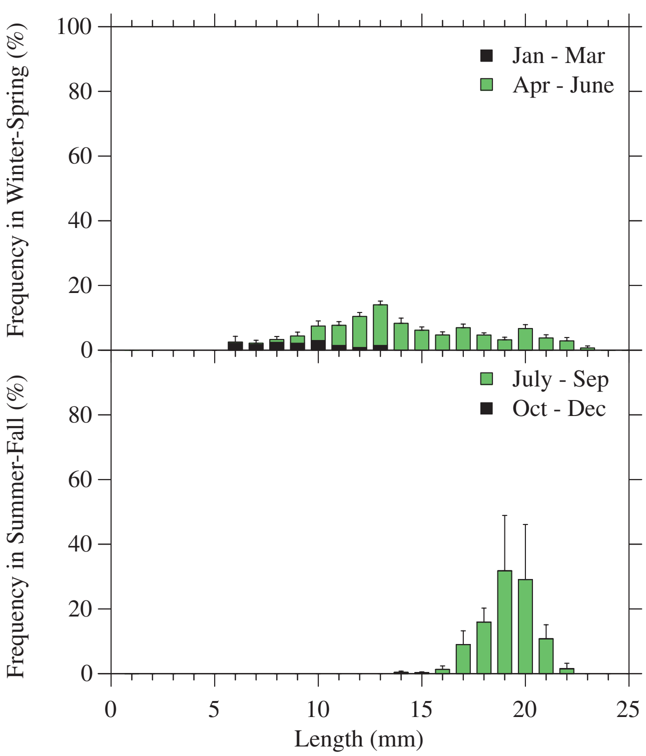

Adult Occurrence
Absent
Present

Life history *Hemilepidotus hemilepidotus* are found from the Bering Sea to central California and are most common in Alaska, from intertidal rocky areas to depths of 275 m. Red Irish lords have been reported to reach 51 cm TL, but are generally no greater than 30 cm TL. After adults reach maturity at 4 years, females deposit 59,000–126,000 demersal, adhesive eggs (about 1.5 mm in diameter) on rocks or pilings in areas of high current velocities October–January. One or both parents guard the eggs. Pelagic larvae hatch at 5–6 mm SL; transformation to juveniles (also pelagic) takes place at 19–23 mm SL.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

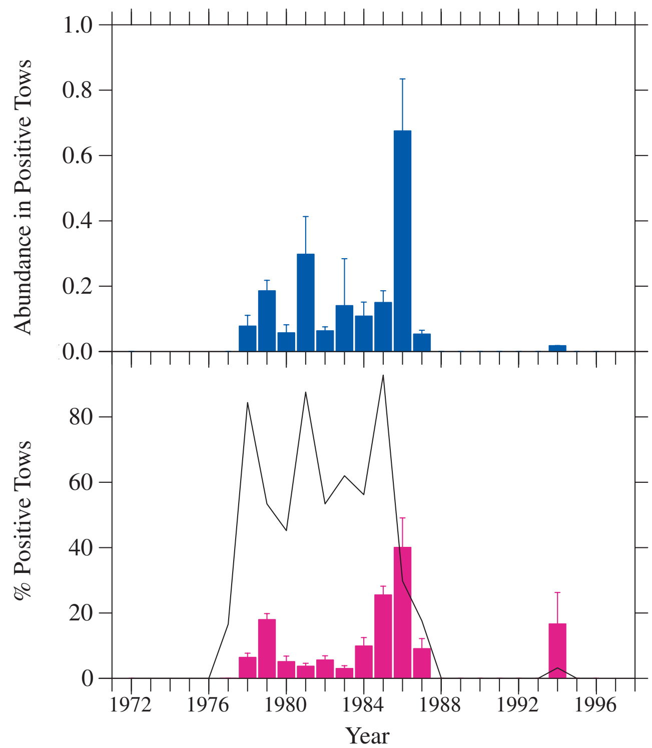
Larval distribution Red Irish lord larvae are collected in neuston samples from the Bering Sea, eastward into the Gulf of Alaska to British Columbia, and along the U.S. west coast off Washington and Oregon. Larvae are widely distributed, but most abundant over the shelf in the Bering Sea and southwest of Kodiak Island. Most larvae are collected in spring, but are found January–July. Larvae collected in winter–spring represent newly hatched to pelagic prejuveniles over a wide size range (6–23 mm SL); those collected in summer–fall are mostly larger (14–22 mm SL). Overall catch by year indicates larvae were present in more tows from the late 1970s and early 1980s when neuston tows were more frequent.



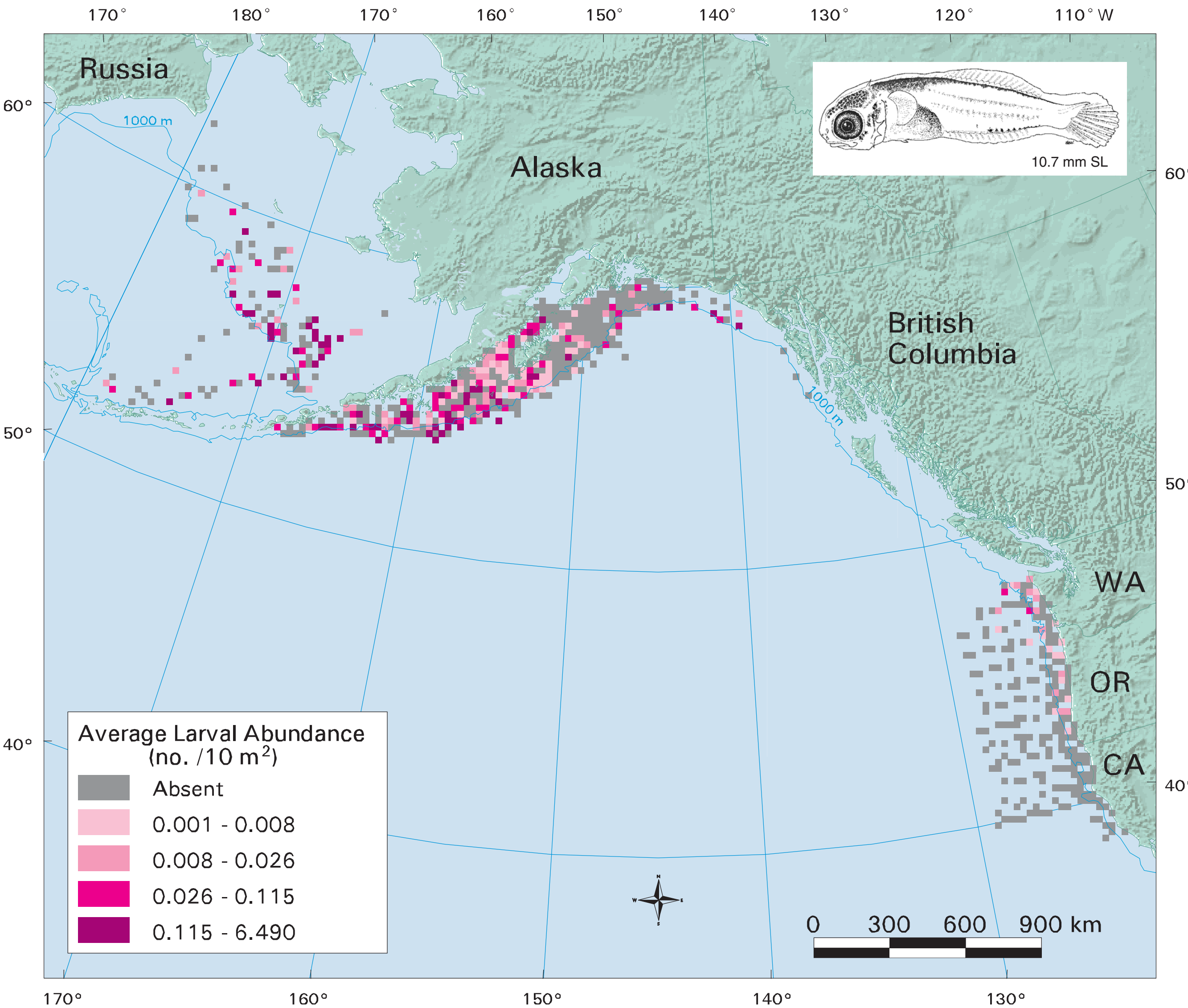
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

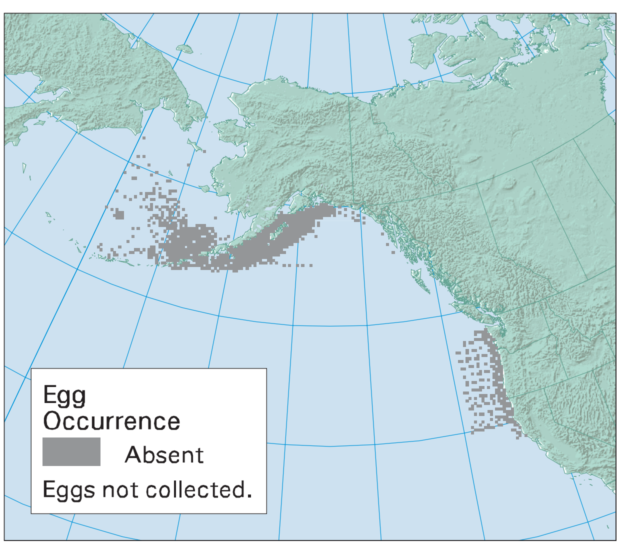


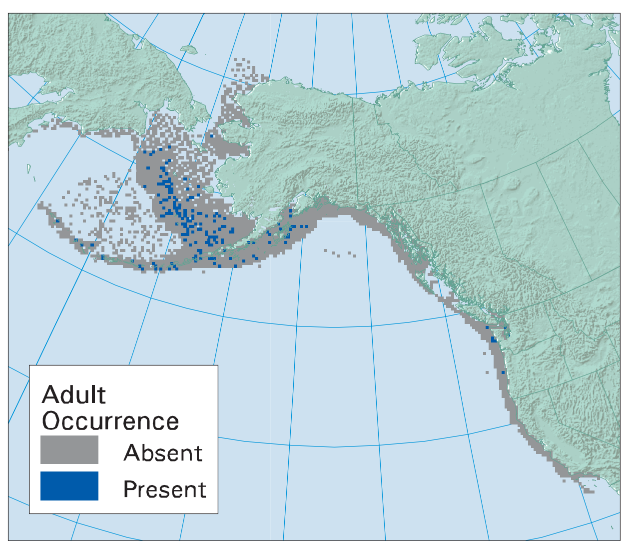
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 2708 for winter–spring (Jan–June), 106 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

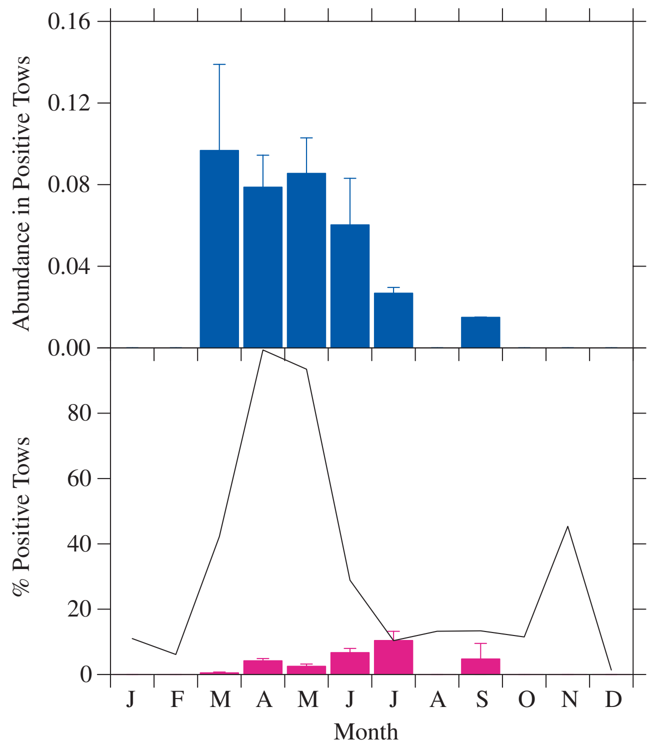

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.7 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.008
0.008 - 0.026
0.026 - 0.115
0.115 - 6.490
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

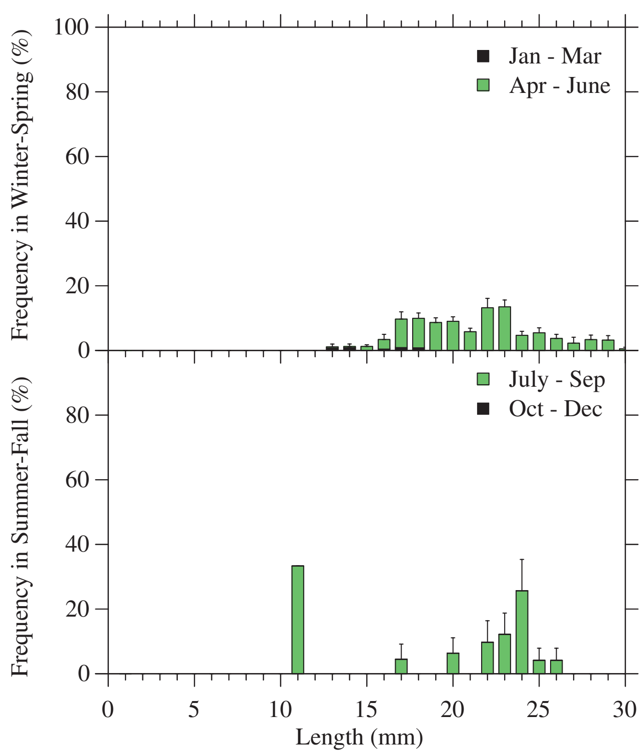

Adult Occurrence
Absent
Present

Life history *Hemilepidotus jordani* range from the Bering Sea to Southeast Alaska, where they are fished commercially. Adult yellow Irish lords can grow to 41 cm TL and are found from subtidal areas to depths of 525 m. Eggs are probably demersal, and larvae and juveniles are pelagic; otherwise, little is known of their early life history.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

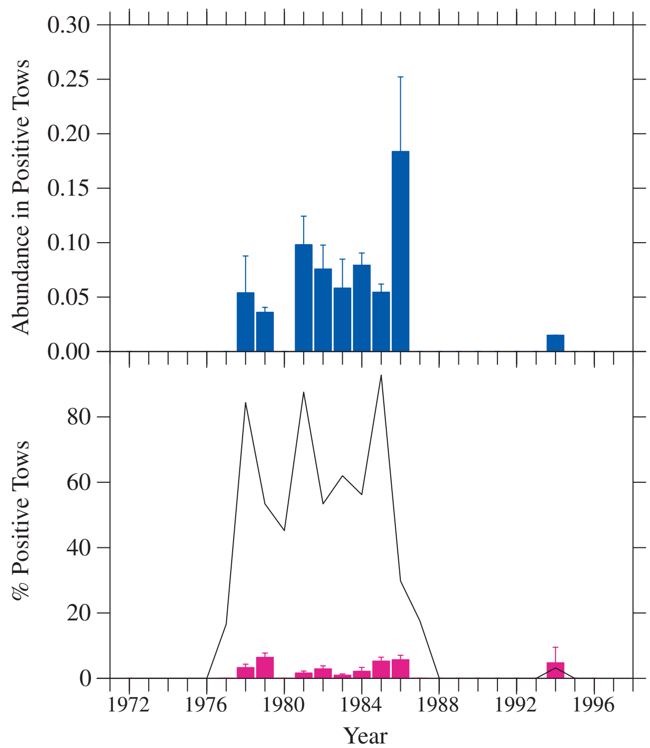
Larval distribution Yellow Irish lord larvae are collected in neuston samples taken in the Bering Sea and Gulf of Alaska, with higher concentrations widely distributed in the vicinity of the shelf edge. Larvae are present March–September, but abundances are highest in the spring. Newly hatched larvae <10 mm SL have not been collected. Larvae 13–29 mm SL are collected in winter–spring with similar sizes in the summer–fall (11–26 mm SL). Generally, larvae were taken in fewer than 10% of the samples when neuston nets were routinely used during the late 1970s and early 1980s.



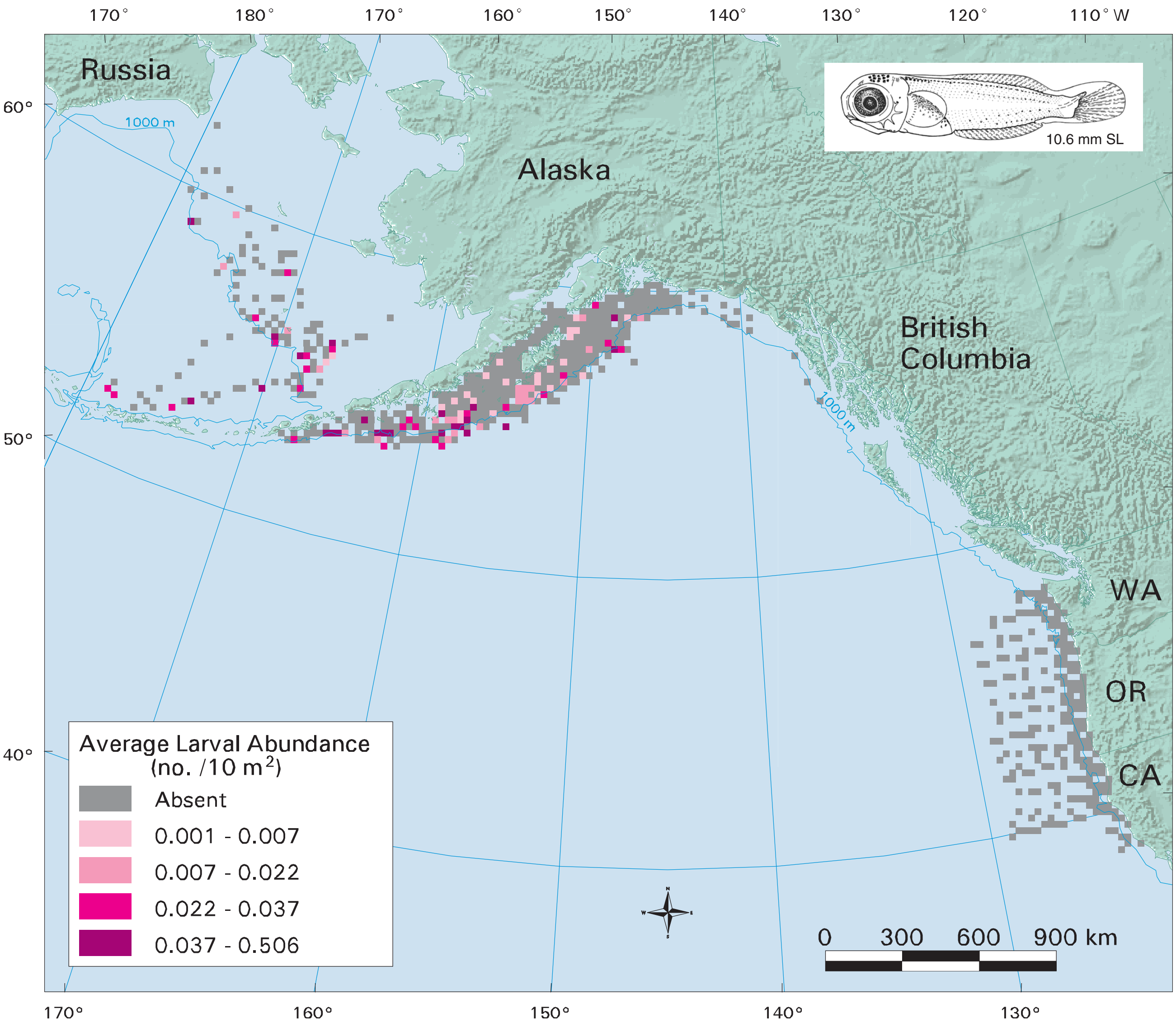
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

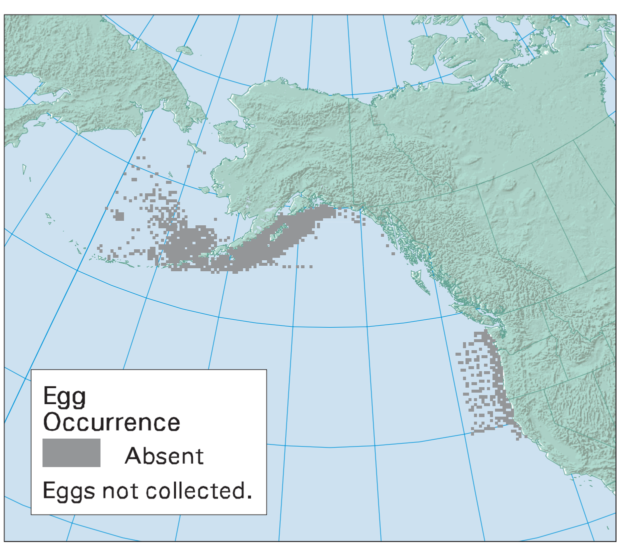


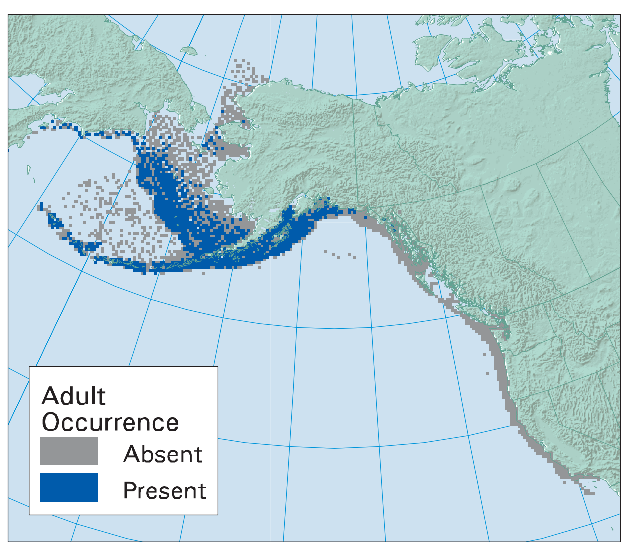
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 357 for winter–spring (Jan–June), 18 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

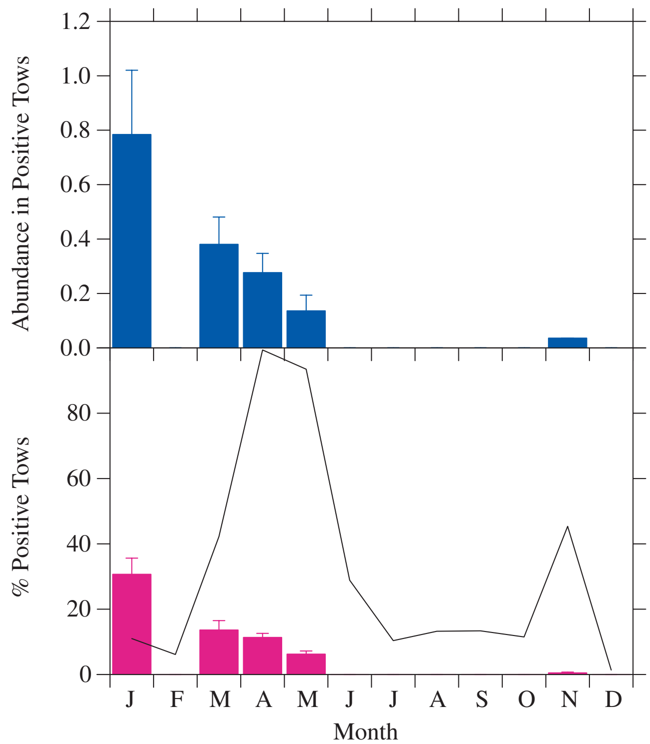

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.6 mm SL
Average Larval Abundance (no. /10 m2)
Absent
0.001 - 0.007
0.007 - 0.022
0.022 - 0.037
0.037 - 0.506
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

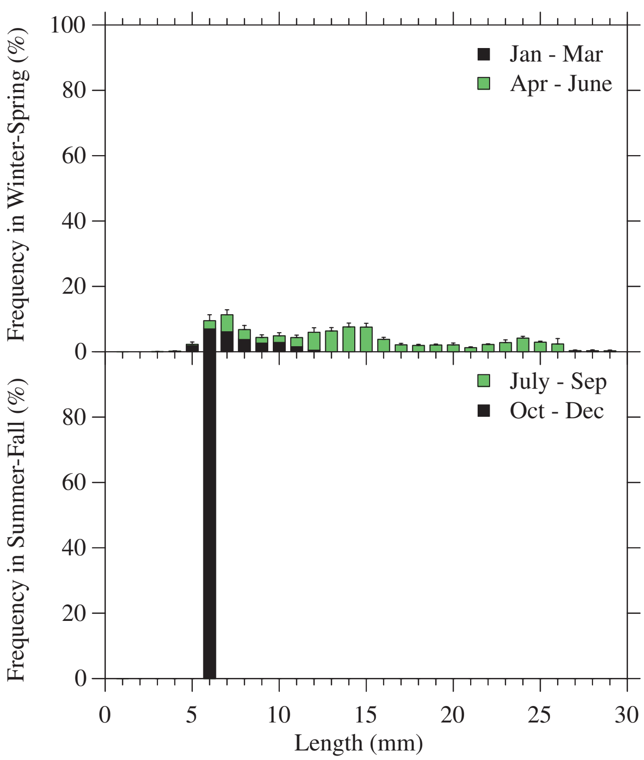

Adult Occurrence
Absent
Present

Life history Distribution of *Hemilepidotus spinosus* is more southerly than the other members of the genus, extending from Southeast Alaska to southern California. Found from intertidal areas to depths of 97 m, brown Irish lords usually inhabit subtidal areas of exposed coast. Adults can grow to 29 cm TL. Eggs are probably demersal; pelagic larvae are about 5 mm SL at hatch and transform into pelagic juveniles at about 19 mm SL. [Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

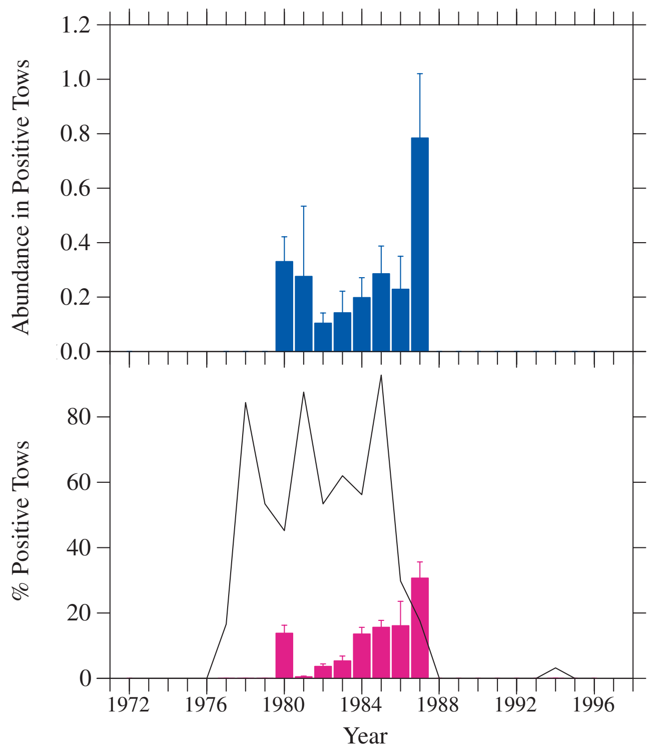
Larval distribution Brown Irish lord larvae are collected in neuston samples from the Gulf of Alaska to off the U.S. west coast. Although the reported northern extent of the species is Southeast Alaska, adults and larvae are present in AFSC survey collections in the northern Gulf of Alaska. Several areas of higher abundance are found in Shelikof Strait and northern Gulf of Alaska, but most larvae are collected along the U.S. west coast shelf. Larvae are collected sporadically January–May and in November, but most occur in winter–spring samples. Larvae collected in winter–spring represent newly hatched to pelagic prejuveniles over a wide size range (4–29 mm SL). Overall catch by year indicates larvae were present in more tows from the 1980s when AFSC conducted U.S. west coast surveys and when neuston tows were more frequent.



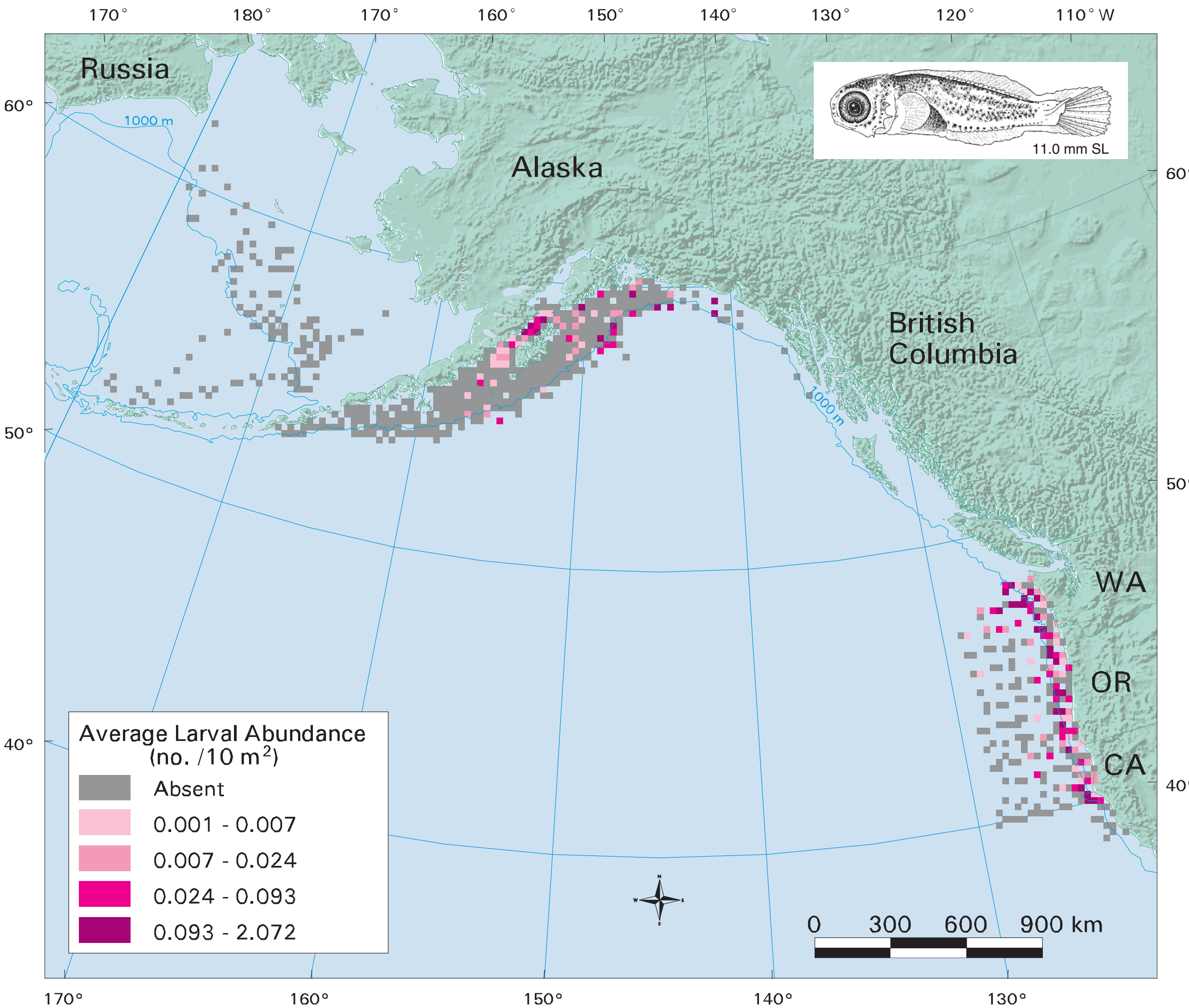
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

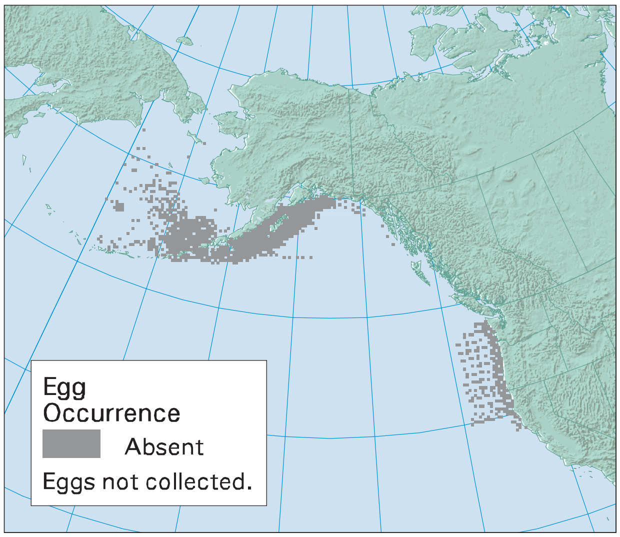


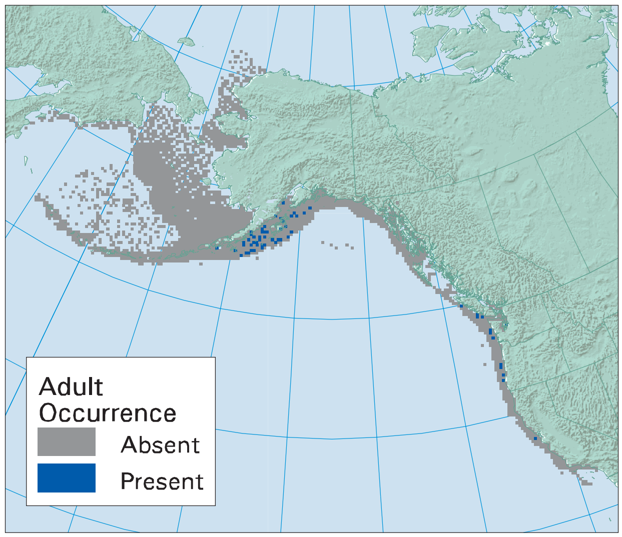
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 2141 for winter–spring (Jan–June), 2 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

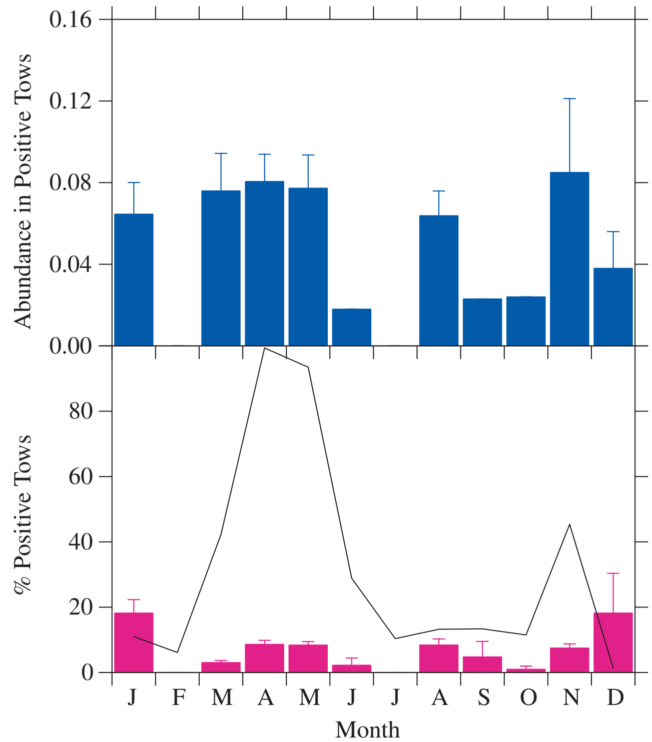

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
11.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.007
0.007 - 0.024
0.024 - 0.093
0.093 - 2.072
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

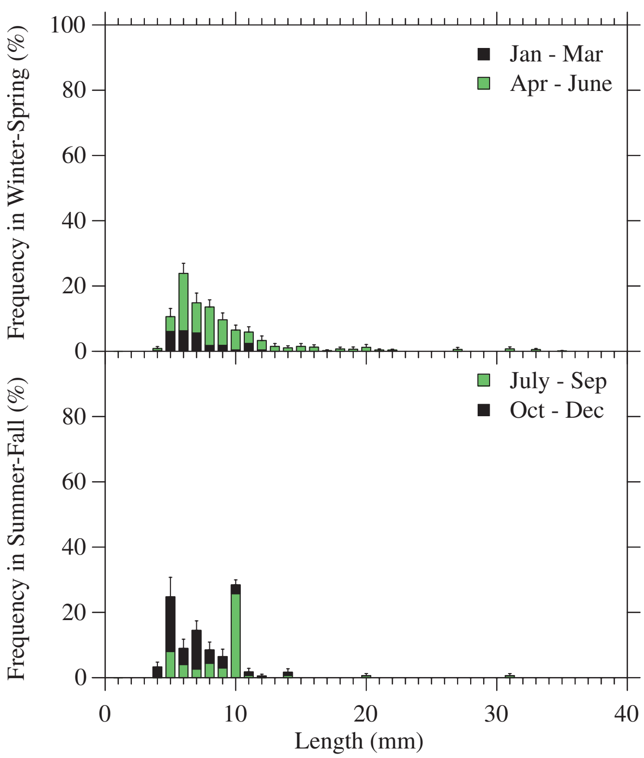

Adult Occurrence
Absent
Present

Life history *Scorpaenichthys marmoratus* are distributed from Southeast Alaska to off the U.S. west coast and south to central Baja California. Cabezon are large and may reach a length of 99 cm TL. Adults are demersal, inhabiting the nearshore shelf from intertidal areas to depths of about 76 m. Spawning occurs inshore along rocky crevices or on algae November–March in California and January–May off British Columbia. Eggs are adhesive and 1.4–1.9 mm in diameter with one large oil globule and 1–4 smaller ones. Larvae hatch at 4–6 mm SL, undergo notochord flexion at 7.6–10.0 mm SL, and begin to transform as early as 14 mm SL, but remain pelagic until 35 mm SL. Larvae are commonly collected in the CalCOFI study area.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989), Ambrose (1996b)]

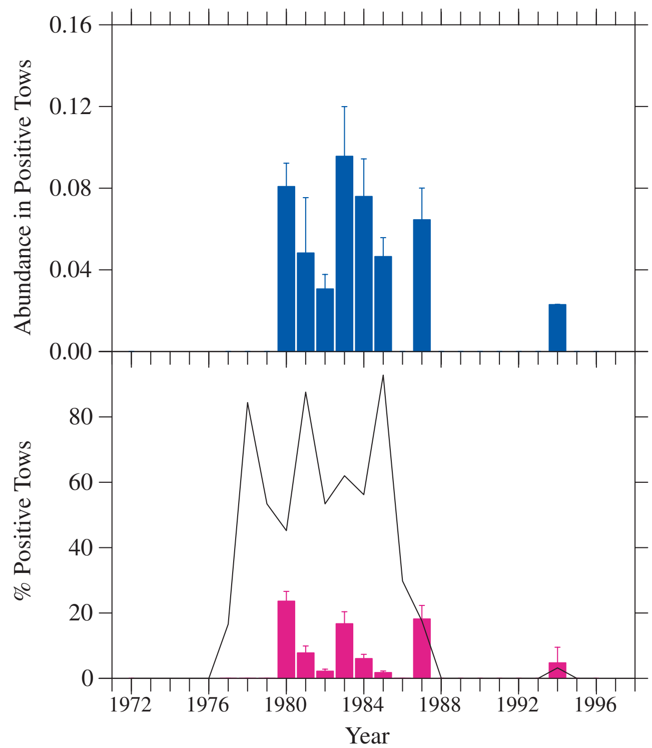
Larval distribution Although their reported northern extent is Southeast Alaska, cabezon larvae are collected in neuston samples along the shelf east of Kodiak Island in the Gulf of Alaska, and off the U.S. west coast. Adults are not commonly collected in AFSC surveys and available data on distribution patterns are limited. Larvae are most abundant along the shelf and shelf edge, but have been collected in both inshore and offshore regions. Larvae are collected throughout the year except in February and July. Larvae and pelagic juveniles range in size from 4 to 33 mm SL throughout the year. Most small larvae appear in winter–spring. Overall catch by year indicates larvae were most abundant during the 1980s when neuston tows were more frequent during AFSC U.S. west coast surveys.



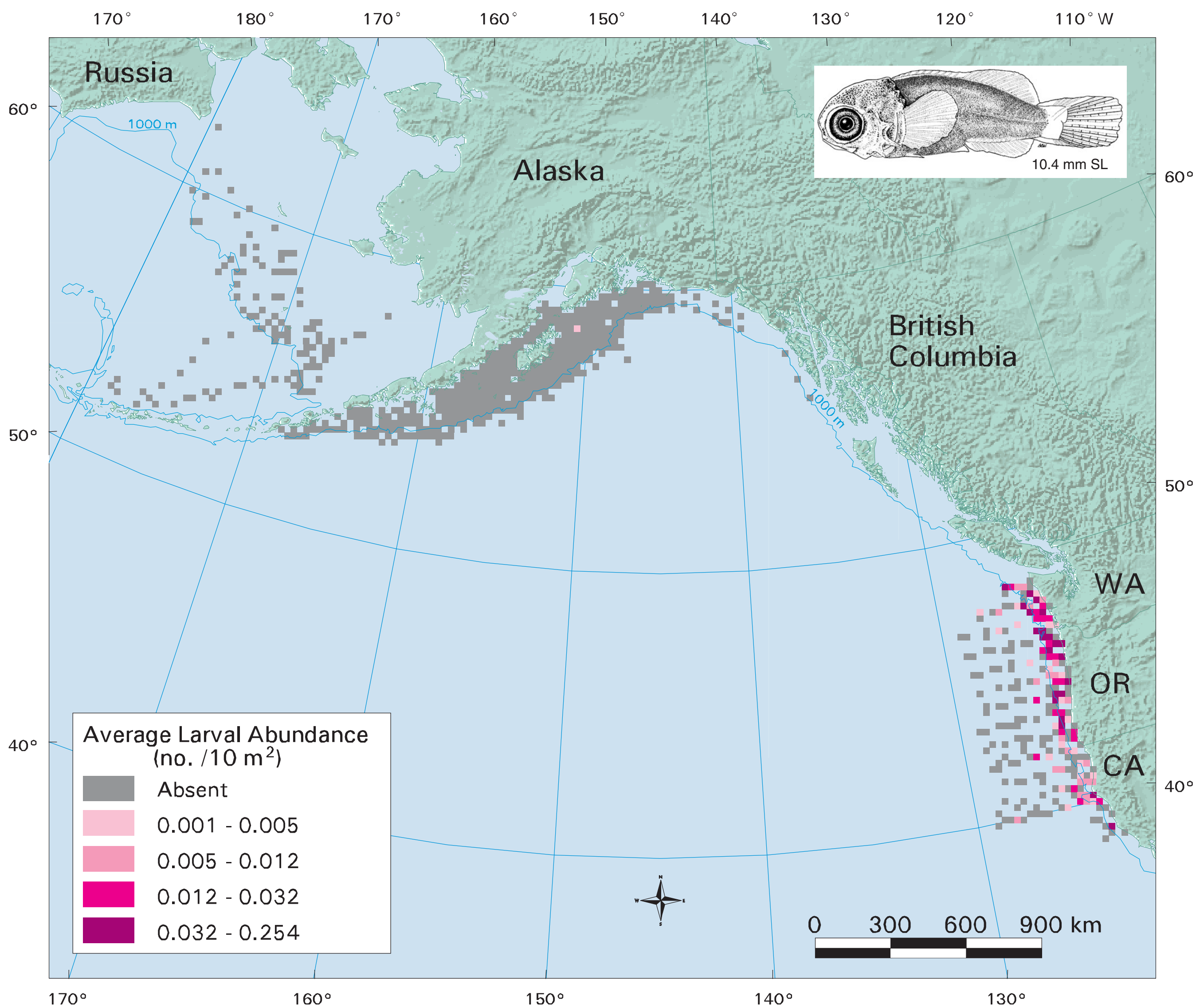
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

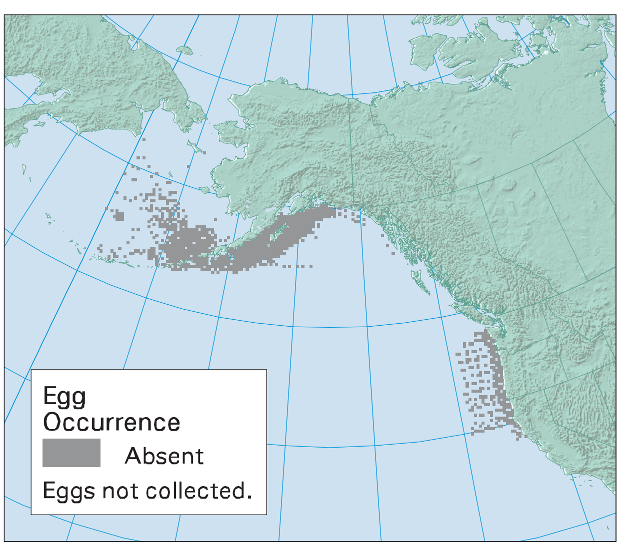


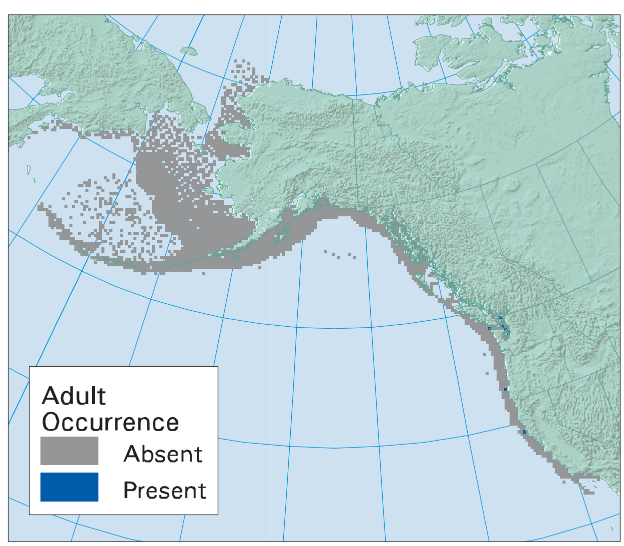
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 426 for winter–spring (Jan–June), 139 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

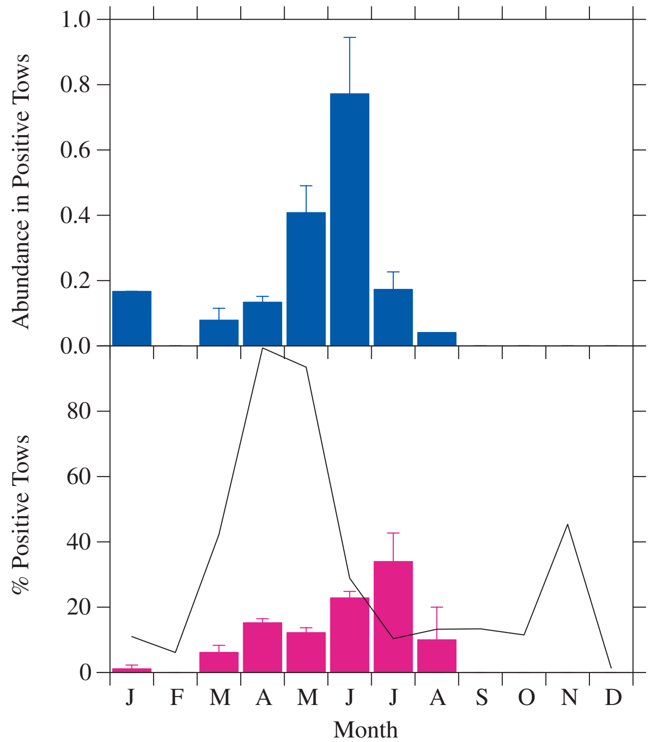

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.4 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.005
0.005 - 0.012
0.012 - 0.032
0.032 - 0.254
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

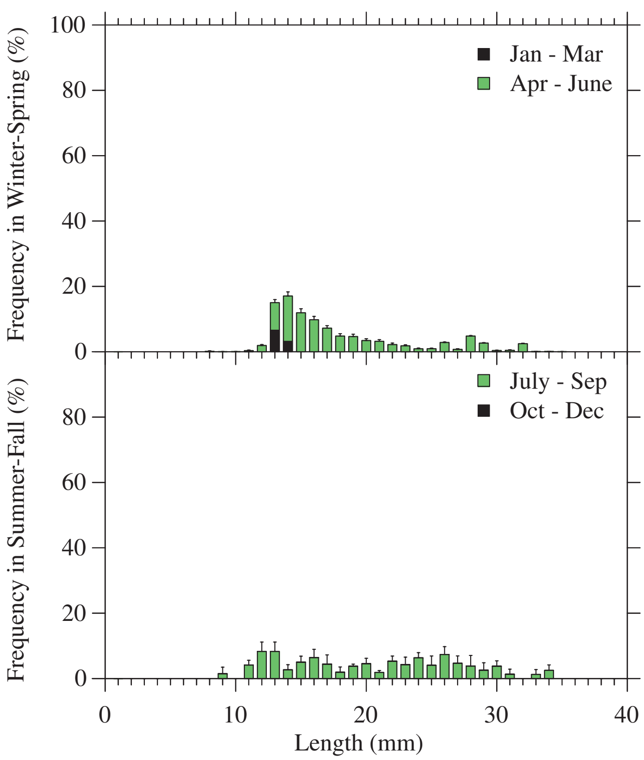

Adult Occurrence
Absent
Present

Life history *Cryptacanthodes aleutensis* range from the Bering Sea to northern California. Dwarf wrymouth grow to 30 cm TL and have been reported to live partially buried in the bottom at depths of 46–350 m. Demersal eggs, spawned in the spring and summer, are 1.8 mm in diameter and have a smooth chorion. Pelagic larvae 6–28 mm SL have been collected off the outlet of the Fraser River and in Saanich Inlet, British Columbia, in May. [Sources include: Hart (1973), Matarese et al. (1989)]

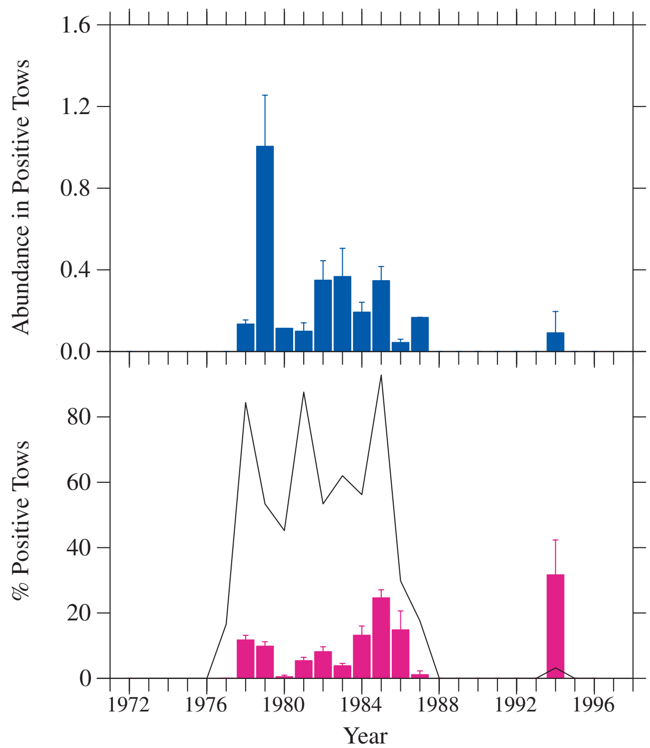
Larval distribution Dwarf wrymouth larvae are common in neuston samples throughout the shelf from the central Bering Sea, Gulf of Alaska around Kodiak Island eastward to British Columbia, and along the U.S. west coast. Larvae are abundant in Shelikof Strait and throughout the sea valley west and southwest of Kodiak Island. Larvae are collected January–August, but are most abundant in May and June. Although the size range of larvae collected during winter–spring is similar to that of larvae collected during summer–fall (about 10–30 mm SL), most larvae are from spring collections and are generally less than 20 mm SL. Overall catch by year indicates that larvae were collected more in the late 1970s and 1980s when the Kodiak Island shelf region was sampled more frequently.



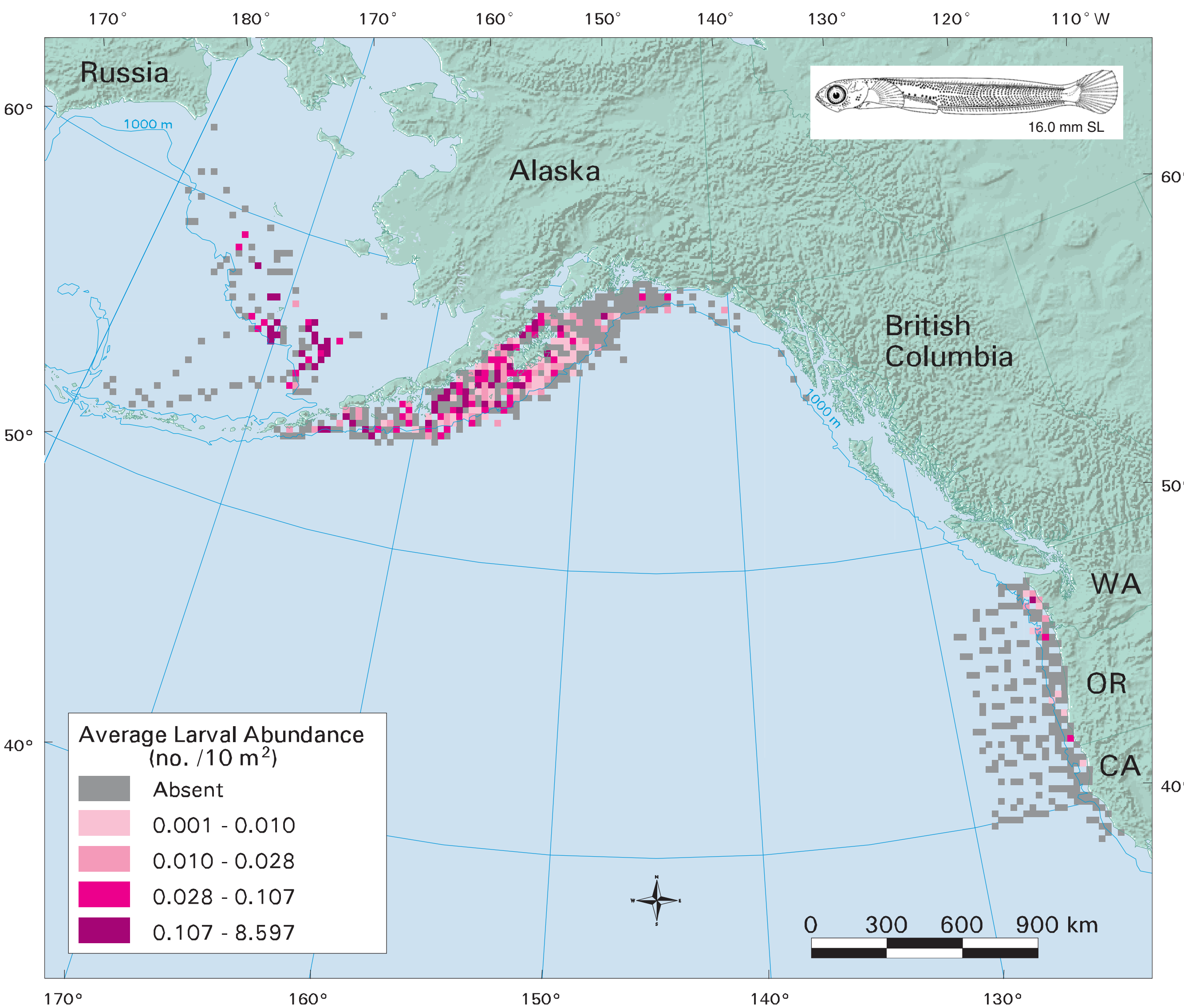
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

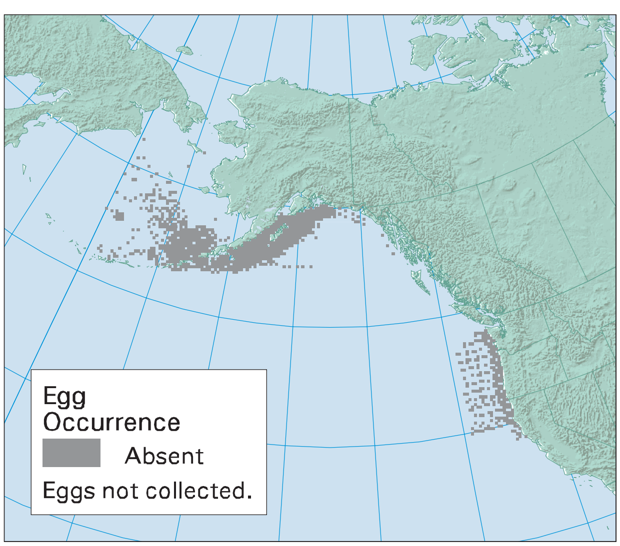


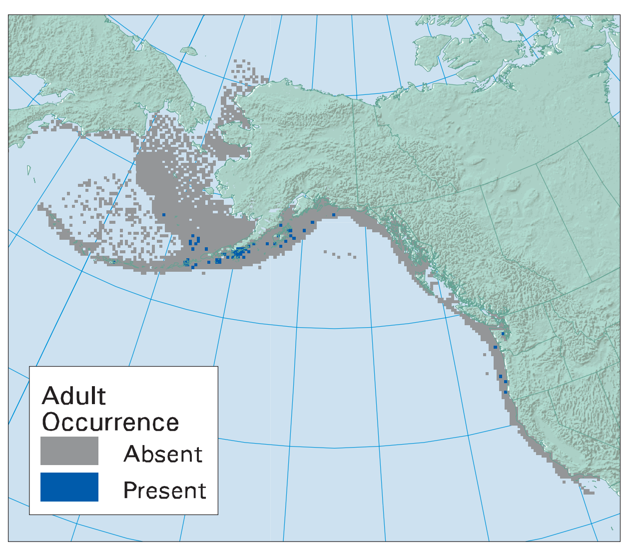
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 2933 for winter–spring (Jan–June), 97 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

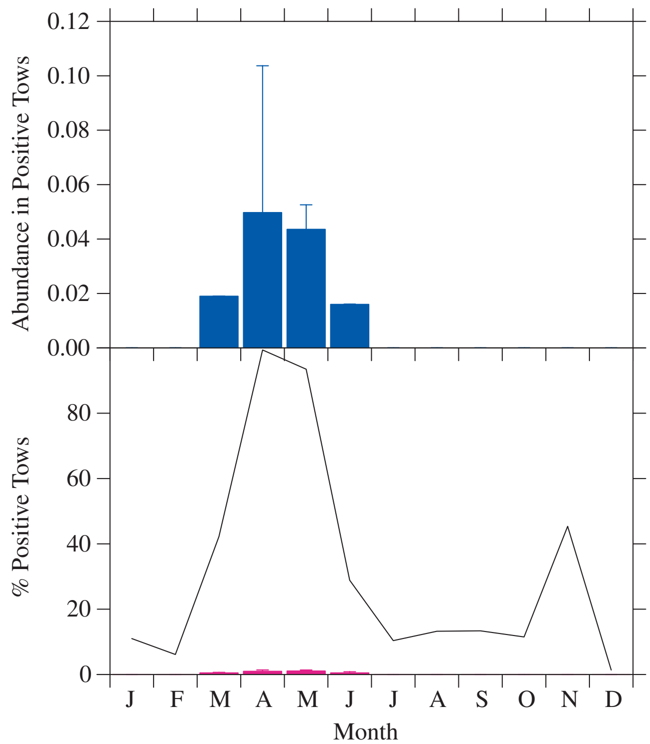

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
WA
OR
CA
16.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.010
0.010 - 0.028
0.028 - 0.107
0.107 - 8.597
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

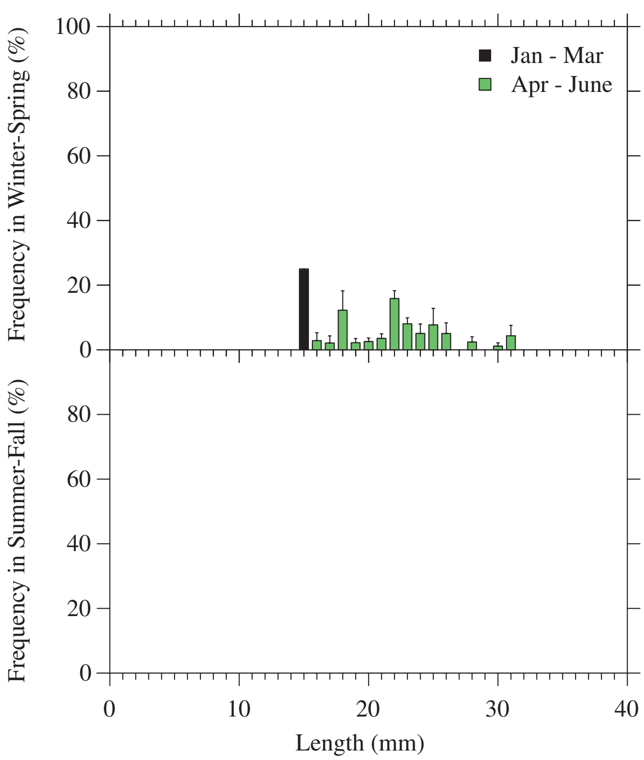

Adult Occurrence
Absent
Present

Life history *Cryptacanthodes gigantea* are found in the Bering Sea, Gulf of Alaska, and along the U.S. west coast to northern California. Inhabiting areas with soft bottom, giant wrymouth adults occur along the near shore shelf at depths of 6–128 m. Eggs are demersal and large (4.41–4.85 mm in diameter), and larvae hatch at a large size, 16–17 mm SL. Fin formation begins prior to hatch and larvae hatch at an advanced stage of development. [Sources include: Matarese et al. (1989)]

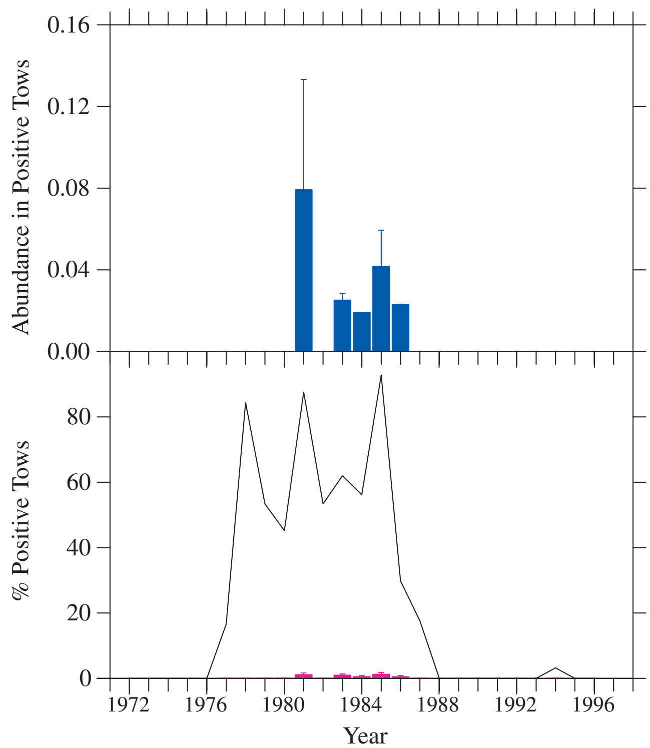
Larval distribution Giant wrymouth larvae are found in neuston samples from the western Gulf of Alaska shelf along the Shelikof Strait and sea valley to northeast of Kodiak Island. Although adults are present in AFSC Bering Sea surveys, larvae have not been collected. Larvae are most abundant in Shelikof Strait and occur March–June with highest numbers in April and May. Larvae from winter–spring are 15–31 mm SL. Overall catch by year indicates that larvae were much more common 1981–1986 when sampling effort in Shelikof Strait was high and neuston nets were used.



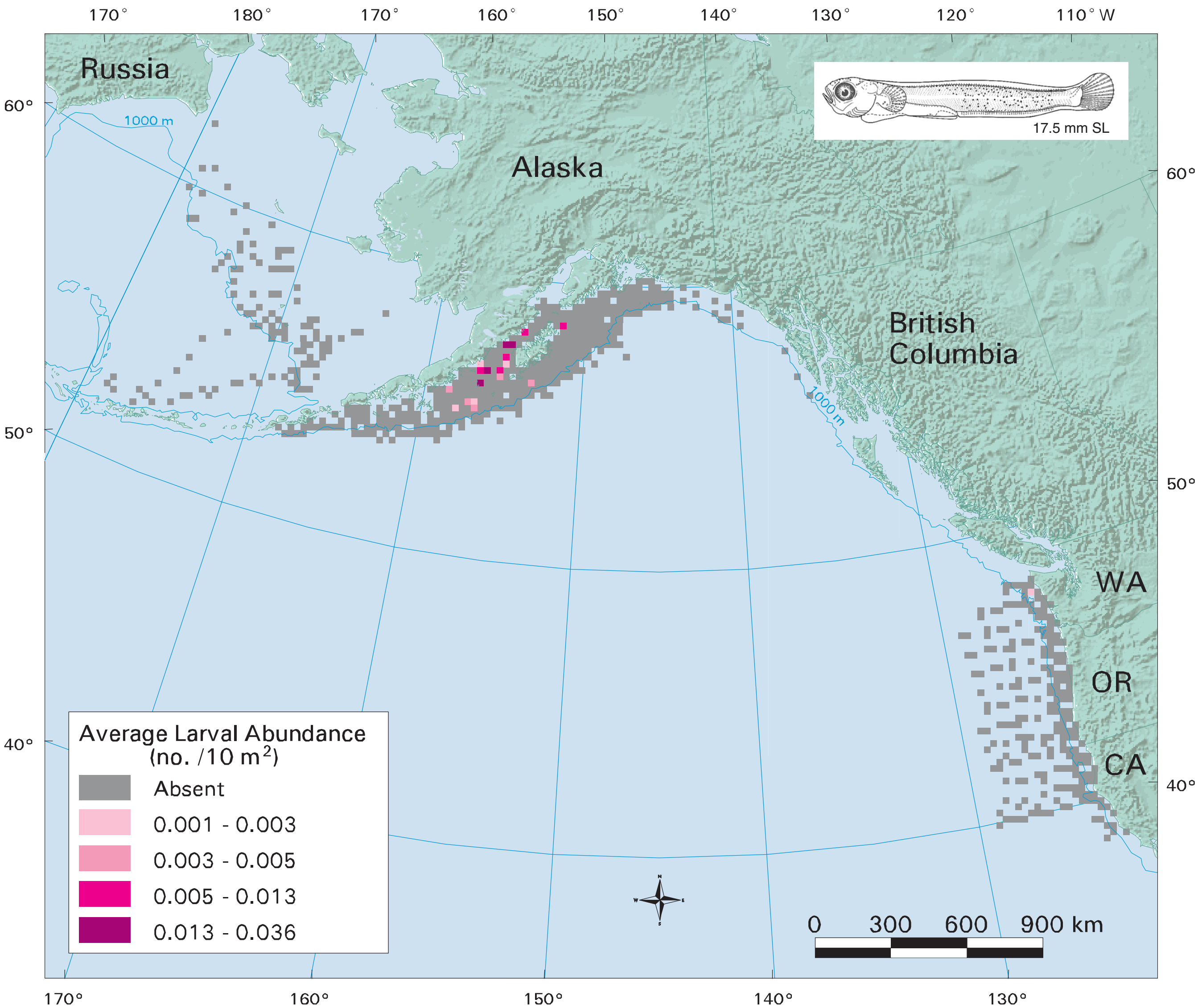
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

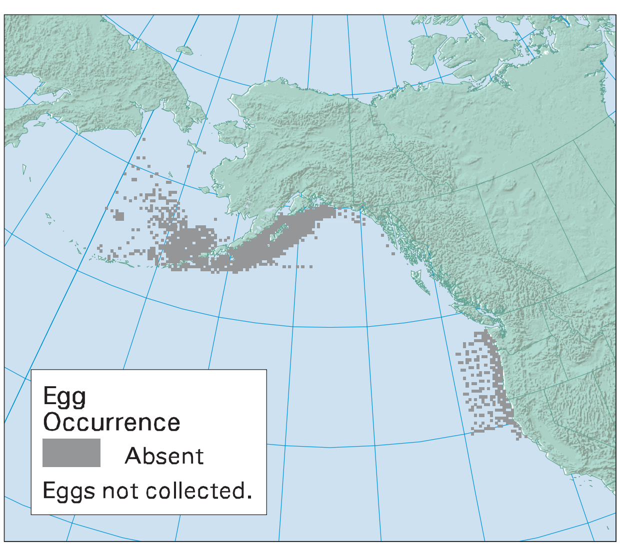


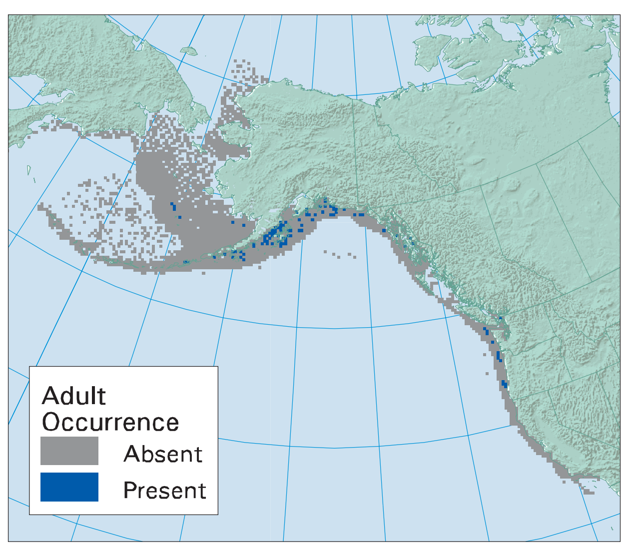
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 42 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

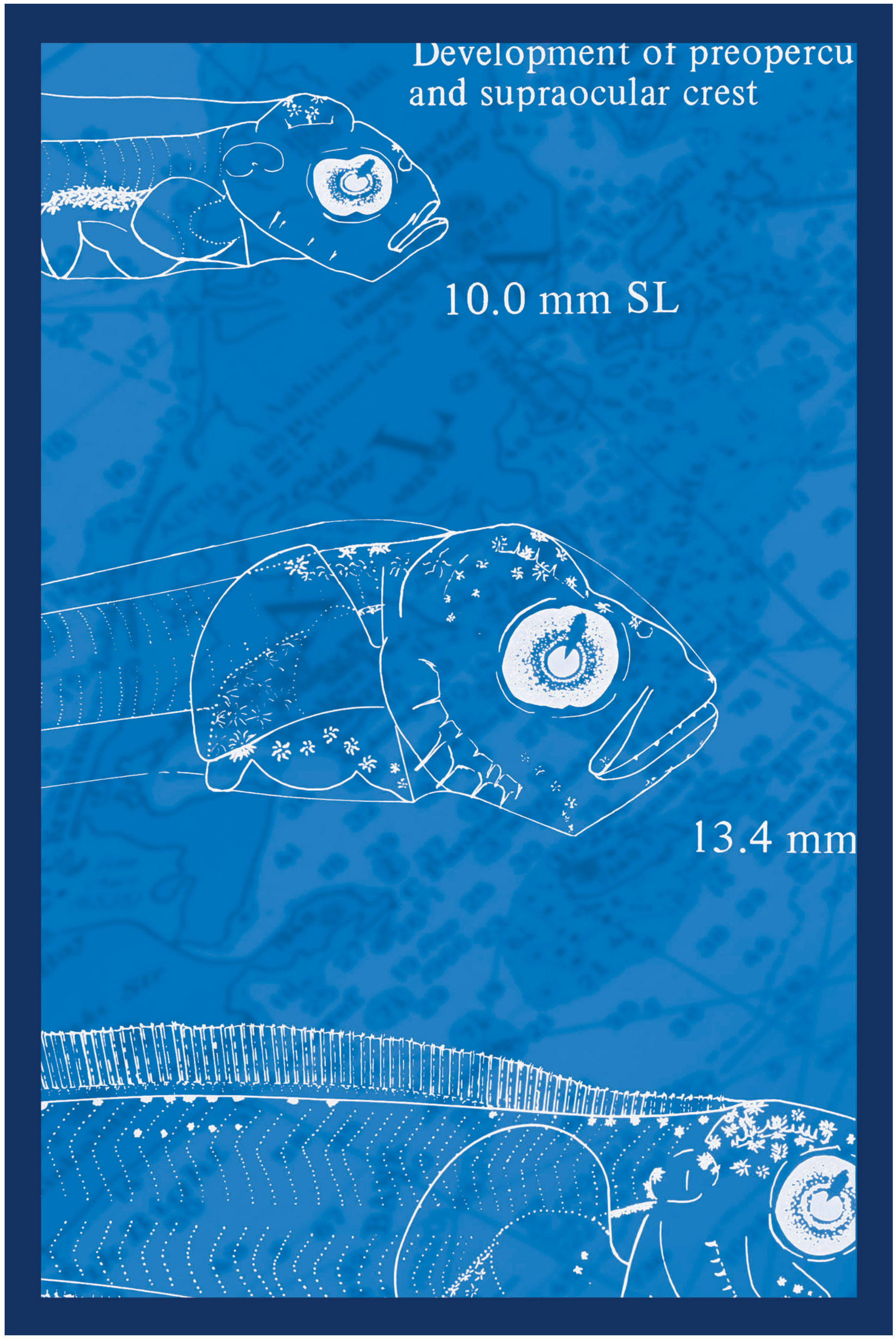

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
17.5 mm SL
60°
50°
40°
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.003
0.003 - 0.005
0.005 - 0.013
0.013 - 0.036
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.


Adult Occurrence
Absent
Present

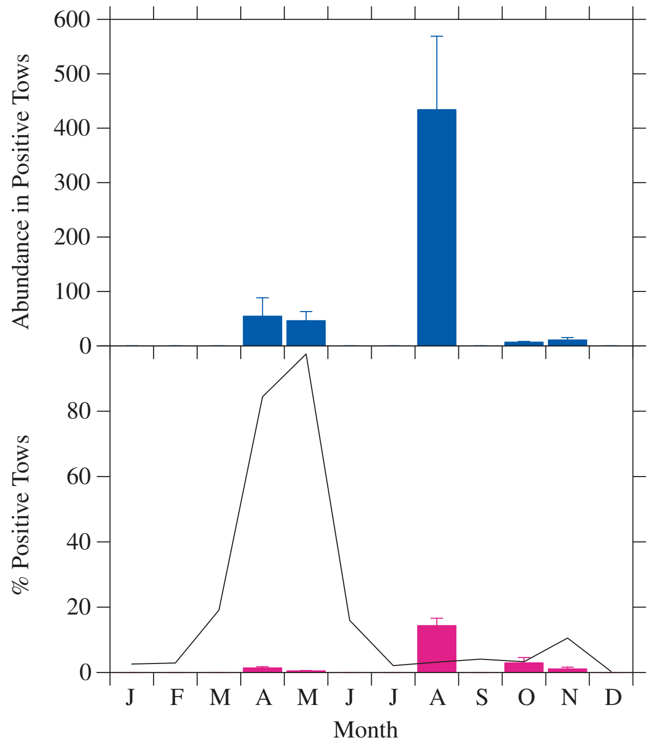
Bongo collections by family

Engraulidae
Clupeidae
Microstomatidae
Bathylagidae
Osmeridae
Stomiidae
Paralepidae
Myctophidae
Trachipteridae
Macrouridae
Merlucciidae
Gadidae
Scomberesocidae
Melamphaidae
Scorpaenidae
Hexagrammidae
Cottidae
Agonidae
Psychrolutidae
Cyclopteridae
Liparidae
Bathymasteridae
Zoarcidae
Stichaeidae
Pholidae
Ptilichthyidae
Zaproridae
Ammodytidae
Icosteidae
Centrolophidae
Paralichthyidae
Pleuronectidae

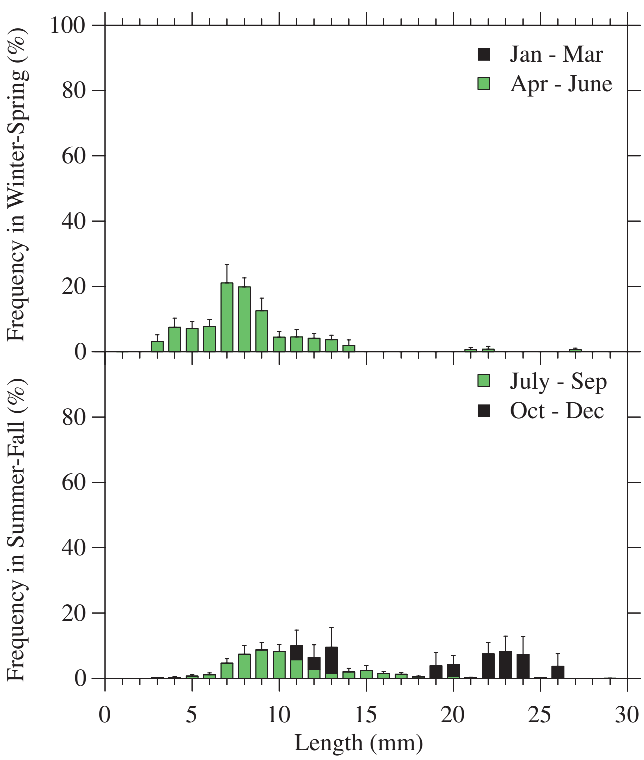


Life history *Engraulis mordax* adults occur in schools along nearshore coastal waters from British Columbia to Baja California. Although they are generally pelagic, they have been collected at depths of 0–300 m. Northern anchovy are small (<20 cm SL), but support an economically important fishery. Spawning usually occurs in late spring and summer, but year-round in California. Eggs are ellipsoidal (1.23–1.35 × 0.65–0.82 mm) with a segmented yolk; larvae hatch at 2–3 mm SL and undergo transformation at about 35–40 mm SL. Larvae are abundant August–November off the U.S. west coast, especially in association with the Columbia River plume. Most engraulid eggs and larvae collected in CalCOFI surveys are northern anchovy, the most abundant taxon collected in CalCOFI surveys.
[Sources include: Doyle et al. (1993), Watson and Sandknop (1996a)]

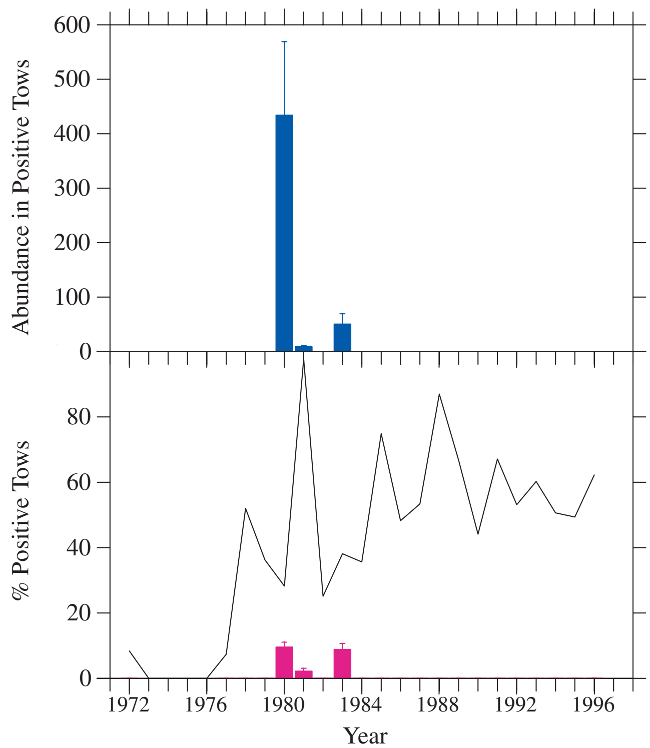
Larval distribution Northern anchovy larvae are collected along the U.S. west coast. Within our study area larvae are most abundant off the Washington and Oregon coasts. Larvae are collected April–November with the highest concentrations occurring in August. Small larvae (<15 mm SL) are more common in winter–spring, whereas larvae occur evenly over a wide size range (3–26 mm SL) in summer–fall. Eggs are present off the U.S. west coast. Larvae were collected rarely throughout the time series; they were present from 1980 to 1983 during AFSC U.S. west coast surveys.



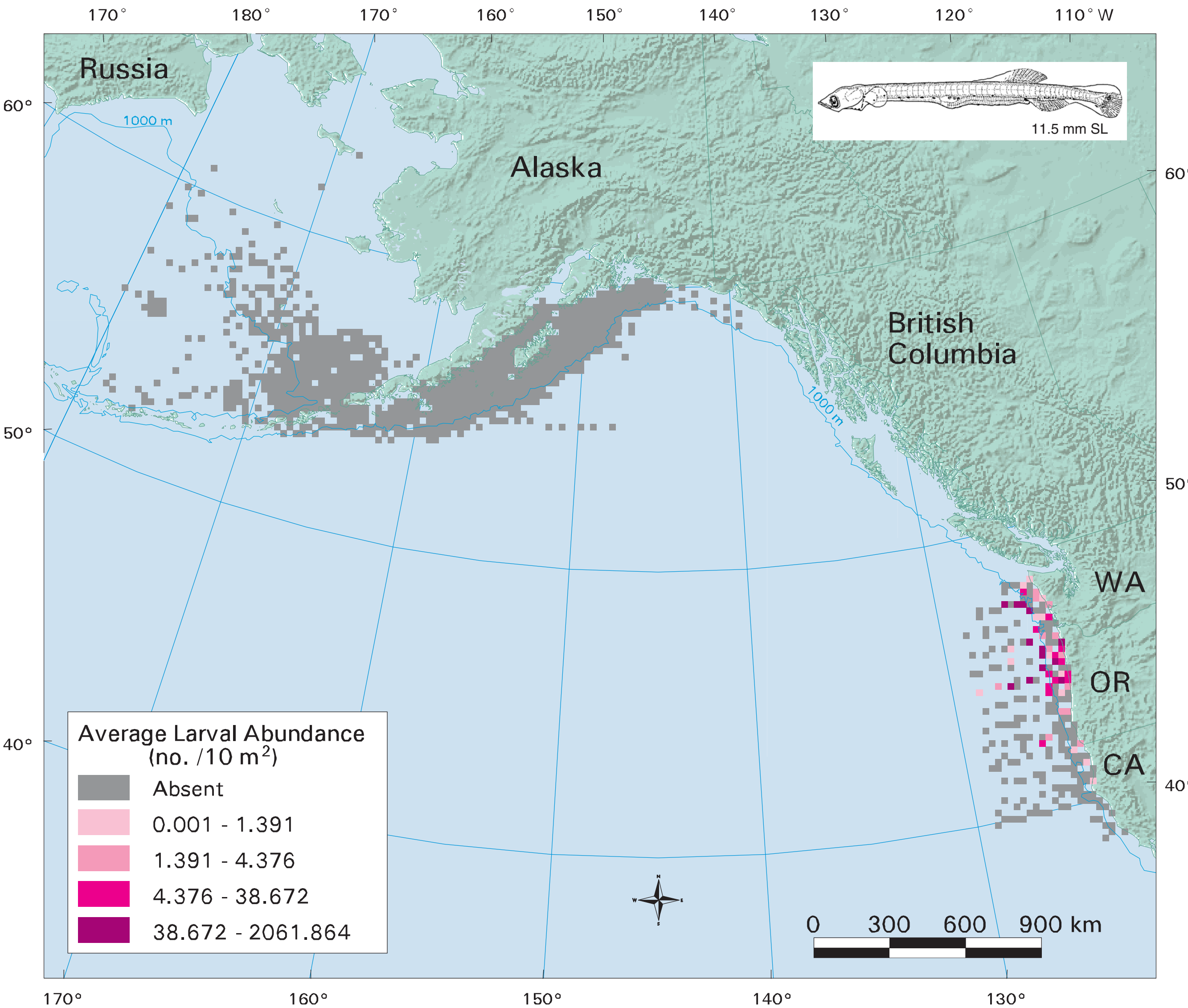
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

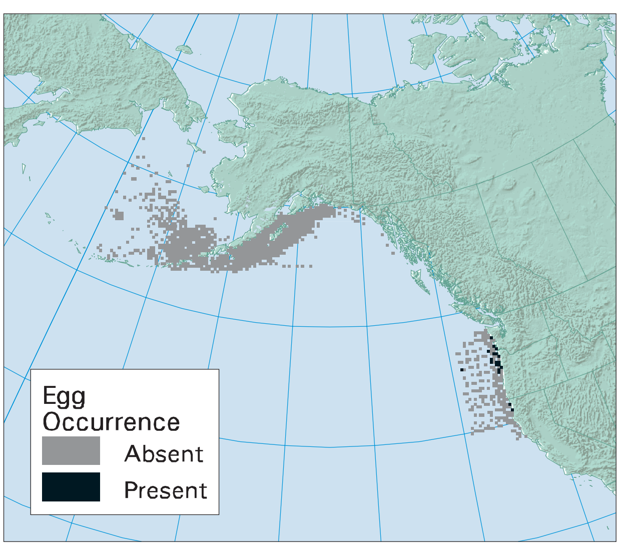


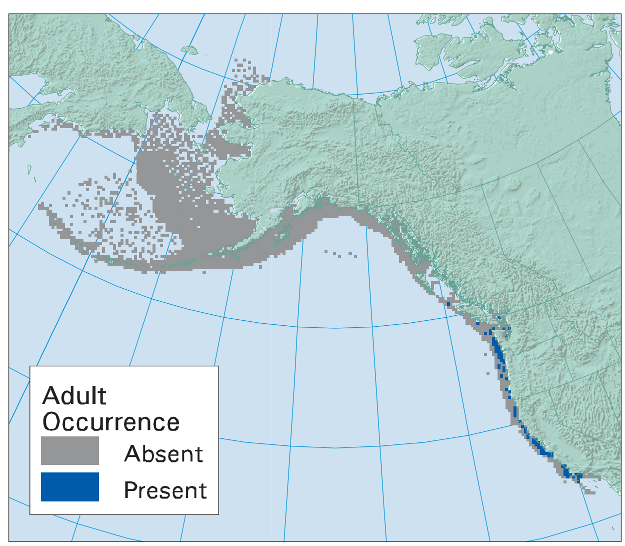
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 162 for winter–spring (Jan–June), 634 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

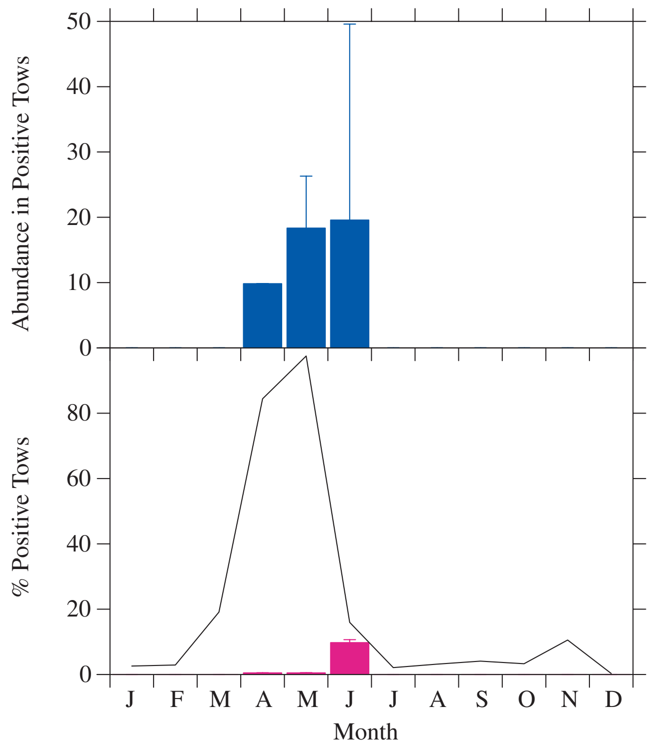

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
11.5 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.391
1.391 - 4.376
4.376 - 38.672
38.672 - 2061.864
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

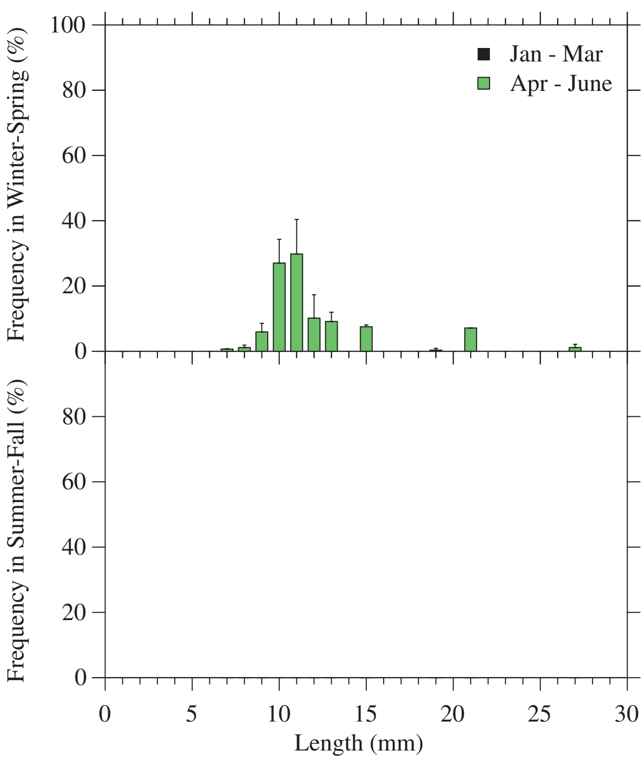

Adult Occurrence
Absent
Present

Life history *Clupea pallasi* occur from Alaska to Baja California in the eastern Pacific, southward to Korea in the western Pacific. Pacific herring are small planktivorous fish that school close to the surface in nearshore shelf waters, entering bays and estuaries to spawn. Their attached adhesive eggs, which are about 1.3–1.7 mm in diameter with segmented yolks, are demersal and spawned in clusters on seaweed and eel grass. Planktonic larvae hatch at 5.6–7.5 mm SL and transform at 25–35 mm SL. Larvae are sometimes collected December–March at CalCOFI stations from central California northward. [Sources include: Watson and Sandknop (1996b)]

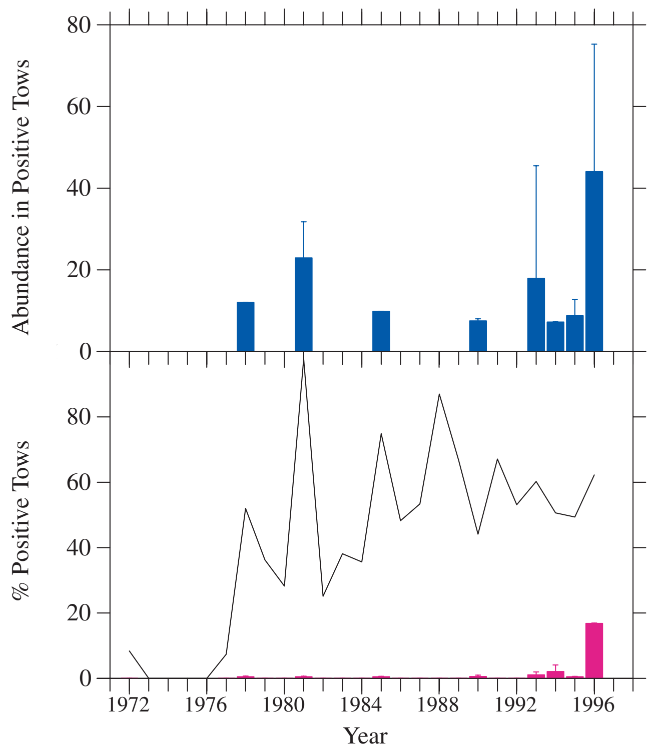
Larval distribution Pacific herring larvae are taken in the Gulf of Alaska along the shelf around Kodiak Island and along the U.S. west coast off Washington and northern Oregon. Although adults are present in AFSC Bering Sea surveys, larvae have not been collected. A small area of concentration is present at the north end of Shelikof Strait and northeast of Kodiak Island. Larvae (7–27 mm SL) are collected April–June. Most of the larvae collected in spring are small (<15 mm SL). Overall, larvae were numerous in more recent collections from 1993 to 1996.



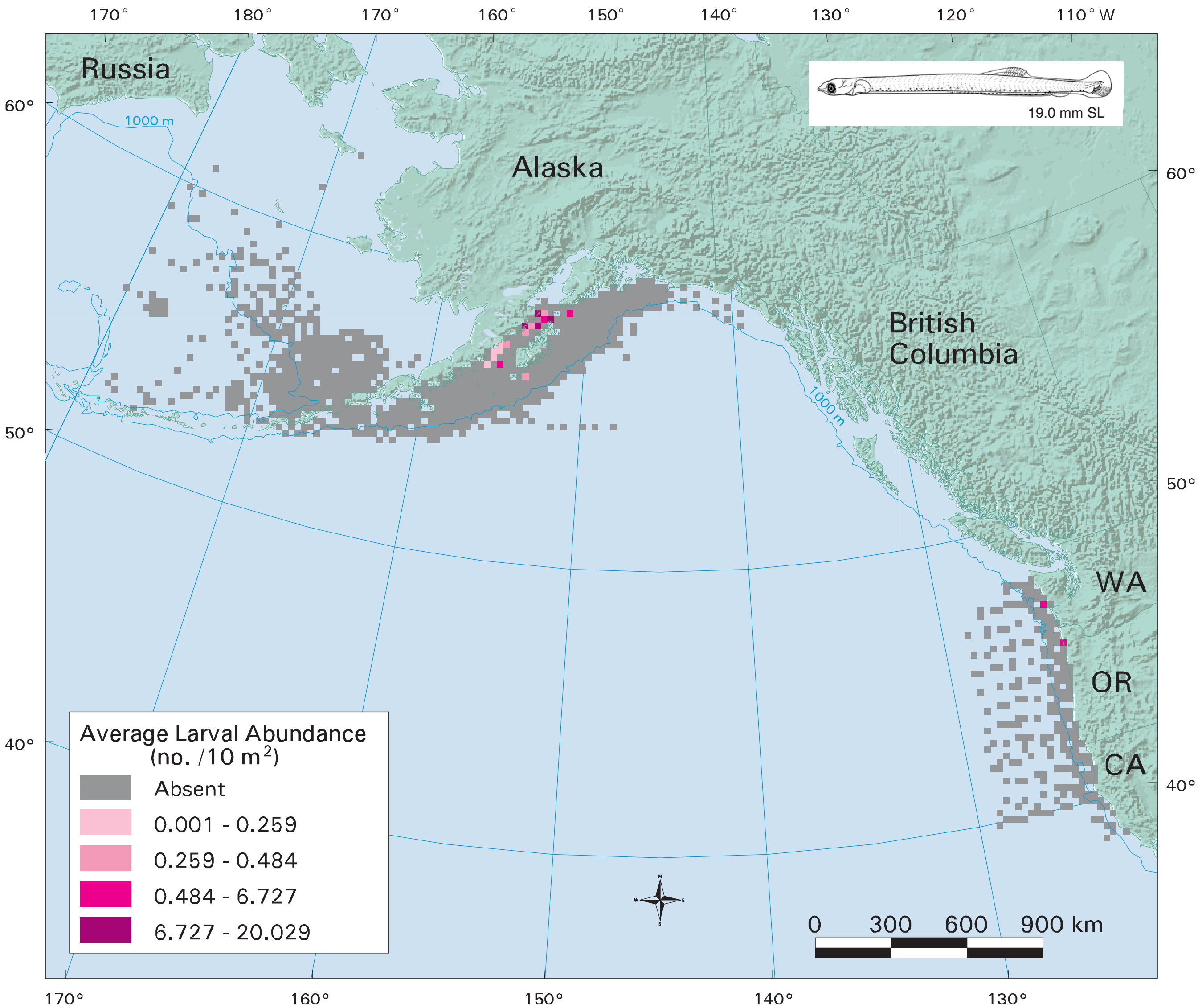
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

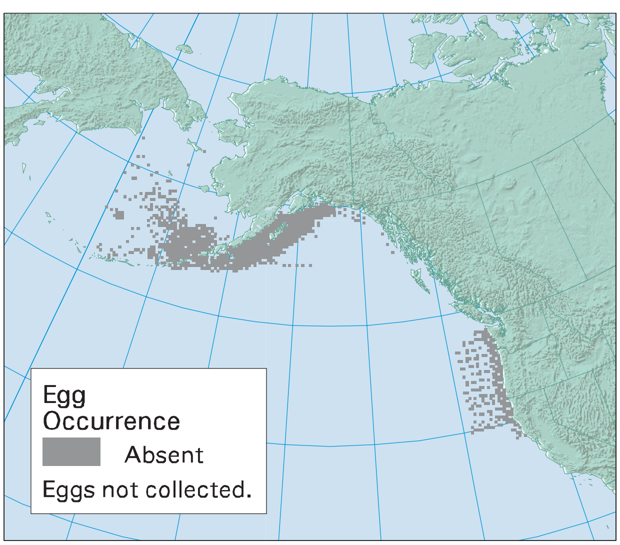


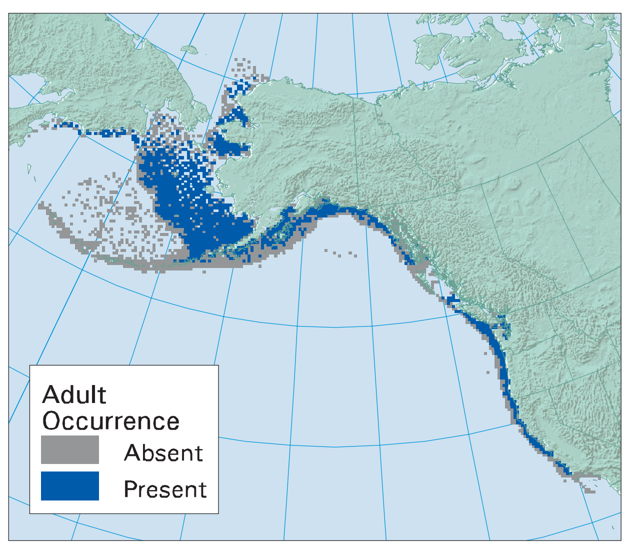
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 119 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

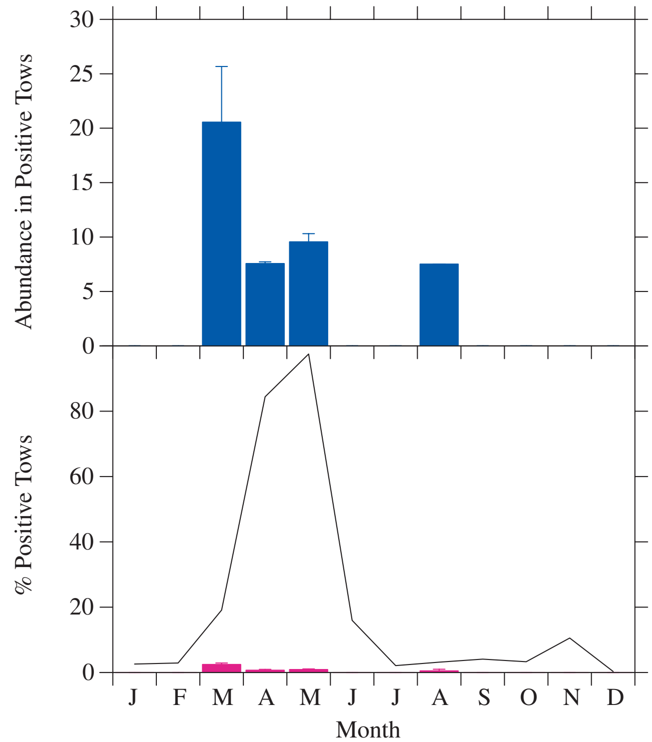

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
19.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.259
0.259 - 0.484
0.484 - 6.727
6.727 - 20.029
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

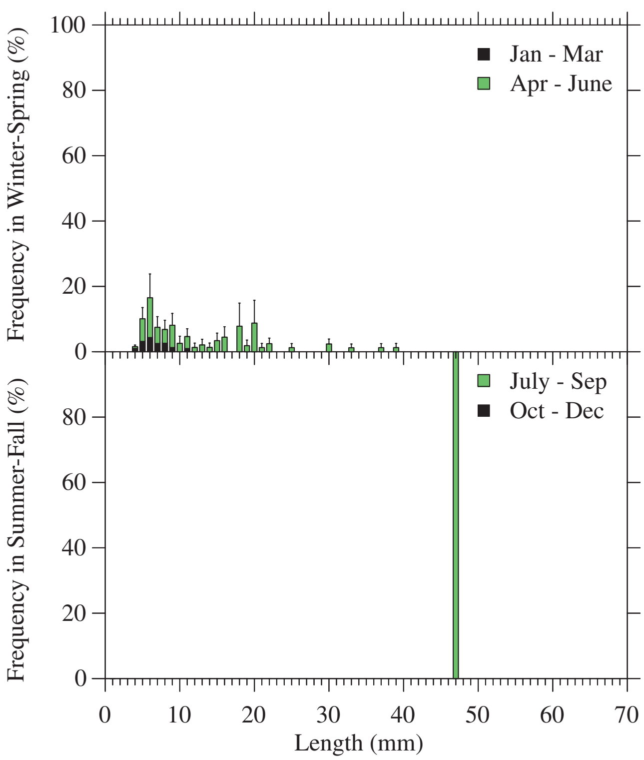

Adult Occurrence
Absent
Present

Life history *Nansenia candida* are distributed from the central Bering Sea, into the Gulf of Alaska, and south to northern Baja California. Bluethroat argentines are epi- and mesopelagic, found at depths of 200–1000 m. Adults can reach 22.2 cm TL. They spawn pelagic eggs that have a diameter of 1.4–1.6 mm, a segmented yolk, one oil globule, and a chorion with pustules on the inner surface. Pelagic larvae hatch at 3.5–4.0 mm SL and transform at 15–17 mm SL. They are present year-round in CalCOFI samples with a peak abundance in February. [Sources include: Hart (1973), Matarese et al. (1989), Moser and Butler (1996)]

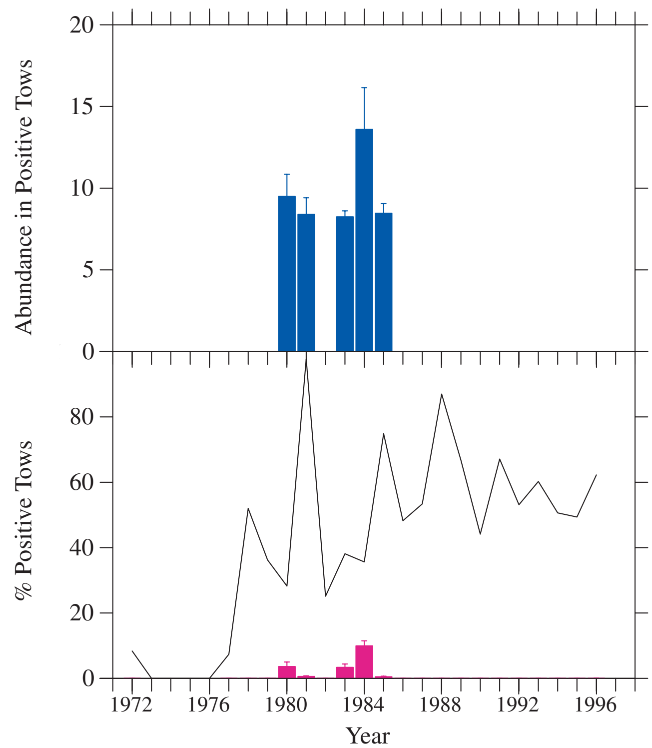
Larval distribution Bluethroat argentine larvae are found throughout the AFSC U.S. west coast survey area. Larvae are most abundant in deeper offshore waters off southern Oregon and northern California. Larvae are collected March–May and in August, with highest numbers occurring in March. Both newly hatched and larger larvae (4–39 mm SL) are collected in winter–spring. Eggs are present off Oregon and northern California. Overall, larvae were more abundant during the 1980s when AFSC conducted U.S. west coast surveys.



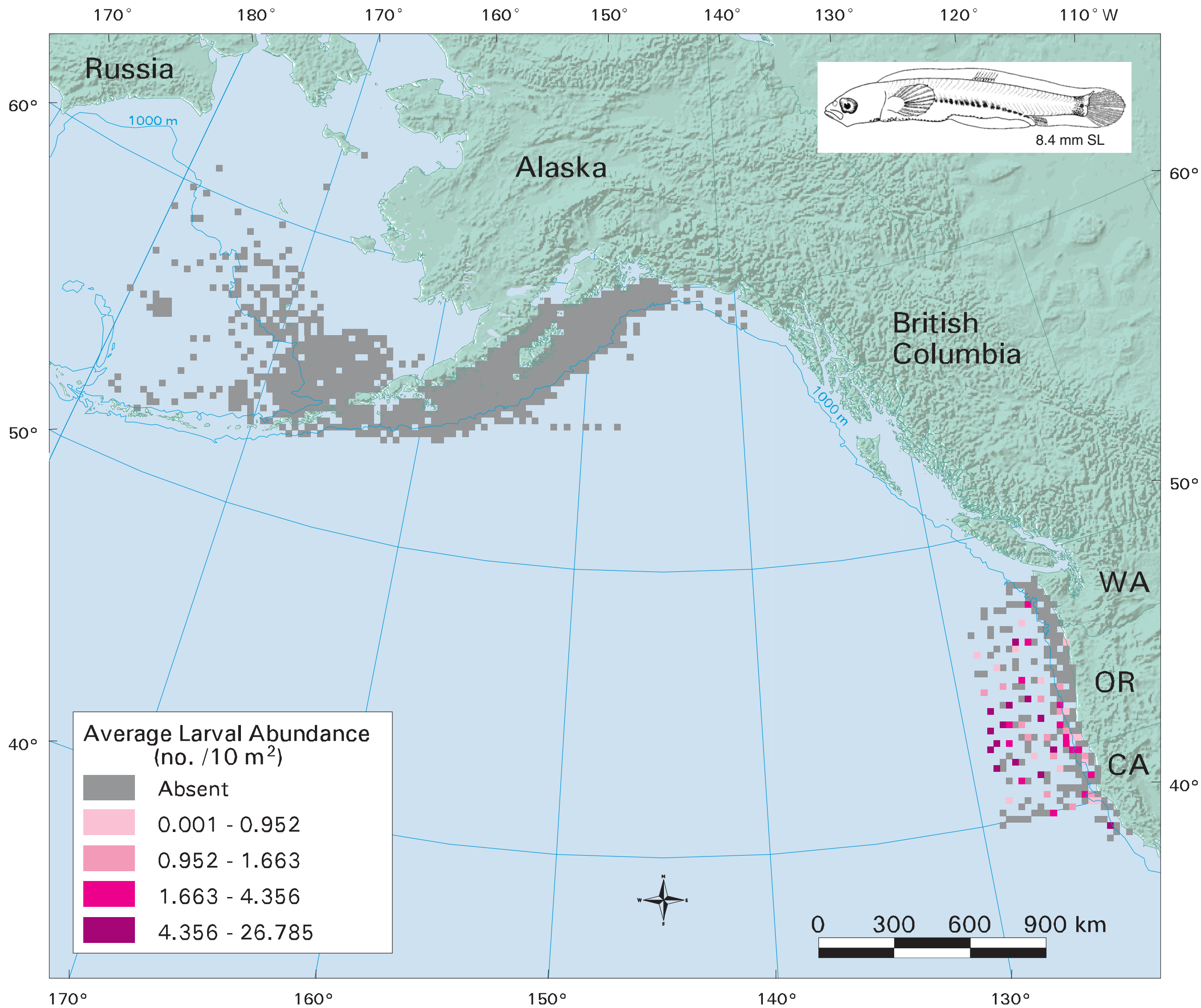
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

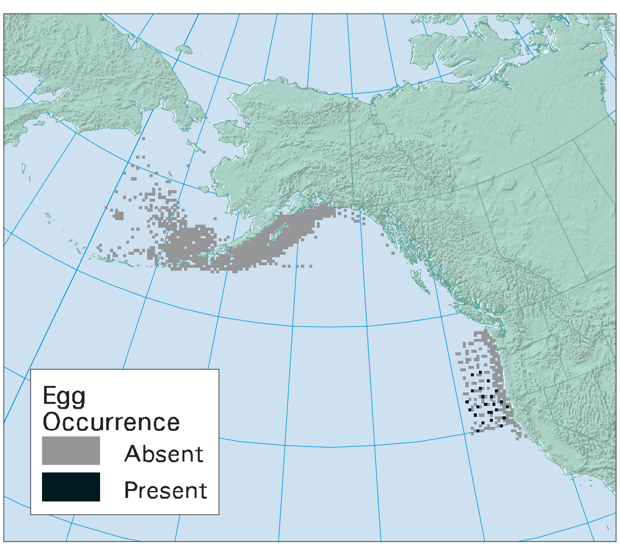


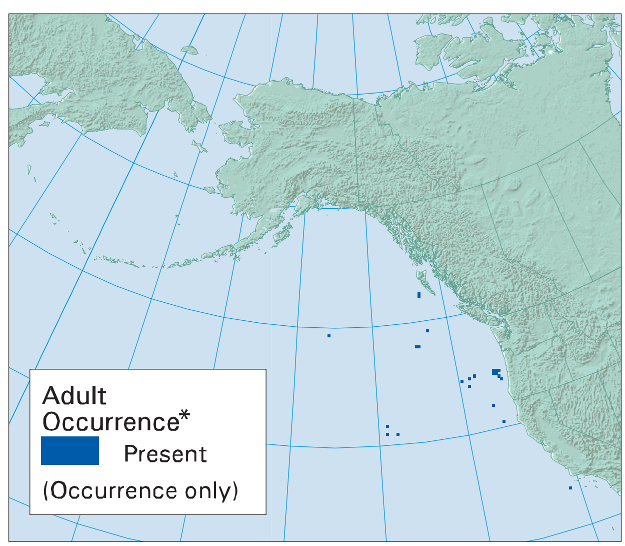
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 126 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

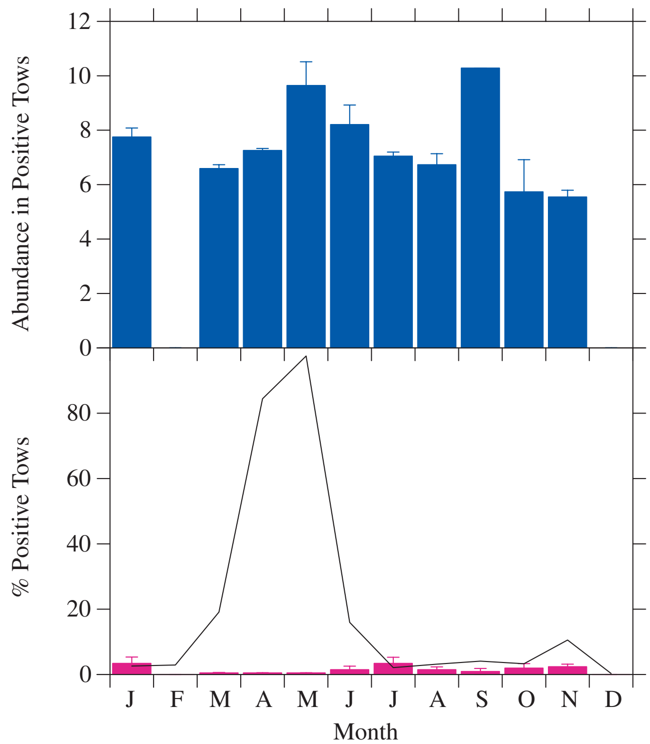

Russia
Alaska
British Columbia
WA
OR
CA
1000 m
8.4 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 0.952
0.952 - 1.663
1.663 - 4.356
4.356 - 26.785
0 300 600 900 km
170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
170° 160° 150° 140° 130°


Egg Occurrence
Absent
Present

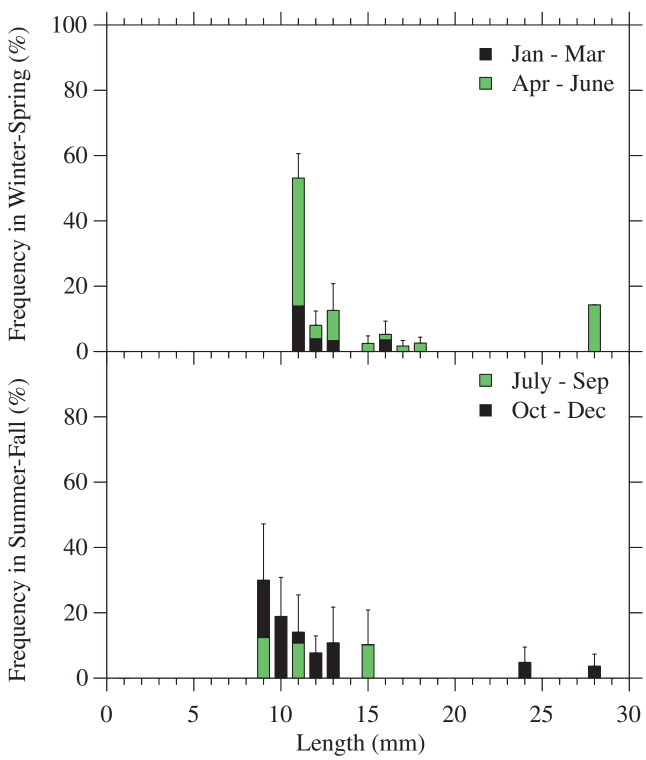

Adult Occurrence*
Present
(Occurrence only)

Life history *Bathylagus milleri* are distributed in the North Pacific from Japan to the Bering Sea, in the Gulf of Alaska, and along the U.S. west coast to southern California. Robust blacksmelt adults are epi- to mesopelagic, occurring at depths of 60–1000 m. Along the southern portion of their range spawning takes place in winter; eggs and larvae are planktonic. Larvae hatch at about 5 mm SL, undergo notochord flexion at 19–24 mm SL, and transform into juveniles at 26–29 mm SL. *Bathylagus milleri* larvae are much less abundant than the other subarctic-transitional species of bathylagids (*B. pacificus* and *Leuroglossus schmidti*). In CalCOFI samples, most are collected in surveys December–February.
[Sources include: Willis et al. (1988), Matarese et al. (1989), Moser and Ahlstrom (1996a)]

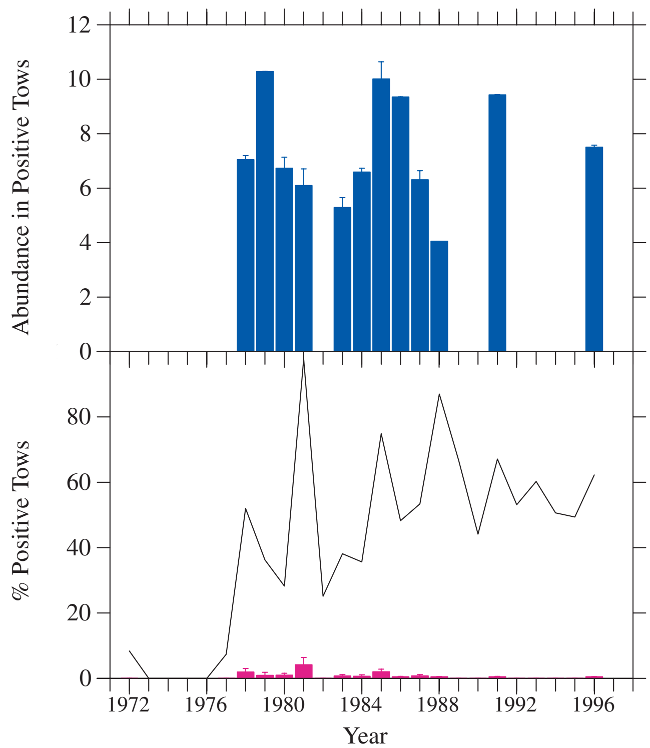
Larval distribution Robust blacksmelt larvae are taken along the shelf (particularly the outer shelf) and slope waters in the western Gulf of Alaska to northeast of Kodiak Island, and off the U.S. west coast. Larvae are most abundant in deeper waters over the shelf edge and are collected throughout the year January–November. The majority of larvae collected are small, ranging in size from 11–28 mm SL in winter–spring and 9–28 mm SL in summer–fall. Although larvae are taken in the Gulf of Alaska, eggs have only been collected along the U.S. west coast off Oregon and California. Overall catch by year indicates that larvae were collected throughout the time series, but more consistently during the 1980s when AFSC conducted U.S. west coast surveys.



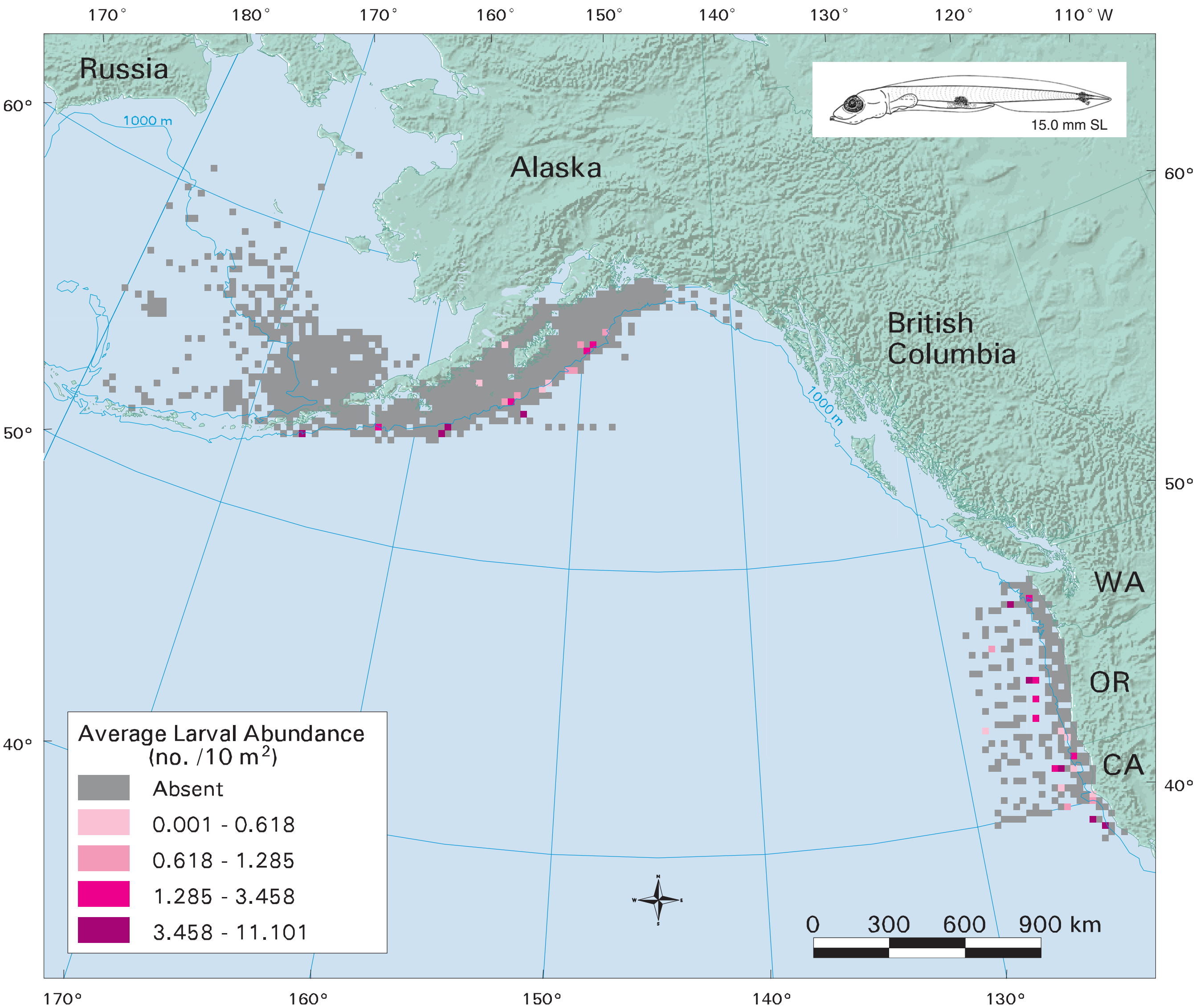
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

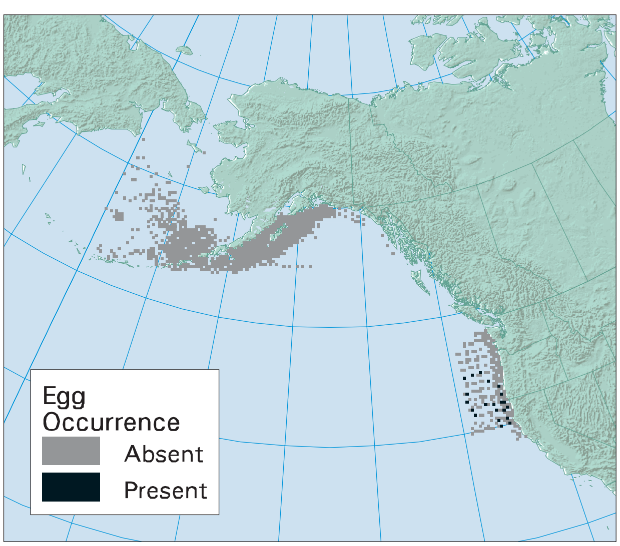


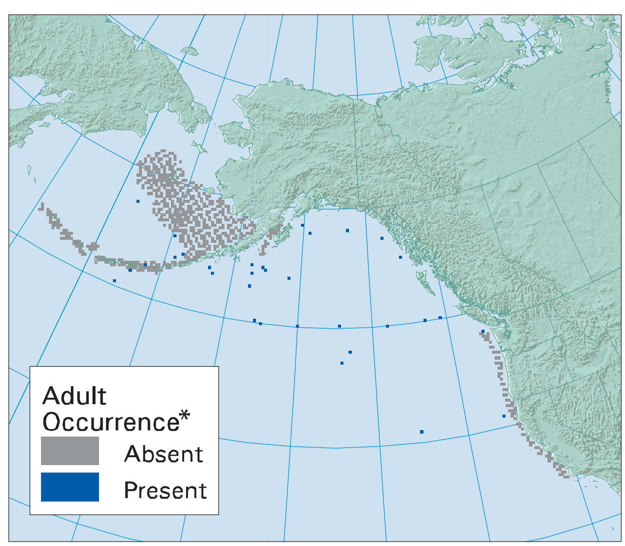
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 20 for winter–spring (Jan–June), 14 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

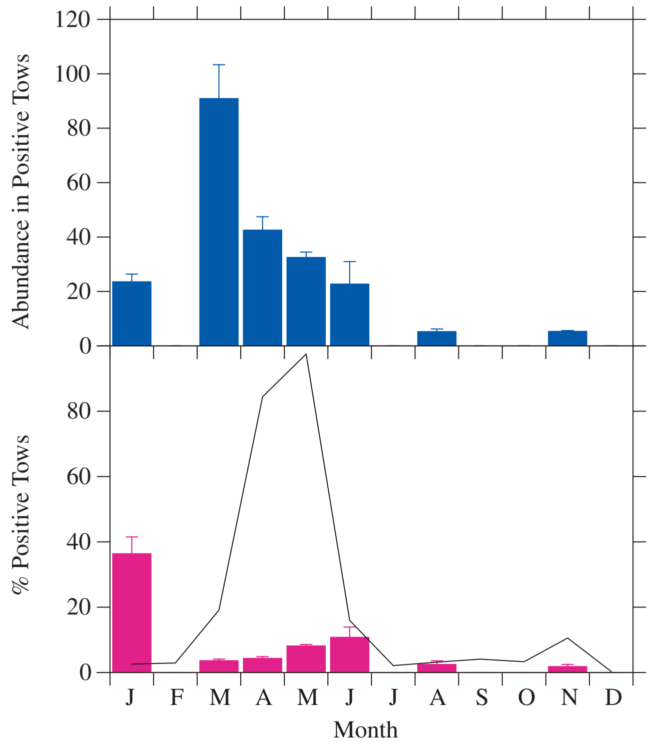

170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
15.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.618
0.618 - 1.285
1.285 - 3.458
3.458 - 11.101
0 300 600 900 km
170° 160° 150° 140° 130°


Egg Occurrence
Absent
Present

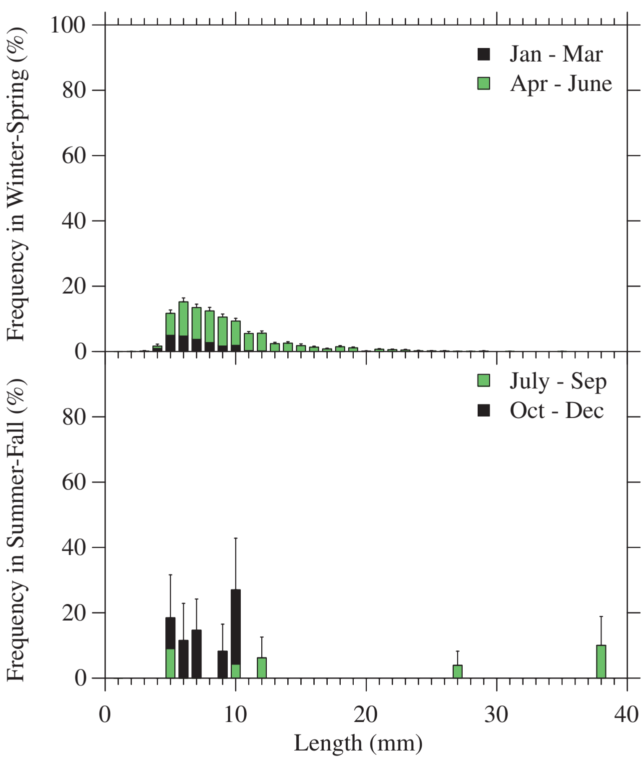

Adult Occurrence*
Absent
Present

Life history *Bathylagus ochotensis* occur from the Bering Sea to Baja California, and extend westward to Japan. Popeye blacksmelt are epi- and mesopelagic with adults collected at depths of 50–900 m. Spawning occurs off the continental slope in winter and spring. Eggs, 0.92–1.1 mm in diameter, are pelagic and distinctive with a segmented yolk, pustules on the inner surface of the chorion, and >10 oil globules that coalesce to two during development. Larvae hatch at about 3 mm SL and undergo transformation at about 26 mm SL. Larvae are among the most abundant in the CalCOFI time series.
[Sources include: Willis et al. (1988), Moser and Ahlstrom (1996a)]

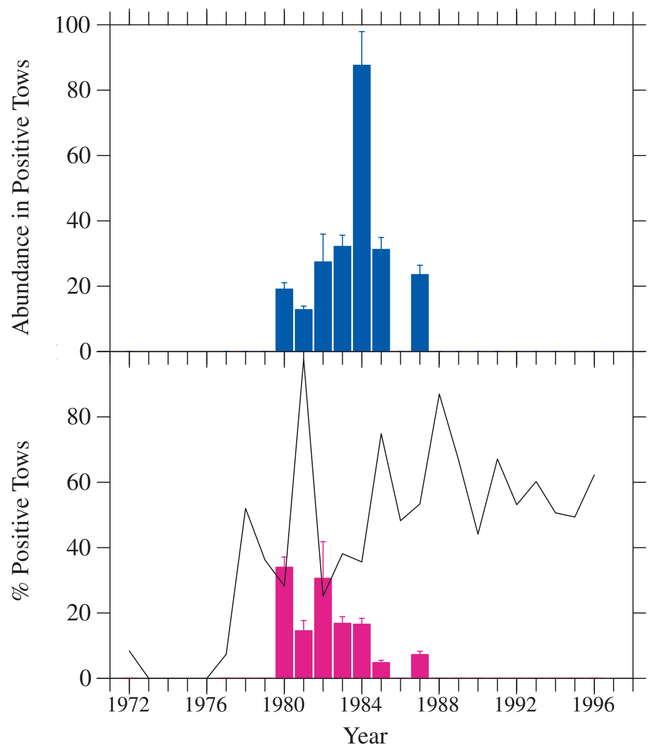
Larval distribution Popeye blacksmelt larvae are found along the U.S. west coast where they are most abundant along the shelf edge and in deeper offshore waters. Although the reported northern extent of the species is the Bering Sea, eggs and larvae have not been collected north of Washington. Larvae are collected in most months January–November, but abundances are much higher in winter–spring. Newly hatched larvae <10 mm SL are common in winter–spring. A few larvae from a wide size range (5–38 mm SL) are occasionally taken in summer–fall. Although eggs are present from off Washington to northern California, they are more common in the southern portion of their distribution. Overall, larvae were more abundant during the 1980s when AFSC conducted U.S. west coast surveys.



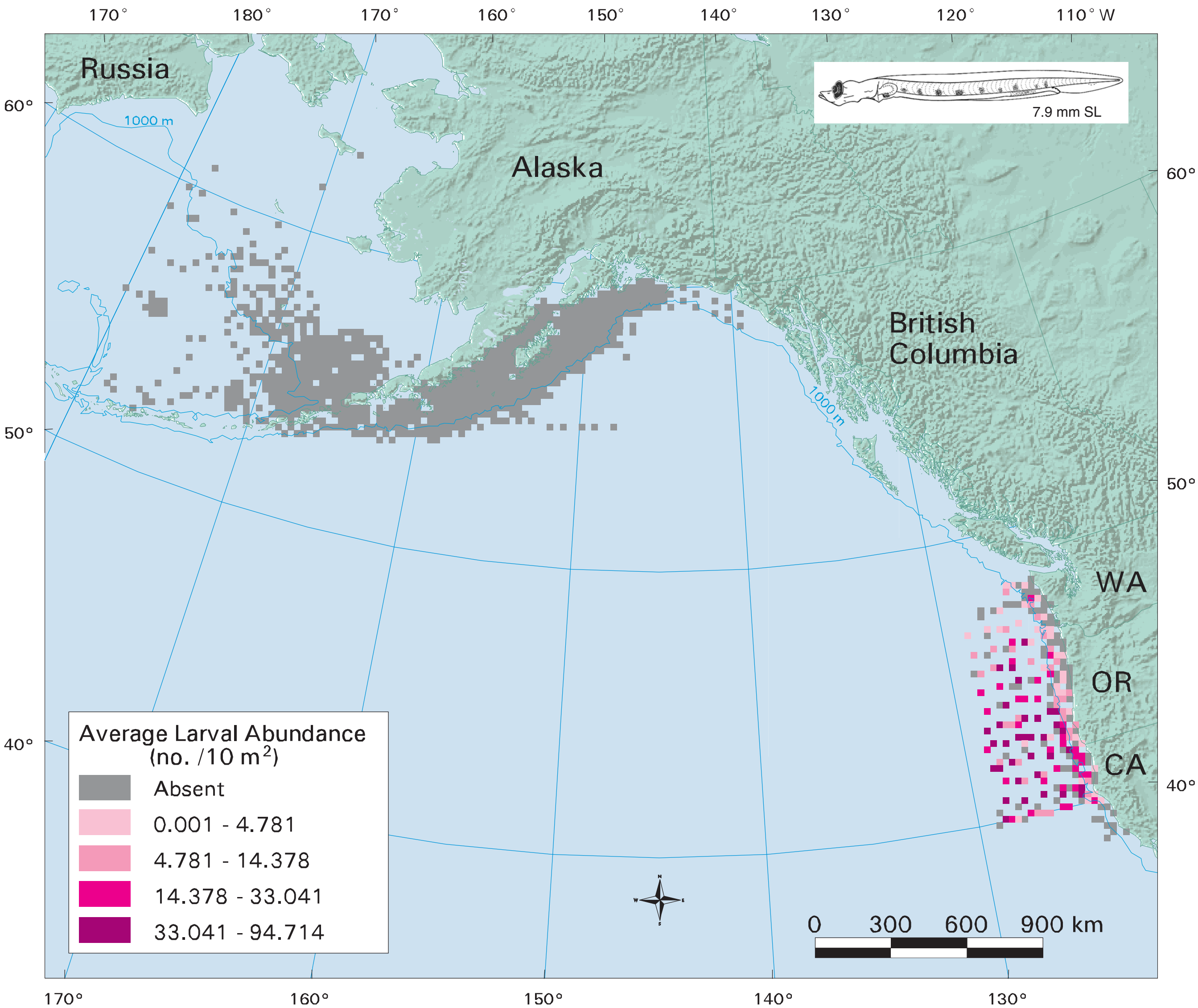
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

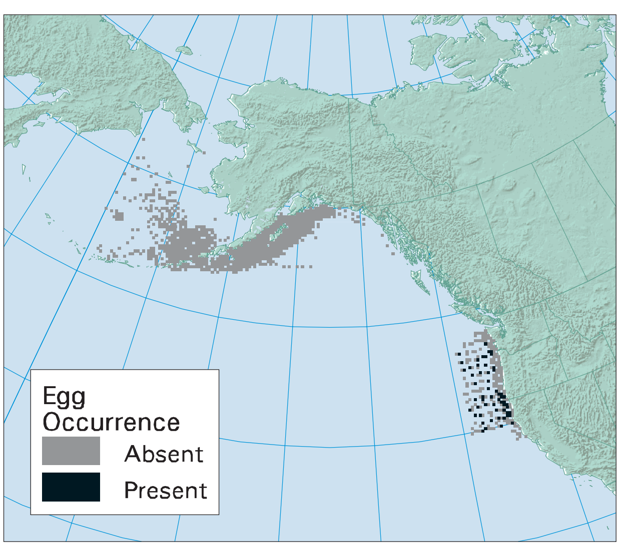


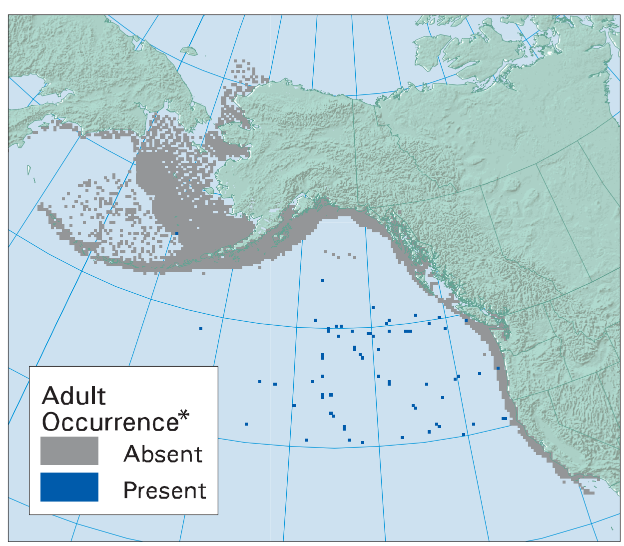
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 1932 for winter–spring (Jan–June), 12 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

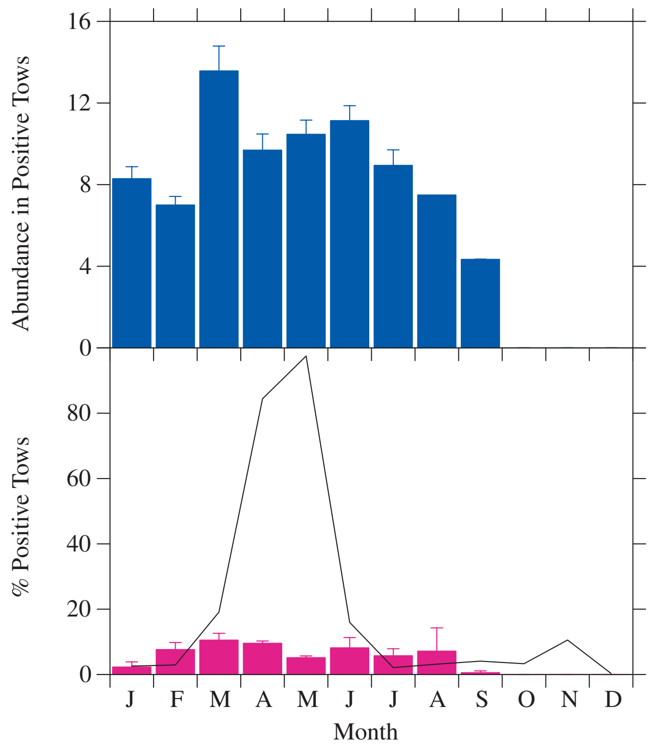

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
7.9 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 4.781
4.781 - 14.378
14.378 - 33.041
33.041 - 94.714
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

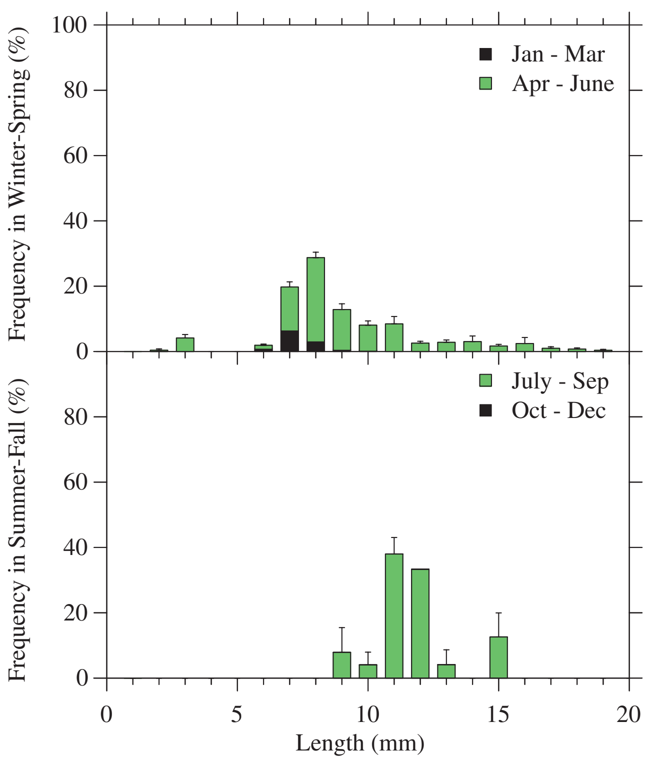

Adult Occurrence*
Absent
Present

Life history *Bathylagus pacificus* occur from Japan, eastward to the Bering Sea and Gulf of Alaska, and south to Baja California. They are epi- and mesopelagic and have been found at depths of 149–1000 m. Adult Pacific blacksmelt reach a maximum size of 25 cm TL. Pelagic eggs, 1.4–1.6 mm in diameter, have a segmented yolk and pustules on the inner surface of the chorion. Pelagic larvae hatch at 3.5–4.0 mm SL and transform at 20–24 mm SL. Larvae are most abundant in CalCOFI surveys in the winter and spring months, with a peak in February and March.
[Sources include: Hart (1973), Willis et al. (1988), Matarese et al. (1989), Moser and Ahlstrom (1996a)]

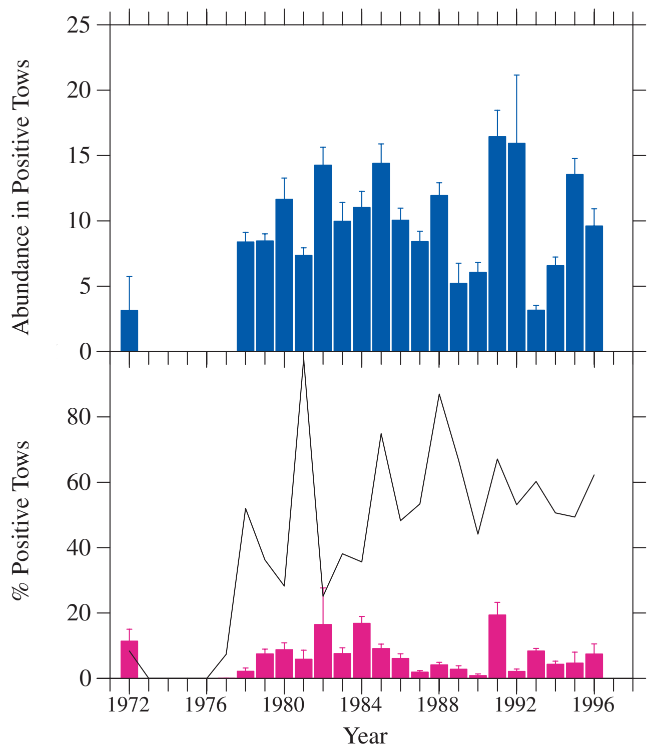
Larval distribution Pacific blacksmelt larvae are distributed from the northern Bering Sea slope waters, eastward along the deeper slope areas seaward of the Alaska Peninsula and east of Kodiak Island in the Gulf of Alaska, and off the slope and oceanic regions along the U.S. west coast. Highest abundances of larvae are along continental shelf edges and in deeper slope waters along their range. Larvae are collected January–September and are most abundant in winter–spring. Larvae within a wide size range (2–19 mm SL) are collected in winter–spring, although most are small (<10 mm SL). Larvae were common in deep water tows throughout the time series from 1972 to 1996.



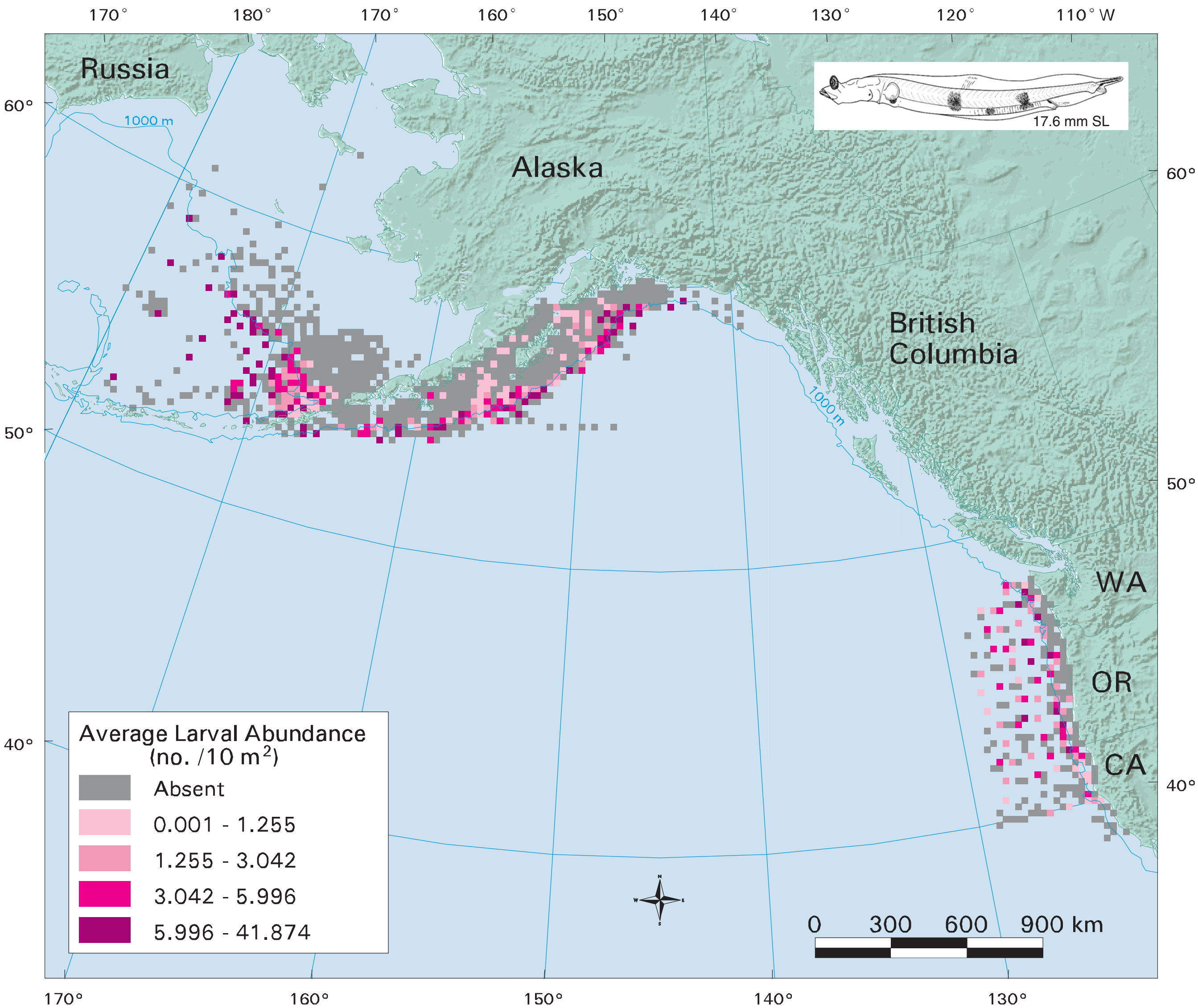
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

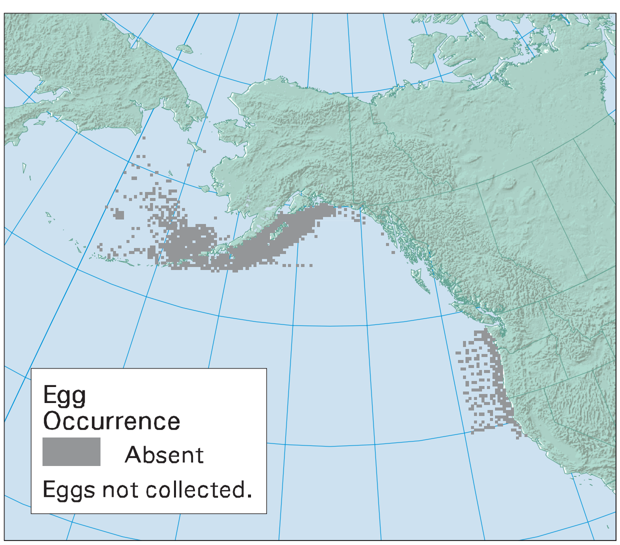


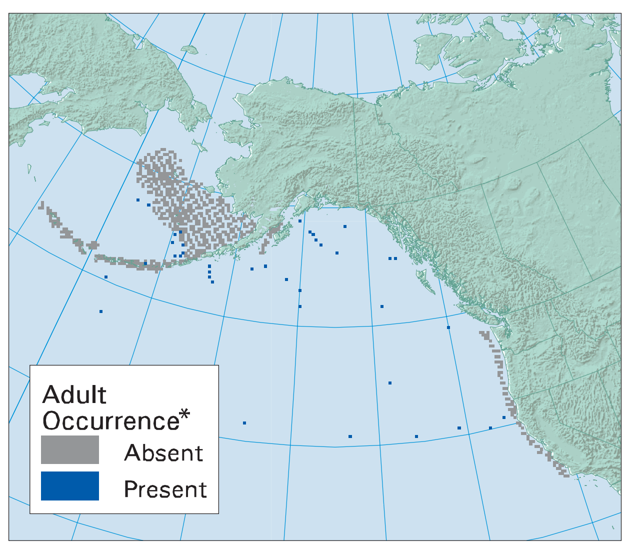
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 791 for winter–spring (Jan–June), 10 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

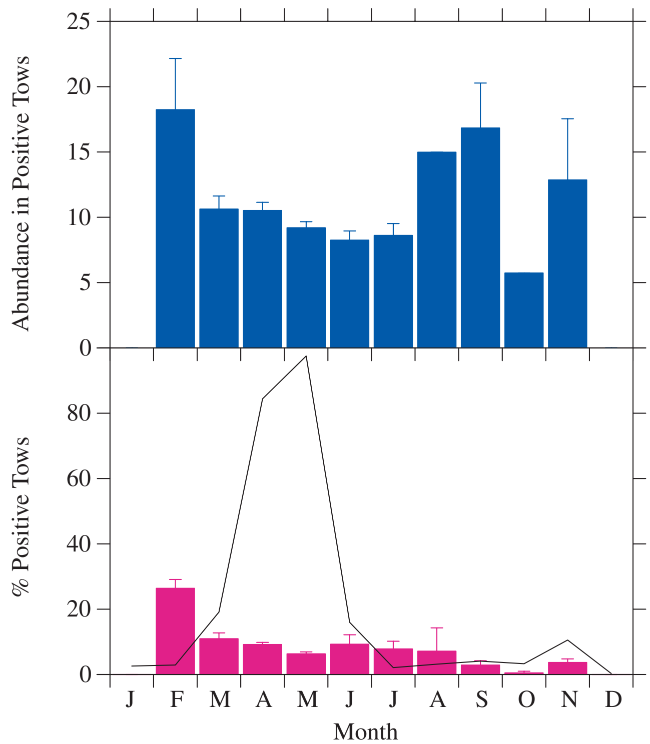

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
17.6 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.255
1.255 - 3.042
3.042 - 5.996
5.996 - 41.874
0 300 600 900 km


Egg Occurrence
Absent
Eggs not collected.

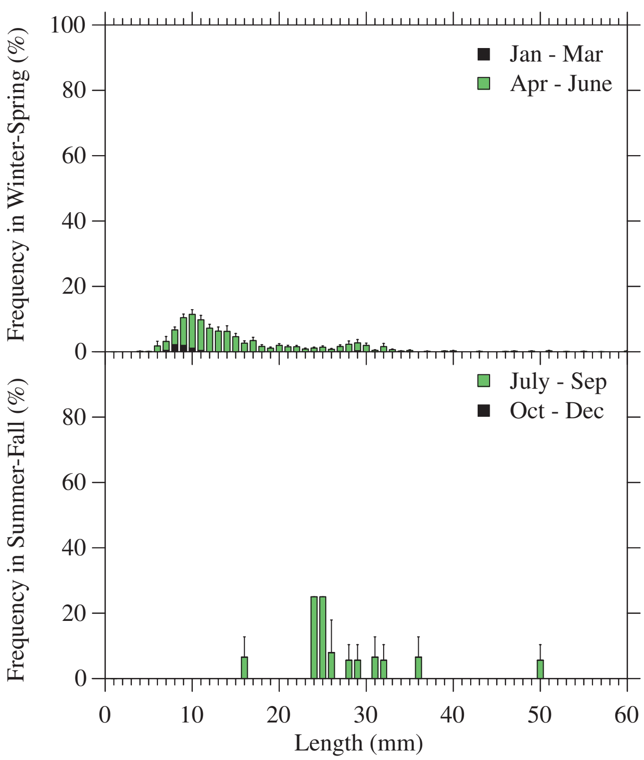

Adult Occurrence*
Absent
Present

Life history *Leuroglossus schmidti* adult distribution is reported as the Bering Sea to British Columbia. Northern smoothtongue adults are bathypelagic, but have been collected from the surface to 1800 m. Spawning occurs fall–winter over the continental slope. Eggs are pelagic, 1.65–1.90 mm in diameter, and have pustules on the chorion that are typical within the family. The eggs contain up to nine oil globules early in development that coalesce to one prior to hatching. Larvae hatch at 4–5 mm SL and transform at 31–35 mm SL.
[Sources include: Matarese et al. (1989), Moser and Ahlstrom (1996a)]

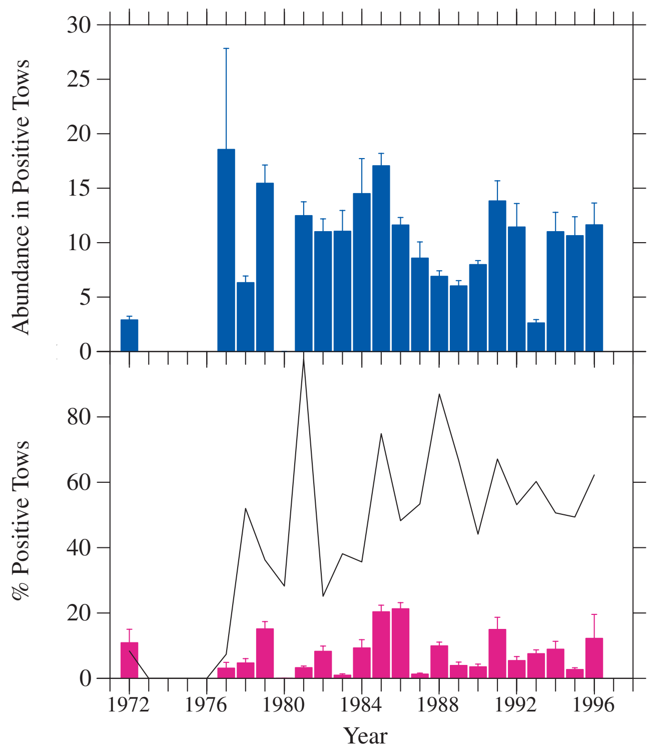
Larval distribution Northern smoothtongue larvae are widely distributed over slope waters in the Bering Sea and in the Gulf of Alaska, including Shelikof Strait. Highest abundances are over deep slope waters and along the shelf edge. Larvae are collected February–November, with a peak in abundance occurring in February. Newly hatched larvae (< 10 mm SL) are collected in winter–spring along with larvae and juveniles within a wide size range up to 50 mm SL. In summer–fall, larvae and juveniles are generally larger (16–50 mm SL). Eggs are present in the western Gulf of Alaska, especially along the shelf and in deeper water. Larvae were routinely collected in most years throughout the time series.



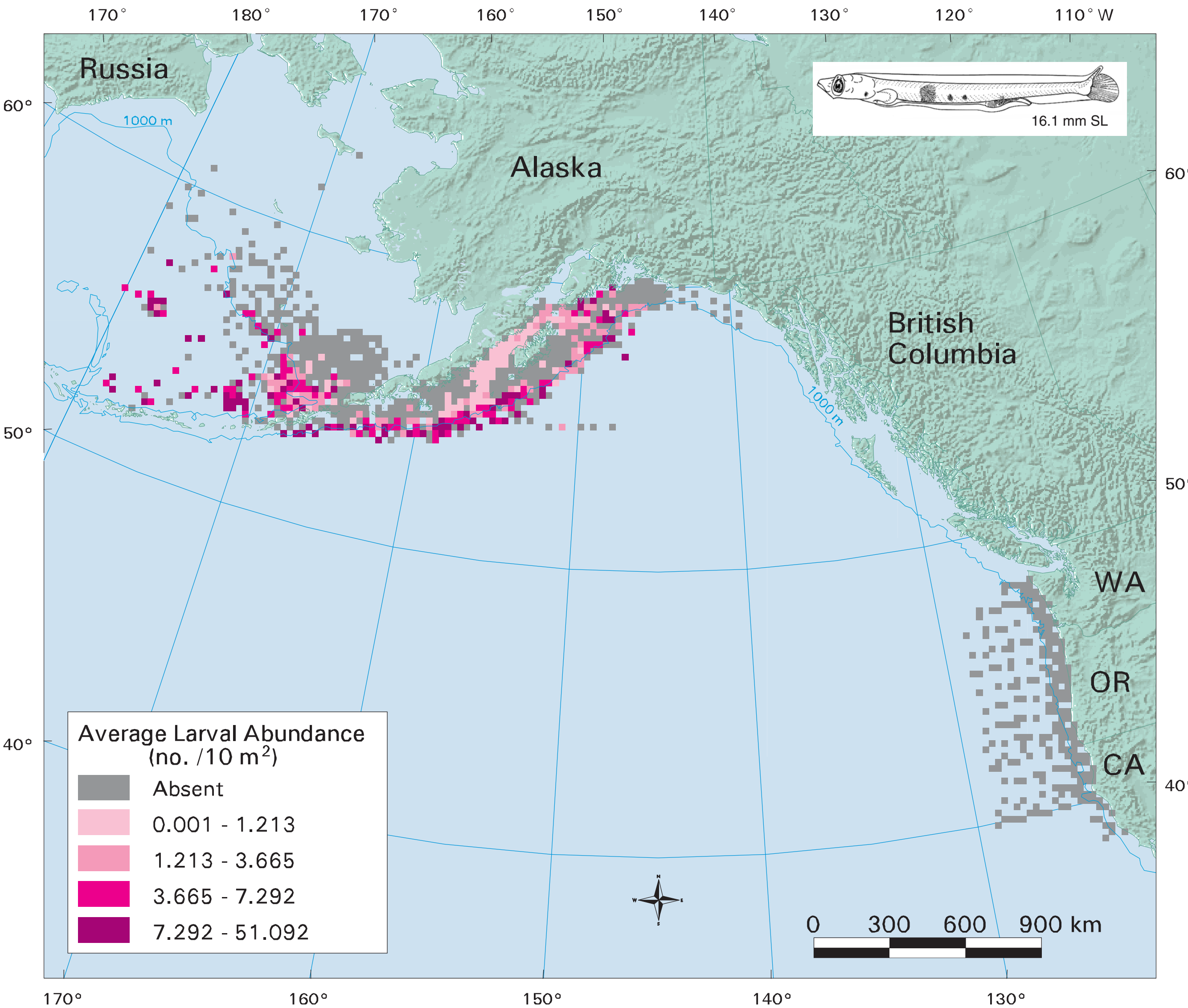
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

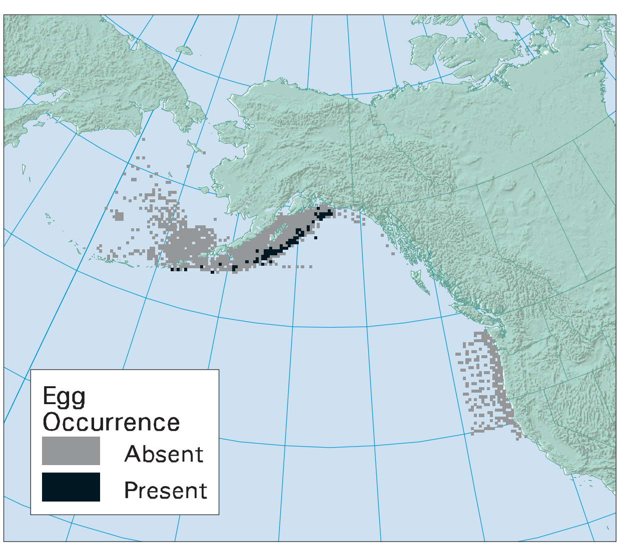


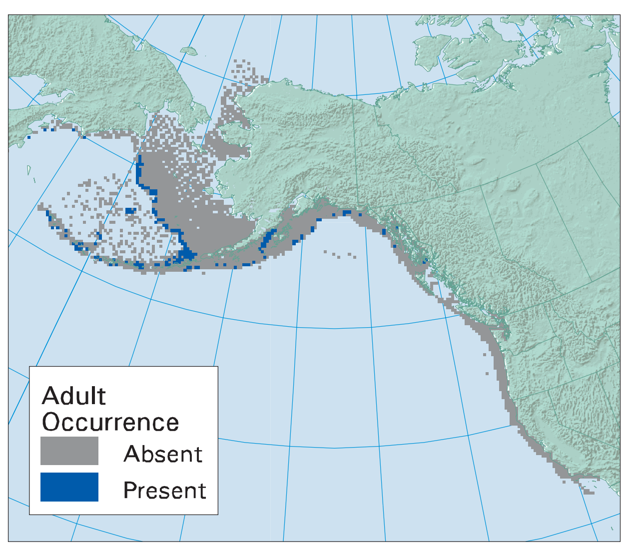
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 1027 for winter–spring (Jan–June), 10 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

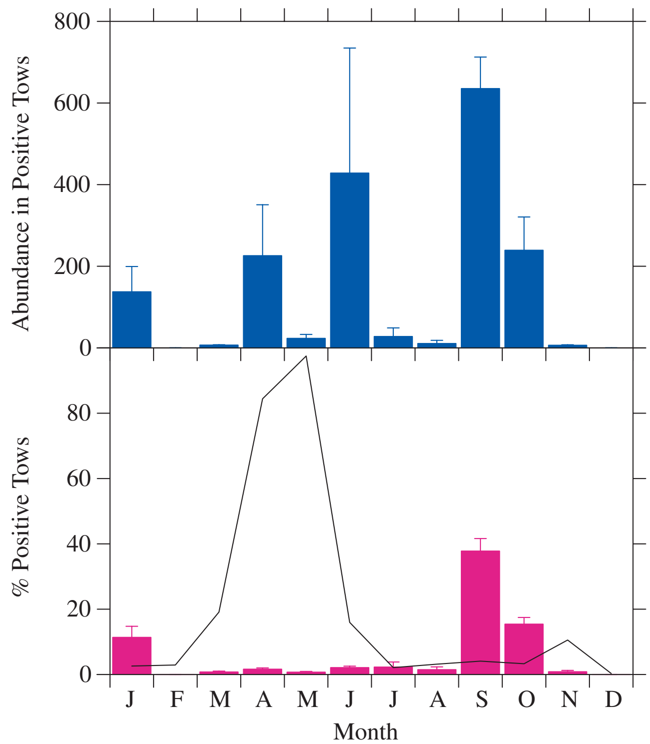

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
16.1 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 1.213
1.213 - 3.665
3.665 - 7.292
7.292 - 51.092
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

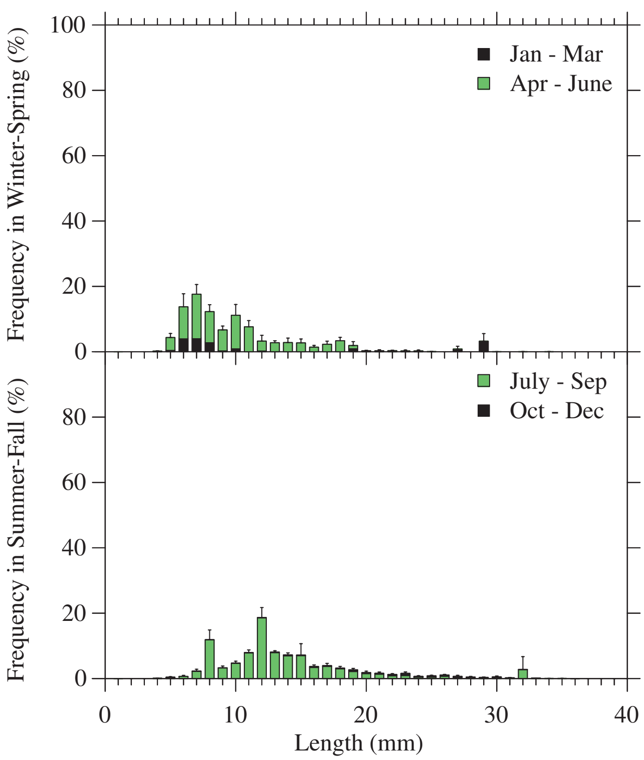

Adult Occurrence
Absent
Present

Life history The Osmeridae is represented by seven species distributed in the northeastern Pacific from the Bering Sea to southern California (see species list, Appendix Table 2). Adults are shallow-water marine species. *Mallotus villosus* and *Hypomesus pretiosus* spawn on beaches; others are anadromous or spawn in estuaries. Spawning is protracted and en masse. Eggs are 0.80–1.1 mm in diameter, adhesive, and have numerous oil globules. Larvae are elongate with long guts that have a single row of melanophores along the ventral midline. Larvae are abundant nearshore off Oregon; most are collected January–June. In CalCOFI surveys, only 13 occurrences of osmerid larvae have been reported from 1951 to 1984; these are most likely *Hypomesus pretiosus*.
[Sources include: Moser et al. (1994), Moser (1996b)]

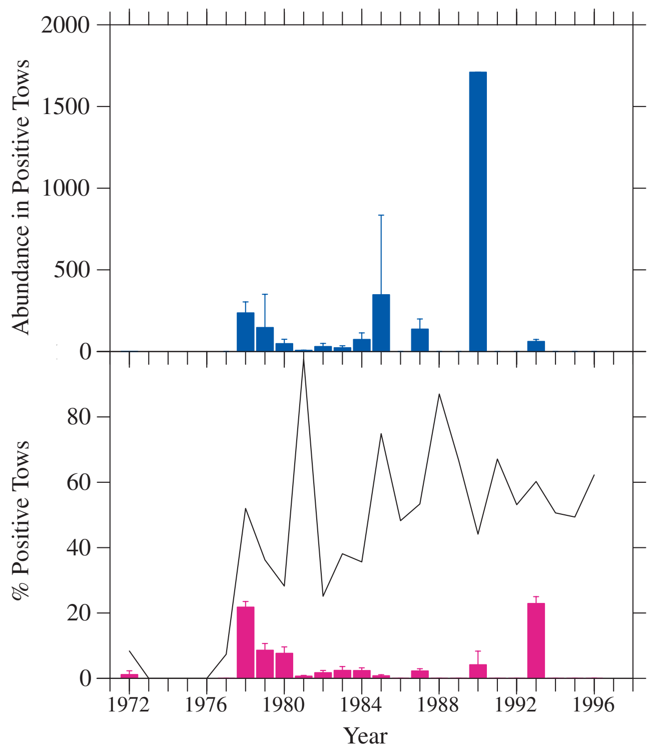
Larval distribution Smelt larvae are found in the Gulf of Alaska, east of Kodiak Island to Prince William Sound, and off the U.S. west coast. Larvae have not been collected in the Bering Sea. Most occurrences of larvae in the Gulf of Alaska probably represent small *Mallotus villosus* larvae that could not be identified to species. Occurrences off the U.S. west coast may represent several taxa, not including *M. villosus*. Highest concentrations are on the shelf east of Kodiak Island and along the inshore shelf region off the U.S. west coast. Larvae are collected January–November with higher abundances in late spring and late summer/early fall. Although larvae up to 29 mm SL are collected in winter–spring, small larvae (<10 mm SL) are more frequent. In summer–fall most larvae are 10–20 mm SL. Larvae occurred during most years from 1972 to 1993.



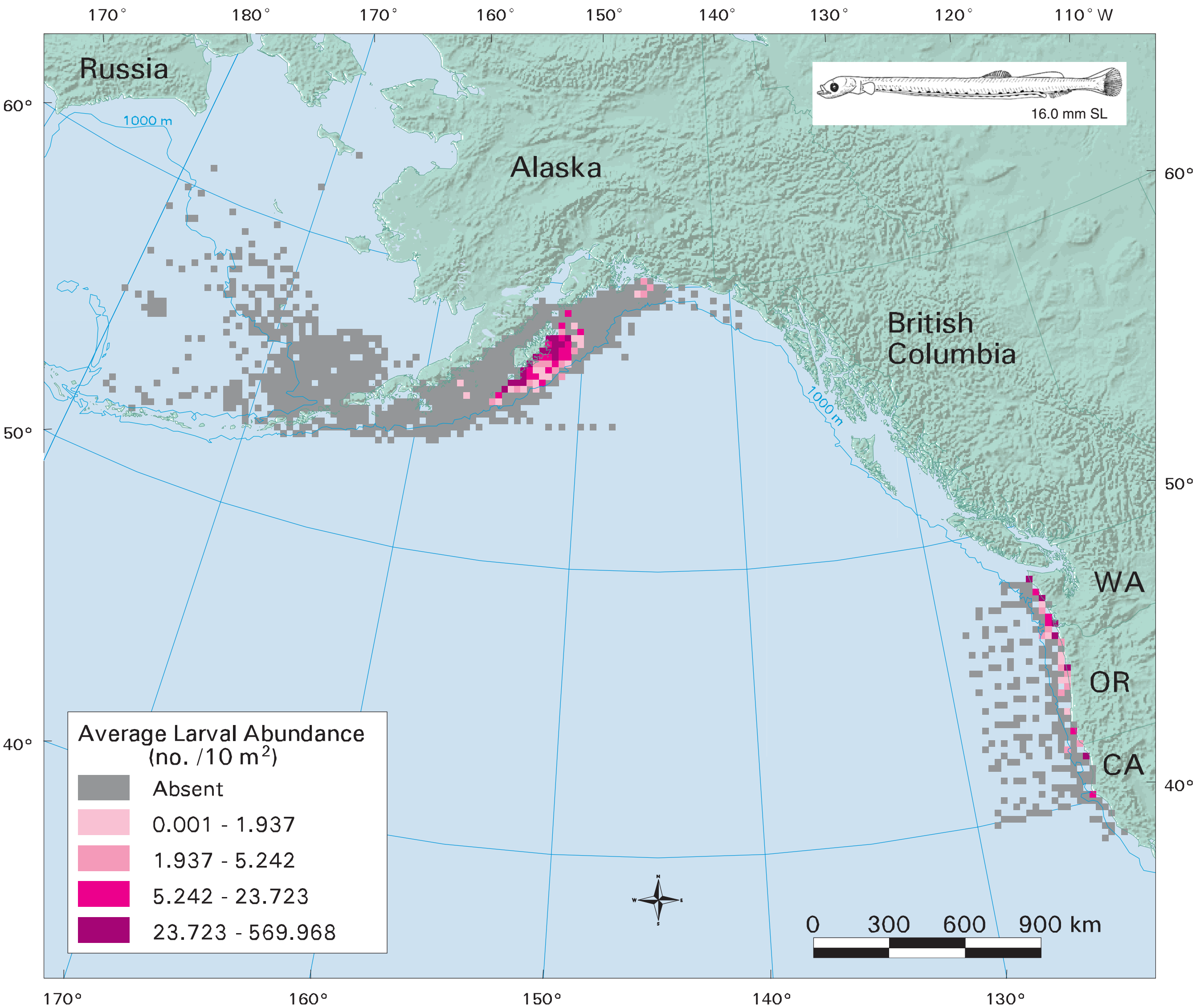
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.



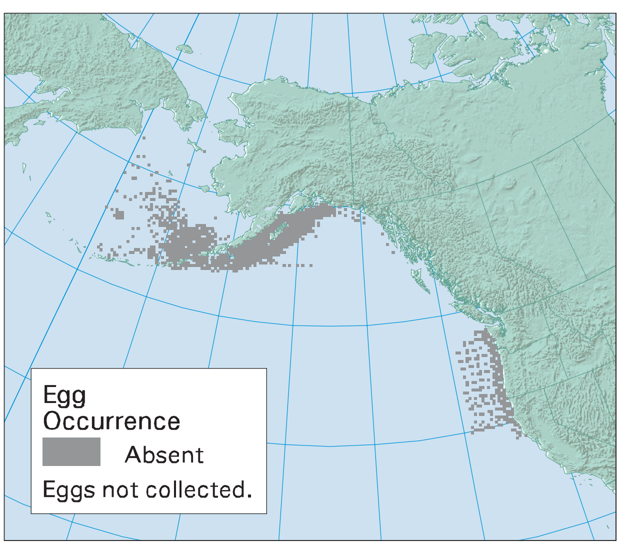
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 522 for winter–spring (Jan–June), 1925 for summer–fall (July–Dec).



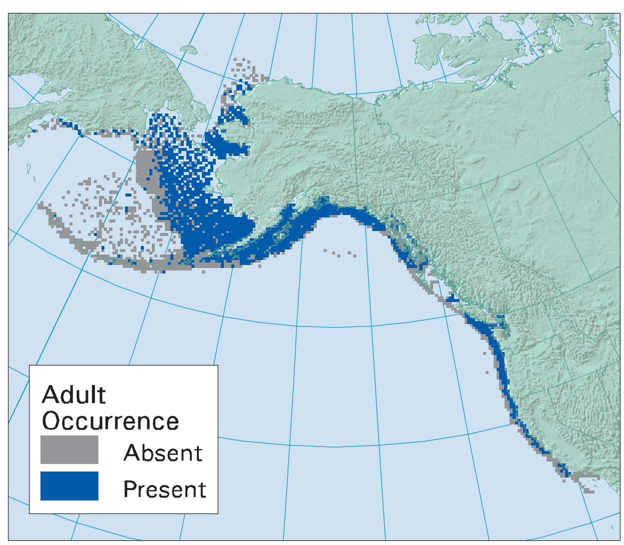
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.



170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
16.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.937
1.937 - 5.242
5.242 - 23.723
23.723 - 569.968
0 300 600 900 km
170°
160°
150°
140°
130°



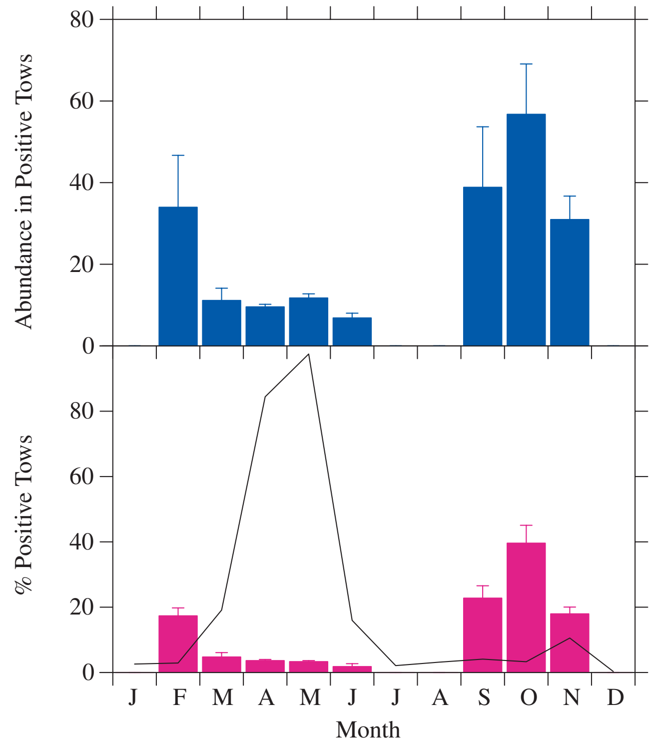
Egg Occurrence
Absent
Eggs not collected.



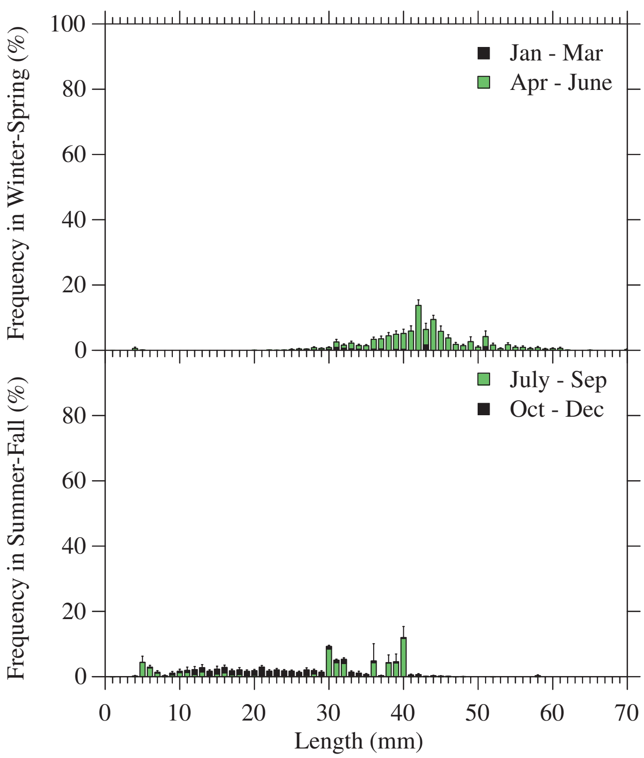
Adult Occurrence
Absent
Present

Life history *Mallotus villosus* occur nearshore from arctic waters to Washington in the northeastern Pacific Ocean. Capelin adults are pelagic and have been collected from the surface to depths of 750 m. Spawning occurs in schools along gravel beaches during late spring, summer, and early fall. Eggs are about 1 mm in diameter and adhesive; larvae hatch at 3–6 mm SL. Prior to 1989, larvae of *Mallotus villosus* were the only osmerid identified in AFSC collections and were commonly collected throughout the Gulf of Alaska. Larger larvae and early juveniles appear to undergo a nocturnal migration to the surface and commonly occur in neuston collections in the Gulf of Alaska.
[Sources include: Warner and Shafford (1978), Blackburn et al. (1981), Pahlke (1985), Matarese et al.(1989), Doyle et al. (1995), Brown et al. (1999)]

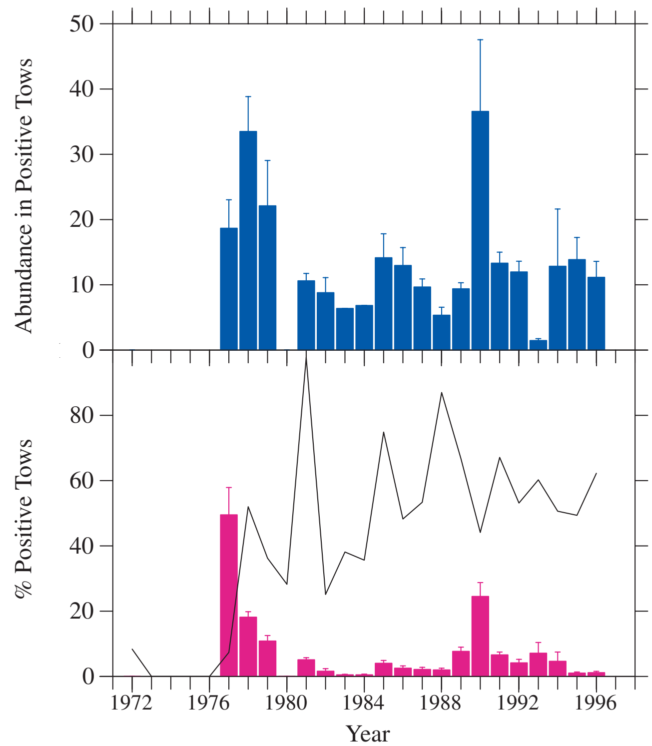
Larval distribution Capelin larvae are collected along the shelf from near Unimak Pass in the Aleutian Islands, in the Shelikof sea valley, and east to Cape St. Elias in the Gulf of Alaska. Highest concentrations are found on the shelf east of Kodiak Island. Larvae occur February–November with abundances higher in the fall. Smaller larvae (<30 mm SL) are more frequent in summer–fall collections (4–58 mm SL), whereas larger larvae (>30 mm SL) are more frequent in winter–spring (4–61 mm SL). Larvae commonly occurred throughout the time series from 1977 to 1996.



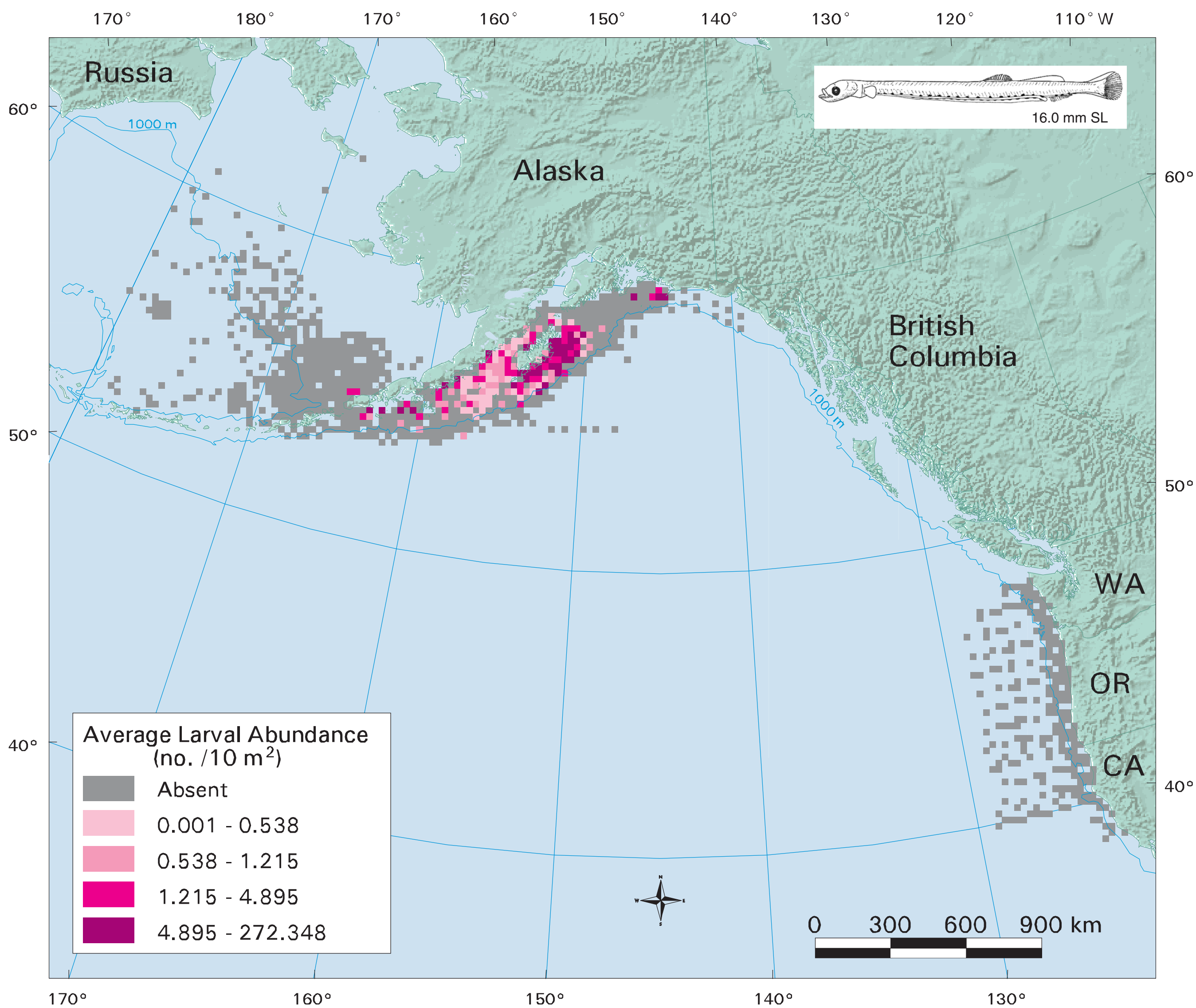
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



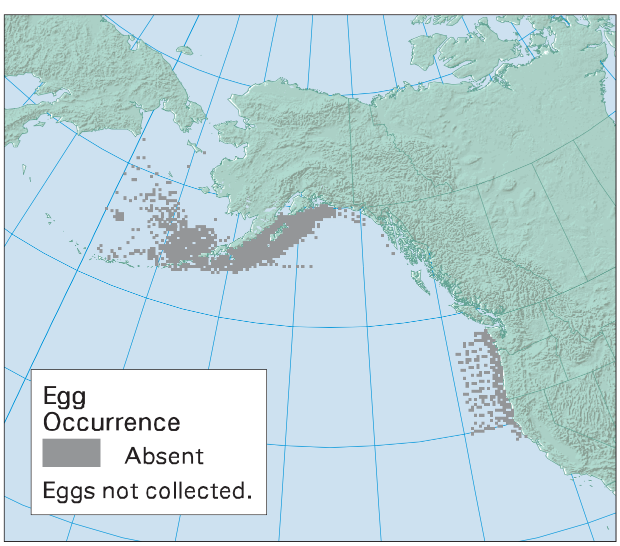
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 715 for winter–spring (Jan–June), 1016 for summer–fall (July–Dec).



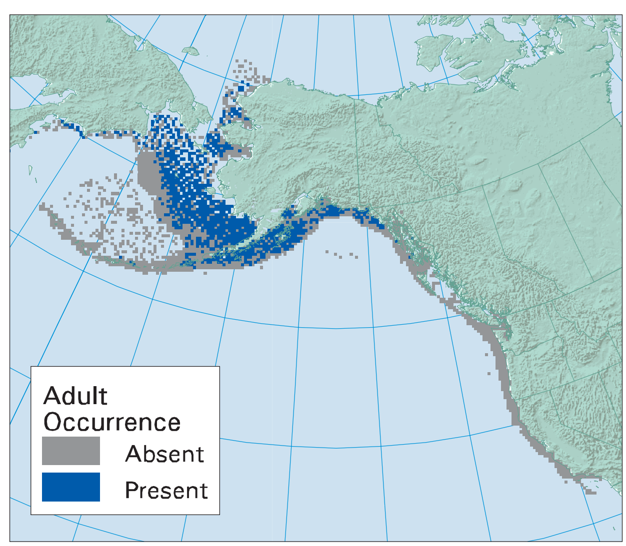
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
16.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.538
0.538 - 1.215
1.215 - 4.895
4.895 - 272.348
0 300 600 900 km
170° 160° 150° 140° 130°



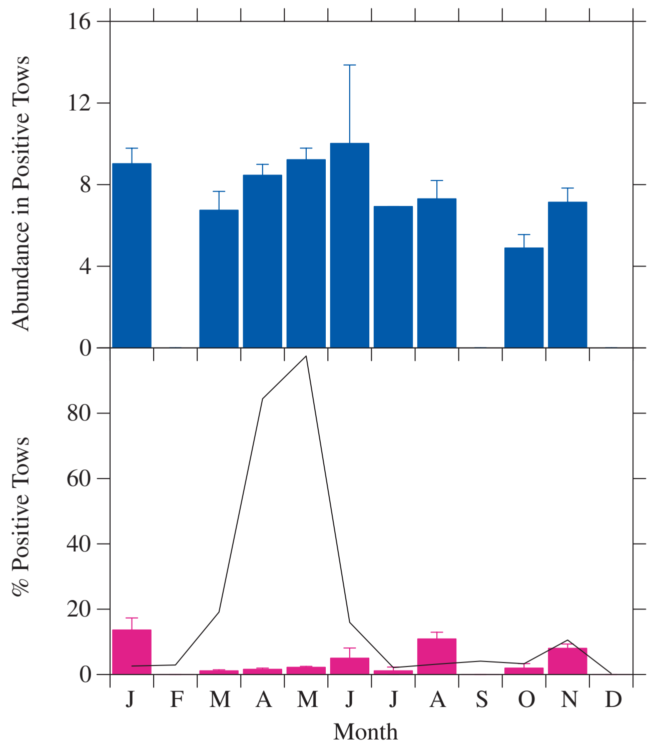
Egg Occurrence
Absent
Eggs not collected.



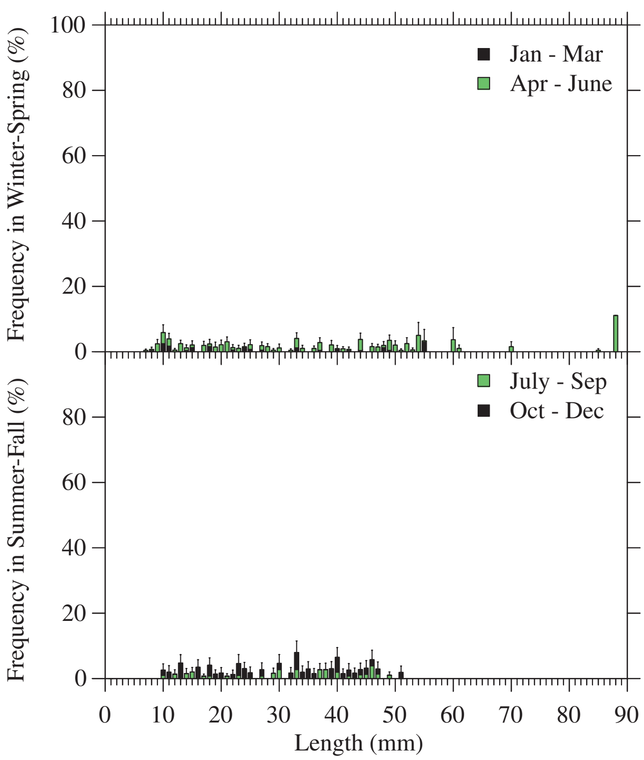
Adult Occurrence
Absent
Present

Life history *Chauliodus macouni* range from the Bering Sea to central Baja California and have been reported at depths between 76 and 4231 m. In addition to photophores on the body, Pacific viperfish have luminous organs around the mouth, branchiostegals, and on the end of the first dorsal ray. They grow to a length of 22.9 cm TL and may live to be eight years old. Pelagic eggs (2.7–3.2 mm) have a thin chorion and a segmented yolk. Pelagic larvae, which hatch at about 5 mm SL and transform at 33–49 mm SL, are found throughout the year in CalCOFI samples with a peak in abundance in February.
[Sources include: Hart (1973), Matarese et al. (1989), Moser (1996c)]

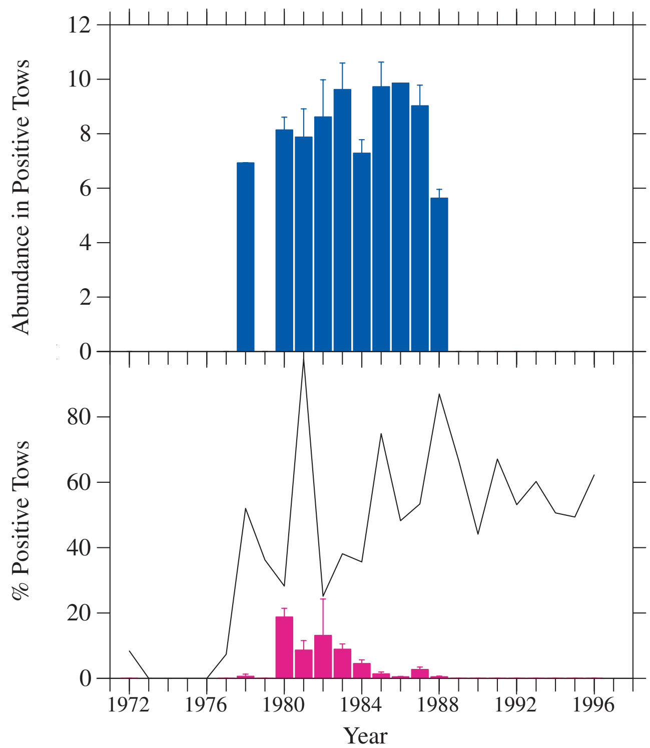
Larval distribution Pacific viperfish larvae are sparsely distributed along the outer shelf in the Gulf of Alaska from Unimak Pass to northeast of Kodiak Island, and more abundantly off the U.S. west coast primarily in slope and oceanic waters. Most abundant off Oregon and northern California in deep oceanic waters, larvae are found January–November. Larvae and juveniles are collected in winter–spring (7–88 mm SL) and in summer–fall (10–51 mm SL). Eggs are abundant and widely distributed off the outer shelf and offshore regions along the U.S. west coast. Although adults are collected in AFSC adult surveys along the outer shelf edge in the Bering Sea, eggs and larvae have not been collected that far north. Overall, larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



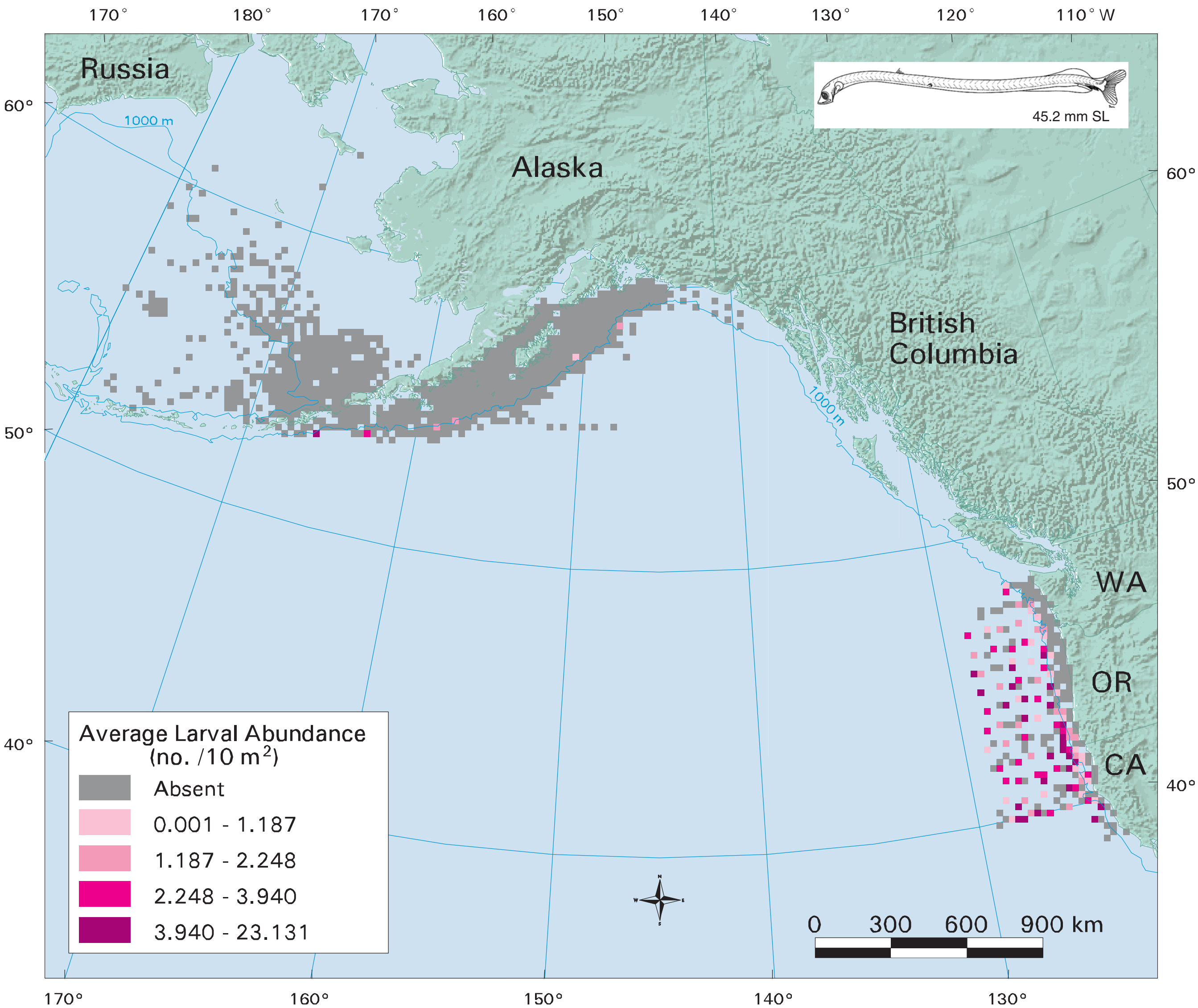
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

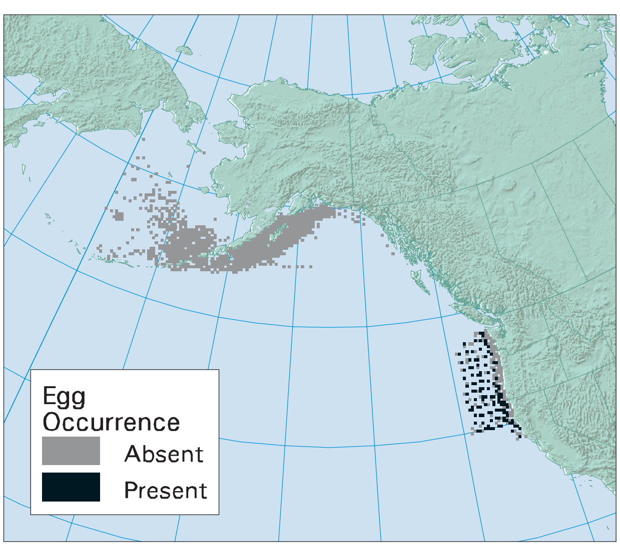


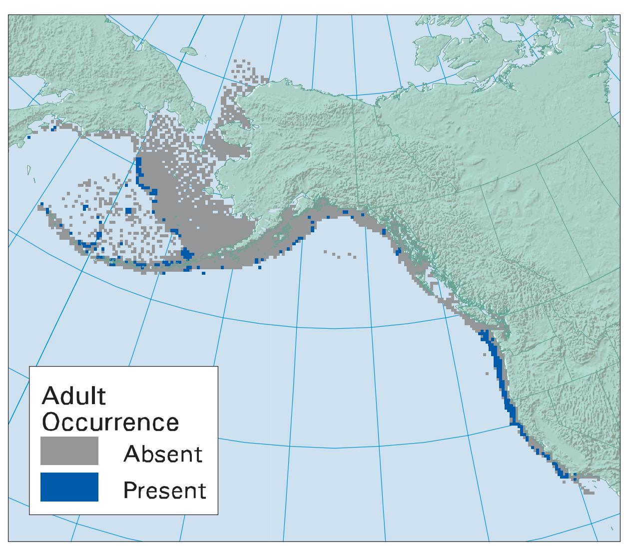
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 117 for winter–spring (Jan–June), 69 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

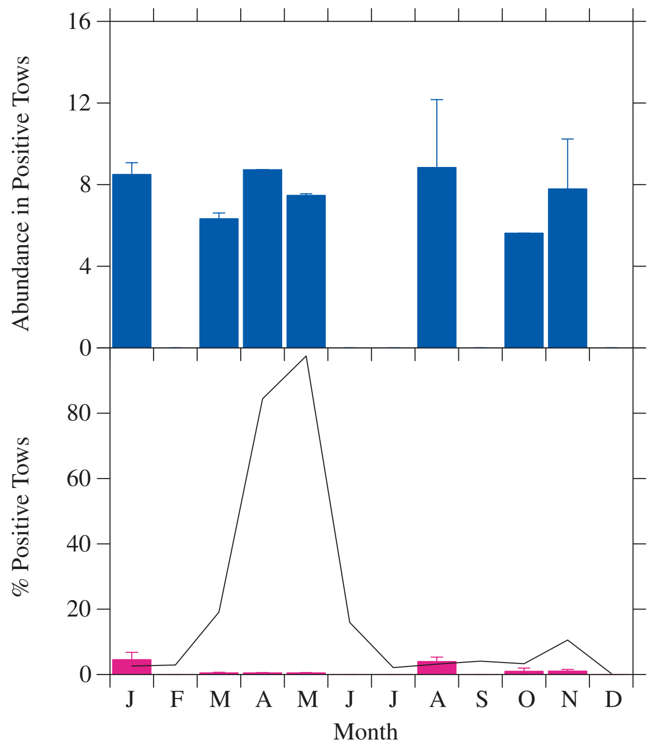

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
45.2 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.187
1.187 - 2.248
2.248 - 3.940
3.940 - 23.131
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

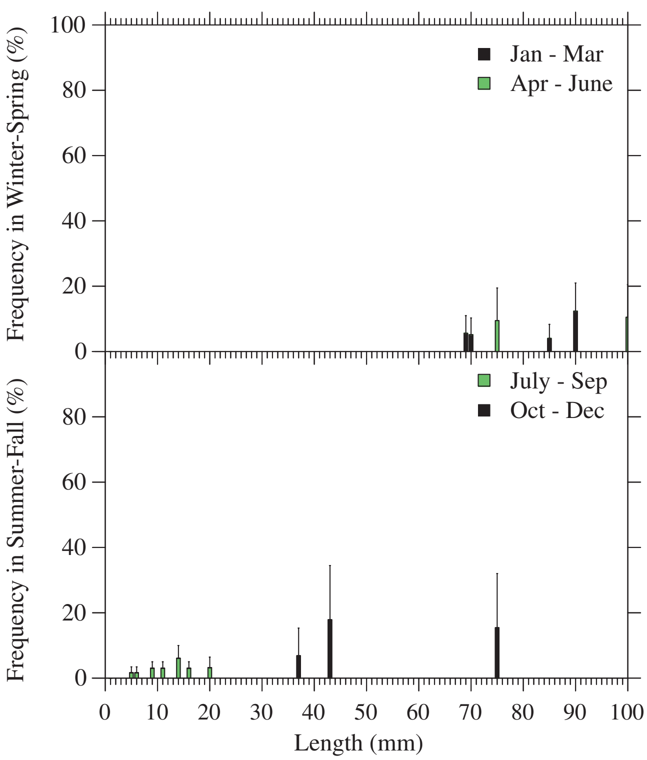

Adult Occurrence
Absent
Present

Life history *Tactostoma macropus* are found from the Bering Sea to central Baja California. Generally mesopelagic, but migrating into the epipelagic zone at night, longfin dragonfish have been collected at depths of 31–549 m. Adults can reach 34.5 cm TL. Females mature at age 6 and spawn 24,000–66,000 pelagic eggs at one time in summer. Eggs are 1.38–1.55 mm in diameter and have a segmented yolk and one oil globule. Pelagic larvae hatch at 4 mm SL and transform at 44–55 mm SL. In CalCOFI surveys, larvae are most abundant in summer with peaks July–September.
[Sources include: Hart (1973), Willis et al. (1988), Matarese et al. (1989), Moser (1996d), Moser et al. (2001)]

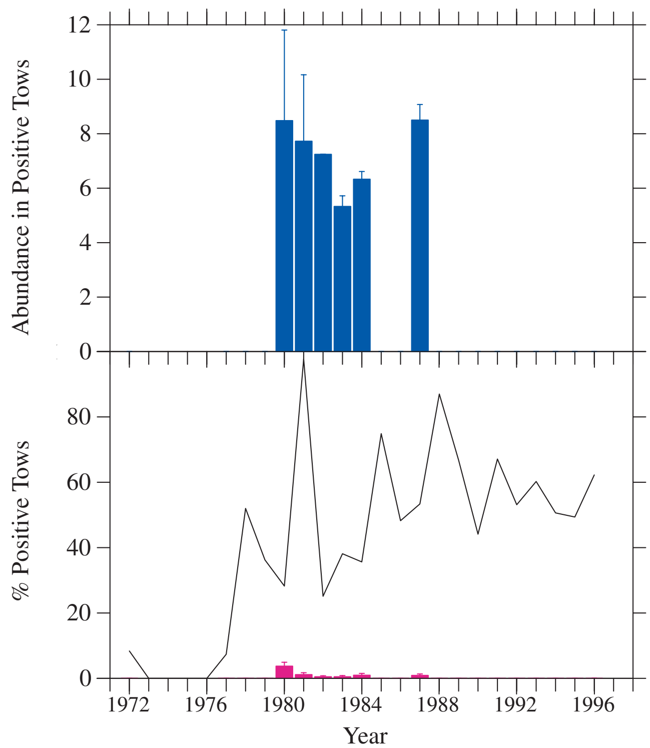
Larval distribution Early life history stages of longfin dragonfish are found throughout the AFSC U.S. west coast survey area, and are most abundant in deep water along the shelf edge and in oceanic waters. Although adults have been collected in the Bering Sea and Gulf of Alaska, eggs and larvae have not. Larvae and older life history stages are found in small numbers January–November, but spawning occurs in late summer and fall. Small larvae and juveniles (<75 mm SL) are collected in summer–fall, whereas juveniles and adults (>75 mm SL) are collected in winter–spring. Overall, longfin dragonfish were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



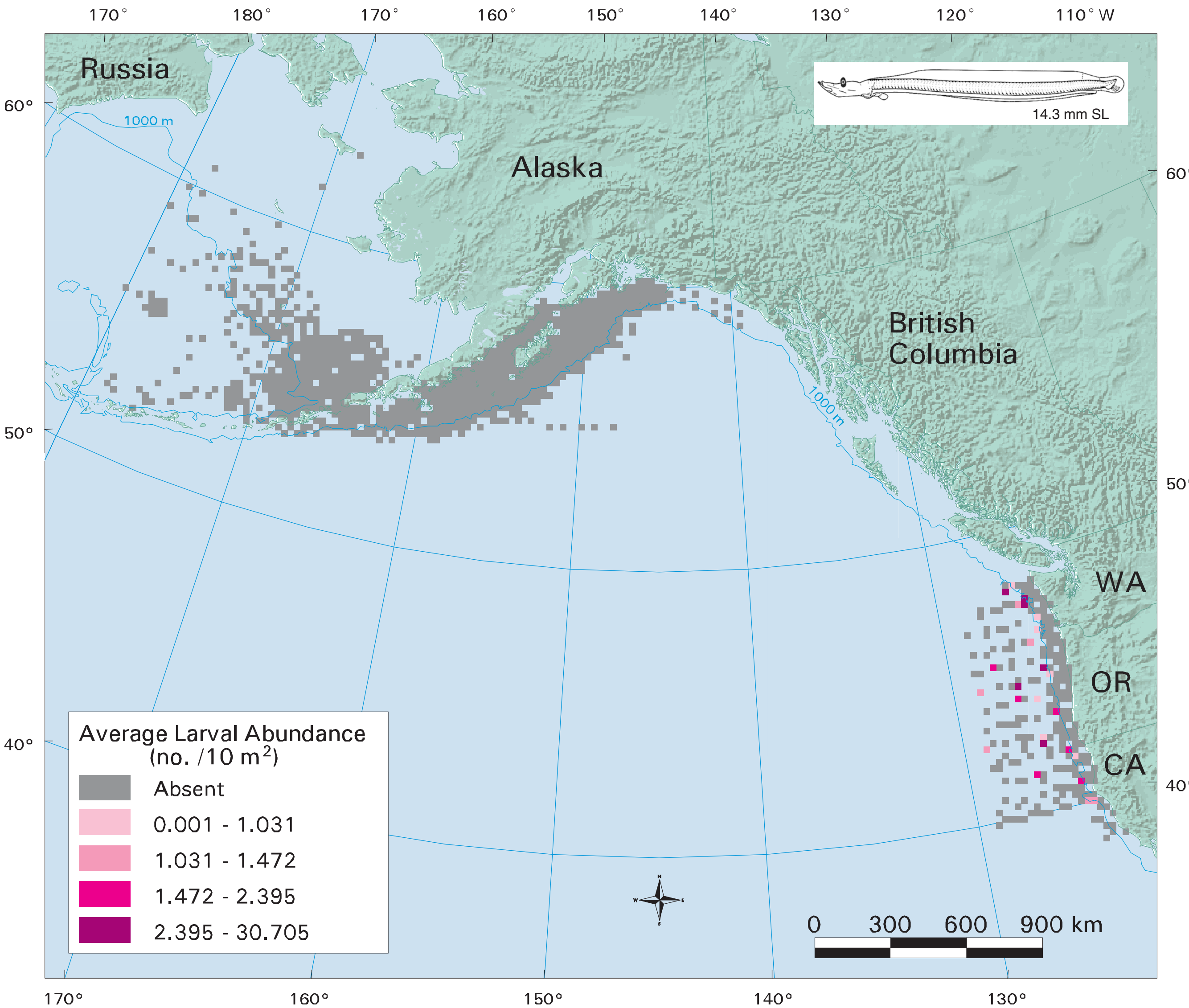
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

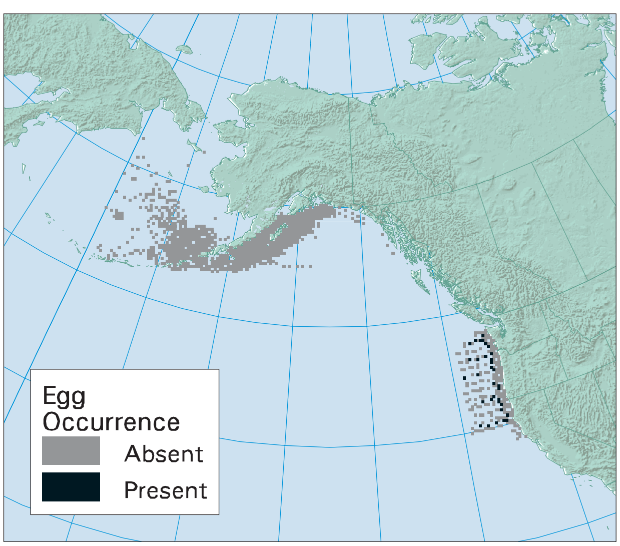


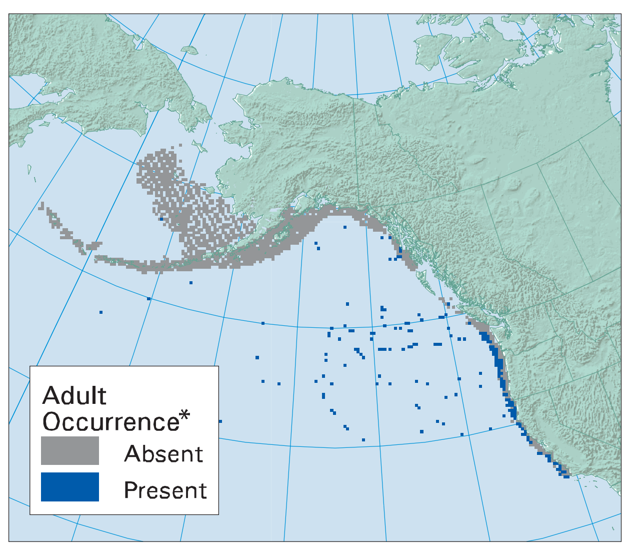
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 15 for winter–spring (Jan–June), 19 for summer–fall (July–Dec); 16 specimens >100 mm SL omitted.



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

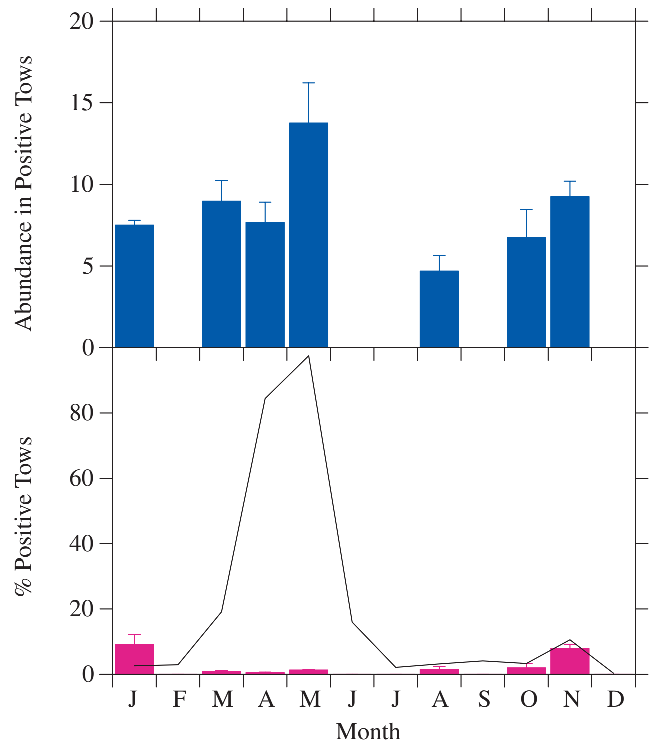

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
14.3 mm SL
Average Larval Abundance
(no. /10 m²)
Absent
0.001 - 1.031
1.031 - 1.472
1.472 - 2.395
2.395 - 30.705
0 300 600 900 km
170°
160°
150°
140°
130°


Egg
Occurrence
Absent
Present

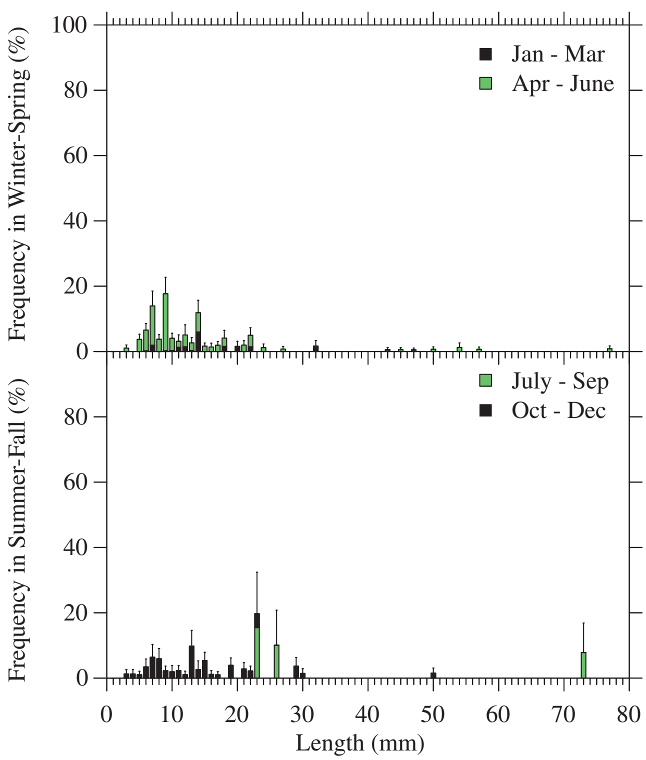

Adult
Occurrence*
Absent
Present

Life history *Lestidiops ringens* are found from British Columbia to Baja California. Slender barracudina are pelagic and inhabit a wide range of depths; individuals have been collected from depths of 29–3920 m. Adults can reach 20.9 cm TL and are synchronous hermaphrodites. Eggs are unknown. Pelagic larvae hatch at <3 mm SL and undergo a gradual transformation at 40–60 mm SL. Preflexion larvae occur throughout the year in CalCOFI ichthyoplankton collections.
[Sources include: Hart (1973), Matarese et al. (1989), Ambrose (1996c)]

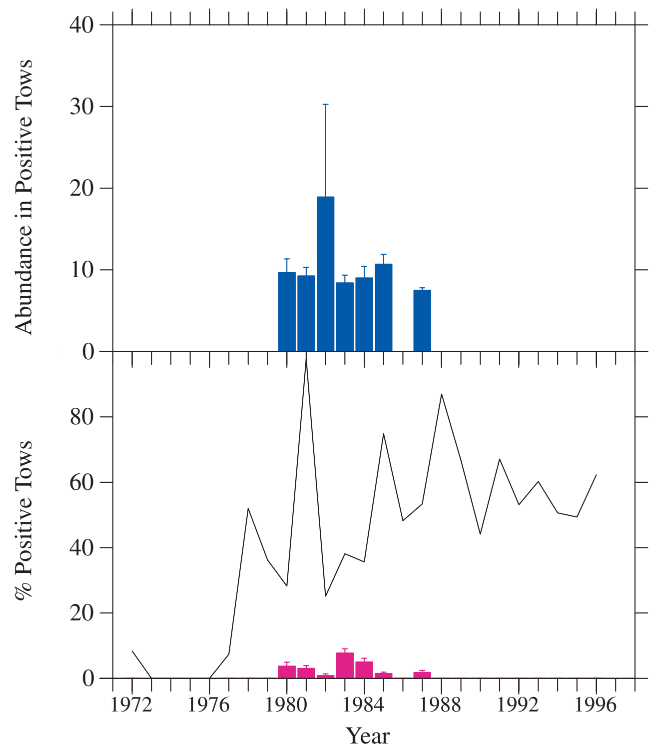
Larval distribution Slender barracudina larvae are collected in outer shelf and deep oceanic waters off Oregon and northern California in the AFSC U.S. west coast survey area. Larvae are most abundant offshore. Larvae are found January–November, with the number of collections higher in winter–spring. Similar size ranges of larvae and juveniles are collected in winter–spring (3–77 mm SL) and summer–fall (3–73 mm SL). Overall, larvae and juveniles were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



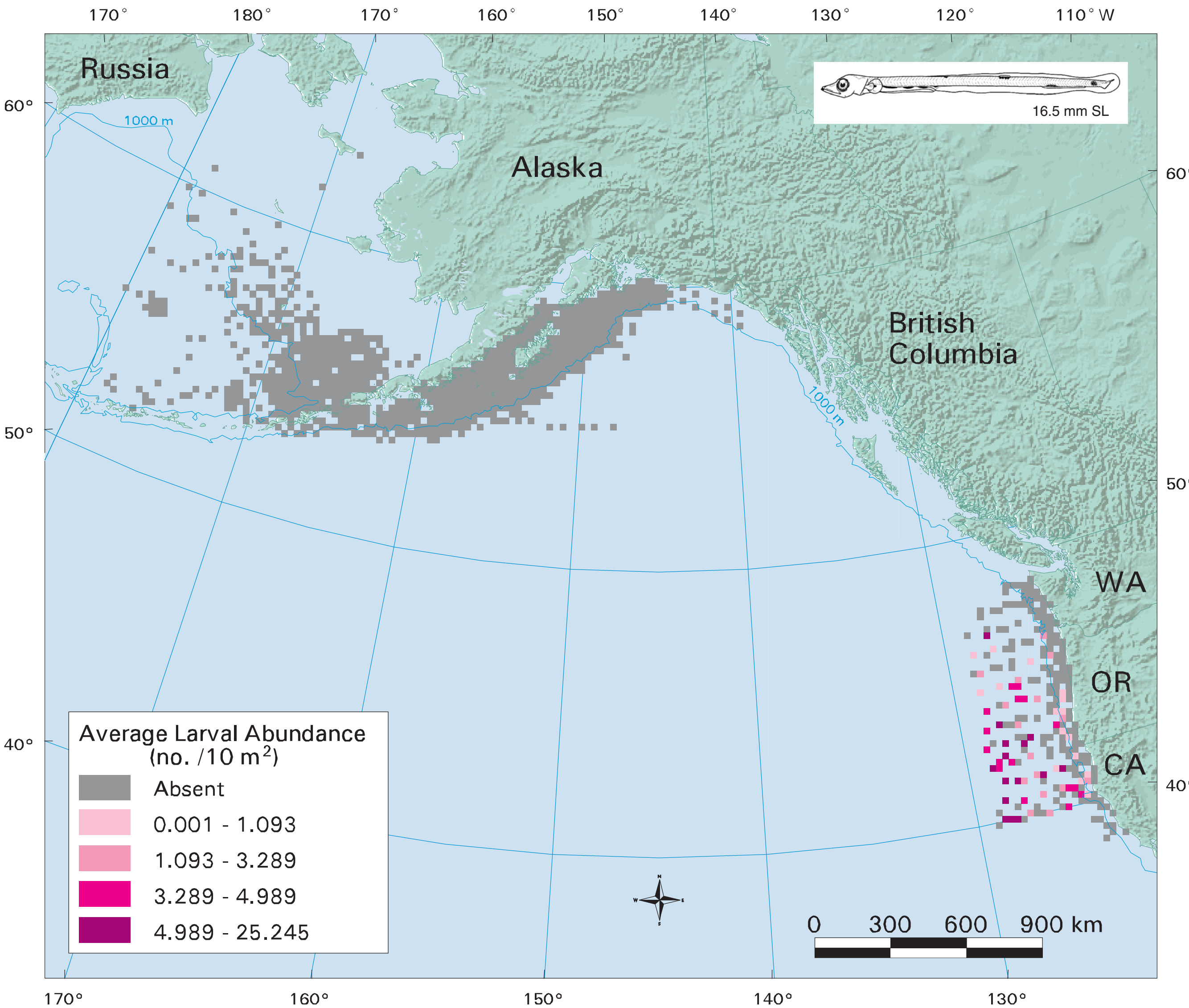
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

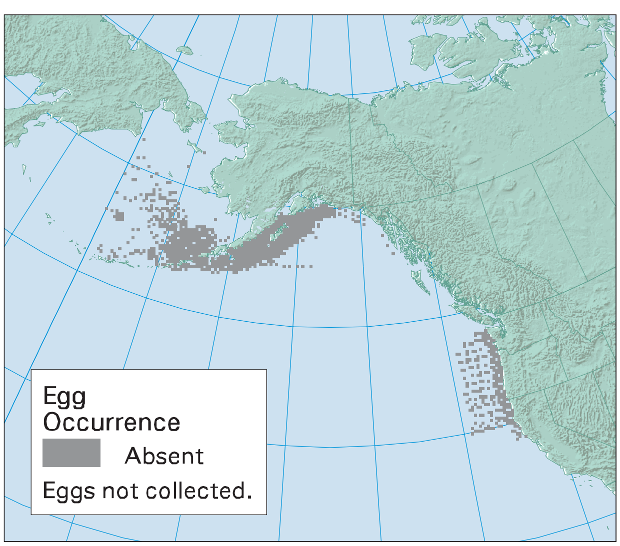


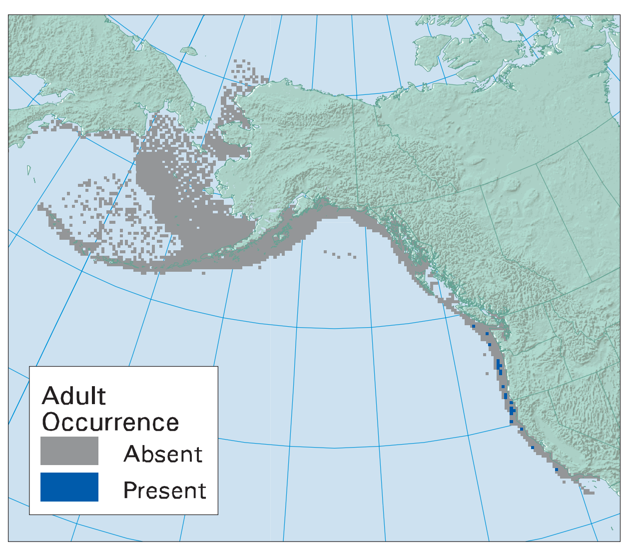
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 93 for winter–spring (Jan–June), 45 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

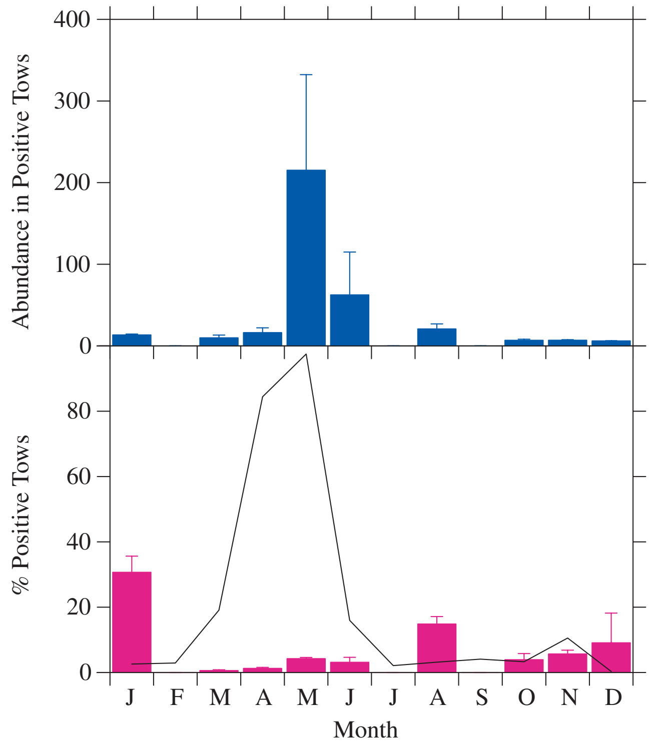

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
60°
50°
40°
1000 m
16.5 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.093
1.093 - 3.289
3.289 - 4.989
4.989 - 25.245
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

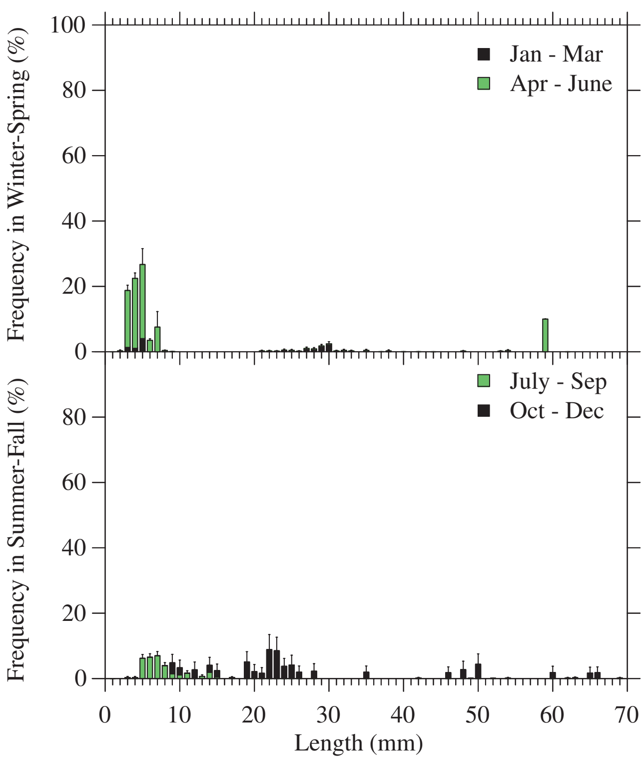

Adult Occurrence
Absent
Present

Life history *Diaphus theta* occur in the Bering Sea, along the Aleutian Islands, throughout the Gulf of Alaska, and south to central California. Generally bathypelagic, California headlightfish undergo diel vertical migrations and have been collected nearshore along the Canadian and Alaskan coasts. Like other members of the family Myctophidae, adults have diagnostic, species-specific photophore patterns. Adults reach full size at 11.4 cm TL. Spawning occurs throughout the year off California, with highest abundances of larvae in spring–summer. Larvae hatch at <3.0 mm SL from pelagic eggs and become pelagic juveniles at 11–14 mm SL. [Sources include: Hart (1973), Willis et al. (1988), Matarese et al. (1989), Moser and Ahlstrom (1996b)]

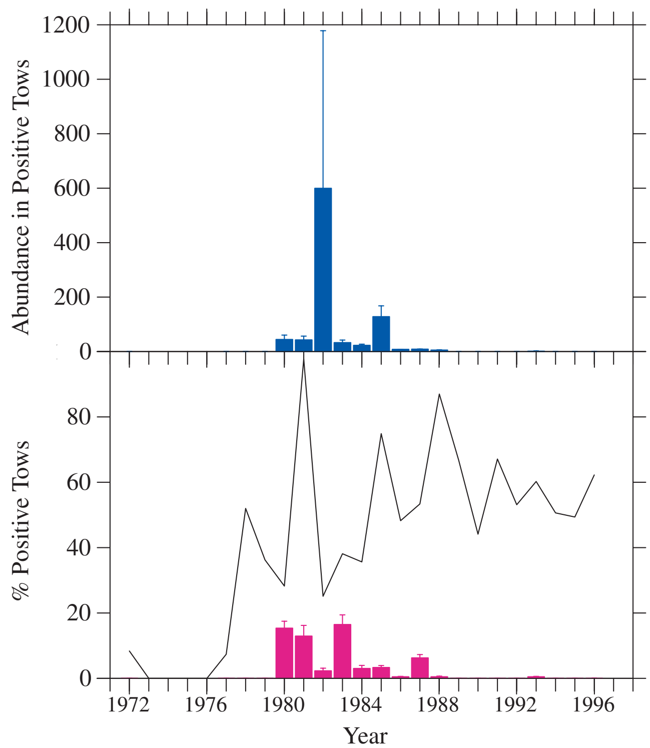
Larval distribution California headlightfish larvae are found in the Bering Sea near the Aleutian Islands, northern Gulf of Alaska, and along the U.S. west coast. Rarely encountered in the Bering Sea and Gulf of Alaska, highest concentrations of larvae are found off Oregon and northern California. Larvae are collected during most months of the year with higher abundances in May. Larvae and juveniles (newly hatched to >50 mm SL) are taken throughout the year, but greater numbers of newly hatched larvae appear in winter–spring. Overall, catches were high in the 1980s when AFSC conducted U.S. west coast surveys.



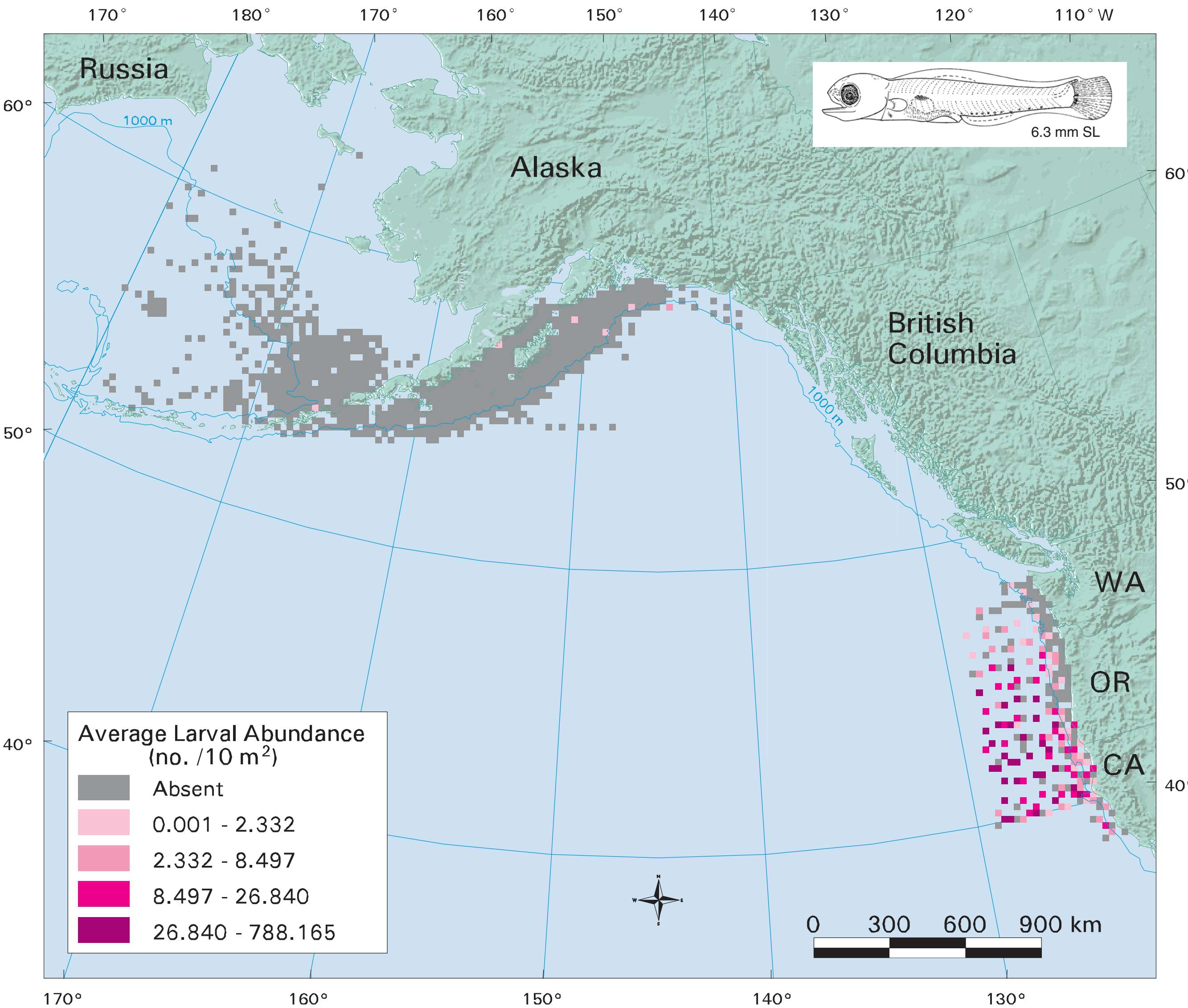
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

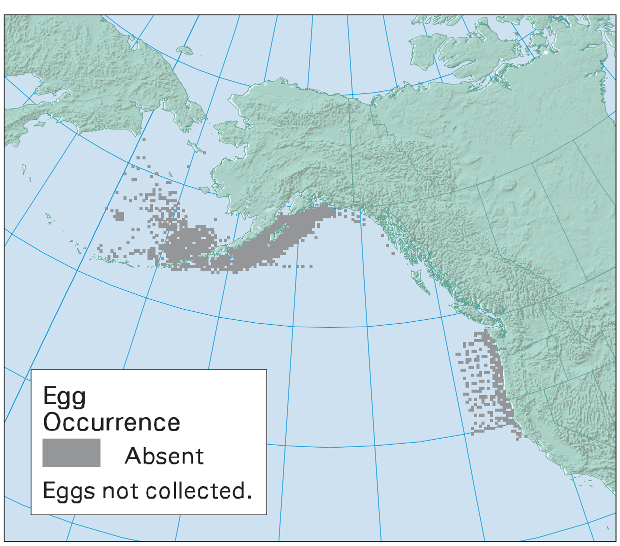


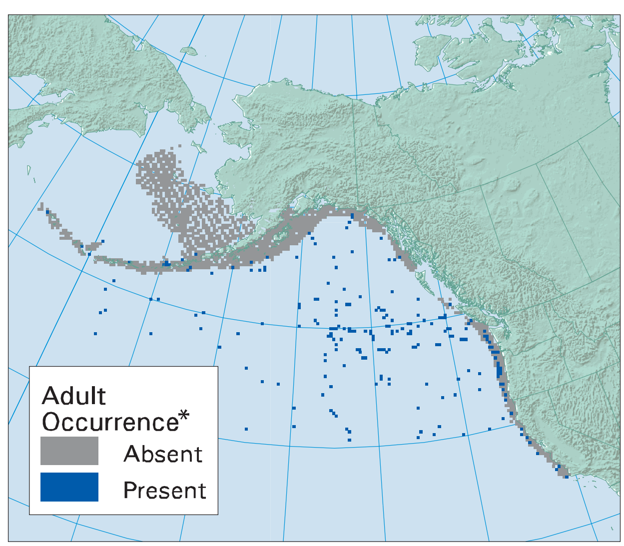
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 1580 for winter–spring (Jan–June), 133 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

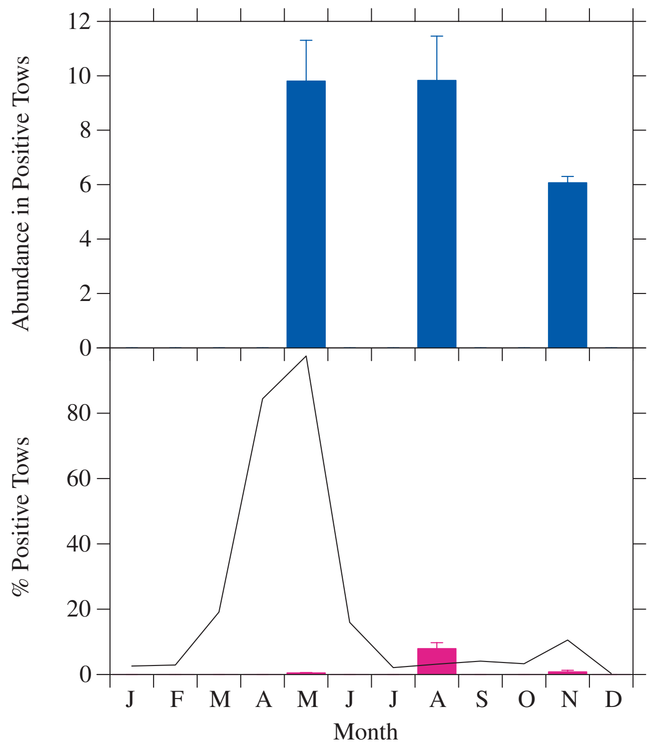

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
6.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 2.332
2.332 - 8.497
8.497 - 26.840
26.840 - 788.165
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

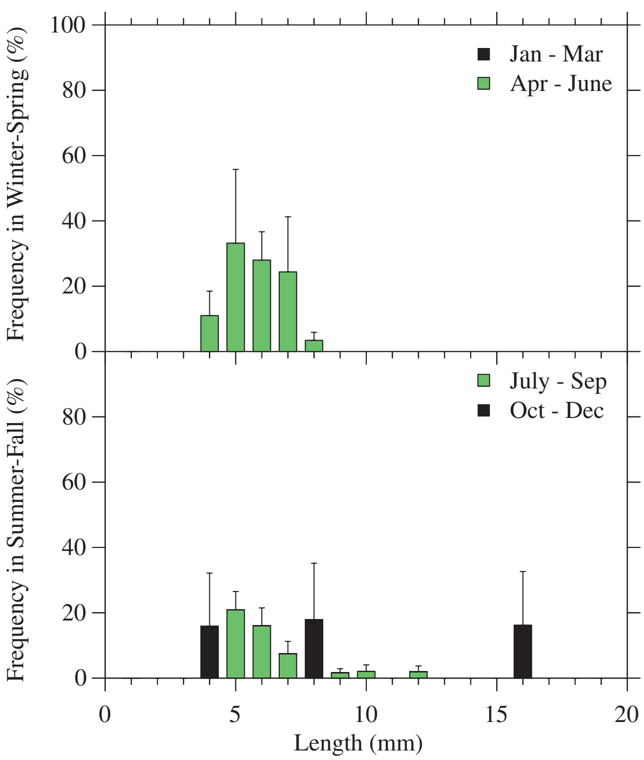

Adult Occurrence*
Absent
Present

Life history *Lampanyctus regalis* range from the Bering Sea near the Aleutian Islands, eastward to the Gulf of Alaska, and south to Baja California. Pinpoint lampfish undergo diel vertical migrations and have been taken in nets as shallow as 46 m, but are generally distributed in deeper layers to 1630 m. Among the largest of the myctophids found in our area, adults can reach a length of 19 cm TL. Like other members of the family Myctophidae, adults have diagnostic, species-specific photophore patterns. Eggs are probably pelagic; larvae hatch at <3.2 mm SL and transform at about 20 mm SL. Larvae occur throughout the year in the CalCOFI area; highest abundances are in spring–summer, with a peak in July. [Sources include: Hart (1973), Willis et al. (1988), Moser and Ahlstrom (1996b)]

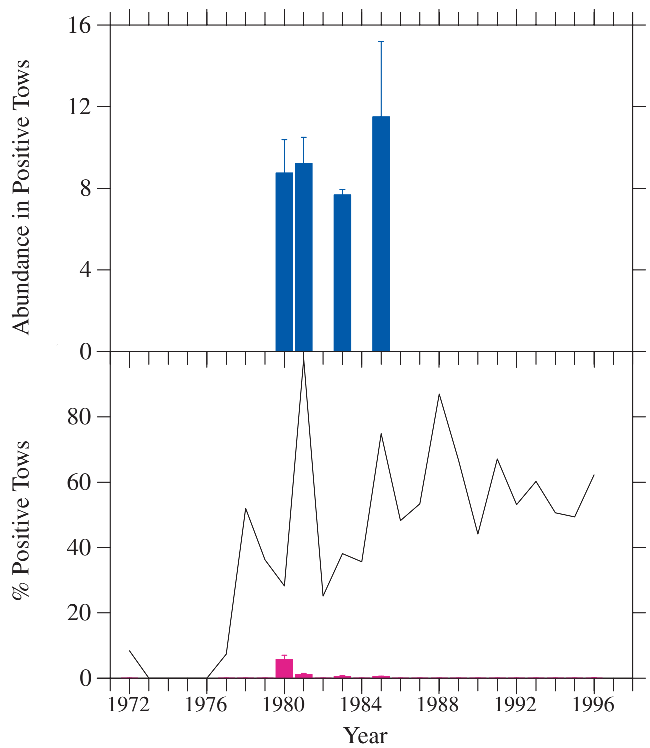
Larval distribution Pinpoint lampfish larvae are found throughout the AFSC U.S. west coast survey area. Although adults are present in the Gulf of Alaska, larvae have not been collected there. More abundant offshore in deeper waters, larvae appear in collections during May, August, and November, with a slightly higher frequency in August. Only small larvae (< 10 mm SL) appear in winter–spring; larvae 4–16 mm SL appear in summer–fall. Overall, larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



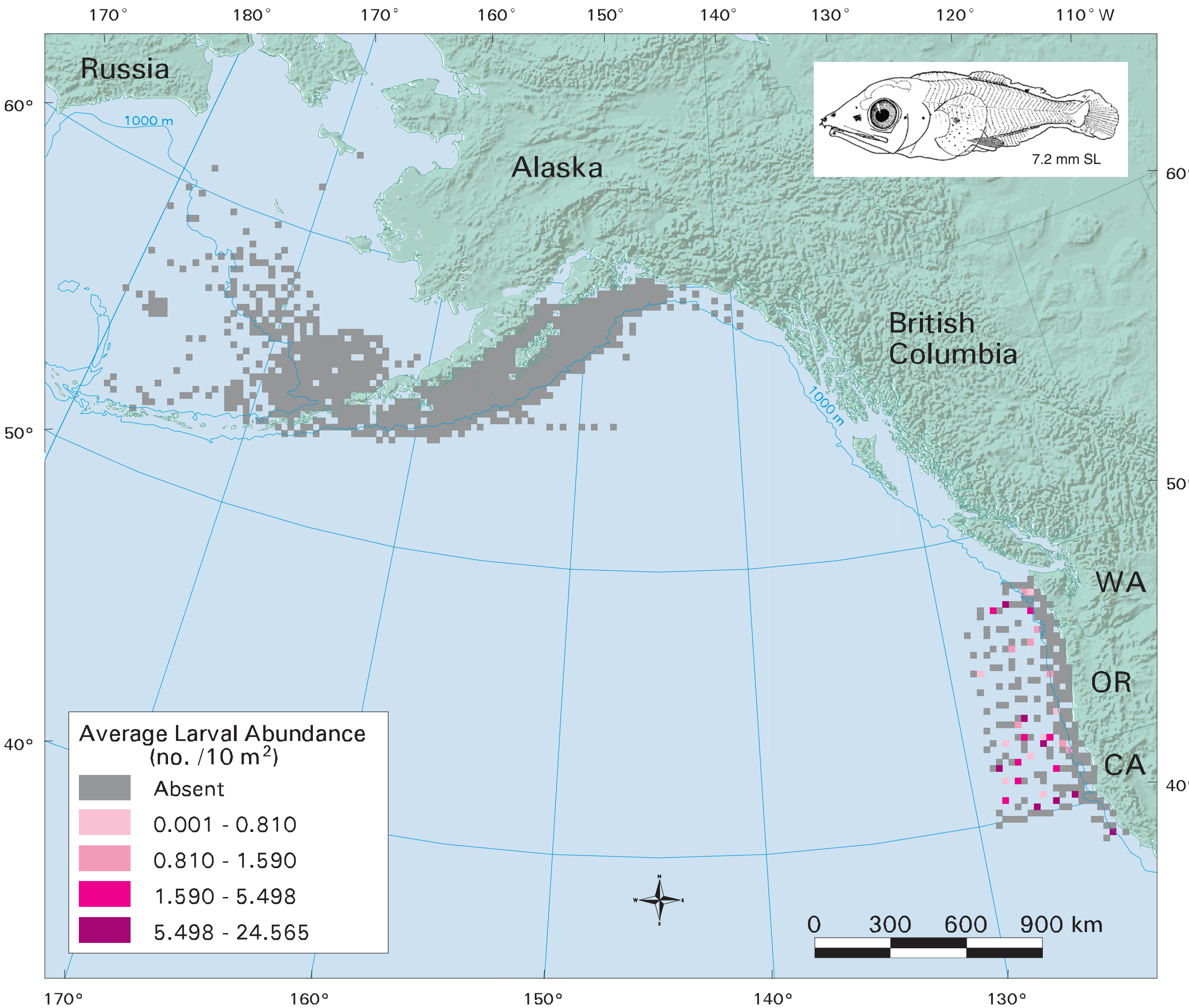
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

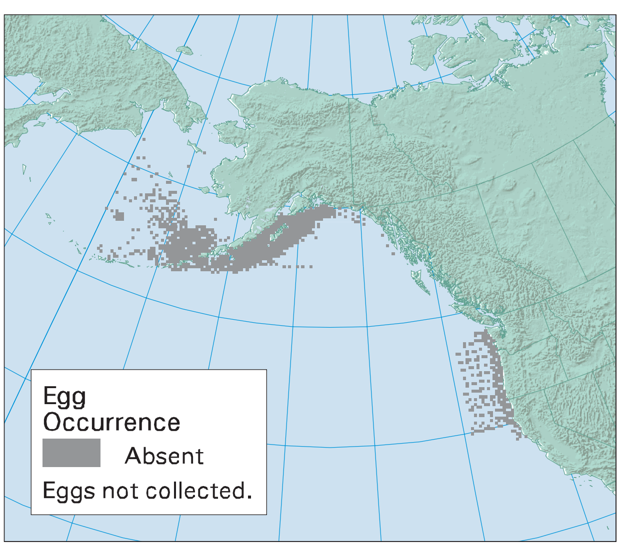


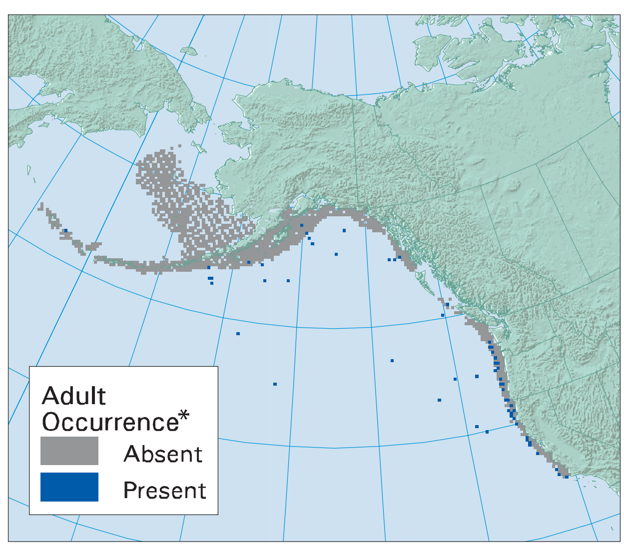
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 23 for winter–spring (Jan–June), 34 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

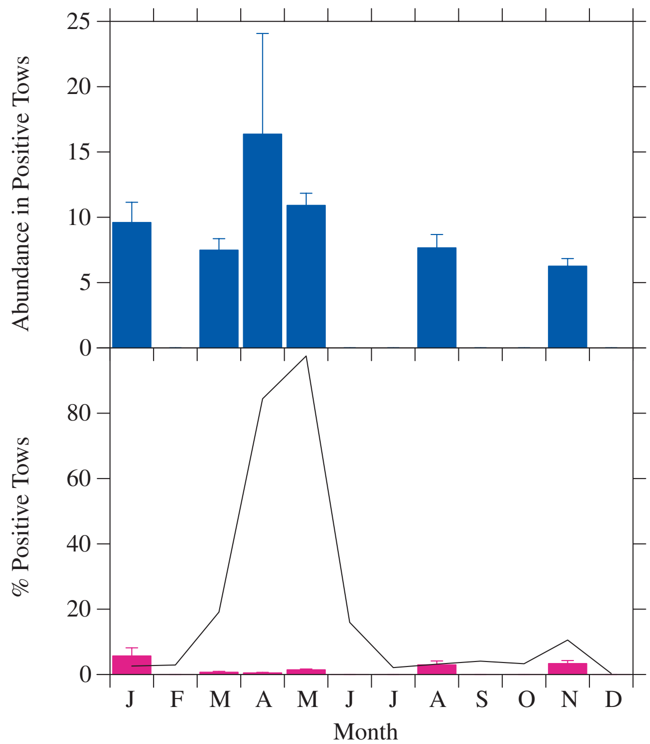

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
7.2 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.810
0.810 - 1.590
1.590 - 5.498
5.498 - 24.565
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

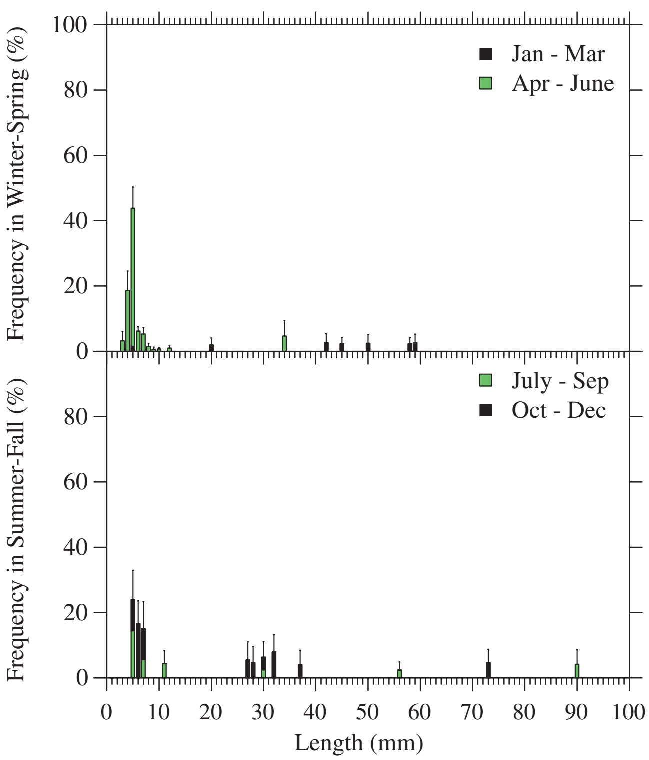

Adult Occurrence*
Absent
Present

Life history *Lampanyctus ritteri* occur in the Bering Sea, along the Aleutian Island chain, and northern Gulf of Alaska to Baja California. Broadfin lampfish are generally mesopelagic, but have been found at depths of 20–1098 m. Among the largest of the myctophids found in our area, adults can reach a length of 19 cm TL. Like other members of the family Myctophidae, adults have diagnostic, species-specific photophore patterns. Eggs are probably pelagic; larvae hatch at <3 mm SL and transform at 16–18 mm SL. Larvae occur throughout the year in the CalCOFI area; highest abundances are in winter–spring, with a peak in March.
[Sources include: Hart (1973), Willis et al. (1988), Matarese et al. (1989), Moser and Ahlstrom (1996b)]

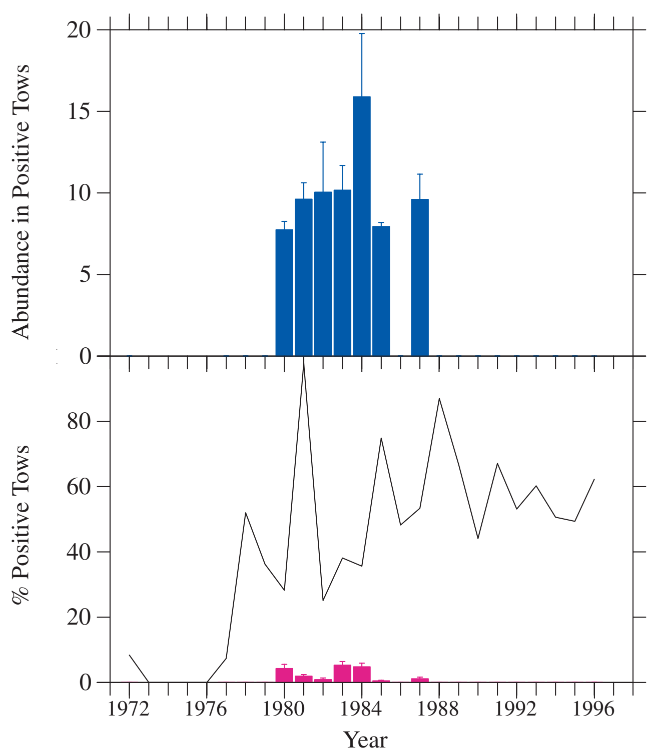
Larval distribution Broadfin lampfish larvae are found throughout the AFSC U.S. west coast survey area. Although adults are present in the Gulf of Alaska, larvae have not been collected. Larvae are most abundant in deeper slope and oceanic waters off southern Oregon and northern California. Larvae are found January–November, with highest abundances in winter–spring. Newly hatched larvae (<10 mm SL) are most abundant in winter–spring (3–59 mm SL). Larger larvae and juveniles appear in summer–fall collections (5–90 mm SL). Overall, larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



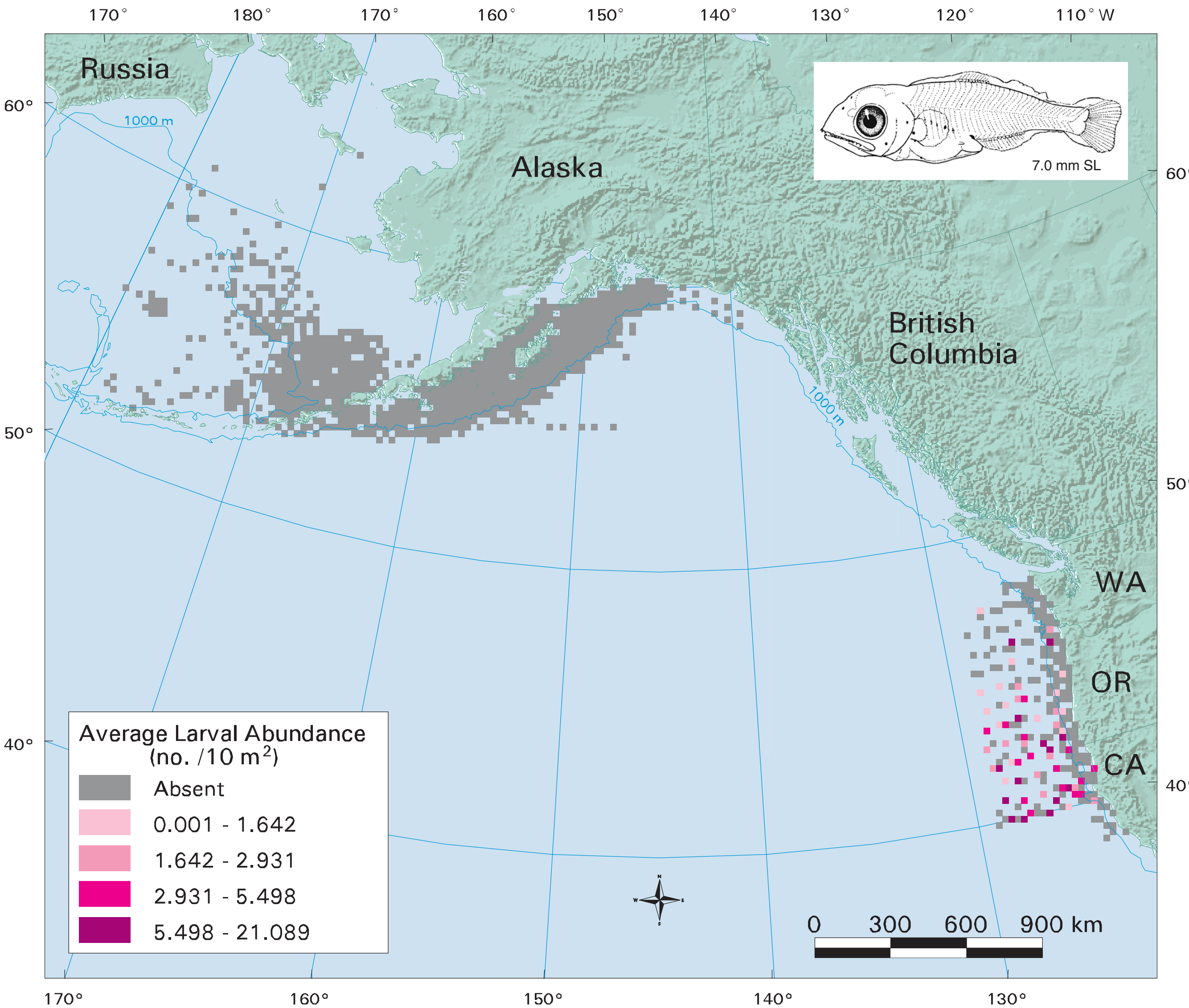
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



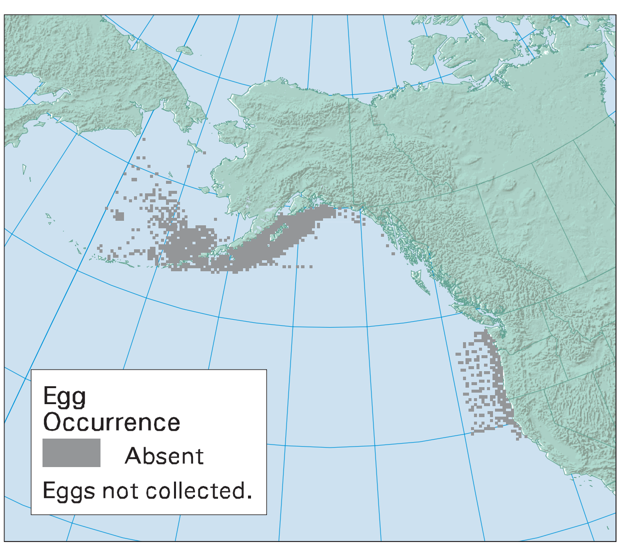
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 127 for winter–spring (Jan–June), 22 for summer–fall (July–Dec).



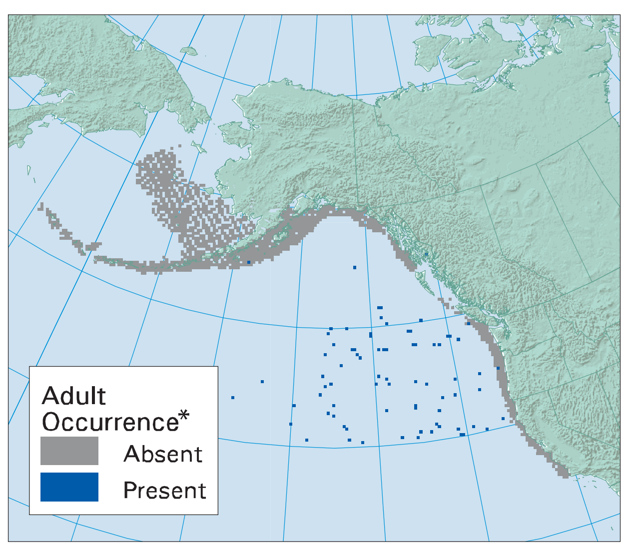
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
7.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.642
1.642 - 2.931
2.931 - 5.498
5.498 - 21.089
0 300 600 900 km



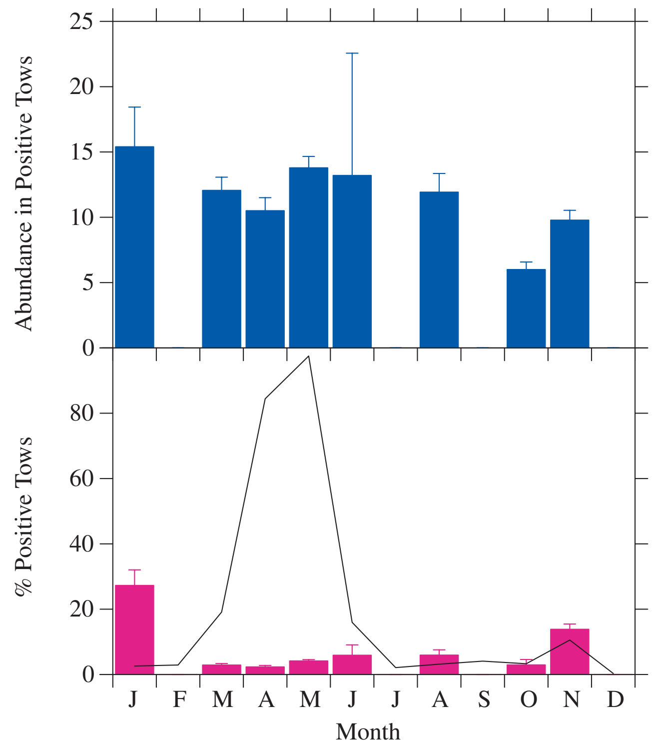
Egg Occurrence
Absent
Eggs not collected.



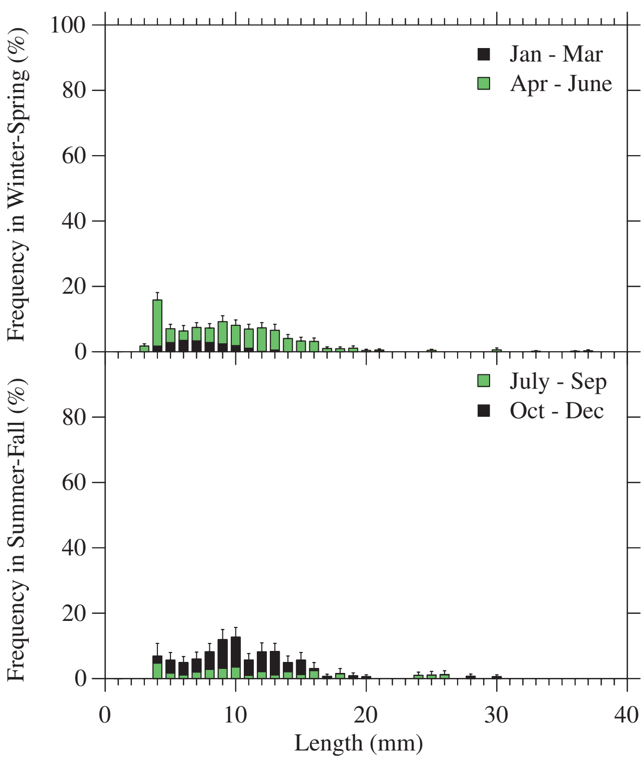
Adult Occurrence*
Absent
Present

Life history *Protomyctophum crockeri* are found from the subarctic Pacific Ocean to Baja California. Described as epi- and mesopelagic, California flashlightfish are commonly taken at night above 100 m, but not at the surface. They are the smallest myctophid in our study area; adults typically reach only 46 mm SL. Like other members of the family Myctophidae, adults have diagnostic, species-specific photophore patterns. Pelagic larvae hatch at <3.8 mm SL and transform at 15.2–17.6 mm SL. Larvae are present in the CalCOFI area throughout the year, but are most abundant in the winter with a peak in December.
[Sources include: Wisner (1974), Willis et al. (1988), Matarese et al. (1989), Moser and Ahlstrom (1996b)]

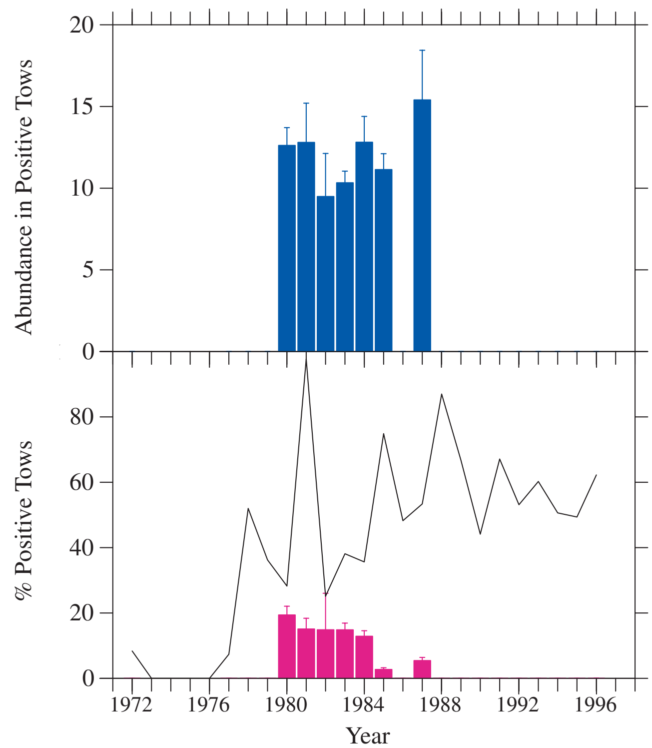
Larval distribution California flashlightfish larvae are distributed throughout the AFSC U.S. west coast survey area. Larvae are most abundant along the shelf edge and in slope and deeper waters. Larvae are found January–November, with abundances slightly higher in winter–spring. The length distribution of larvae collected in winter–spring (3–37 mm SL) is similar to that of larvae collected in summer–fall (4–30 mm SL). Overall, larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



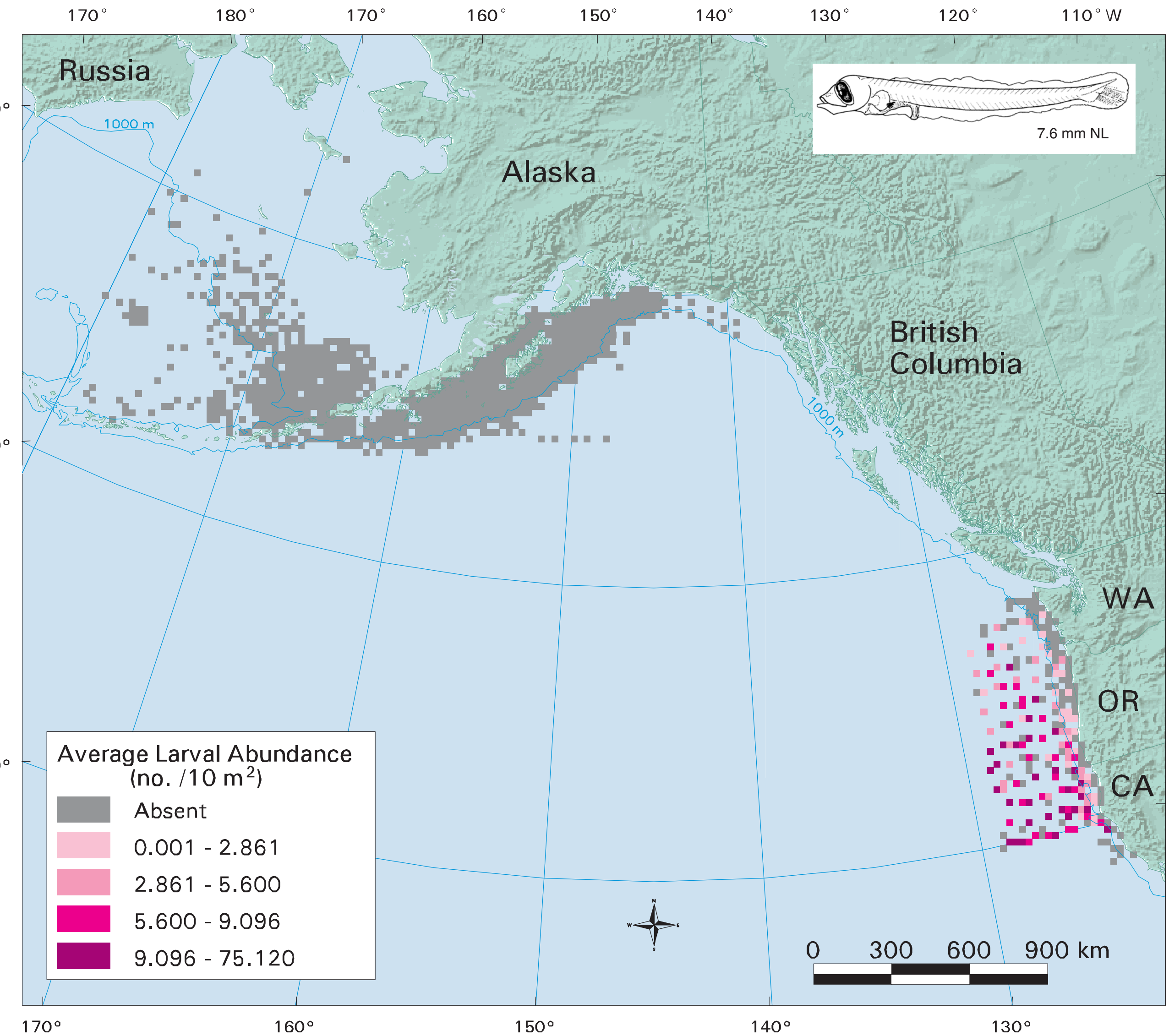
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

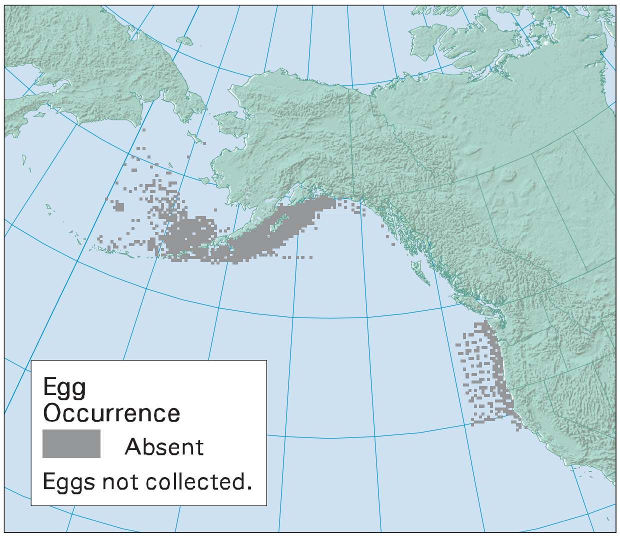


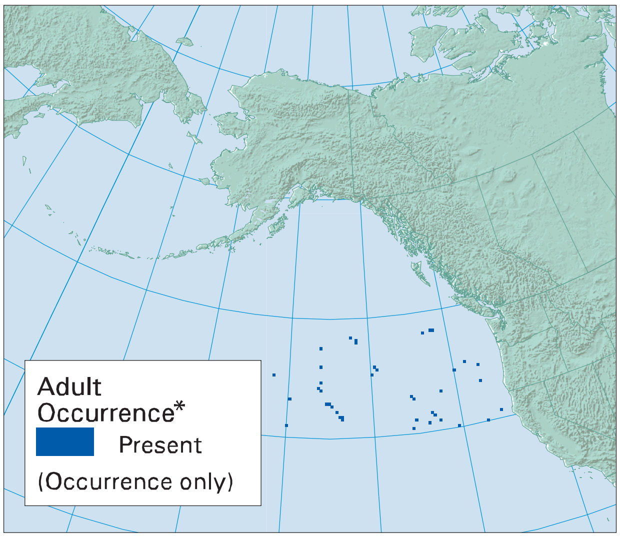
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 365 for winter–spring (Jan–June), 122 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

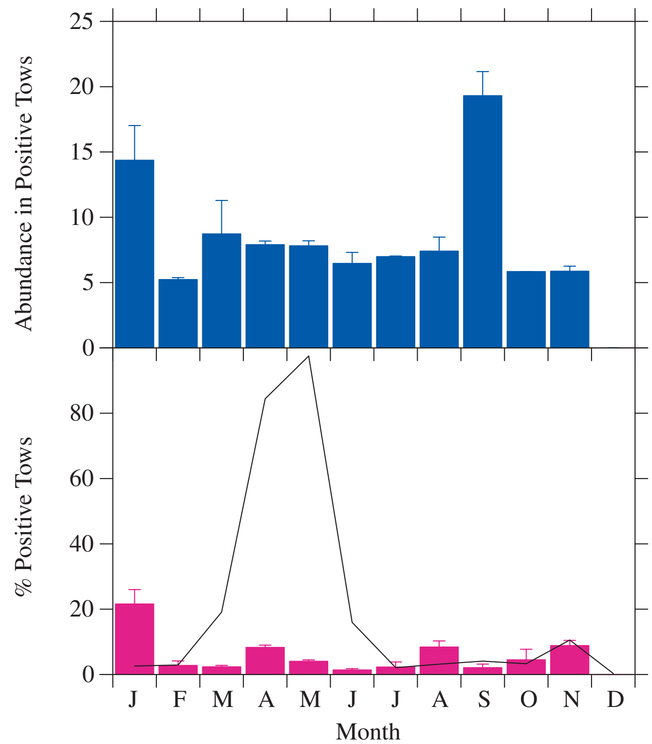

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
7.6 mm NL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 2.861
2.861 - 5.600
5.600 - 9.096
9.096 - 75.120
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

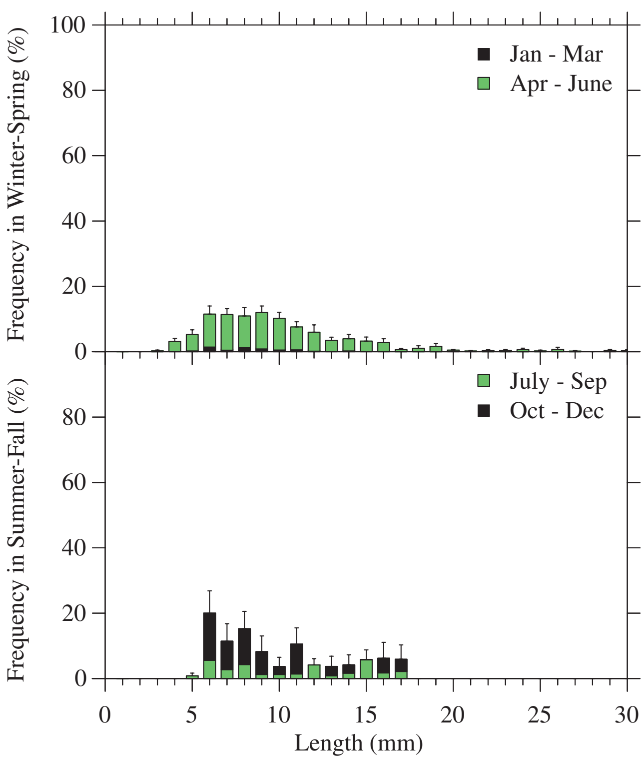

Adult Occurrence*
Present
(Occurrence only)

Life history *Protomyctophum thompsoni* range from the Bering Sea, throughout the Gulf of Alaska, and south to central California. Northern flashlightfish undergo diel vertical migrations and have been taken as shallow as 31 m, but are generally distributed in deeper layers to 1370 m. Among the smallest of the myctophids found in the area, adults reach a maximum size of 70 mm TL. Like other members of the family Myctophidae, adults have diagnostic, species-specific photophore patterns. Larvae hatch at <2.8 mm SL from pelagic eggs and transform into pelagic juveniles at 17–18 mm SL. Larvae are most abundant off the northern California coast in winter, but have also been collected in October and May.
[Sources include: Hart (1973), Willis et al. (1988), Matarese et al. (1989), Moser and Ahlstrom (1996b)]

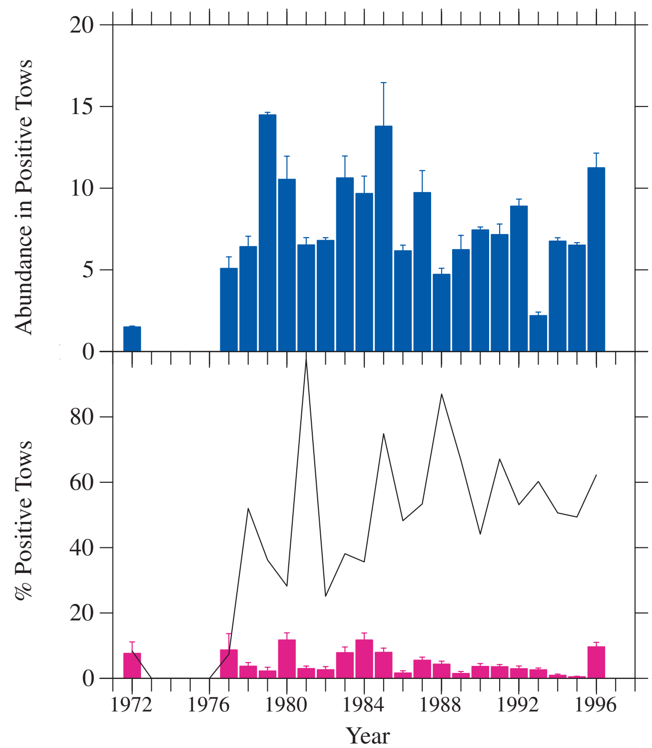
Larval distribution Northern flashlightfish larvae are collected from the southern Bering Sea, into the western Gulf of Alaska around Kodiak Island and throughout the Shelikof sea valley, and along the U.S. west coast. Throughout their range larvae are most abundant over the shelf edge and in deeper slope waters. They are collected January–November. In winter–spring a wide size range of larvae occur (3–30 mm SL), whereas in summer–fall collections only larvae <20 mm SL (5–17 mm SL) occur. Although they generally occur in fewer than 20% of the tows, overall catch by year indicates that larvae were routinely collected in most years throughout the time series.



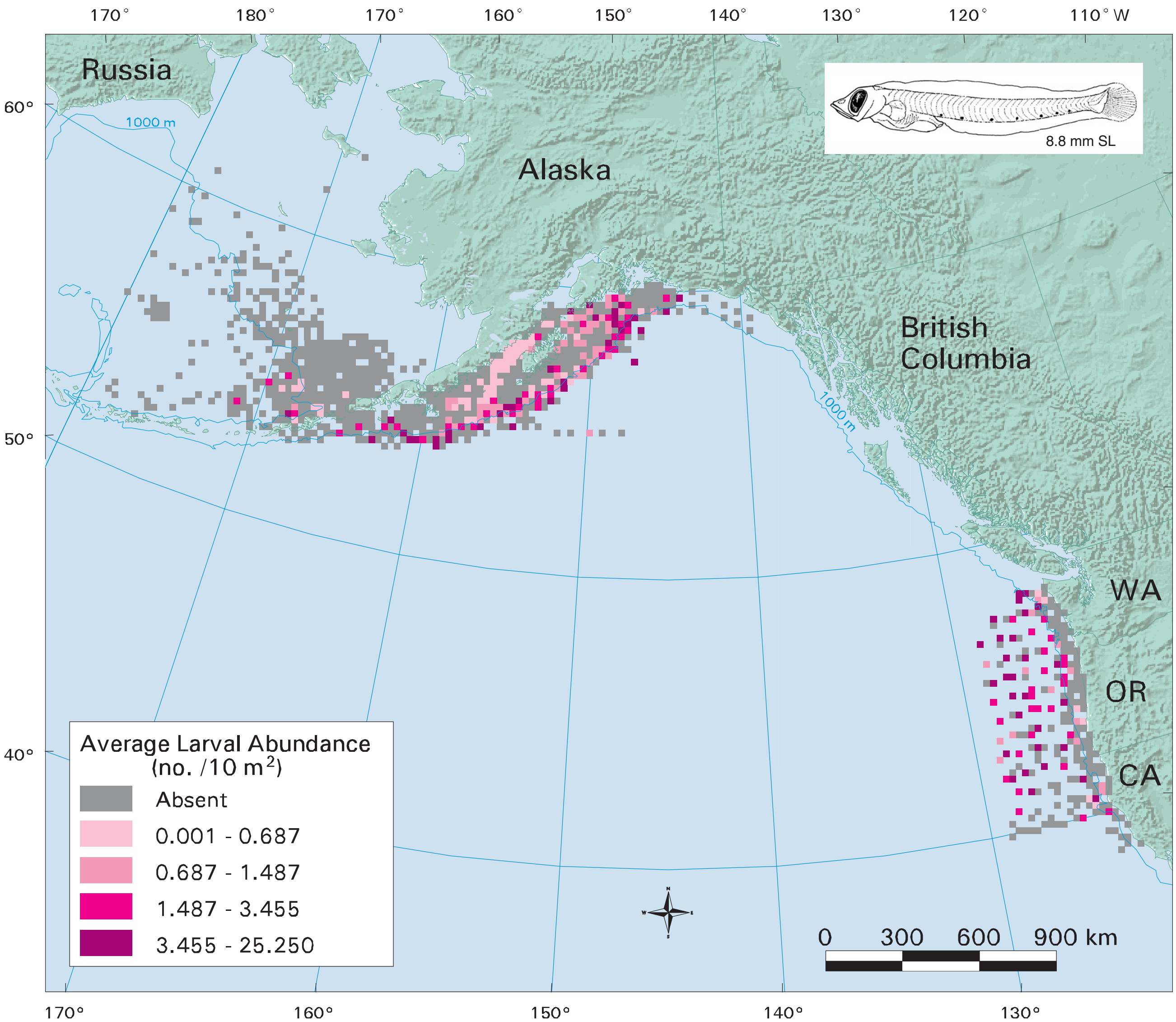
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



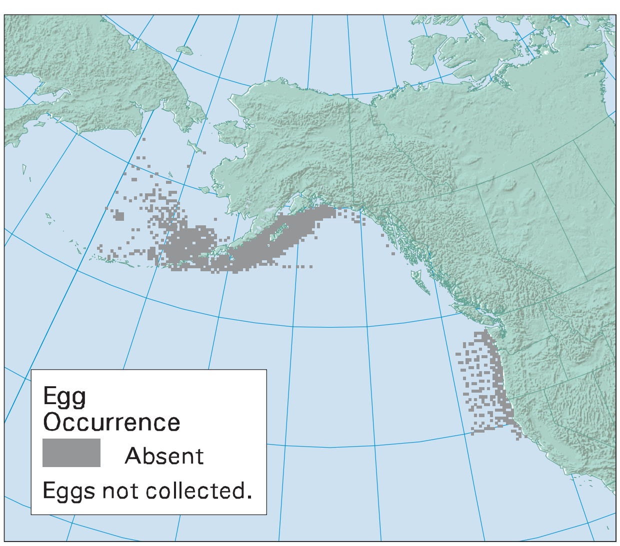
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 497 for winter–spring (Jan–June), 46 for summer–fall (July–Dec).



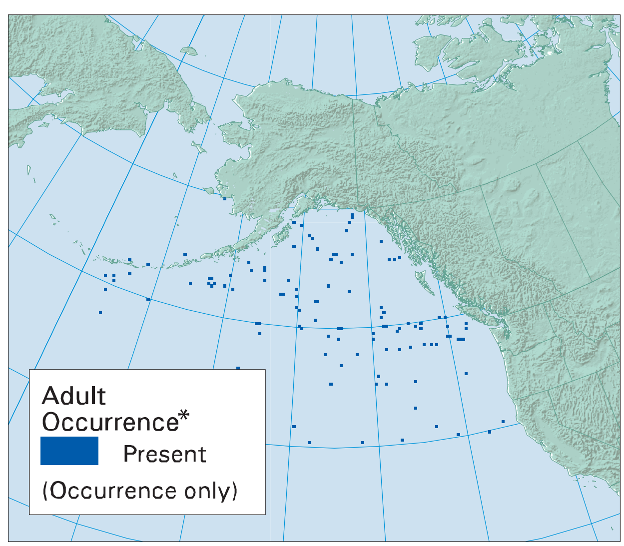
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
8.8 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.687
0.687 - 1.487
1.487 - 3.455
3.455 - 25.250
0 300 600 900 km
170° 160° 150° 140° 130°



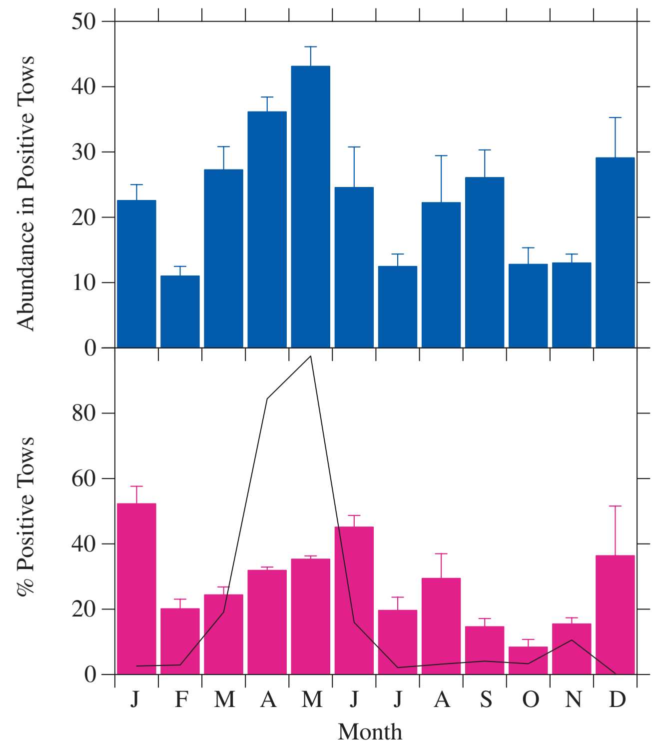
Egg Occurrence
Absent
Eggs not collected.



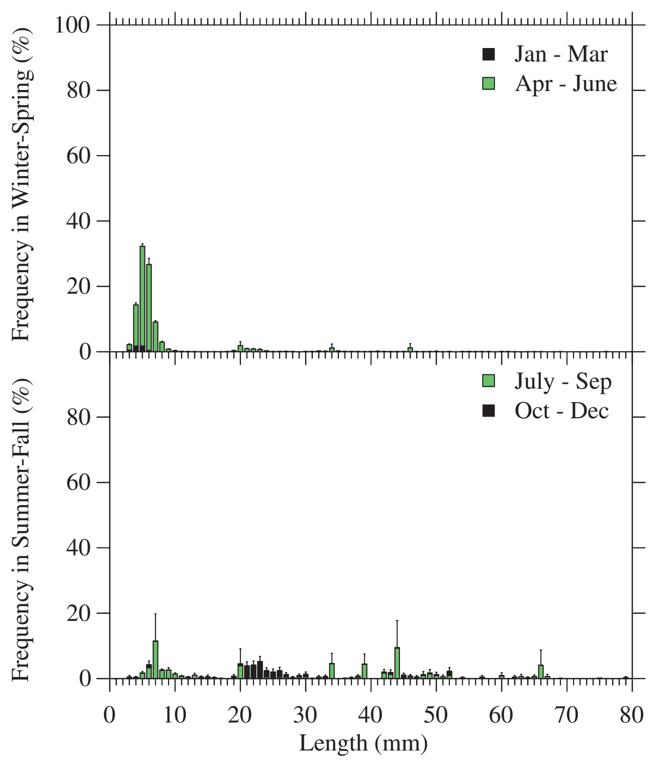
Adult Occurrence*
Present
(Occurrence only)

Life history *Stenobrachius leucopsarus* are abundant and widely distributed from the Bering Sea and along the Aleutian Islands to the California–Mexico border. Although diel vertical migration brings them near the surface at night in some areas, northern lampfish are bathypelagic and have been collected at depths greater than 2900 m. Fish mature at about 4 years of age and may live up to 8 years. Like other members of the family Myctophidae, adults have diagnostic, species-specific photophore patterns. Spawning occurs mainly in the winter in northern areas. Larvae hatch from pelagic eggs at about 2 mm SL and become pelagic juveniles at about 16–19 mm SL. They are the most abundant and ubiquitous species in the AFSC U.S. west coast survey area. In the CalCOFI area, larvae are present throughout the year off California, with the highest abundance in winter–spring. [Sources include: Hart (1973), Willis et al. (1988), Doyle et al. (1993), Moser and Ahlstrom (1996b)]

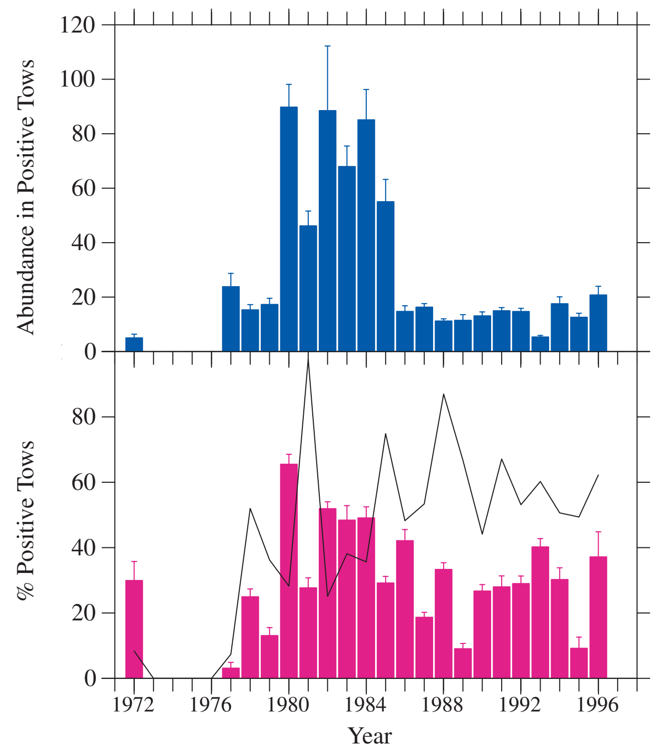
Larval distribution Northern lampfish larvae are collected throughout the AFSC survey area. Greatest numbers are found over deeper waters along the shelf edge in the Gulf of Alaska southwest and east of Kodiak Island, and offshore along the U.S. west coast. Larvae are collected throughout the year; highest abundances occur in winter and early spring. Small larvae (<10 mm SL) are more common in winter–spring (3–45 mm SL), whereas larger larvae and juveniles (3–79 mm SL) are found in summer–fall. Larvae were routinely collected throughout the time series, occurring in greater than 30% of the tows in most years. Overall catches were high in the early 1980s when AFSC conducted U.S. west coast surveys.



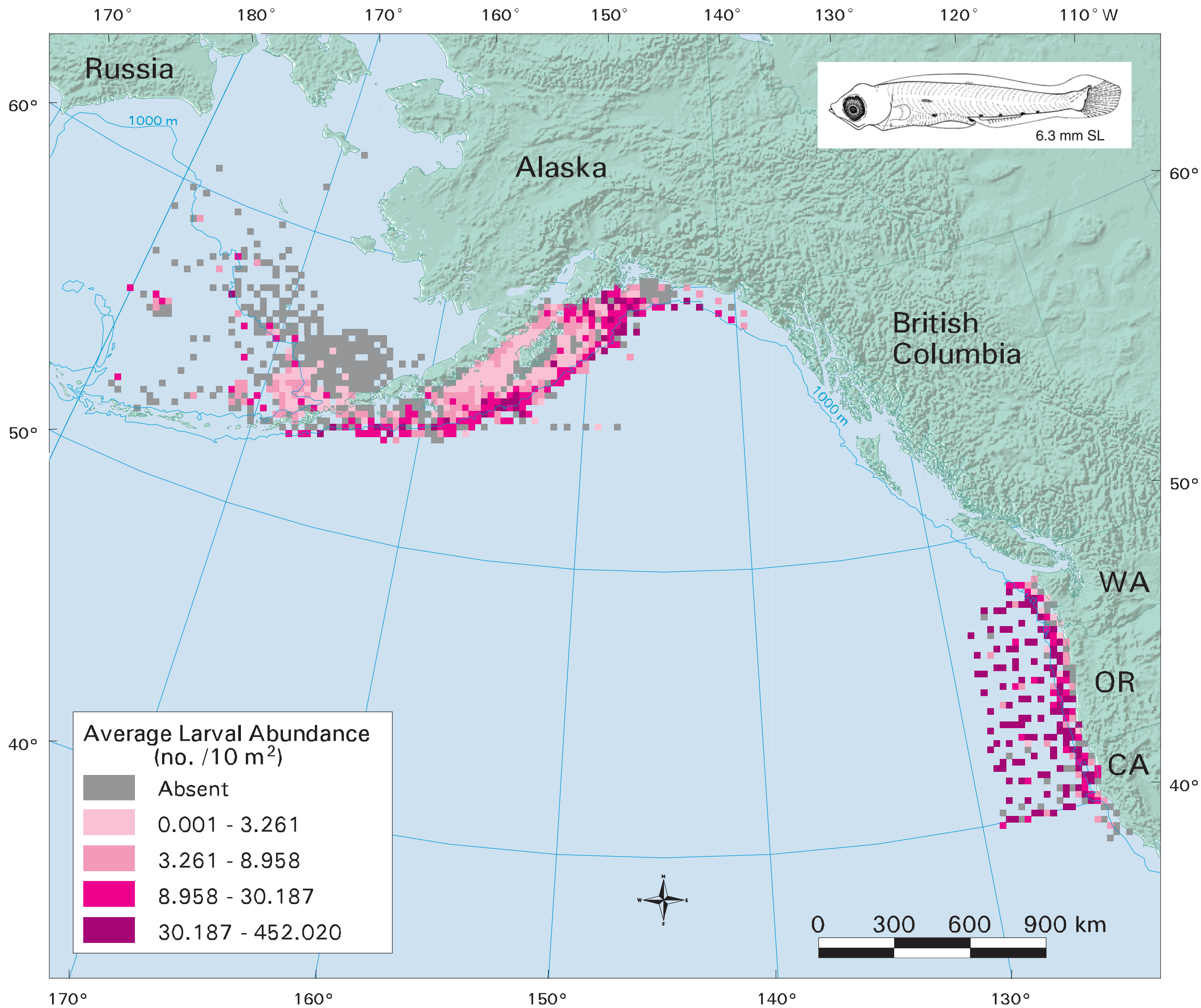
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



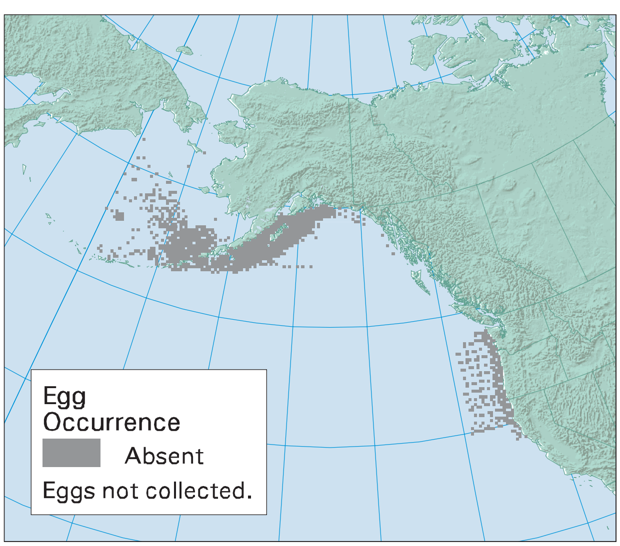
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 12,946 for winter–spring (Jan–June), 513 for summer–fall (July–Dec).



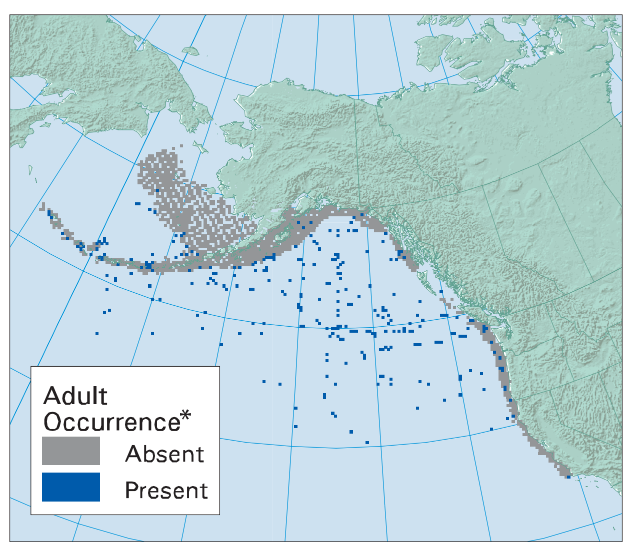
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
6.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 3.261
3.261 - 8.958
8.958 - 30.187
30.187 - 452.020
0 300 600 900 km
170°
160°
150°
140°
130°



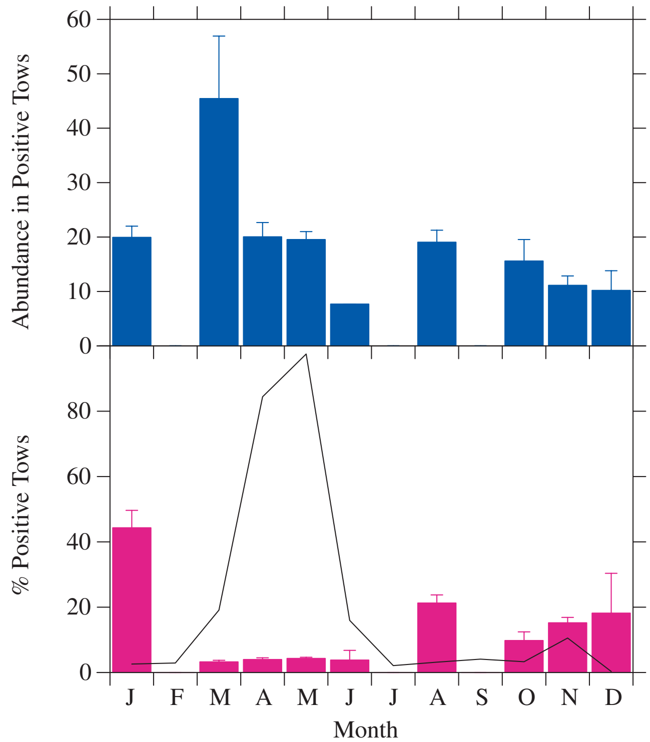
Egg Occurrence
Absent
Eggs not collected.



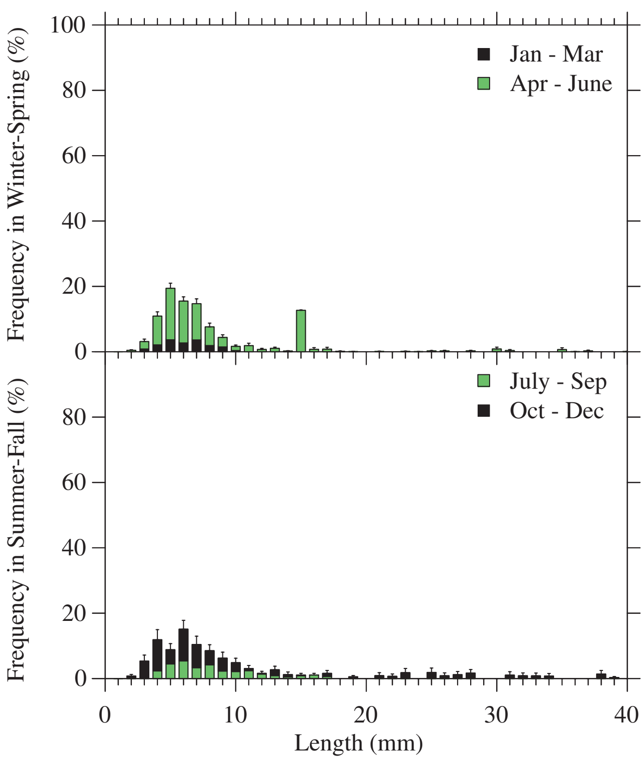
Adult Occurrence*
Absent
Present

Life history *Tarletonbeania crenularis* can be found from the Bering Sea to Baja California. Adults are bathypelagic and have been collected as deep as 800 m, but they undergo diel vertical migration and are commonly encountered at night at the surface. Blue lanternfish reach a maximum size of 12.7 cm TL. Like other members of the family Myctophidae, adults have diagnostic, species-specific photophore patterns. Larvae hatch from pelagic eggs at <3.0 mm SL; transformation takes place at 19.3–21.7 mm SL. Although present off the central and northern California coasts throughout the year, pelagic larvae are most abundant January–March. Larvae and young juveniles (>20 mm SL) undergo nocturnal migrations to the surface and they are abundant in neuston collections of AFSC U.S. west coast surveys.
[Sources include: Hart (1973), Matarese et al. (1989), Doyle (1992), Moser and Ahlstrom (1996b), Doyle[2]]

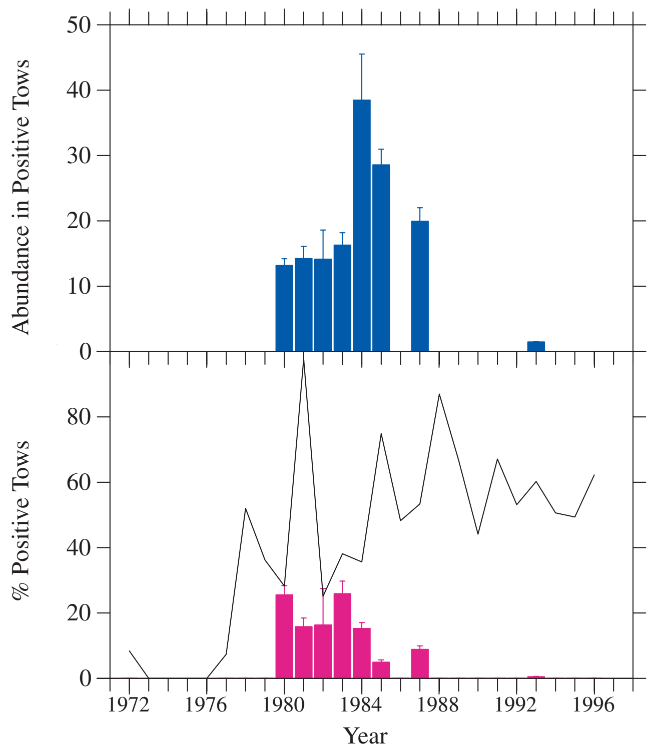
Larval distribution Blue lanternfish larvae are found in the Gulf of Alaska and along the U.S. west coast throughout the AFSC survey area. Larvae occur in highest abundances in deeper waters off the continental shelf along the U.S. west coast. Although adults have not been collected north of Washington during AFSC surveys, larvae are occasionally encountered in the Gulf of Alaska. Larvae occur throughout most months of the year, with more positive tows in fall–winter. Small larvae (<10 mm SL) are collected in higher abundances than larger larvae, but newly hatched larvae through juveniles (2–39 mm SL) are present throughout the year. Overall catch by year indicates larvae were present in more tows from the 1980s when AFSC conducted U. S. west coast surveys.



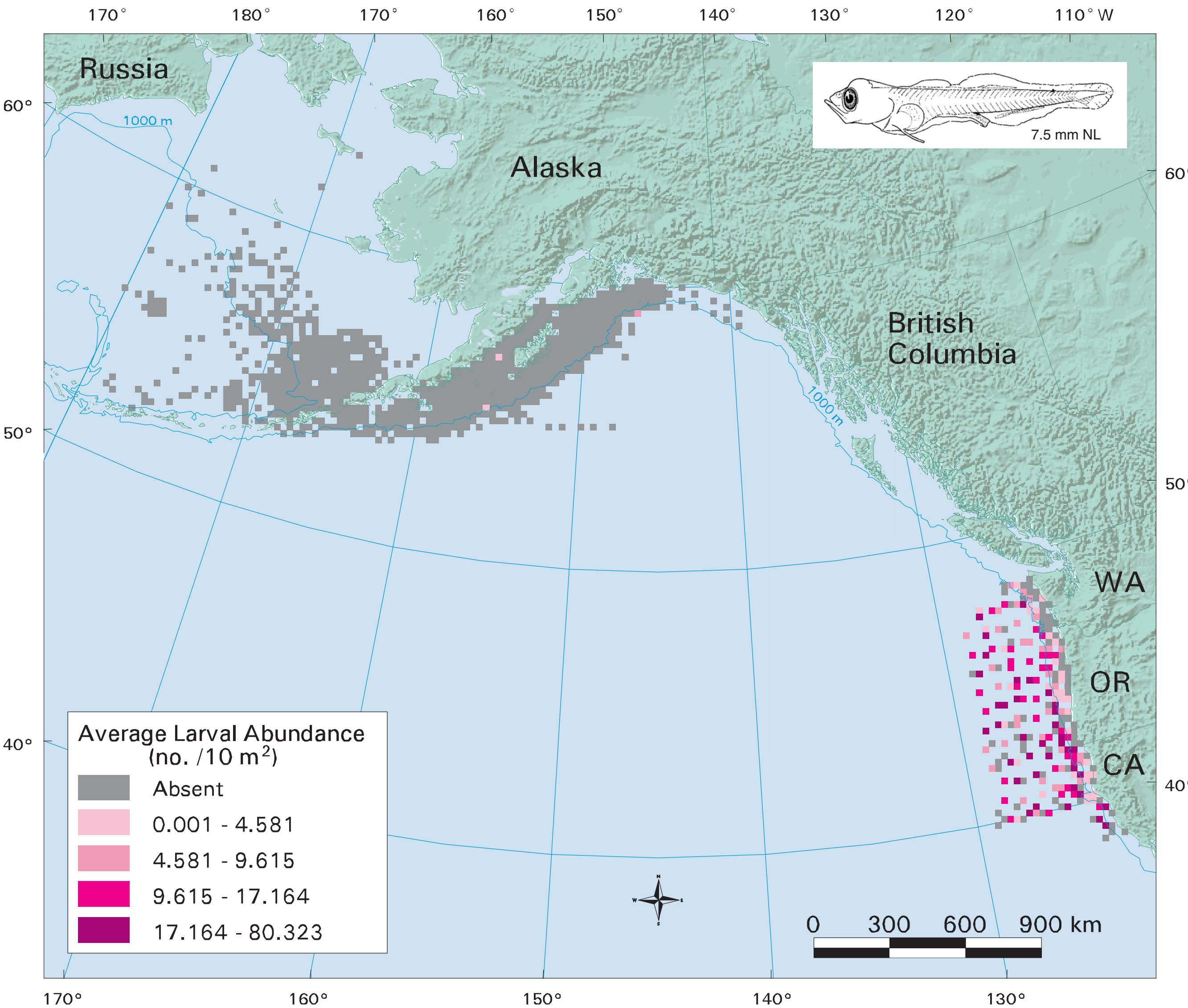
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

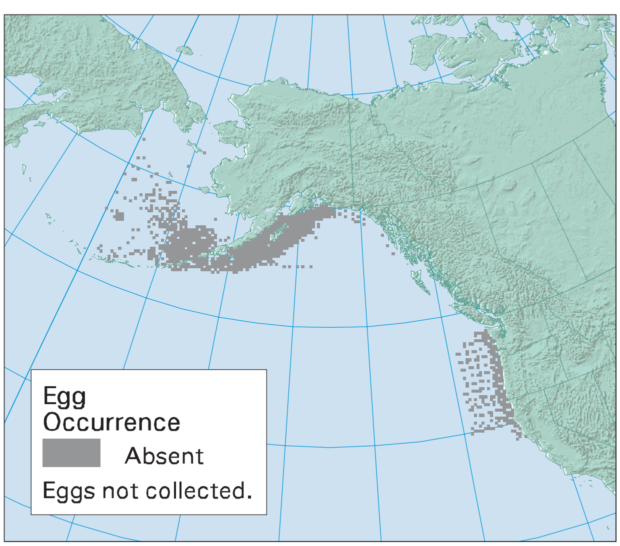


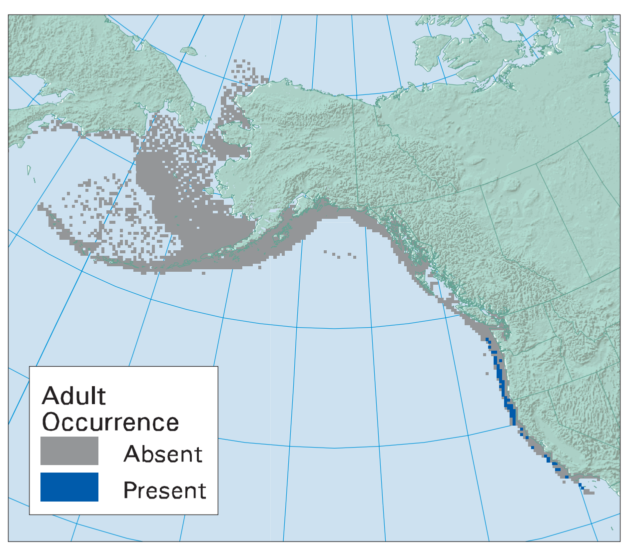
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 906 for winter–spring (Jan–June), 295 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

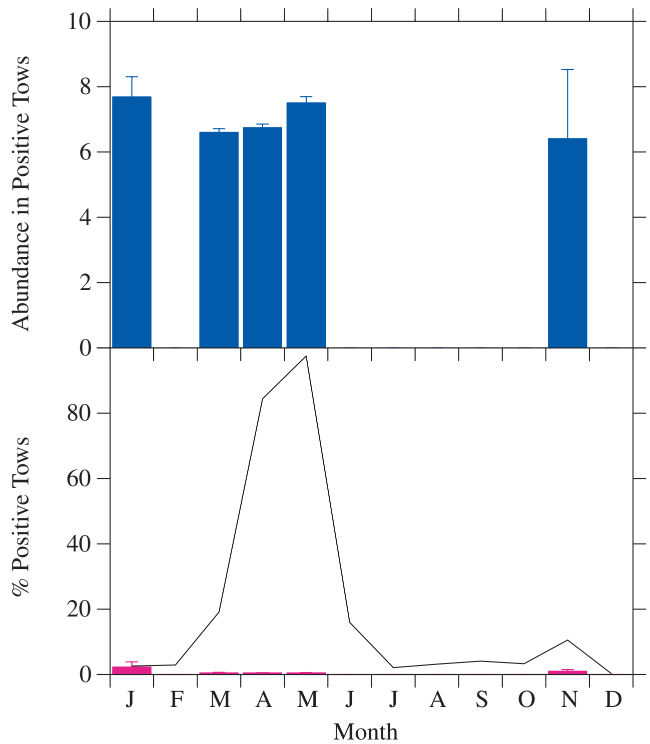

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
7.5 mm NL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 4.581
4.581 - 9.615
9.615 - 17.164
17.164 - 80.323
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

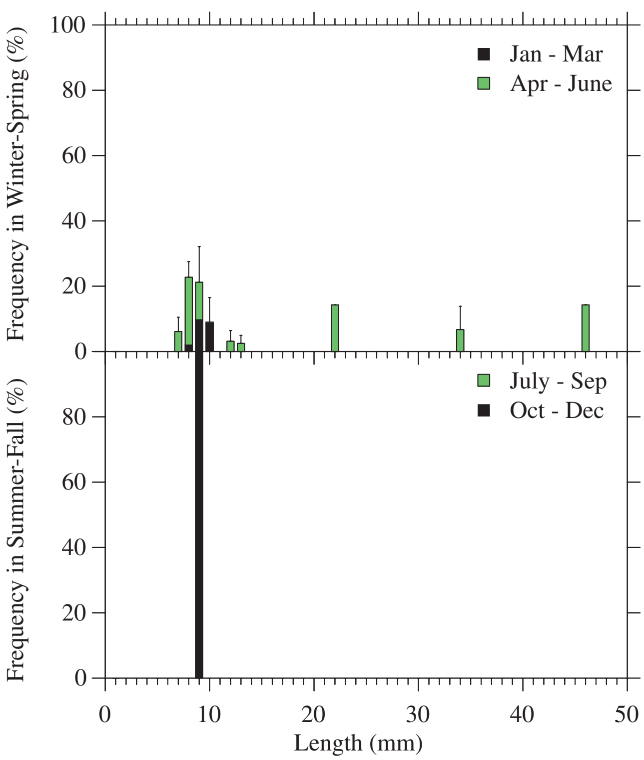

Adult Occurrence
Absent
Present

Life history *Trachipterus altivelis* are widely distributed in the Pacific Ocean from Alaska to Chile. Adult king-of-the-salmon are primarily oceanic fishes found from the surface to depths of 900 m. Eggs and larvae are pelagic. Eggs are large (2.8–3.1 mm) and are noted for the precocious dorsal and pelvic fin ray development of the embryo in the late-stage egg. Larvae hatch at 7.2–7.4 mm SL and undergo notochord flexion by 16.2 mm SL. Transformation to the juvenile stage is protracted and gradual, occurring at sizes >54.7 mm SL. In the CalCOFI study area, spawning probably takes place year-round as larvae are collected throughout the year.
[Sources include: Matarese et al. (1989), Charter and Moser (1996a)]

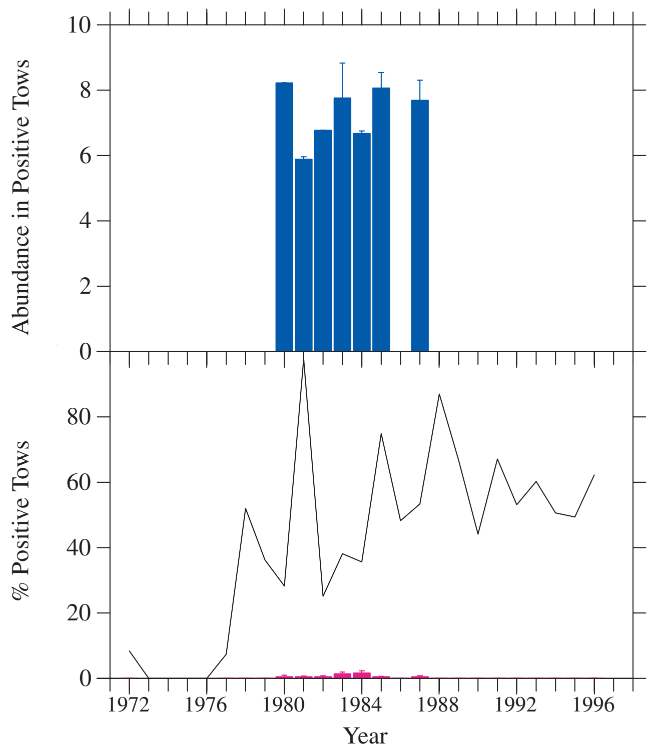
Larval distribution King-of-the-salmon larvae are collected off the U.S. west coast off Oregon and California. Larvae are most abundant along the outer shelf edge and in deeper oceanic water. They occur intermittently January–November, with higher abundance in early spring. Larvae from winter–spring are mostly small (<13 mm SL), but range in size from 8–46 mm SL. Only two small larvae (9 mm SL) were collected in summer–fall. Eggs are very abundant throughout the AFSC U.S. west coast survey area. Although larvae have not been collected in the Gulf of Alaska, eggs are found along the outer shelf edge south and west of Kodiak Island. Larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



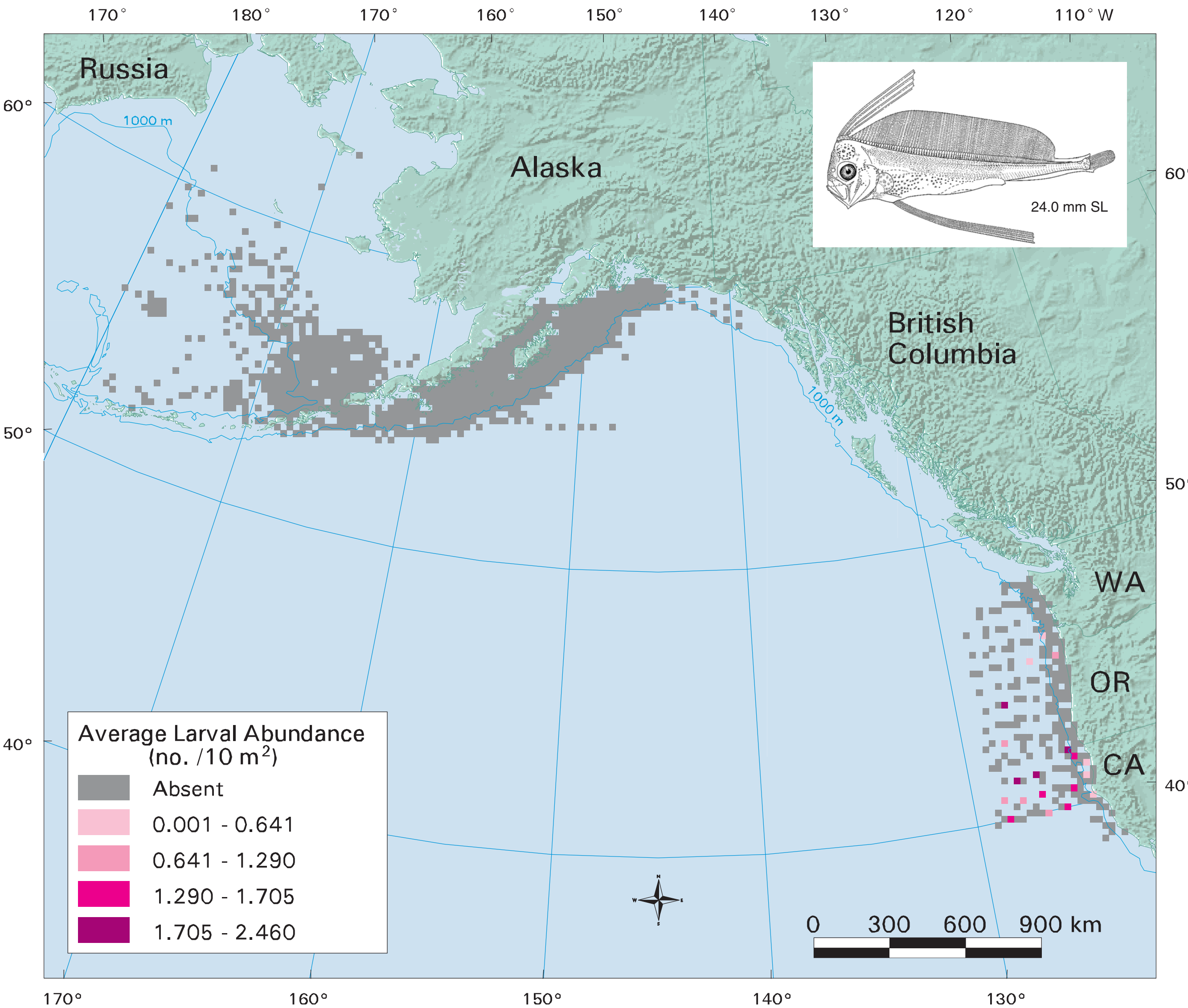
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

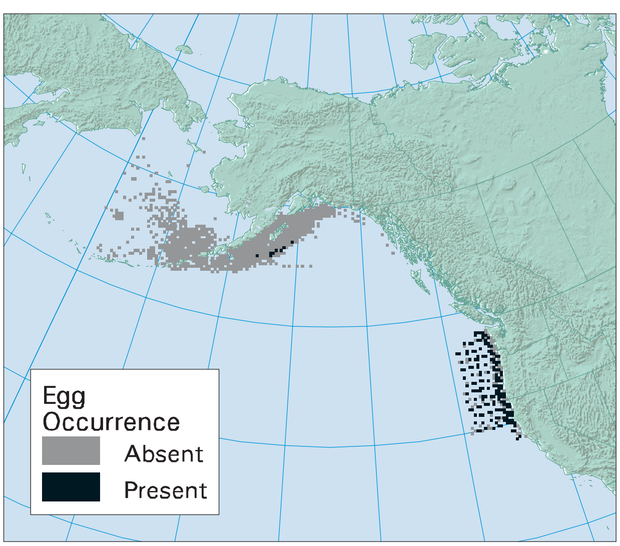


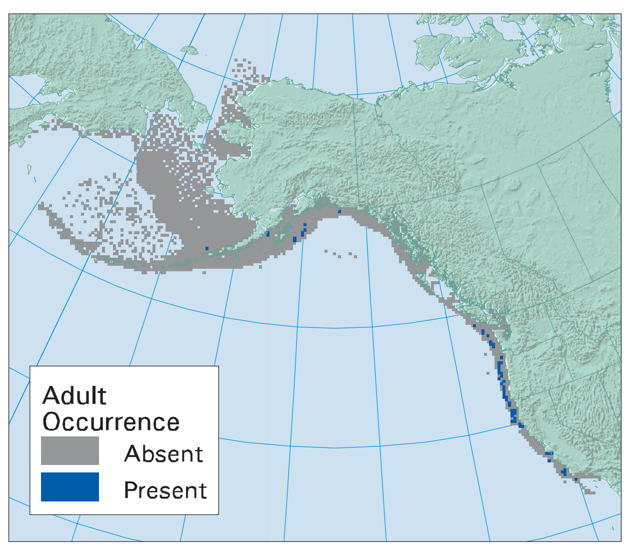
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 17 for winter–spring (Jan–June), 2 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

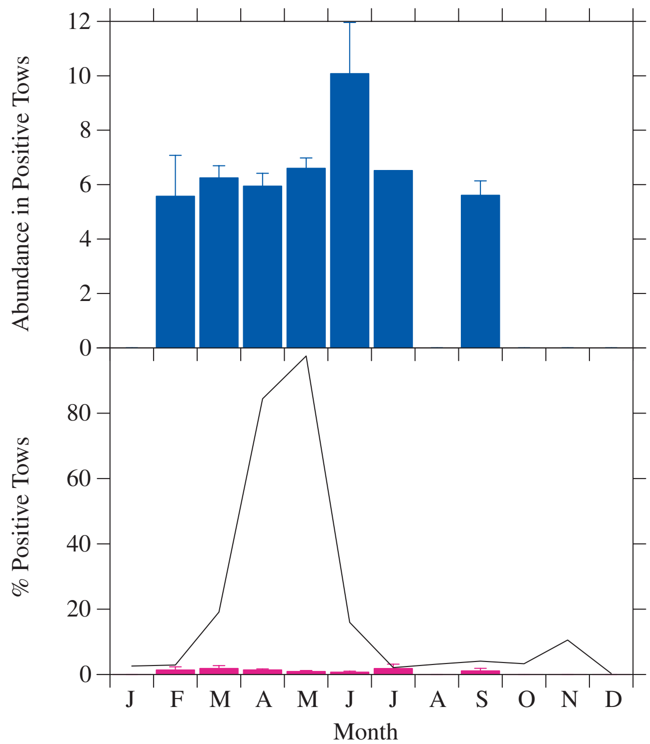

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
24.0 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 0.641
0.641 - 1.290
1.290 - 1.705
1.705 - 2.460
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

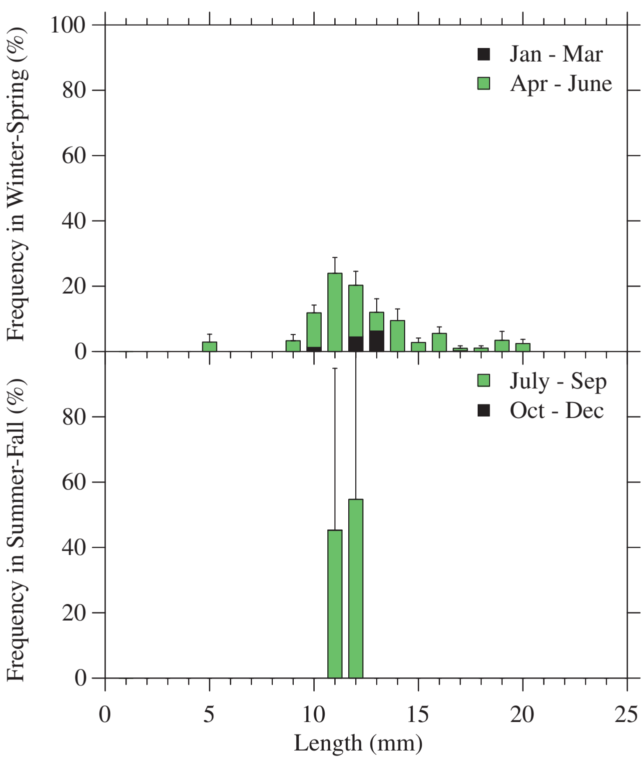

Adult Occurrence
Absent
Present

Life history At least 10 species within 3 genera of macrourids occur in the Bering Sea and North Pacific (see species list, Appendix Table 2). Grenadiers are benthopelagic, inhabiting slope waters >300 m. Adults (30–150 cm TL) have large heads, short trunks, and a long tail tapering to a fine point. Data on reproduction are limited; eggs are probably released near the bottom and develop as they drift toward the surface. Eggs are usually <2 mm in diameter with a single oil globule and distinctive hexagonal sculpturing on the chorion. Hatching can occur at sizes <5 mm SL. Larvae have large heads, long tapering tails, and markedly stalked pectoral fin bases. Few larvae are collected despite the abundance of adults in slope areas; development and transition to the juvenile stage, accompanied by the descent to the bottom, may be rapid. [Sources include: Matarese et al. (1989), Cohen et al. (1990), Ambrose (1996d)]

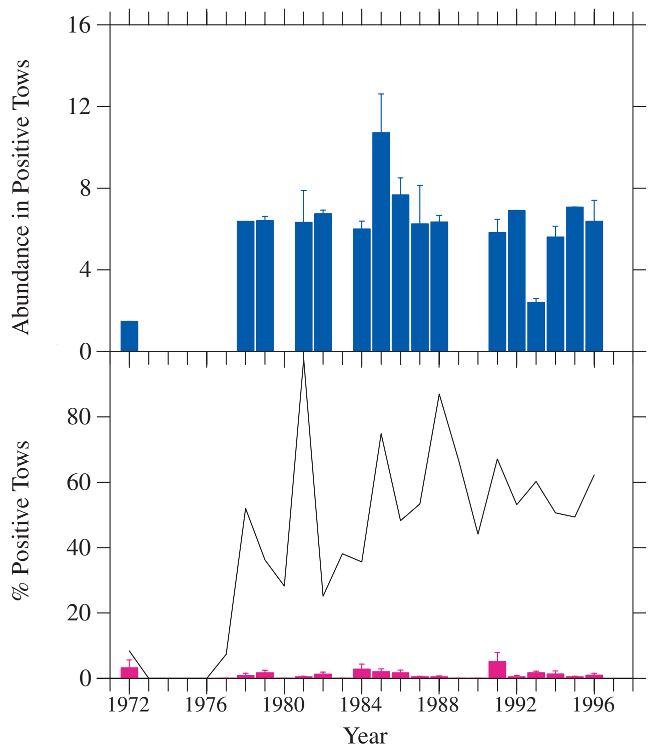
Larval distribution Grenadier larvae are found along outer shelf edges and deeper waters from the northern Bering Sea to the U.S. west coast. Larvae, most abundant in deeper waters off the shelf in the Bering Sea and Gulf of Alaska, are found in most months February–September. Most larvae (5–20 mm SL) are collected in winter–spring; only two larvae (11–12 mm SL) have been collected in summer–fall. Eggs are frequently collected over the Bering Sea slope and along the shelf edge in the Gulf of Alaska, and are also present along the U.S. west coast. Catches of larvae were low, but consistent, during the time series.



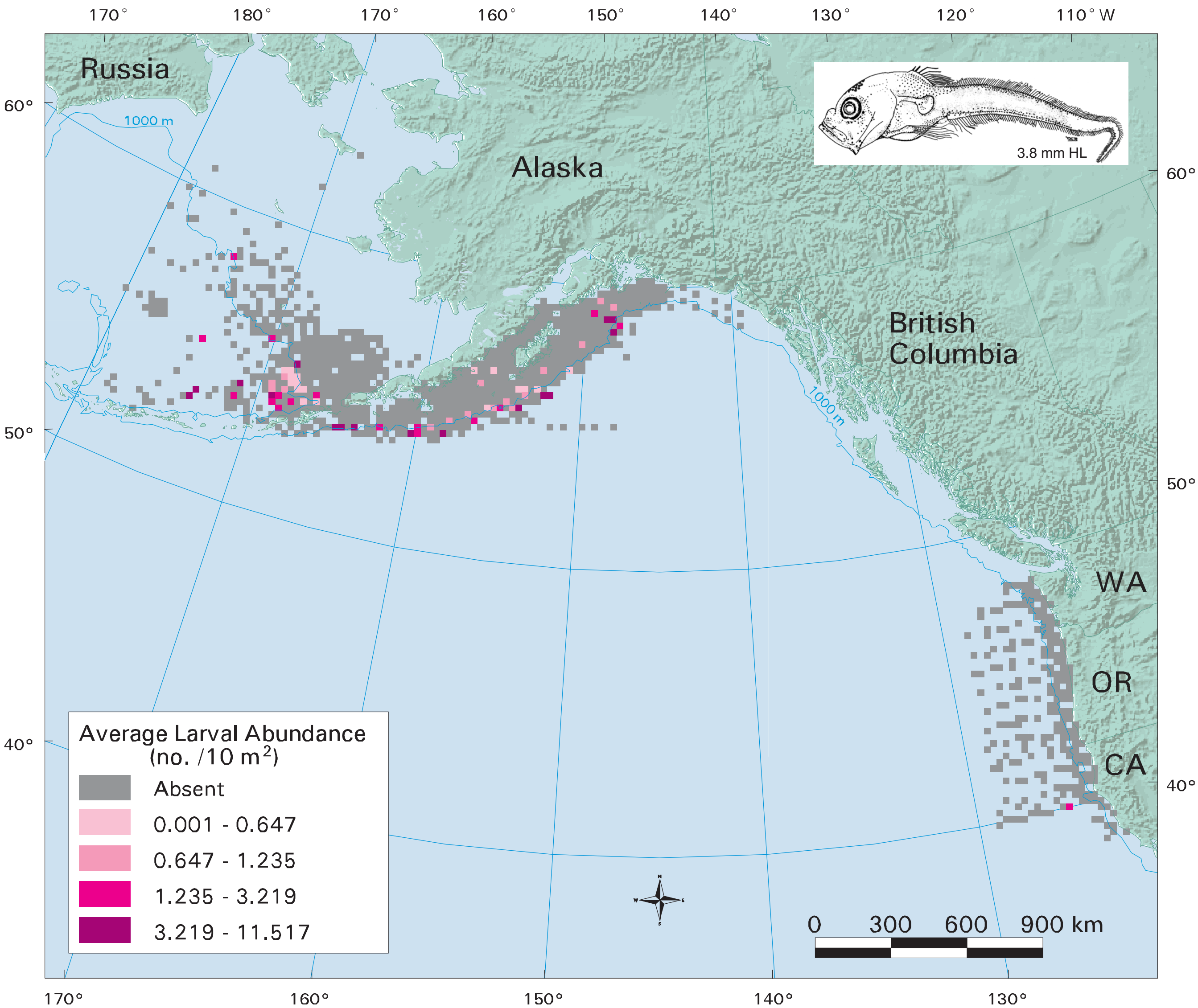
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.



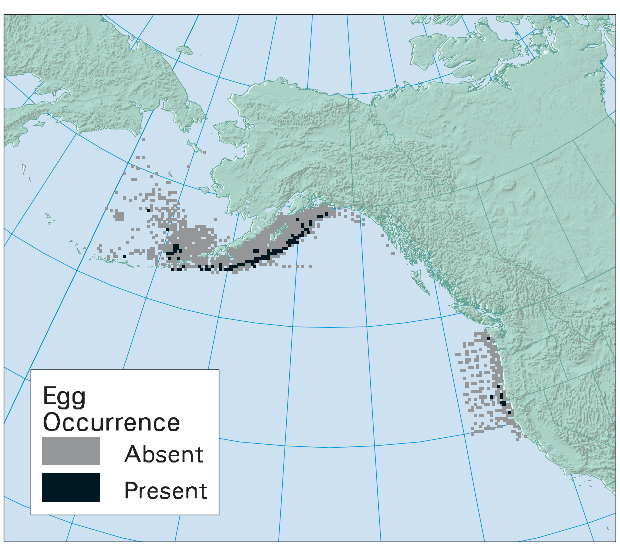
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 68 for winter–spring (Jan–June), 2 for summer–fall (July–Dec).



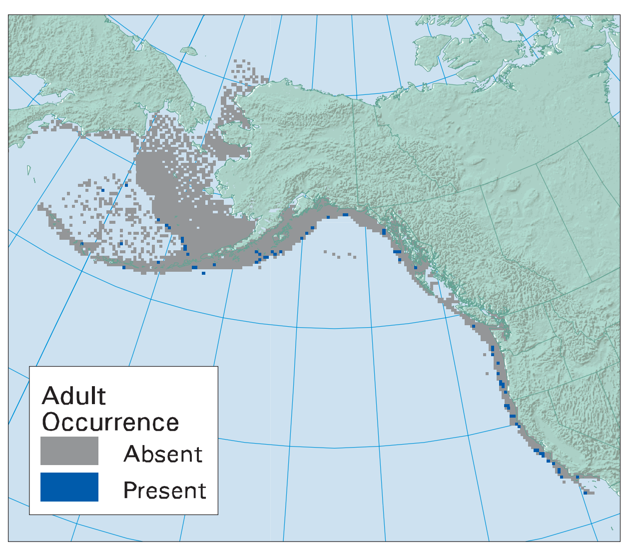
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.



170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
3.8 mm HL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.647
0.647 - 1.235
1.235 - 3.219
3.219 - 11.517
0 300 600 900 km



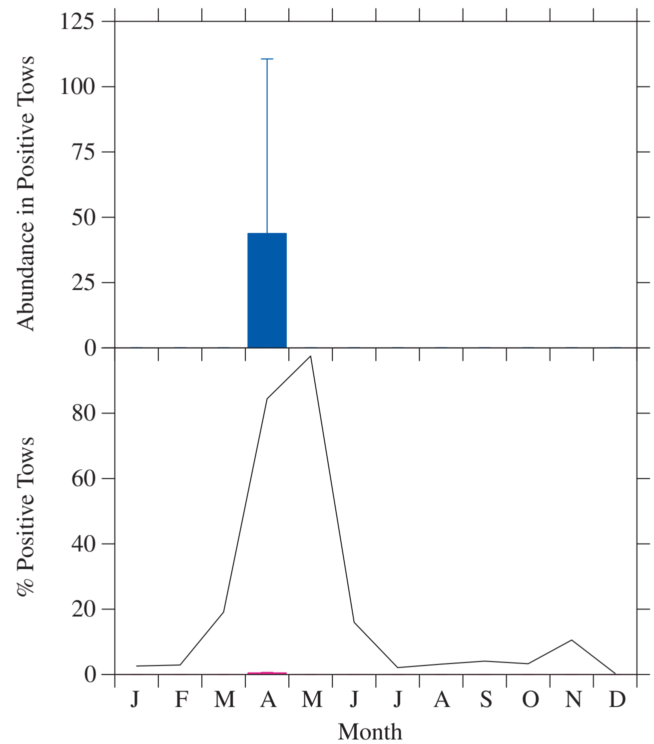
Egg Occurrence
Absent
Present



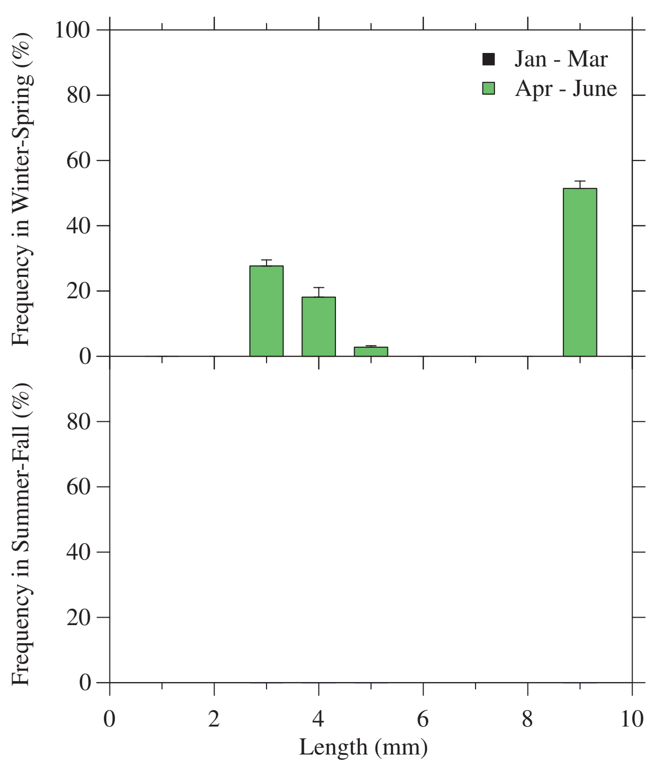
Adult Occurrence
Absent
Present

Life history *Merluccius productus* adults have been reported from the Bering Sea to the Gulf of California, but generally are found from British Columbia southward. Several subpopulations have been identified along the northeastern Pacific coast. Pacific hake are found from the surface to 1000 m, but generally occur over the shelf and slope at depths of 45–500 m. Adults mature at 2–4 years of age and live to about 17 years. Adults remain at the bottom during spawning, which occurs January–June with a peak in January–February, in deep water off southern California and Baja California. Eggs are pelagic, 1.07–1.18 mm in diameter, with a homogenous yolk and one oil globule. Small larvae hatch at about 2.4 mm SL and undergo transformation at 30–35 mm SL. The 1983–1984 occurrences of larvae off the AFSC U.S. west coast survey area are associated with an El Niño event.
[Sources include: Bailey et al. (1982), Matarese et al. (1989), Doyle (1995), Ambrose (1996e)]

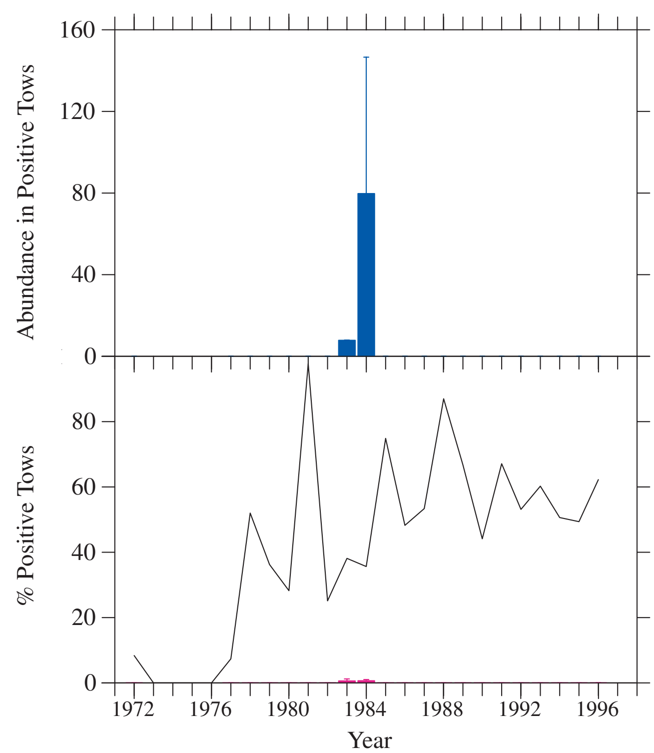
Larval distribution Pacific hake larvae are distributed along the U.S. west coast. Although adults are collected as far north as the Gulf of Alaska, larvae are rare throughout the survey area except off northern California. Small larvae (3–9 mm SL) are collected in April and May. Eggs are collected along the entire west coast survey area, but are more common along the southernmost extent of the survey area. Overall catch by year indicates larvae were only collected in 1983 and 1984, as a result of an El Niño event.



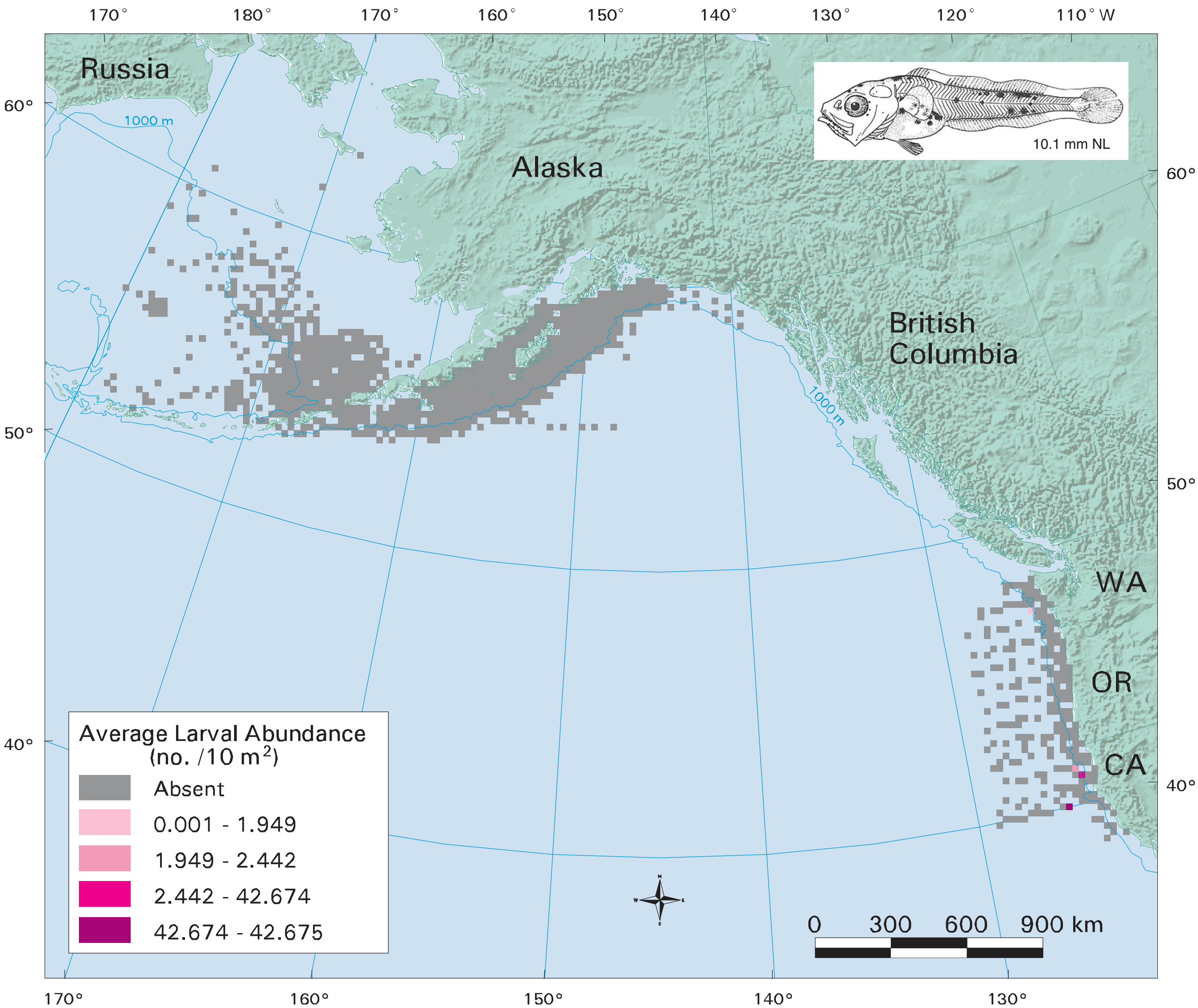
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



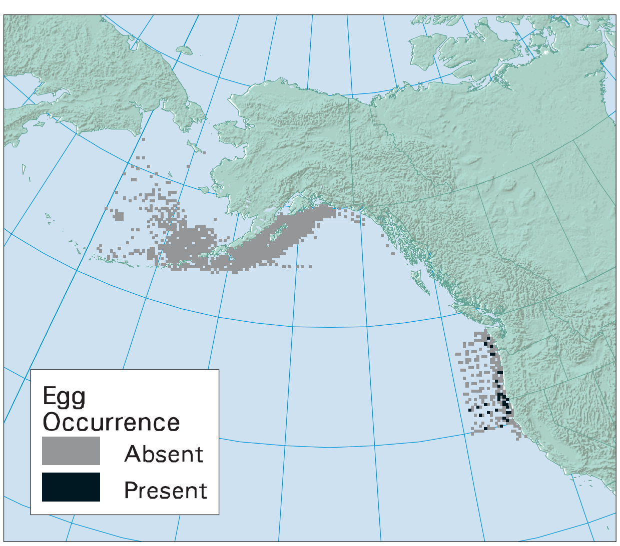
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 37 for winter–spring (Jan–June).



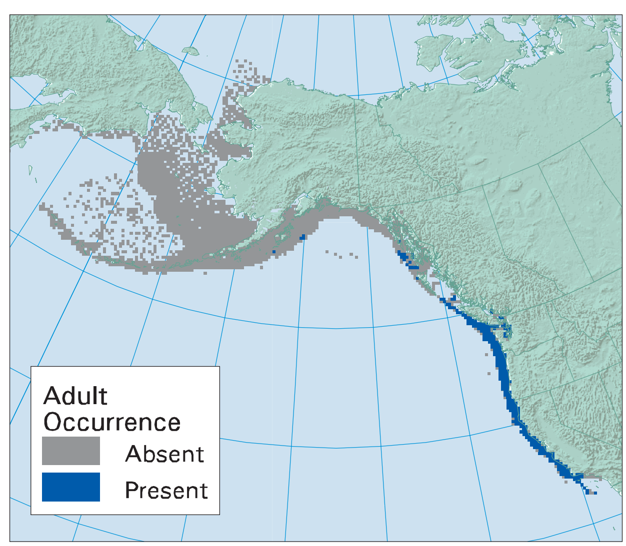
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.1 mm NL
Average Larval Abundance (no. /10 m2)
Absent
0.001 - 1.949
1.949 - 2.442
2.442 - 42.674
42.674 - 42.675
0 300 600 900 km
170°
160°
150°
140°
130°



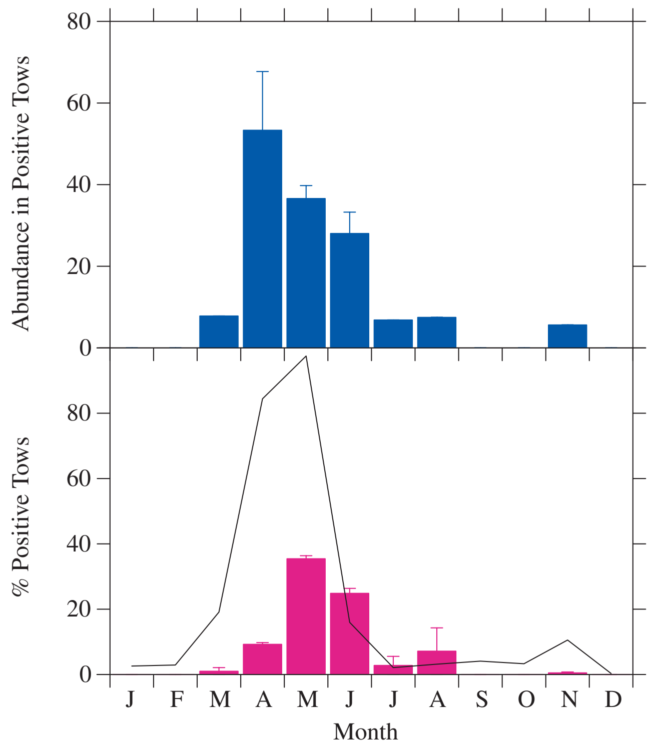
Egg Occurrence
Absent
Present



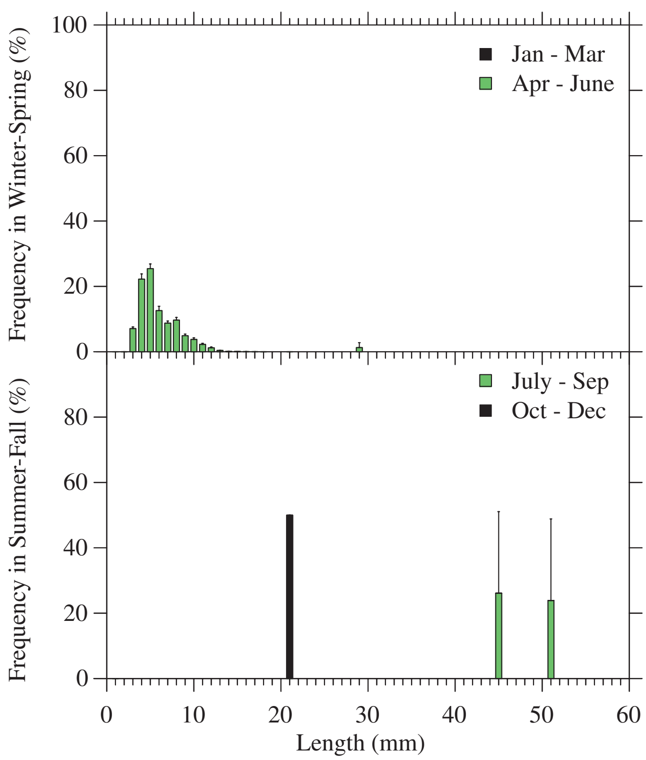
Adult Occurrence
Absent
Present

Life history *Gadus macrocephalus* are reported to be found from the Chukchi Sea to southern California, but occurrence off California is uncommon. Adults are benthic and are found at depths of 75–550 m. Fish reach maturity at 2–3 years and may live up to 13 years. Spawning occurs winter–spring; females may produce up to 3 million eggs that are semi-demersal, 0.98–1.08 mm in diameter, and not commonly collected in plankton gear. Pelagic larvae hatch at about 3–4 mm SL and transform to juveniles by 35 mm SL.
[Sources include: Hart (1973), Matarese et al. (1989)]

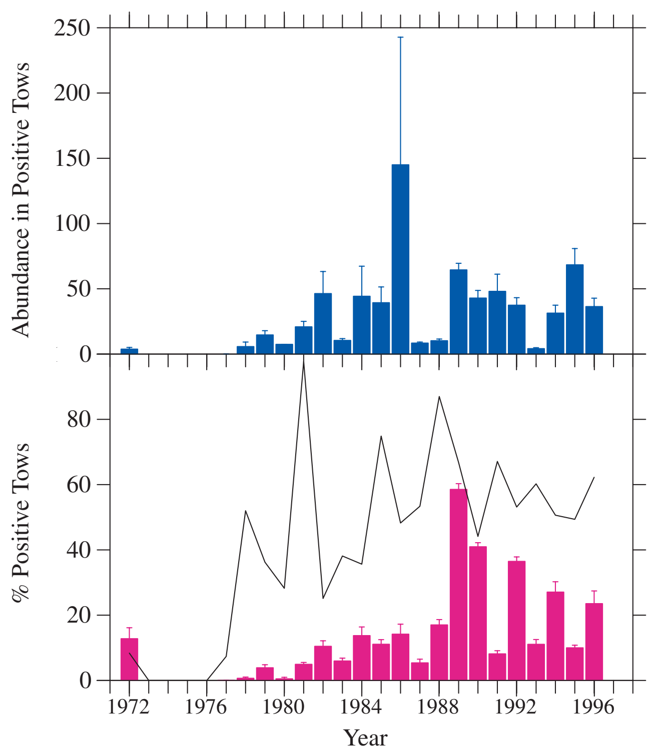
Larval distribution Pacific cod larvae are found in collections from the Bering Sea and Unimak Pass area and eastward into the Shelikof sea valley and Gulf of Alaska. They are present in low numbers inshore along the shelf in AFSC U.S. west coast collections from Washington to northern California, but are most abundant in the Gulf of Alaska west of Kodiak Island along the Alaska Peninsula. Larvae are collected March–November, but are more abundant as small larvae (<10 mm SL) in spring collections; larger larvae (>20 mm SL) are found in summer–fall. Although eggs are semi-demersal, they are occasionally collected in bongo tows in Shelikof Strait and west of Kodiak Island. Overall catch for Pacific cod was higher after the mid-1980s when larvae were first consistently identified, but larvae were present in ichthyoplankton collections throughout the time series.



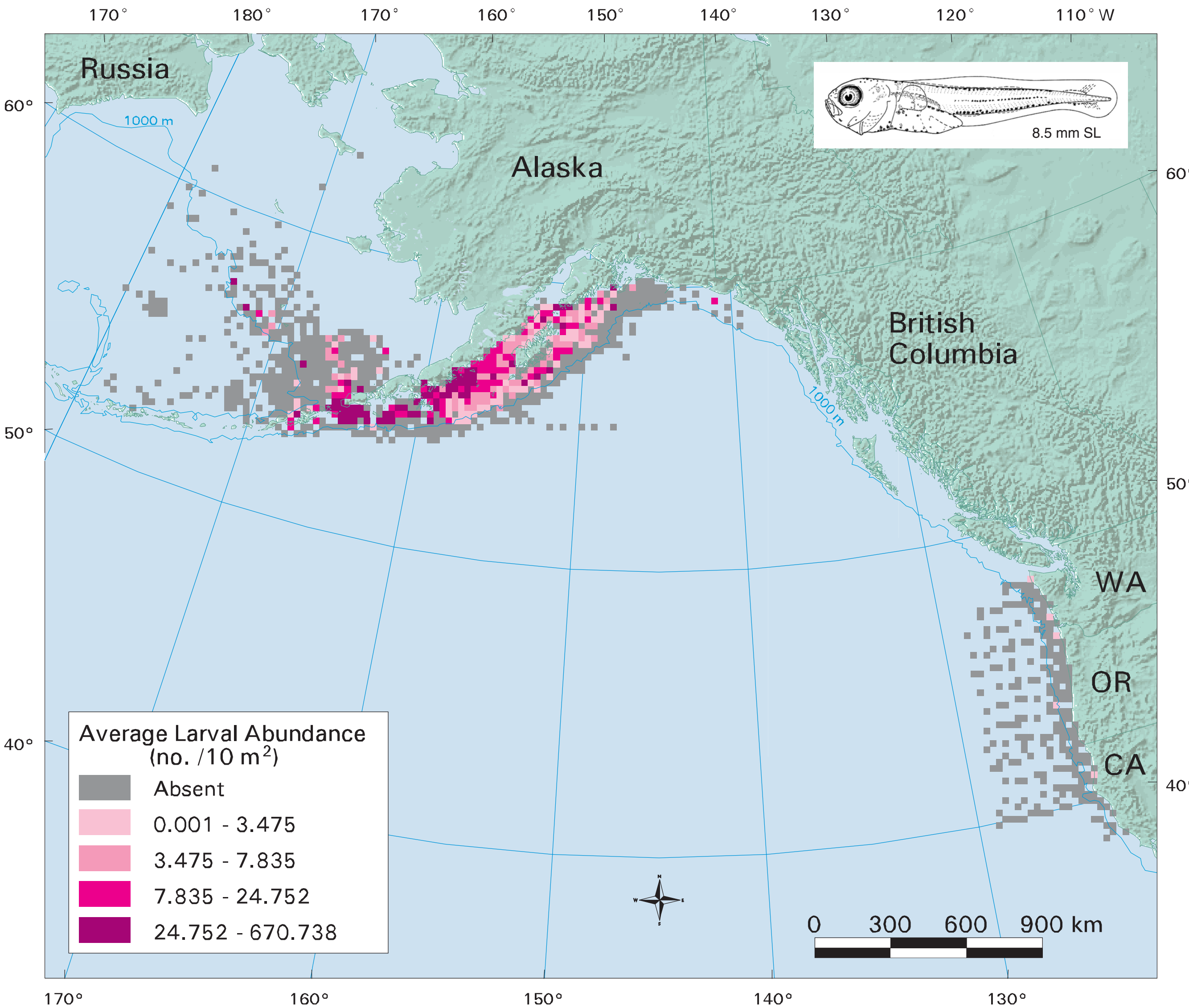
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

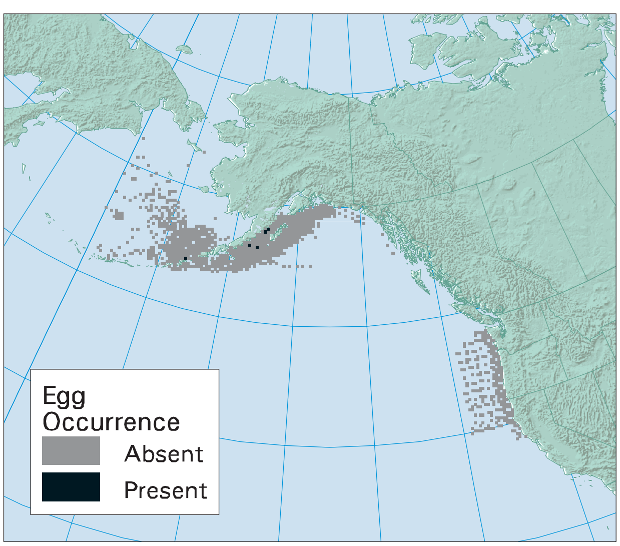


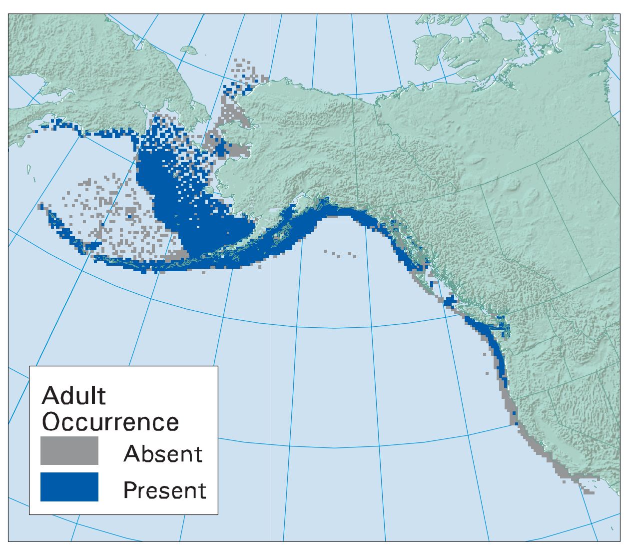
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 12,681 for winter–spring (Jan–June), 3 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

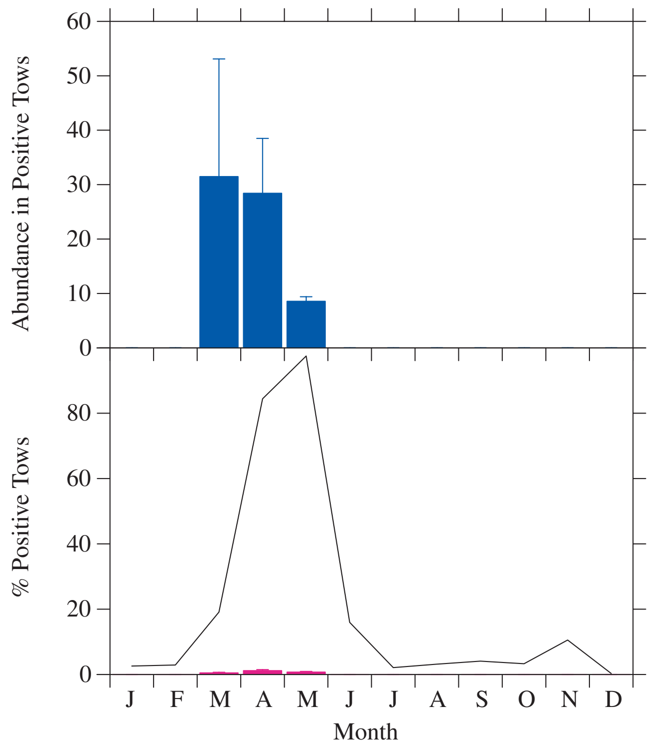

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
8.5 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 3.475
3.475 - 7.835
7.835 - 24.752
24.752 - 670.738
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

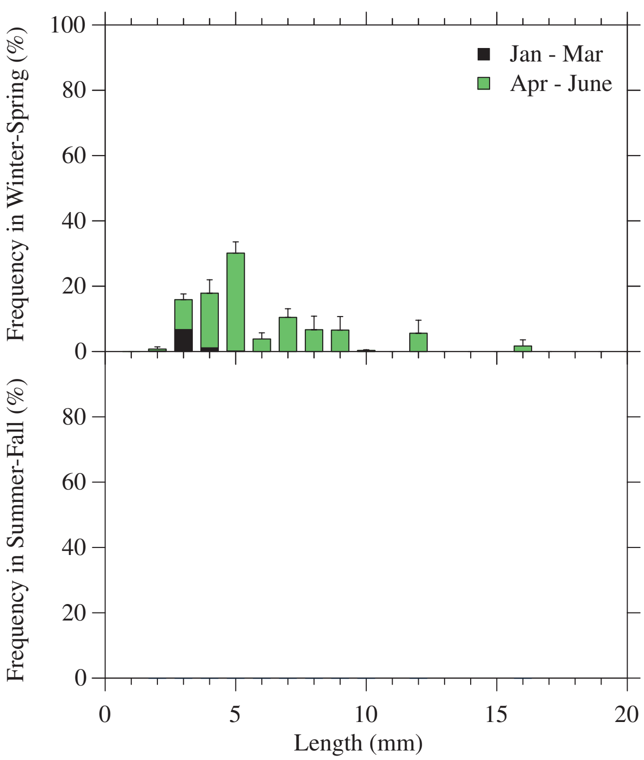

Adult Occurrence
Absent
Present

Life history *Microgadus proximus* range from the Bering Sea to central California. Adult Pacific tomcod are primarily near-shore fishes, epi- and mesobenthic at depths of 0–275 m. Spawning generally occurs in winter–spring. Eggs are demersal, but specific information is not available. Pelagic larvae hatch at about 3 mm SL, undergo notochord flexion at 8–15 mm SL, and begin to transform at 22–28 mm SL. Early juveniles may remain pelagic until they reach about 45 mm SL.
[Sources include: Matarese et al. (1989)]

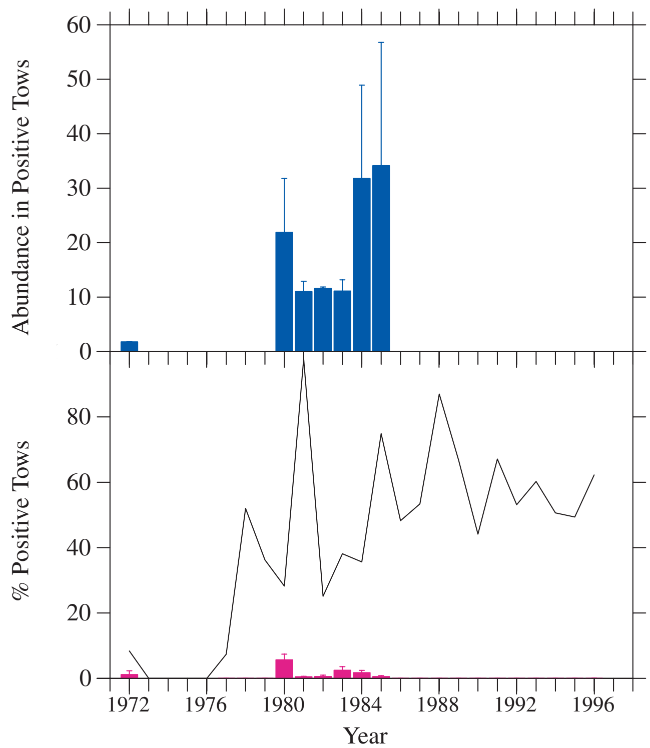
Larval distribution Pacific tomcod larvae are collected along the shelf and coastal areas from northeast of Kodiak Island in the Gulf of Alaska to along the U.S. west coast. Larvae are uncommon in the Gulf of Alaska, but are abundant inshore along the coast off Washington and Oregon. Larvae are collected March–May, with higher numbers in late winter–early spring. Larvae taken in winter–spring range from newly hatched to larger larvae (2–16 mm SL). Larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



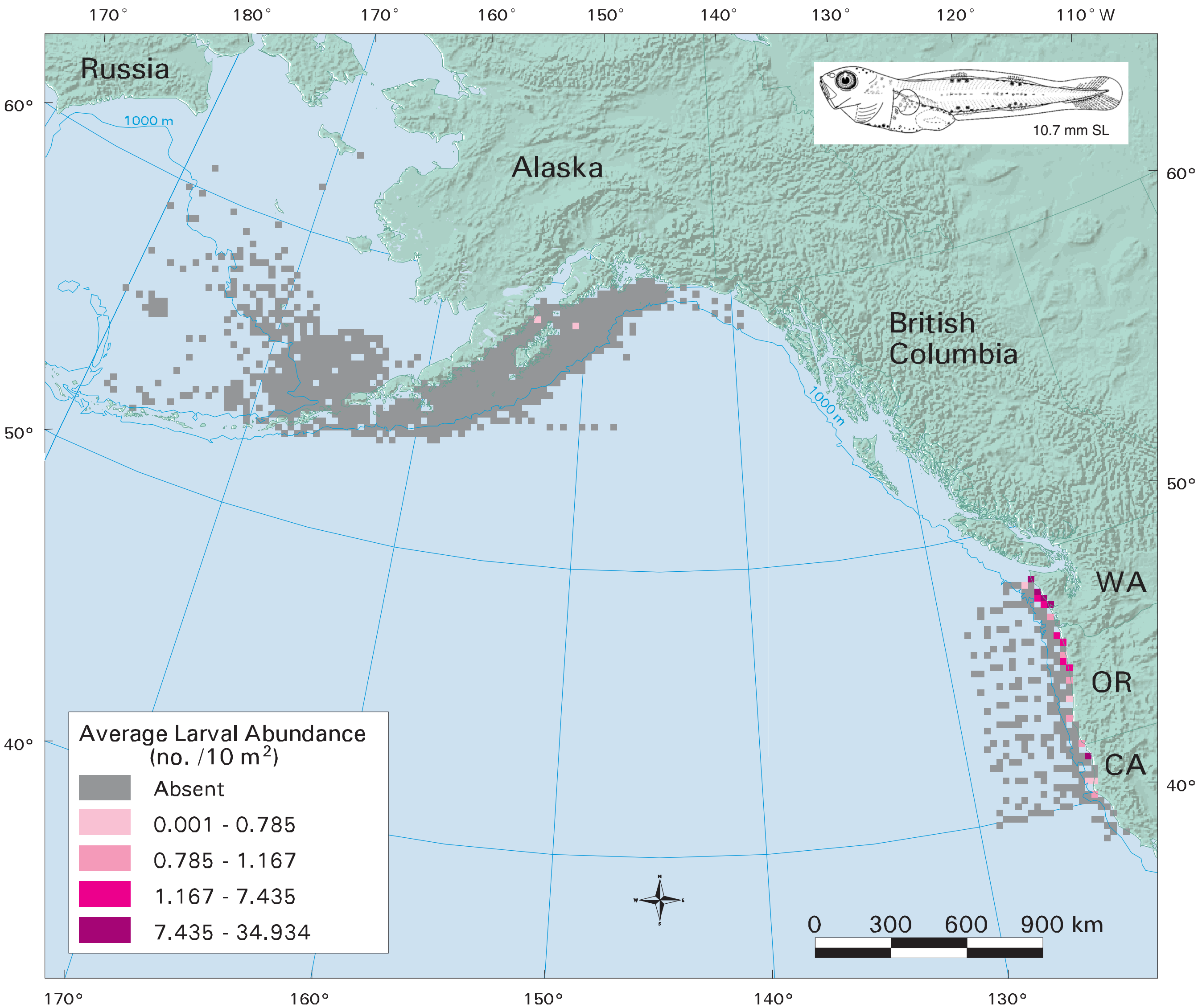
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

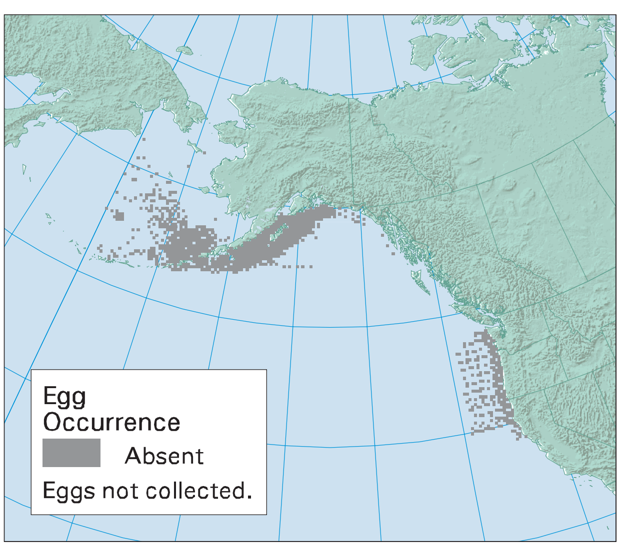


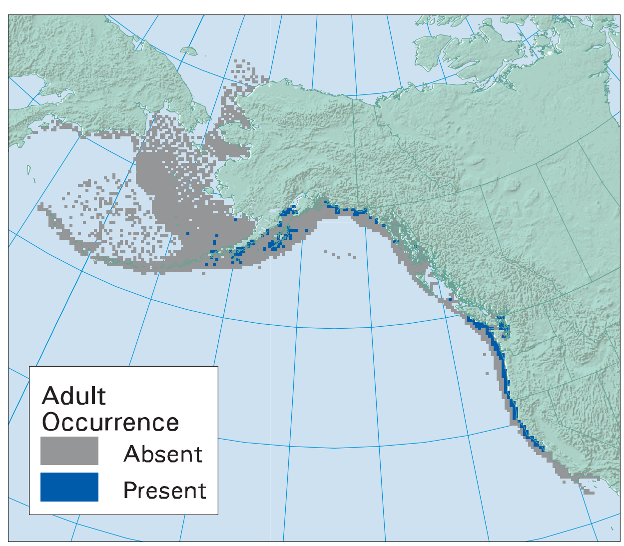
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 115 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

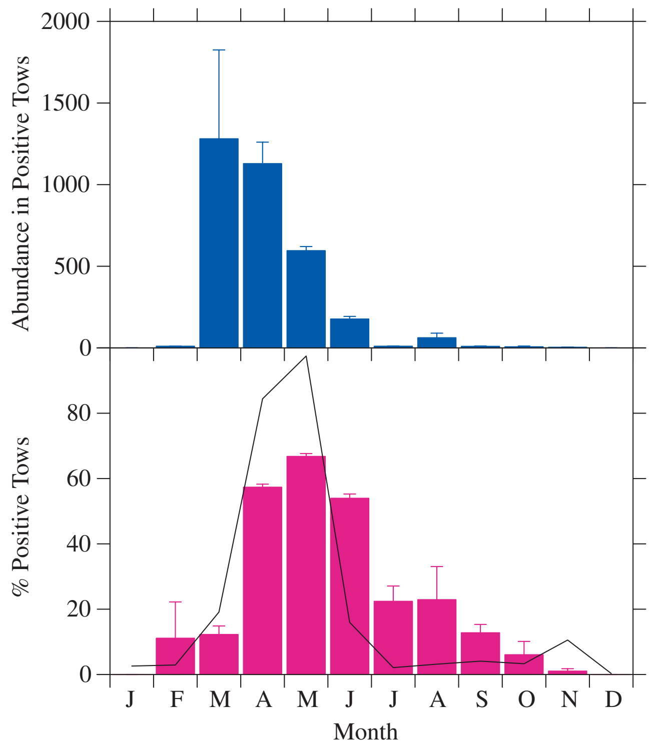

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.7 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.785
0.785 - 1.167
1.167 - 7.435
7.435 - 34.934
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

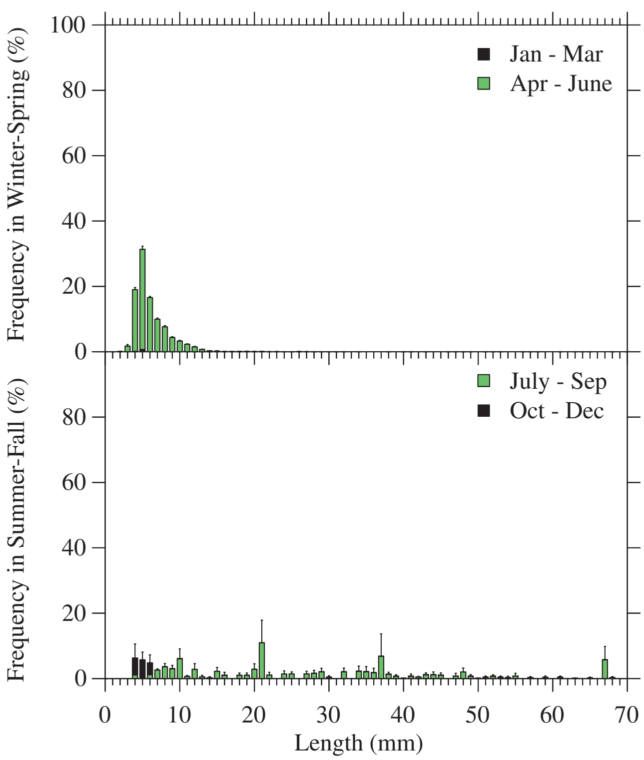

Adult Occurrence
Absent
Present

Life history *Theragra chalcogramma* are found from Japan to the Chukchi Sea and to central California, although they are uncommon south of Oregon. Typically a midwater species, adults occur from near surface to 1000 m. Walleye pollock migrate in large schools to spawn February–May in the Shelikof Strait sea valley; those found in the central and southeast Bering Sea migrate to the upper slope, where spawning occurs as early as February, and the outer shelf, where spawning generally begins by April. Females are batch spawners, producing up to 1.2 million pelagic eggs each season. Eggs are 1.2–1.8 mm in diameter and larvae hatch at 3–4 mm SL. Transformation into pelagic juveniles begins at about 25 mm SL and is complete at about 40 mm SL.
[Sources include: Matarese et al. (1989), Brown et al. (2001)]

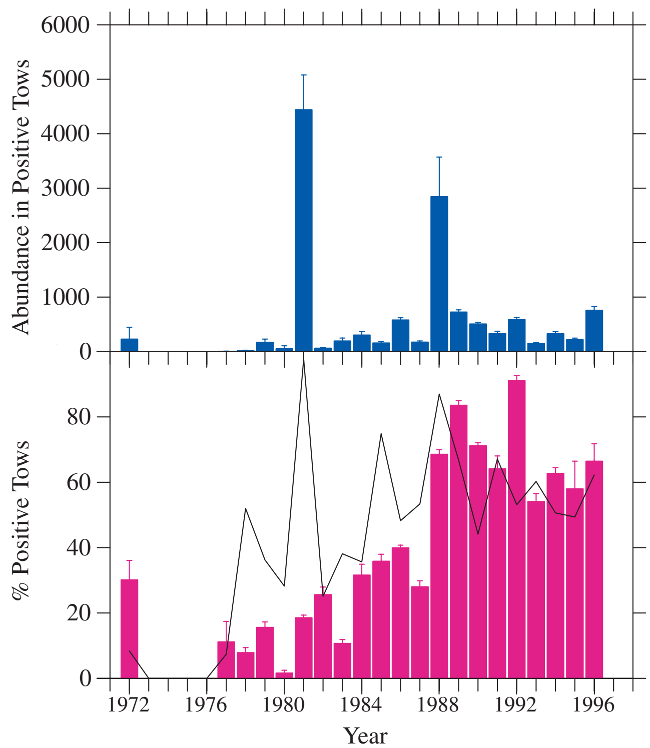
Larval distribution Walleye pollock larvae are collected in the Bering Sea, Gulf of Alaska and Shelikof Strait, and off Washington and Oregon. Larvae are most abundant in deeper waters; highest abundances occur in slope waters of the eastern Bering Sea and in Shelikof Strait. Larvae are collected February–November, but most are taken April–June. Eggs are collected in the Bering Sea, western Gulf of Alaska, and less commonly off the U.S. west coast. Larvae <10 mm SL are abundant in winter–spring, whereas larvae/juveniles 4–68 mm SL are collected in summer–fall. Larvae were collected in high numbers after the early 1980s when they were first routinely identified and separated from other similar gadids in the area.



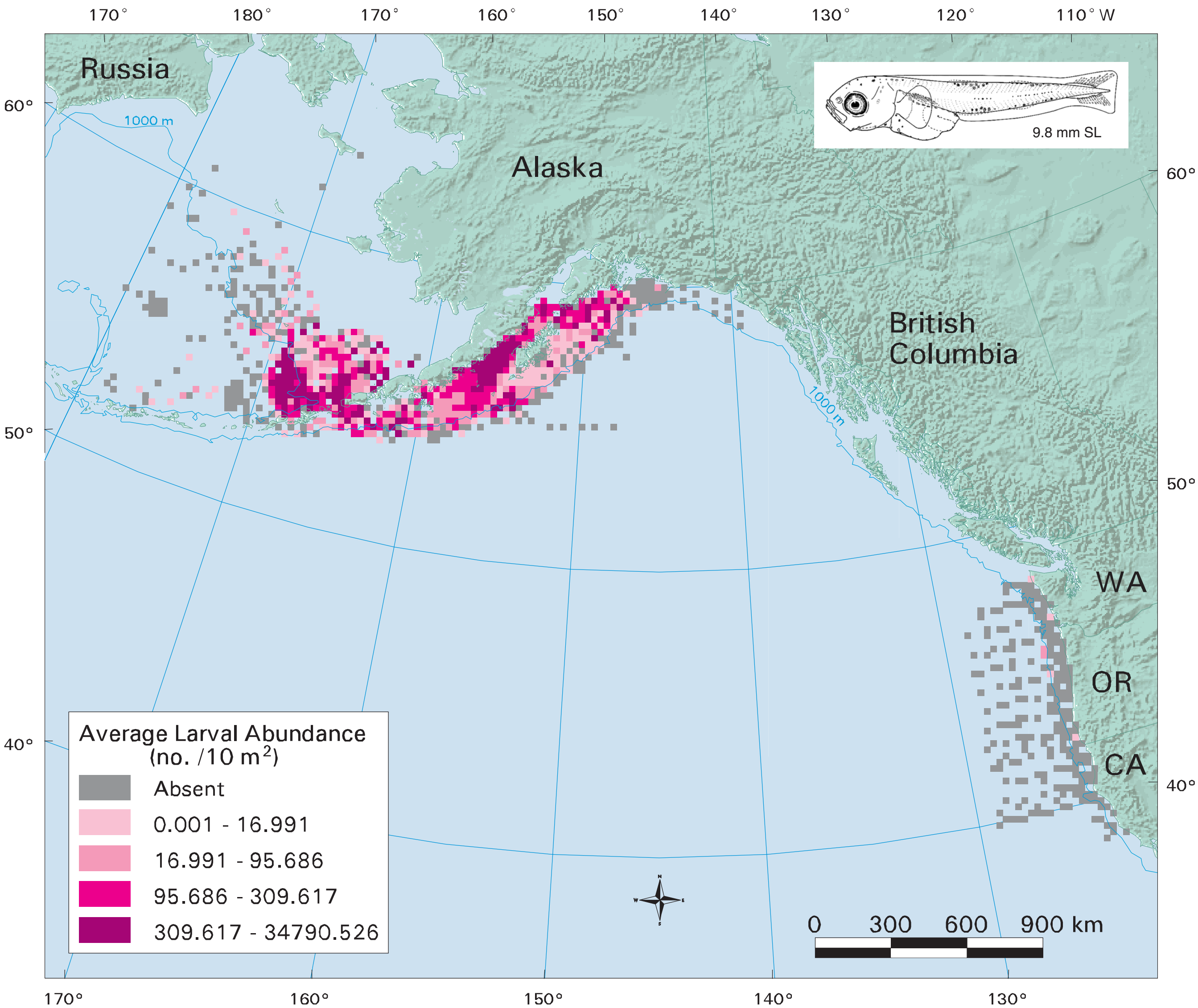
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

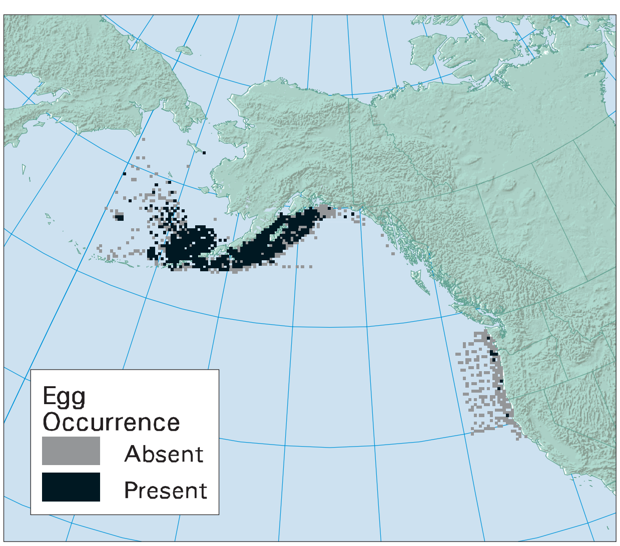


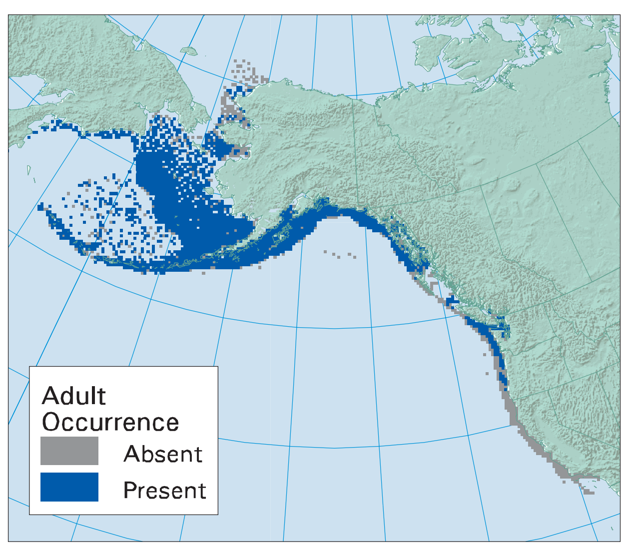
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 130,658 for winter–spring (Jan–June), 160 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

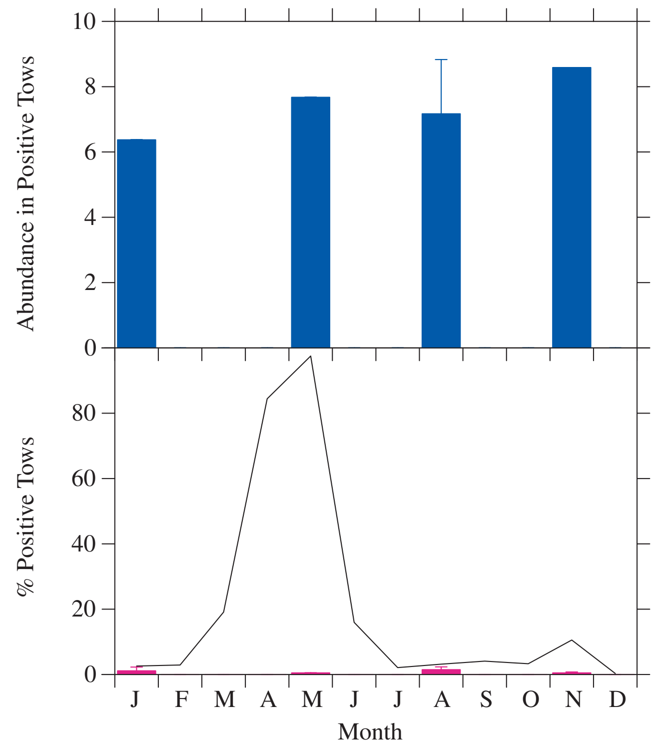

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
1000 m
9.8 mm SL
Alaska
60°
50°
40°
British Columbia
1000 m
WA
OR
CA
Average Larval Abundance
(no. /10 m²)
Absent
0.001 - 16.991
16.991 - 95.686
95.686 - 309.617
309.617 - 34790.526
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

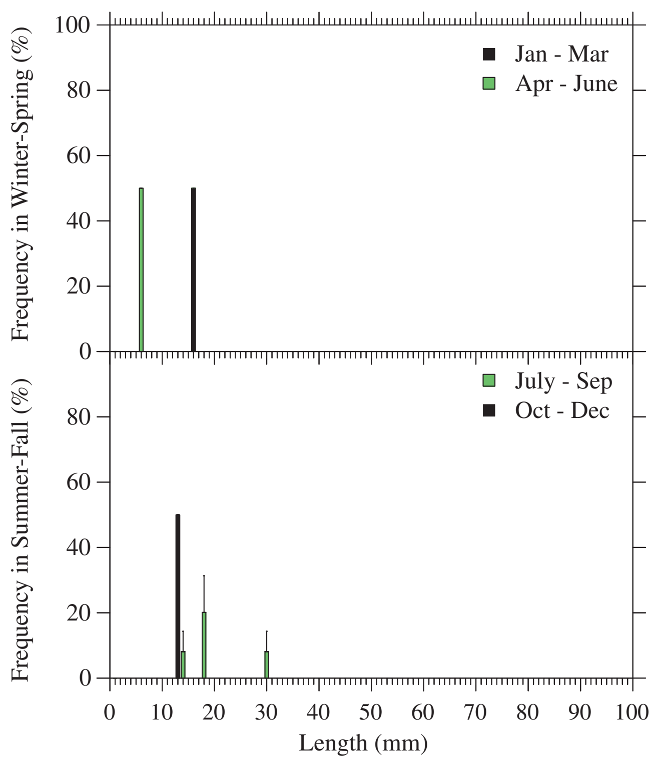

Adult Occurrence
Absent
Present

Life history *Cololabis saira* are found throughout the North Pacific Ocean and in the eastern Pacific from the Gulf of Alaska to Mexico. Pacific saury adults are primarily epipelagic, occurring near the surface, but occasionally to depths of 200 m. Spawning takes place year-round with various peaks (spring in the CalCOFI area) within their range. Eggs are pelagic and attach via adhesive filaments to one another and to floating objects like kelp. Eggs are slightly ovoid, 1.5–1.8 × 1.6–1.9 mm in diameter, with a cluster of 12–20 filaments at one pole. Larvae are neustonic and hatch at sizes between 5 and 7 mm SL with a well-developed tail. Transformation occurs at 21–30 mm SL.
[Sources include: Matarese et al. (1989), Watson (1996a)]

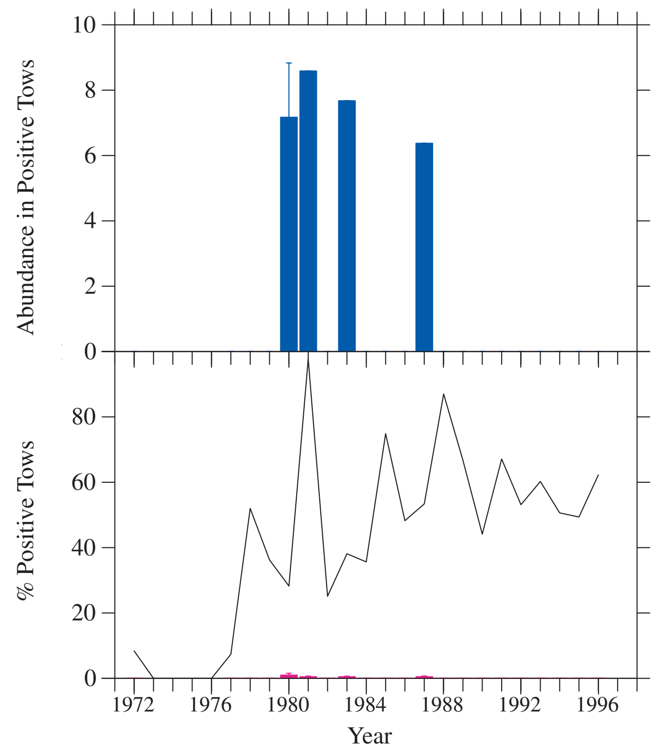
Larval distribution Pacific saury larvae and juveniles are collected off the U.S. west coast off Washington, Oregon, and California. Although adults are present in Gulf of Alaska AFSC surveys, neither eggs nor larvae have been collected. Although larvae are neustonic, individuals are collected as the bongo nets pass through the surface layer. Larvae occur in deeper slope and oceanic waters and are found intermittently in January, May, August, and November. Larvae <15 mm SL occur in winter–spring, whereas in summer–fall larger juveniles are occasionally encountered. Eggs are present mostly in oceanic waters throughout the AFSC U.S. west coast survey area. Uncommon in bongo samples, larvae were collected in the early 1980s when AFSC conducted U.S. west coast surveys.



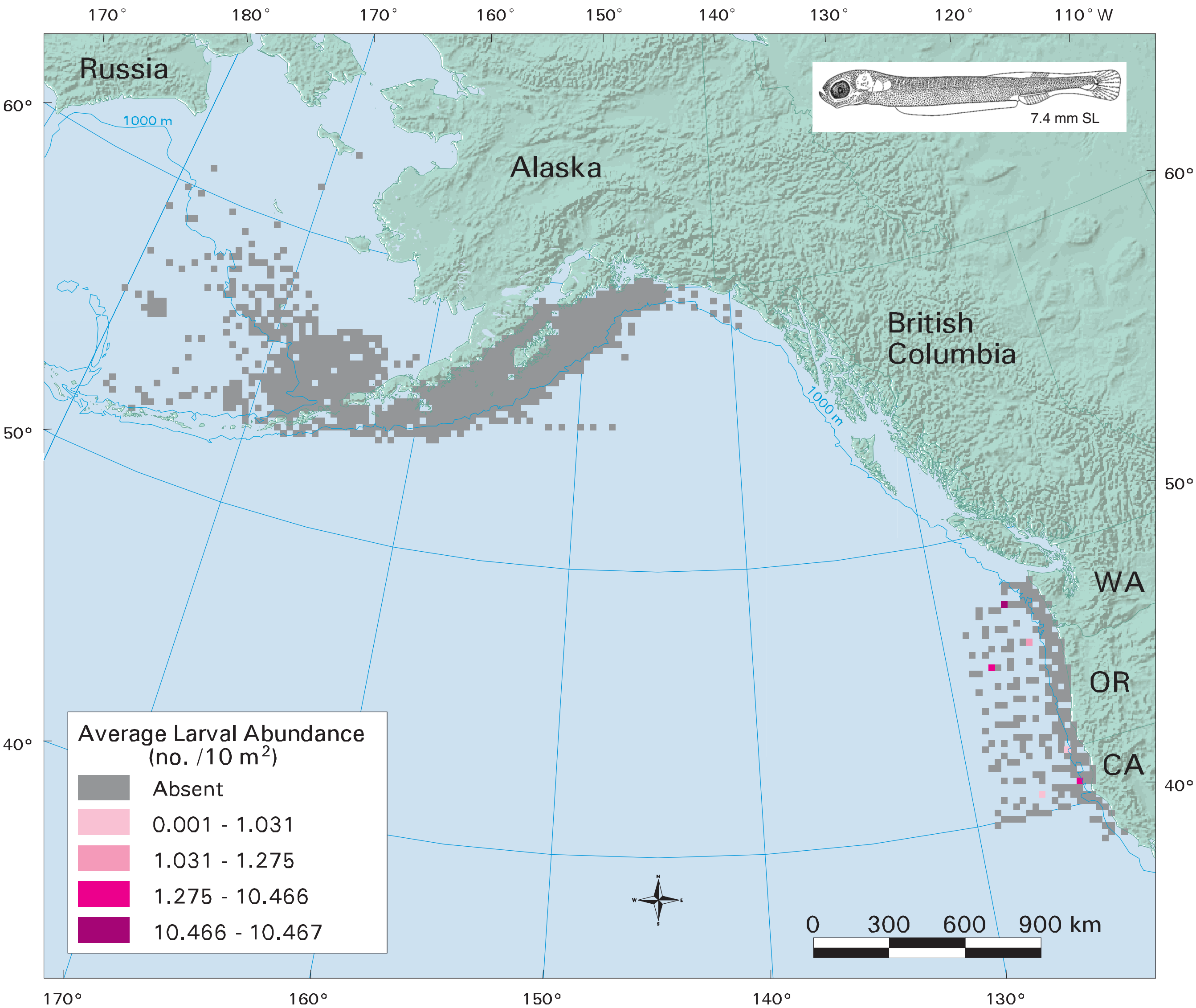
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

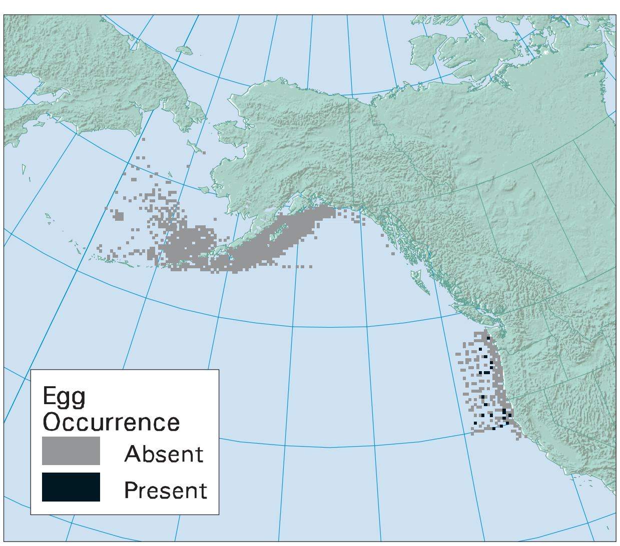


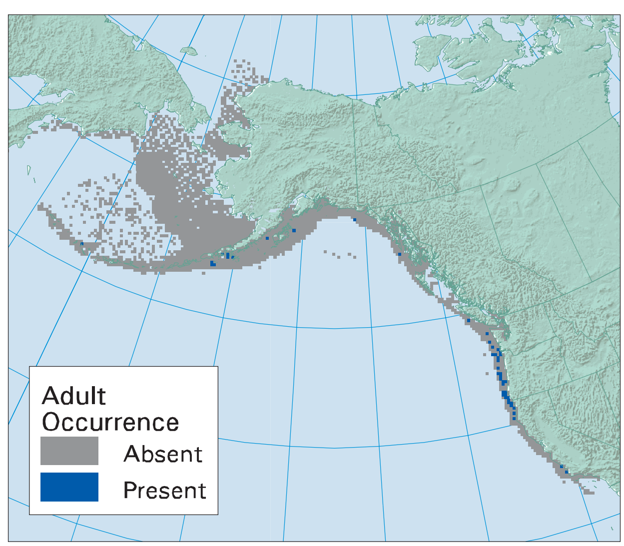
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 2 for winter–spring (Jan–June), 6 for summer–fall (July–Dec); 1 specimen >100 mm SL omitted.



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

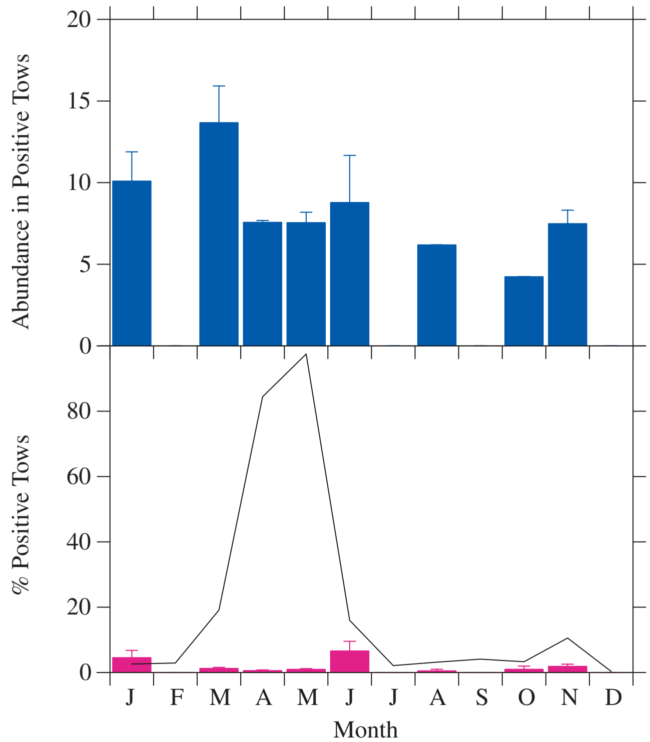

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
7.4 mm SL
60°
50°
40°
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.031
1.031 - 1.275
1.275 - 10.466
10.466 - 10.467
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

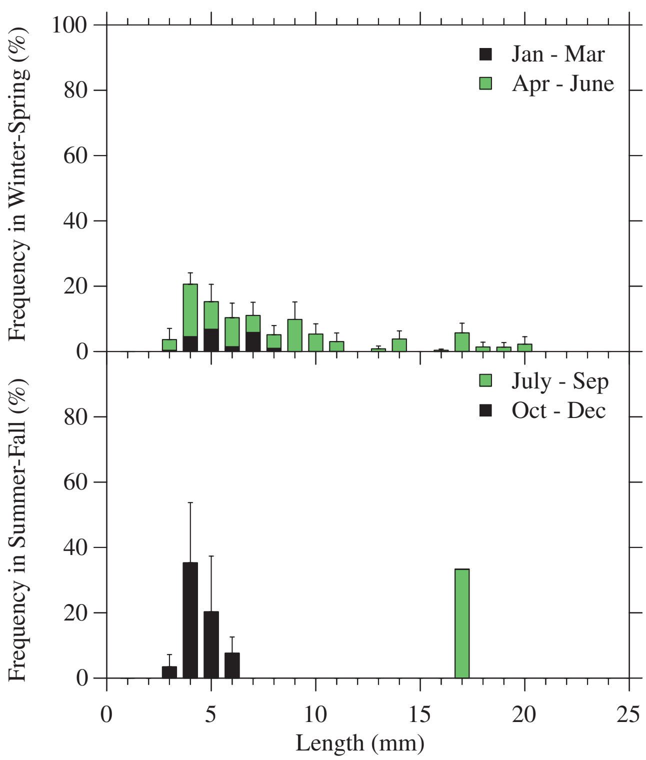

Adult Occurrence
Absent
Present

Life history Melamphaids or bigscales are small, meso- and bathypelagic fishes occurring in tropical and temperate waters of most oceans. They are distinct with dark bodies, thin head bones with ridges and crests, and large cycloid scales. They are represented in our study area by five species within four genera (see species list, Appendix Table 2). *Melamphaes parvus* and *Scopelogradus bispinosus* are not likely to spawn in our study area. Eggs are unknown, but later stages are well known for several species. Thus far, *Melamphaes lugubris,* the only identified series of melamphaids in our collection, most likely represents the dominant melamphaid in our area. Larvae of nine species, including the five that occur in our area, have been identified in CalCOFI ichthyoplankton collections, primarily from the more offshore stations during spring and summer months.
[Sources include: Matarese et al. (1989), Sandknop and Watson (1996)]

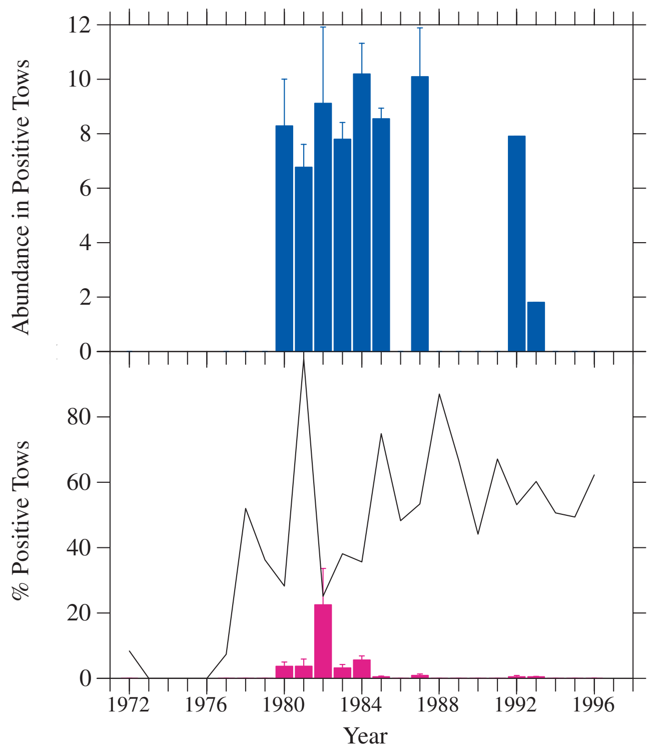
Larval distribution Bigscale larvae are collected in Shelikof Strait in the Gulf of Alaska and off the U.S. west coast. Abundances are higher in deeper slope waters off Oregon and northern California. Larvae are collected in almost every month throughout the year from January through November with numbers consistently higher in the spring. Larvae 3–20 mm SL are found in winter–spring and larvae 3–17 mm SL are found in summer–fall. Overall catch by year indicates abundance was higher in the 1980s when AFSC conducted U.S. west coast surveys and in 1992–1993.



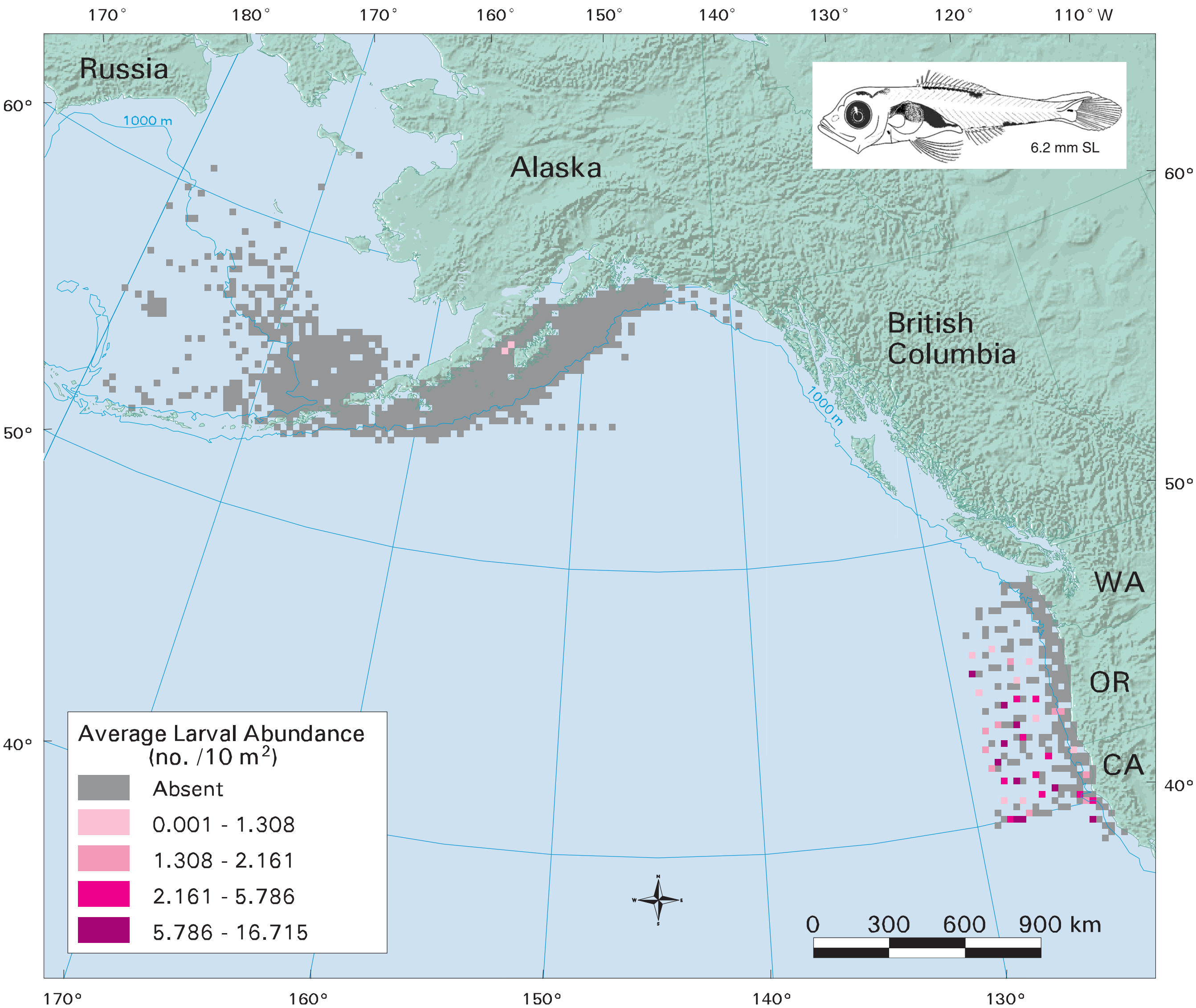
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

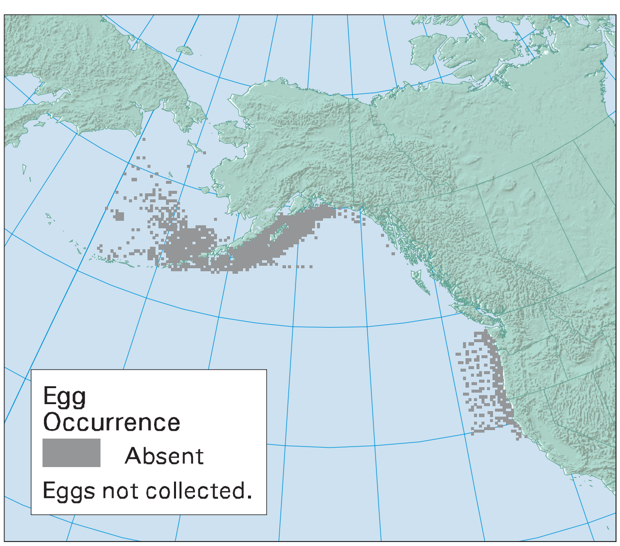


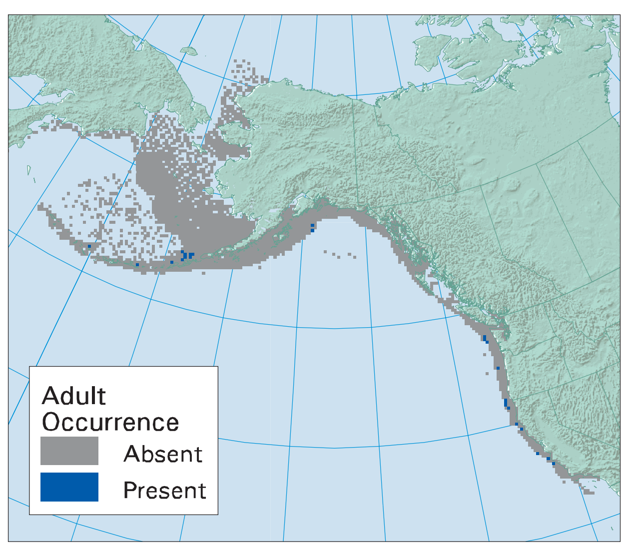
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 75 for winter–spring (Jan–June), 12 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

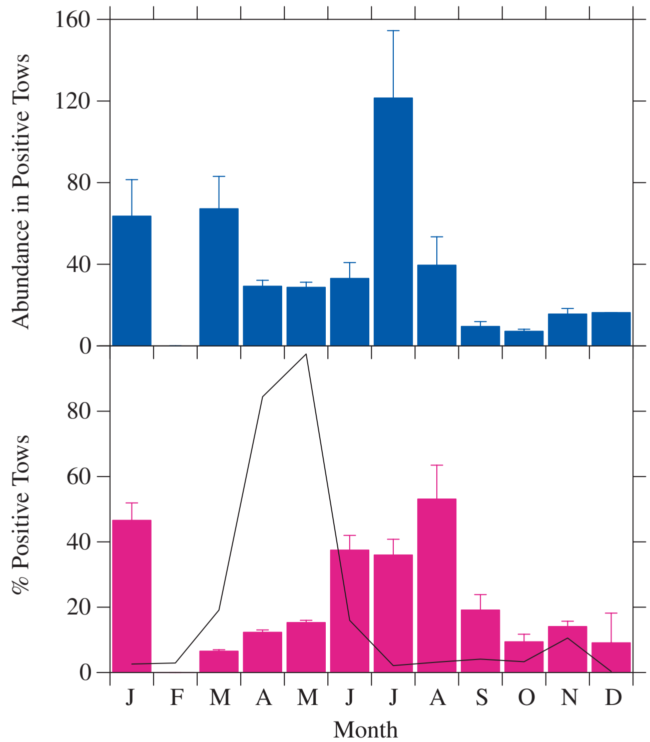

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
6.2 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.308
1.308 - 2.161
2.161 - 5.786
5.786 - 16.715
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

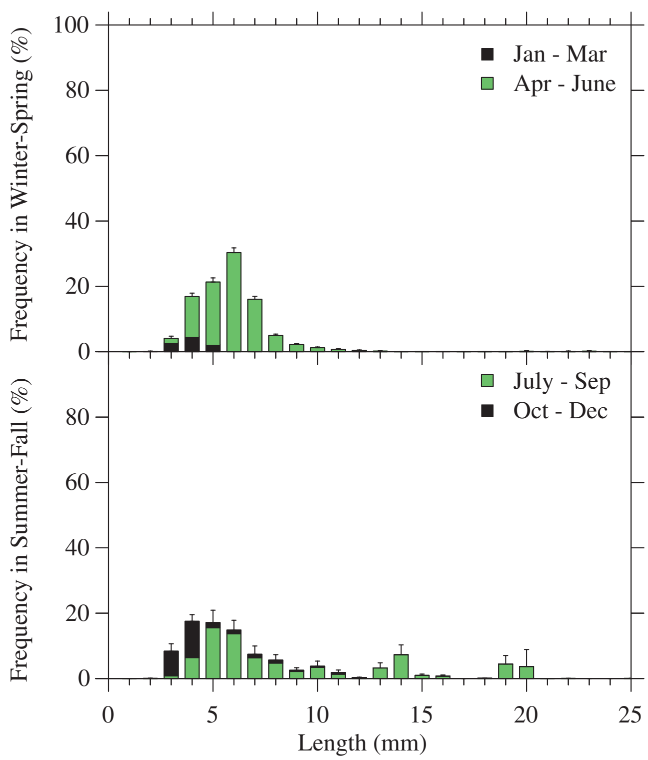

Adult Occurrence
Absent
Present

Life history The temperate boreal genus *Sebastes* accounts for one-third of all scorpaenid species in the North Pacific. Among the >70 species occurring in the Northeast Pacific, about 40 occur in our study area (see species list, Appendix Table 2). Adult rockfish occupy intertidal to mid-slope habitats and support sport and commercial fisheries throughout the North Pacific. *Sebastes* are live-bearers; larvae are extruded at 3.8–7.5 mm SL with functional eyes, jaws, and pectoral fins. Larvae live in the upper 80 m for 1–2 months, then transform at 15–20 mm SL into pelagic juveniles that occupy a variety of niches for several months before settling. In west coast neuston samples, larvae >10 mm SL are abundant. Although *Sebastes* larvae are often quite abundant in plankton samples from the Northeast Pacific in winter and spring, the specific identity of most cannot be determined. *Sebastes* larvae are a major component of the CalCOFI collections and occur throughout the sampling area.
[Sources include: Matarese et al. (1989), Doyle (1992), Moser (1996e), Doyle[2]]

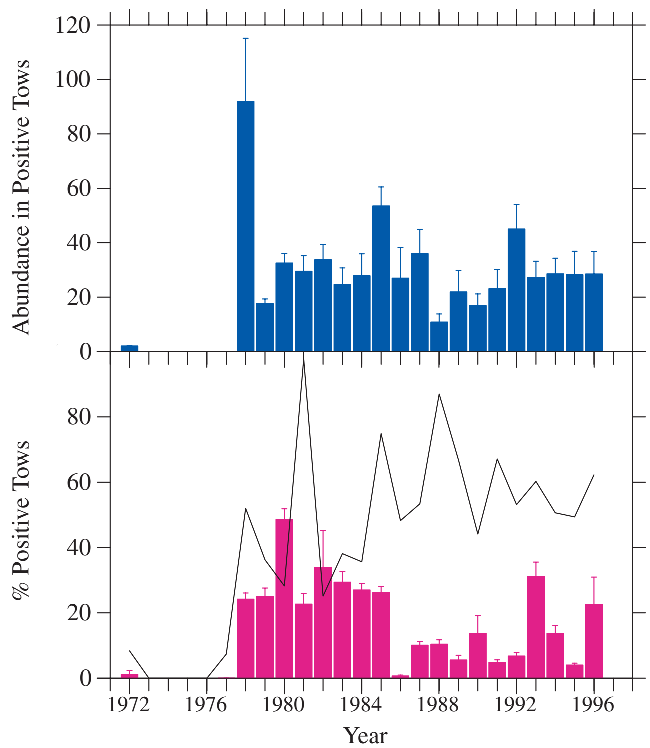
Larval distribution Rockfish larvae are distributed throughout the Bering Sea, Aleutian Islands, Gulf of Alaska, and along the U.S. west coast. Larvae are more abundant over the shelf and shelf edges and have been collected every month except February. Newly extruded larvae (<10 mm SL) are abundant in winter–spring. Small larvae, as well as larvae >10 mm SL, are found in summer–fall. Overall catch by year indicates that larvae were present throughout the time series, but were common during the 1980s when AFSC conducted U.S. west coast surveys.



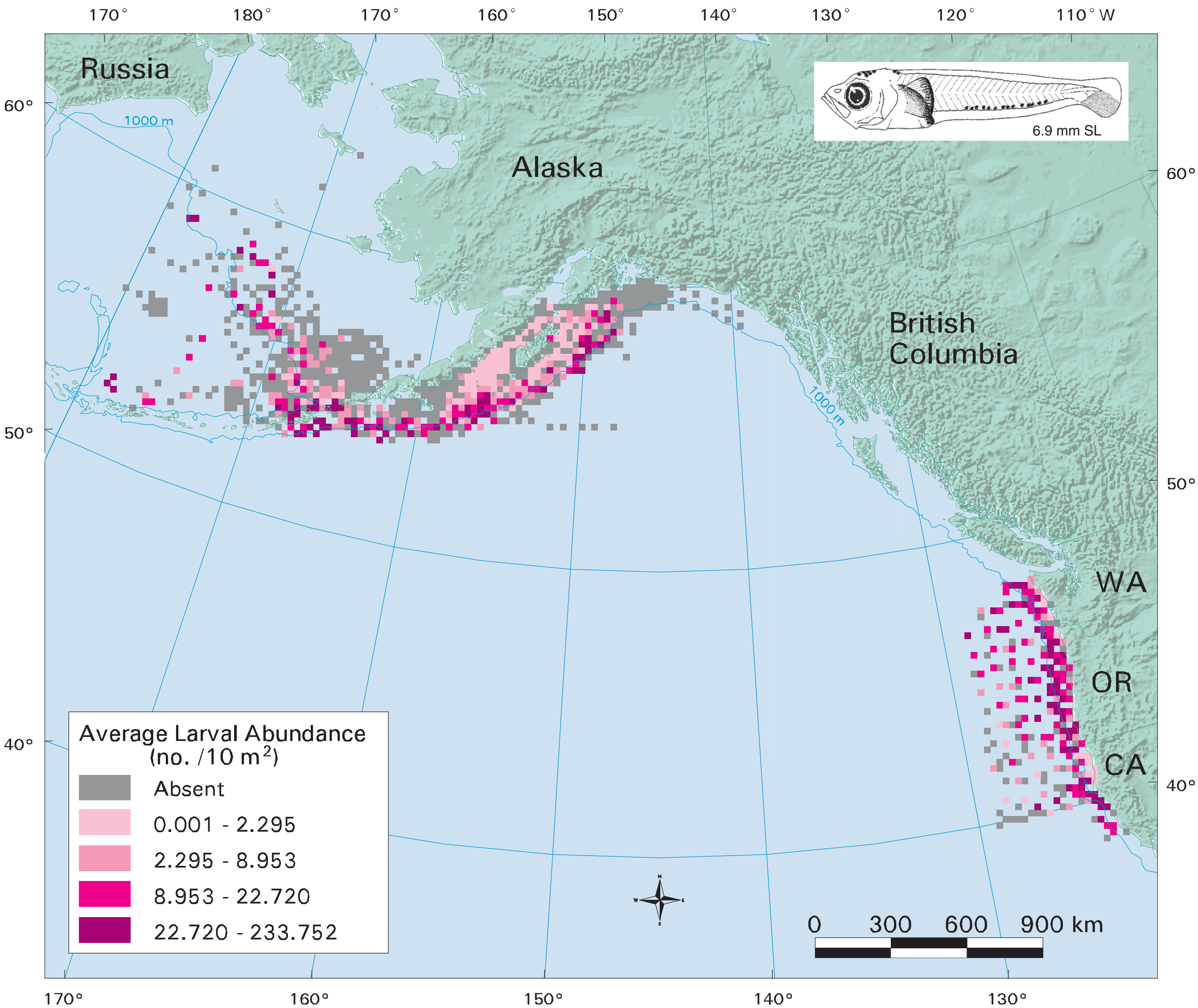
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

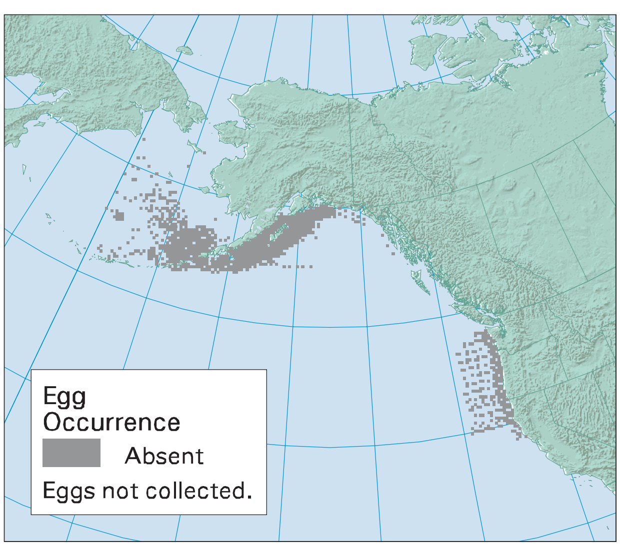


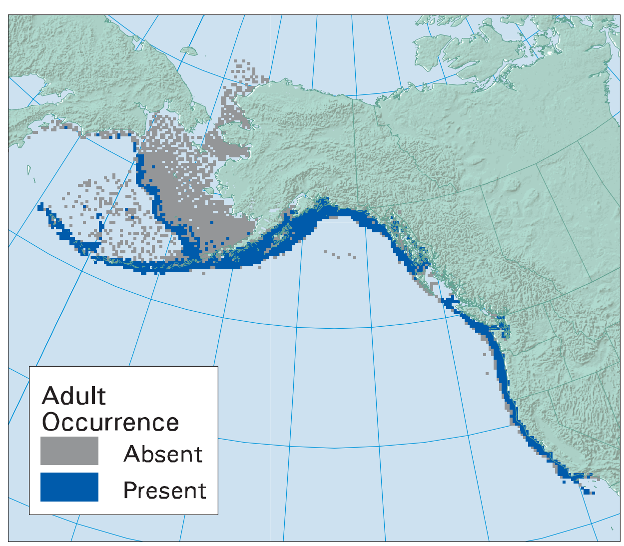
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 6386 for winter–spring (Jan–June), 800 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

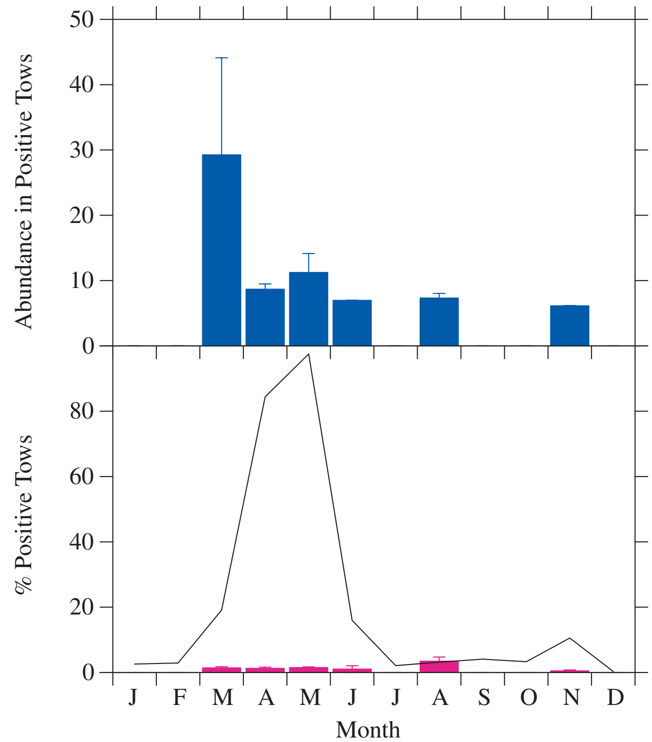

170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
6.9 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 2.295
2.295 - 8.953
8.953 - 22.720
22.720 - 233.752
0 300 600 900 km
170° 160° 150° 140° 130°


Egg Occurrence
Absent
Eggs not collected.

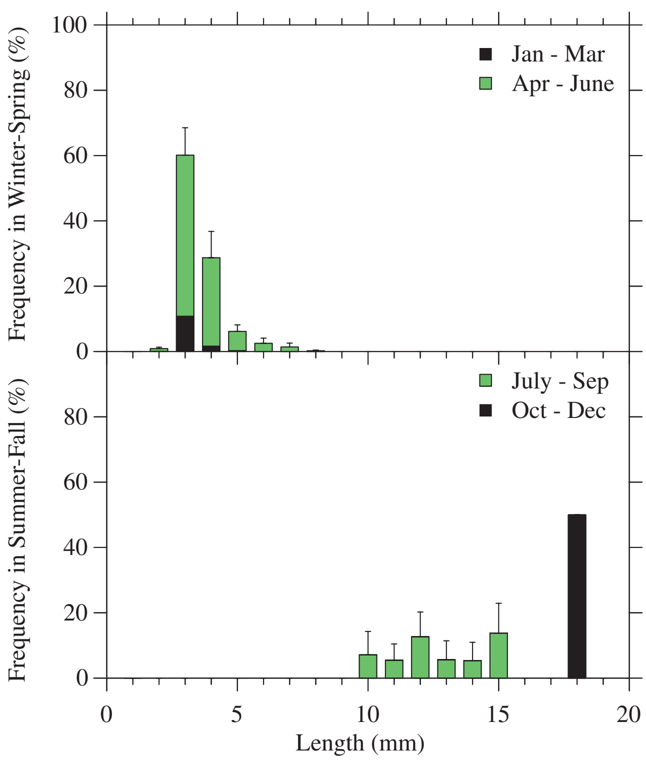

Adult Occurrence
Absent
Present

Life history The genus *Sebastolobus* is composed of three species that are all found within our study area. *Sebastolobus macrochir* are rare and larvae have not been collected in the study area. *Sebastolobus alascanus* and *S. altivelis* (Bering Sea to northern Baja California) are common and fished commercially. Adult thornyheads occupy soft-bottom slope habitat to depths of 1500 m. Spawning occurs January–June in the CalCOFI area (*S. alascanus* and *S. altivelis*). Females are oviparous and extrude eggs in gelatinous masses that float at the surface. Eggs are 1.2–1.4 mm, slightly elliptical, and have one oil globule (0.1–0.2 mm). Larvae hatch at 2.6–3.0 mm SL and cannot be identified to species until pectoral fin rays have formed at ≥10.0 mm SL. Transformation to a pelagic prejuvenile stage occurs at about 20 mm SL and lasts until 42–56 mm SL.
[Sources include: Eschmeyer et al. (1993), Matarese et al. (1989), Moser (1996e)]

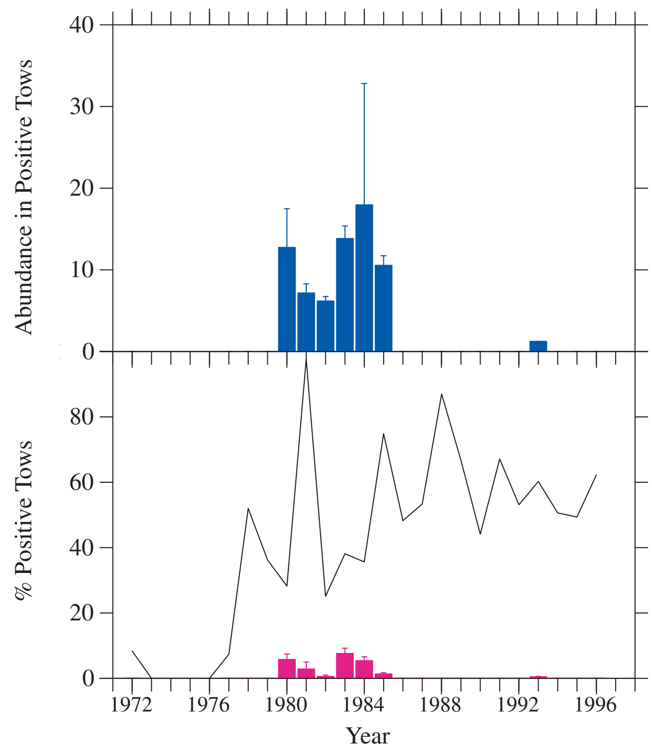
Larval distribution Thornyhead larvae are distributed in the northern Gulf of Alaska and along the U.S. west coast. Although adults are common along the outer shelf and slope in the Bering Sea and Gulf of Alaska, larvae are uncommon. Larvae are more abundant in outer shelf, slope, and oceanic waters off the U.S. west coast. Larvae are found March–June, August, and November. Small larvae <10 mm SL are collected in spring. Eggs are encountered in the Gulf of Alaska and in large numbers along the U.S. west coast. Overall, larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys or when sampling occurred in summer months.



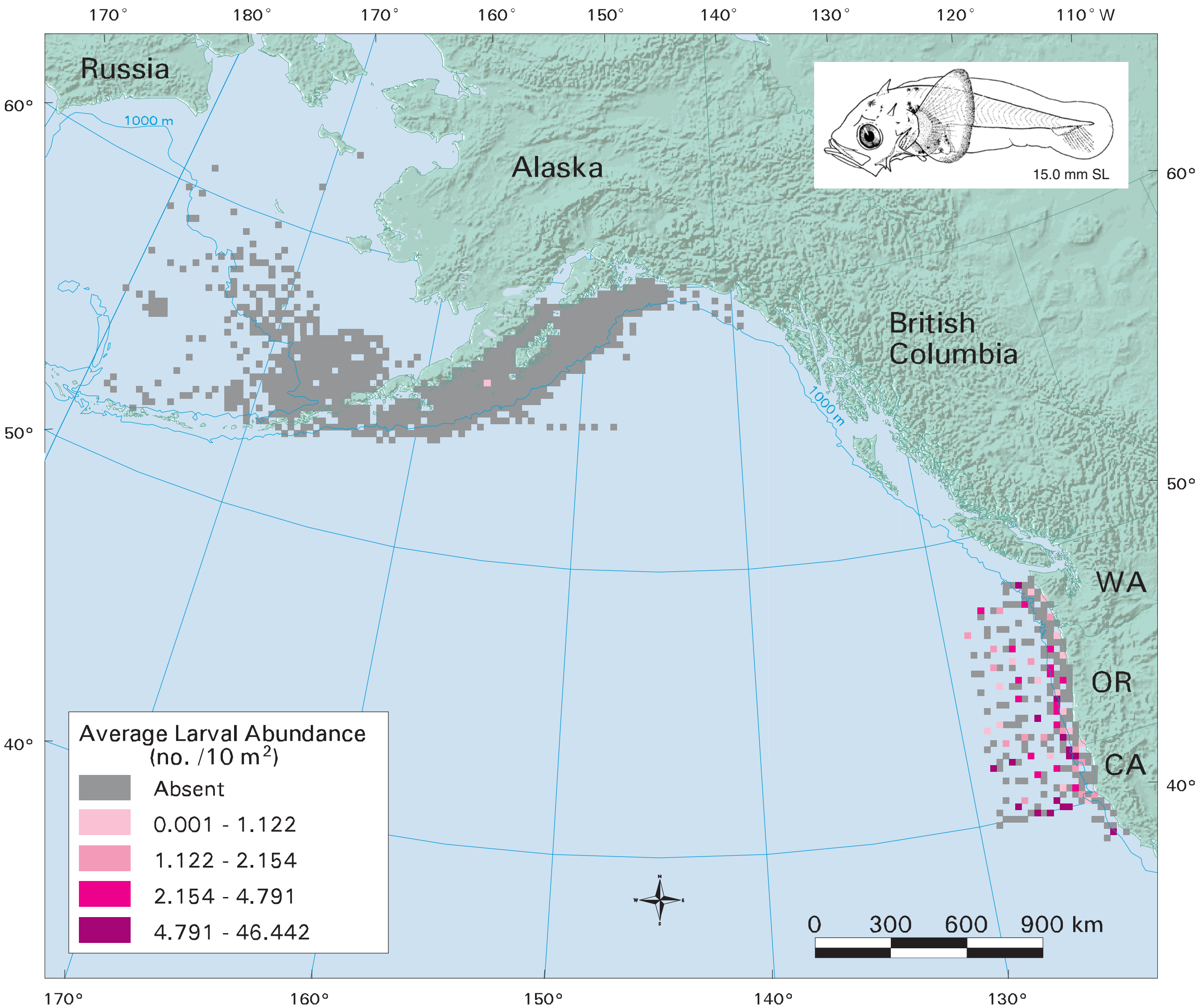
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

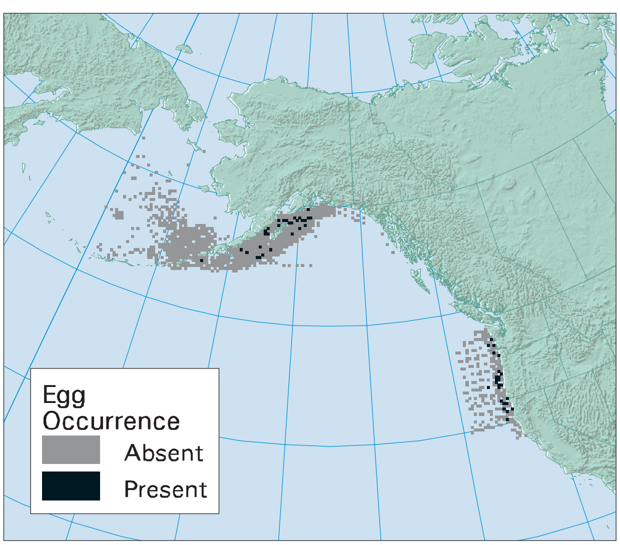


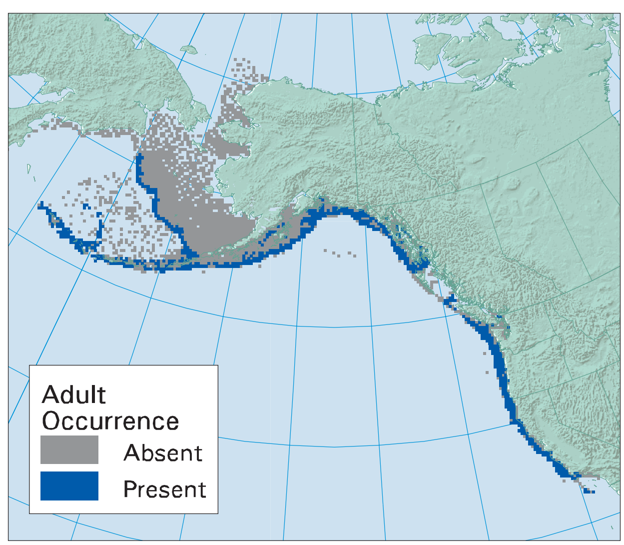
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 178 for winter–spring (Jan–June), 9 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

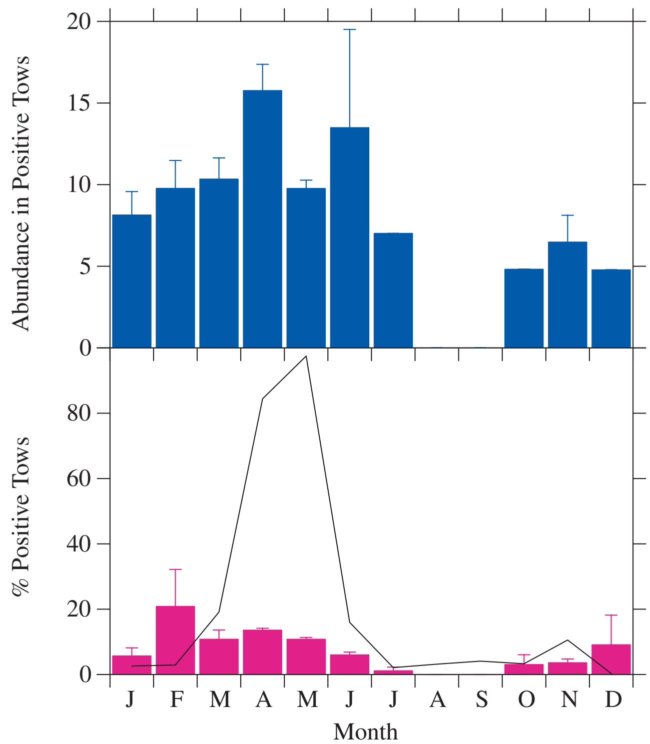

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
15.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.122
1.122 - 2.154
2.154 - 4.791
4.791 - 46.442
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

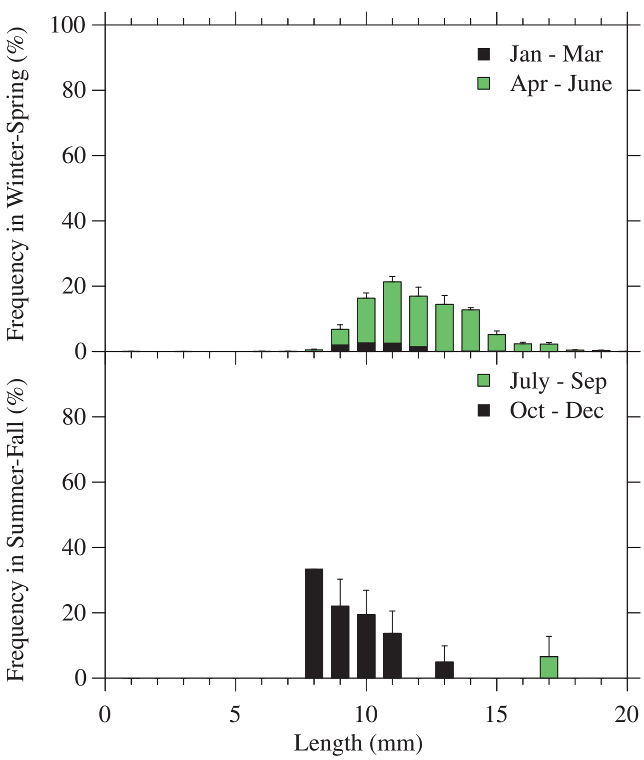

Adult Occurrence
Absent
Present

Life history *Hexagrammos decagrammus* are found from the Bering Sea to southern California, although occurrences off southern California are rare. Kelp greenling adults inhabit intertidal and nearshore areas to depths of 46 m and are commonly found in kelp beds. Demersal, adhesive eggs are pale blue and laid in masses on rocks during October and November. Larvae hatch at 7–9 mm SL and reside in the neuston until completion of an extended juvenile transformation stage (about 70 mm SL).
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

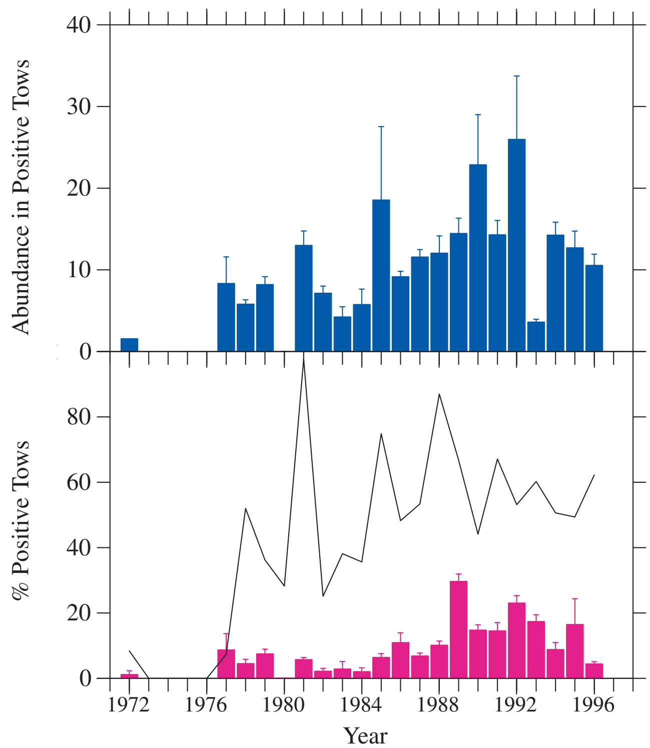
Larval distribution Kelp greenling larvae are found throughout the study area from the Bering Sea and Gulf of Alaska to off the U.S. west coast. They are abundant along the shelf edge around Unimak Pass in the Bering Sea, Shelikof sea valley, and in the Gulf of Alaska around Kodiak Island. Larvae have been collected every month except in late summer during August and September. Newly hatched larvae (<15 mm SL) are more abundant in winter–spring. Highest catches are in winter–spring (8–19 mm SL); a few small larvae (8–17 mm SL) are collected in the summer–fall. Overall catch by year indicates larvae were collected throughout the time series.



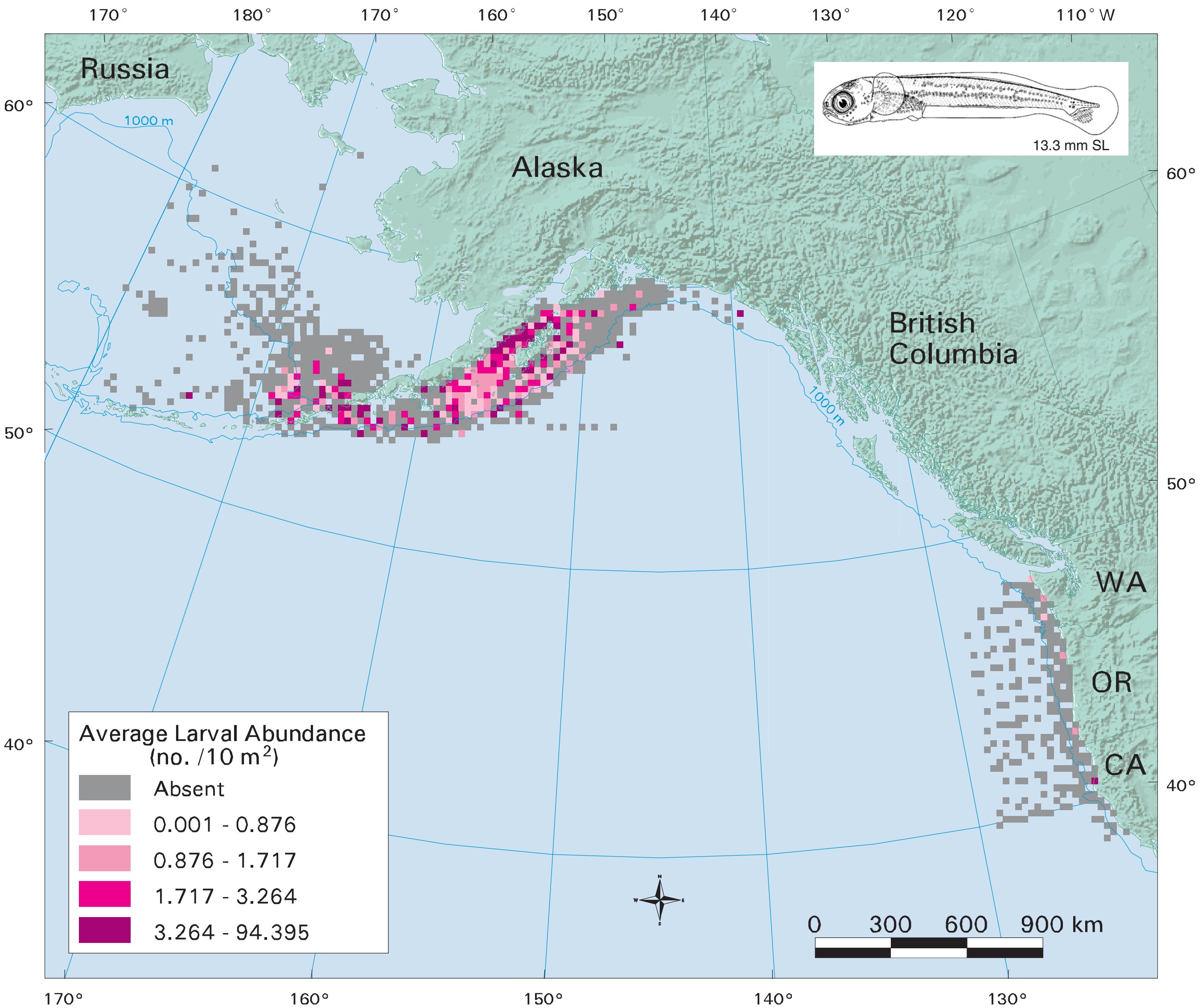
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

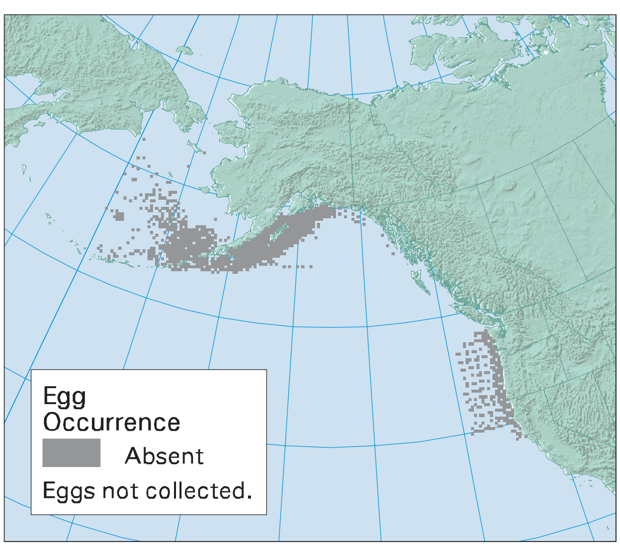


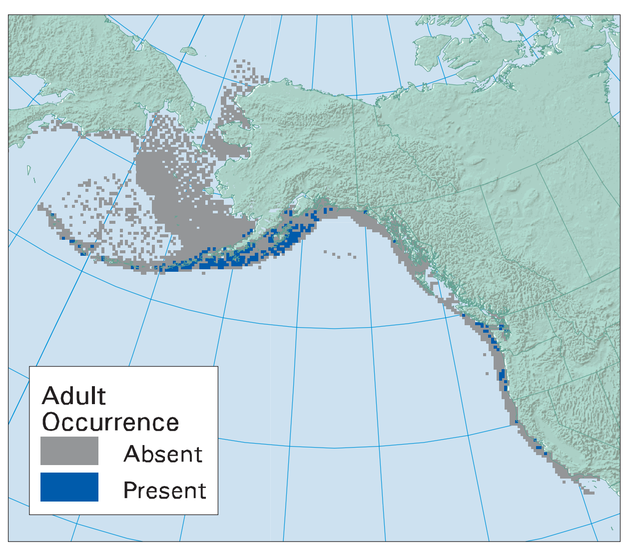
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 2397 for winter–spring (Jan–June), 19 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

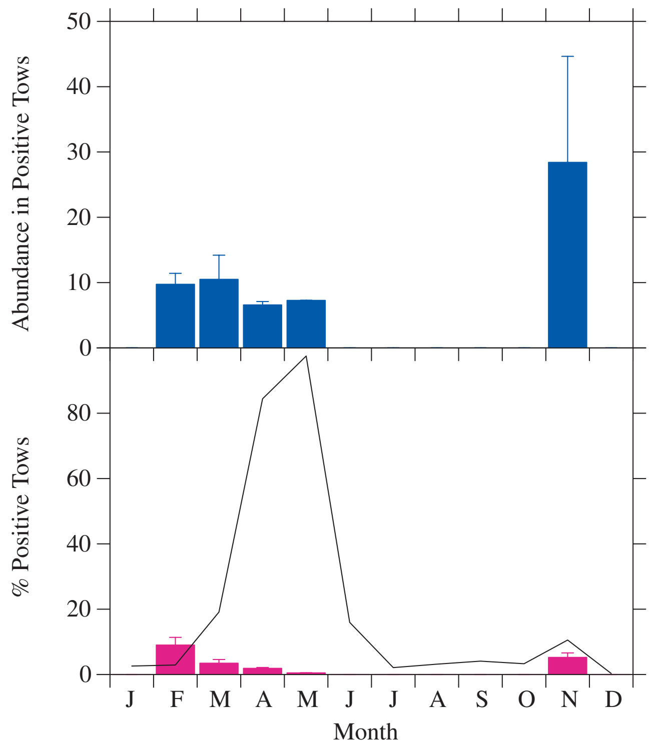

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
13.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.876
0.876 - 1.717
1.717 - 3.264
3.264 - 94.395
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

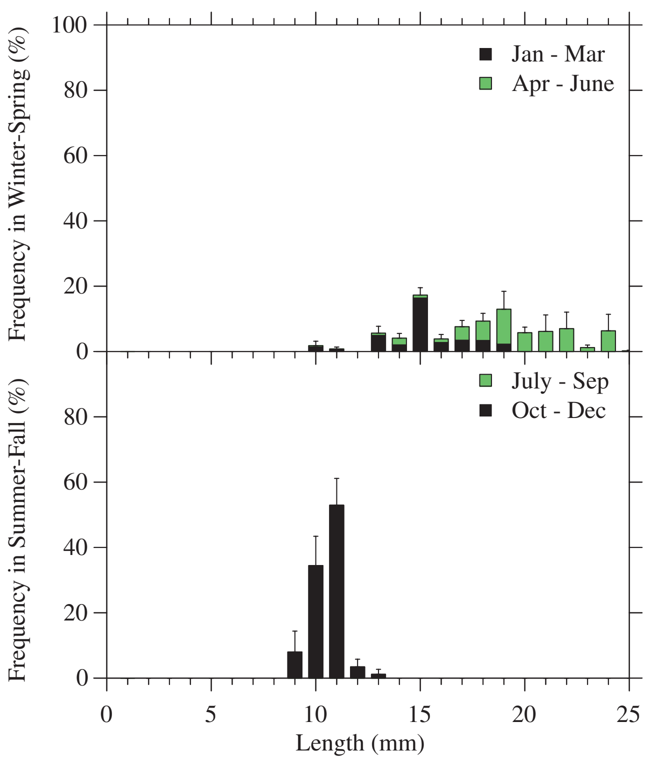

Adult Occurrence
Absent
Present

Life history *Pleurogrammus monopterygius* have been reported from the Bering Sea to southern California, although occurrences south of Alaska are rare. Atka mackerel are a schooling, semi-demersal species found from intertidal areas to depths of 575 m. Adults mature at 3–4 years and may live up to 11 years. In summer they move shoreward where males establish nesting areas. Females deposit 3,600–18,694 demersal, attached eggs (2.5–2.8 mm) in nests guarded by males. Larvae hatch at about 8 mm SL and reside in the neuston until completion of an extended transformation stage (about 75 mm SL). [Sources include: Gorbunova (1962), Matarese et al. (1989)]

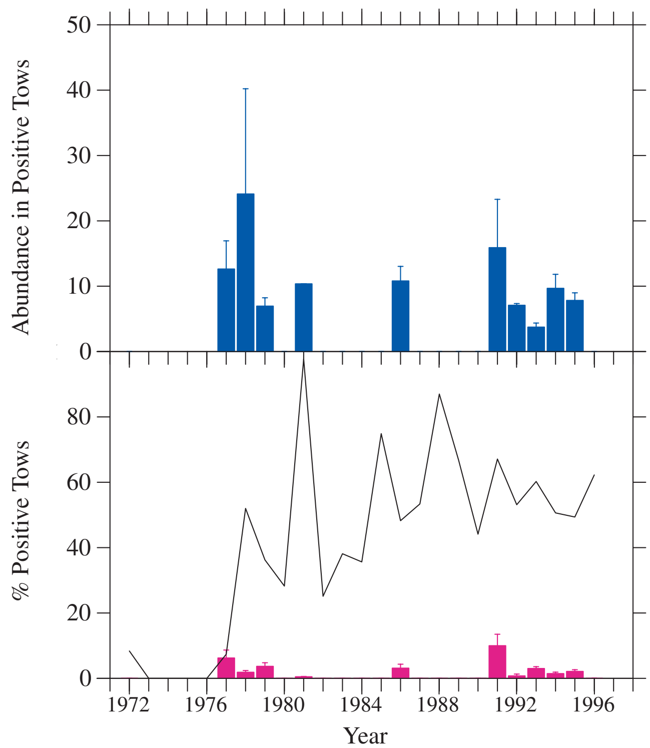
Larval distribution Atka mackerel larvae are collected in the Bering Sea and Gulf of Alaska. Patches of high abundance are widely distributed over the Bering Sea and east of Kodiak Island. Larvae are found primarily in fall–winter (November–April). Small larvae (9–13 mm SL) are found in fall, whereas larger larvae and pelagic prejuveniles (10–24 mm SL) are found in winter–spring. Overall catch by year indicates the presence of larvae in the time series has been sporadic, but they were abundant during the late 1970s when sampling east of Kodiak Island was more frequent and in the 1990s when sampling in the Bering Sea increased. Overall, larvae in the Gulf of Alaska were abundant in neuston samples; numbers appeared higher in bongo catches in the Bering Sea since neuston sampling was limited.



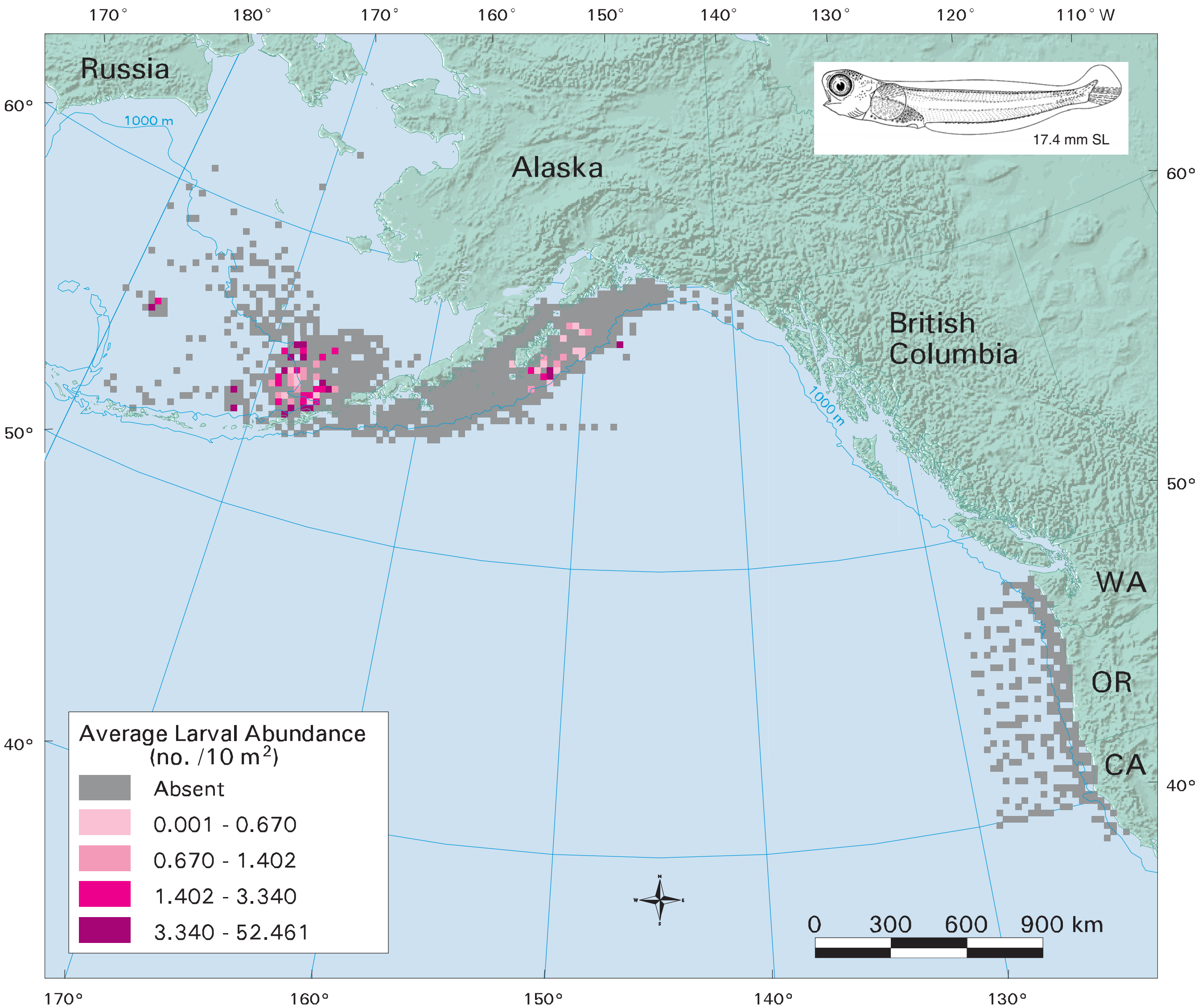
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



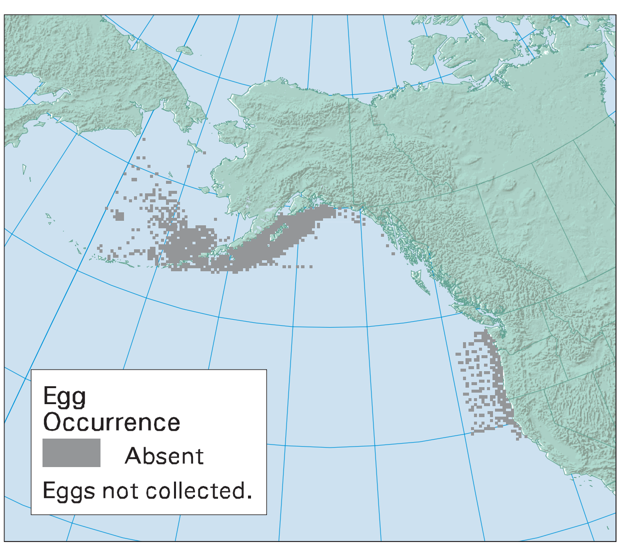
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 122 for winter–spring (Jan–June), 60 for summer–fall (July–Dec).



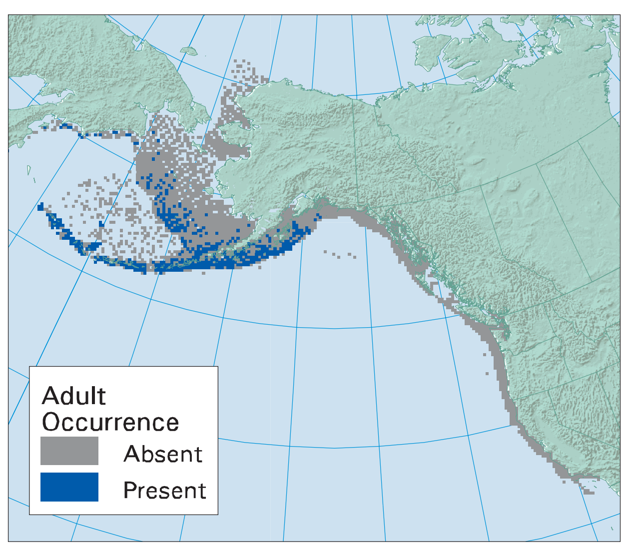
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
17.4 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 0.670
0.670 - 1.402
1.402 - 3.340
3.340 - 52.461
0 300 600 900 km



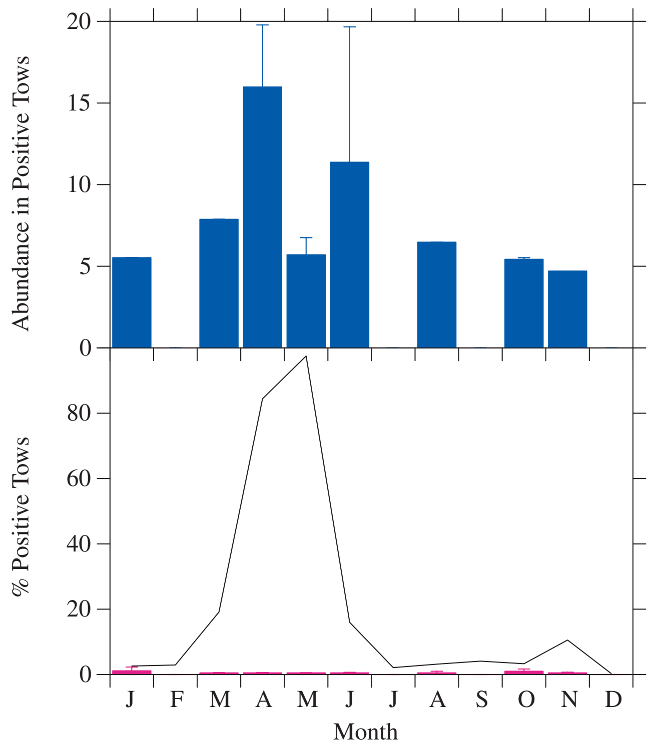
Egg Occurrence
Absent
Eggs not collected.



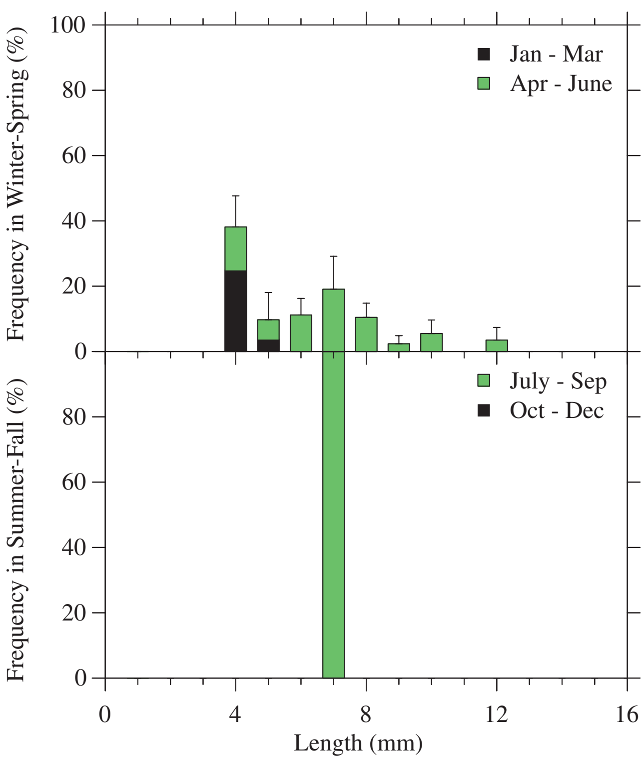
Adult Occurrence
Absent
Present

Life history *Artedius fenestralis* are found from the Aleutian Islands to central California. Padded sculpin adults are demersal fishes, living along the nearshore shelf from the intertidal zone to depths of 55 m. Spawning occurs intertidally under rocks February–May. Eggs are demersal, adhesive, and spawned in nests. Larvae hatch at sizes of 3.5–3.8 mm SL, undergo notochord flexion at lengths of 5.9–6.8 mm SL, and transform at 12–14 mm SL. Larvae are uncommon in the CalCOFI survey area. [Sources include: Matarese et al. (1989), Ambrose (1996b)]

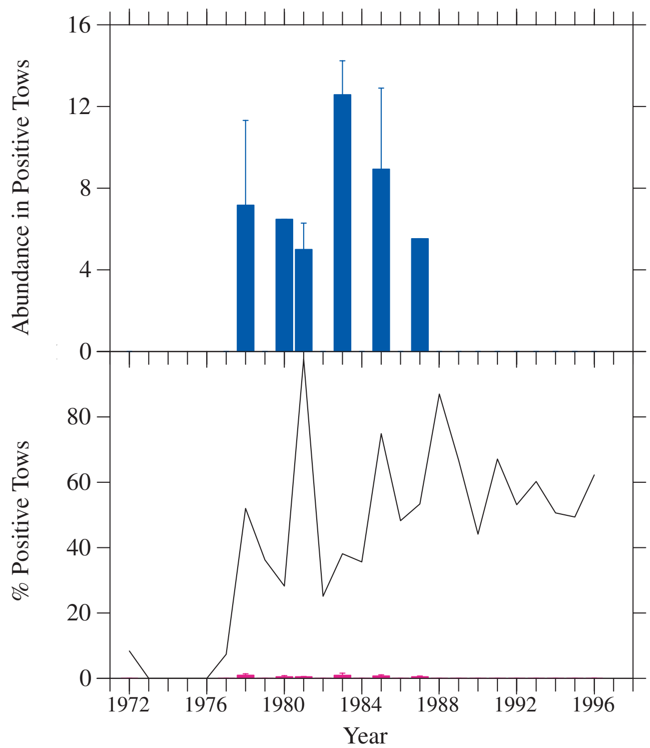
Larval distribution Padded sculpin larvae are collected over the shelf around Kodiak Island in the Gulf of Alaska and along the U.S. west coast. Adults are not collected in AFSC adult surveys and available data on distribution patterns are limited. Larvae are more numerous inshore along coastal regions. Larvae occur intermittently in low numbers throughout the year January–November. Most larvae are collected in winter–spring and range in size from 4 to 12 mm SL. Overall catch by year indicates that larvae were most common in the late 1970s and 1980s when AFSC conducted U.S. west coast surveys and sampled more frequently east of Kodiak Island.



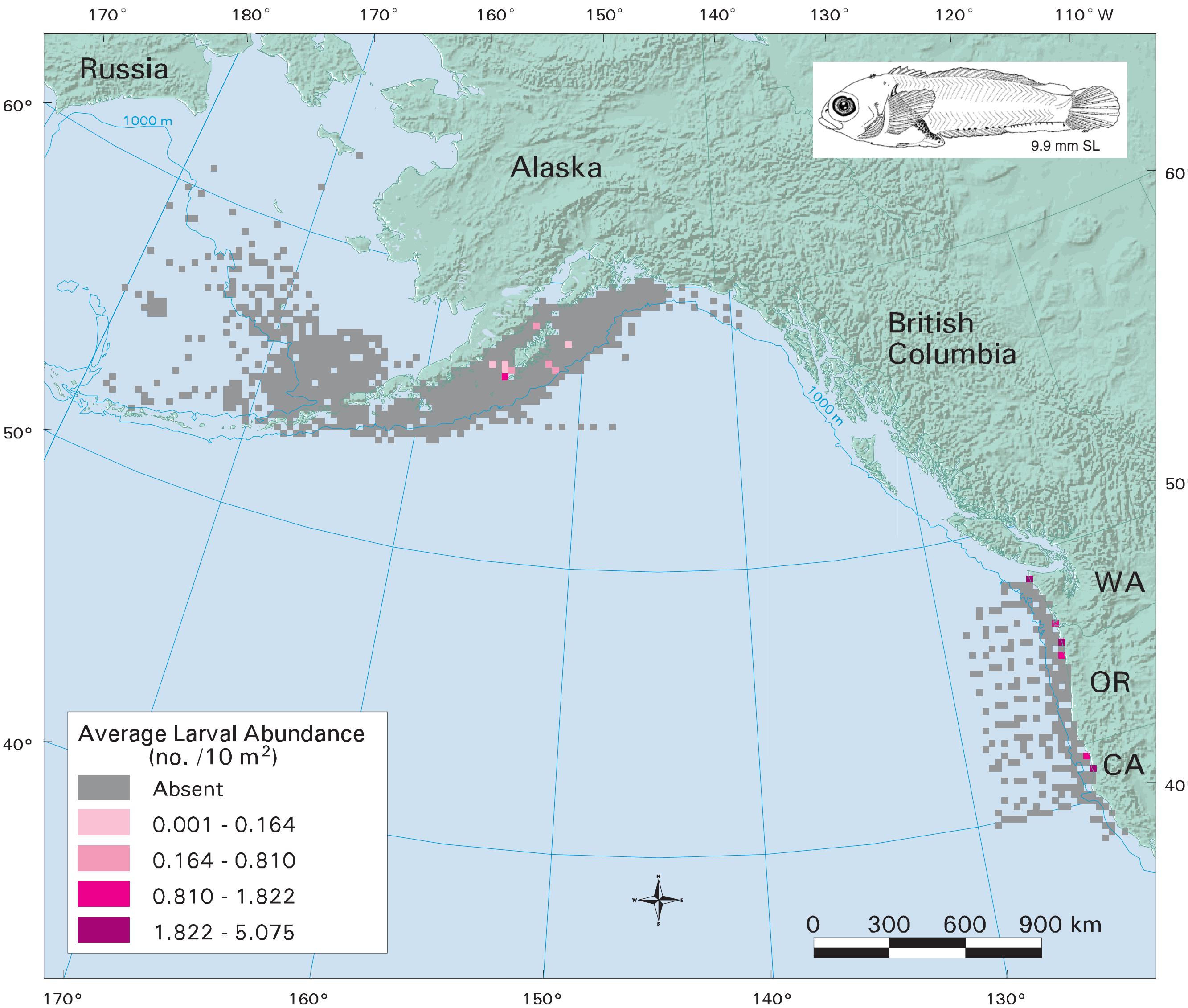
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

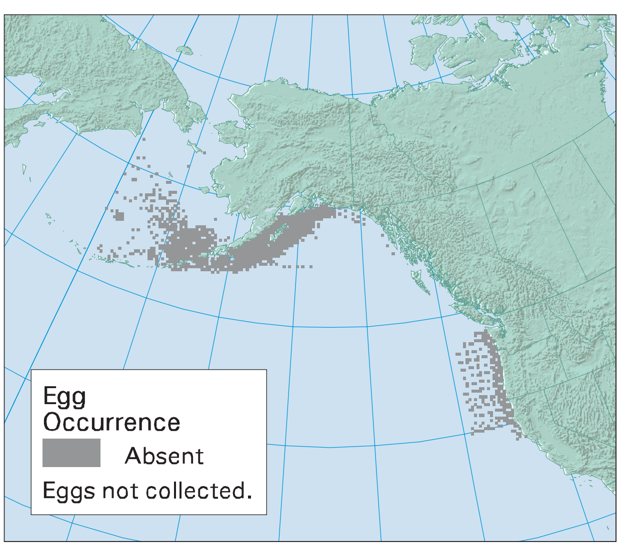


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 18 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

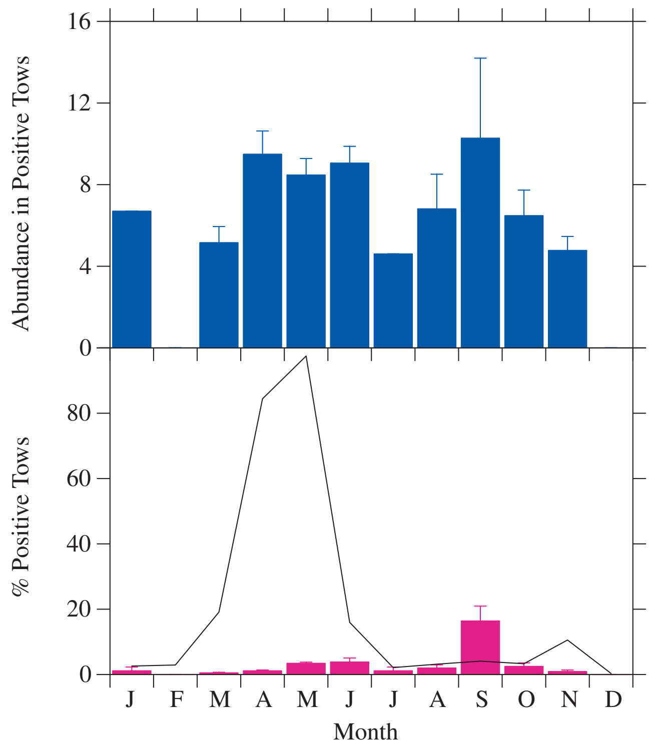

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
60°
50°
40°
9.9 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.164
0.164 - 0.810
0.810 - 1.822
1.822 - 5.075
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

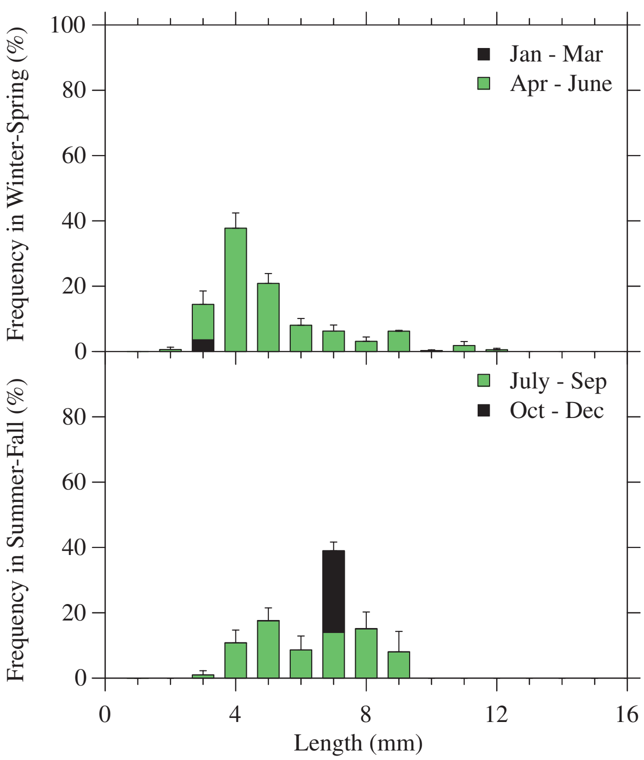

Adult Occurrence*
Present
(Occurrence only)

Life history *Artedius harringtoni* are found from the Aleutian Islands to southern California. Adult scalyhead sculpins are demersal and occur in intertidal and near-shore shelf areas to depths of about 21 m. Spawning (at least in the southern portion of their range) may occur in spring and internal fertilization is likely. Larvae hatch at sizes <3 mm SL, undergo notochord flexion at 5.2–6.4 mm SL, and transform at 12–14 mm SL. Larvae are uncommon in the CalCOFI study area.
[Sources include: Matarese et al. (1989), Ambrose (1996b)]

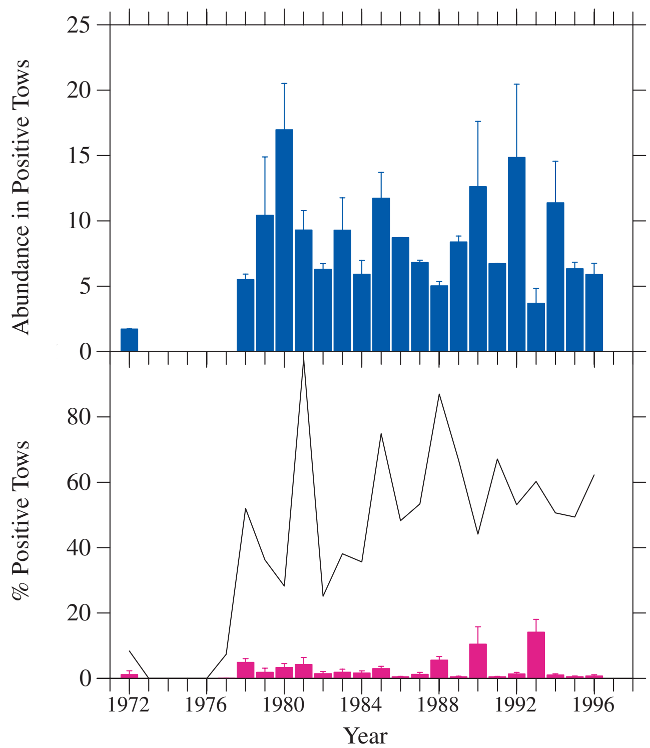
Larval distribution Scalyhead sculpin larvae are distributed throughout the continental shelf regions from Unimak Pass along the Alaska Peninsula, around Kodiak Island in the Gulf of Alaska, and nearshore along the U.S. west coast. Adults are not collected in AFSC adult surveys and available data on distribution patterns are limited. Larvae are more abundant in coastal and shelf areas, and in shallower water. Larvae are collected during most of the year January–November, with highest numbers occurring in spring–summer. The majority of larvae (2–12 mm SL) are collected in winter–spring, but small larvae (3–9 mm SL) are also taken in summer–fall. Overall catch by year indicates that larvae were found in low numbers throughout most of the time series.



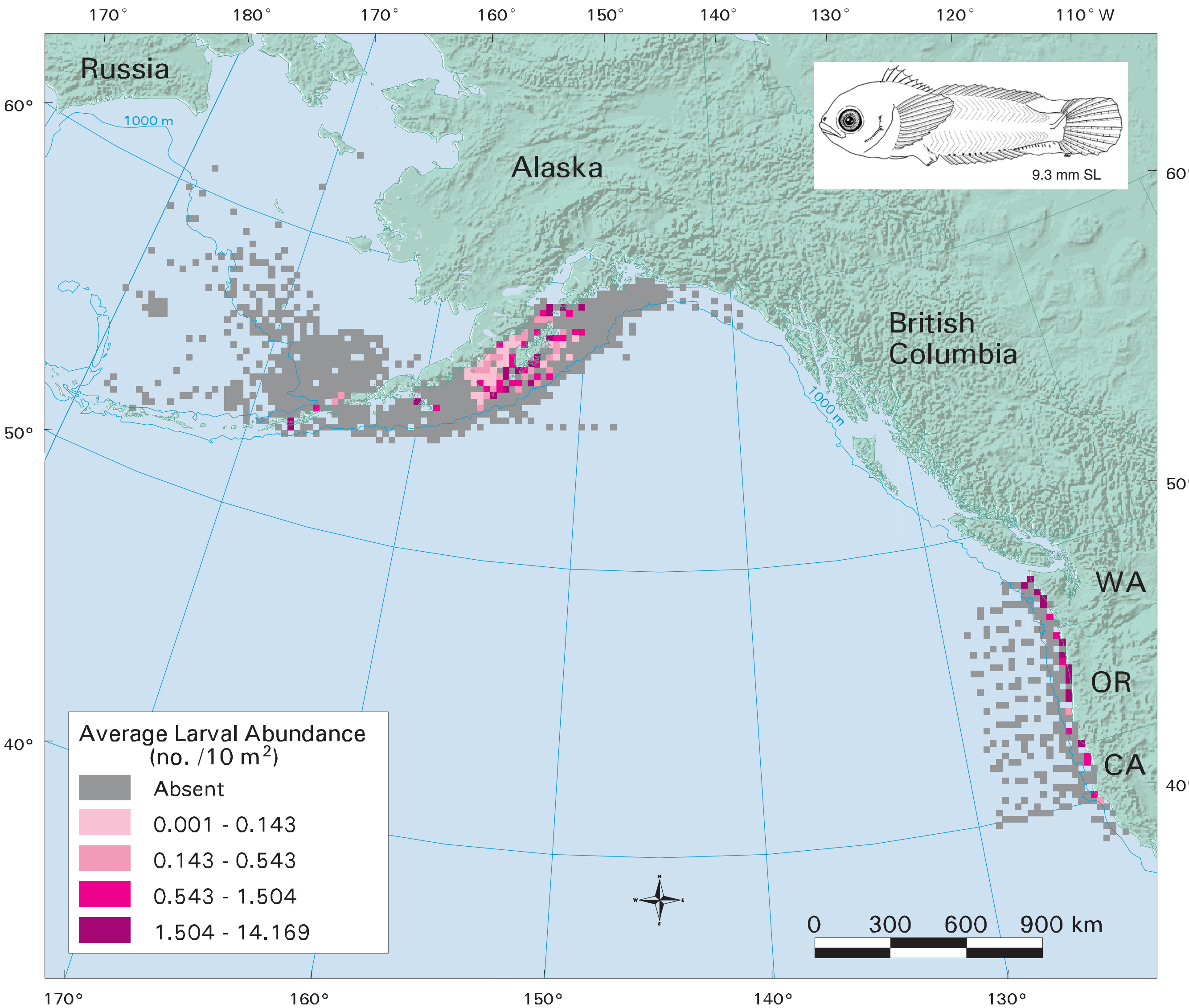
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

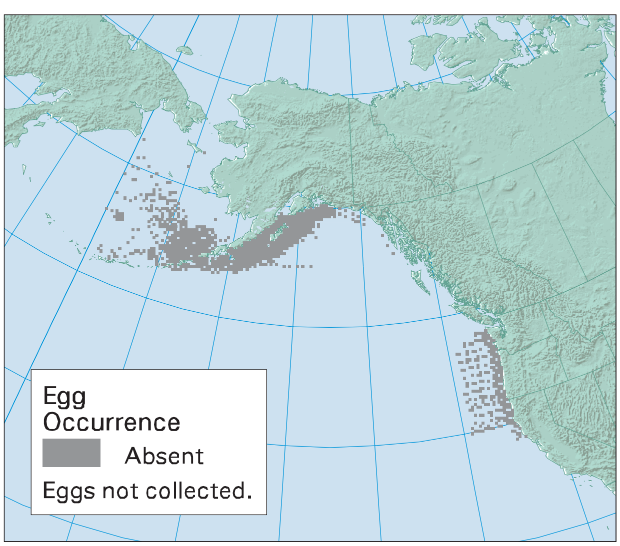


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 245 for winter–spring (Jan–June), 27 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

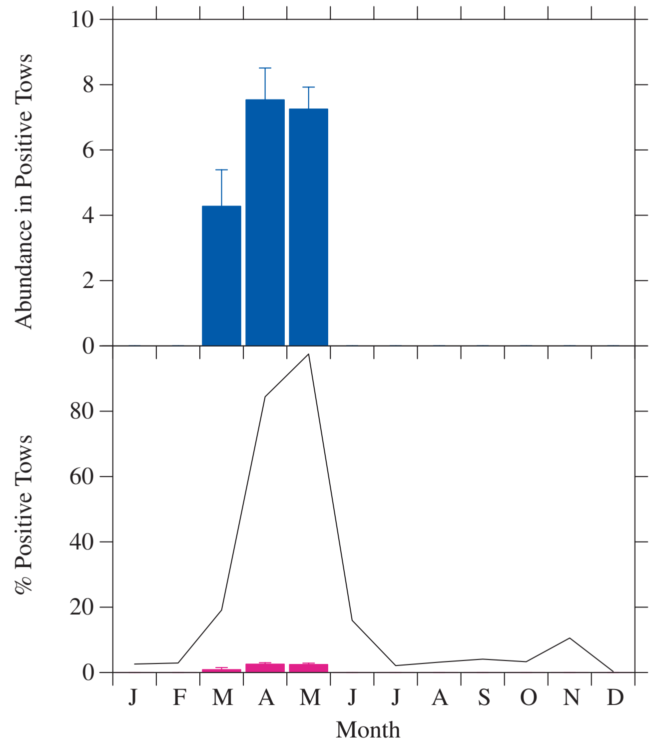

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
9.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.143
0.143 - 0.543
0.543 - 1.504
1.504 - 14.169
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

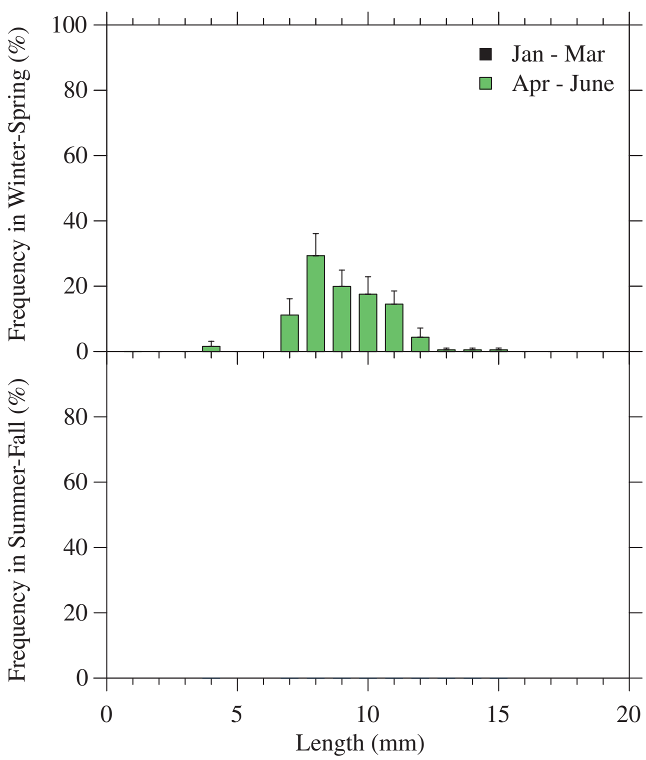

Adult Occurrence*
Present
(Occurrence only)

Life history *Gymnocanthus* spp. adults occur in arctic waters, Bering Sea, and along the eastern Pacific coast to the Alaska–British Columbia border. At least four species (*G. detrisus*, *G. galeatus*, *G. pistilliger*, and *G. tricuspis*) are known to occur as adults in our study area (*G. tricuspis* are found only as far south as Norton Sound, Alaska). Little is known of their ecology and life history patterns. *Gymnocanthus galeatus* adults are collected on soft bottom, near shore to 167 m, but more commonly at depths below 50 m. *Gymnocanthus pistilliger* are most abundant in Bristol Bay, Alaska, in waters less than 50 m deep. Eastern Bering Sea *G. pistilliger* are short-lived (9–10 years) and spawn late winter–early spring. Larvae of at least one species (identified as *Gymnocanthus* A—probably *G. galeatus*) have been collected in AFSC surveys in the Northeast Pacific.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989), Hoff (2000)]

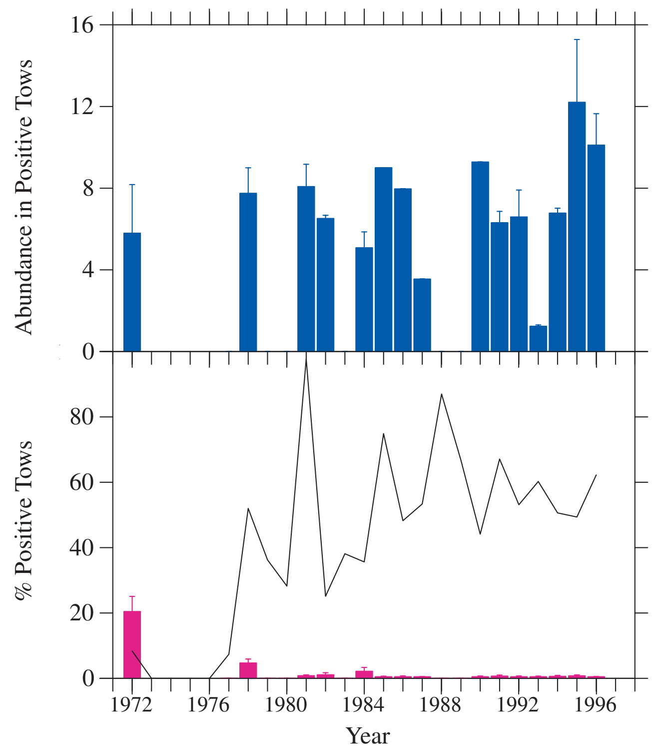
Larval distribution Larvae of the genus *Gymnocanthus* are found over shelf waters of the Bering Sea and Gulf of Alaska around Kodiak Island. Abundances are higher in the Bering Sea and in the Gulf of Alaska around Kodiak Island. Larvae representing more than one species occur March–May, with abundances higher later in the spring. Although they range in size from 4–15 mm SL, most larvae in winter–spring are small (<10 mm SL). Overall catch by year indicates larvae in this genus were uncommon, but were collected in most years during the time series.



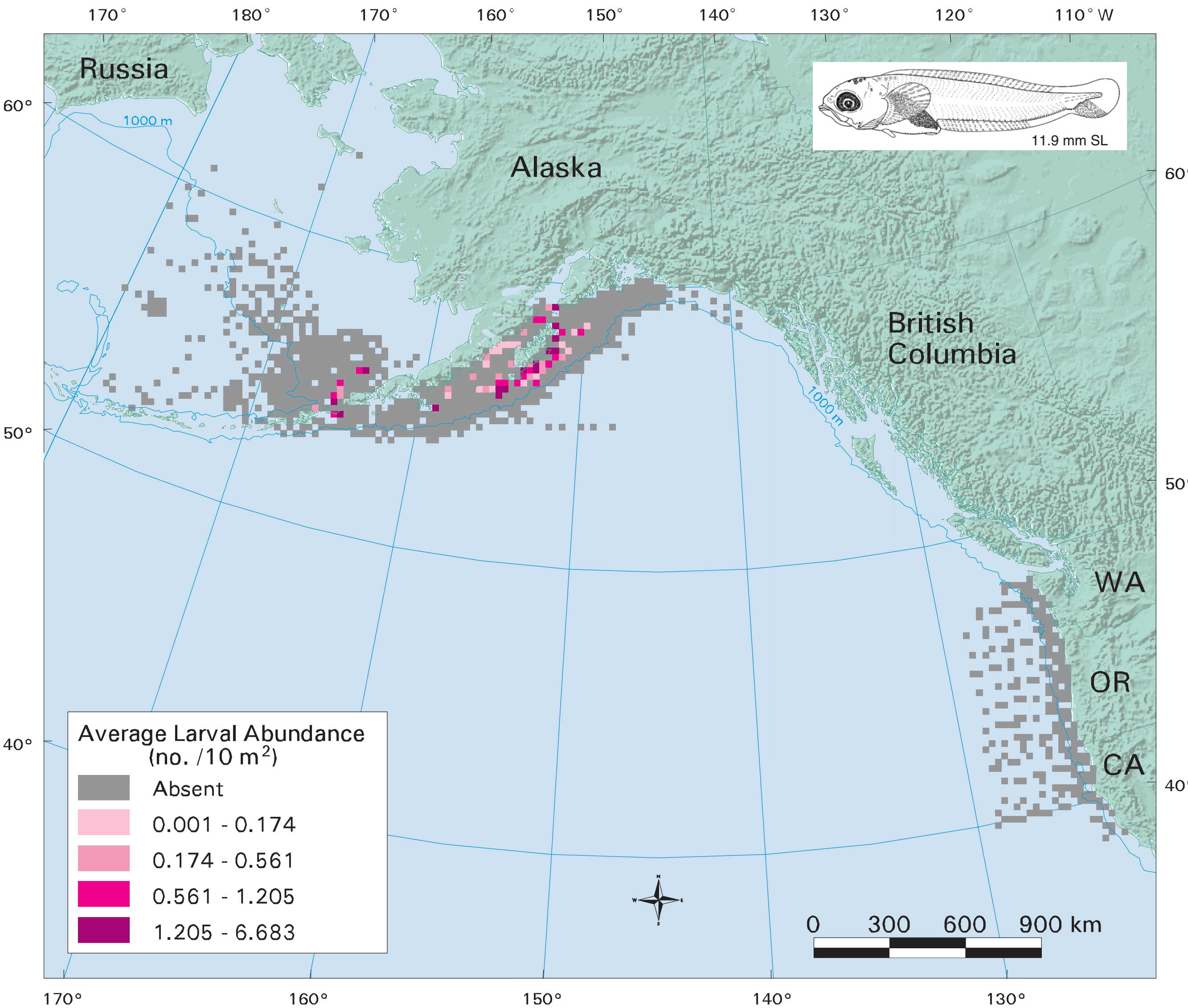
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

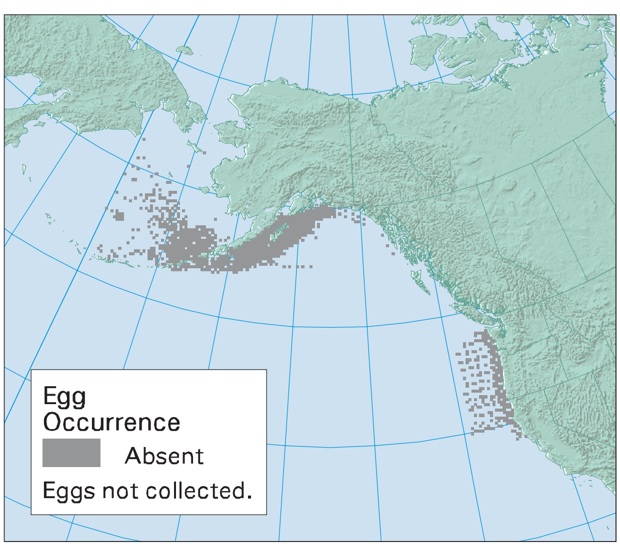


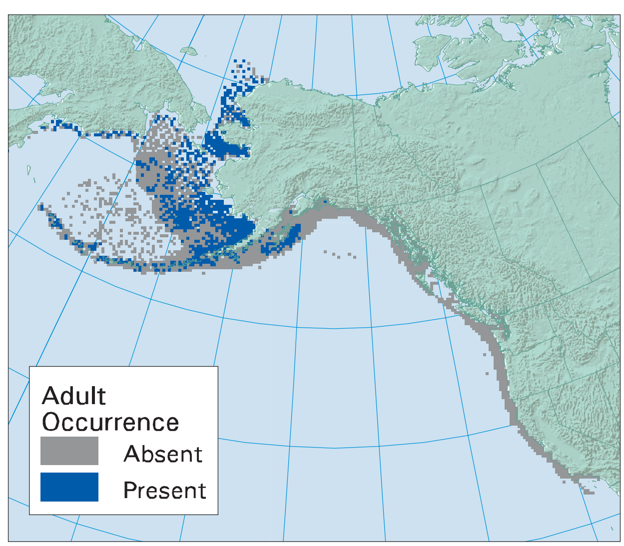
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 62 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

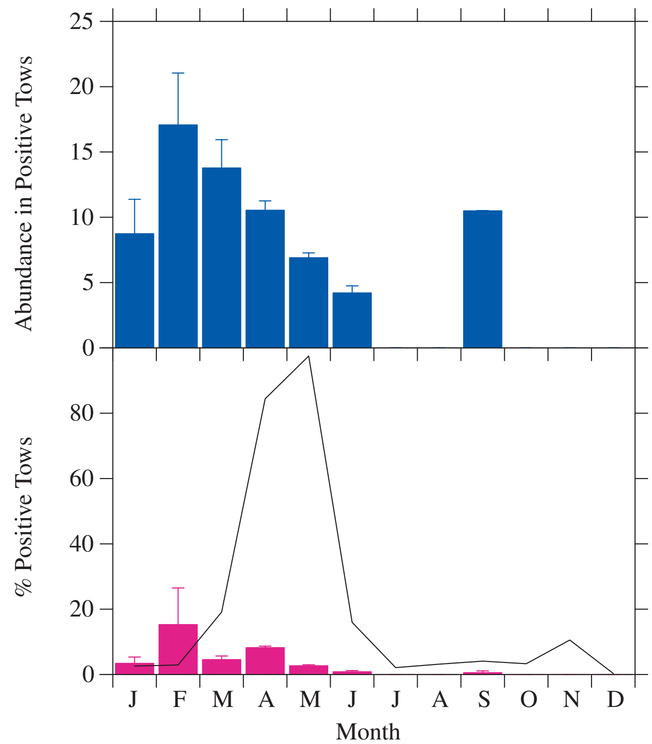

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
11.9 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.174
0.174 - 0.561
0.561 - 1.205
1.205 - 6.683
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

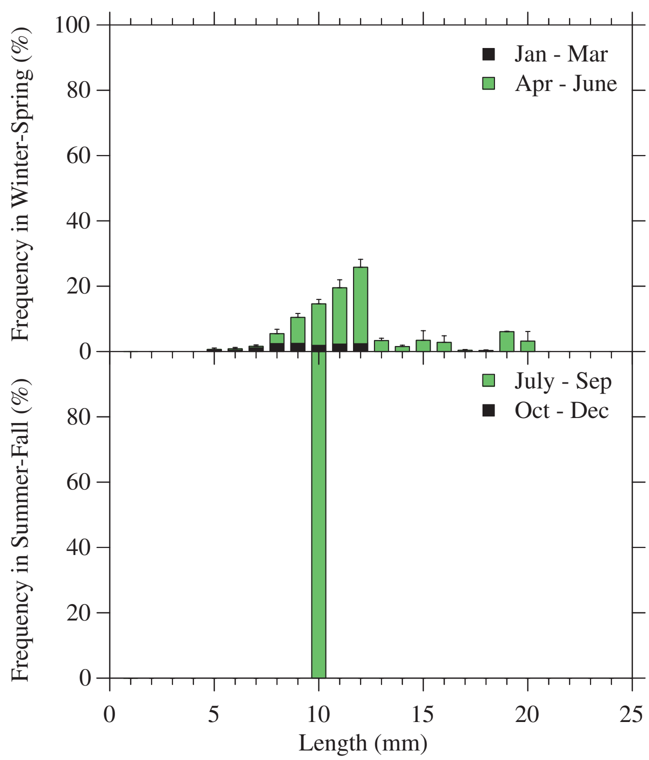

Adult Occurrence
Absent
Present

Life history *Hemilepidotus hemilepidotus* are found from the Bering Sea to central California and are most common in Alaska, from rocky intertidal areas to depths of 275 m. Red Irish lords have been reported to reach 51 cm TL, but are generally no greater than 30 cm TL. After adults reach maturity at 4 years, females deposit 59,000–126,000 demersal, adhesive eggs (about 1.5 mm in diameter) on rocks or pilings in areas of high current velocities October–January. One or both parents guard the eggs. Pelagic larvae hatch at 5–6 mm SL; transformation to juveniles (also pelagic) takes place at 19–23 mm SL. Larvae and prejuveniles are also neustonic. [Sources include: Eschmeyer et al. (1983), Matarese et al. (1989), Doyle et al. (1995)]

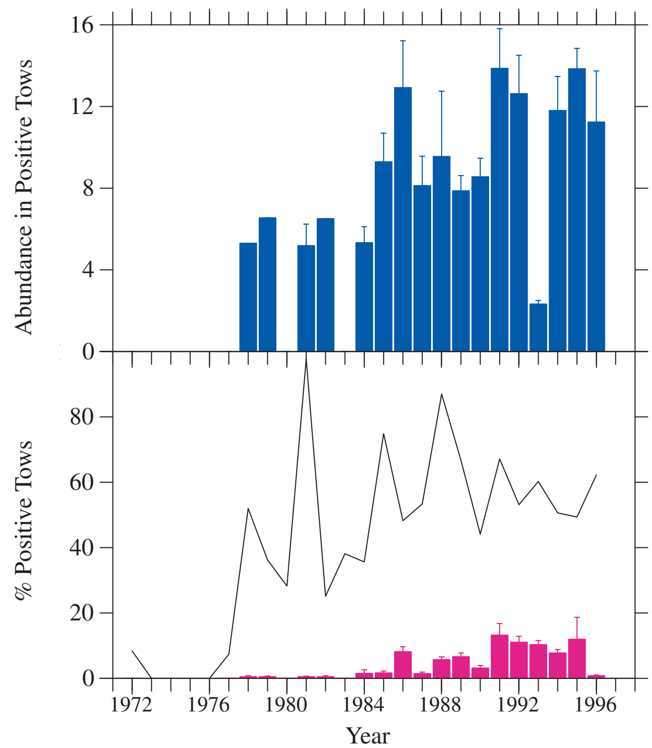
Larval distribution Red Irish lord larvae are taken in the southeastern Bering Sea, Shelikof sea valley to northeast of Kodiak Island in the Gulf of Alaska, and along the U.S. west coast off Oregon. Highest concentrations of larvae are in the southeastern Bering Sea north of Unimak Pass over both shelf and slope waters. Larvae are collected January–September, but abundances are higher in winter–spring. Although larvae collected in winter–spring represent a wide size range (5–20 mm SL), the majority of larvae are small (8–12 mm SL). Overall catch per year indicates larvae were common in samples from the late 1980s and 1990s when sampling in the Bering Sea was more frequent.



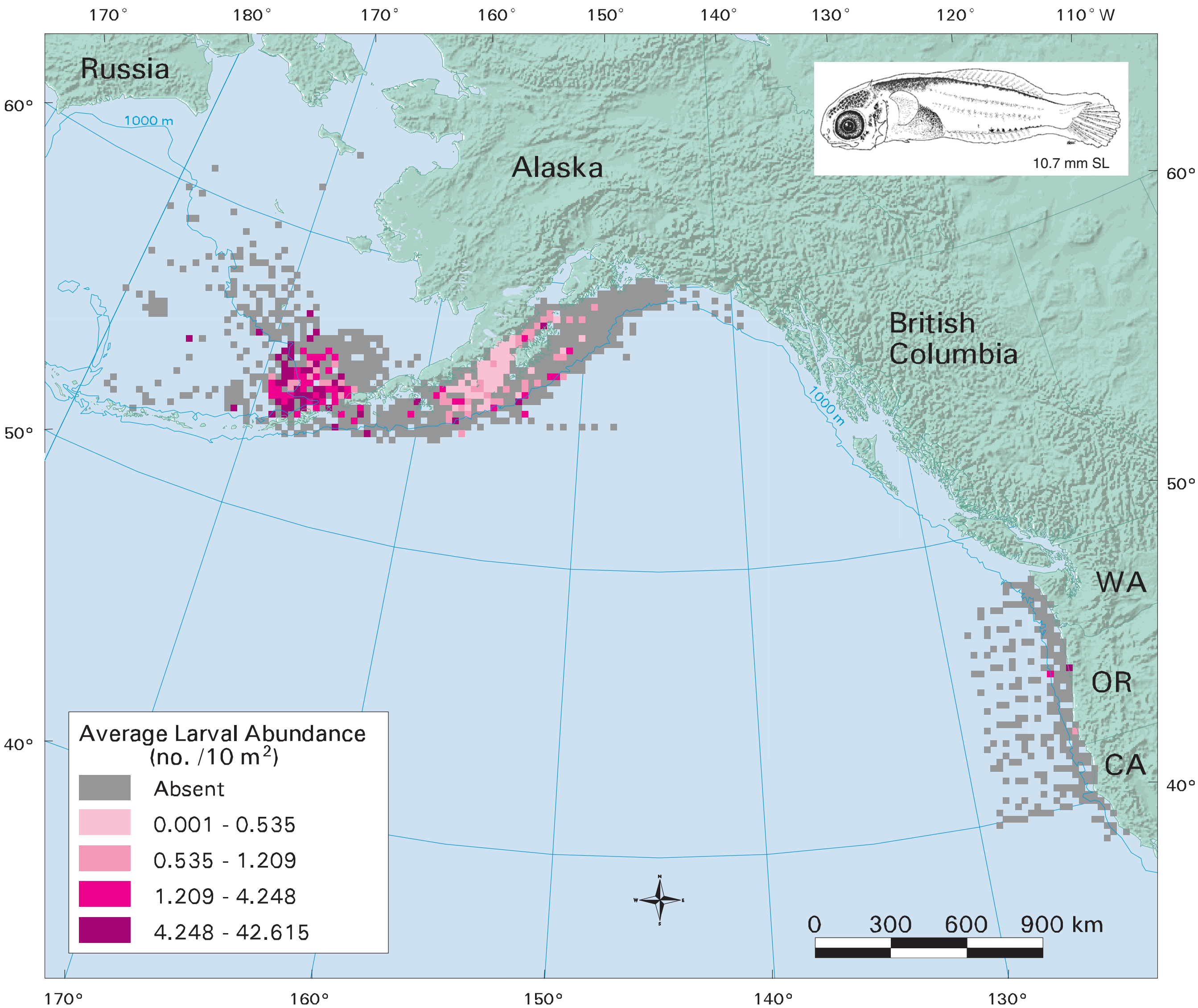
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

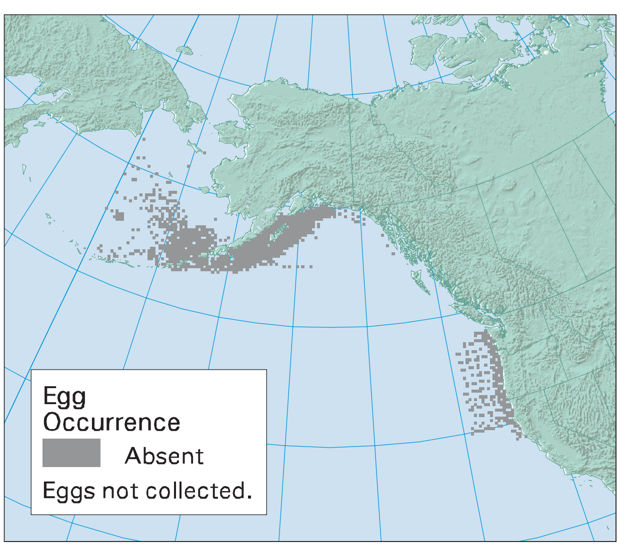


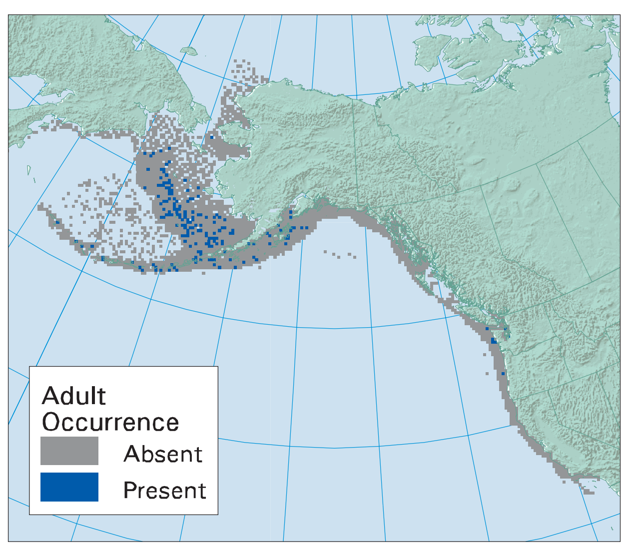
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 738 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

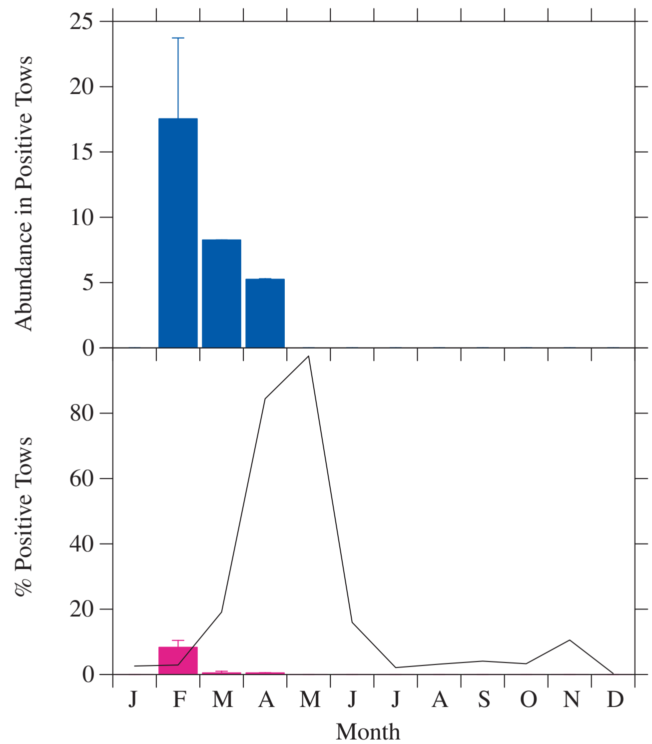

170° 180° 170° 160° 150° 140° 130° 120° 110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.7 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.535
0.535 - 1.209
1.209 - 4.248
4.248 - 42.615
0 300 600 900 km
170° 160° 150° 140° 130°


Egg Occurrence
Absent
Eggs not collected.

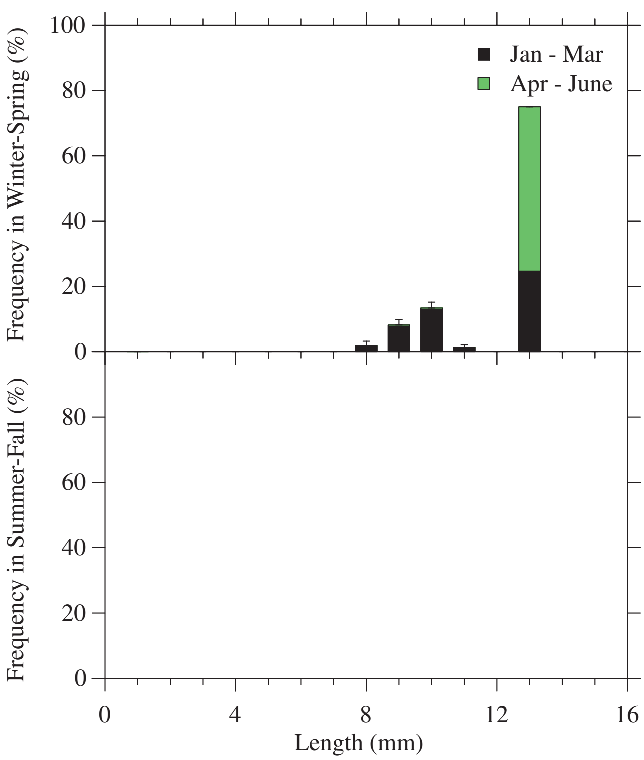

Adult Occurrence
Absent
Present

Life history *Hemilepidotus zapus* range from the Chukchi Sea to the Aleutian Islands. Less common than other members of the genus, longfin Irish lords are found along nearshore shelf bottom habitat at depths of 61–107 m. They are by far the smallest of the Irish lords; adults grow to only 13 cm TL. Eggs are probably demersal. Pelagic larvae hatch at 4.3 mm SL and transform at >22.8 mm SL.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

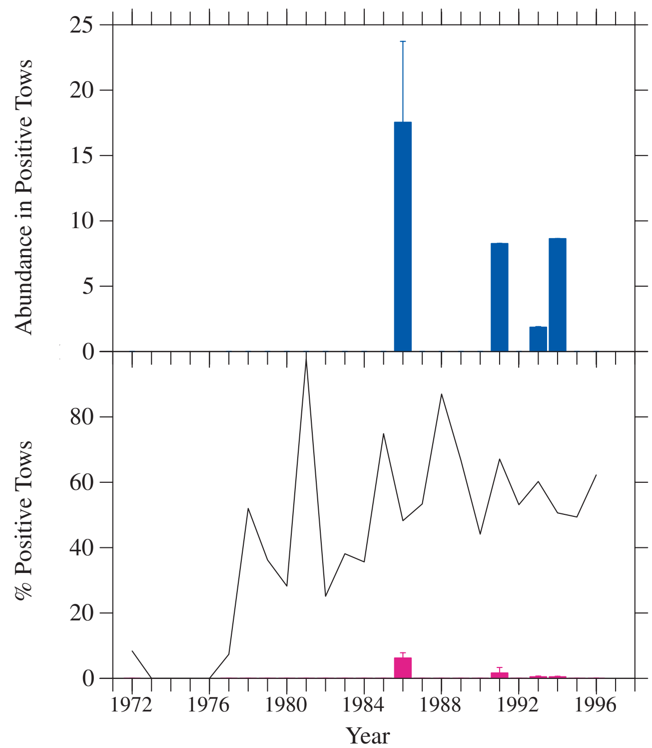
Larval distribution Longfin Irish lord larvae are found over the deep-water areas (>1000 m) in the central Bering Sea and on the shelf near Unimak Pass. Adult collections from AFSC surveys are limited to the Aleutian Islands. Small and newly hatched larvae (8–12 mm SL) are collected February–April with highest abundances in February. Larvae were rarely encountered over the years (1986, 1991, 1993–1994) and collections were limited to those years that AFSC sampled in the Bering Sea during winter. Larvae were also collected using neuston nets (8 tows in 1979, lengths of larvae unavailable), but since neuston nets were not used routinely in the Bering Sea, data were limited.



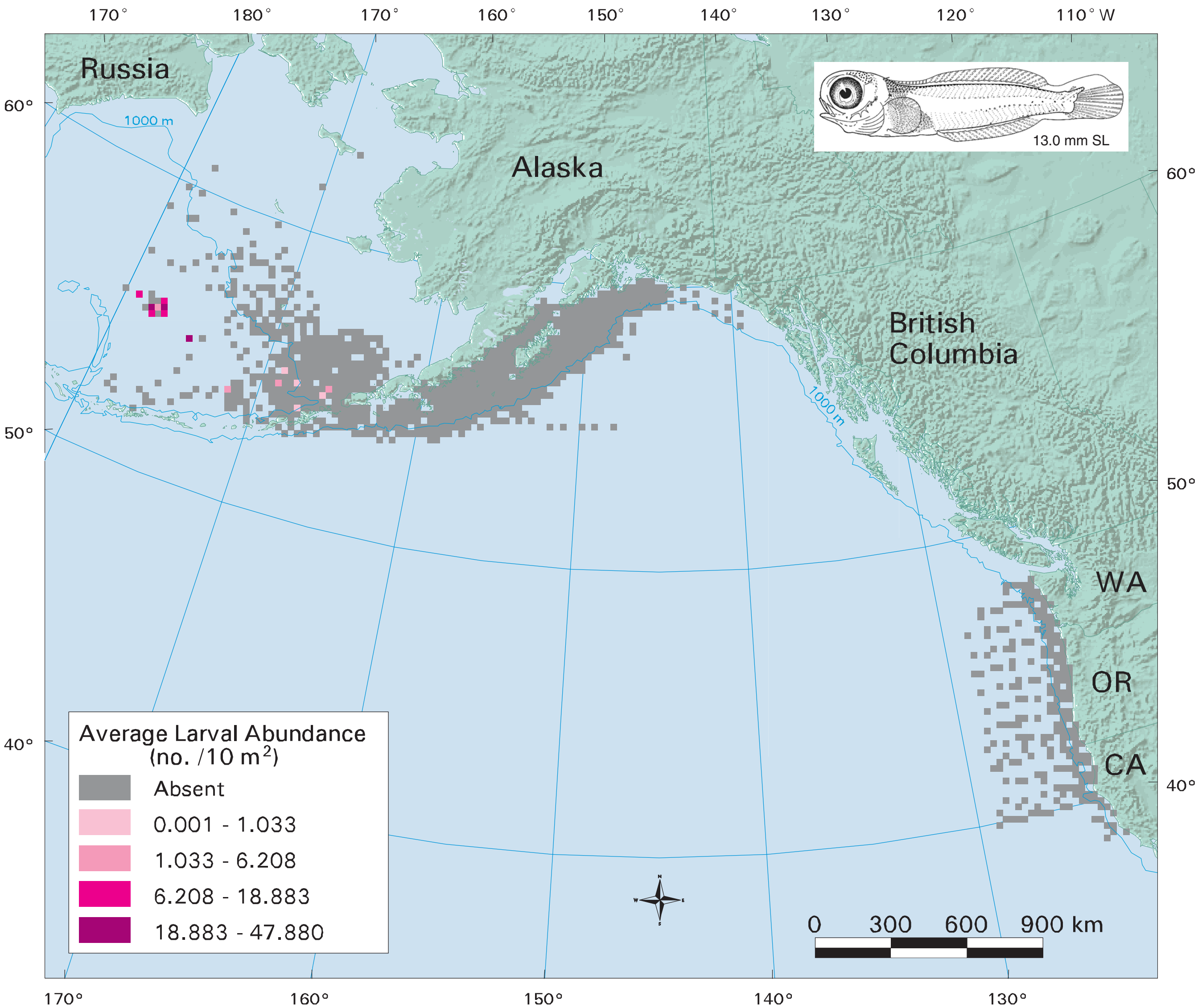
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

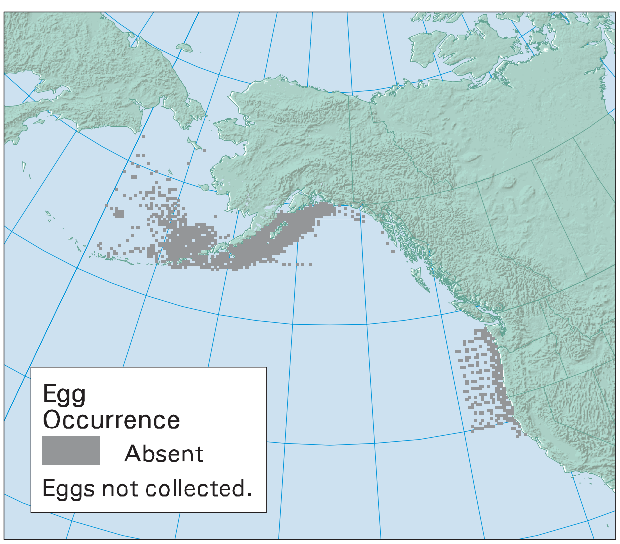


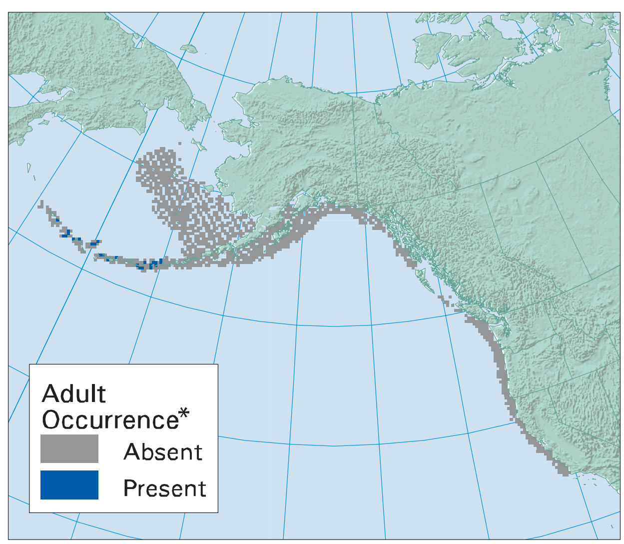
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 41 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

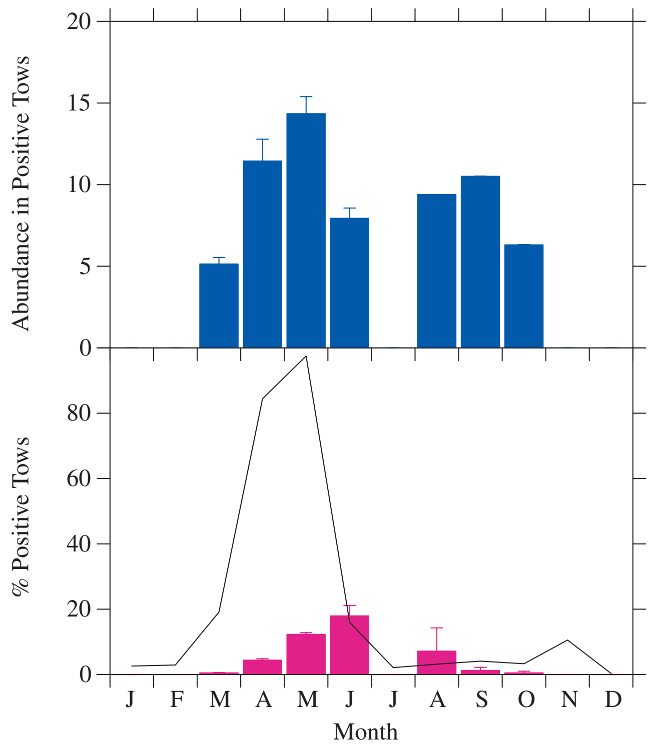

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
13.0 mm SL
Average Larval Abundance
(no. /10 m²)
Absent
0.001 - 1.033
1.033 - 6.208
6.208 - 18.883
18.883 - 47.880
0 300 600 900 km
170°
160°
150°
140°
130°


Egg
Occurrence
Absent
Eggs not collected.

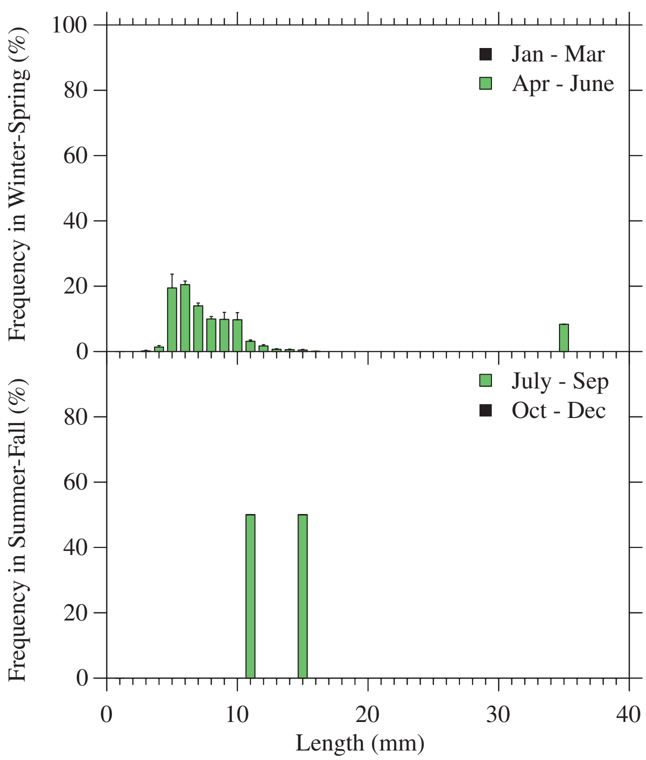

Adult
Occurrence*
Absent
Present

Life history There are five species of *Icelinus* in our study area. *Icelinus burchami*, *I. filamentosus*, *I. fimbriatus*, and *I. tenuis* have overlapping distributions extending from the Gulf of Alaska to Baja California; *Icelinus borealis* have a more northerly range from the Bering Sea to Washington. Adults, demersal and inhabiting soft or mud bottom at depths of 9–567 m, reach lengths of 10–27 cm TL. At present, preflexion and flexion larvae are unknown for all but *Icelinus borealis*. Except for larvae collected in the Bering Sea, these species can be identified only after fin rays are fully formed. Our data most likely include misidentified *Icelus* spp. larvae, which are similar in appearance and cannot be identified until the late flexion or juvenile stage. [Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

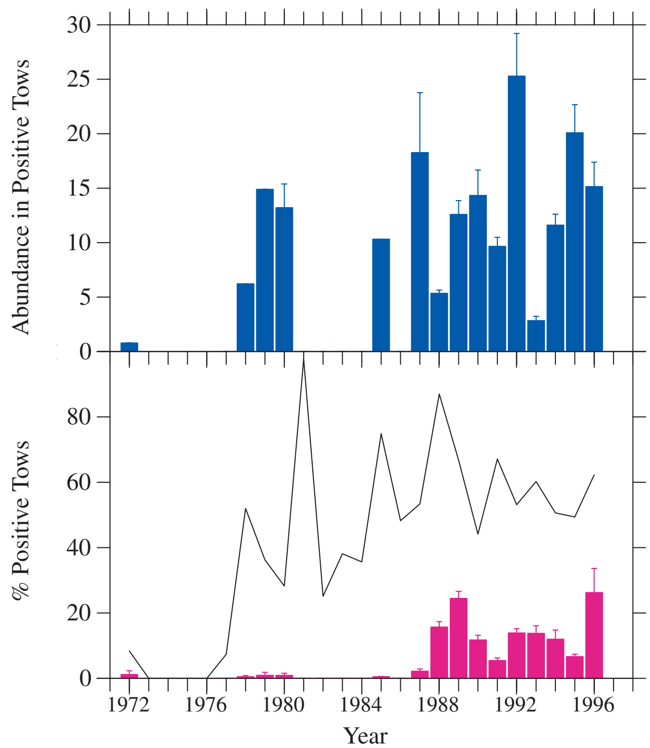
Larval distribution *Icelinus* spp. larvae are found along shelf and slope waters from the Bering Sea, through Unimak Pass to the Shelikof sea valley and around Kodiak Island, to off the U.S. west coast. Larvae are most abundant along the Alaska Peninsula side of the Shelikof sea valley. Several taxa may be represented in AFSC collections since this is an area where slope and shelf species routinely mix. Larvae are collected March–October, but abundances are highest in late winter–spring. Small larvae <20 mm SL dominate winter–spring collections. Overall catch by year indicates that larvae appeared in AFSC collections during the 1970s, but were much more common after 1988.



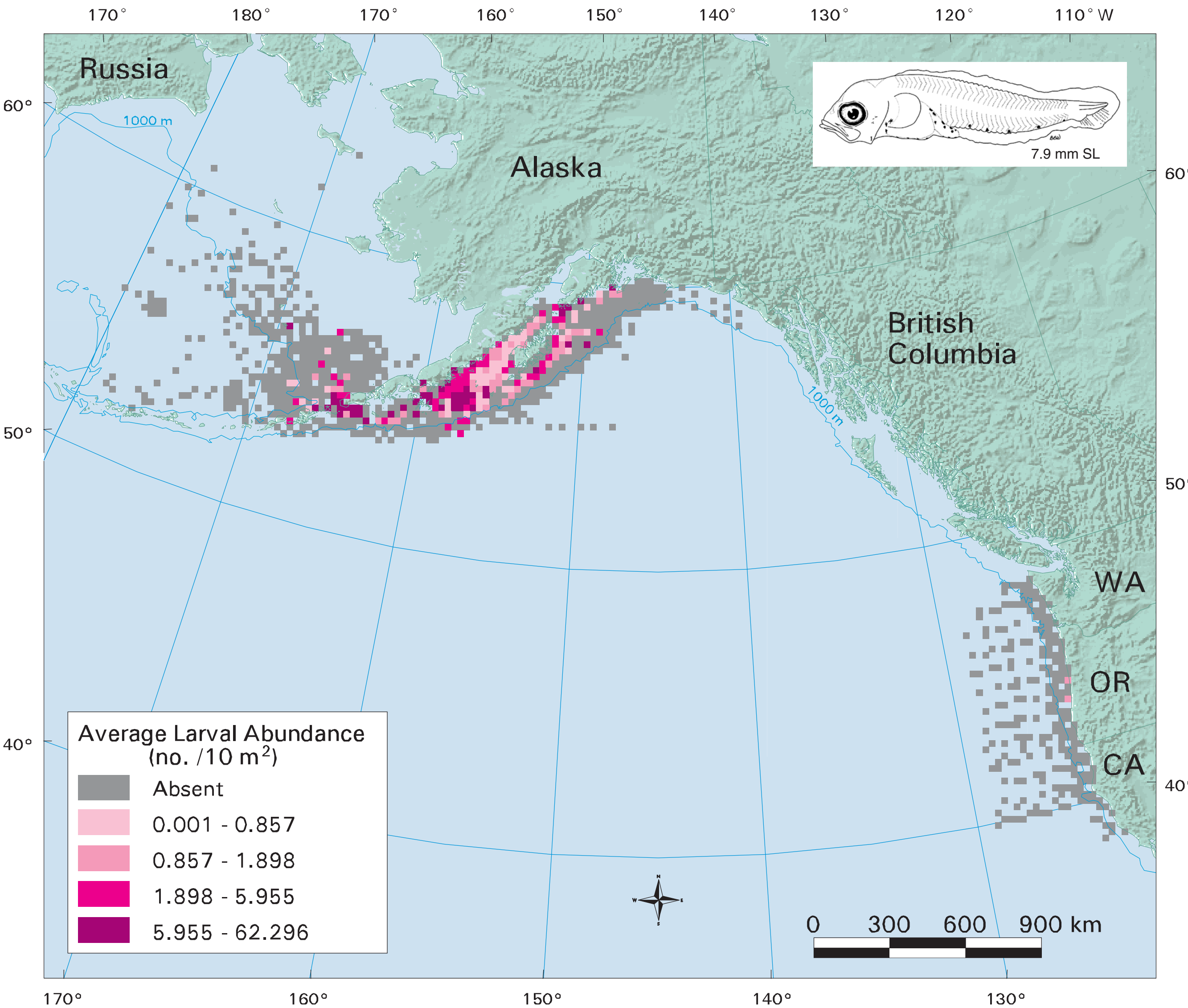
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

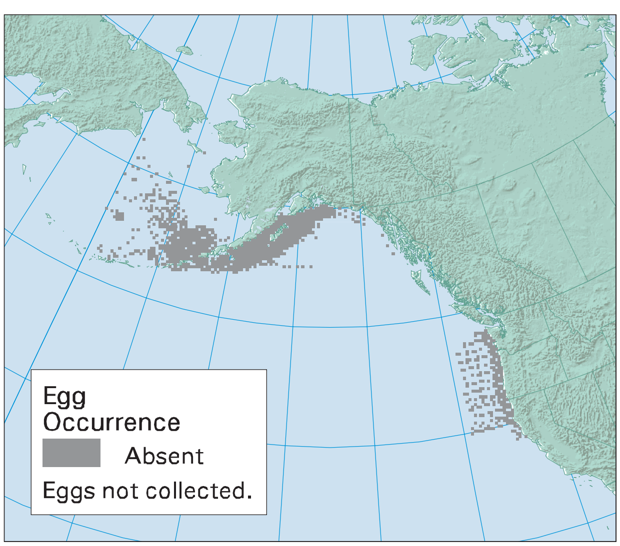


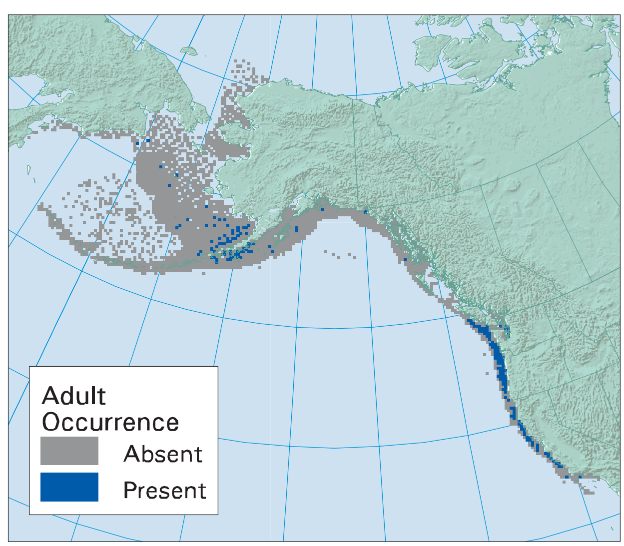
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 2228 for winter–spring (Jan–June), 2 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

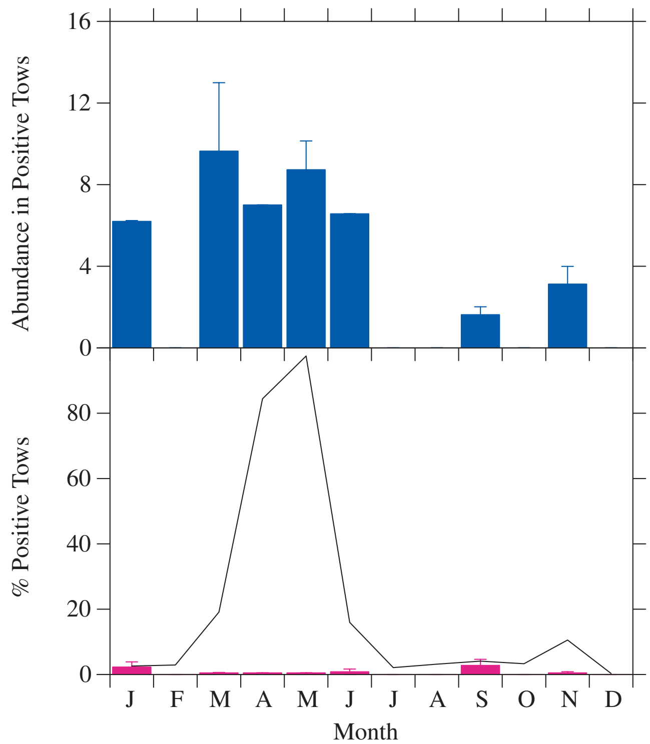

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
7.9 mm SL
60°
50°
40°
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.857
0.857 - 1.898
1.898 - 5.955
5.955 - 62.296
0 300 600 900 km
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

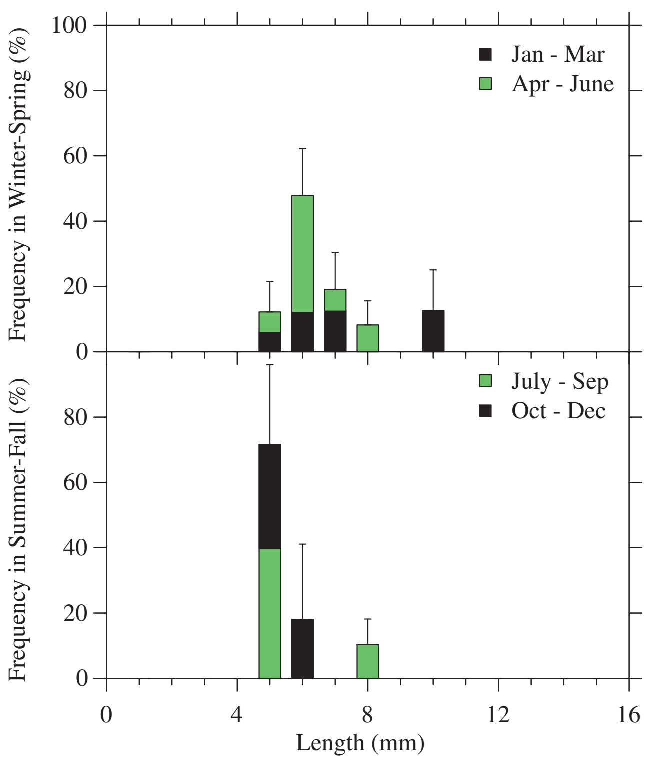

Adult Occurrence
Absent
Present

Life history *Leptocottus armatus* are found along the nearshore shelf regions from the Bering Sea to north central Baja California. Pacific staghorn sculpin adults are demersal and inhabit areas from the intertidal zone and depths to about 91 m. Spawning (in California) takes place in the fall through early spring (March). Demersal adhesive eggs, 1.4–1.5 mm in diameter, have a bumpy egg membrane and one large (0.3 mm) oil globule plus additional smaller ones. Larvae hatch at sizes of 3.8–5.0 mm SL, undergo flexion at about 8 mm SL, and transform at 15–20 mm SL. Larvae are common in the CalCOFI study area.
[Sources include: Matarese et al. (1989), Ambrose (1996b)]

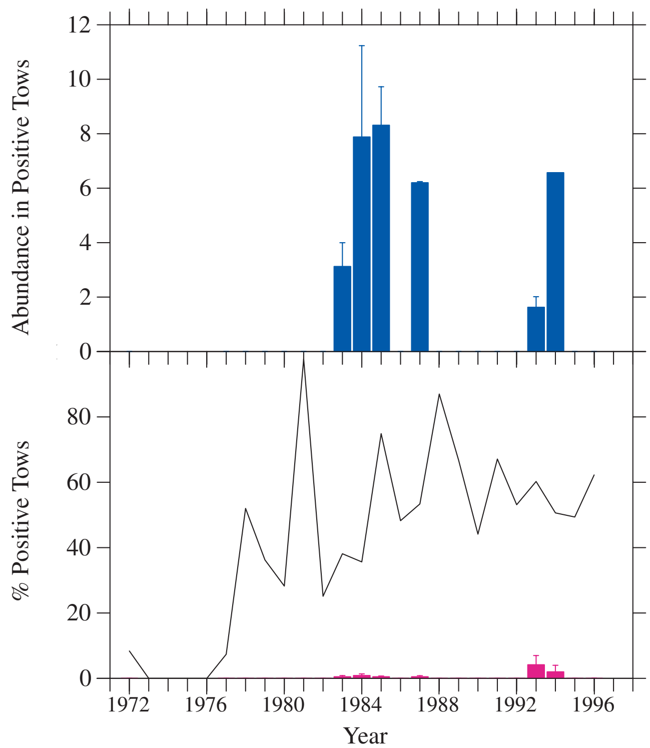
Larval distribution Pacific staghorn sculpin larvae are collected along the Alaska Peninsula shelf and around Kodiak Island in the Gulf of Alaska, and along the U.S. west coast off Washington and Oregon. Larvae are most abundant in nearshore areas. Larvae occur intermittently in low numbers throughout the year January–November. Small larvae ≤10 mm SL are collected in winter–spring as well as summer–fall, which may reflect different spawning times in the Gulf of Alaska versus the U.S. west coast. Larvae were found 1983–1987, when AFSC conducted U.S. west coast surveys, and 1993–1994.



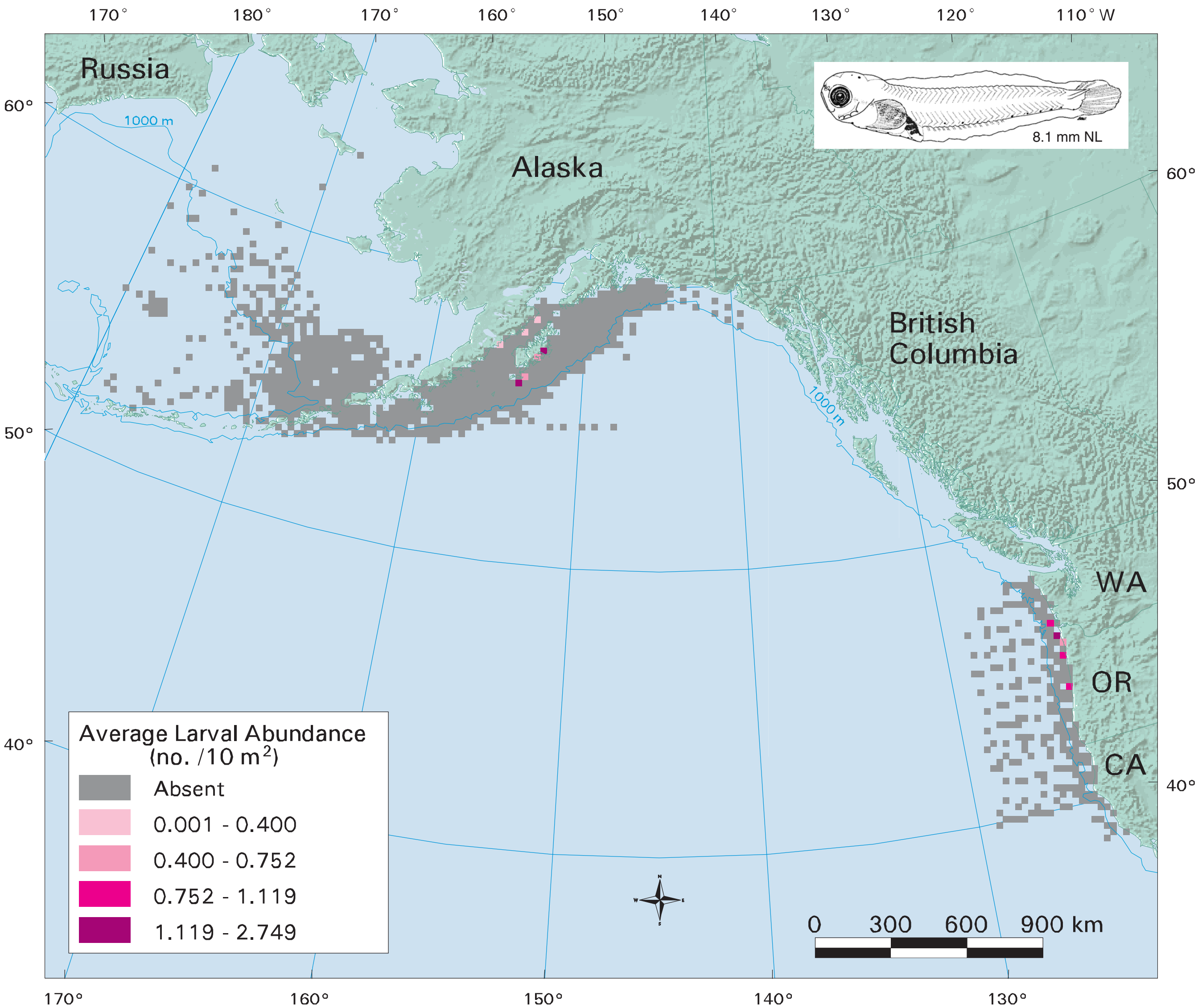
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



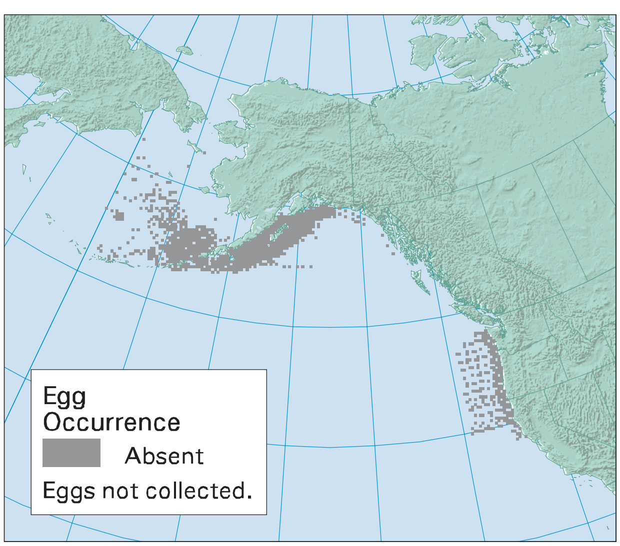
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 11 for winter–spring (Jan–June), 6 for summer–fall (July–Dec).



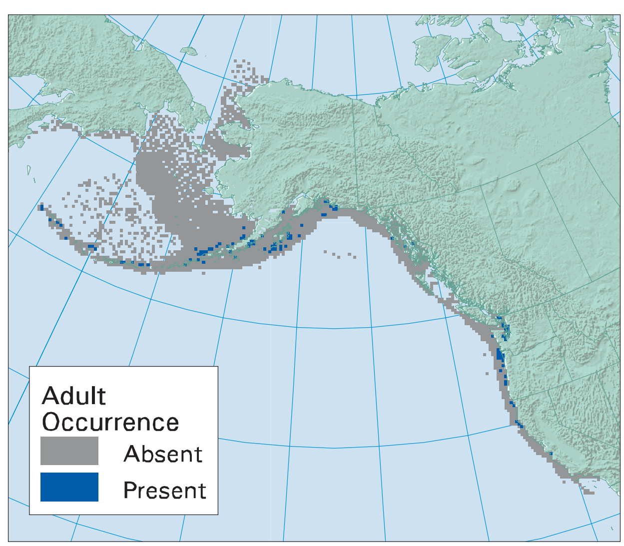
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
8.1 mm NL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.400
0.400 - 0.752
0.752 - 1.119
1.119 - 2.749
0 300 600 900 km
170° 160° 150° 140° 130°



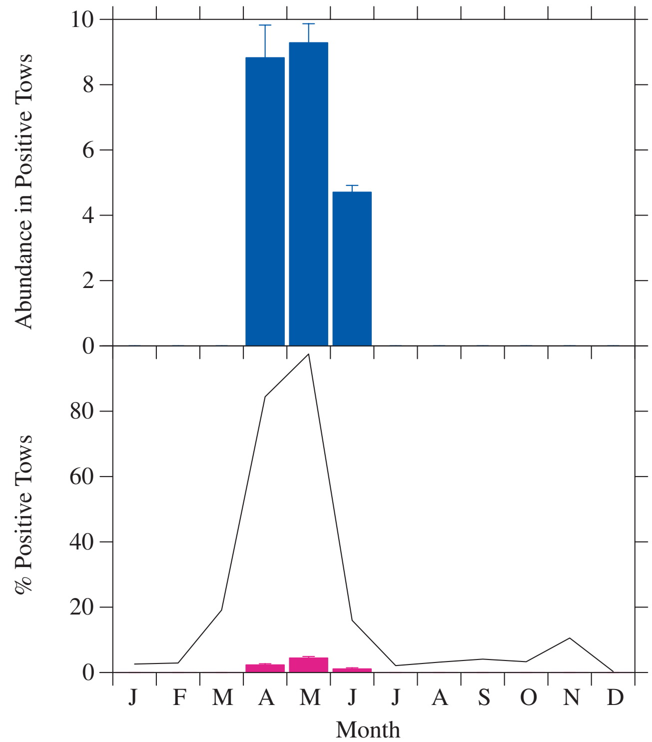
Egg Occurrence
Absent
Eggs not collected.



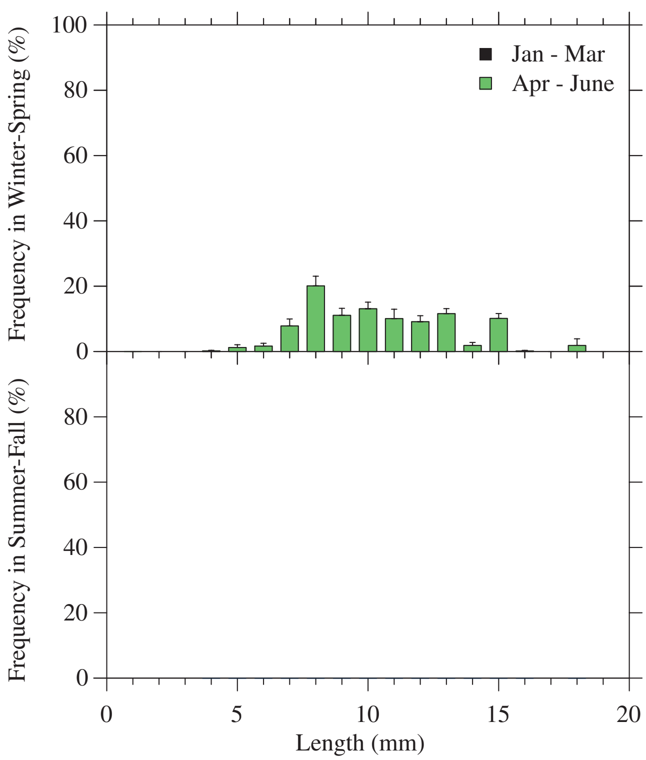
Adult Occurrence
Absent
Present

Life history The genus *Myoxocephalus* is represented by nine species within our study area (see species list, Appendix Table 2). Most *Myoxocephalus* spp. are found in the Arctic Ocean and Bering Sea; four species are found south of the Aleutian Islands. *Myoxocephalus polyacanthocephalus* occur as far south as Puget Sound. *Myoxocephalus* spp. are demersal and are found from nearshore to depths of 240 m. Eggs of Atlantic species are demersal, adhesive, 1.5–2.5 mm in diameter, and have 1–2 oil globules; *M. octodecemspinosus* are known to deposit their eggs in sponges (*Haliclona* spp.). At present, we collect two types (types B and G) of *Myoxocephalus* larvae, but we cannot identify them to species based on the current literature from samples in our study area except for those larvae collected in Puget Sound, which are *M. polyacanthocephalus*.
[Sources include: Morrow (1951), Eschmeyer et al. (1983), Fahay (1983), Matarese et al. (1989), Sokolovskii and Sokolovskaya (1997)]

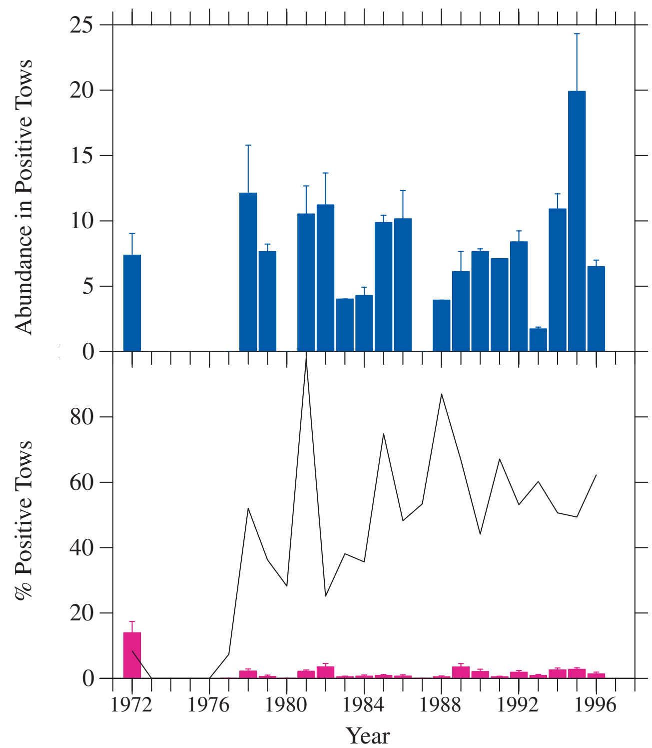
Larval distribution *Myoxocephalus* spp. larvae are distributed primarily along the shelf regions in the Bering Sea, south of the Alaska Peninsula, and around Kodiak Island in the Gulf of Alaska. Larvae 4–8 mm SL, representing at least two species, are collected in spring during April–June, with highest abundances in April and May. Overall catch by year indicates that larvae were found in low numbers throughout the time series.



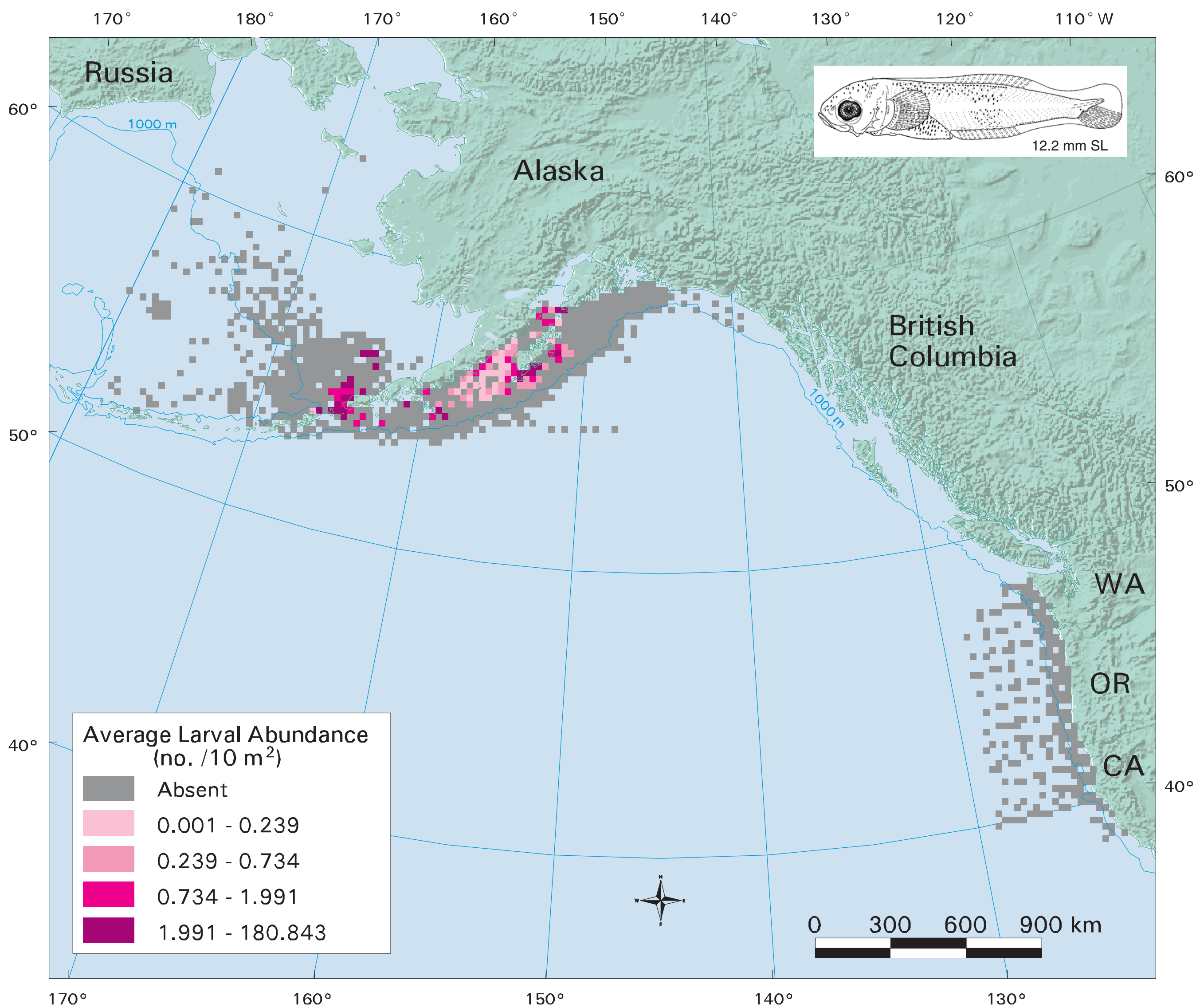
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

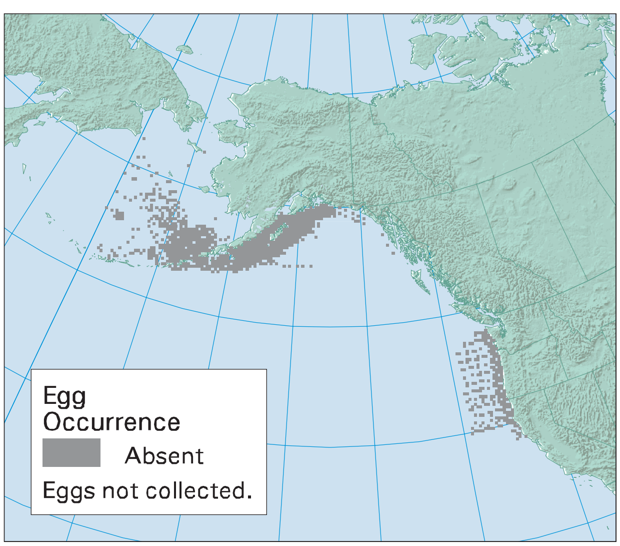


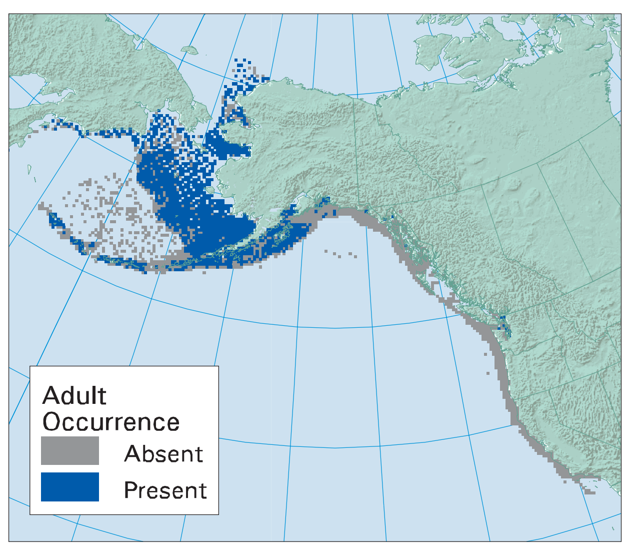
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 307 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

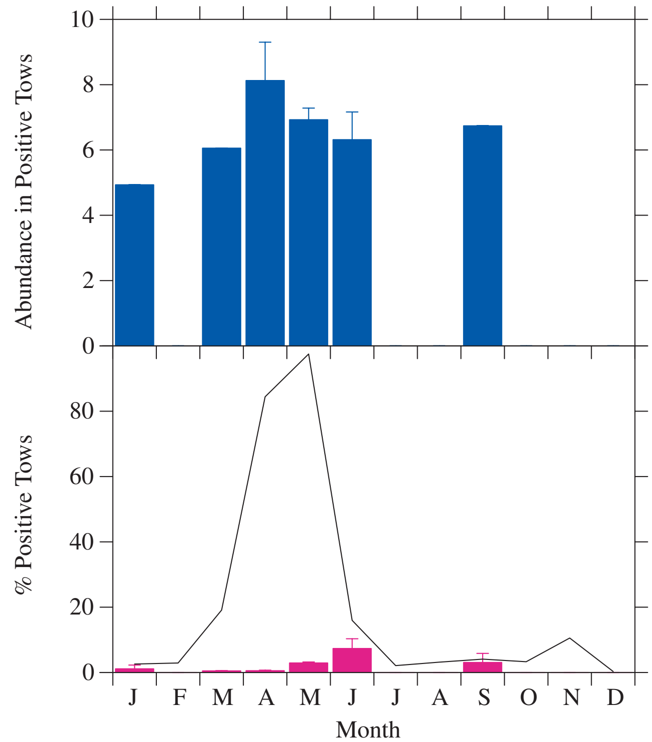

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
12.2 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.239
0.239 - 0.734
0.734 - 1.991
1.991 - 180.843
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

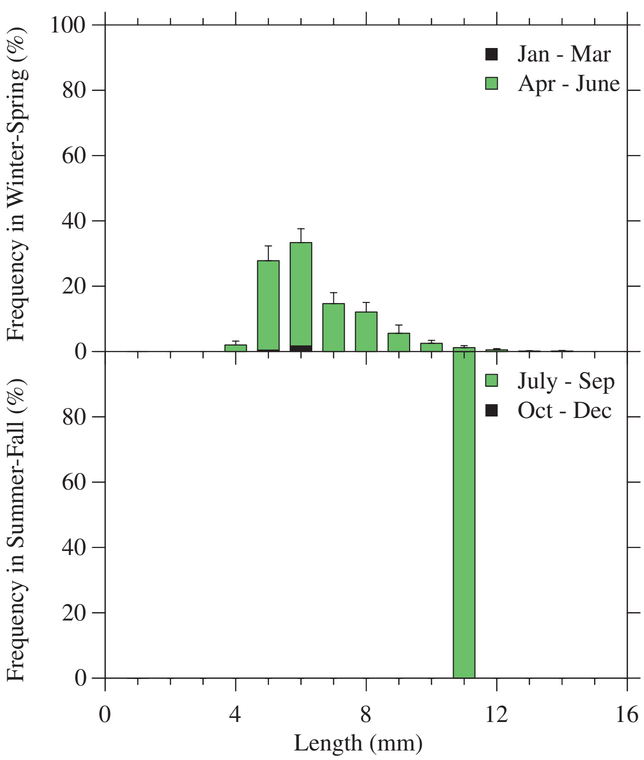

Adult Occurrence
Absent
Present

Life history *Radulinus asprellus* occur from Kodiak Island to northern Baja California. Slim sculpin adults are epi- and mesobenthic, occurring at depths of 18–283 m. Eggs are demersal. Larvae hatch at about 4.5 mm SL, undergo notochord flexion at 7.2–10.9 mm SL, and transform at about 15 mm SL. Larvae are uncommon in the CalCOFI study area.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

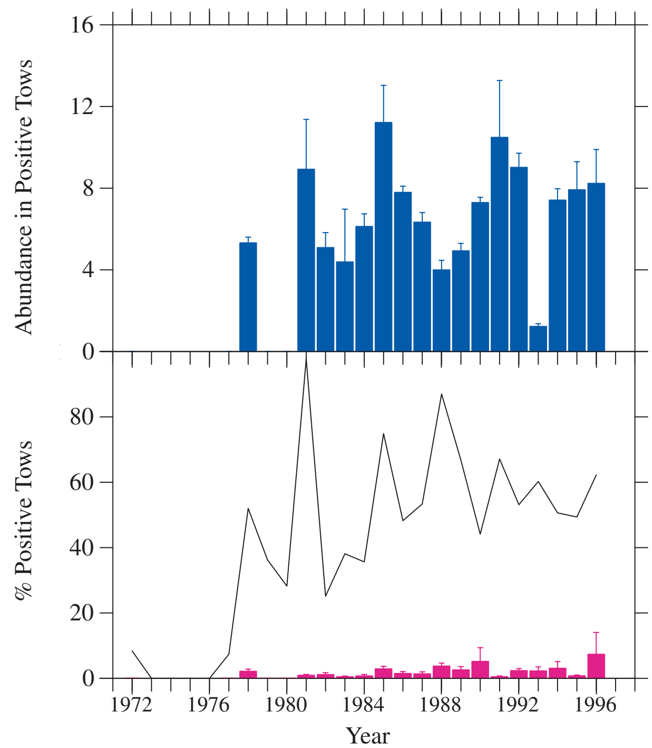
Larval distribution Slim sculpin larvae are collected along the Aleutian Islands, eastward to around Kodiak Island and the Kenai Peninsula in the Gulf of Alaska, and along the U.S. west coast. Although the reported western extent of the species is Kodiak Island, Alaska, adults and larvae are present in AFSC survey collections in the Aleutian Islands. Adults are rarely collected in AFSC surveys in the Gulf of Alaska. Larvae are most abundant along the outer shelf west and east of Kodiak Island and nearshore along the shelf off Washington and Oregon. Larvae are found January–September, but are most abundant in late spring. Most larvae (4–14 mm SL) are collected in winter–spring; only one larva (11 mm SL) was measured from summer–fall. Overall catch by year indicates that larvae were found in low numbers throughout most of the time series from 1978 to 1996.



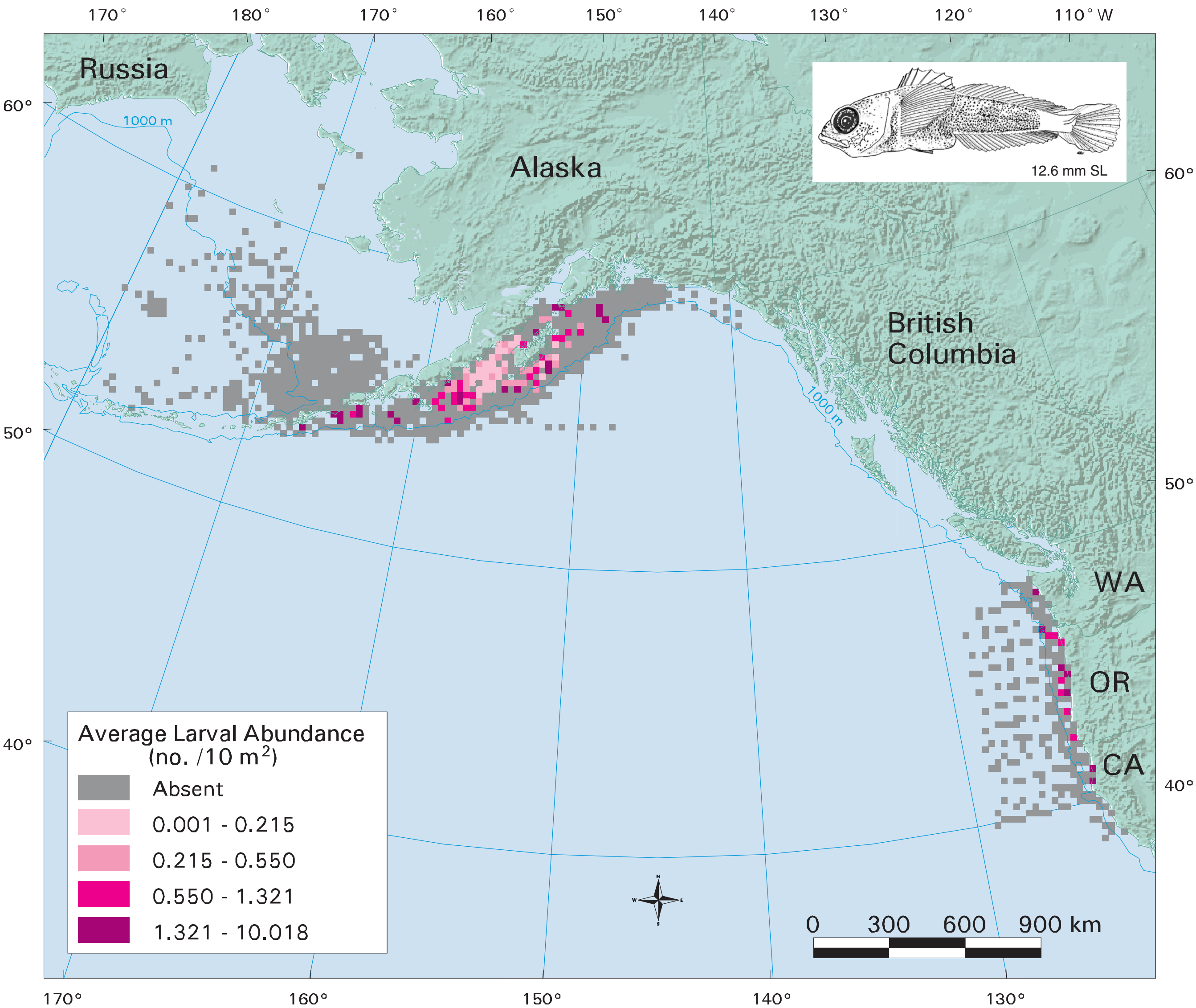
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

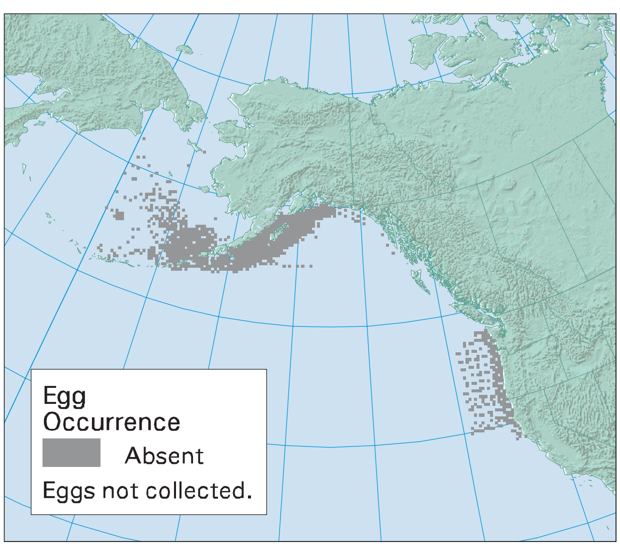


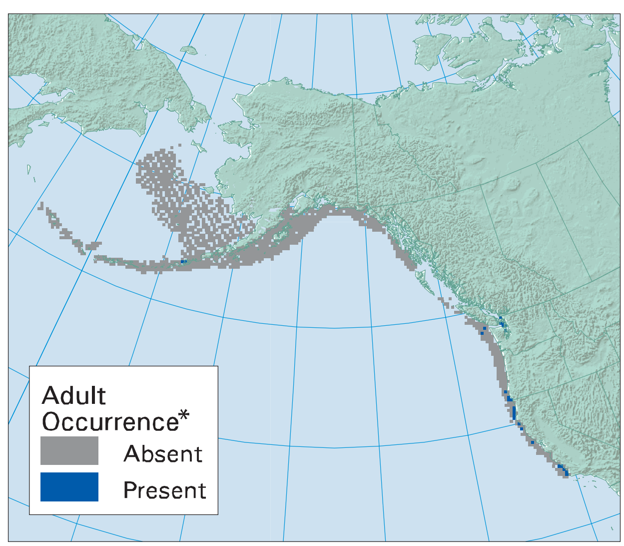
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 190 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

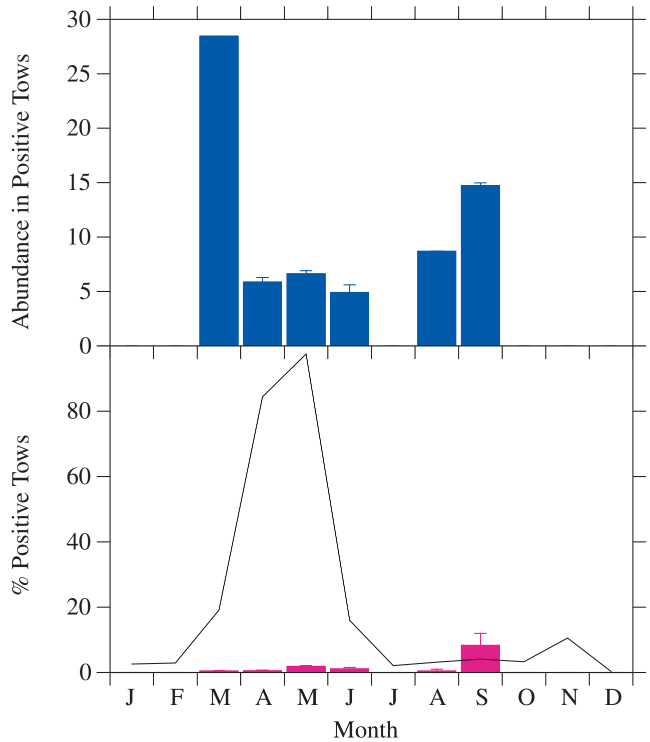

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
60°
1000 m
Alaska
12.6 mm SL
60°
British Columbia
50°
1000 m
50°
WA
OR
40°
CA
40°
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.215
0.215 - 0.550
0.550 - 1.321
1.321 - 10.018
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

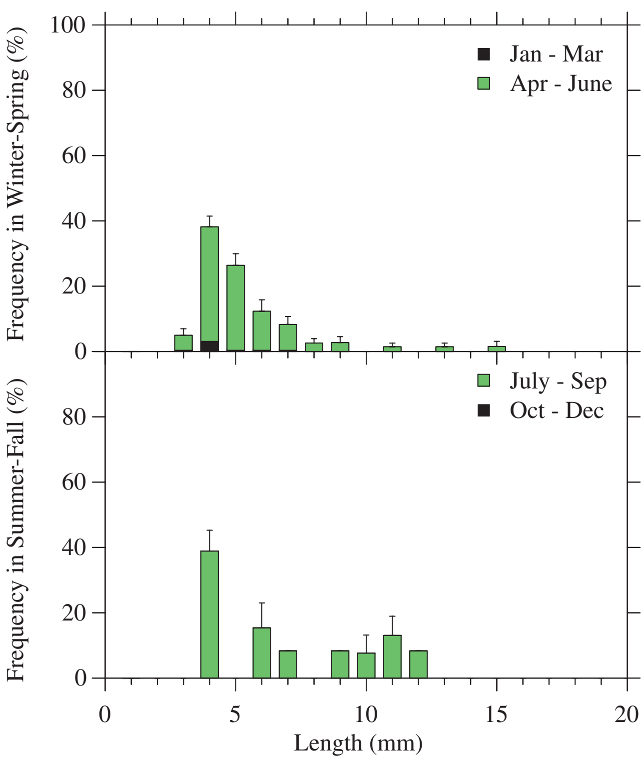

Adult Occurrence*
Absent
Present

Life history Although the published range of *Ruscarius meanyi* is from Southeast Alaska to northern California, the presence of larvae in the Gulf of Alaska and Aleutian Islands suggests a wider geographic distribution of adults. Puget Sound sculpin are demersal and occur along the nearshore shelf from intertidal areas to depths of 82 m. Larvae hatch at about 3 mm SL, undergo notochord flexion at 5.7–7.9 mm SL, and transform at about 13.5 mm SL. Larvae are rare in the CalCOFI study area. [Sources include: Matarese et al. (1989), Ambrose (1996b)]

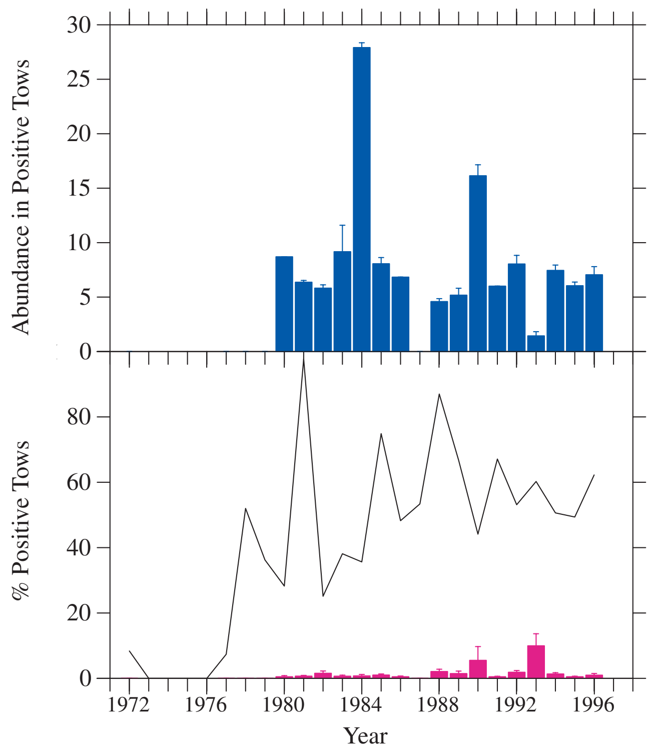
Larval distribution Puget Sound sculpin larvae are found in the Unimak Shelf region in the Bering Sea, around Kodiak Island in the Gulf of Alaska, and along the U.S. west coast to northern California. Adults are not collected in AFSC adult surveys and available data on distribution patterns are limited (British Columbia to Puget Sound). Larvae are most abundant along the inner shelf and coastal areas and are collected in most months May–September, with highest catches in spring. Most small larvae (3–15 mm SL) are taken in winter–spring, but some larvae (4–12 mm SL) appear in summer–fall. Overall catch by year indicates that larvae were collected in low numbers consistently 1980–1996.



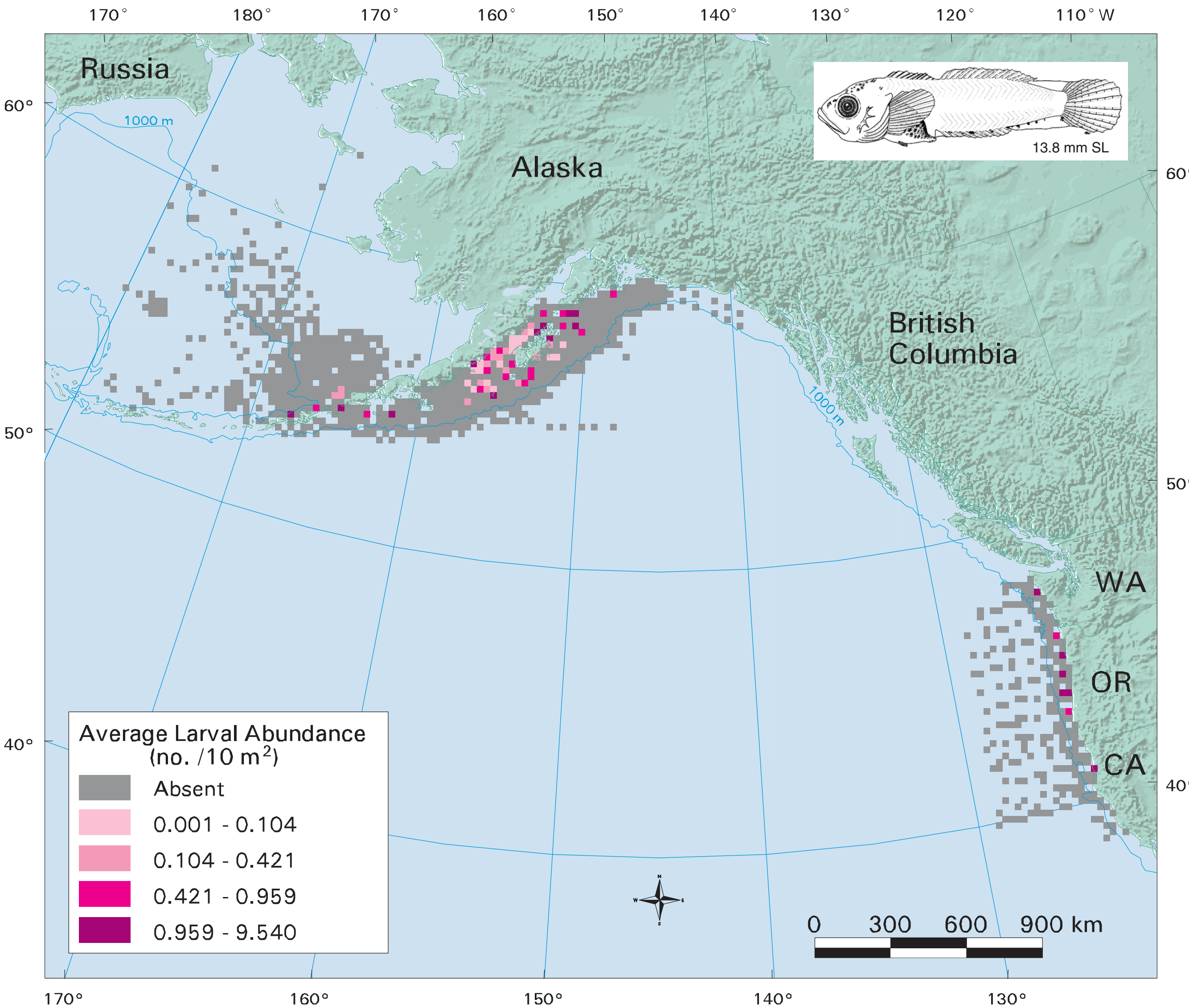
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



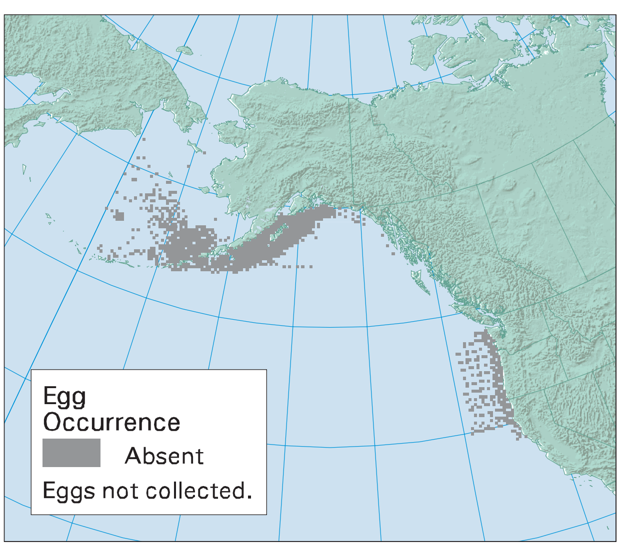
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 114 for winter–spring (Jan–June), 11 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
13.8 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.104
0.104 - 0.421
0.421 - 0.959
0.959 - 9.540
0 300 600 900 km
170°
160°
150°
140°
130°

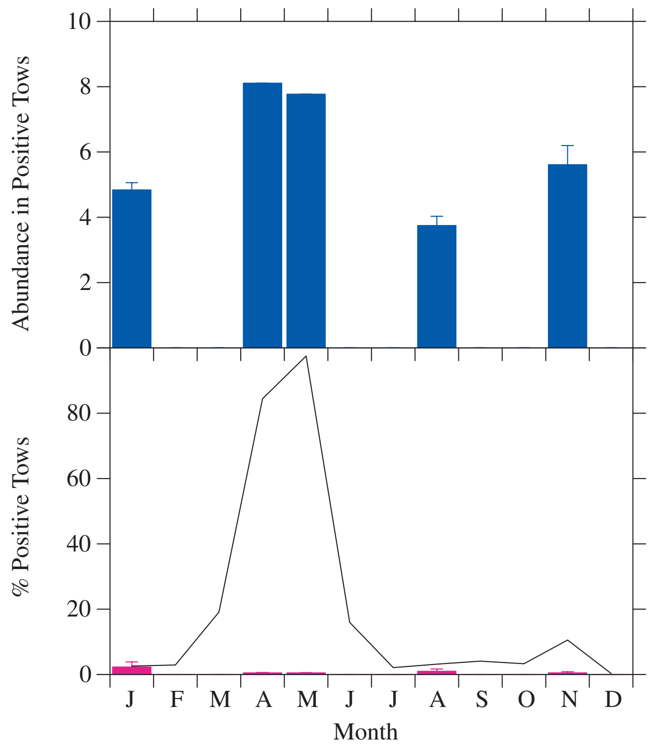


Egg Occurrence
Absent
Eggs not collected.

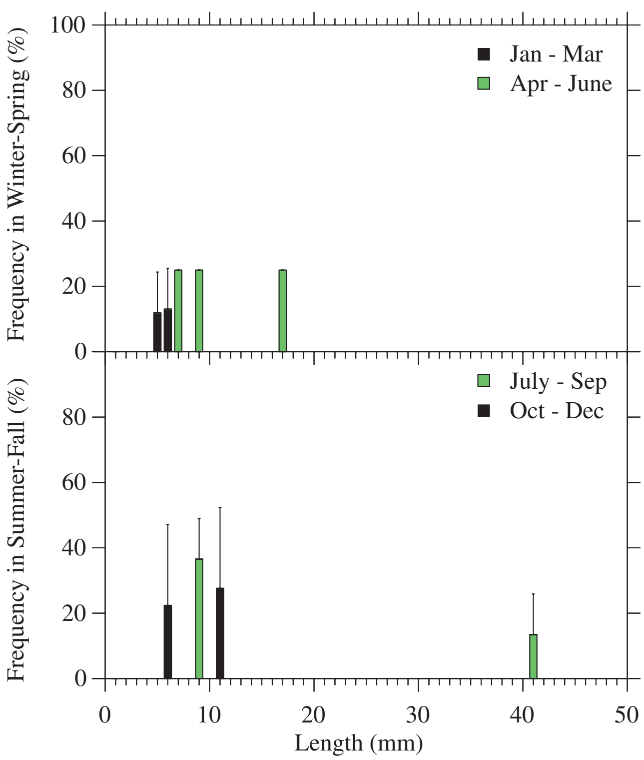
Adult Occurrence*
Present
(Occurrence only)

Life history *Scorpaenichthys marmoratus* are distributed from Southeast Alaska to off the U.S. west coast and south to central Baja California. Cabezon are the largest of the cottid family and may reach a length of 99 cm TL. Adults are demersal, inhabiting the nearshore shelf from intertidal areas to depths of about 76 m. Spawning occurs inshore along rocky crevices or on algae November–March in California and January–May off British Columbia. Eggs are adhesive and 1.4–1.9 mm in diameter with one large oil globule and 1–4 smaller ones. Larvae hatch at 4–6 mm SL, undergo notochord flexion at 7.6–10.0 mm SL, and begin to transform as early as 14 mm SL, but remain pelagic until 35 mm SL. From AFSC U.S. west coast data, larvae appear to be primarily neustonic. Larvae are commonly collected in the CalCOFI study area. [Sources include: Eschmeyer et al. (1983), Matarese et al. (1989), Doyle (1992), Ambrose (1996b), Doyle[2]]

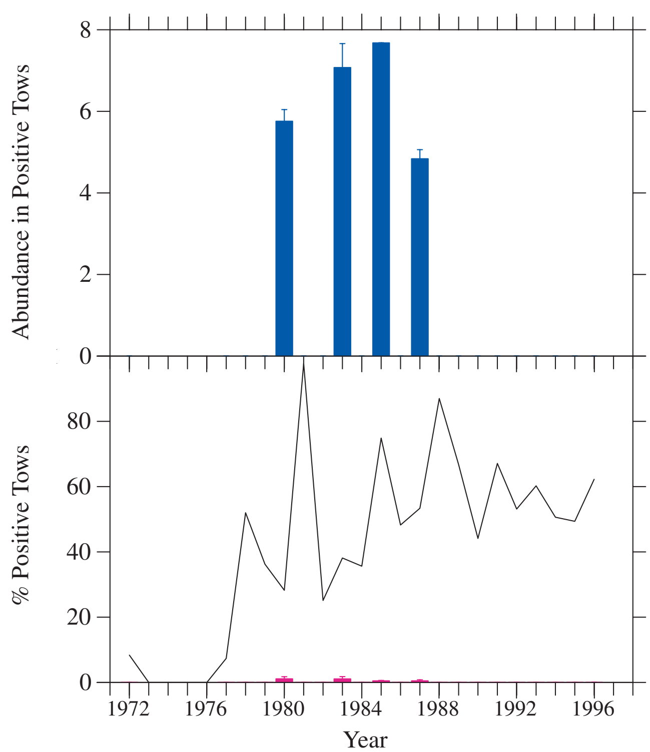
Larval distribution Cabezon larvae are collected off the U.S. west coast. Adults are not commonly collected in AFSC adult surveys and available data on distribution patterns are limited. Larvae are uncommon, but have been collected in both inshore and offshore regions. Occurrence is sporadic throughout the year January–November. Larvae range in size from 5–17 mm SL in winter–spring and 6–41 mm SL in summer–fall. Overall catch by year indicates larvae were uncommon in bongo nets, but were intermittently present in the time series 1980–1987 when AFSC conducted U.S. west coast surveys.



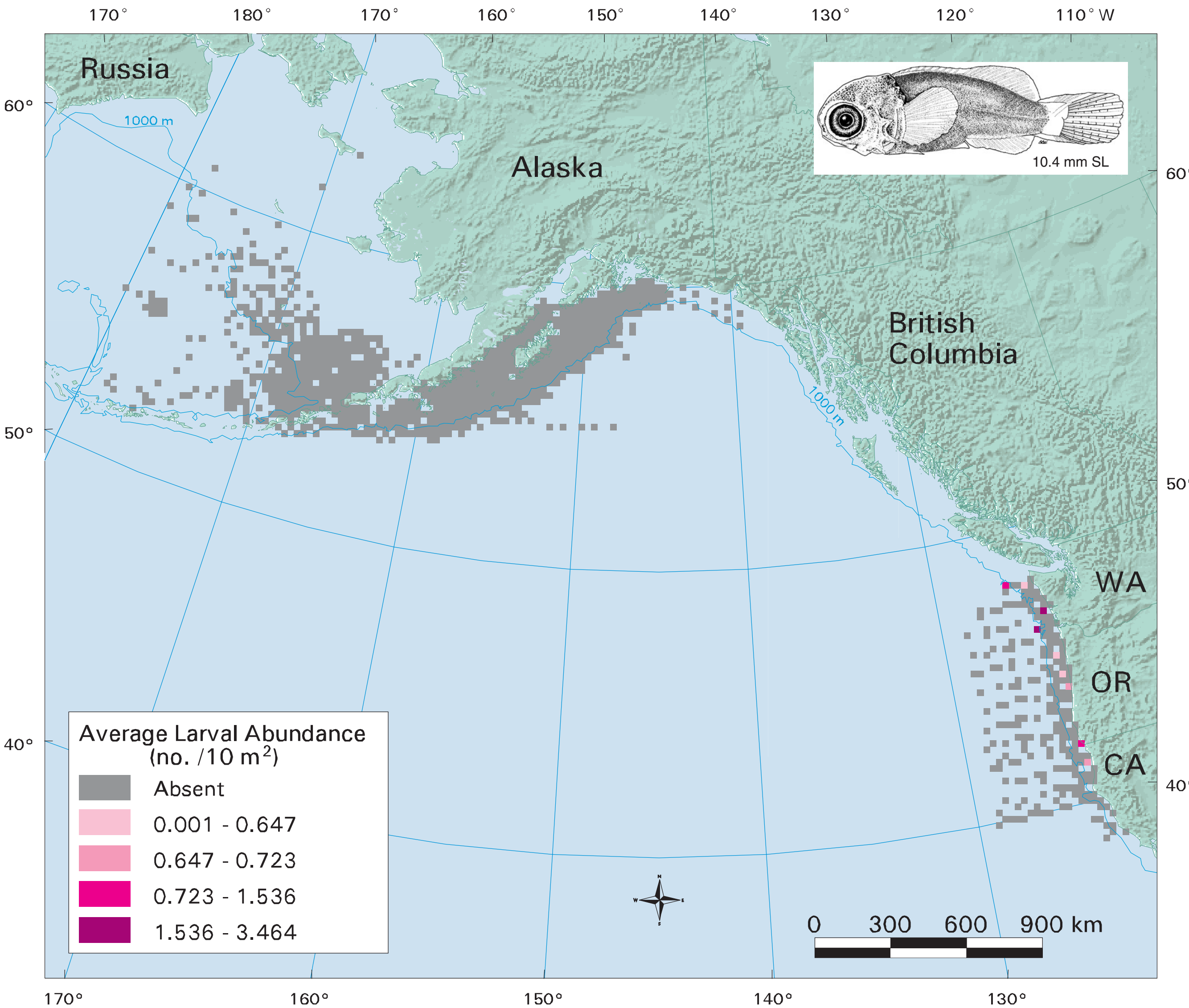
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

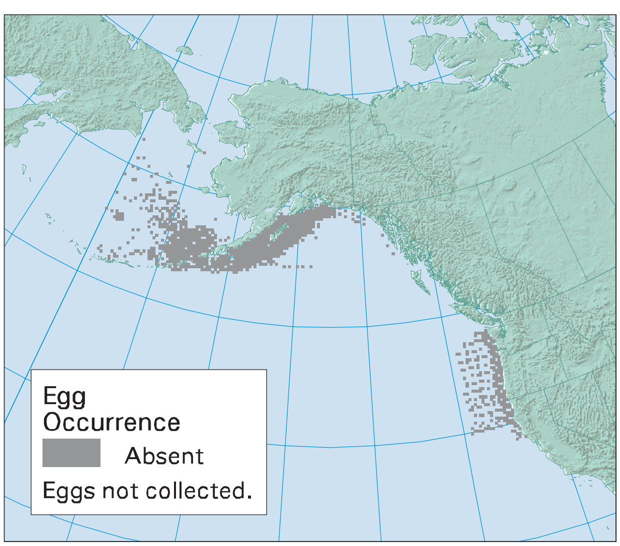


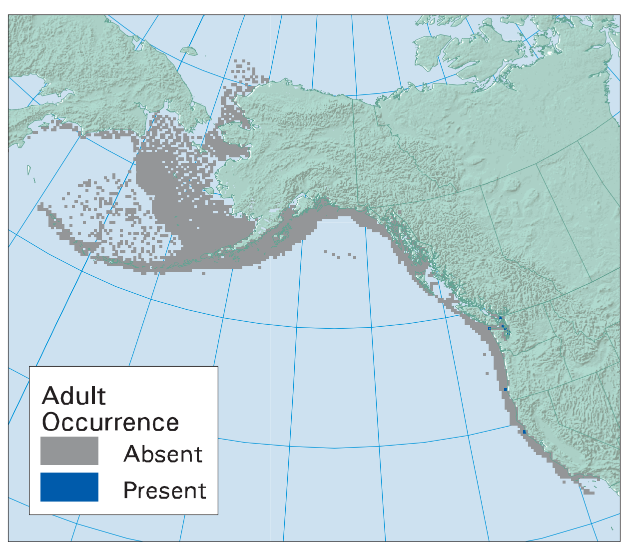
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 7 for winter–spring (Jan–June), 5 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

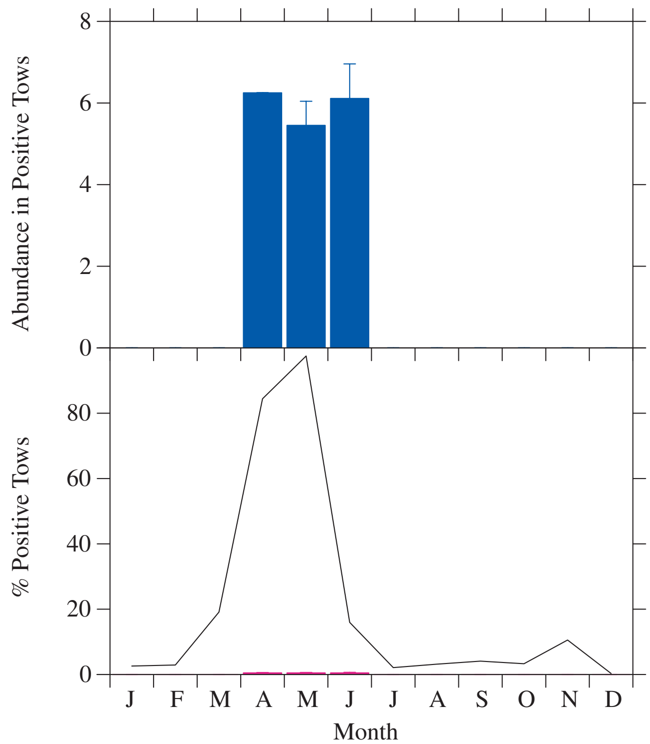

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.4 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.647
0.647 - 0.723
0.723 - 1.536
1.536 - 3.464
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

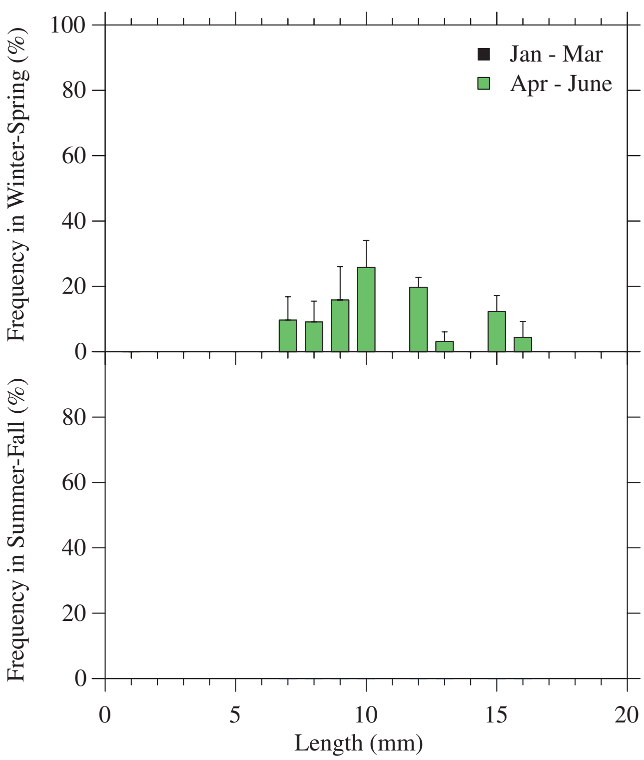

Adult Occurrence
Absent
Present

Life history *Anoplagonus inermis* occur from the Aleutian Islands to northern California. Smooth alligatorfish adults are found along rocky habitats at depths of 7.5–102 m. As their name implies, smooth alligatorfish are covered by bony plates that are smooth rather than bearing spines like most other agonids. Adults grow to about 15 cm TL. Larvae, which are uncommon in plankton samples, hatch at sizes as small as 5 mm SL and undergo notochord flexion at 7.5–10.0 mm SL. The juvenile stage begins at about 17 mm SL.
[Sources include: Eschmeyer et al. (1983), Ambrose (1996f), Busby (1998)]

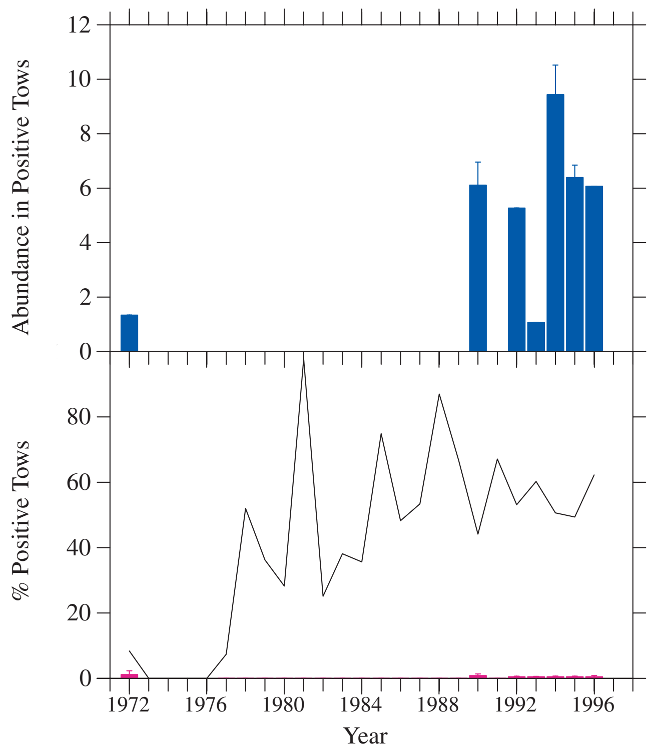
Larval distribution Smooth alligatorfish larvae are found along the coastal shelf near Unimak Pass in the Bering Sea, east along the Shelikof sea valley, and over the shelf east of Kodiak Island in the Gulf of Alaska. Adults are not collected in AFSC adult surveys and available data on distribution patterns are limited. Larvae are most abundant west of Kodiak Island. Larvae 7–16 mm SL occur in the spring April–June. Although larvae were collected in 1972, most larvae were found during the 1990s when AFSC sampling was more frequent west of Kodiak Island and into the Bering Sea.



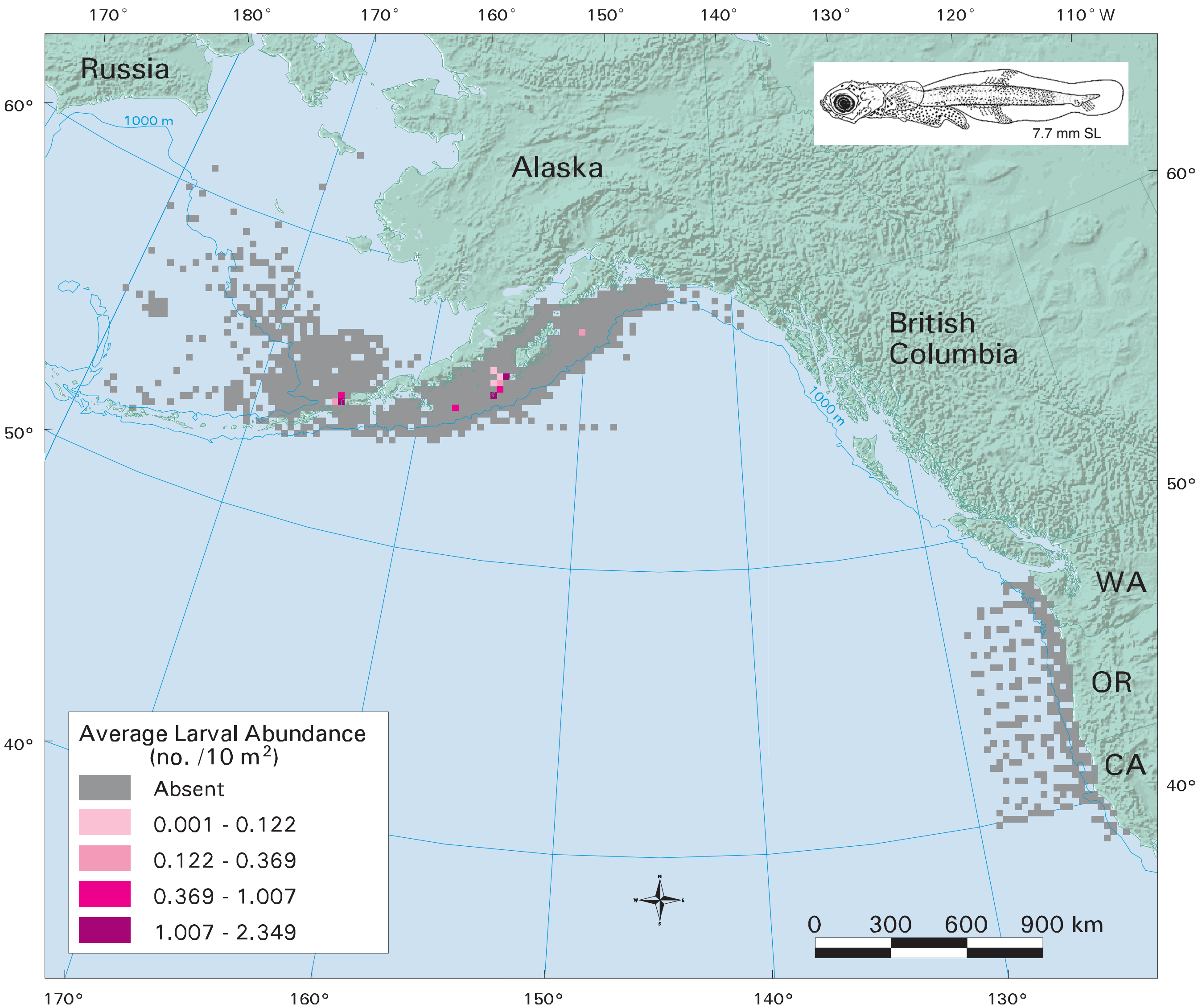
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

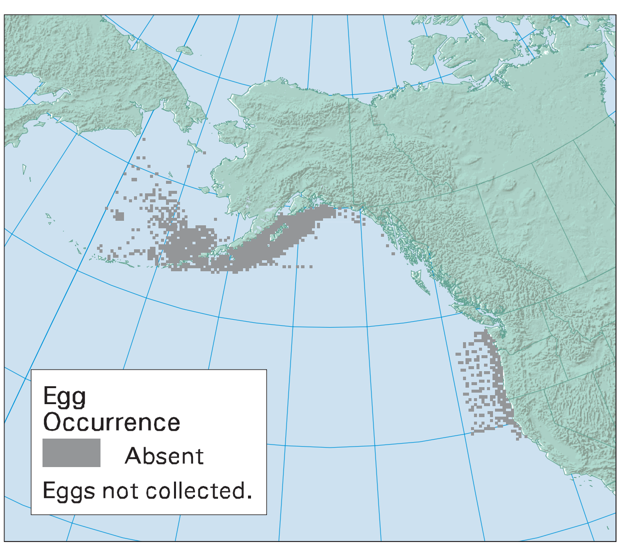


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 15 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

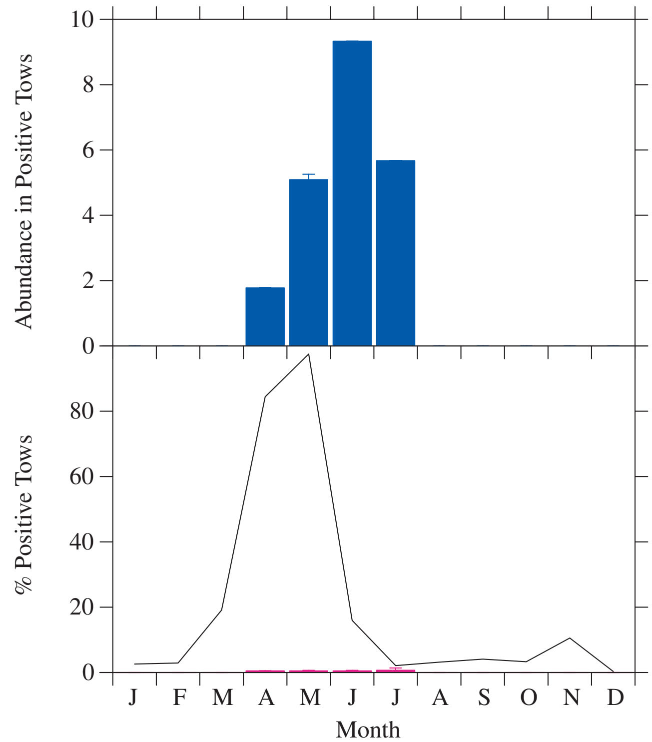

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
7.7 mm SL
Average Larval Abundance
(no. /10 m²)
Absent
0.001 - 0.122
0.122 - 0.369
0.369 - 1.007
1.007 - 2.349
0 300 600 900 km
170°
160°
150°
140°
130°


Egg
Occurrence
Absent
Eggs not collected.

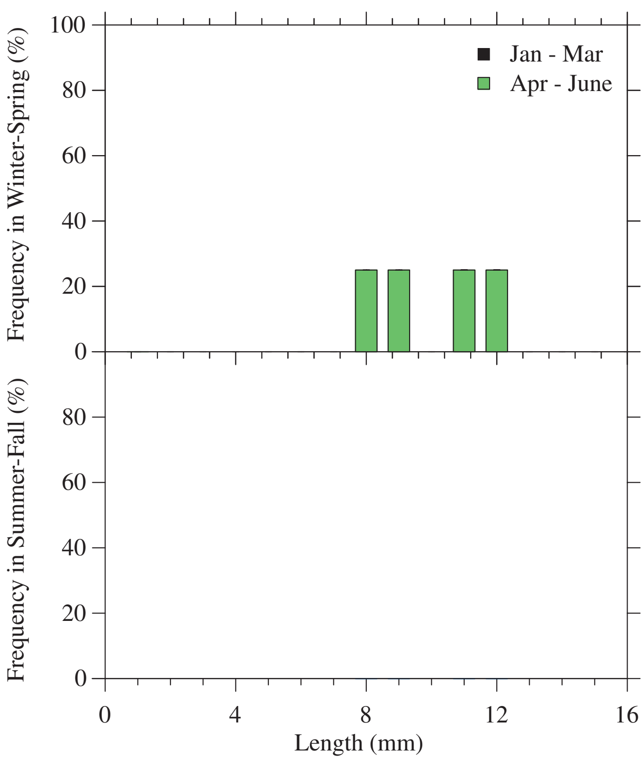

Adult
Occurrence*
Present
(Occurrence only)

Life history *Aspidophoroides monopterygius* adults are circumpolar in distribution, occurring southward to Cape Cod, Massachusetts, and New Jersey in the North Atlantic and to the Gulf of Alaska in the North Pacific. Alligatorfish inhabit shelf regions throughout their range. Adults may grow to 18 cm TL and are elongate and covered by large fused bony plates that are modified scales. Larvae are uncommon in plankton samples. Pelagic larvae hatch by 5.1 mm SL and undergo notochord flexion at 8.0–15.0 mm SL. Size at transformation is unknown as the largest individuals examined (30.0 mm SL) still possess a larval finfold.
[Sources include: Kessler (1985), Busby (1998)]

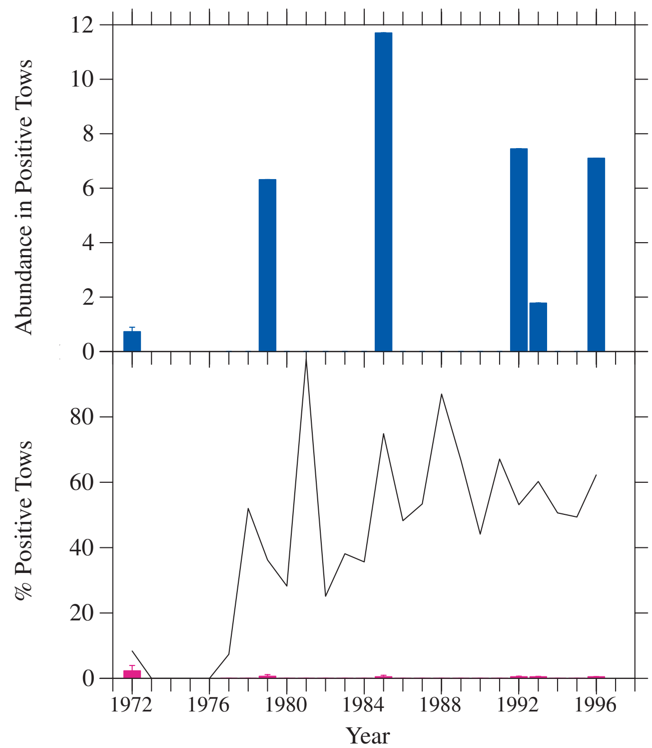
Larval distribution Alligatorfish larvae are collected sporadically along the Bering Sea shelf from the western Aleutian Islands to north of the Pribilof Islands, and along the outer shelf south and east of Kodiak Island in the Gulf of Alaska. In AFSC surveys, adults are common along the Bering Sea shelf. Larvae are collected April–July; small larvae (8–12 mm SL) are found during spring. Overall catch by year indicates larvae were very uncommon, but intermittently present, in the time series.



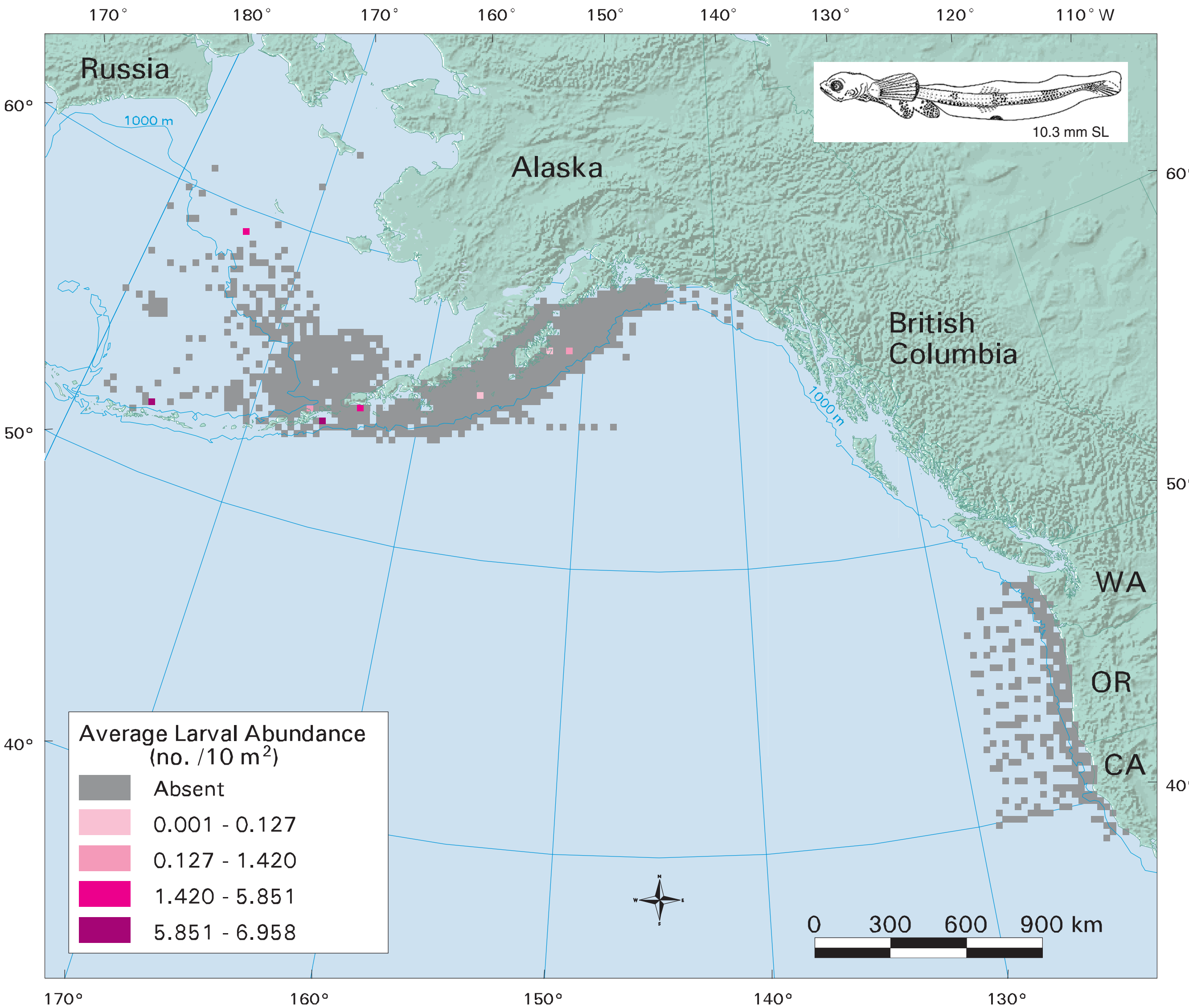
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

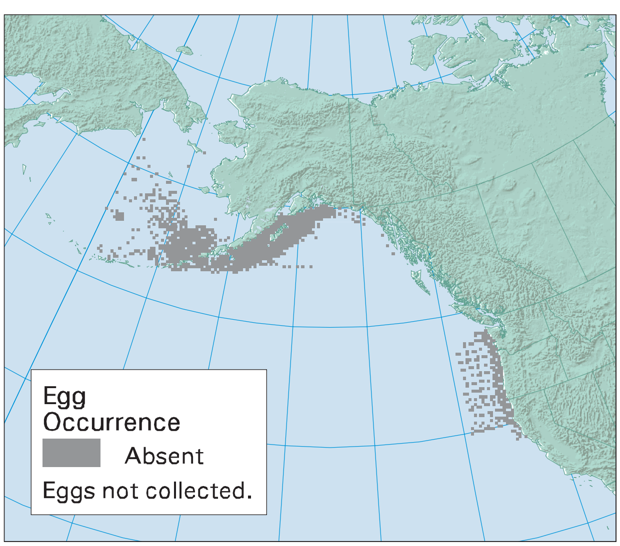


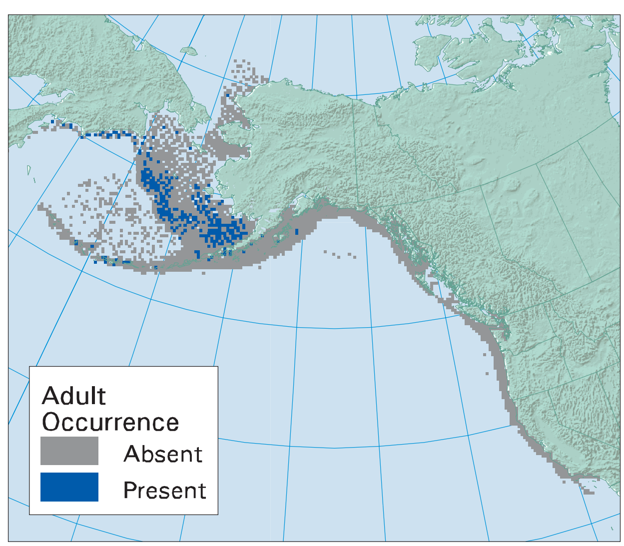
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 4 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

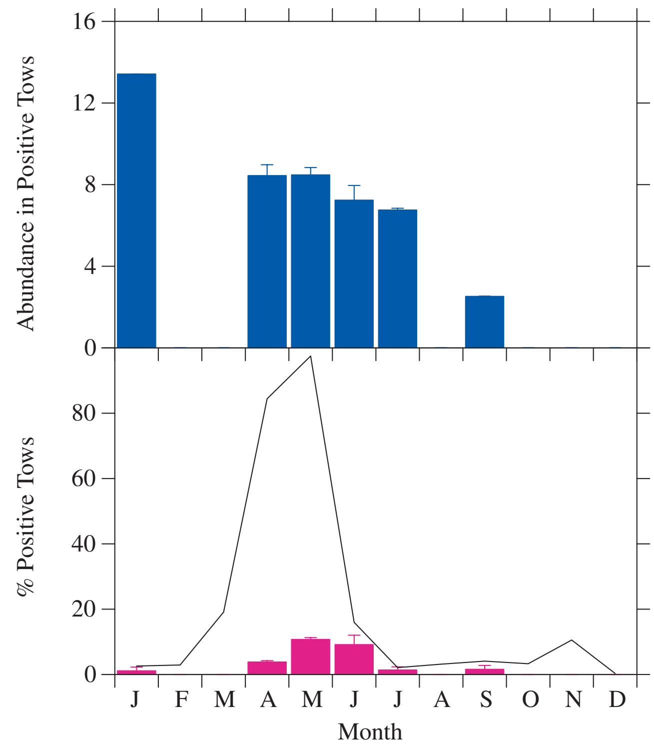

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.127
0.127 - 1.420
1.420 - 5.851
5.851 - 6.958
0 300 600 900 km
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

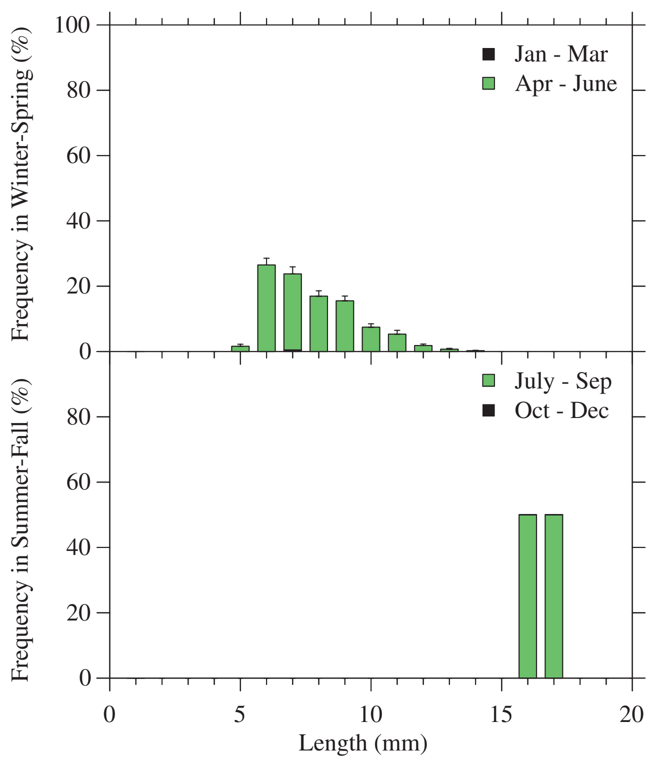

Adult Occurrence
Absent
Present

Life history *Bathyagonus alascanus* range from the Bering Sea to northern California and are found over rocky substrates at depths of 18–252 m. Gray starsnout are one of the smaller species of poachers (13 cm TL). Larvae are pelagic and are the most commonly occurring larval agonid in samples from AFSC ichthyoplankton surveys in the Gulf of Alaska near Kodiak Island.
[Sources include: Eschmeyer et al. (1983), Busby (1998)]

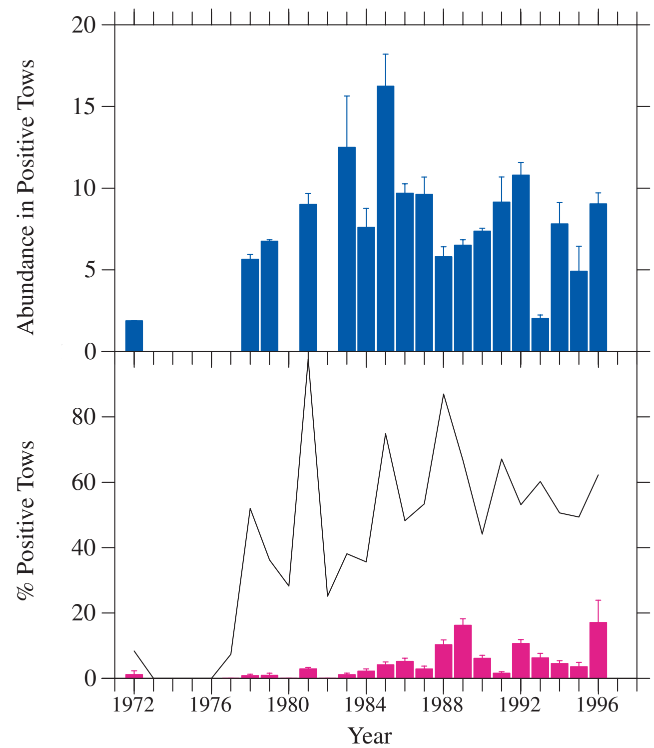
Larval distribution Gray starsnout larvae are found from the central Bering Sea, Gulf of Alaska, and off Washington and Oregon along the U.S. west coast. Adults are not collected in AFSC adult surveys and available data on distribution patterns are limited (Bering Sea to Washington). Larvae are widely distributed in the western Gulf of Alaska and around Kodiak Island; highest abundances occur northeast and southwest of Kodiak Island. Larvae are collected January, April–July, and in September with high concentrations in early winter and spring. Small larvae <15 mm SL are collected in winter–spring, whereas larger larvae >15 mm SL are found in summer–fall. Although larvae appeared in fewer than 20% of the tows from year to year, they were found most years after 1980.



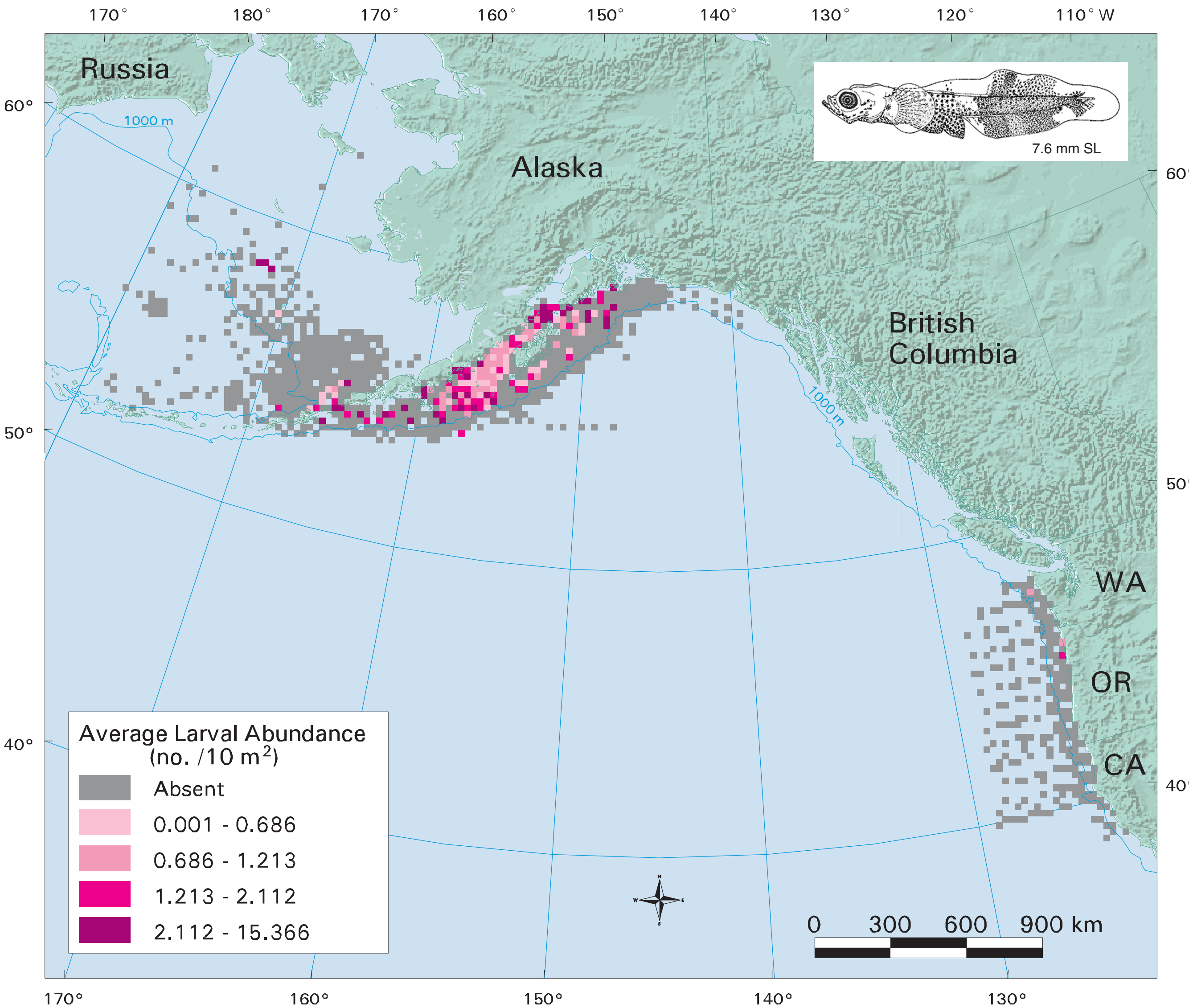
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

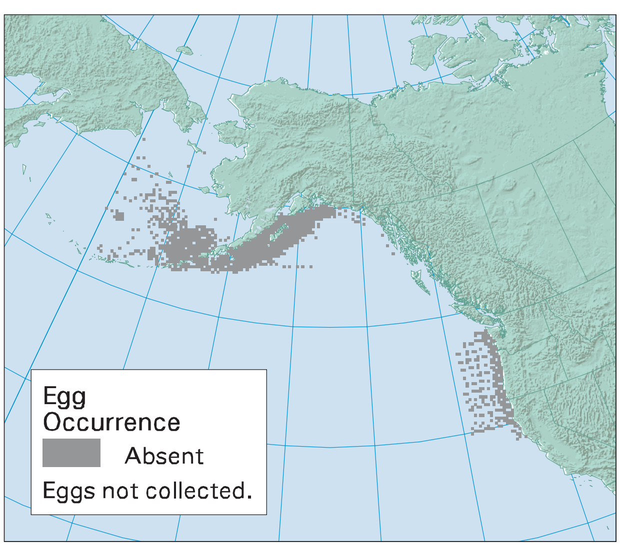


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 790 for winter–spring (Jan–June), 2 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

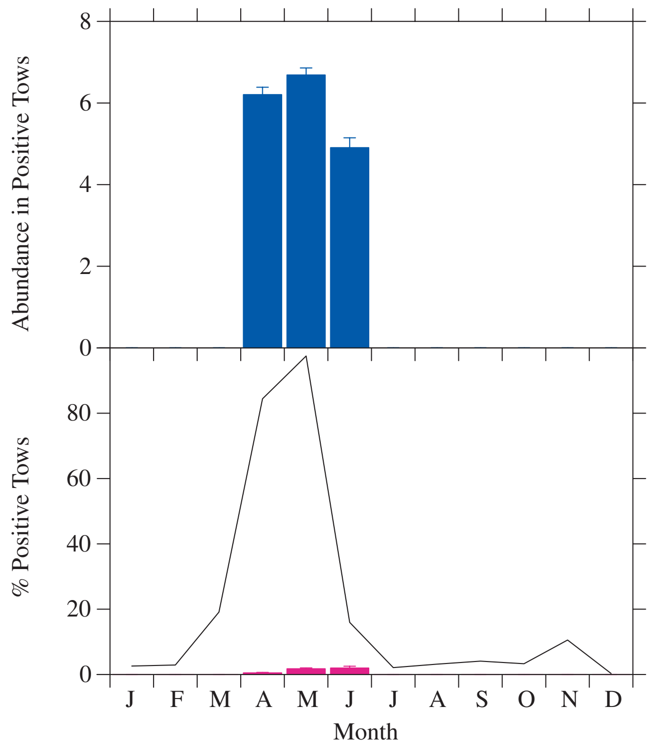

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
7.6 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 0.686
0.686 - 1.213
1.213 - 2.112
2.112 - 15.366
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

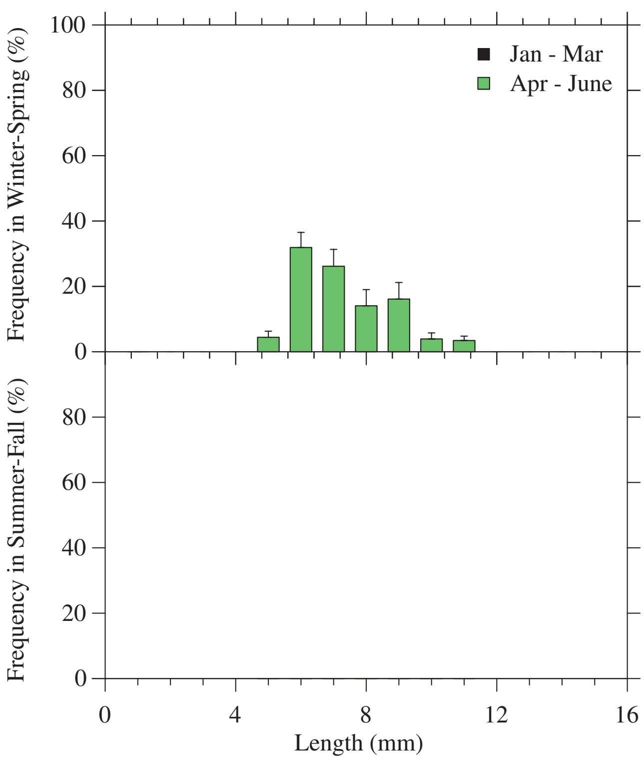

Adult Occurrence*
Present
(Occurrence only)

Life history *Bathyagonus infraspinatus* occur from the Bering Sea to northern California. Spinycheek starsnout are usually found on soft (sand and mud) bottoms at depths between 18 and 183 m. Adults, which may reach 13 cm TL in length, are elongate and covered by large fused bony plates that are modified scales. Larvae hatch at sizes <4.5 mm SL and undergo notochord flexion at 7.5–12.0 mm SL. The juvenile stage begins at about 17 mm SL.
[Sources include: Kessler (1985), Busby (1998)]

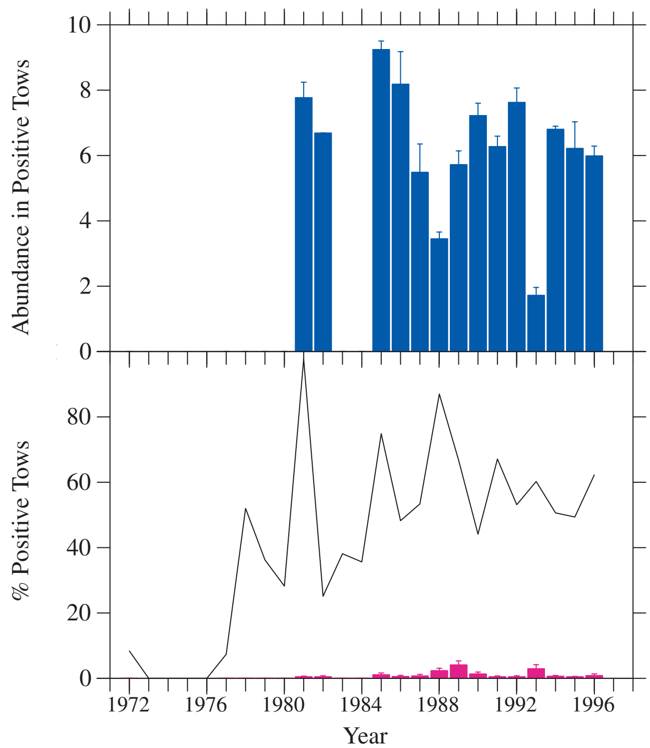
Larval distribution Spinycheek starsnout larvae are distributed on the shelf from the Bering Sea, along the Alaska Peninsula, around and northeast of Kodiak Island in the Gulf of Alaska, and along the U.S. west coast off northern California. Adults are not collected in AFSC adult surveys and available data on distribution patterns are limited (Aleutian Islands to Oregon). Newly hatched and small larvae (5–11 mm SL) are collected during spring April–June. Overall catch by year indicates larvae were consistently present after 1980 when AFSC began frequent sampling around Kodiak Island.



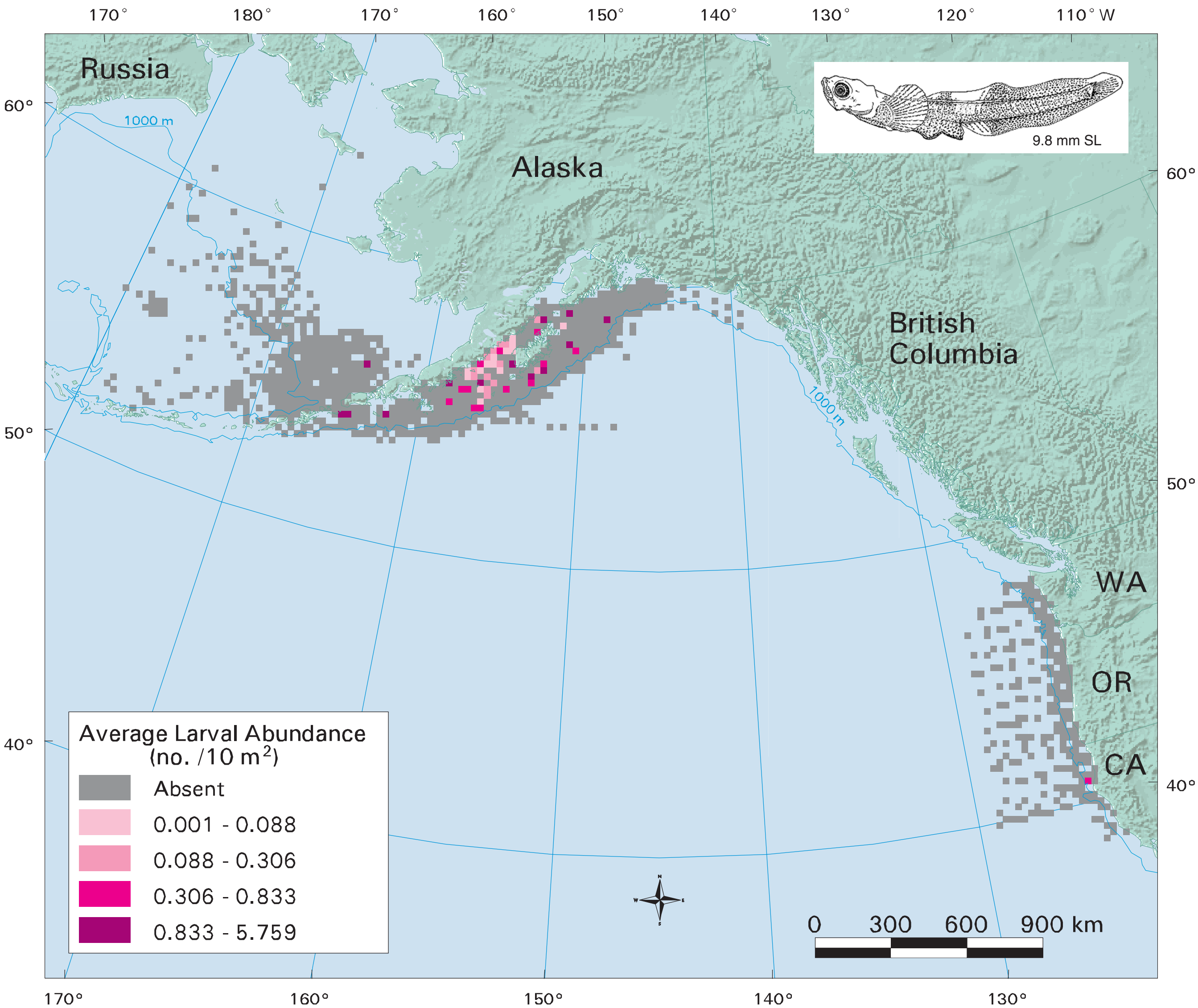
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

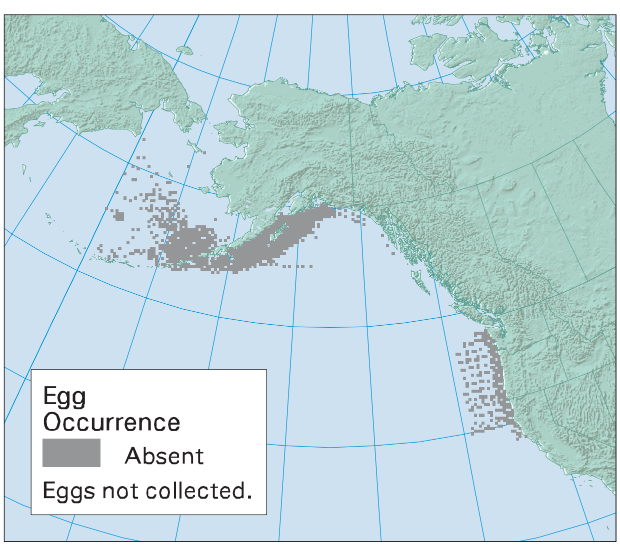


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 89 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

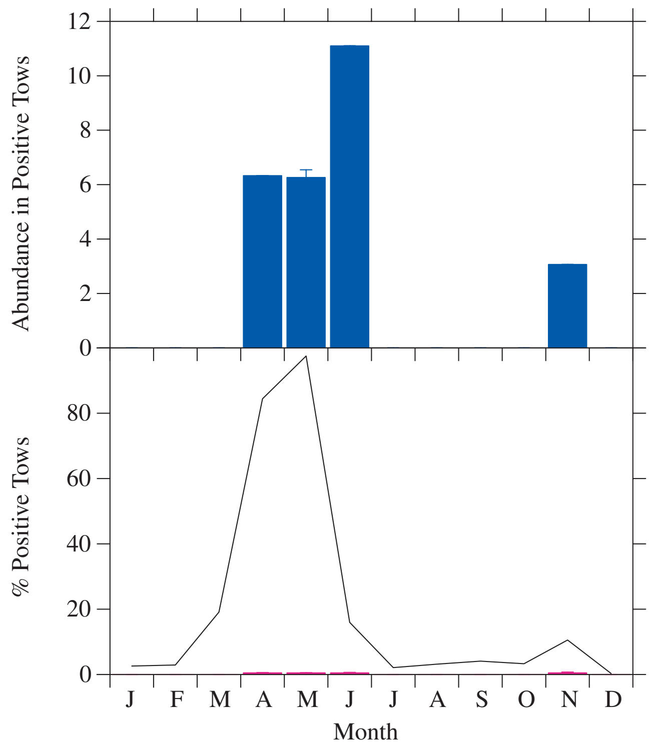

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
9.8 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.088
0.088 - 0.306
0.306 - 0.833
0.833 - 5.759
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

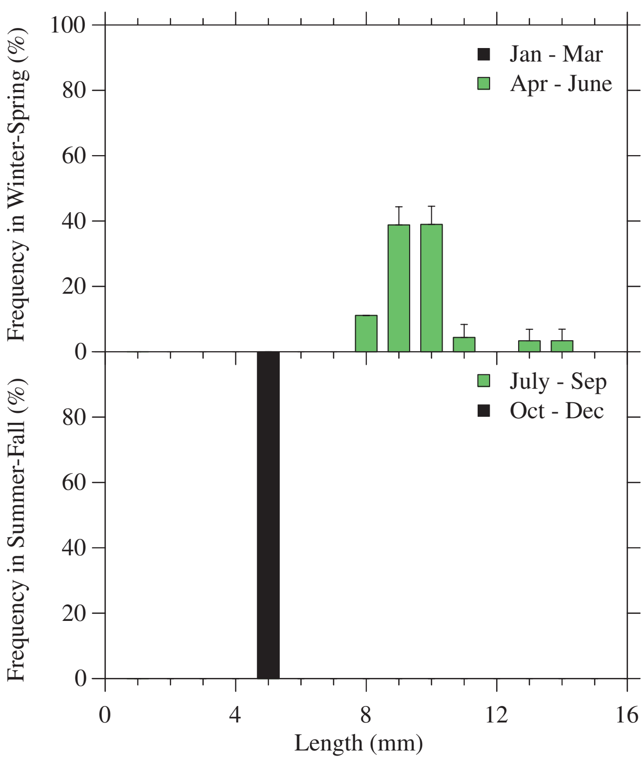

Adult Occurrence*
Present
(Occurrence only)

Life history *Bathyagonus nigripinnis* range from the Bering Sea to northern California. Blackfin poacher usually inhabit soft substrates at depths of 91–1247 m and are commonly collected by trawl at depths of 100–500 m. Adults can reach a length of 21 cm TL. Larvae are rare in plankton samples and occur primarily in samples collected from west of Kodiak Island in the Gulf of Alaska. Larvae hatch at sizes <6.0 mm SL and begin to undergo notochord flexion by 8.0 mm SL. Postflexion and juvenile stages are unknown.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989), Kanayama (1991), Busby (1998)]

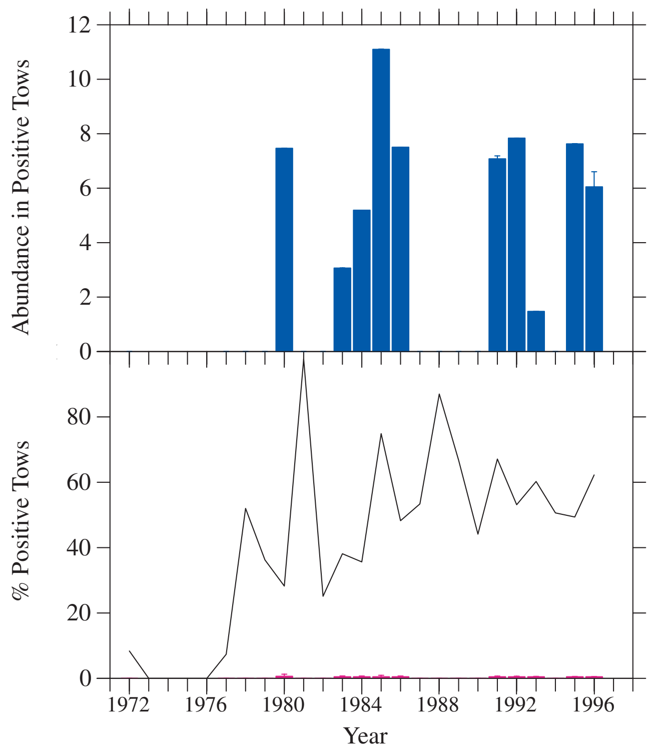
Larval distribution Blackfin poacher larvae are collected along the shelf and outer shelf along the Aleutian Islands, to Kodiak Island in the Gulf of Alaska, and along the U.S. west coast off Washington and Oregon. Although larvae have not been collected in AFSC surveys in the Bering Sea, adults occur there. Larvae are most abundant along outer shelf edges. Larvae occur April–June and in November. Most occur in spring, during which time they range in size from 8 to 12 mm SL. Larvae are uncommon and catches were variable throughout the time series from 1980 to 1996.



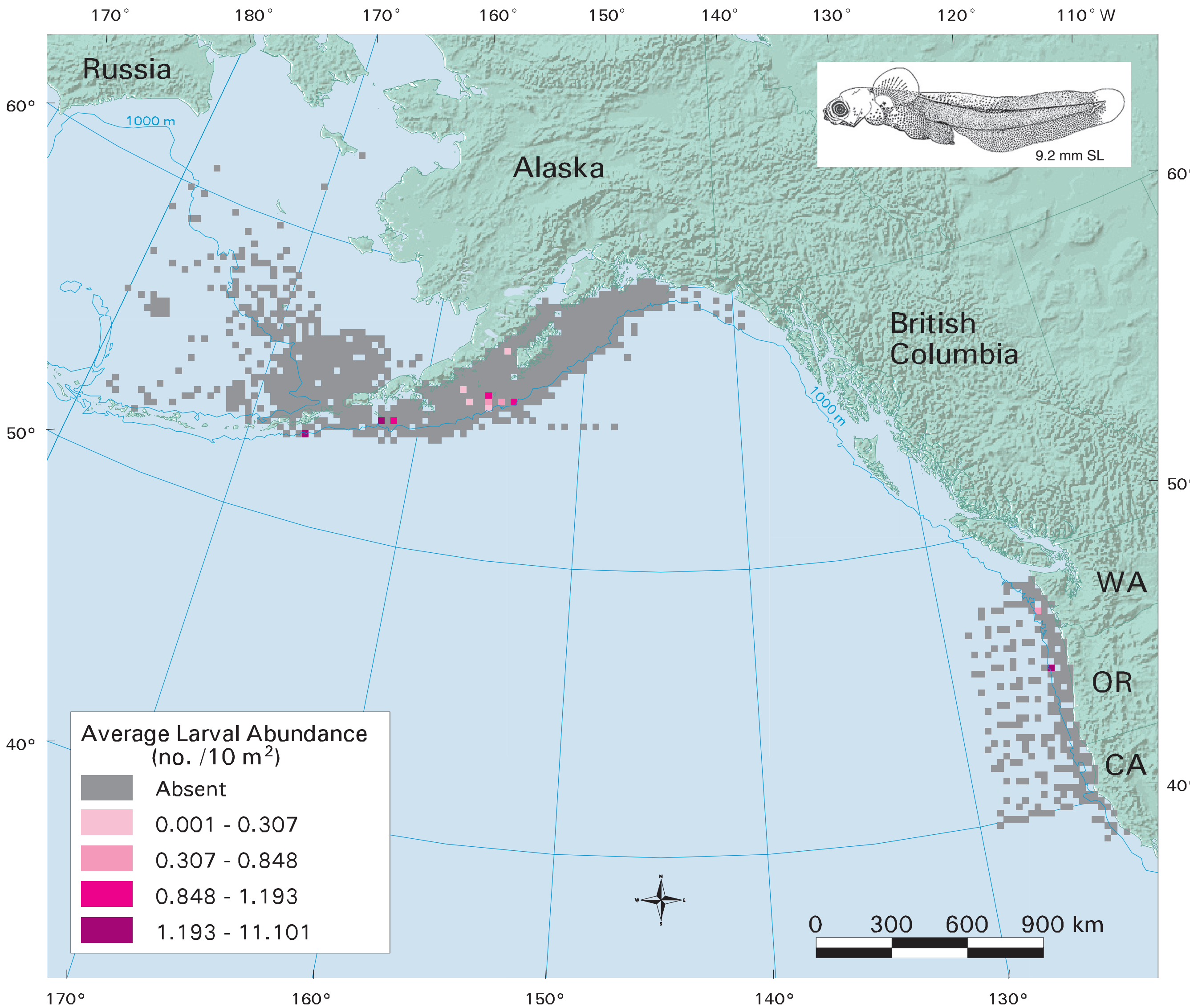
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

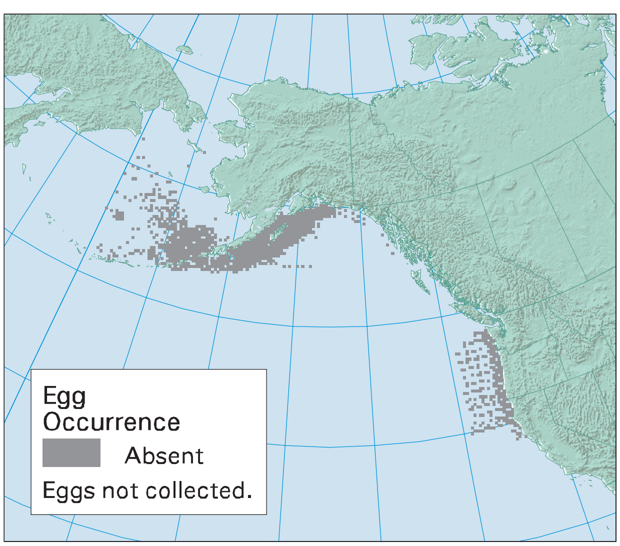


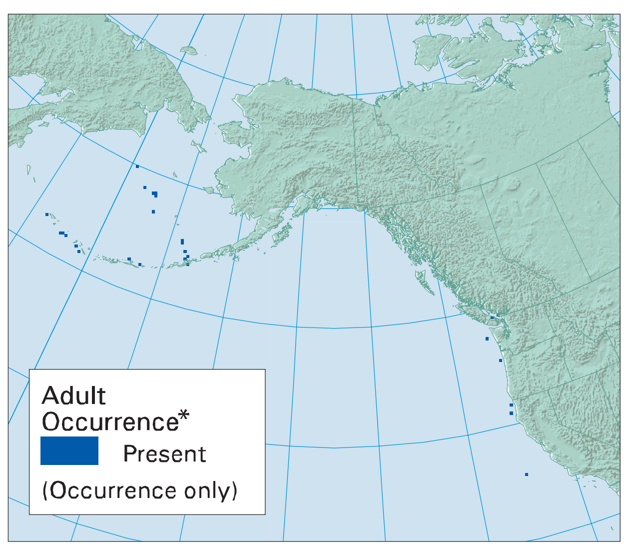
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 12 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

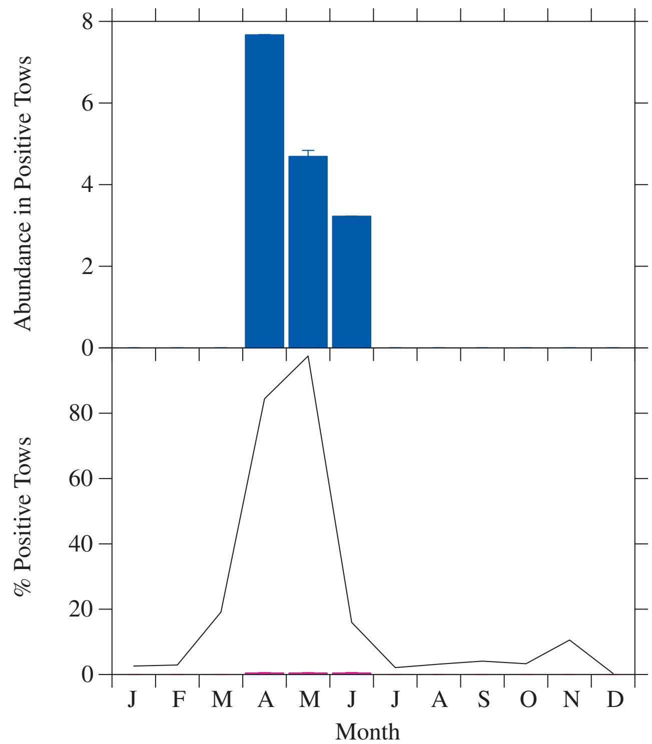

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
170°
160°
150°
140°
130°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
9.2 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.307
0.307 - 0.848
0.848 - 1.193
1.193 - 11.101
0 300 600 900 km


Egg Occurrence
Absent
Eggs not collected.

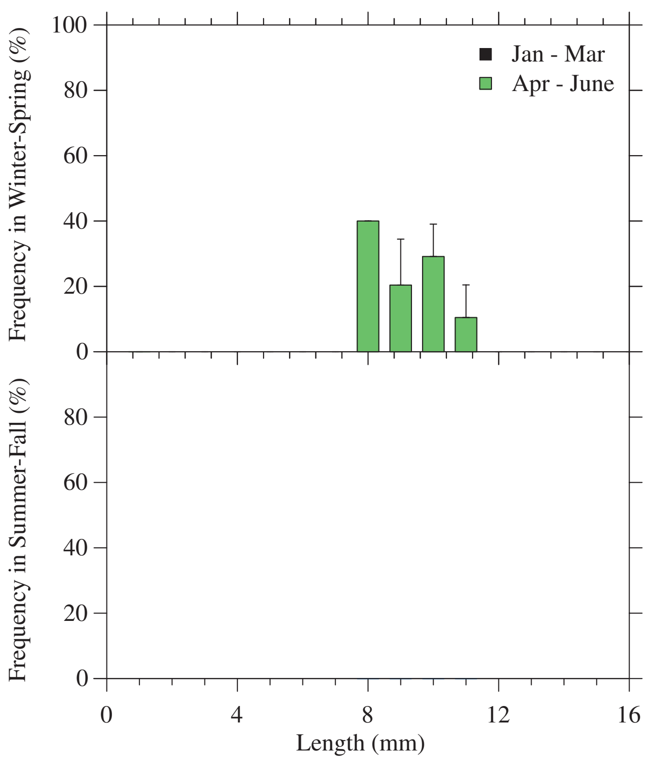

Adult Occurrence*
Present
(Occurrence only)

Life history *Bathyagonus pentacanthus* are found from the Bering Sea to along the U.S. west coast to southern California. Adult bigeye poachers usually inhabit soft substrates at depths of 110–910 m, occurring at depths of 110–375 m in the CalCOFI region. Bigeye poachers are among the larger of the agonids; adults can grow to 23 cm TL. Pelagic larvae hatch at sizes <5.0 mm SL, undergo notochord flexion at 7.5–12.0 mm SL, and begin transforming by about 15 mm SL; the juvenile stage begins by about 25.0 mm SL. Larvae are rare in plankton samples from the northern extent of their distribution, but preflexion larvae are collected in CalCOFI surveys from January–May, with a peak in January–February. [Sources include: Eschmeyer et al. (1983), Ambrose (1996f), Busby (1998)]

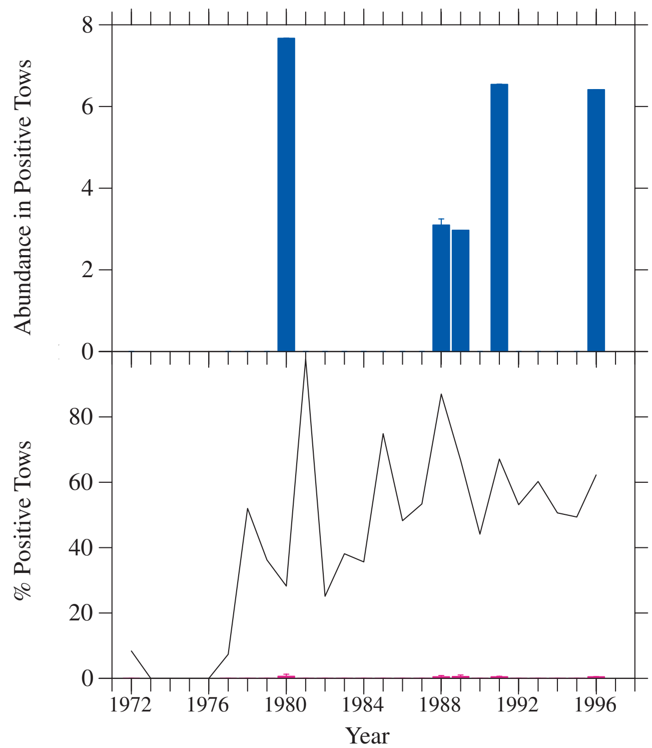
Larval distribution Bigeye poacher larvae are distributed west of Kodiak Island along the Shelikof sea valley in the Gulf of Alaska, and off Washington along the U.S. west coast. Adults are not collected in AFSC surveys, but our limited data on distribution patterns indicates adults are present off the U.S. west coast. There are no AFSC records of adults or larvae in the Bering Sea. Larvae are found mainly in deeper and outer shelf waters. Small larvae (8–11 mm SL) are collected April–June. Larvae were rare, but occurred intermittently in the time series from 1980 to 1996.



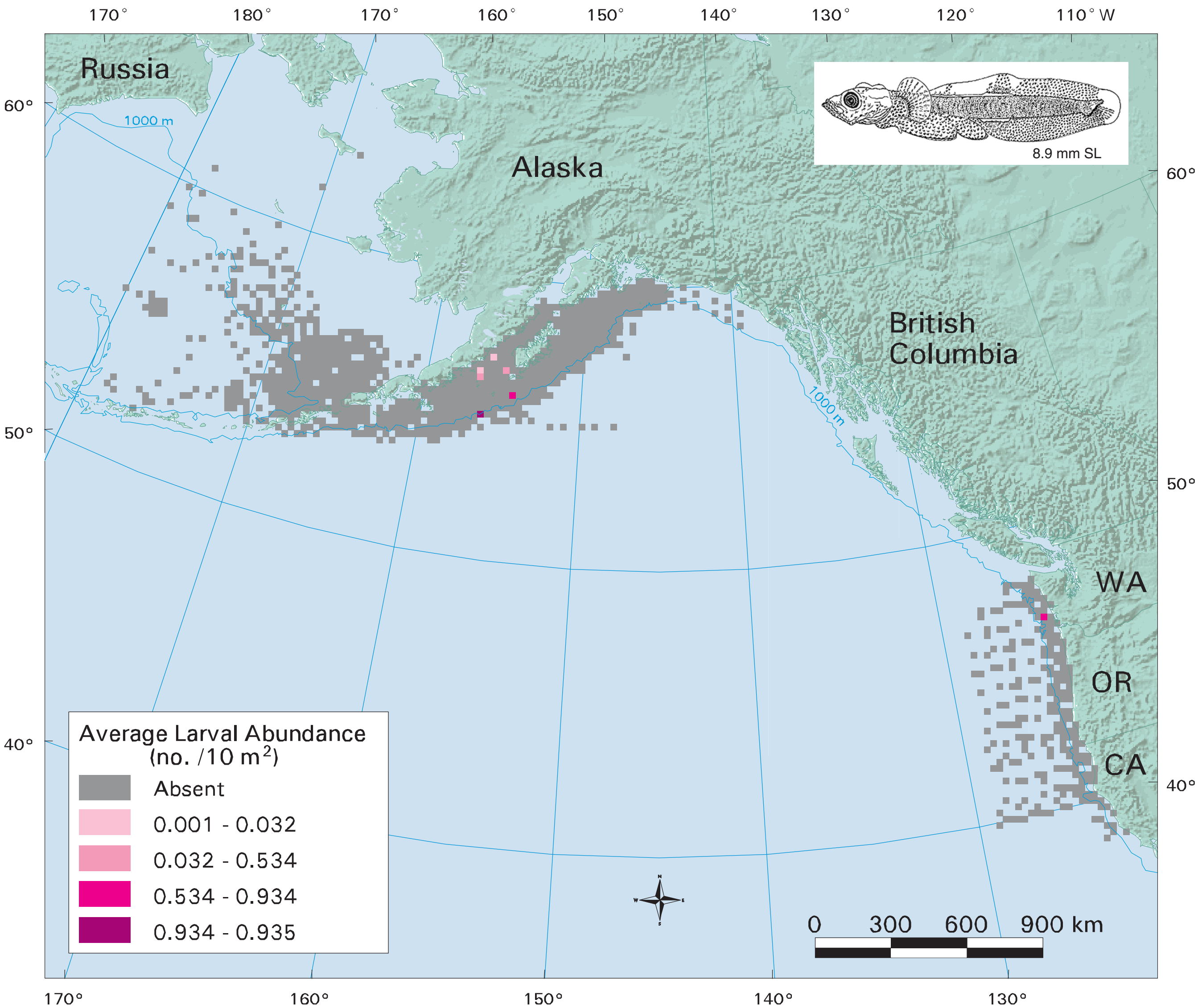
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

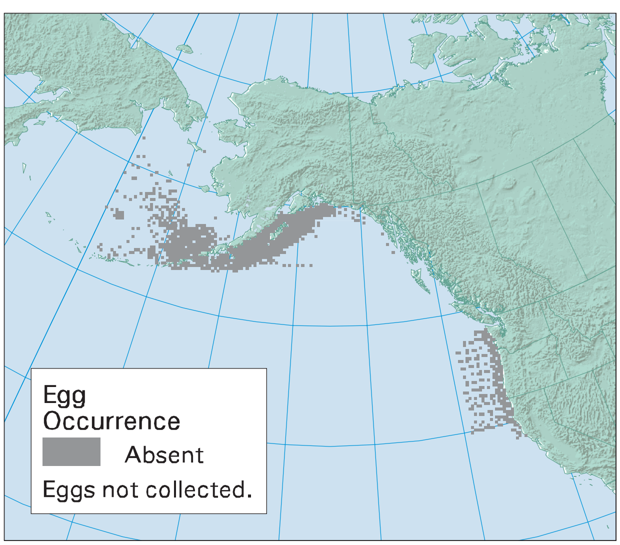


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 7 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

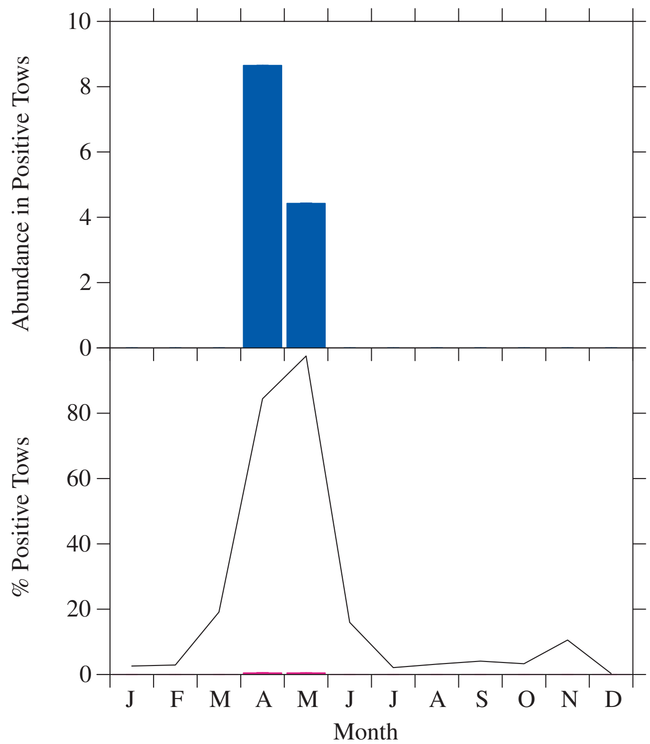

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
8.9 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.032
0.032 - 0.534
0.534 - 0.934
0.934 - 0.935
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

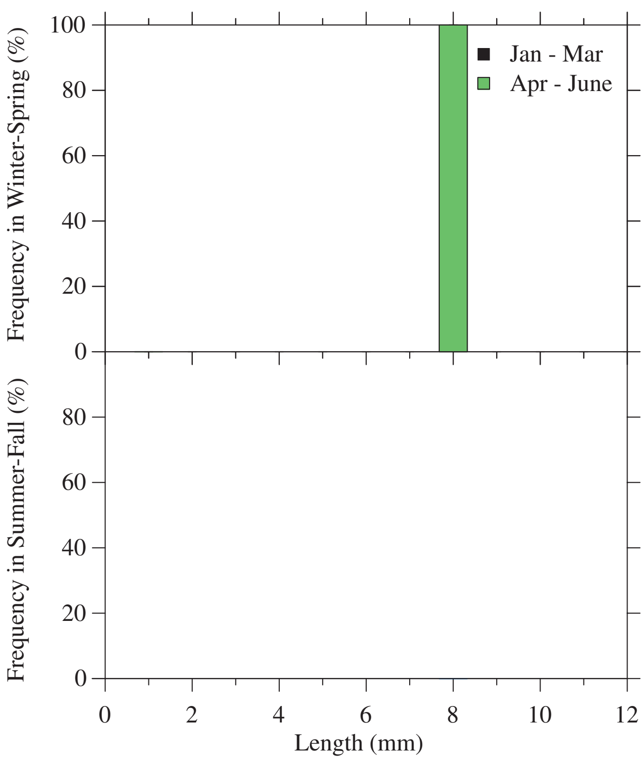

Adult Occurrence*
Present
(Occurrence only)

Life history Although the range for *Hypsagonus mozinoi* is reported as the North Pacific Ocean from British Columbia to central California, Busby (1998) described kelp poacher larvae from the Bering Sea, and their range is presumably further to the north and west. Kelp poachers occur along intertidal and nearshore habitats to depths of 11 m. Adults crawl over the sea bottom and climb rock faces with their pectoral fins; their bodies are often covered with small sponges and seaweed that, together with the striking red and brown coloration, provide camouflage. Eggs are demersal, about 1 mm in diameter, red in color, and deposited at intervals in separate masses (6-25 eggs per mass) during winter and spring. Larvae hatch at 3.9-5.5 mm SL and undergo notochord flexion beginning by 8.1 mm SL; postflexion and juvenile stages are unknown. Larvae are extremely rare in plankton samples.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989), Busby (1998)]

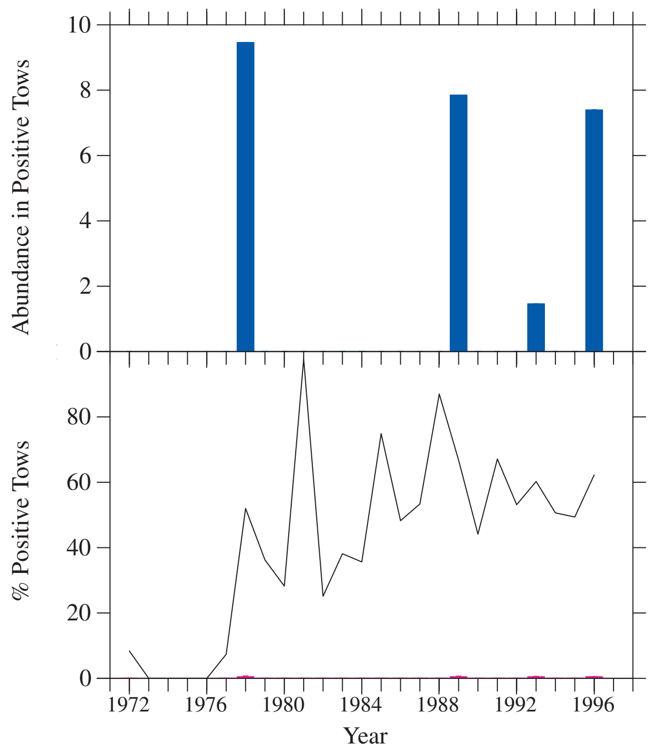
Larval distribution Kelp poacher larvae are collected along the Shelikof sea valley and over the shelf east of Kodiak Island in the Gulf of Alaska. Adults are not collected in AFSC adult surveys and available data on distribution patterns are limited (British Columbia and California). Small larvae (8 mm SL) are found in April and May. Larvae were very rare, occurring only in 1978, 1989, 1993, and 1996.



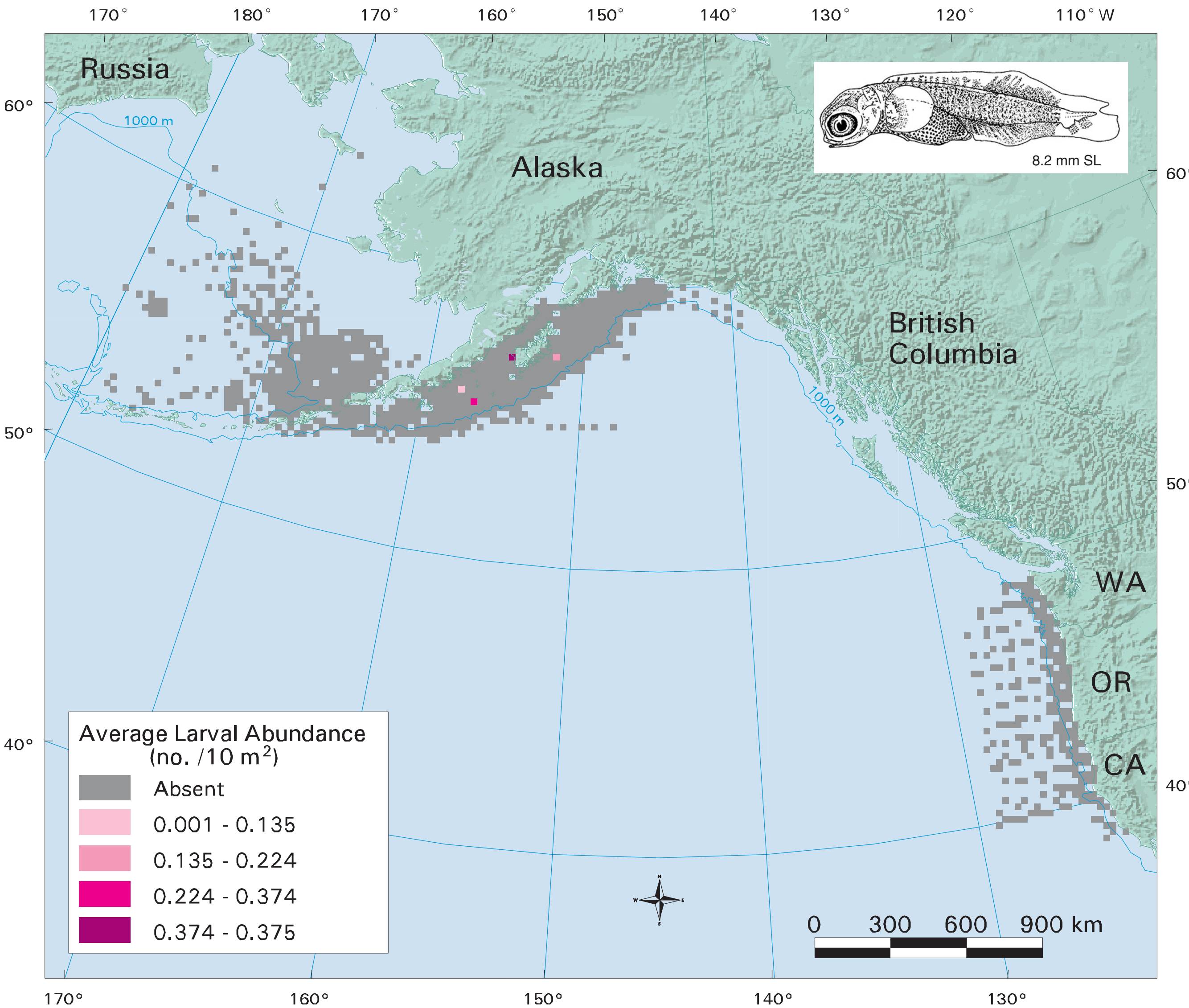
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

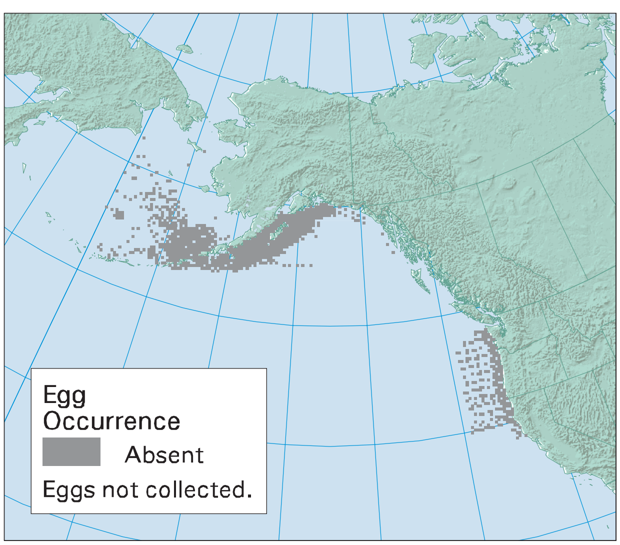


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 3 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

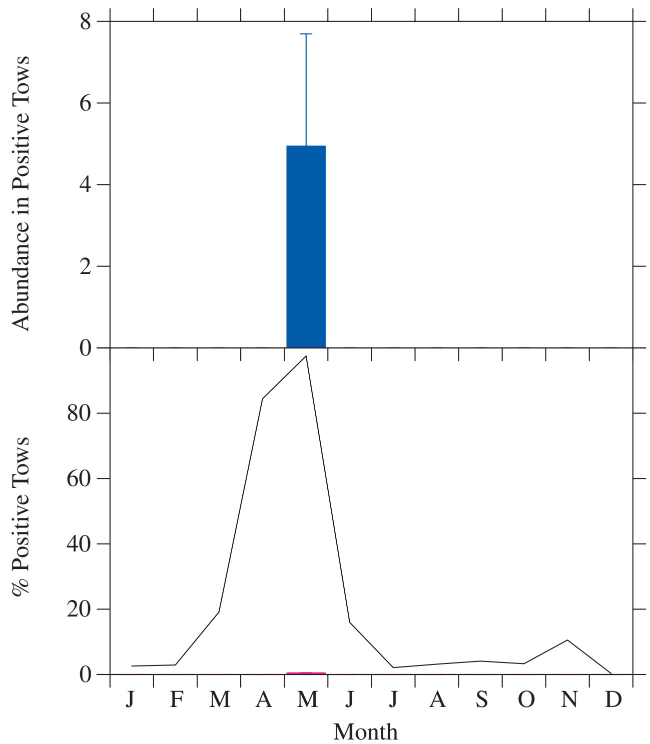

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
8.2 mm SL
Average Larval Abundance
(no. /10 m2)
Absent
0.001 - 0.135
0.135 - 0.224
0.224 - 0.374
0.374 - 0.375
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

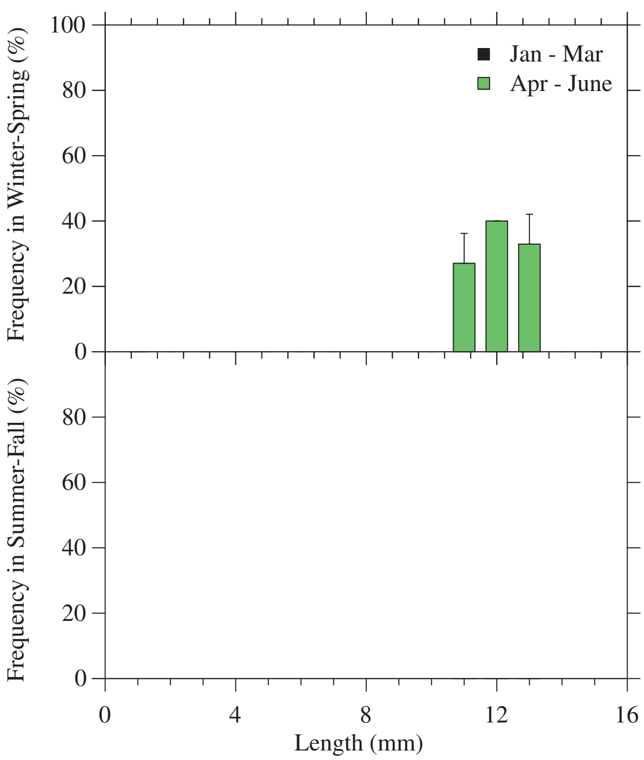

Adult Occurrence*
Present
(Occurrence only)

Life history *Hypsagonus quadricornis* are collected from the Bering Sea to Puget Sound, Washington. Adult fourhorn poachers occupy intertidal and nearshore rocky bottom habitats at depths of 15–258 m. They are smaller (reaching a length of 10 cm TL) and stouter than most other agonids and are frequently covered by featherlike polyps. Eggs and early stage larvae are unknown. Notochord flexion begins at sizes smaller than 6.4 mm SL (the smallest specimen examined by Busby (1998)) and is completed by 9.0 mm SL. The juvenile stage begins at 14.0 mm SL. Larvae are rare in plankton samples.
[Sources include: Eschmeyer et al. (1983), Kessler (1985), Busby (1998)]

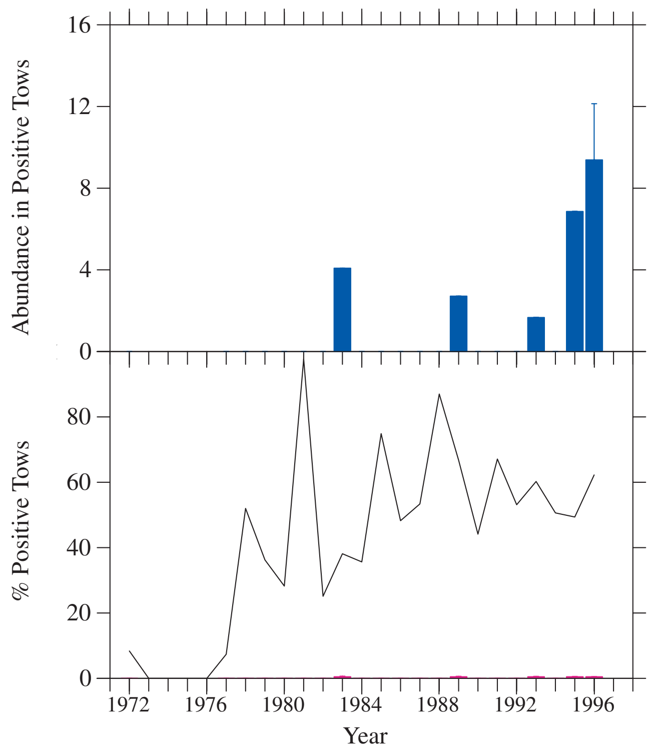
Larval distribution Fourhorn poacher larvae are collected on the Bering Sea shelf, in the Unimak Pass area, and southwest of Kodiak Island in the Gulf of Alaska. Larvae and adults have not been collected during AFSC surveys in the U.S. west coast survey areas. Small larvae (11–13 mm SL) are found in May. Larvae were rare and occurred intermittently in the time series from 1983 to 1996.



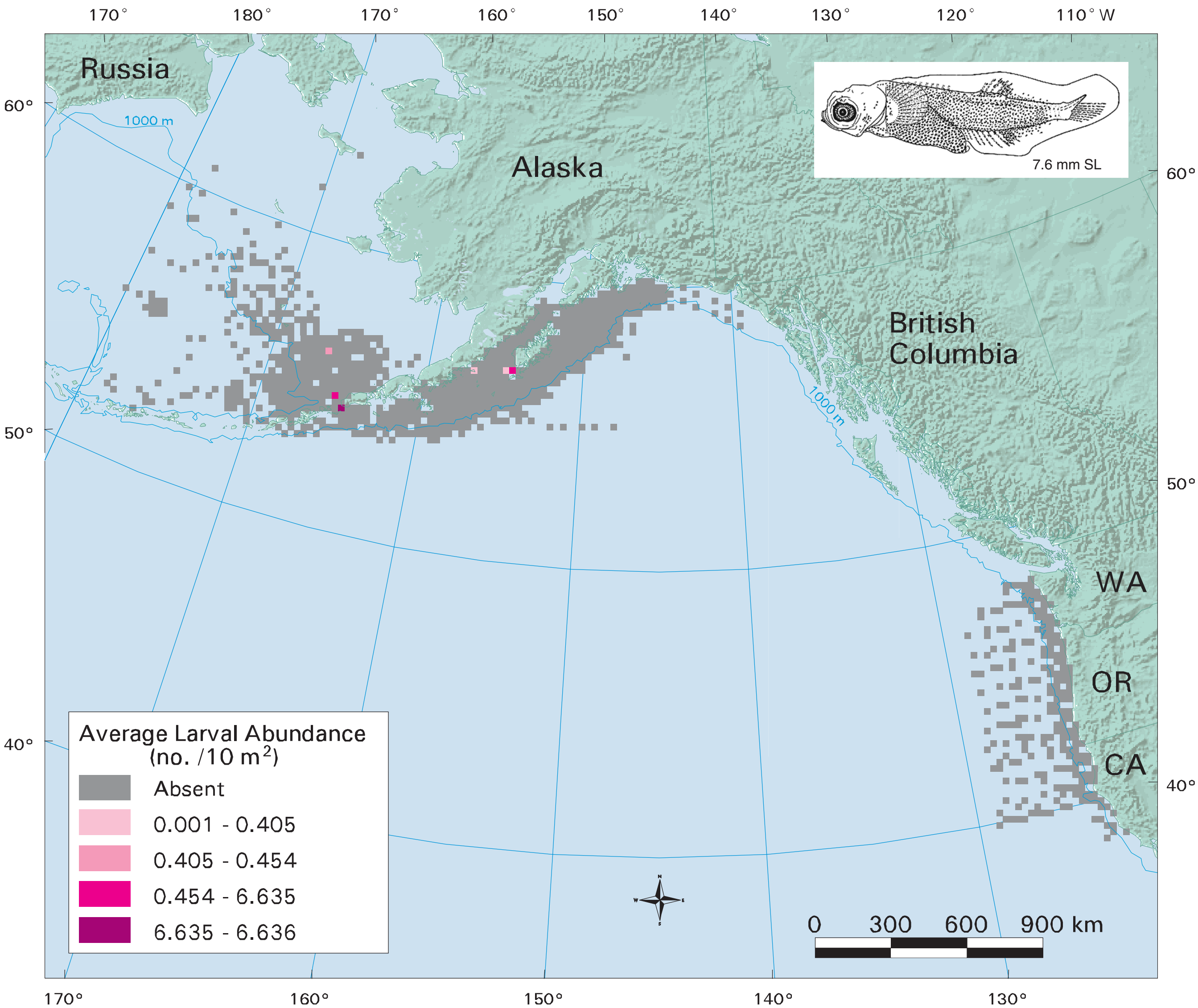
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



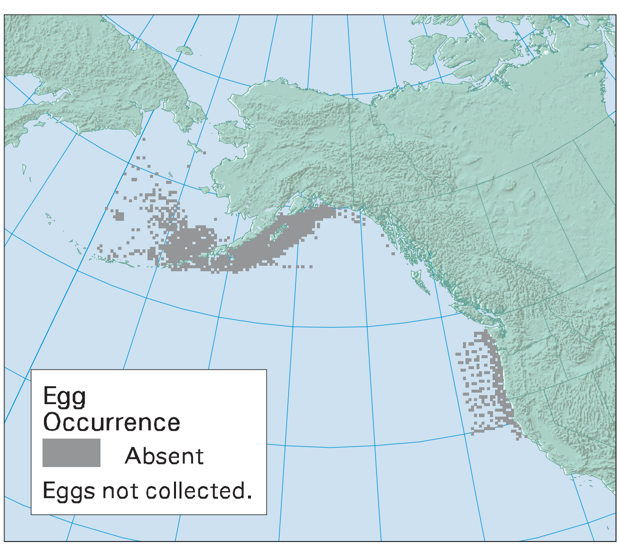
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 6 for winter–spring (Jan–June).



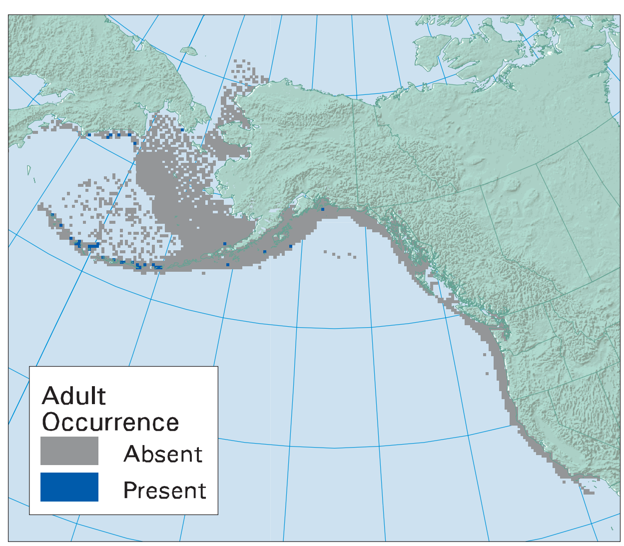
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
7.6 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.405
0.405 - 0.454
0.454 - 6.635
6.635 - 6.636
0 300 600 900 km
170°
160°
150°
140°
130°



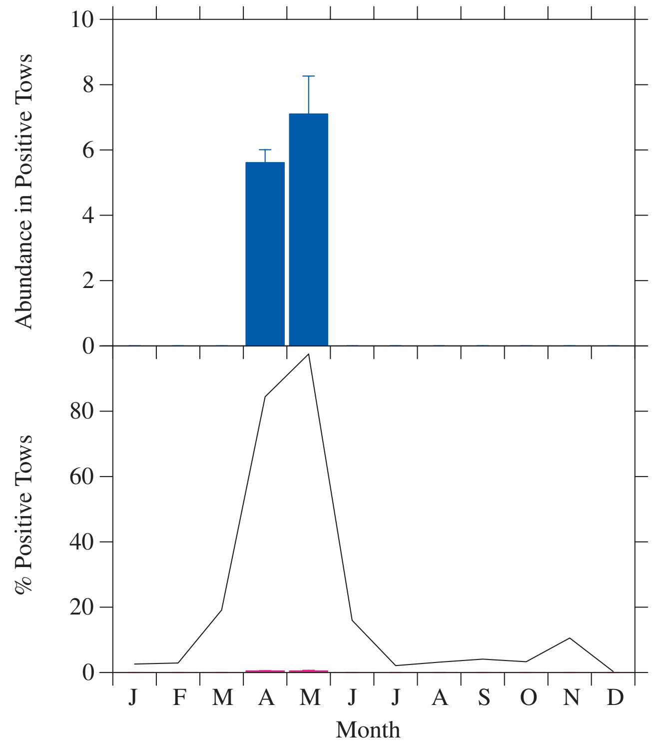
Egg Occurrence
Absent
Eggs not collected.



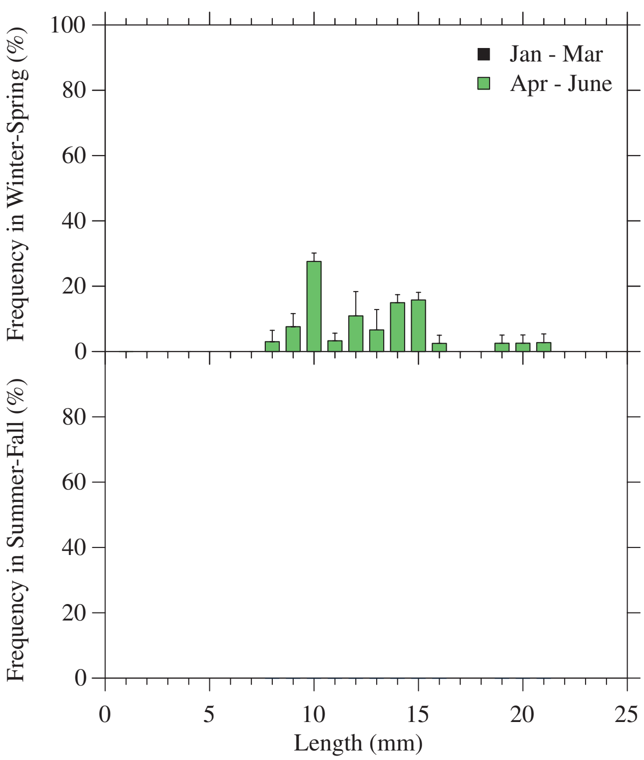
Adult Occurrence
Absent
Present

Life history *Leptagonus frenatus* are found from the Bering Sea to British Columbia. Sawback poachers are common in the Bering Sea; adults are benthic and are found at depths of 50–250 m over muddy sand or rocky habitat. According to Busby (1998), pelagic larvae and juveniles are collected in plankton gear other than bongo nets (e.g., Methot trawl) in the eastern Bering Sea.
[Sources include: Busby (1998)]

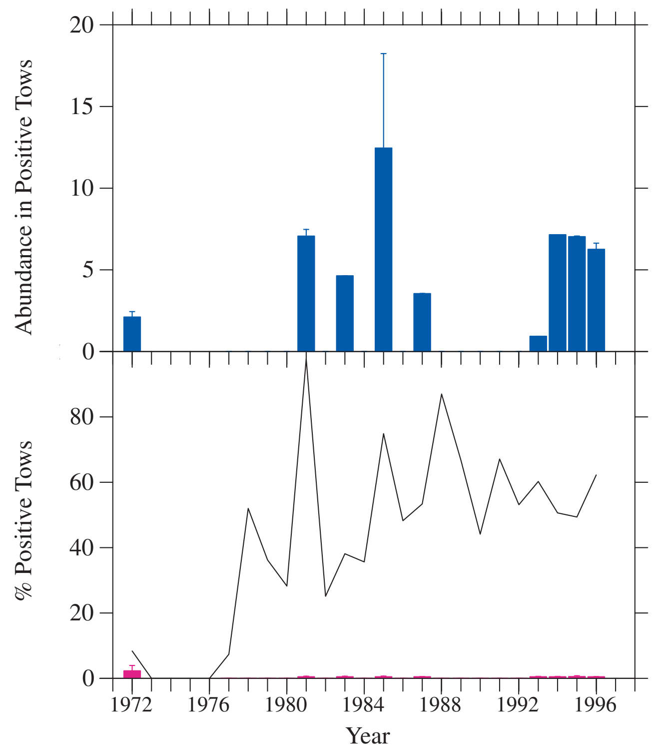
Larval distribution Sawback poacher larvae are found on the southeast Bering Sea shelf, the Gulf of Alaska near Unimak Pass, Shelikof sea valley and Strait, and east of Kodiak Island. Larvae are not as widespread as adults in the Bering Sea or along the Aleutian Islands. Larvae are collected in April–May and span a wide size range (8–21 mm SL). Overall catch by year indicates larvae were uncommon, but appeared sporadically throughout the time series.



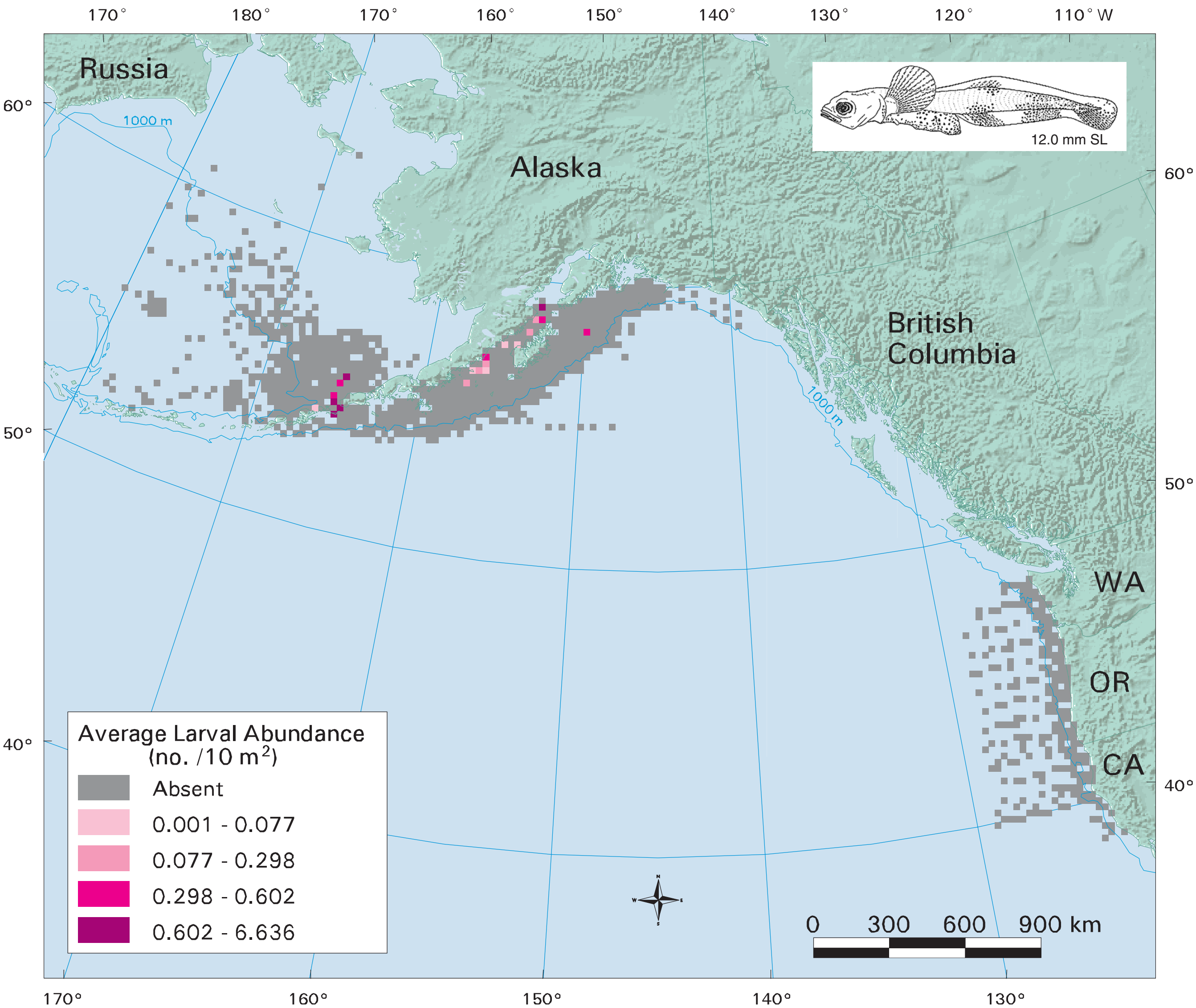
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

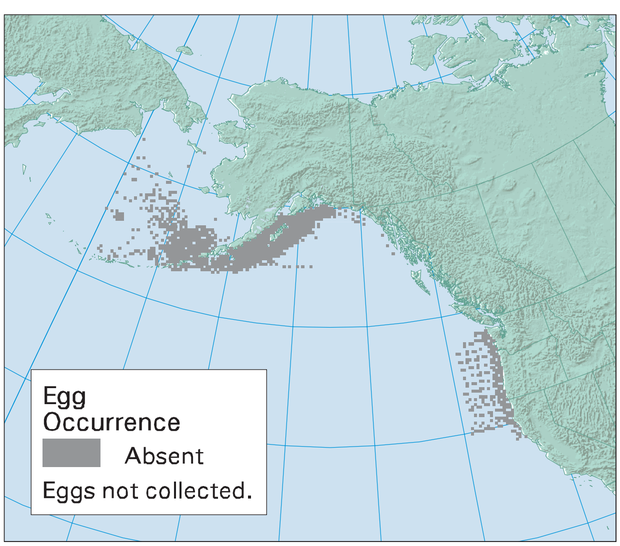


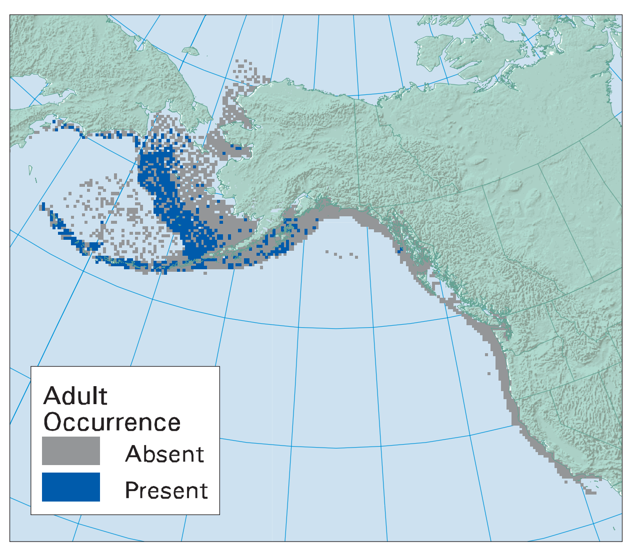
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 20 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

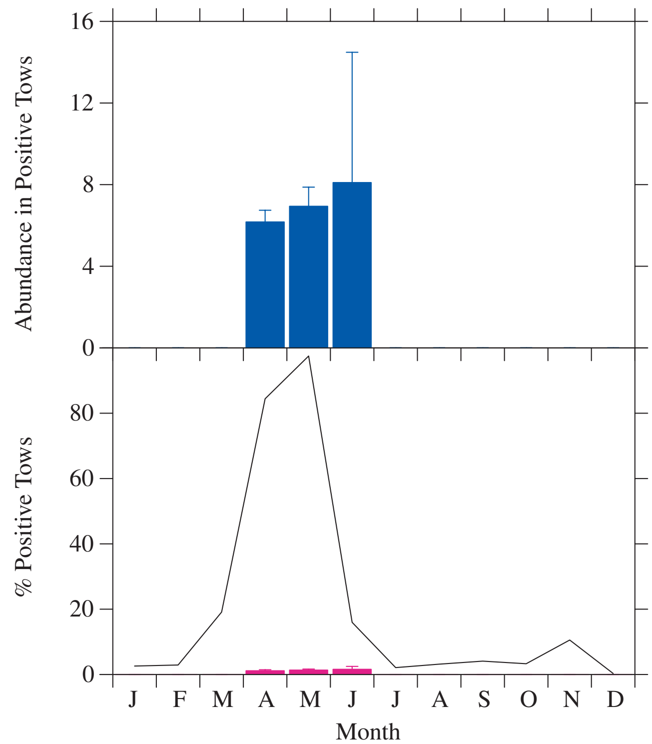

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
12.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.077
0.077 - 0.298
0.298 - 0.602
0.602 - 6.636
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

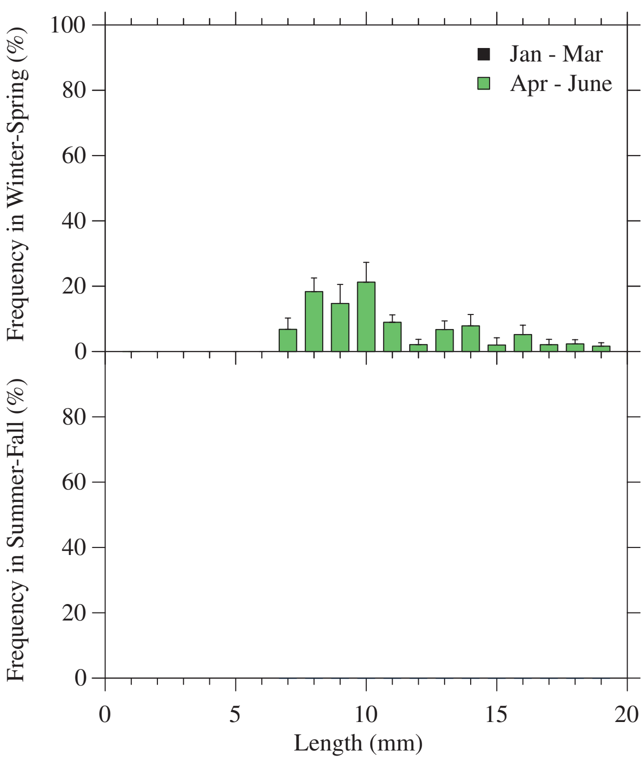

Adult Occurrence
Absent
Present

Life history *Podothecus acipenserinus*' distribution is reported in the literature as the Chukchi Sea to northern California. However, a number of specimens from north of St. Matthew Island in the Bering Sea to the Chukchi Sea have been re-identified as *Podothecus veternus.* It is likely that the two species' distributions overlap. Largest of all agonids in the study area (30 cm TL), sturgeon poachers are benthic and are found at depths of 18–55 m over soft substrate off British Columbia and at 50–300 m in the Bering Sea; larvae are pelagic. [Sources include: Hart (1973), Eschmeyer et al. (1983), Allen and Smith (1988), Matarese et al. (1989), Kanayama (1991), Busby (1998)]

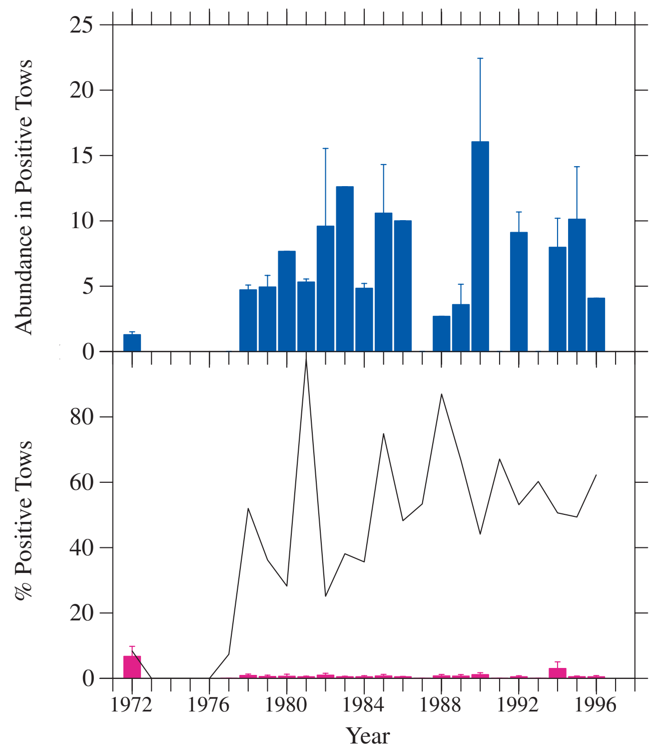
Larval distribution Sturgeon poacher larvae are found north of and around Unimak Pass on the Bering Sea shelf, around Kodiak Island in the Gulf of Alaska, and along the U.S. west coast off Washington. Larval distribution is patchy and not as widespread as that of adults, but abundance is high southwest of Kodiak Island. Larvae (7–19 mm SL) appear in collections April–June. Larvae occurred in fewer than 5% of the samples from year to year, but were present in most years throughout the time series.



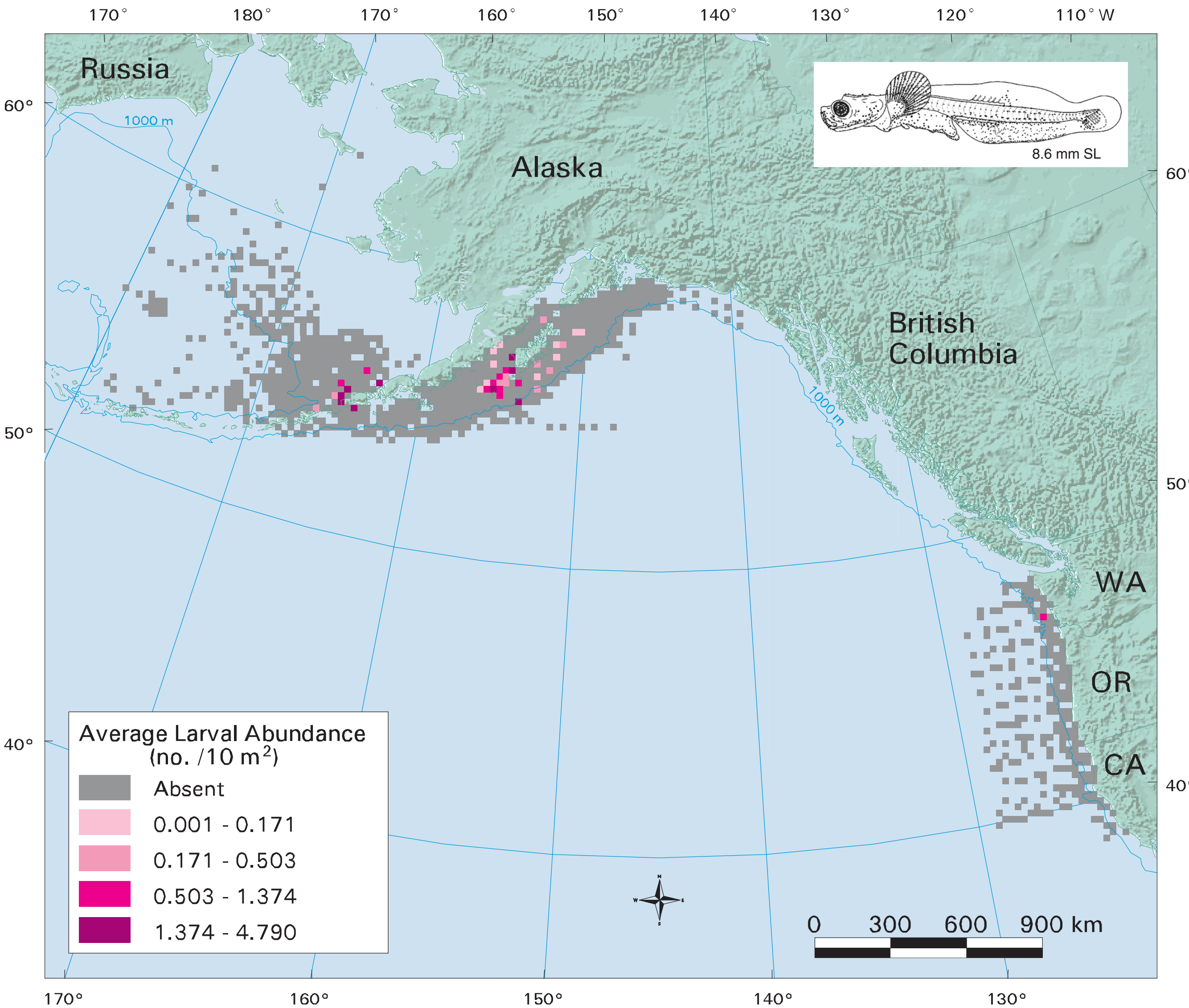
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

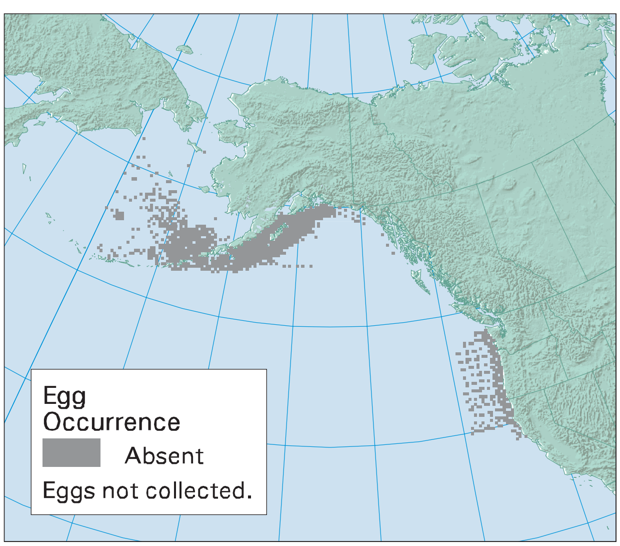


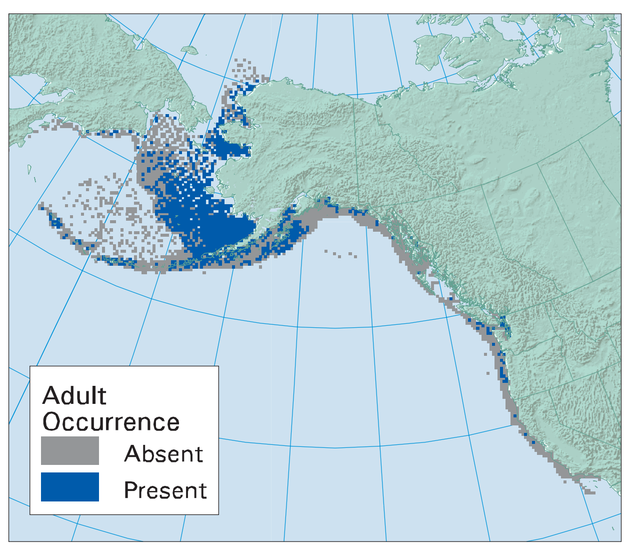
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 65 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

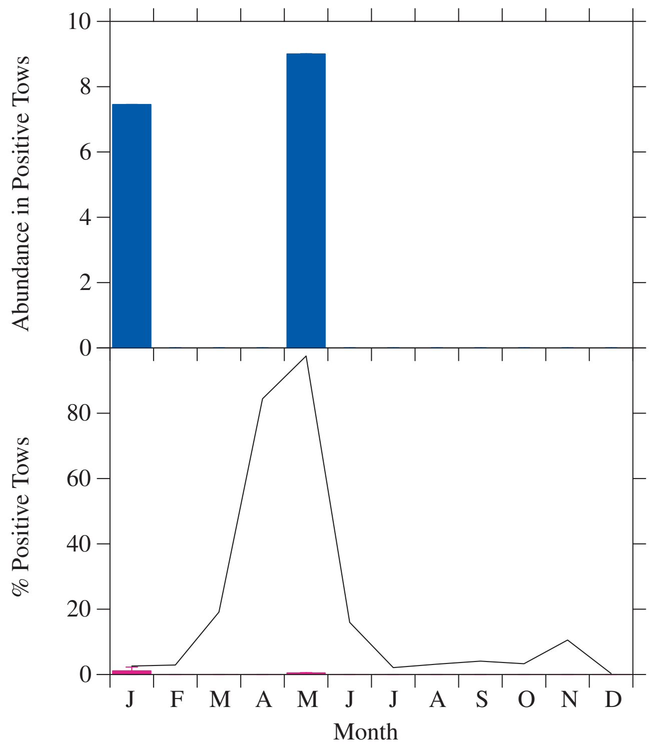

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
170°
160°
150°
140°
130°
Russia
1000 m
Alaska
8.6 mm SL
British Columbia
1000 m
WA
OR
CA
Average Larval Abundance
(no. /10 m²)
Absent
0.001 - 0.171
0.171 - 0.503
0.503 - 1.374
1.374 - 4.790
0 300 600 900 km


Egg
Occurrence
Absent
Eggs not collected.

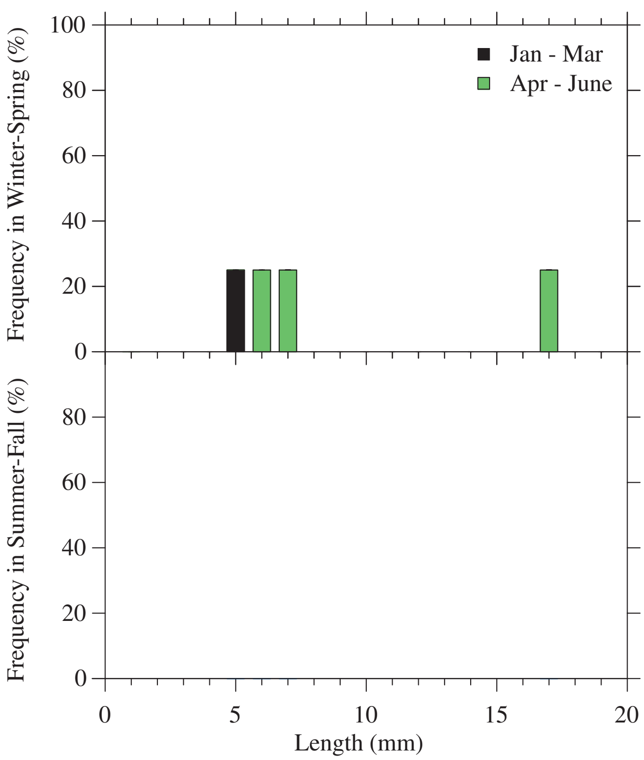

Adult
Occurrence
Absent
Present

Life history *Xeneretmus latifrons* are reported to be found from British Columbia to Baja California. However, several larvae have been identified in some AFSC surveys in the northern Gulf of Alaska. Blacktip poachers live on soft bottoms at depths of 18–400 m. Adults can reach 19 cm TL and live to at least 6 years. Although spawning has been reported as occurring in the spring off California, preflexion larvae have been collected in all seasons with a peak in March. Eggs are demersal; pelagic larvae hatch at <4.9 mm SL and undergo gradual transformation at about 15 mm SL.
[Sources include: Hart (1973), Matarese et al. (1989), Ambrose (1996f)]

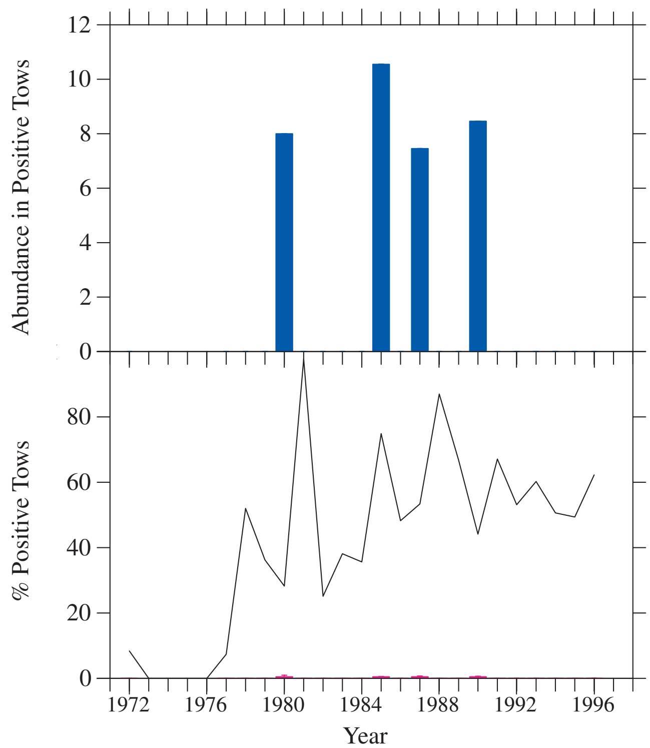
Larval distribution Blacktip poacher larvae occur on the shelf north and east of Kodiak Island in the Gulf of Alaska, and along the shelf off the Oregon coast. Small larvae (5–7 mm SL) are collected in May in the Gulf of Alaska and in January off Oregon. Although adults are not collected in AFSC surveys north of Washington, the presence of larvae in the Gulf of Alaska indicates adults are present as far north as Kodiak Island. The largest larva (17.0 mm SL) was collected off Oregon in May. Overall catch by year indicates larvae were rarely caught, with only four occurrences between 1980 and 1990.



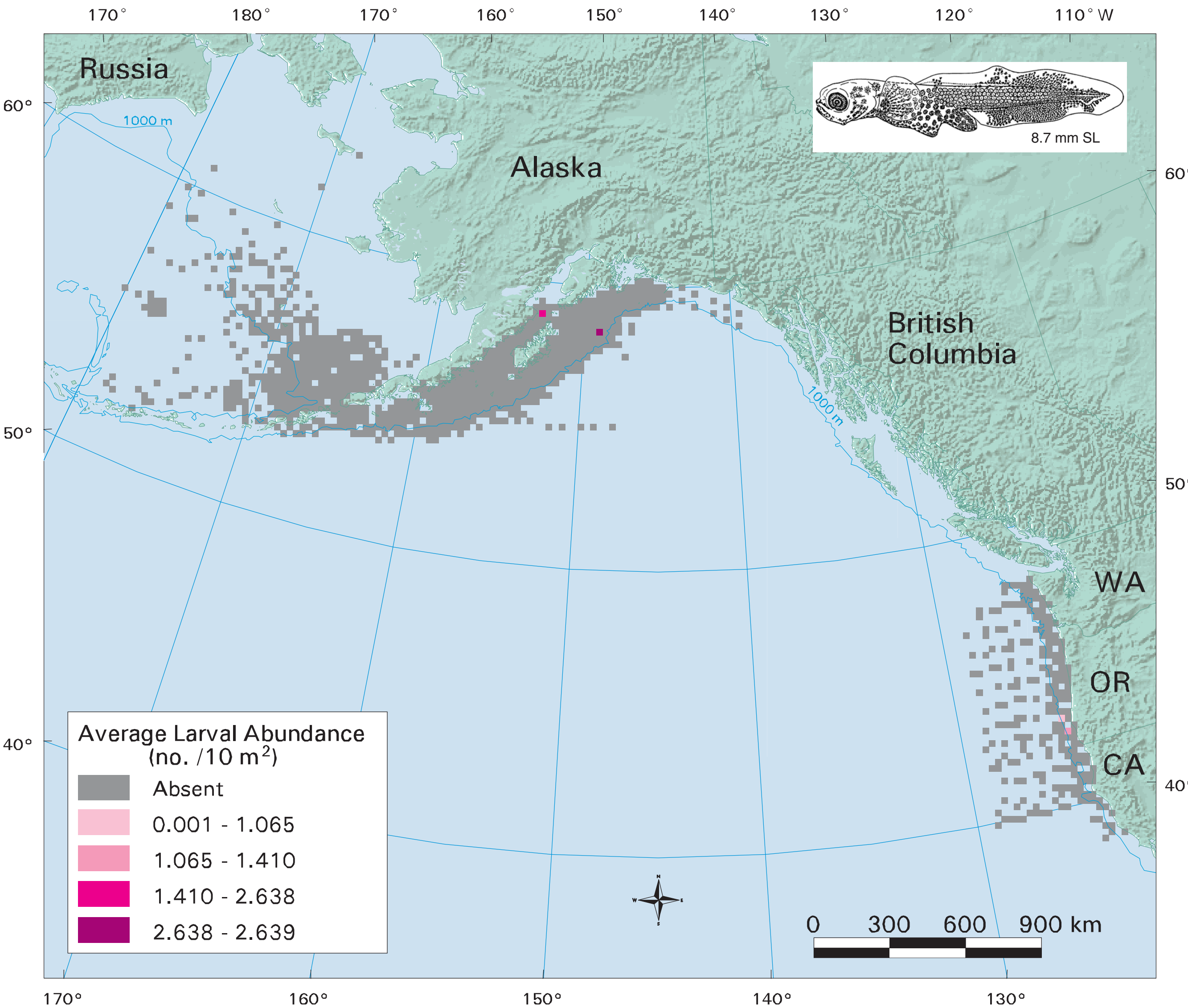
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

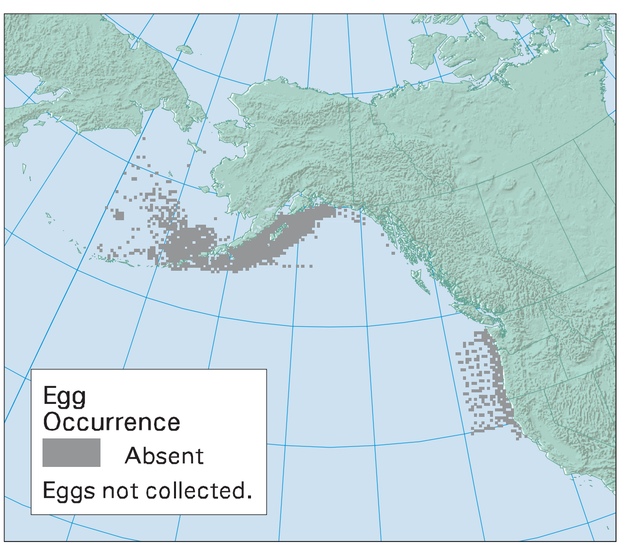


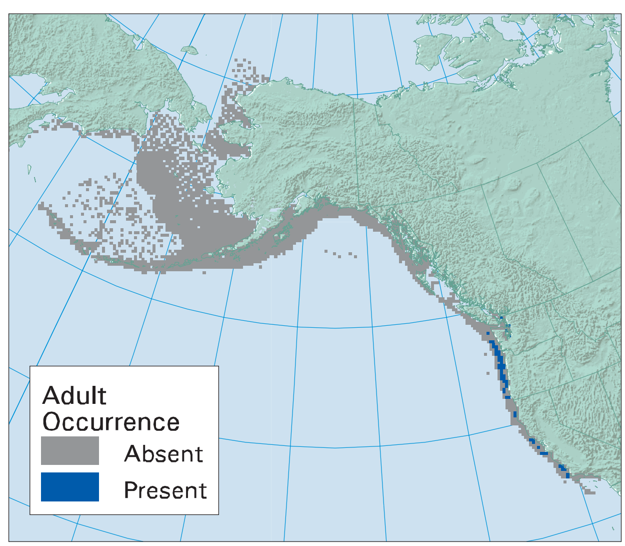
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 4 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

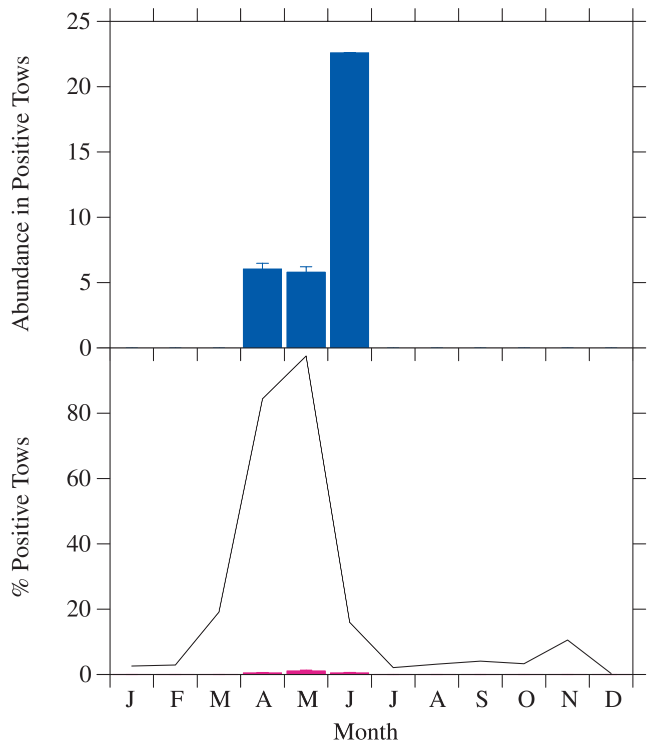

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
8.7 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.065
1.065 - 1.410
1.410 - 2.638
2.638 - 2.639
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

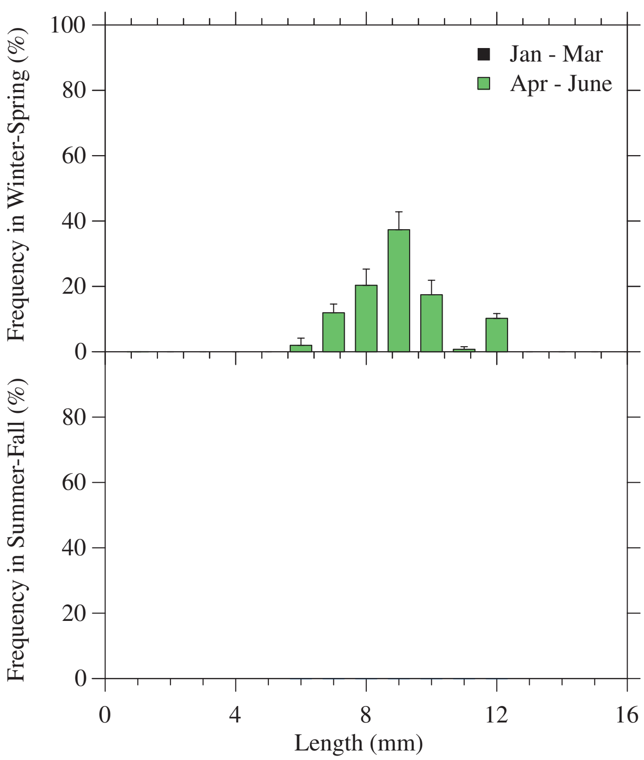

Adult Occurrence
Absent
Present

Life history *Dasycottus setiger* have been collected from the Bering Sea to along the U.S. west coast off Washington. Spinyhead sculpin adults are epi-, meso-, and bathybenthic at depths between 18 and 825 m. Information on spawning and eggs is unknown. Pelagic larvae hatch at about 7.4 mm SL and development of fin rays is complete at about 12 mm SL.
[Sources include: Matarese et al. (1989)]

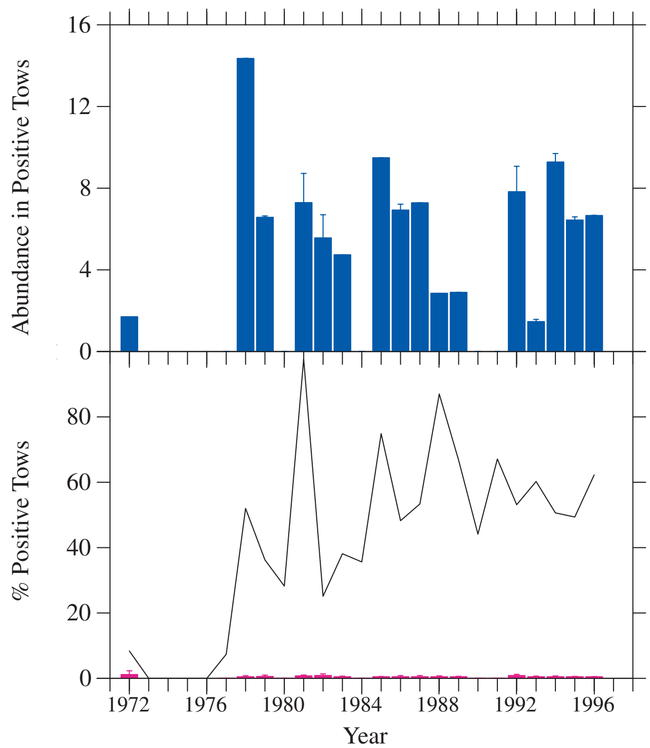
Larval distribution Spinyhead sculpin larvae are collected on the Bering Sea shelf near Unimak Pass and along the shelf around Kodiak Island in the Gulf of Alaska. Larvae are found April–June, with highest numbers occurring in June. The majority of larvae collected in winter–spring are small, ranging in size from 6–12 mm SL. Larvae are uncommon. Catches were small, but consistent, throughout the time series.



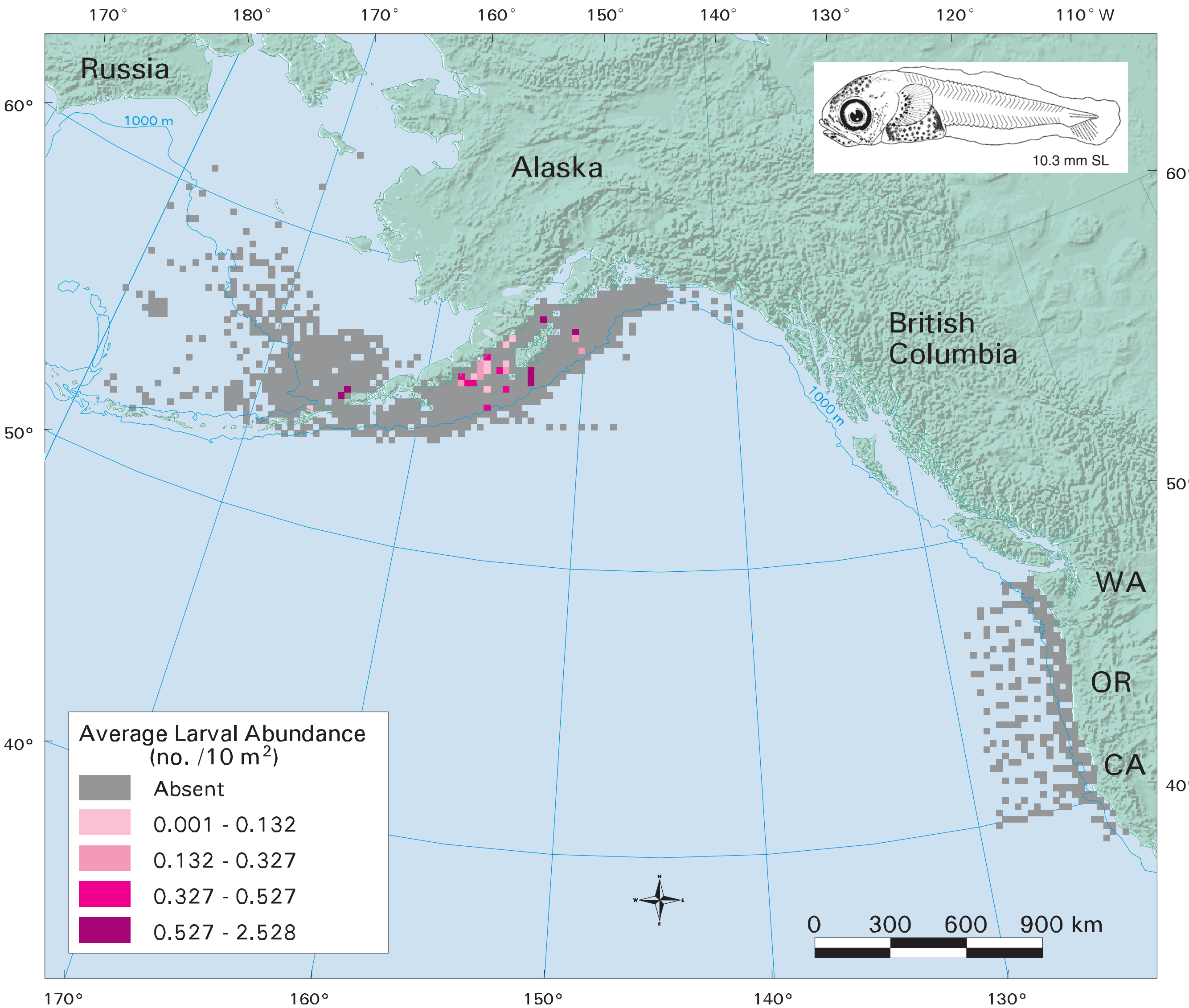
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

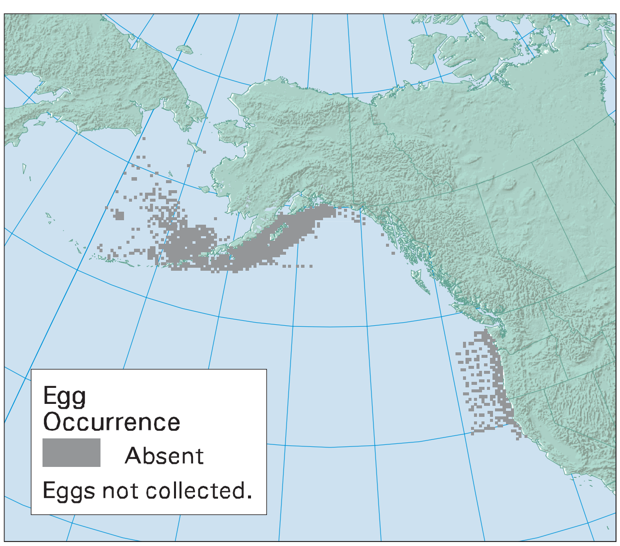


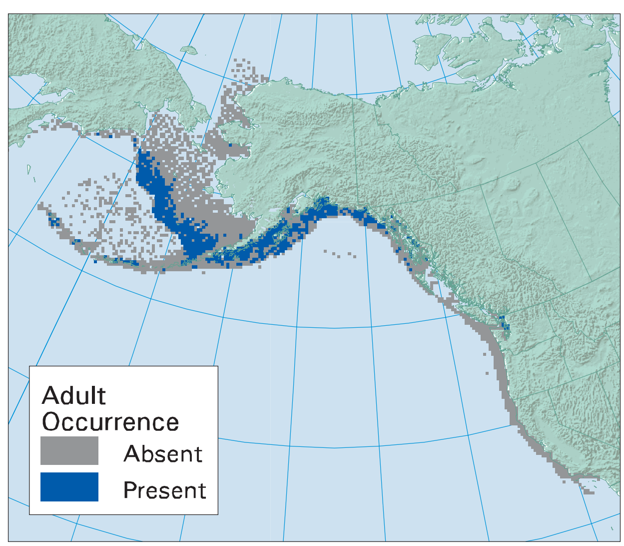
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 39 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

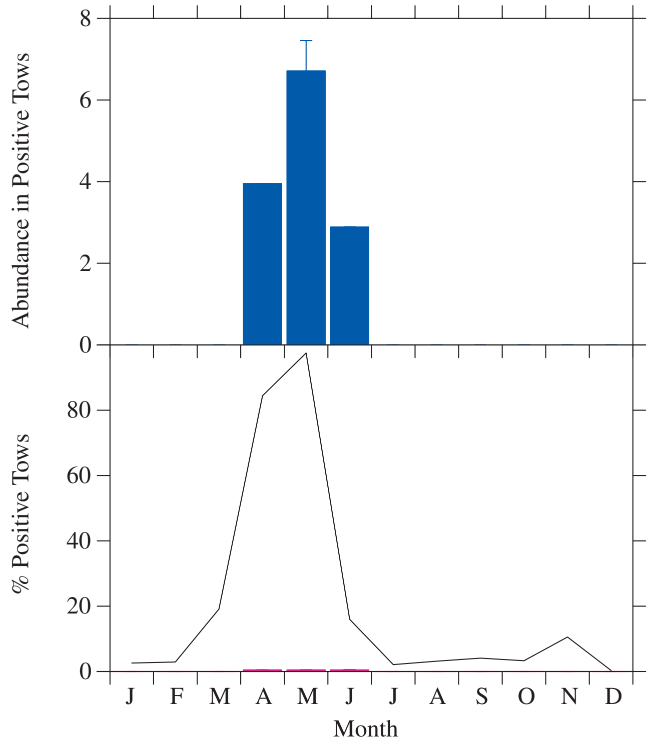

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.132
0.132 - 0.327
0.327 - 0.527
0.527 - 2.528
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

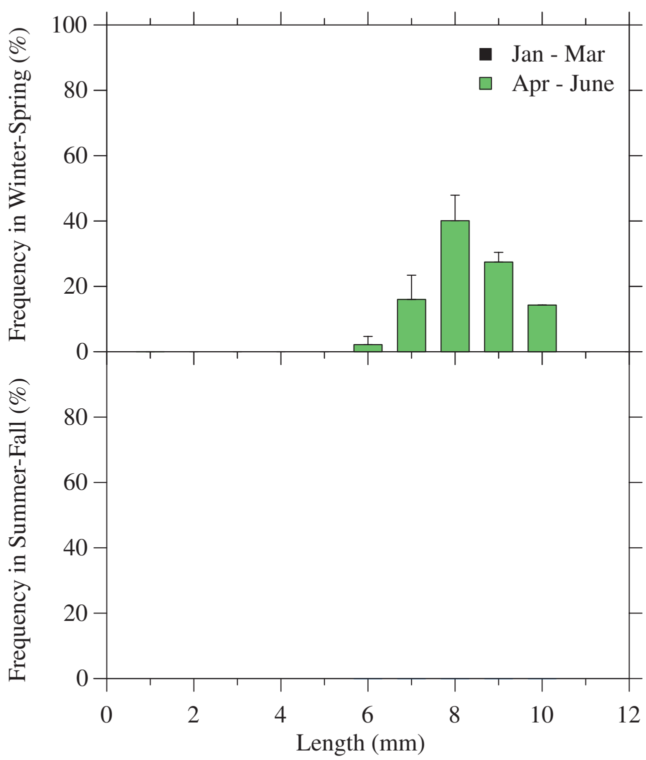

Adult Occurrence
Absent
Present

Life history *Psychrolutes paradoxus* have been collected from the Bering Sea to along the U.S. west coast off Washington. Tadpole sculpin adults, distinguished by their naked tadpole-shaped bodies, are epi- and meso-benthic, inhabiting waters between 9 and 219 m. Spawning (in British Columbia) generally takes place during winter–spring. Eggs are demersal and about 1.4 mm in diameter. Pelagic larvae hatch at relatively large sizes (6–7 mm SL) and settle from the plankton beginning at about 13–14 mm SL.
[Sources include: Matarese et al. (1989)]

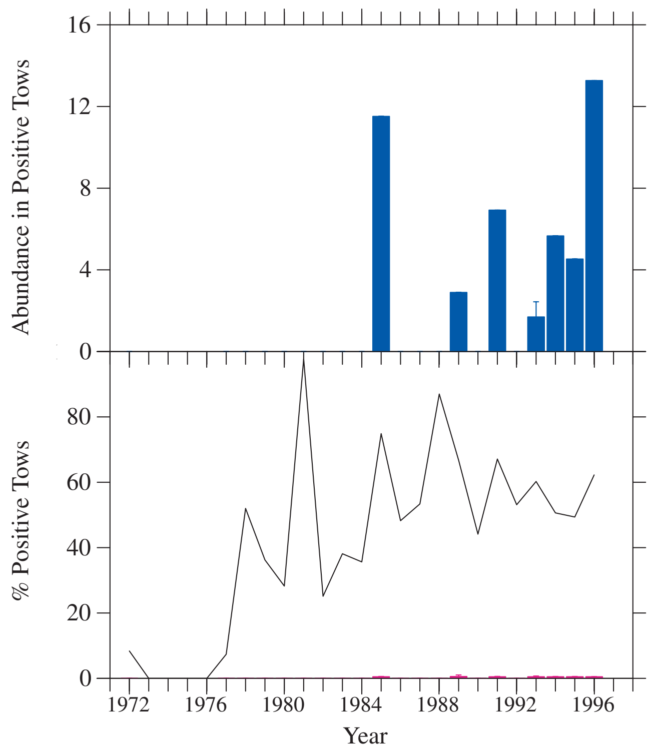
Larval distribution Tadpole sculpin larvae are found along the shelf near Unimak Pass in the Bering Sea and east to Shelikof Strait in the Gulf of Alaska. Although adults have been collected in Puget Sound, Washington, larvae have not been collected in AFSC surveys south of Alaska. Small larvae (6–10 mm SL) occur April–June. Overall catch by year indicates larvae were uncommon, but intermittently present, in the time series from 1985 to 1996.



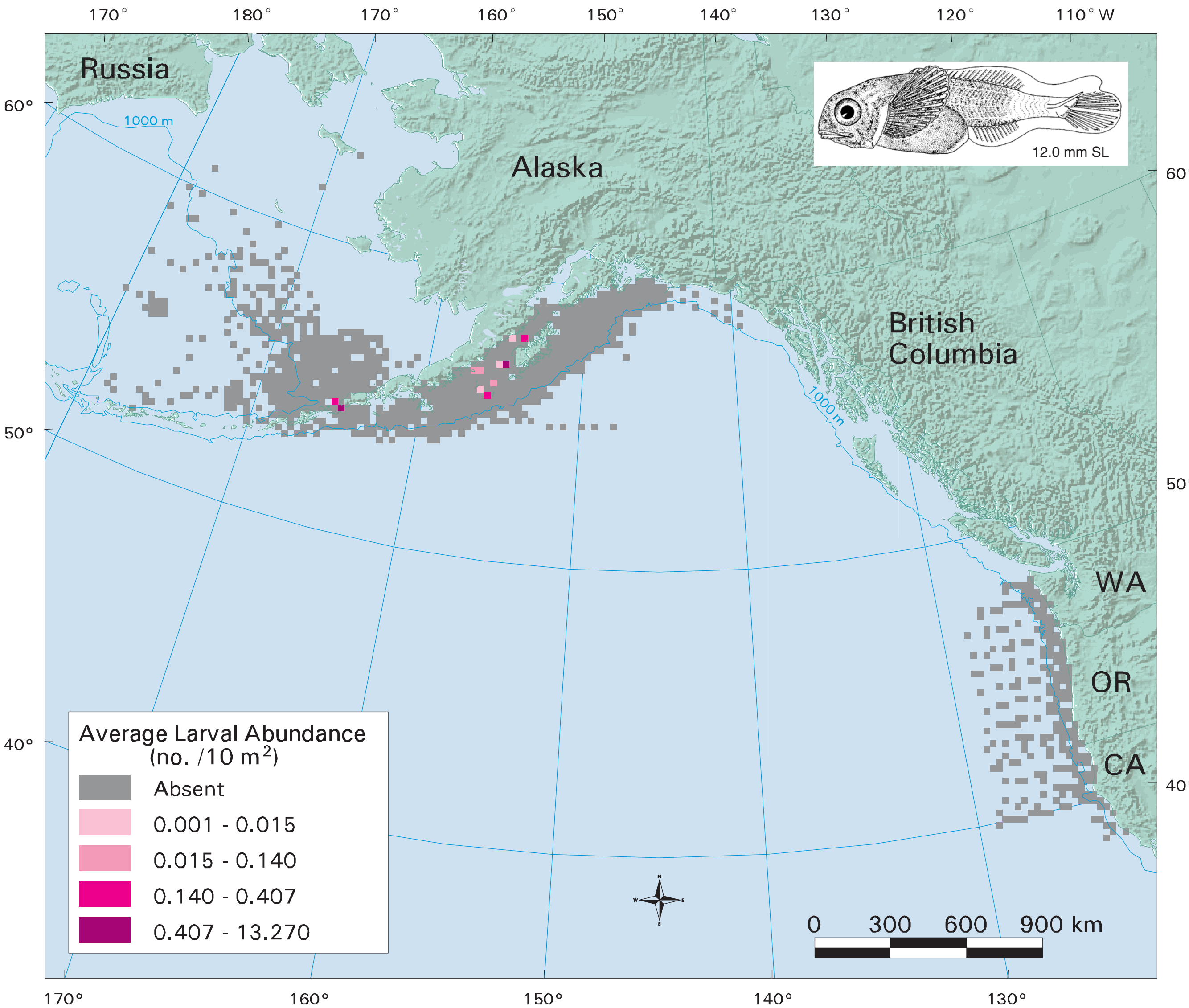
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

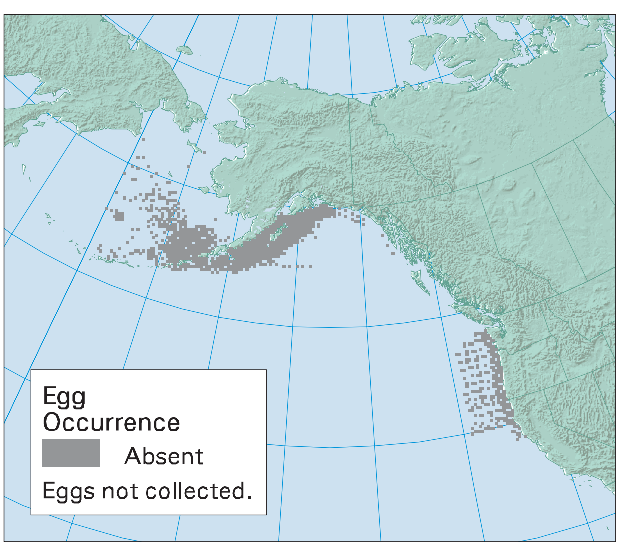


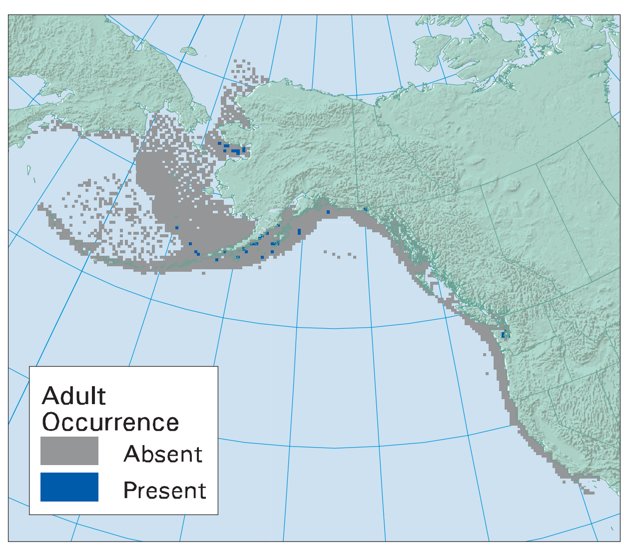
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 14 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

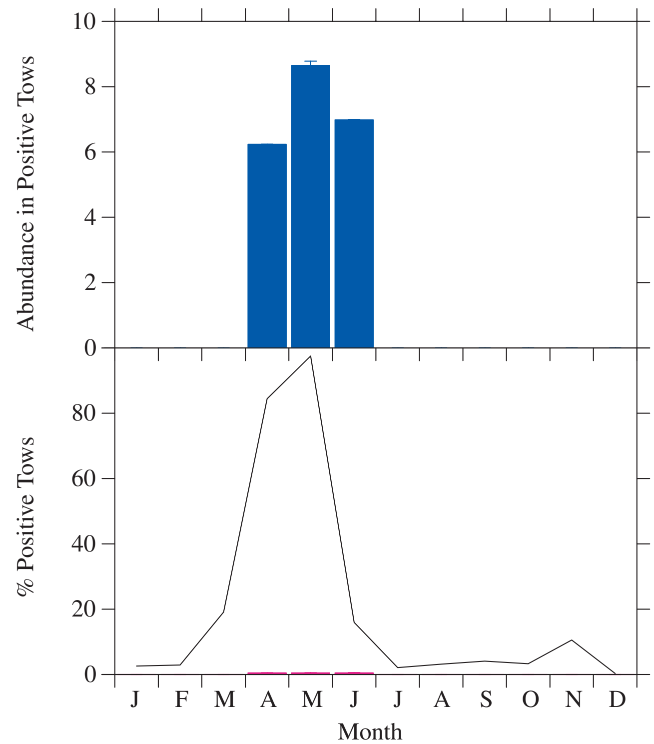

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
60°
50°
40°
12.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.015
0.015 - 0.140
0.140 - 0.407
0.407 - 13.270
0 300 600 900 km
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

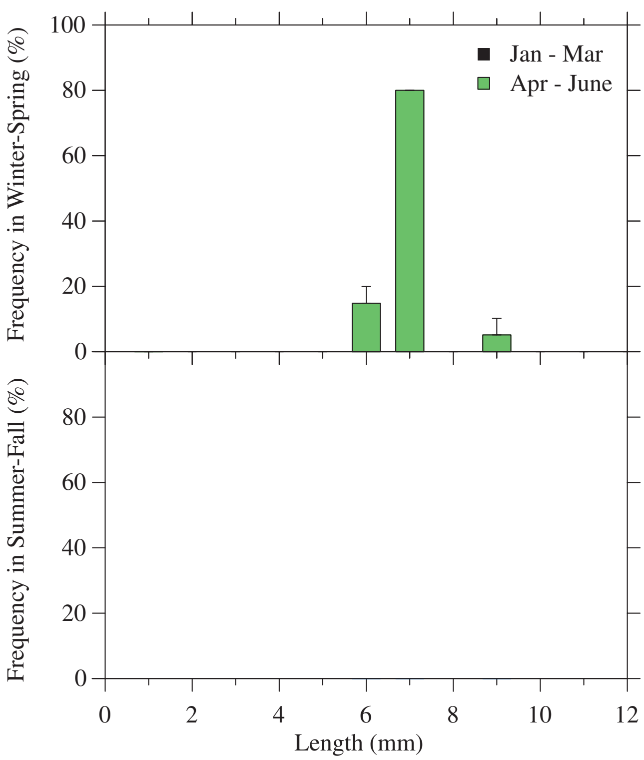

Adult Occurrence
Absent
Present

Life history *Psychrolutes sigalutes* have been collected from the Bering Sea to the U.S. west coast off Washington. Soft sculpin adults are epi- and mesobenthic fishes occurring at depths of 0–225 m. Eggs are demersal and about 2.3 mm in diameter. Spawning takes place in rocky subtidal areas on solid substrate; polygamous males guard the nests. In British Columbia, spawning has been reported in August. Pelagic larvae hatch at about 6–7 mm SL; notochord flexion occurs prior to 18 mm SL when larvae begin to transform. Juveniles may re-enter the water column for feeding, producing a protracted period of ambivalence about settlement.
[Sources include: Matarese et al. (1989)]

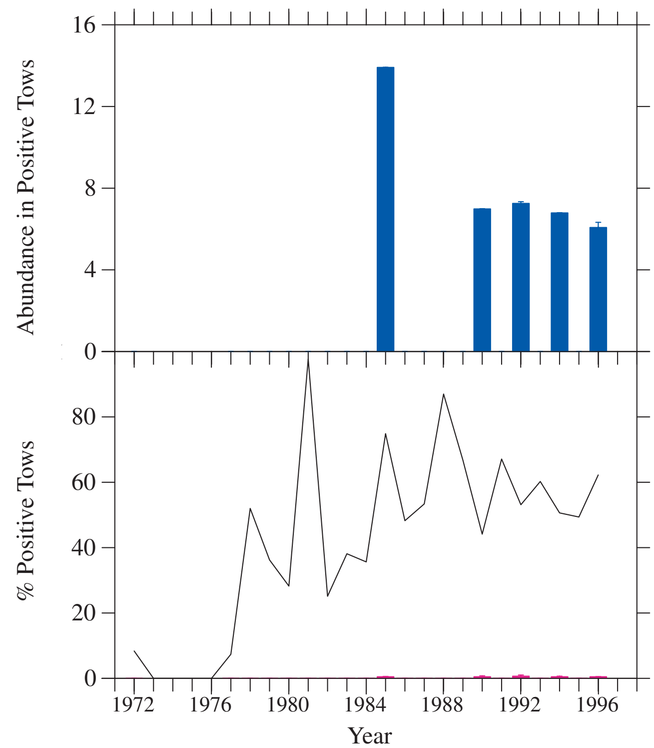
Larval distribution Soft sculpin larvae are found near Unimak Pass in the Bering Sea to along the Alaska Peninsula west of Kodiak Island in the Gulf of Alaska. Adults are collected in the same areas as larvae in AFSC surveys (northern Gulf of Alaska and Aleutian Islands). Larvae are uncommon, but appear to be more abundant nearshore along the shelf. Small larvae (6–9 mm SL) are collected April–June. Overall catch by year indicates larvae were uncommon, but intermittently present, in the time series from 1985 to 1996.



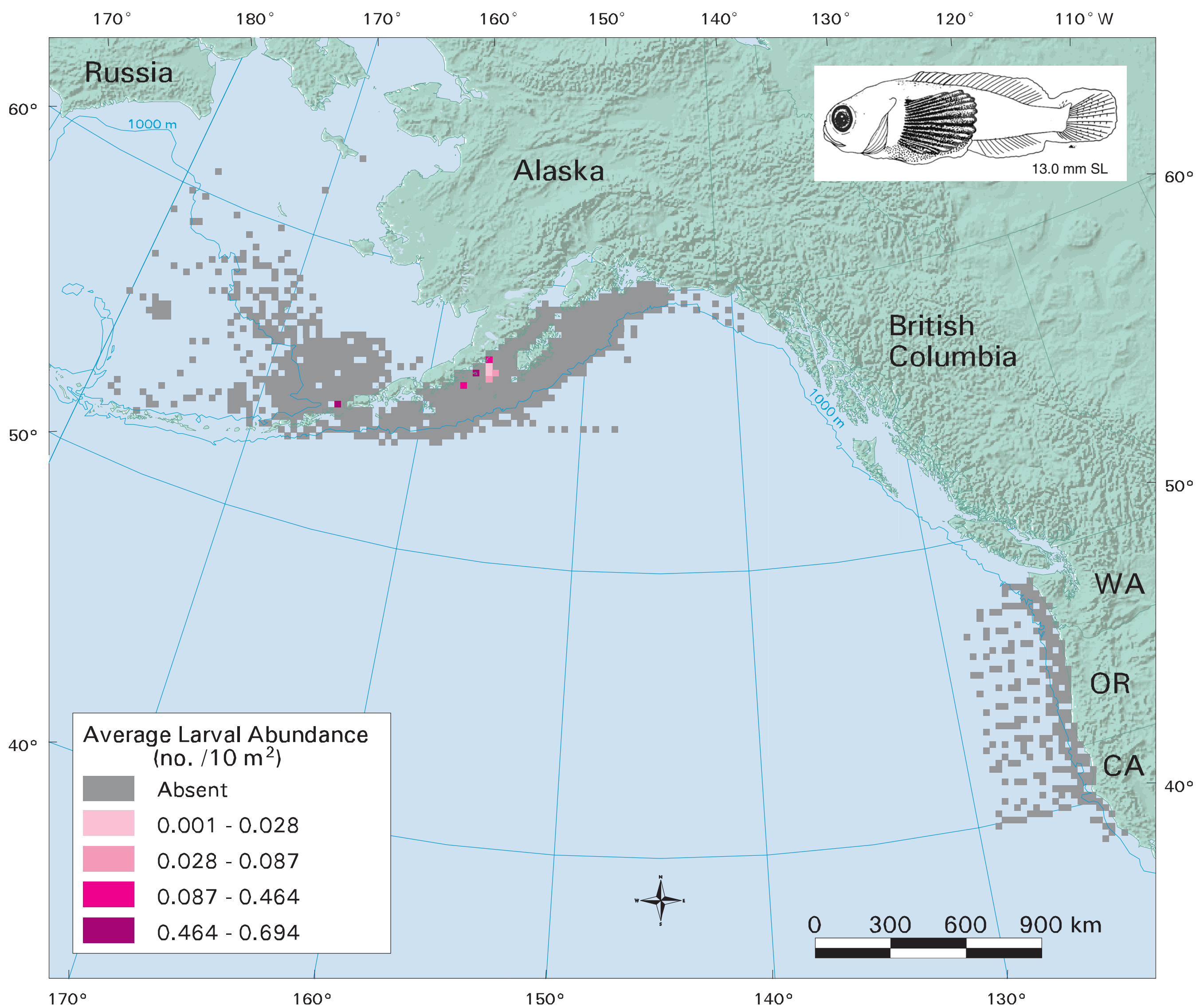
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

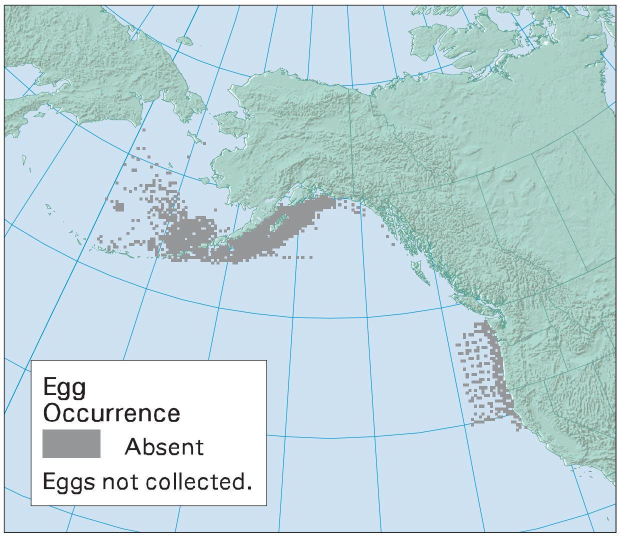


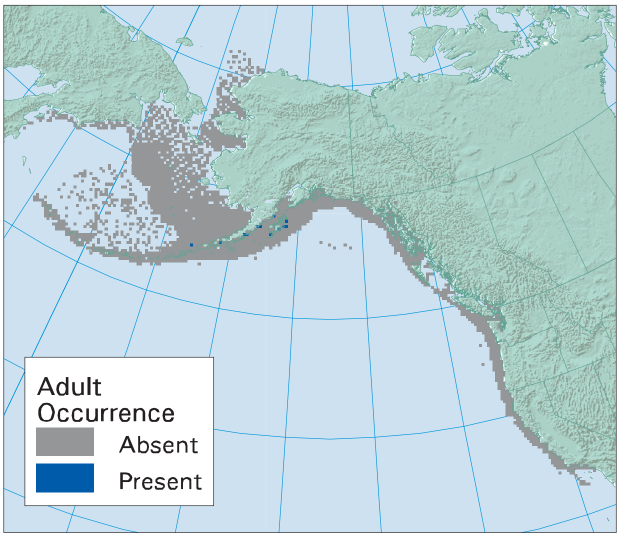
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 11 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

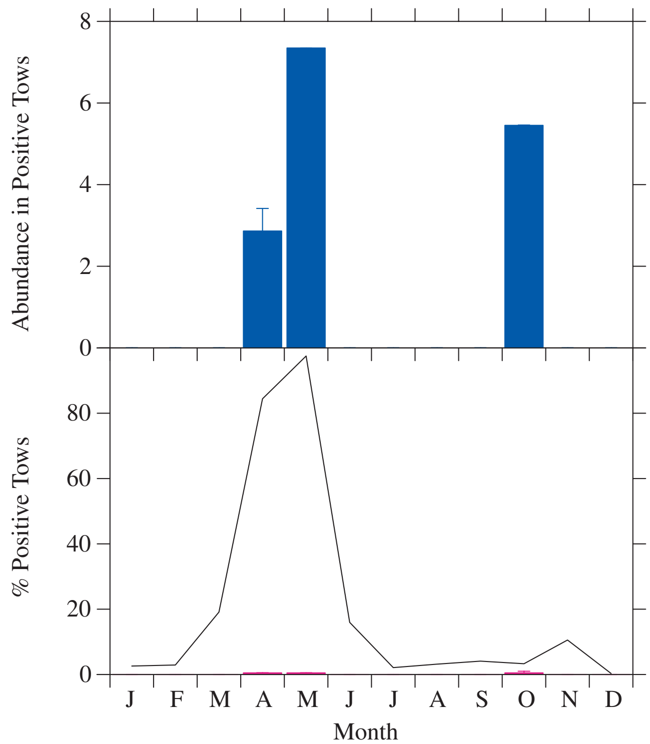

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
13.0 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 0.028
0.028 - 0.087
0.087 - 0.464
0.464 - 0.694
0 300 600 900 km
170°
160°
150°
140°
130°
60°
50°
40°


Egg Occurrence
Absent
Eggs not collected.

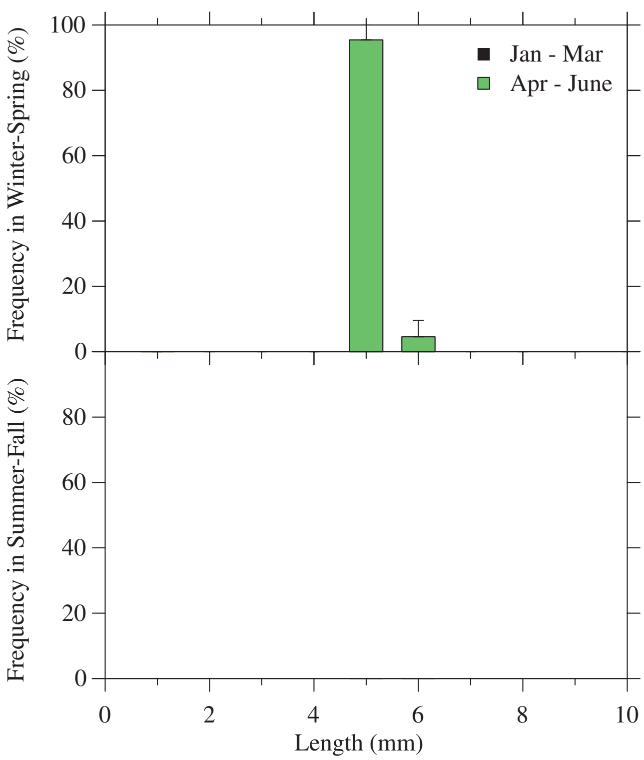

Adult Occurrence
Absent
Present

Life history *Aptocyclus ventricosus* occur in the North Pacific Ocean from Japan to the Bering Sea and in the Gulf of Alaska to British Columbia. Although the smooth, globular, jellylike bodies and sucking disk of adults imply a benthic existence, collection data for smooth lumpsuckers show a distinct midwater distribution. Adults are found most frequently at about 75 m, but have been collected as deep as 1500 m. Eggs, which are guarded by males, are adhesive, demersal, and about 2.3–2.4 mm in diameter with some oil globules. Larvae typically hatch at an advanced stage of development (pectoral and pelvic disk formed) at sizes between 6.5–7.0 mm TL.
[Sources include: Allen and Smith (1988), Matarese et al. (1989)]

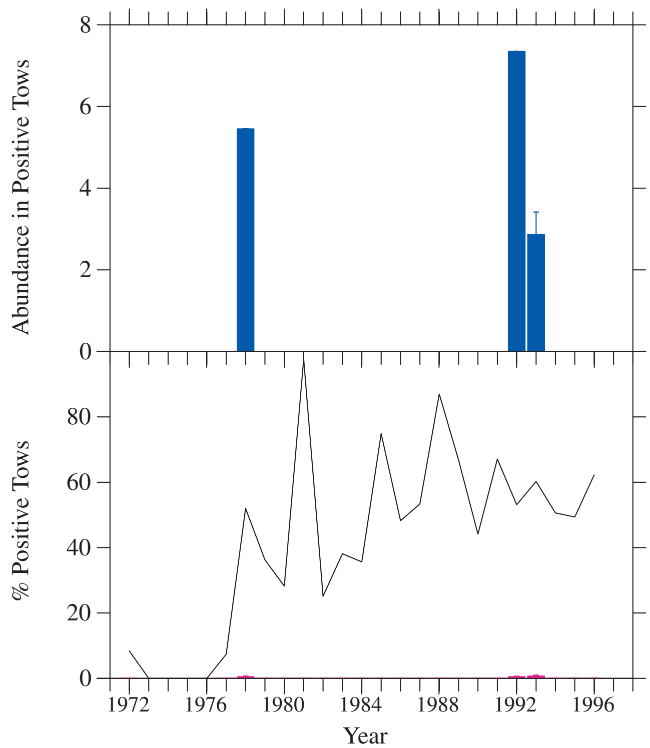
Larval distribution Smooth lumpsucker larvae are collected west of Unimak Pass along the Aleutian Islands and in the Gulf of Alaska in the Shelikof sea valley and east of Kodiak Island. Adults are common in AFSC surveys, occurring over the shelf in the Gulf of Alaska and over the shelf and slope in the Bering Sea. Larvae are found in April, May, and October; small larvae (5–6 mm SL) are collected in winter–spring. Larvae were uncommon and occurred in samples collected in 1978, 1992, and 1993.



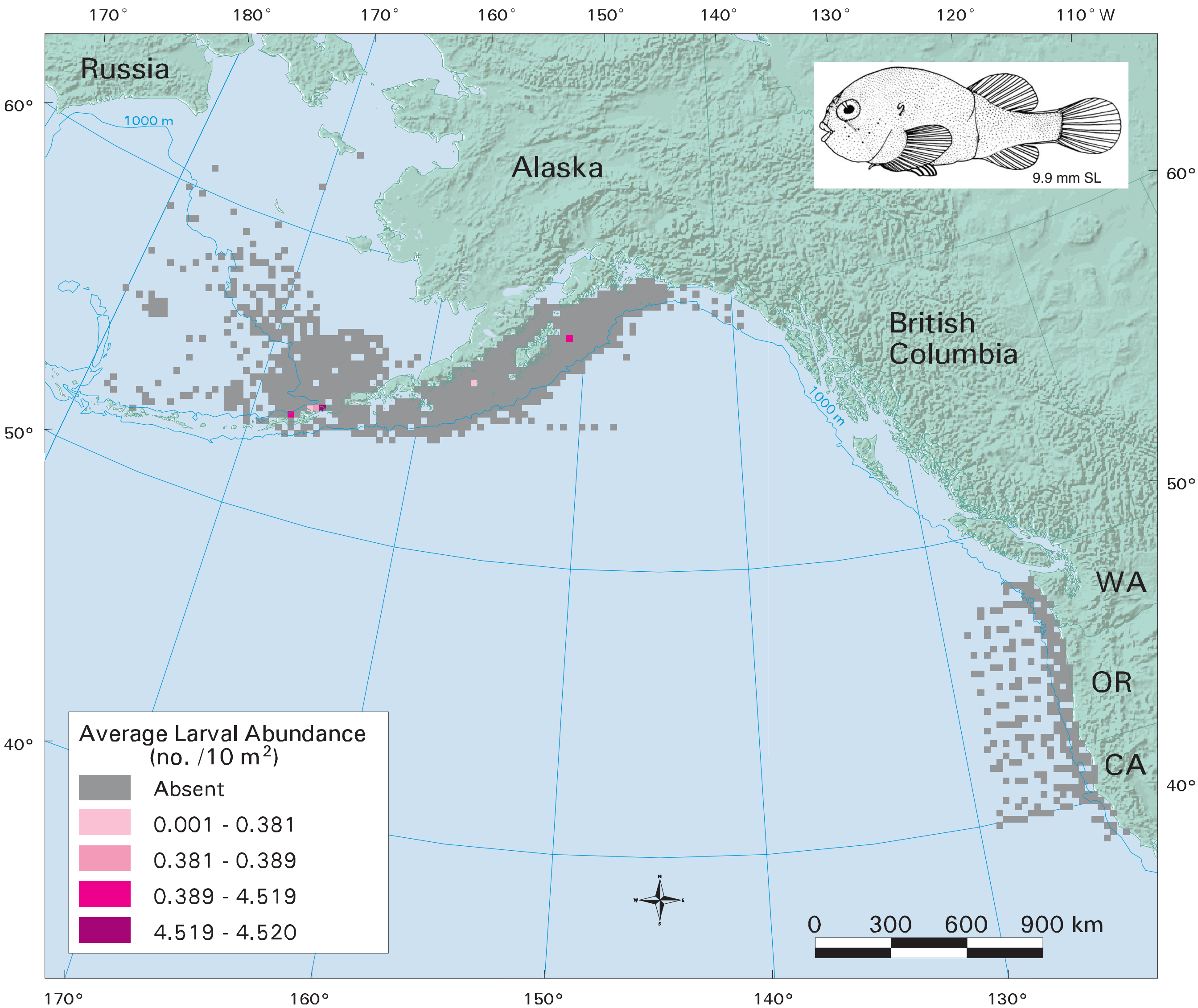
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

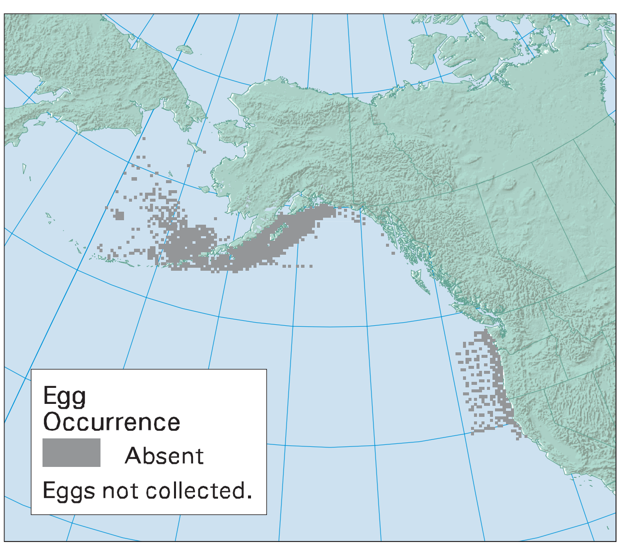


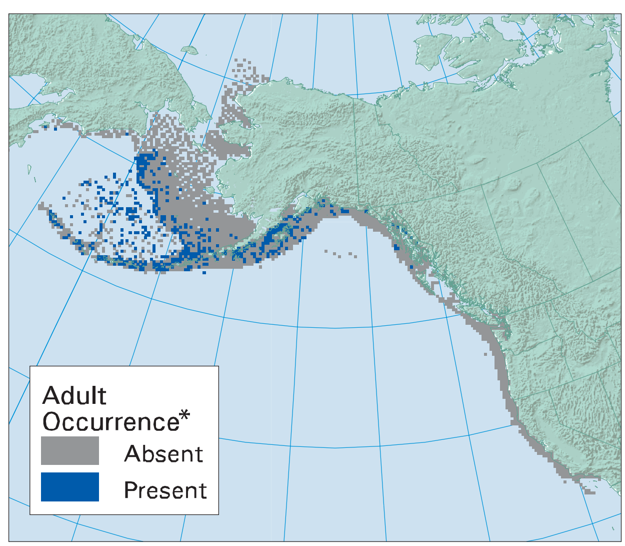
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 12 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

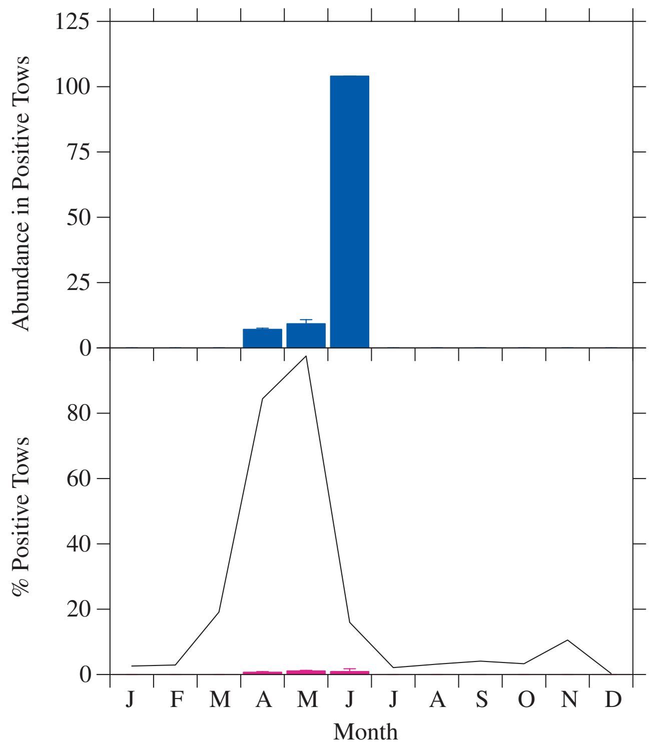

170° 180° 170° 160° 150° 140° 130° 120° 110° W
60°
50°
40°
170° 160° 150° 140° 130°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
9.9 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 0.381
0.381 - 0.389
0.389 - 4.519
4.519 - 4.520
0 300 600 900 km


Egg Occurrence
Absent
Eggs not collected.

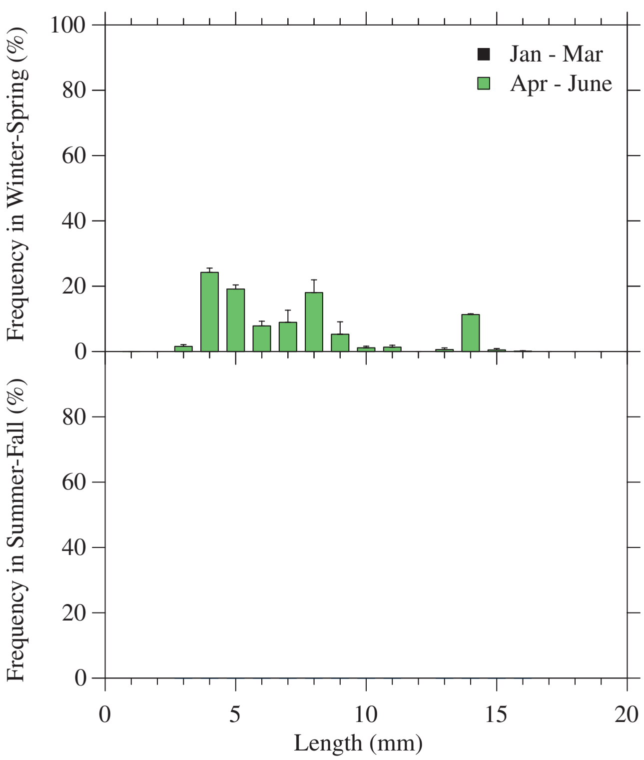

Adult Occurrence*
Absent
Present

Life history The genus *Liparis* is represented by 18 species within our study area (see species list, Appendix Table 2). Distributed from the Arctic to Baja California, adults occur from tidepools to depths of 388 m; most are demersal. Little is known of their life history; larval descriptions are available for only five species (*L. callyodon* (partial series), *L. florae* (unpublished), *L. fucensis*, *L. mucosus*, and *L. pulchellus*). Most eggs are <2 mm in diameter. Larvae hatch at an early developmental state, in contrast to deep-water cyclopterids that hatch at an advanced state of development with disk and fin ray formation complete. Larvae have a bulbous head and loose, flabby skin surrounding the body; during transformation the skin bubble is lost or reduced, giving juveniles a slender liparine appearance. Preflexion larvae occur in CalCOFI samples January–August. [Sources include: Able and McAllister (1980), Eschmeyer et al. (1983), Matarese et al. (1989), Ambrose (1996g), Busby (unpubl.)]

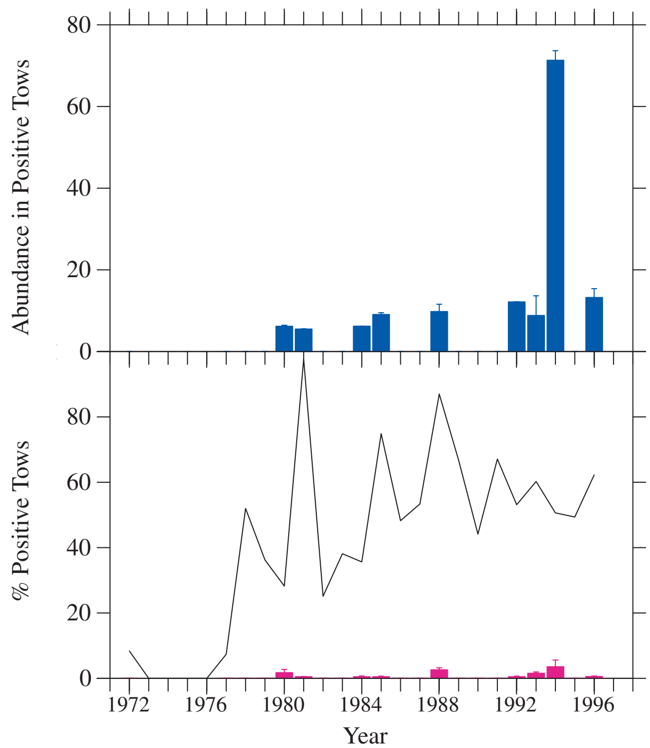
Larval distribution *Liparis* spp. larvae are distributed from the shelf around Unimak Pass, eastward along the Shelikof sea valley into the Strait, south of Kodiak Island, and nearshore along the U.S. west coast. Abundant on the Unimak Pass shelf, several larval taxa may be represented in AFSC collections since this is an area of high diversity where slope and shelf species routinely mix. Larvae (3–15 mm SL) are collected in spring with highest abundances in June; most are small (<10 mm SL). Larvae were uncommon, occurring in low numbers during fewer than half of the years sampled except 1994.



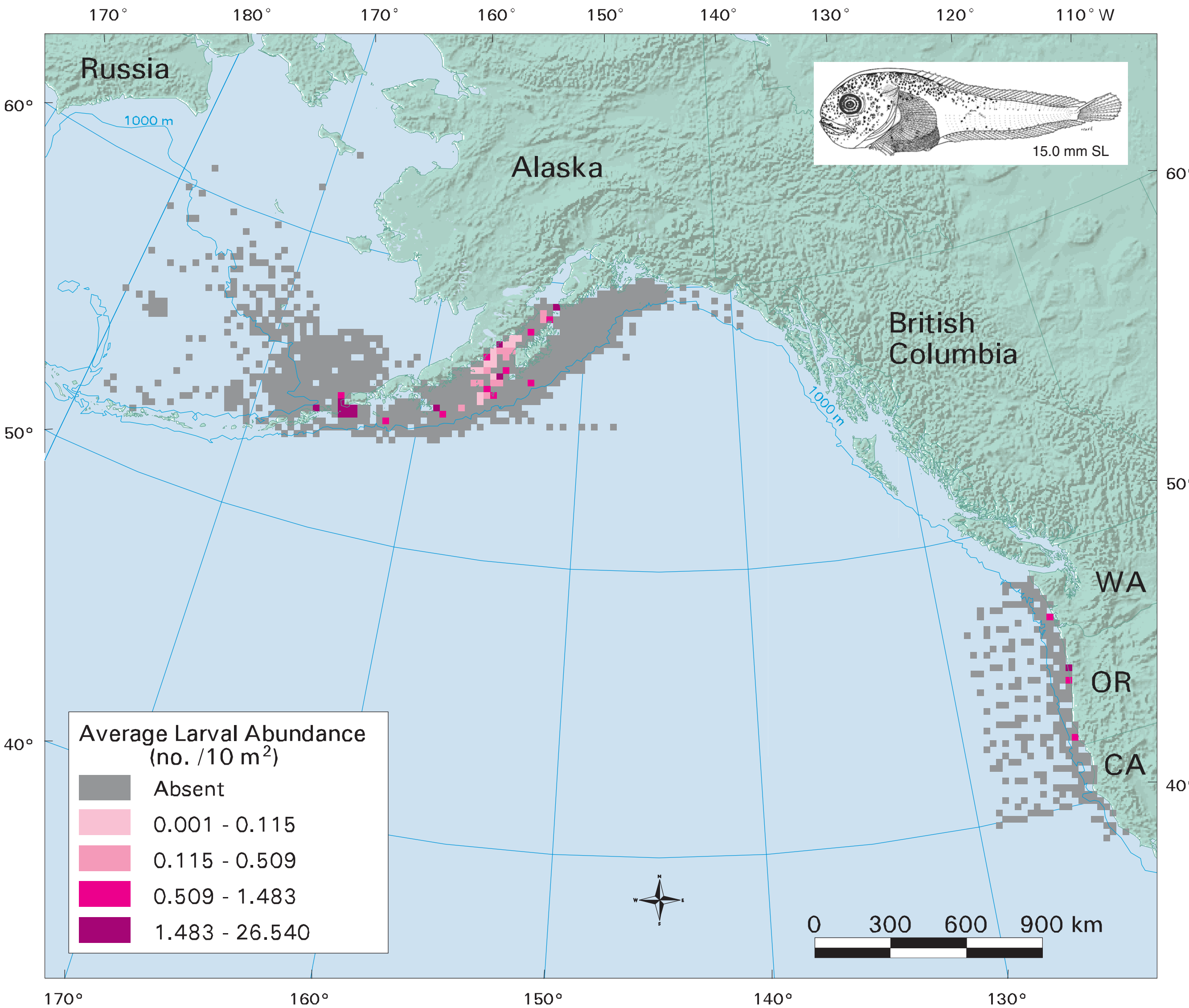
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

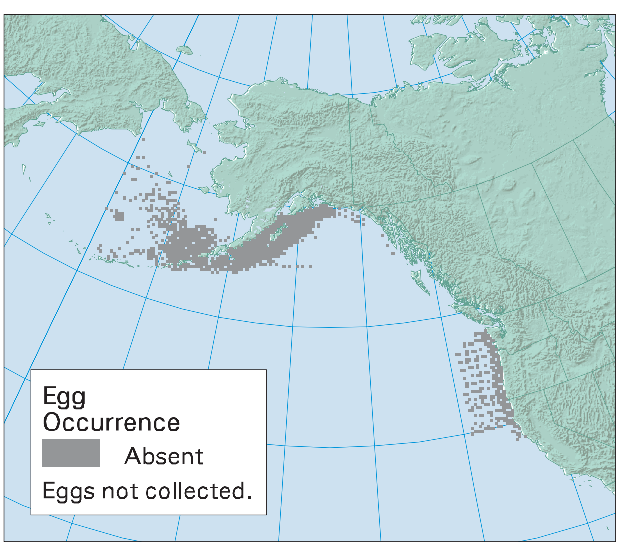


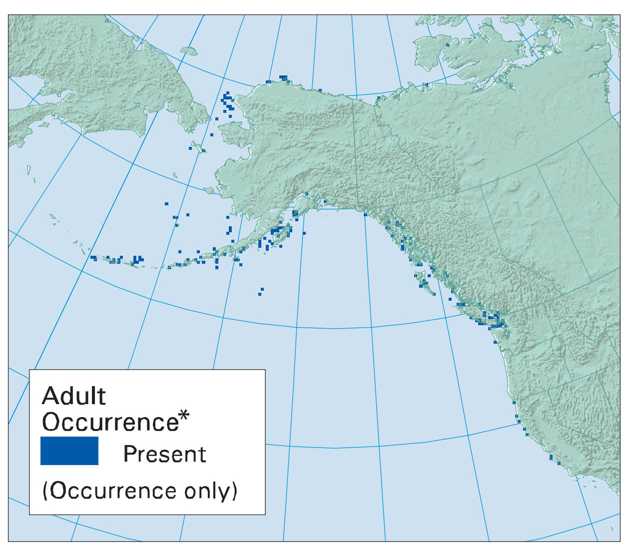
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 211 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

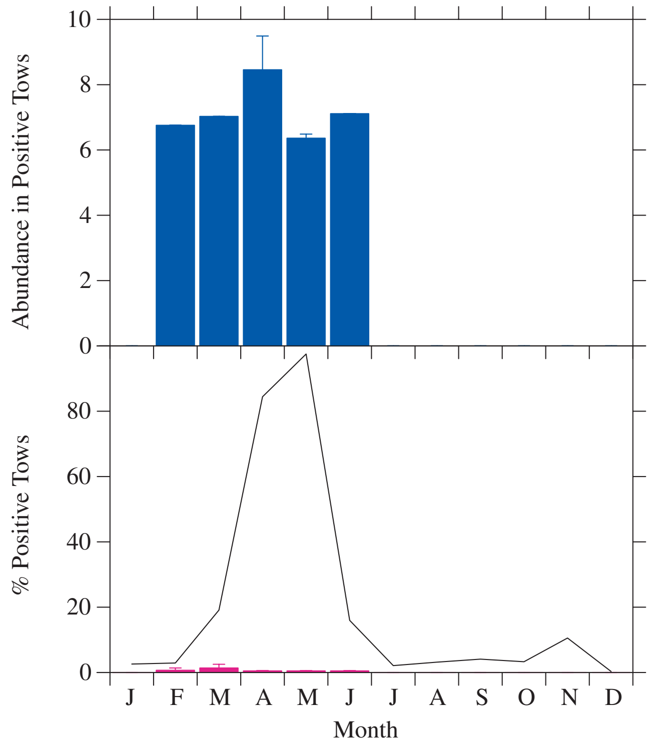

170° 180° 170° 160° 150° 140° 130° 120° 110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
60°
50°
40°
15.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.115
0.115 - 0.509
0.509 - 1.483
1.483 - 26.540
0 300 600 900 km
170° 160° 150° 140° 130°


Egg Occurrence
Absent
Eggs not collected.

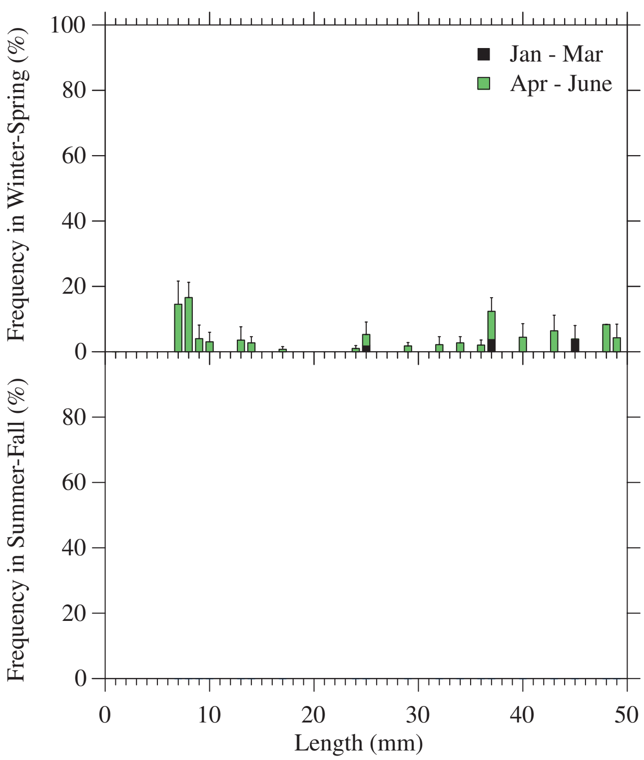

Adult Occurrence*
Present
(Occurrence only)

Life history *Nectoliparis pelagicus* are found from the Bering Sea to central California. Tadpole snailfish, among the few species of snailfish that are known to be pelagic, have been collected from the surface to depths of 1160 m. Adults are small; the known maximum size is 64 mm SL and individuals as small as 25 mm SL can be sexed. Data on spawning and eggs are unknown. Young tadpole snailfish have been taken occasionally in deep plankton tows off central California.
[Sources include: Hart (1973), Stein (1978), Matarese et al. (1989)]

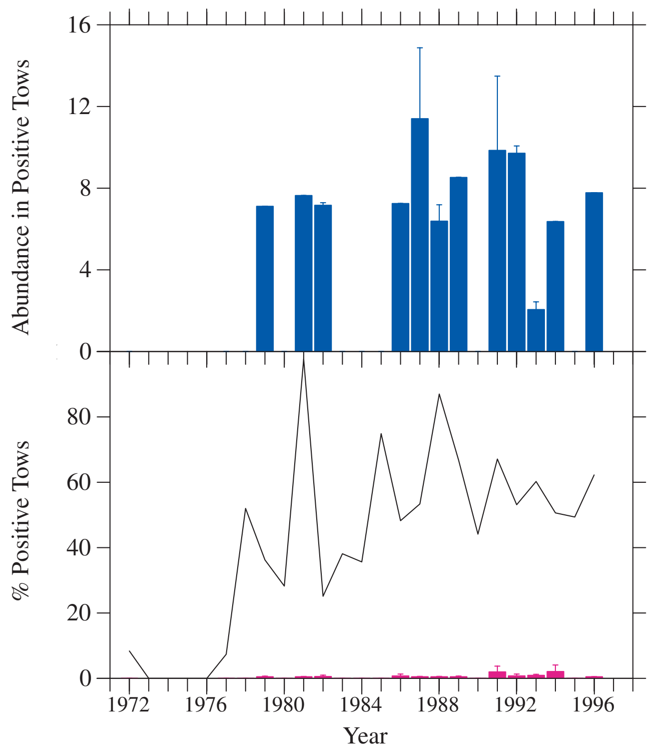
Larval distribution Tadpole snailfish larvae are found in the deeper slope waters of the Bering Sea west of Unimak Pass and along the Shelikof sea valley in Shelikof Strait. Adults are not collected in AFSC surveys and available data on distribution patterns are limited. Larvae are collected February–June. Small larvae and pelagic prejuveniles (7–49 mm SL) occur over a wide size range in winter–spring. Larvae were uncommon, but catches were consistent throughout the time series from 1979 to 1996.



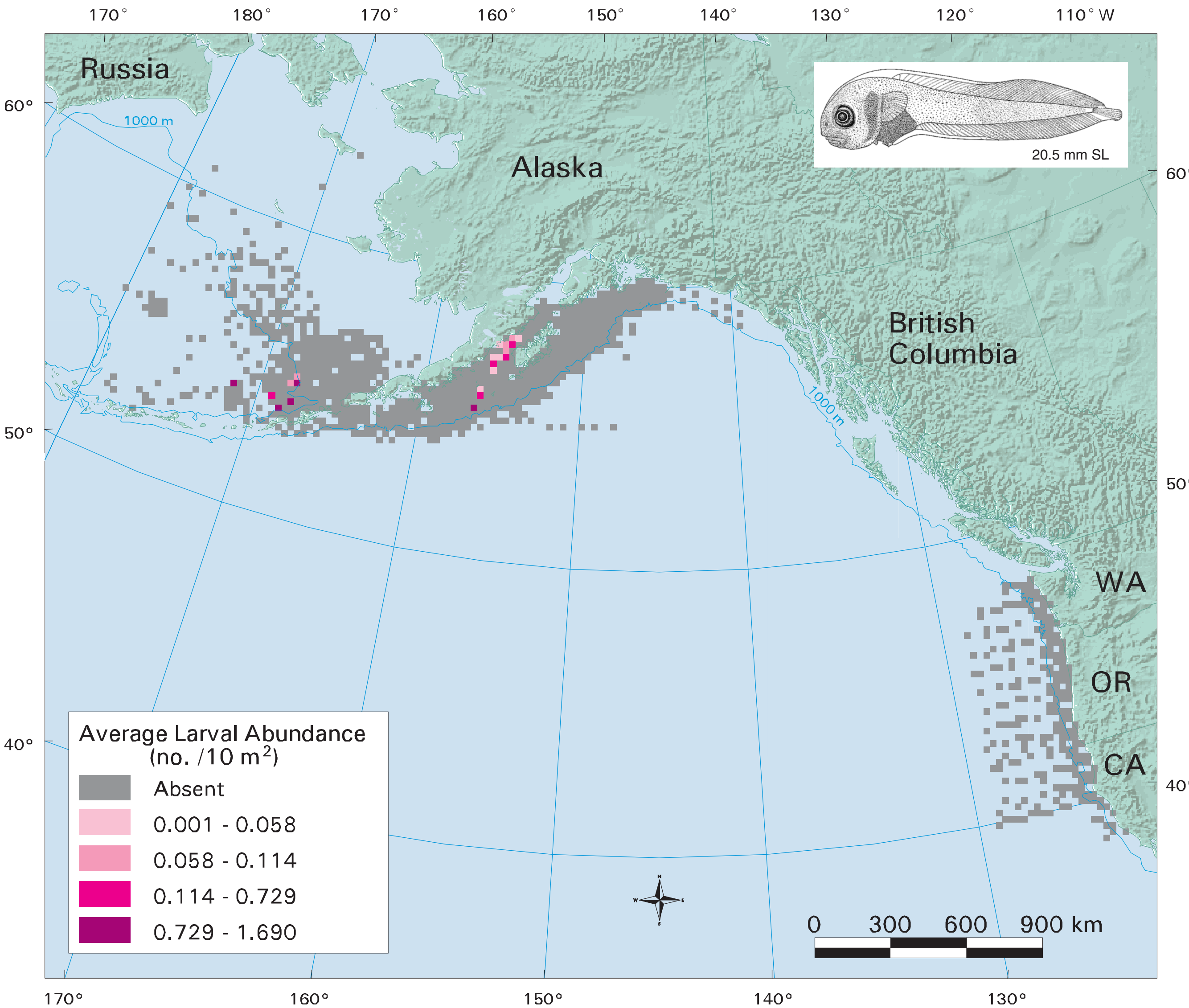
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

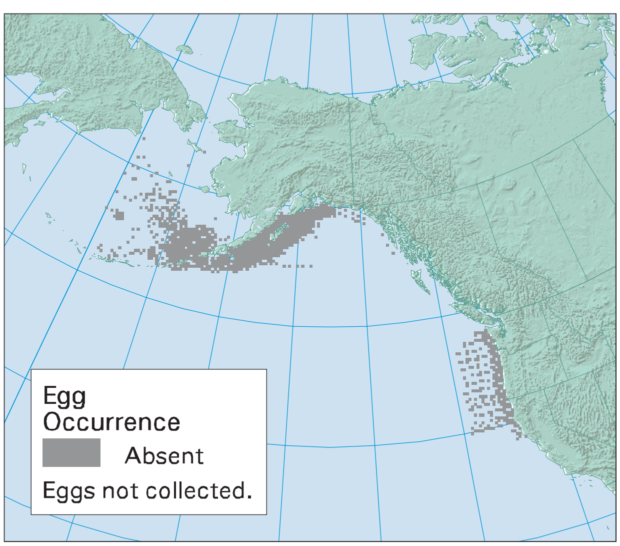


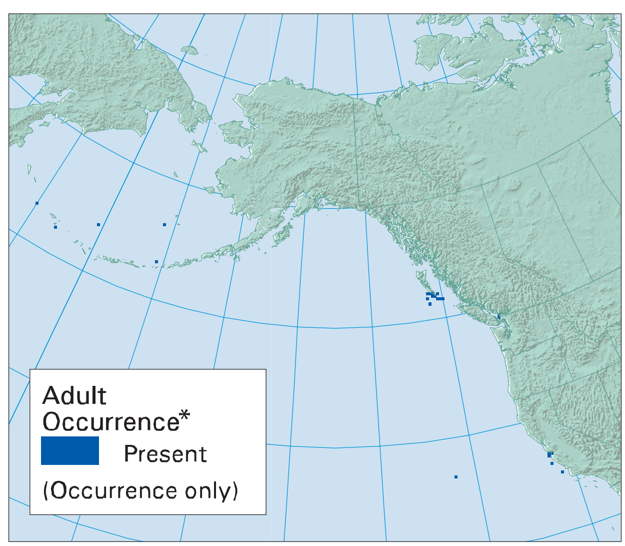
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 32 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

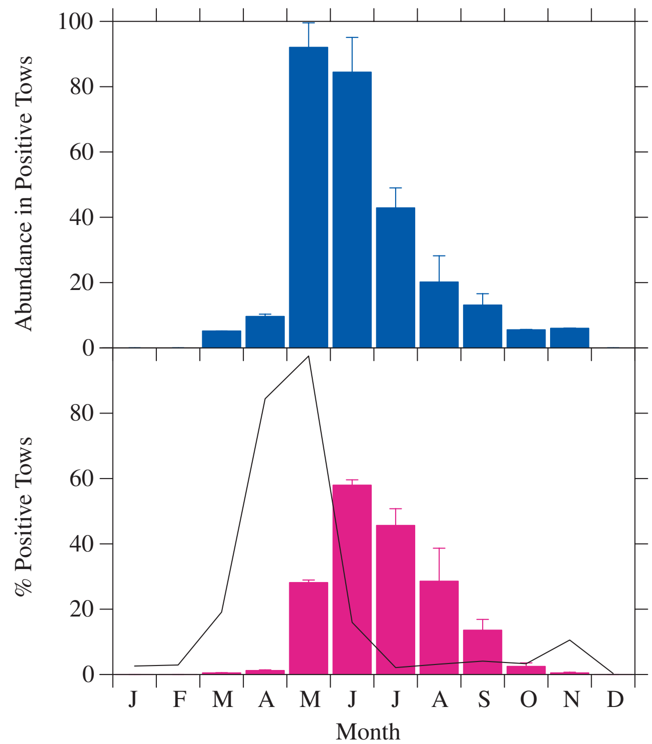

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
20.5 mm SL
British Columbia
1000 m
WA
OR
CA
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.058
0.058 - 0.114
0.114 - 0.729
0.729 - 1.690
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

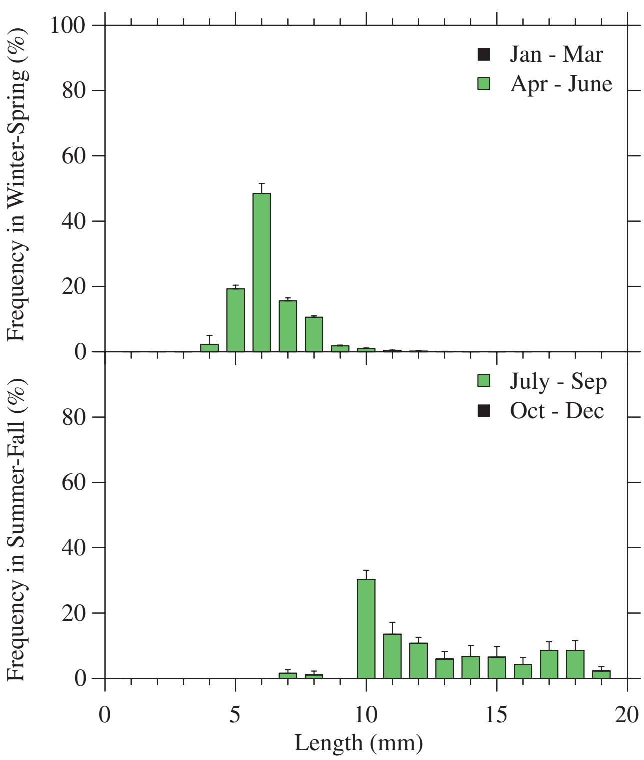

Adult Occurrence*
Present
(Occurrence only)

Life history The genus *Bathymaster*, endemic to the North Pacific, contains three species in the study area ranging from the Bering Sea to the Gulf of Alaska (*Bathymaster leurolepis*–smallmouth ronquil), British Columbia (*B. caeruleofasciatus*–Alaskan ronquil), and Washington (*B. signatus*–searcher). Little is known of their spawning behavior or early life history. Other members of the family spawn demersal eggs about 1 mm in diameter and have pelagic larvae. As reported in Matarese et al. (1989), *Bathymaster* spp. larvae representing more than one taxon (6–40 mm SL) were routinely collected in AFSC samples prior to 1989.
[Sources include: Matarese et al. (1989)]

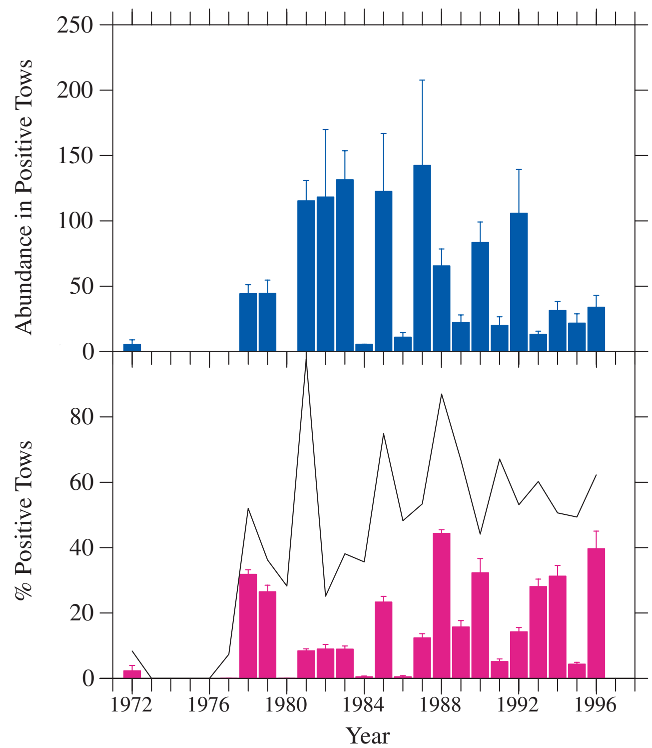
Larval distribution Larvae of the genus *Bathymaster* are collected from the central Bering Sea, eastern Aleutian Islands, throughout the western Gulf of Alaska, and off Washington along the U.S. west coast. Larvae are very abundant in the Gulf of Alaska, with highest concentrations in Unimak Pass to southwest of Kodiak Island. Larvae occur March–November, but are very abundant May–June where they appear in 30–60% of the tows. Small larvae (<10 mm SL) are very abundant in winter–spring, whereas larger larvae (>10 mm SL) are more common in summer–fall. Larger, pelagic prejuvenile *B. signatus* larvae (>30 mm SL) can be identified and are occasionally collected using a neuston net. Overall catch by year indicates that larvae were commonly collected, occurring in >20% of the tows for many of the years during the time series.



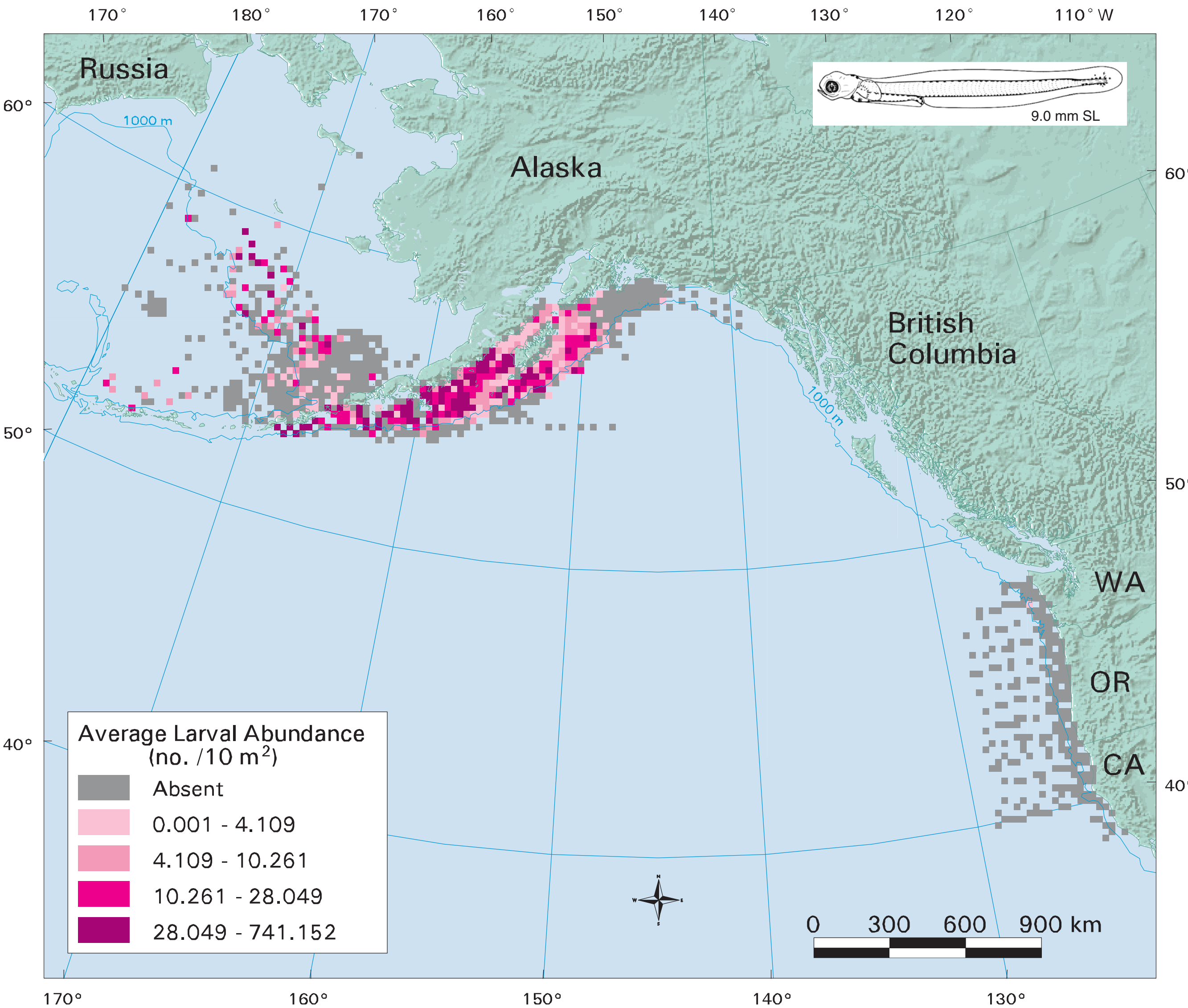
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

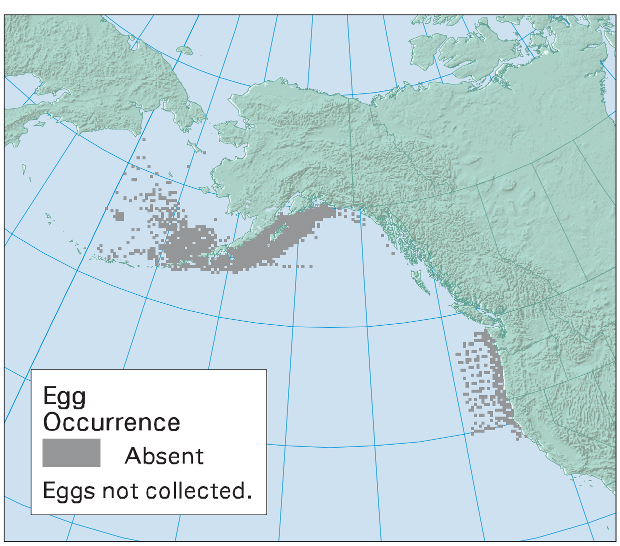


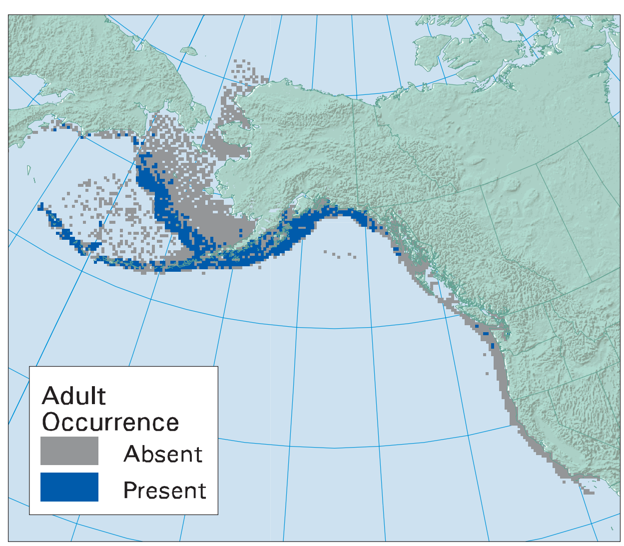
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 15,347 for winter–spring (Jan–June), 115 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

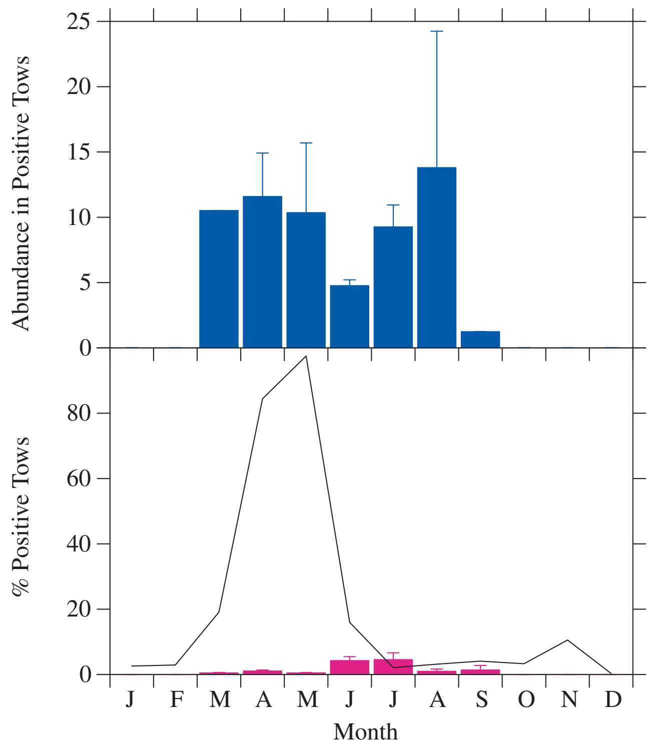

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
9.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 4.109
4.109 - 10.261
10.261 - 28.049
28.049 - 741.152
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

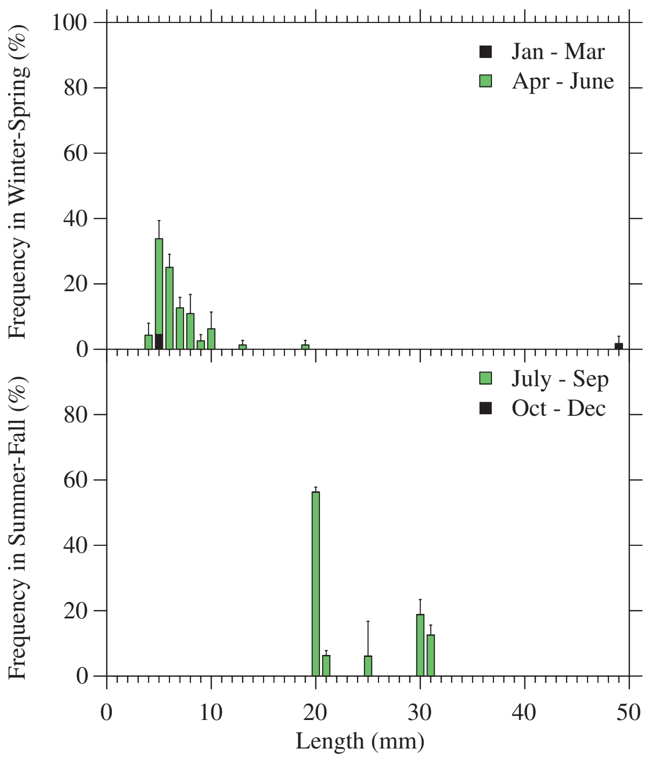

Adult Occurrence
Absent
Present

Life history *Ronquilus jordani* are found from the Bering Sea to Monterey Bay, California. Northern ronquils are benthic and live among the rocks at depths of 3–165 m. Adults can reach about 18 cm TL and are sexually dimorphic; the males are orange on the dorsal surface with an olive ventral surface, whereas females are olive on the dorsal surface with a pale ventral surface. Ripe females have been collected in March off British Columbia. Amber-colored demersal eggs, 0.9–1.1 mm in diameter, are spawned in a nonadhesive mass that the male incubates. Pelagic larvae hatch at 5.5–6.0 mm SL. Significant numbers of larvae have been collected in AFSC U.S. west coast surveys in neuston nets.
[Sources include: Hart (1973), Eschmeyer et al. (1983), Matarese et al. (1989), Doyle (1992), Watson (1996b), Doyle[2]]

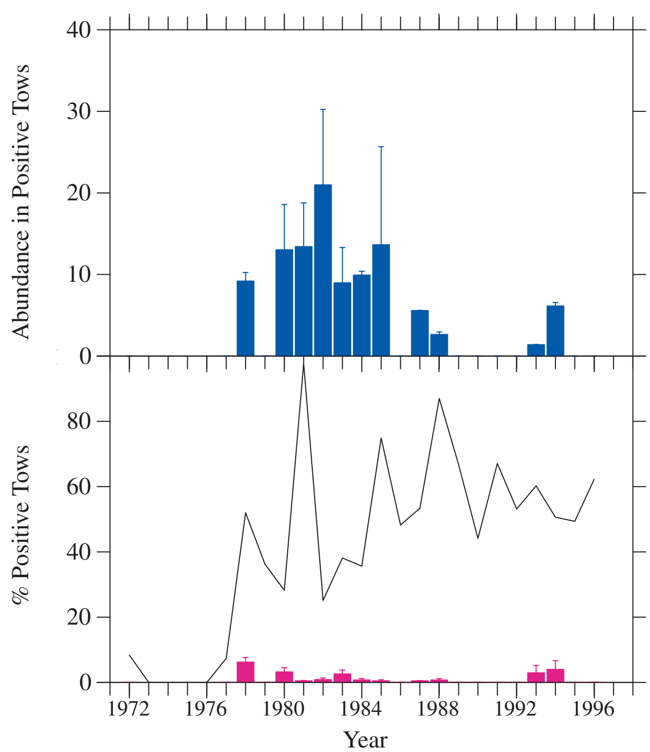
Larval distribution Northern ronquil larvae are collected on the shelf from just west of and around Kodiak Island in the Gulf of Alaska to along the U.S. west coast. Larvae are more abundant off the outer shelf east of Kodiak Island and over the shelf off Washington and northern Oregon. Larvae are collected March–September, with higher abundances in late winter–early spring. Small newly-hatched larvae <10 mm SL are more abundant in winter–spring, whereas larger larvae and early juveniles >20 mm SL are present in summer–fall. Larvae were found in low numbers during most years from 1978 to 1994, but abundance was higher during the 1980s when AFSC conducted U.S. west coast surveys.



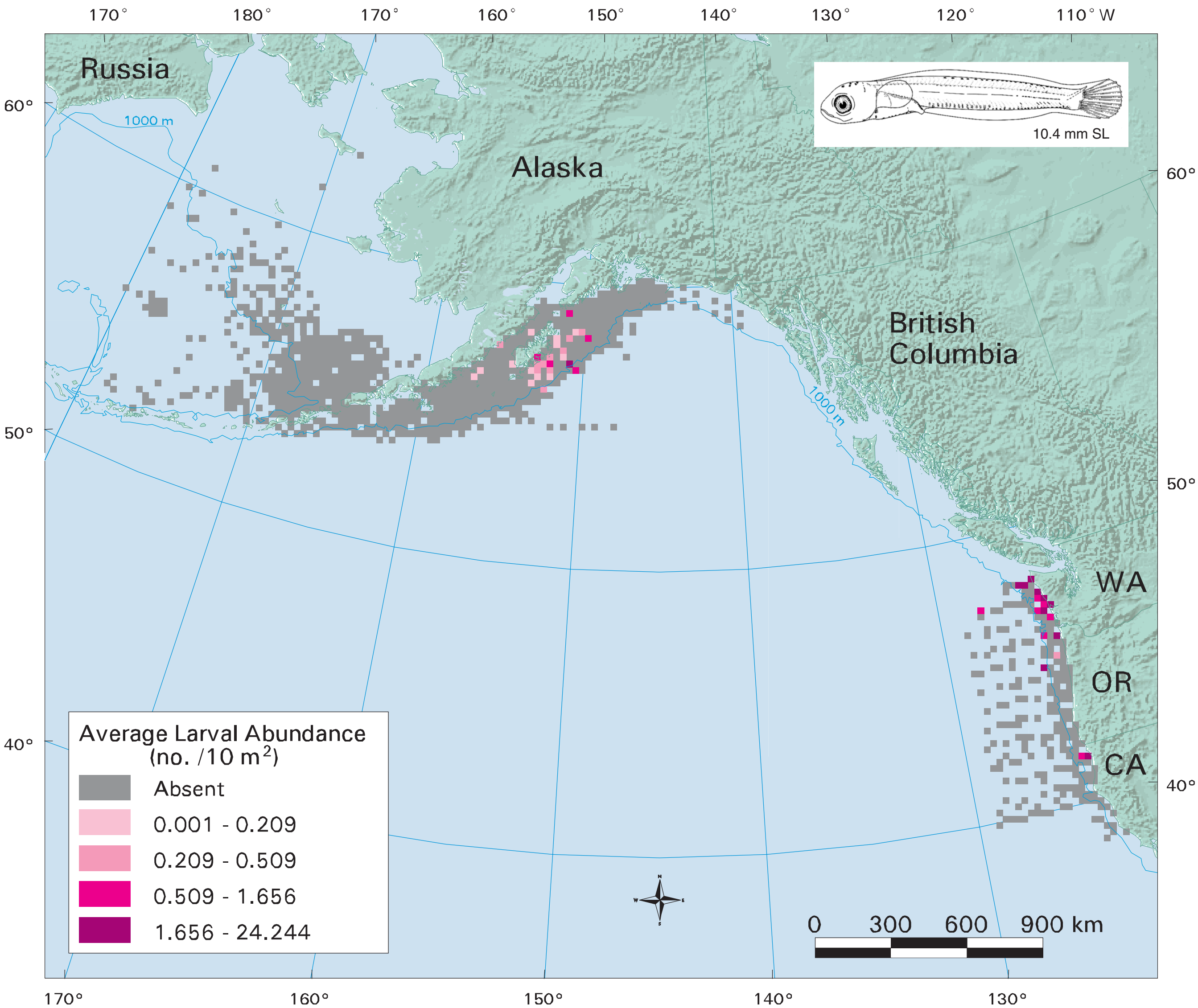
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

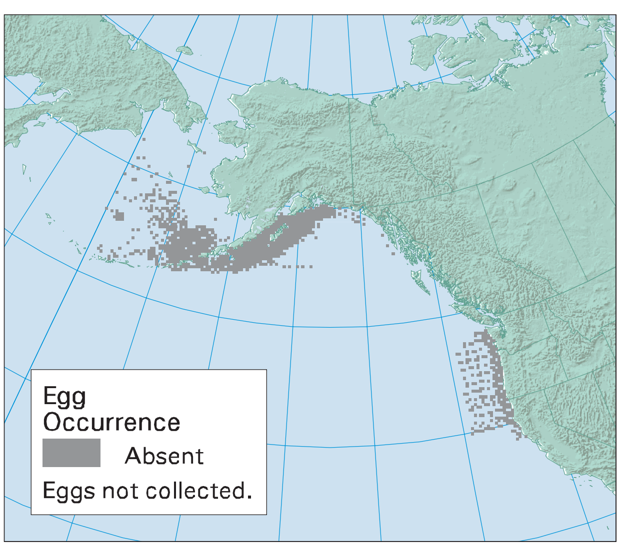


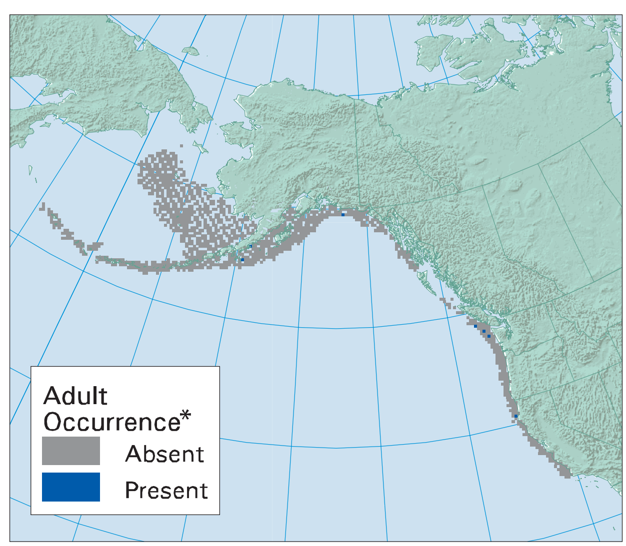
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 51 for winter–spring (Jan–June), 9 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

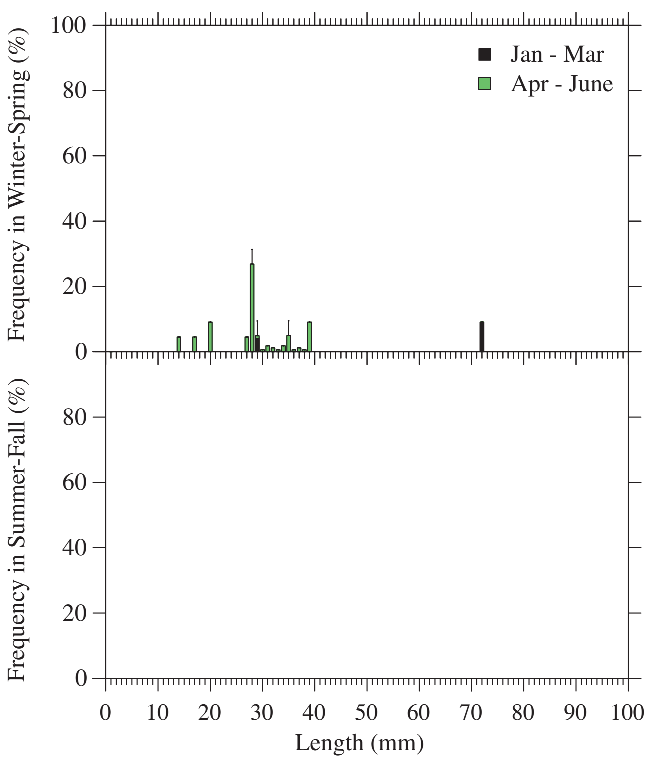

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
10.4 mm SL
British Columbia
1000 m
WA
OR
CA
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.209
0.209 - 0.509
0.509 - 1.656
1.656 - 24.244
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

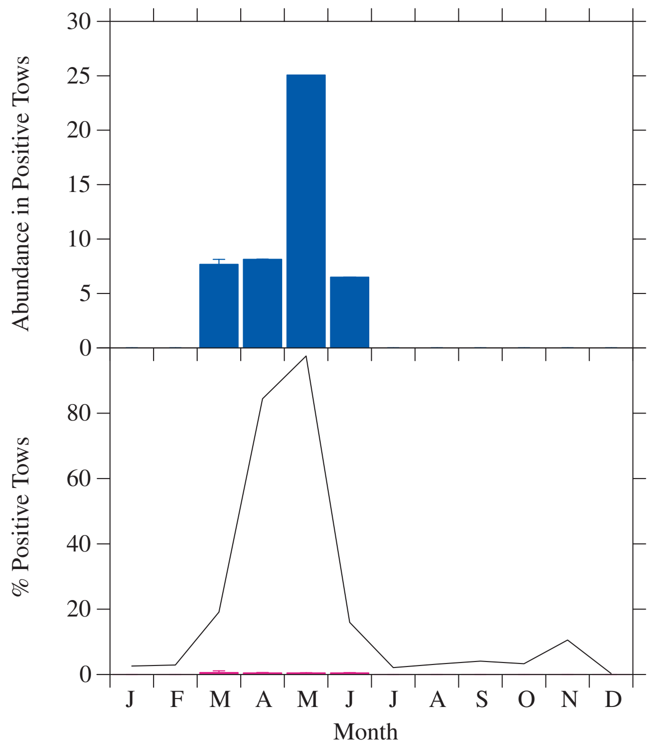

Adult Occurrence*
Absent
Present

Life history The family Zoarcidae is found worldwide in cold and temperate marine waters, including the Arctic and Antarctic Oceans. Some eelpouts occur in shallow temperate seas, but many live on the bottom at moderate or great depths (>1900 m). At least 48 species within 14 genera are reported to occur in our study area (see species list, Appendix Table 2); however, larvae in AFSC collections probably represent no more than several genera, including *Lycodes* and *Lycodapus.* Most zoarcids are oviparous and guard their eggs by wrapping themselves around the egg mass. Demersal eggs are adhesive, spherical, and possess one oil globule; diameters range from 1.7 to 9.0 mm. Newly hatched larvae are highly developed and resemble adult zoarcids. Larval series identified to species are not available in the Northeast Pacific as they are rarely collected in ichthyoplankton surveys from our study area. Larvae most likely become demersal soon after hatching. [Sources include: Matarese et al. (1989)]

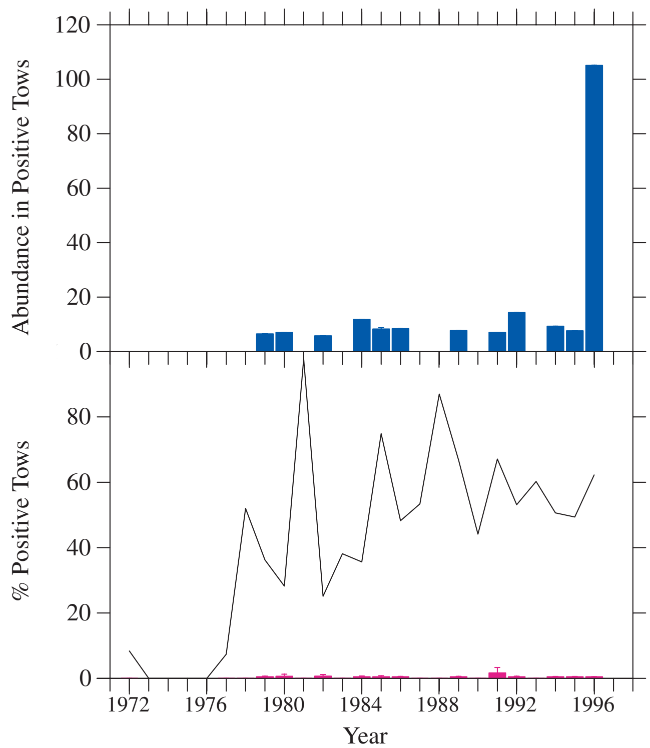
Larval distribution Eelpout larvae are collected from the shelf waters of the eastern Bering Sea, into the Gulf of Alaska and Shelikof Strait to just eastward of Prince William Sound, and along the U.S. west coast off Washington. Larvae are more likely to occur in the Shelikof sea valley and Strait where they appear March–June. Larvae and juveniles collected in winter–spring range in size from 14 to 118 mm SL. Although relatively uncommon, larvae and juveniles were consistently collected throughout the time series from 1979 to 1996.



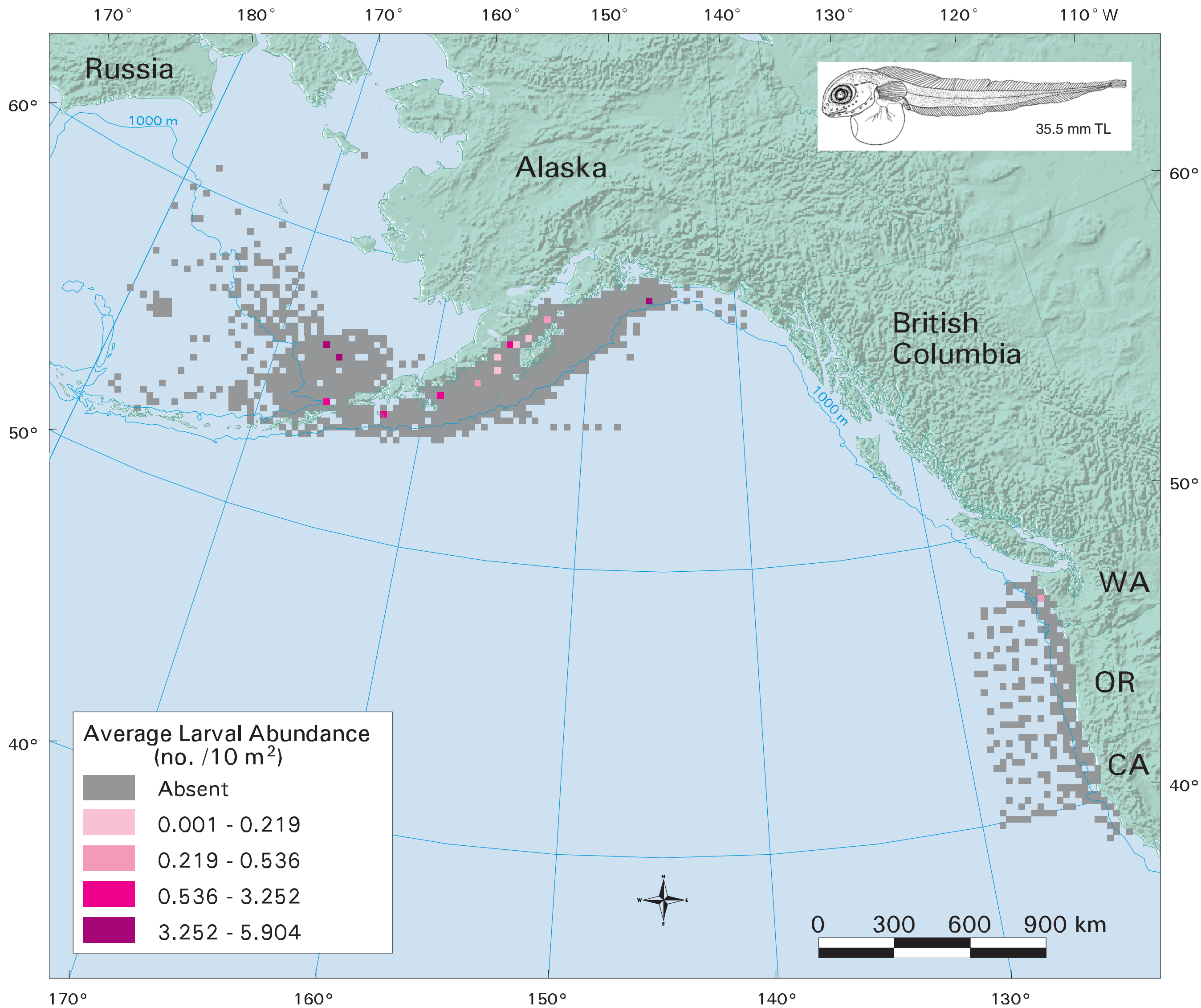
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 29 for winter–spring (Jan–June); 2 specimens >100 mm SL omitted.

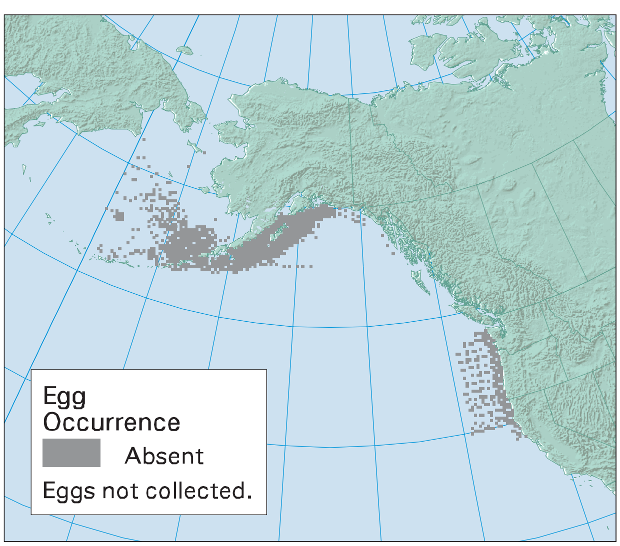


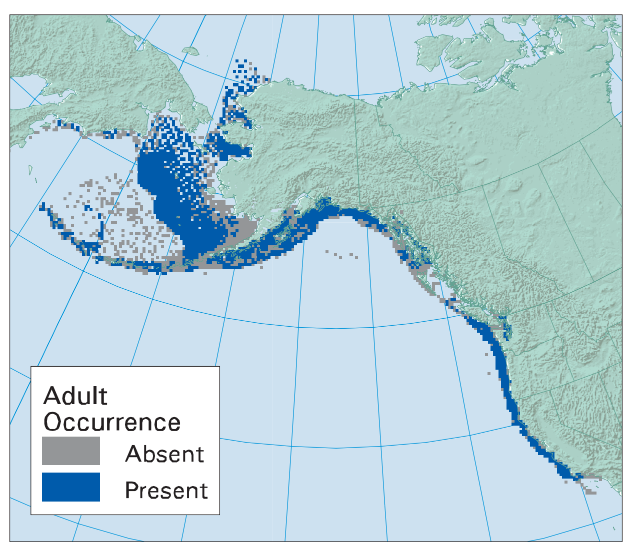
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

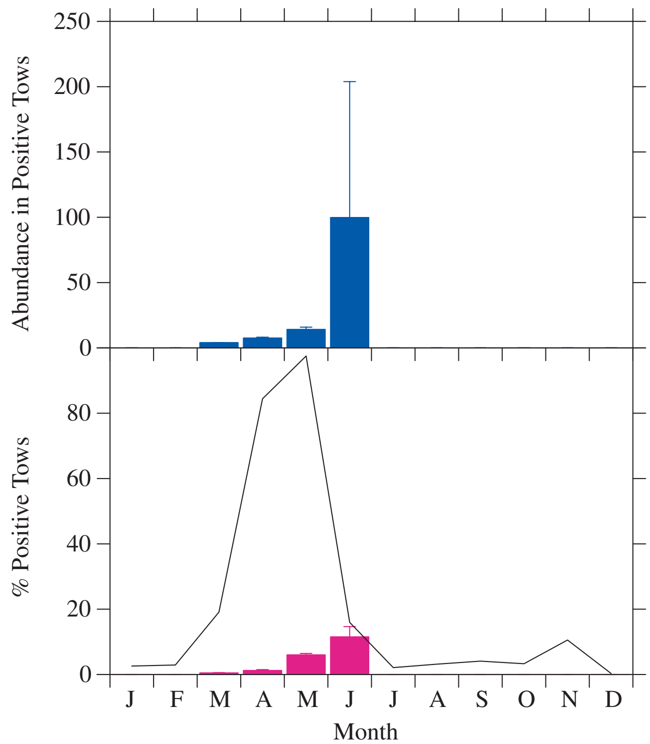

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
60°
50°
40°
35.5 mm TL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.219
0.219 - 0.536
0.536 - 3.252
3.252 - 5.904
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

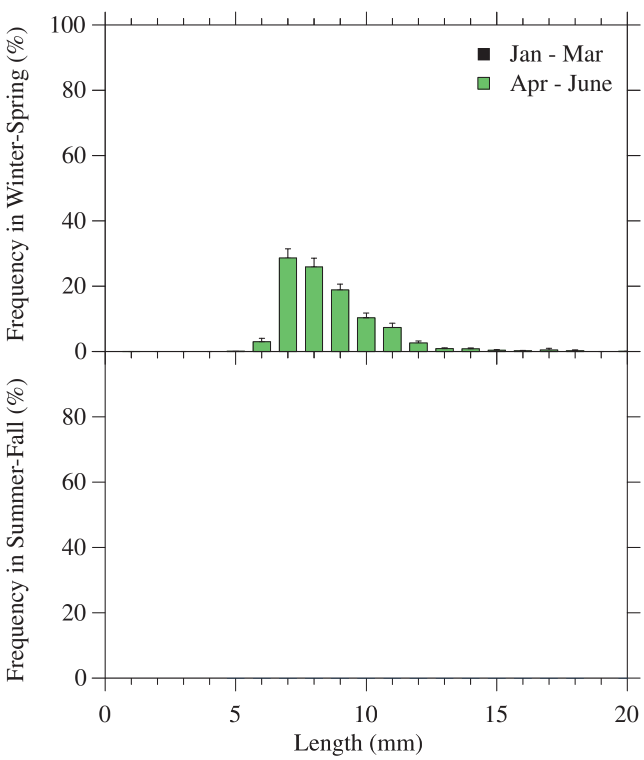

Adult Occurrence
Absent
Present

Life history *Anoplarchus* spp. are demersal fishes found from the Bering Sea to southern California along nearshore shelf and intertidal areas (0–30 m). Two species are found in our study area. *Anoplarchus insignis* (slender cockscomb), found from the Aleutian Islands to northern California, inhabit subtidal areas among rocks at depths to about 30 m. Little is known of its life history, and eggs and larvae are not known. *Anoplarchus purpurescens* (high cockscomb) have a wider distribution. Adults are oviparous and spawning occurs during winter January–March. Pairs spawn adhesive demersal eggs under rocks (1.27–1.45 mm with 1–3 oil globules) that are attached to each other to form a pedestal-shaped mass guarded by the female parent. Larvae hatch at about 7.5 mm TL and undergo transformation at >12 mm SL. [Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

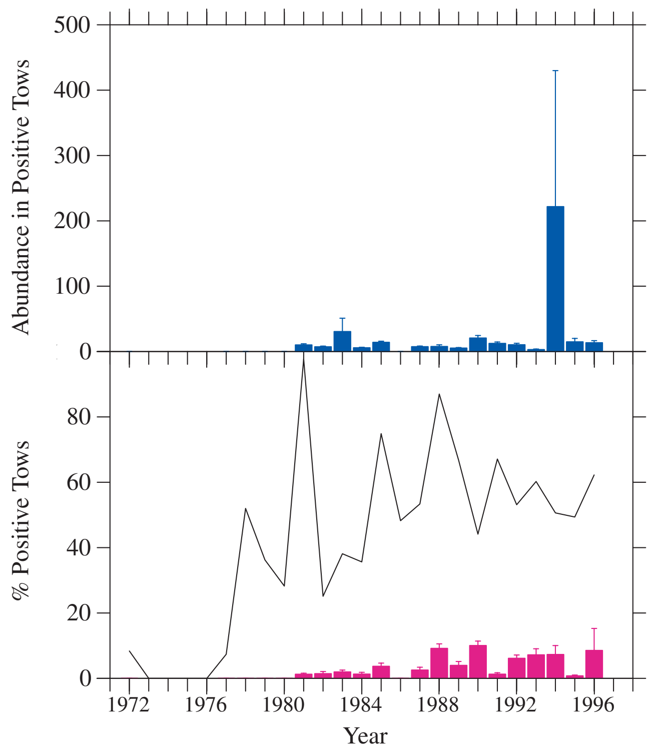
Larval distribution Larvae of the genus *Anoplarchus* are collected from around Unimak Pass in the Aleutian Islands and east to the Gulf of Alaska around Kodiak Island. Adults are not collected in AFSC surveys and available data on distribution patterns are limited. Concentrations are higher near Unimak Pass and southwest and east of Kodiak Island. Larvae are found March–June, with abundances highest in June. Larvae range in size from 6 to 15 mm SL, but small newly-hatched larvae (<10 mm SL) are most abundant in winter–spring. Overall catch by year indicates that larvae were present throughout the time series 1981–1996, but were more common in tows after 1985.



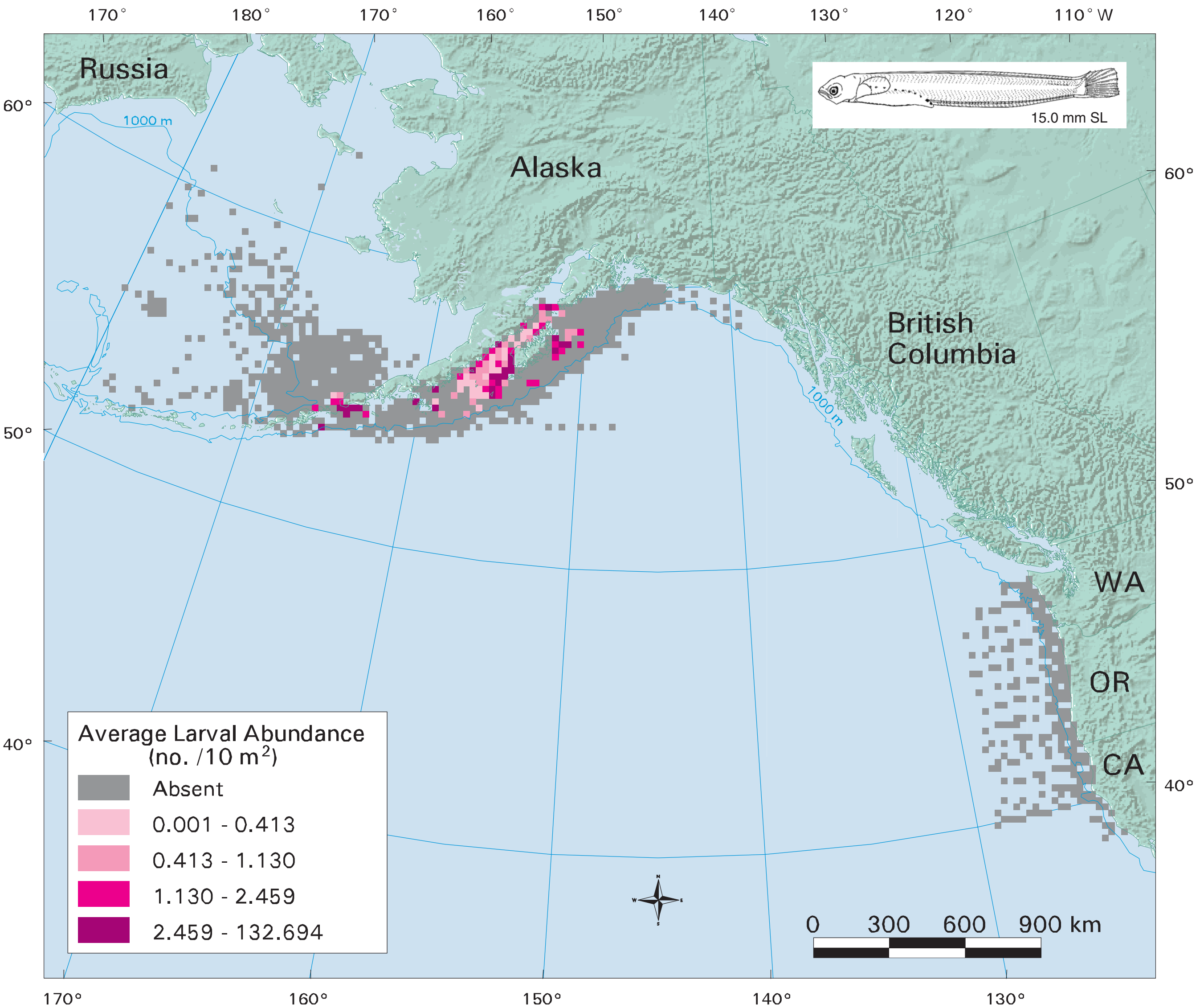
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

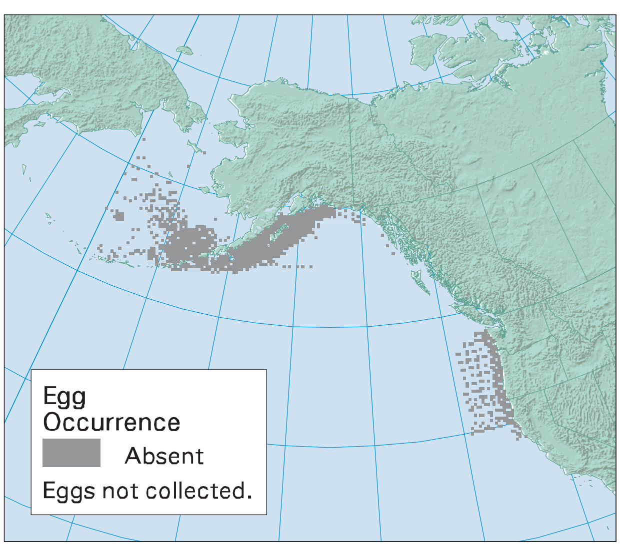


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 943 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

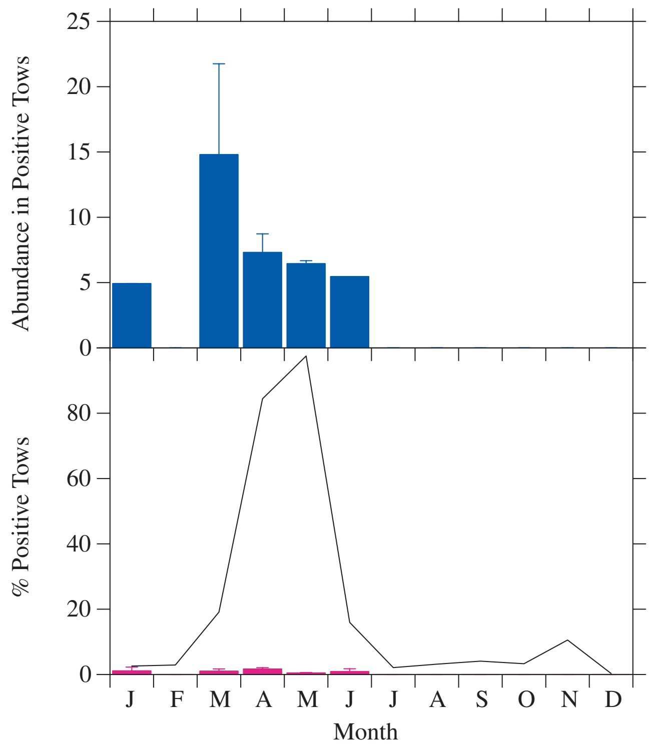

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
15.0 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.413
0.413 - 1.130
1.130 - 2.459
2.459 - 132.694
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

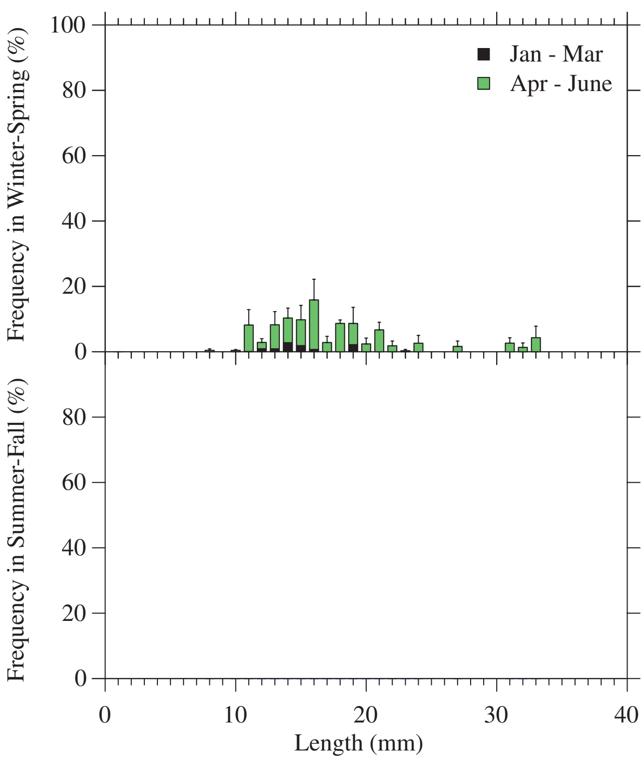

Adult Occurrence*
Present
(Occurrence only)

Life history The genus *Chirolophis* is represented by four species in our study area. *Chirolophis decoratus* (Bering Sea–northern California) and *C. nugator* (Aleutian Islands–southern California) are both common throughout their ranges. *Chirolophis tarsodes* (Bering Sea–British Columbia) and *C. snyderi* (Bering Sea) are less frequently collected. Adults (15–43 mm TL) inhabit areas with rocky bottoms from intertidal zones to 91 m depth. Eggs of *C. nugator* are about 2 mm in diameter; spawning probably takes place in winter. Little else is known of the life history of the warbonnets. Except for *C. nugator, Chirolophis* spp. can be identified only after fin rays are fully formed. [Sources include: Hart (1973), Eschmeyer et al. (1983), Matarese et al. (1989), Mecklenberg et al. (2002)]

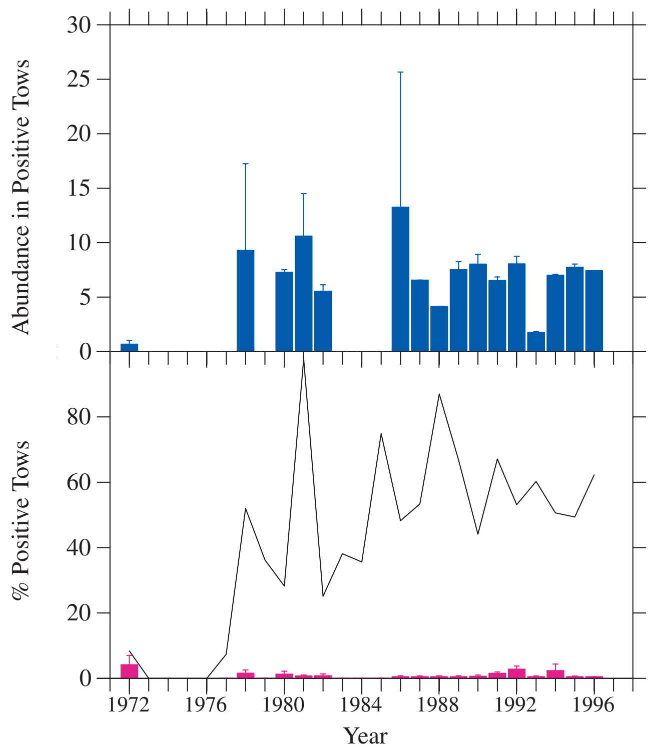
Larval distribution *Chirolophis* spp. larvae are collected from the Bering Sea, in the Gulf of Alaska around Kodiak Island, to along the U.S. west coast. Although AFSC adult surveys show a preponderance of inshore habitats, larvae are more abundant in deeper waters off the slope and outer shelf, especially along the Shelikof sea valley. Several taxa may be represented in AFSC collections. Larvae are collected January–June, with highest numbers in late winter. Newly hatched larvae and early juveniles (8–33 mm SL) are taken in winter–spring. Overall, larvae were collected in low numbers during most years of the time series.



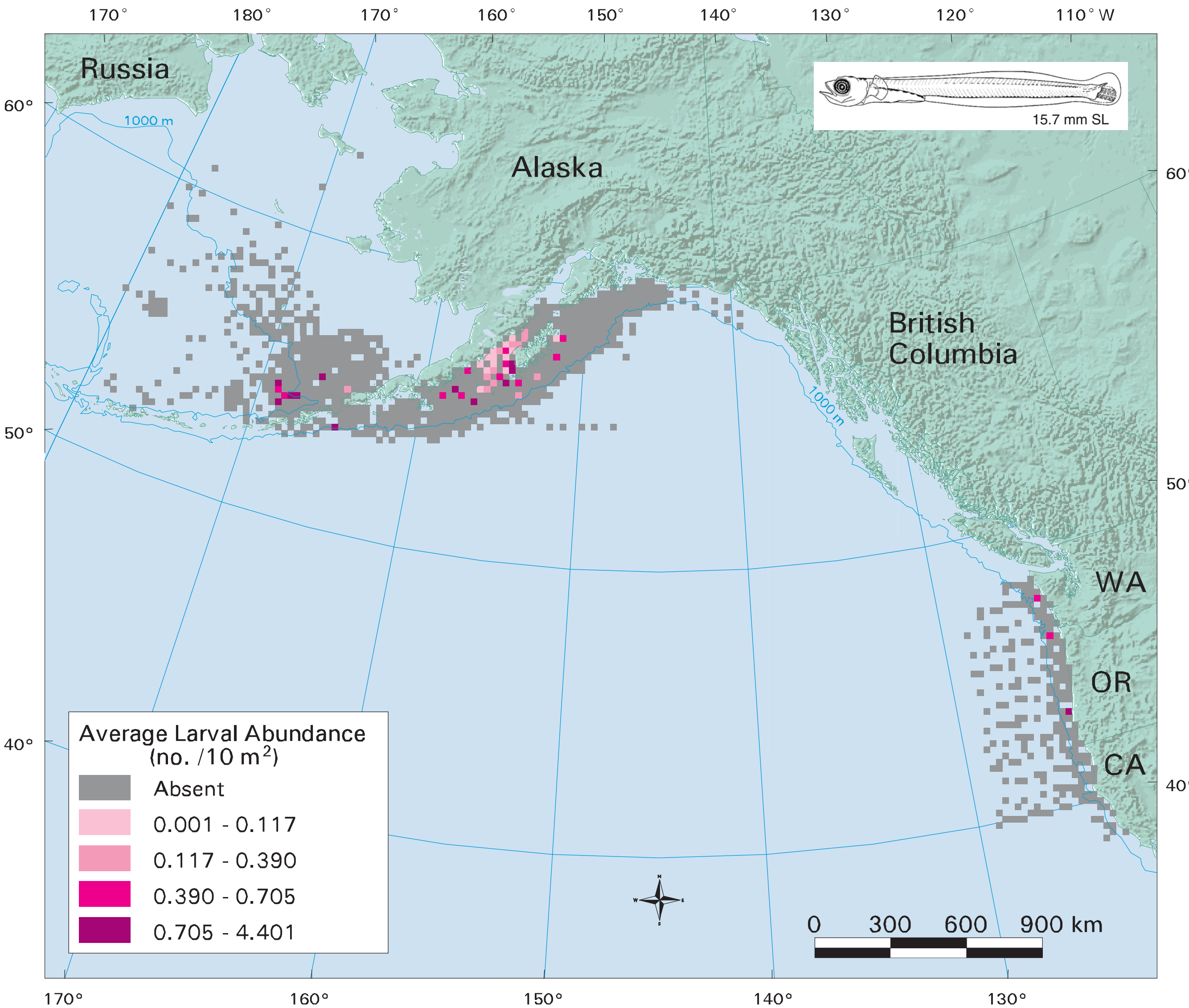
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

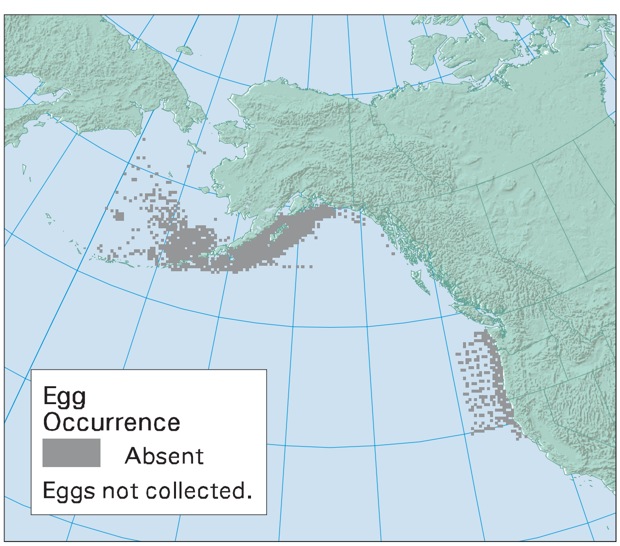


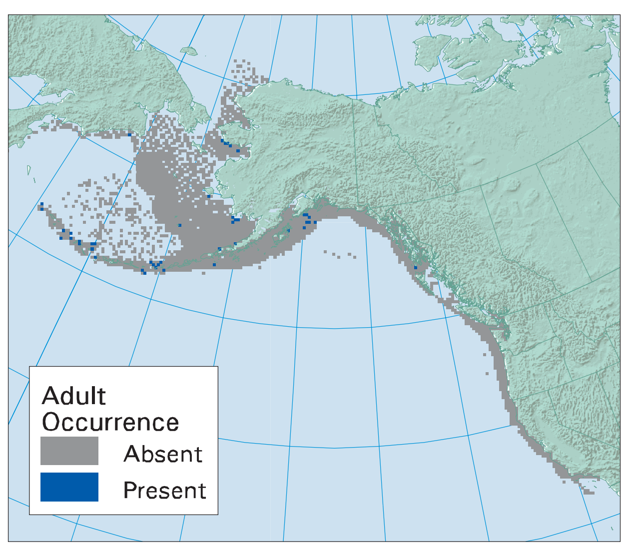
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 91 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

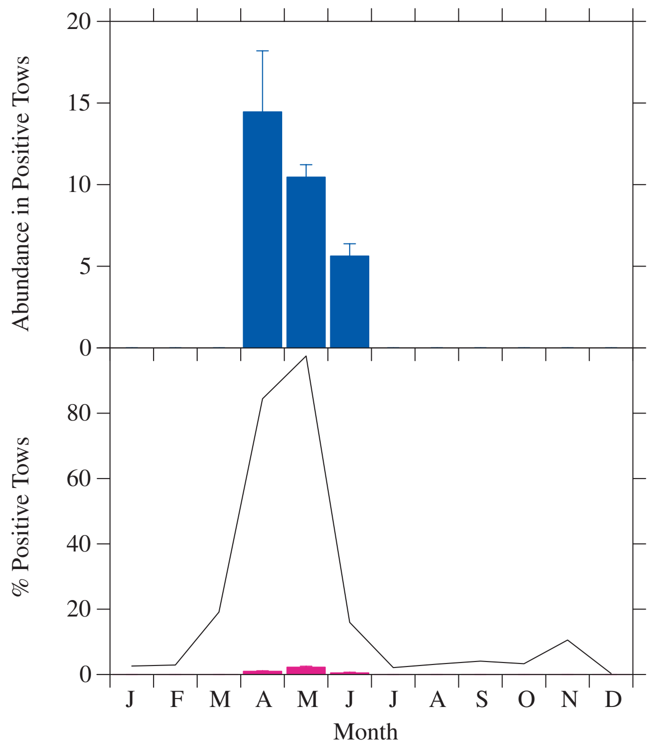

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
15.7 mm SL
Average Larval Abundance
(no. /10 m²)
Absent
0.001 - 0.117
0.117 - 0.390
0.390 - 0.705
0.705 - 4.401
0 300 600 900 km
170°
160°
150°
140°
130°


Egg
Occurrence
Absent
Eggs not collected.

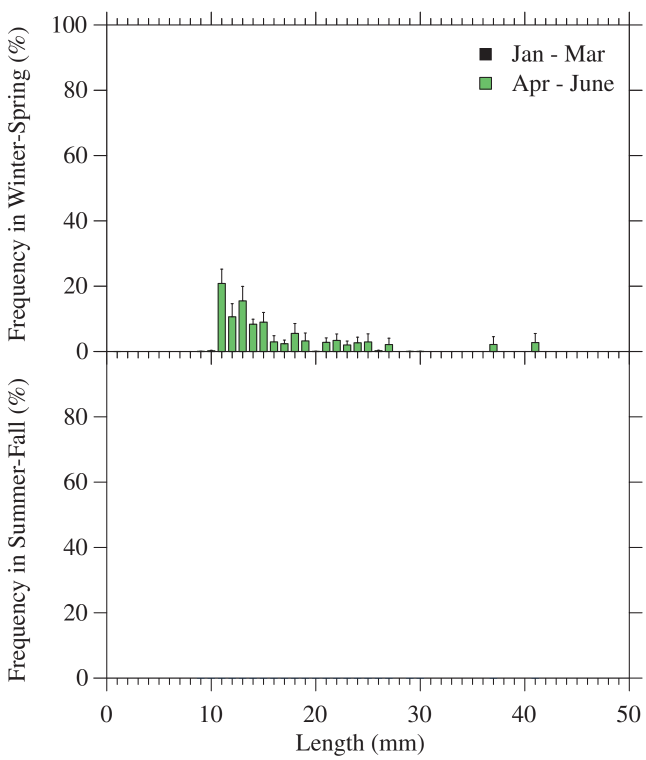

Adult
Occurrence
Absent
Present

Life history *Lumpenella longirostris* occur from the Bering Sea to southern British Columbia. Longsnout prickleback adults, which can reach a length of 31 cm TL, are a demersal species found offshore at depths of 91–141 m. Little is known of the life history. Eggs are probably demersal and spawned in an adhesive mass. Larvae are pelagic.
[Sources include: Eschmeyer et al. (1983), Allen and Smith (1988),Watson (1996c)]

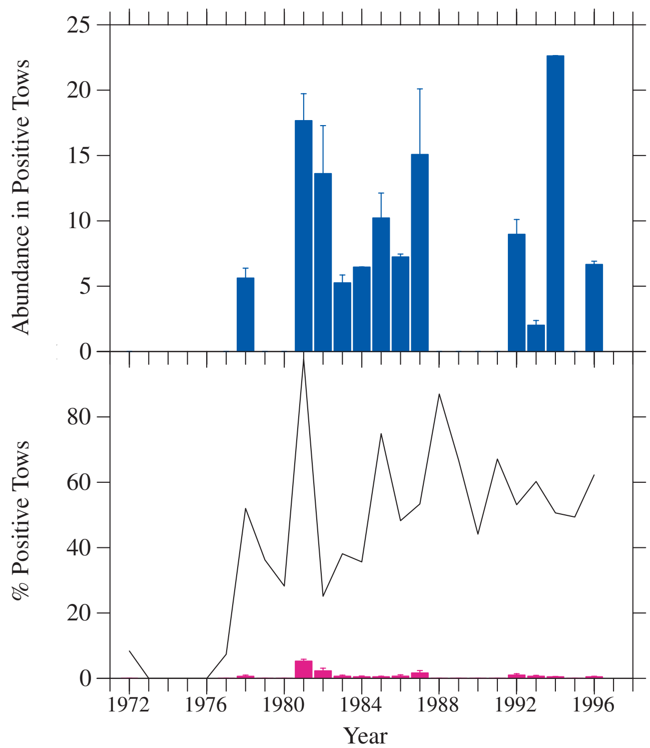
Larval distribution Longsnout prickleback larvae are collected in the Gulf of Alaska in the Shelikof Strait sea valley and along the shelf east of Kodiak Island. Although AFSC surveys collect adults in the central and southeastern Bering Sea, no larvae have been collected in these regions. Larvae are collected April–June with highest abundances in April. Most larvae collected in winter–spring are small (<20 mm SL), but they range in size from 9 to 41 mm SL. Overall catch by year indicates larvae were found in low numbers during more than half the years in the time series. Larvae were caught consistently 1981–1987 and 1992–1994.



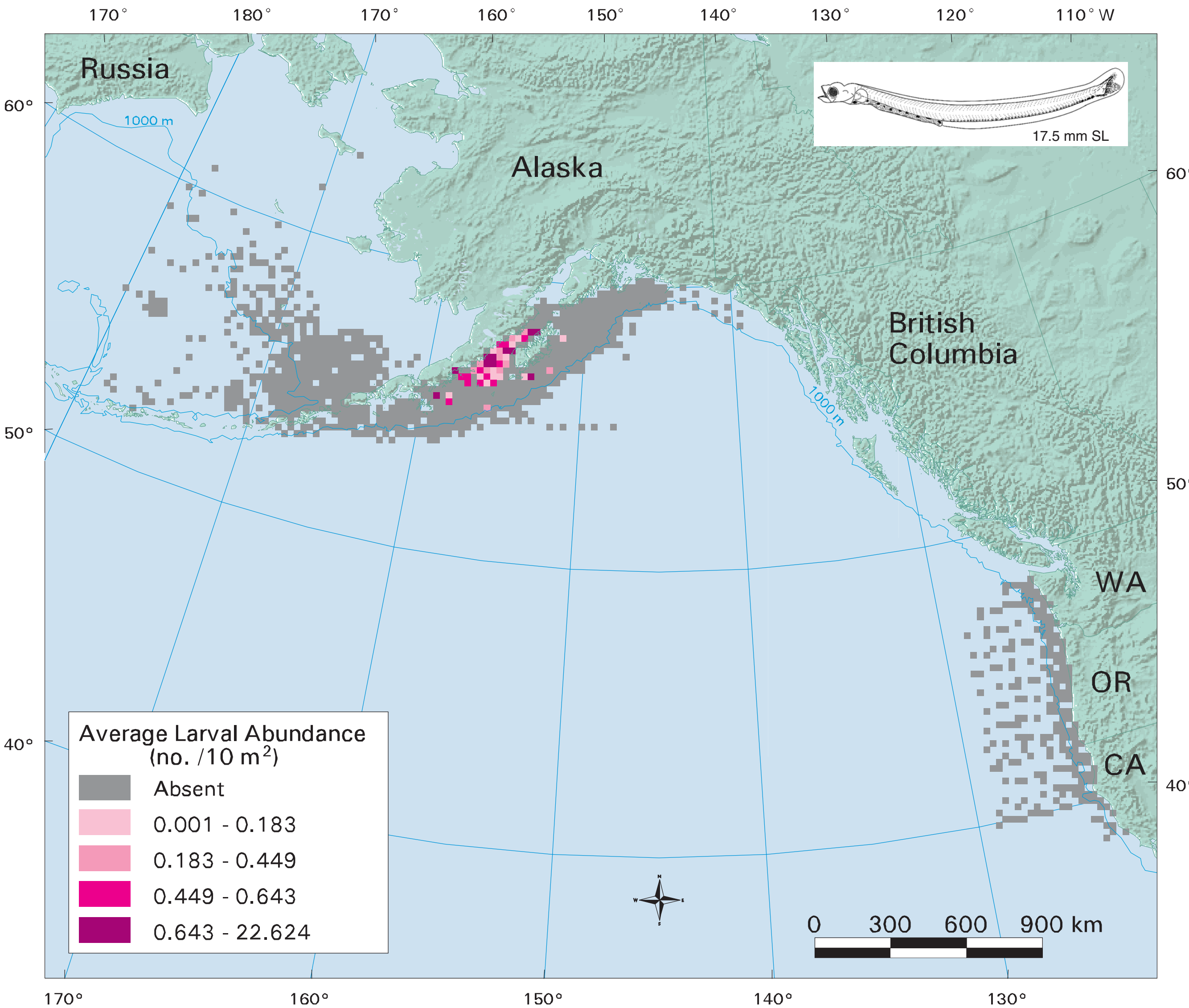
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

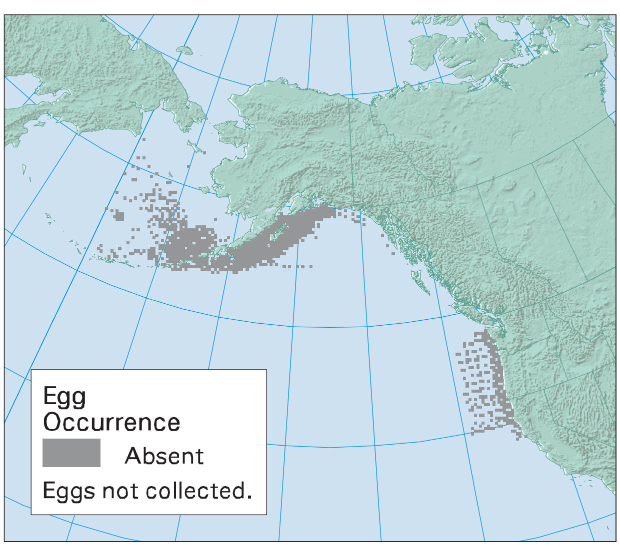


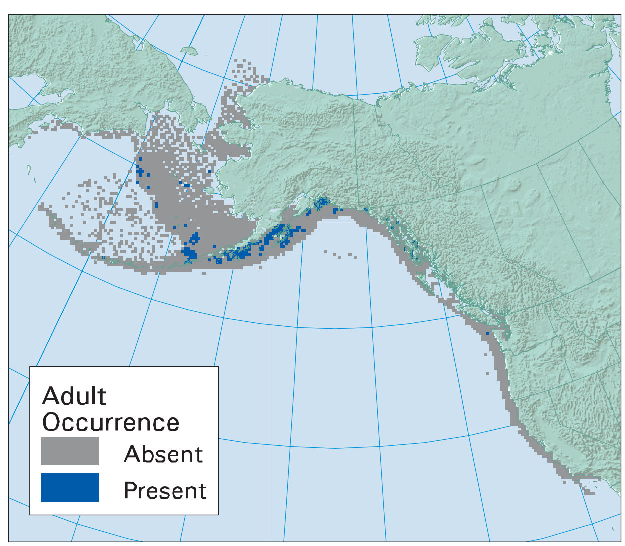
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 231 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

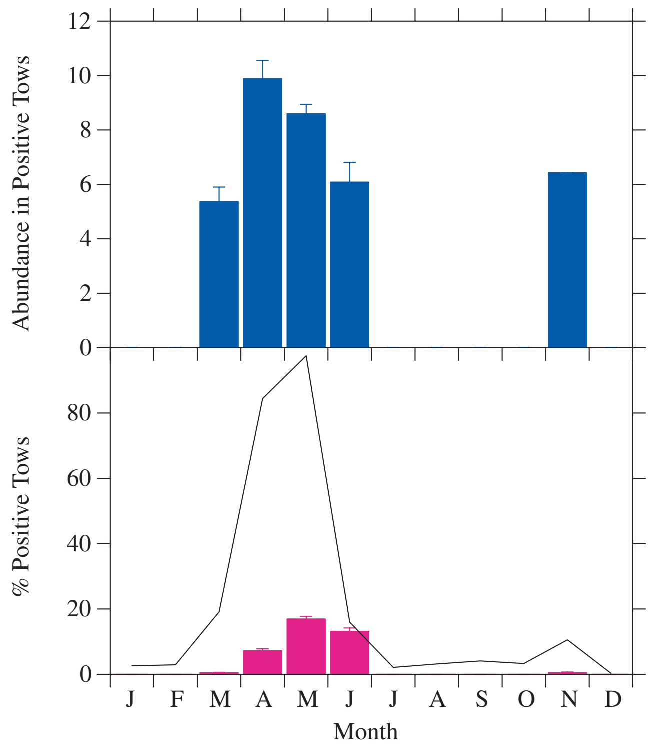

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
17.5 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.183
0.183 - 0.449
0.449 - 0.643
0.643 - 22.624
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

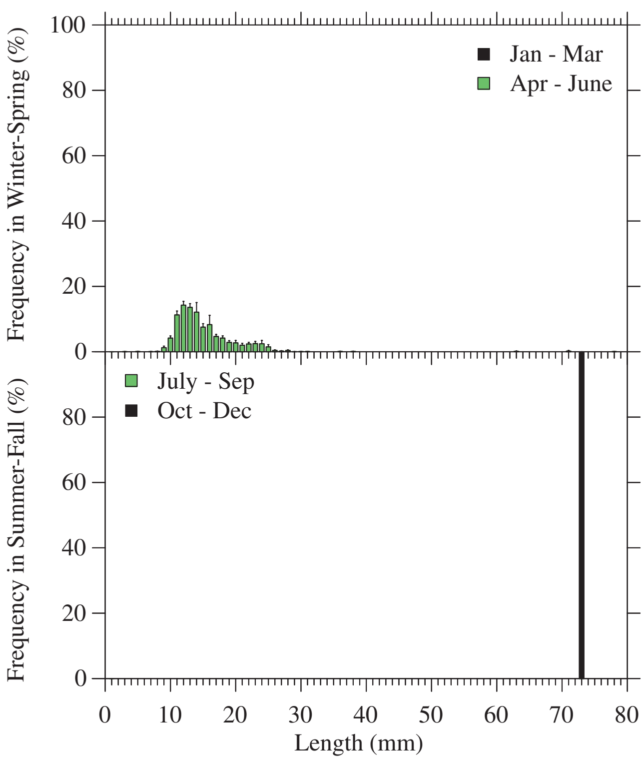

Adult Occurrence
Absent
Present

Life history The genus *Lumpenus* is composed of four species: *Lumpenus fabricii*, *L. maculatus*, *L. medius*, and *L. sagitta*. Only *L. sagitta* larvae are identified at present (see pages 206–207); the other three taxa are grouped together as *Lumpenus* spp. *Lumpenus maculatus* (daubed shanny) are found from the Arctic Ocean to Puget Sound, Washington. Adults are demersal inhabitants of areas with hard sand bottoms at depths of 55–91 m and may grow to 18 cm TL. *Lumpenus fabricii* (stout eelblenny) and *L. medius* (slender eelblenny) are found from the Arctic Ocean to Southeast Alaska. Little is known of the life history of these species. In areas where they co-occur, *Lumpenus* spp. can be identified only after fin rays are fully formed.
[Sources include: Hart (1973), Eschmeyer et al. (1983), Matarese et al. (1989)]

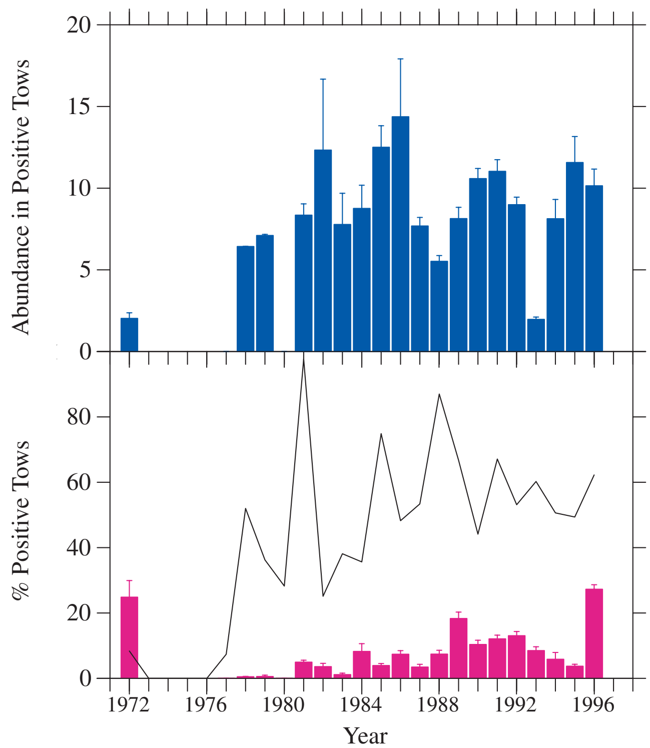
Larval distribution *Lumpenus* spp. larvae are collected along the outer shelf in the Bering Sea, along the Alaska Peninsula, around Kodiak Island, and eastward to Cape St. Elias in the Gulf of Alaska. Although adults are common along the eastern Bering Sea shelf, especially along the Alaskan coast, AFSC larval surveys are not conducted in those areas. Larvae are generally found in spring (March–June) and in November. Small larvae and early juveniles (9–28 mm SL) are collected in winter–spring. Overall catch by year indicates that larvae were commonly present most years during the time series, with occurrences in more than 20% of the tows in the years 1972 and 1996.



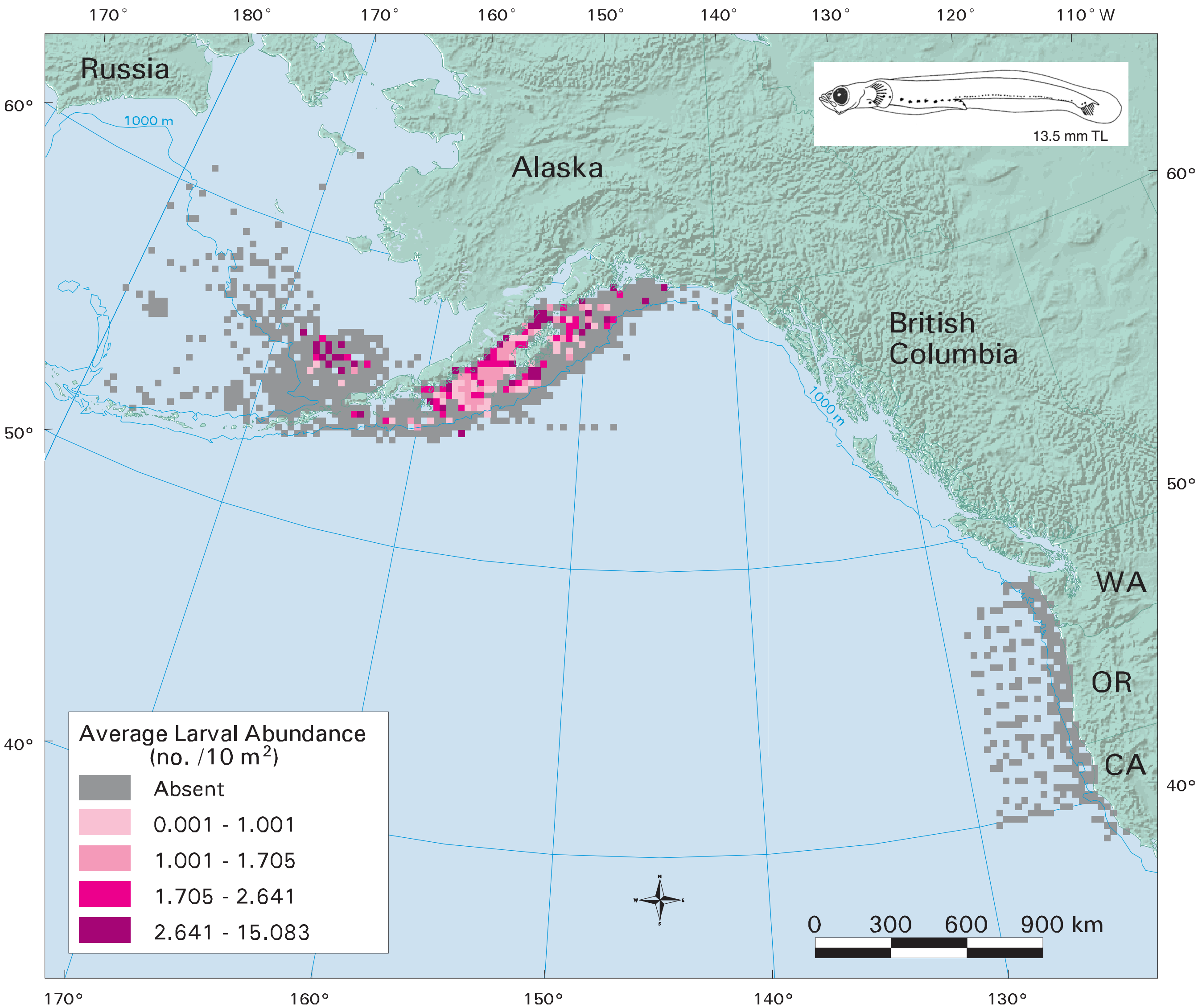
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

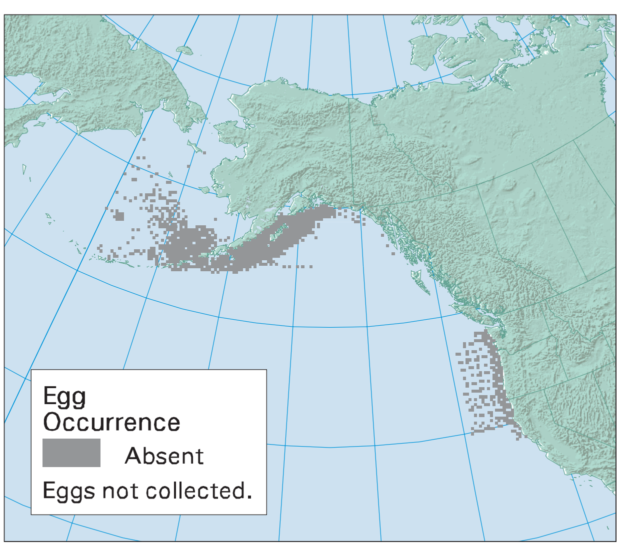


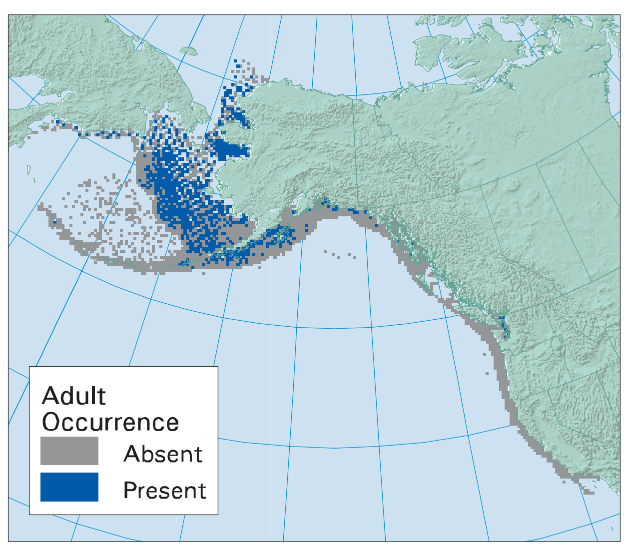
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 1307 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

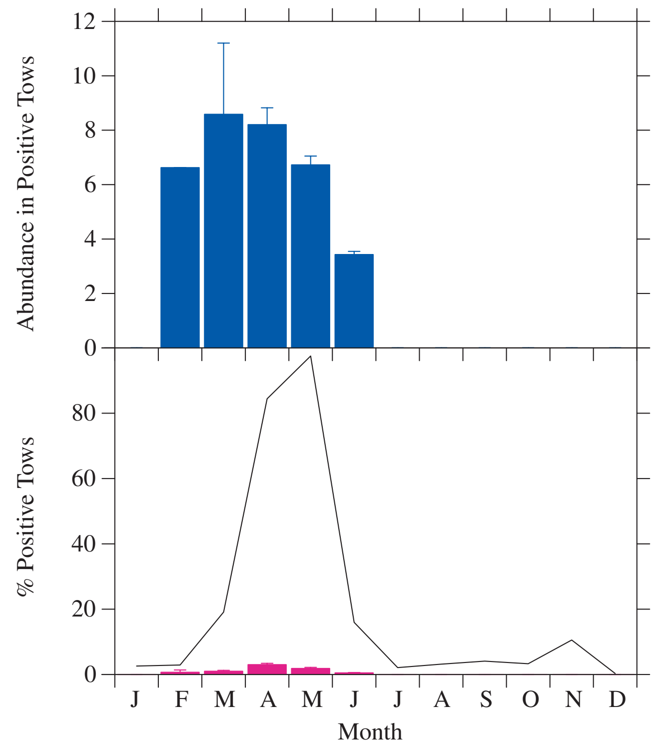

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
WA
OR
CA
13.5 mm TL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.001
1.001 - 1.705
1.705 - 2.641
2.641 - 15.083
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

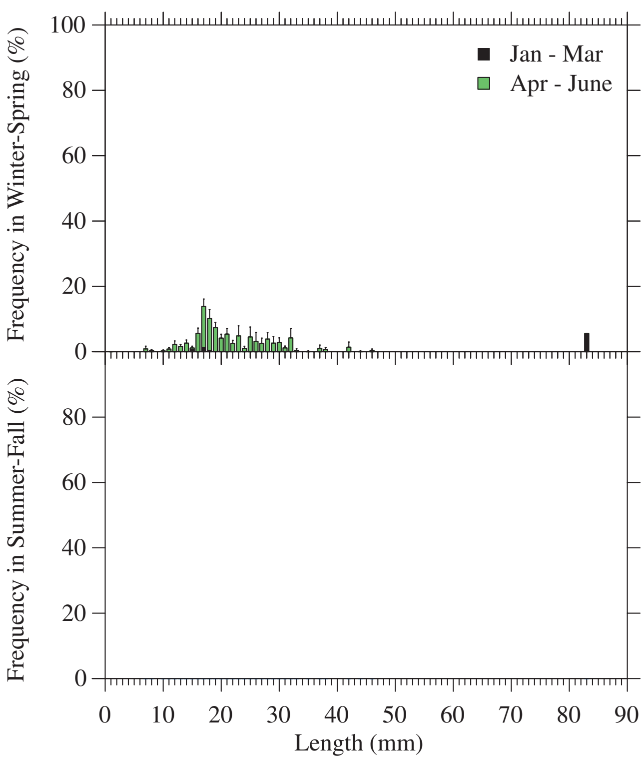

Adult Occurrence
Absent
Present

Life history *Lumpenus sagitta* are found over the shelf from the Bering Sea to northern California. Snake pricklebacks live in demersal habitats that range from shallow bays to offshore waters about 207 m deep. Adults reach a length of 51 cm TL. Little is known of the life history. Eggs are probably demersal and spawned in an adhesive mass; larvae are pelagic. Snake prickleback larvae have been collected February–April in Puget Sound, Washington; larvae 5–52 mm SL are abundant near the surface in April and May off the outlet of the Fraser River in British Columbia.
[Sources include: Blackburn (1973), Hart (1973), Eschmeyer et al. (1983), Watson (1996c)]

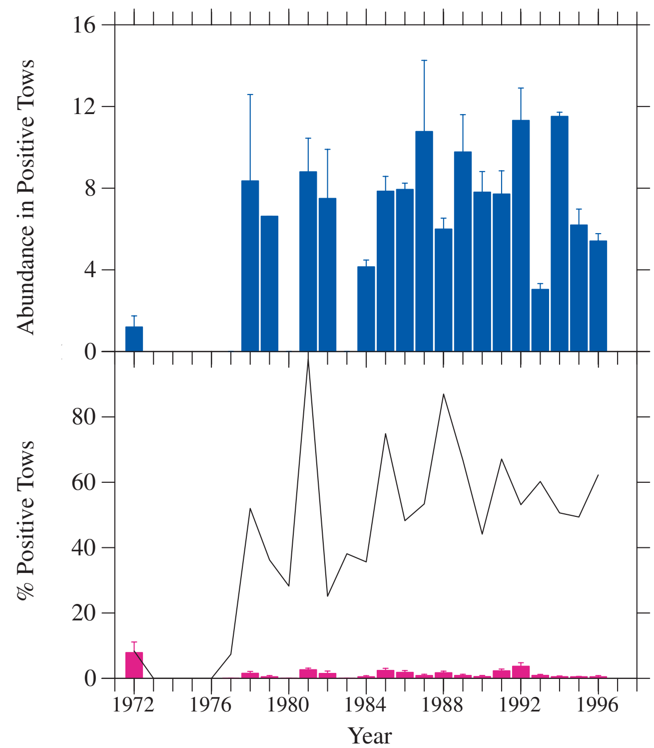
Larval distribution Snake prickleback larvae are found along the shelf in the Gulf of Alaska from Unimak Pass to just eastward of Prince William Sound. Although adults are common along the Bering Sea shelf, larvae have not been collected there. Although adults are reported to occur off the U.S. west coast, neither adults nor larvae have been collected during AFSC surveys. Abundance varies, but larvae are more frequently collected in the Shelikof Strait sea valley. Larvae and juveniles (7–83 mm SL) are collected in winter–spring February–June, with abundances slightly higher in March–April; most are less than 30 mm SL. Overall catch by year indicates that larvae were found in low numbers throughout the time series.



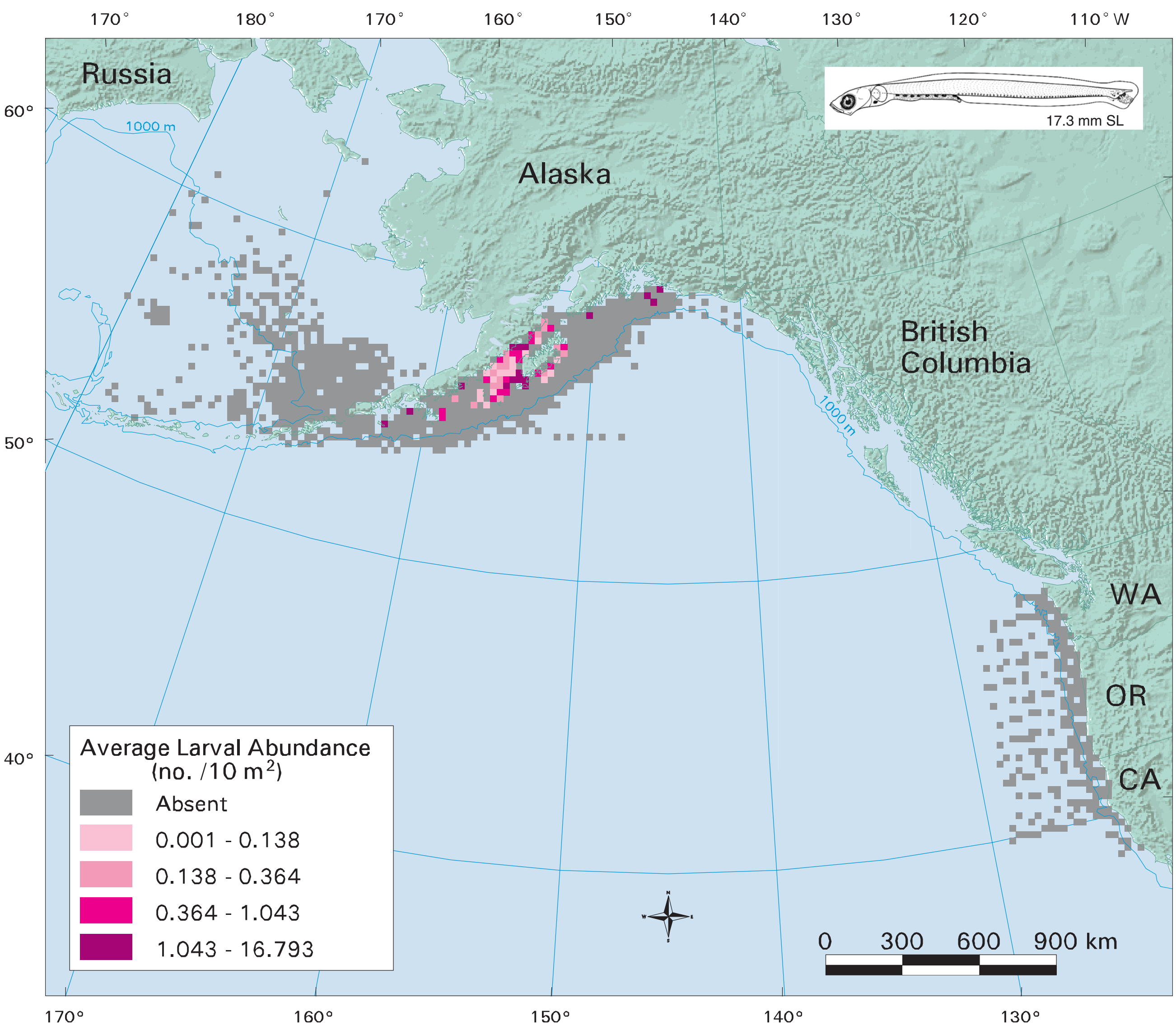
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

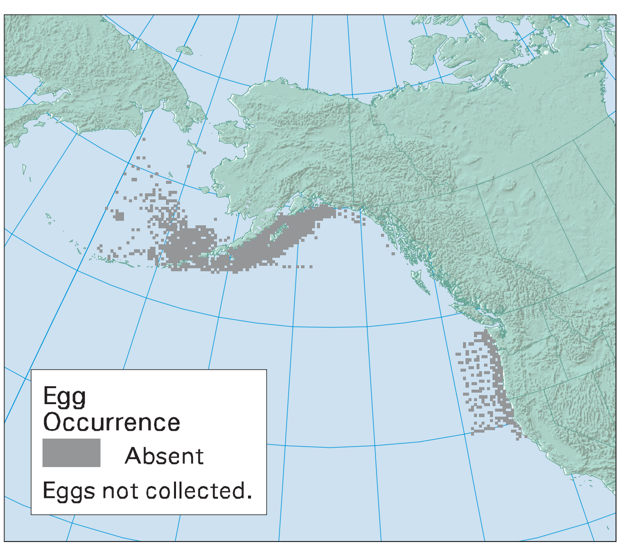


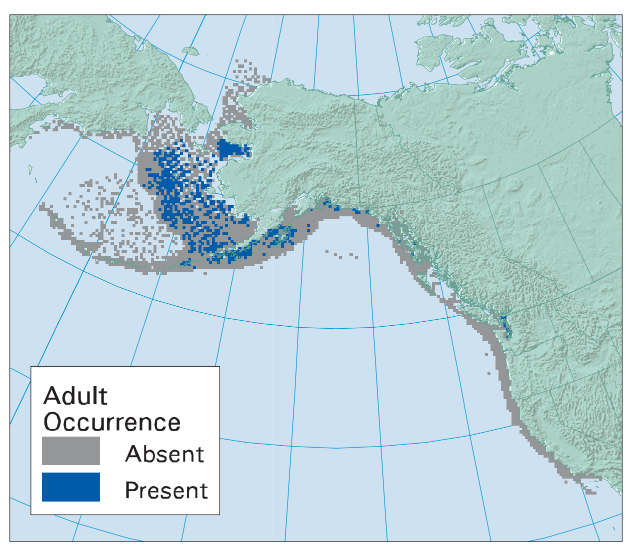
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 202 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

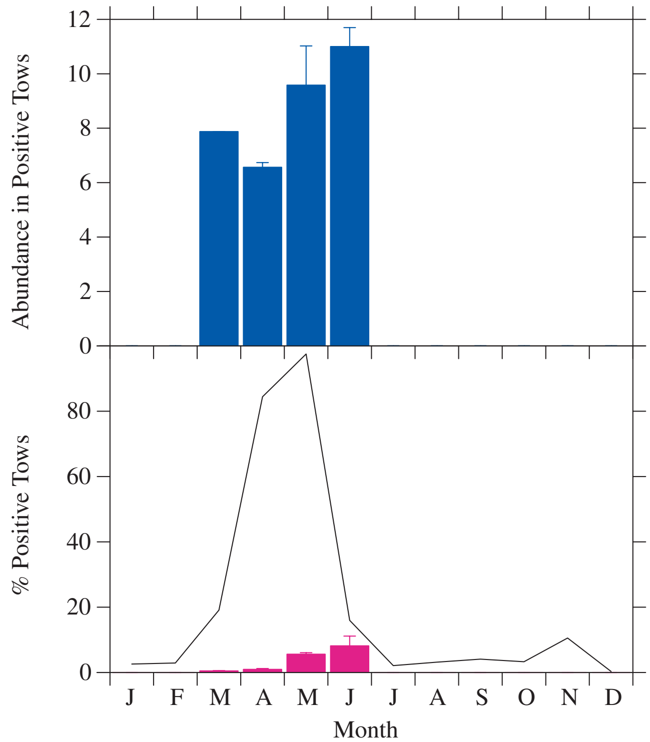

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
17.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.138
0.138 - 0.364
0.364 - 1.043
1.043 - 16.793
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

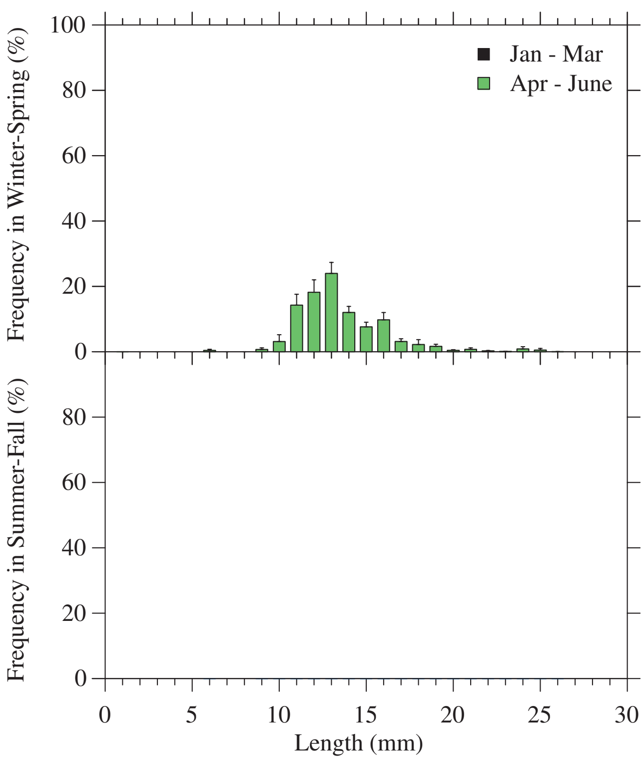

Adult Occurrence
Absent
Present

Life history *Poroclinus rothrocki* are found from the Bering Sea to southern California. Whitebarred pricklebacks, which live in demersal habitats at depths of 46–128 m, can reach a length of 25 cm TL. Little is known of the life history. Eggs are probably demersal and spawned in an adhesive mass. Larvae are pelagic.
[Sources include: Hart (1973), Watson (1996c)]

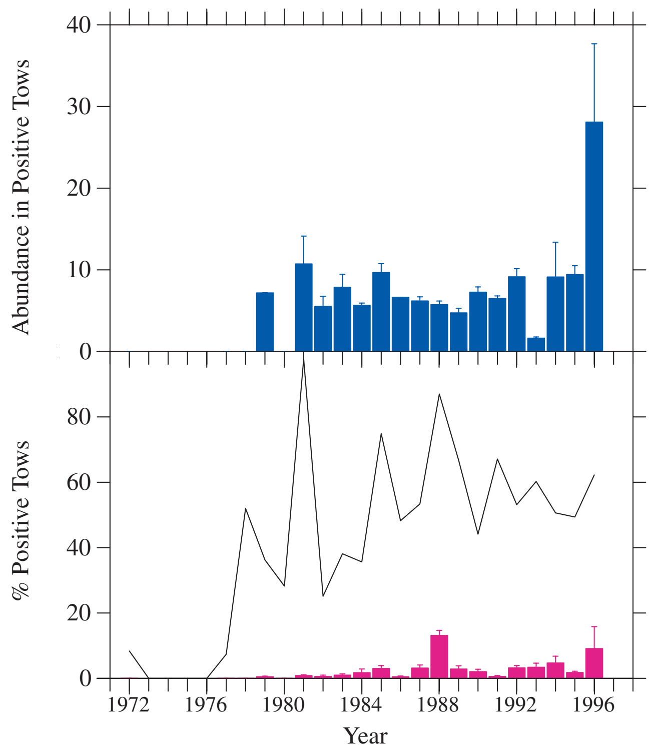
Larval distribution Whitebarred prickleback larvae are distributed throughout the shelf regions from the Bering Sea and Unimak Pass areas to the Shelikof sea valley, around Kodiak Island eastward to the Kenai Peninsula, and along the U.S. west coast off Washington and Oregon. Larvae are found March–June, with highest abundances in May and June. Larvae 6–25 mm SL are collected in winter–spring. Overall catch by year indicates larvae were routinely collected after 1980, but in fewer than 10% of the tows.



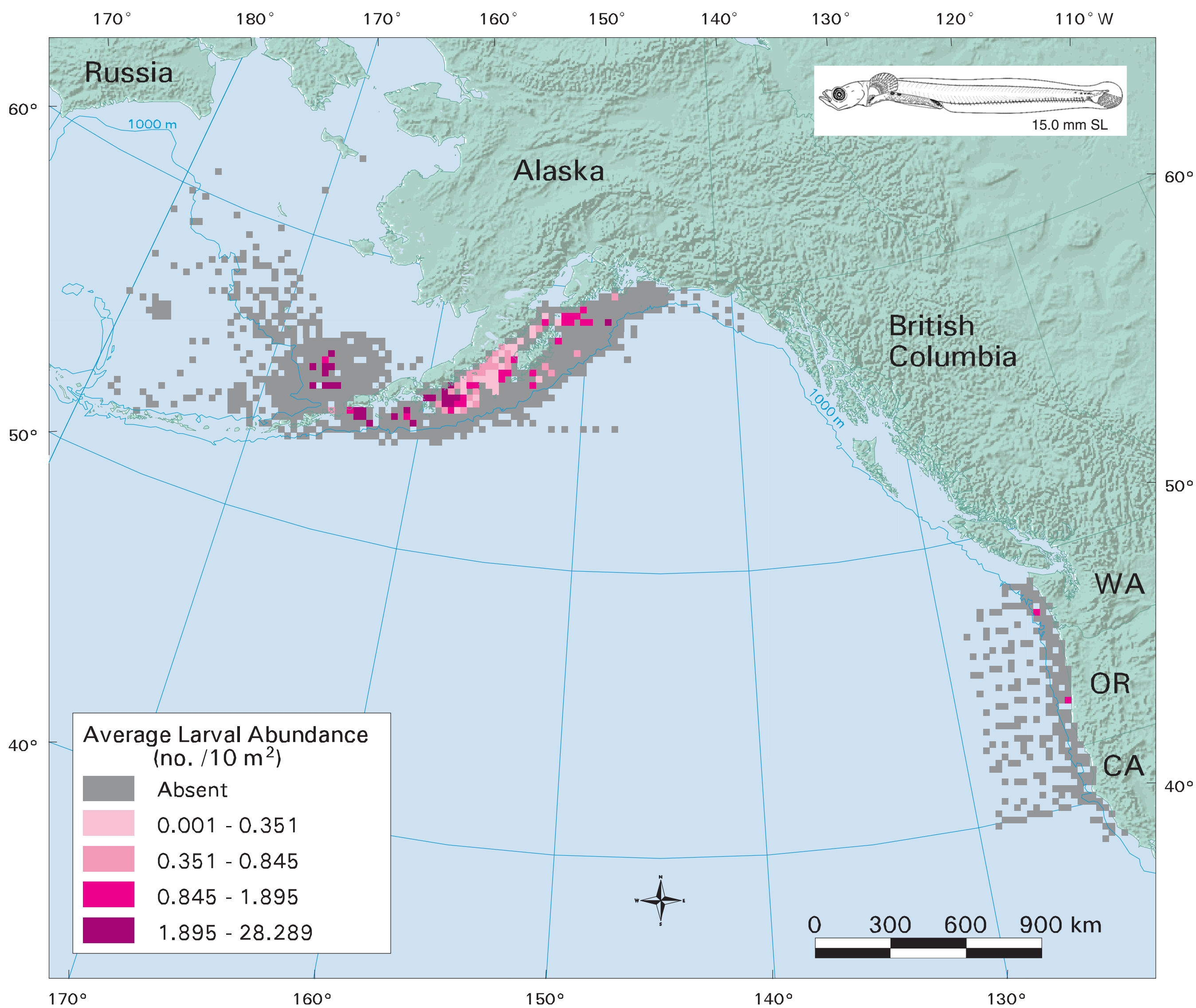
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

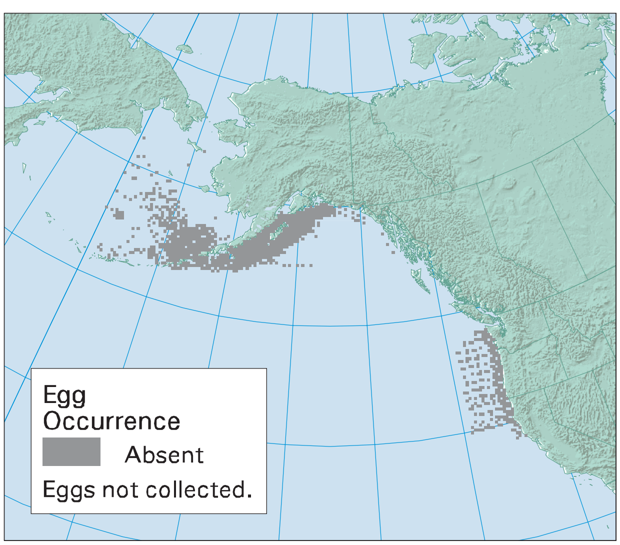


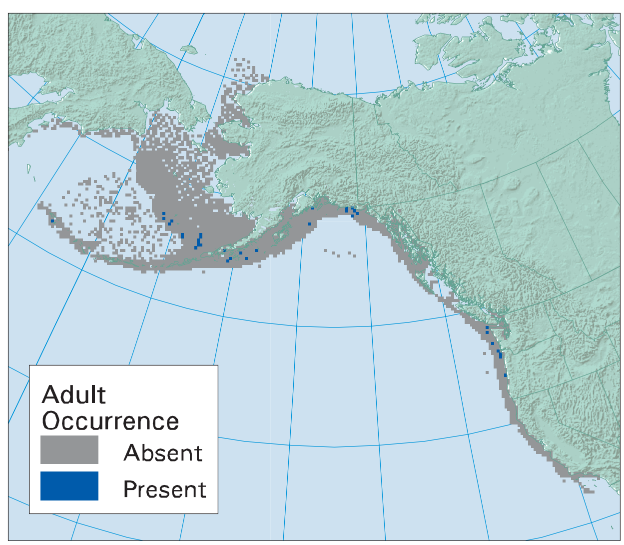
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 452 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

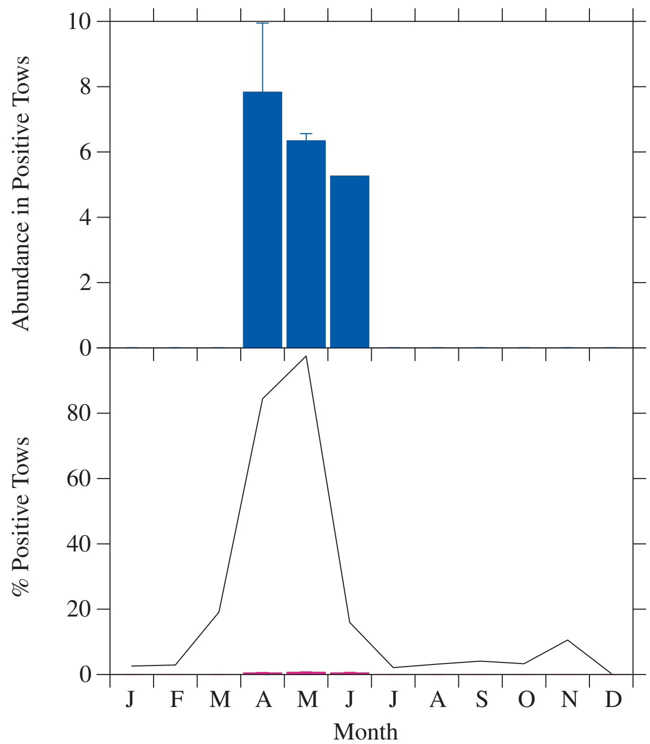

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
60°
50°
40°
15.0 mm SL
Average Larval Abundance (no. /10 m2)
Absent
0.001 - 0.351
0.351 - 0.845
0.845 - 1.895
1.895 - 28.289
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

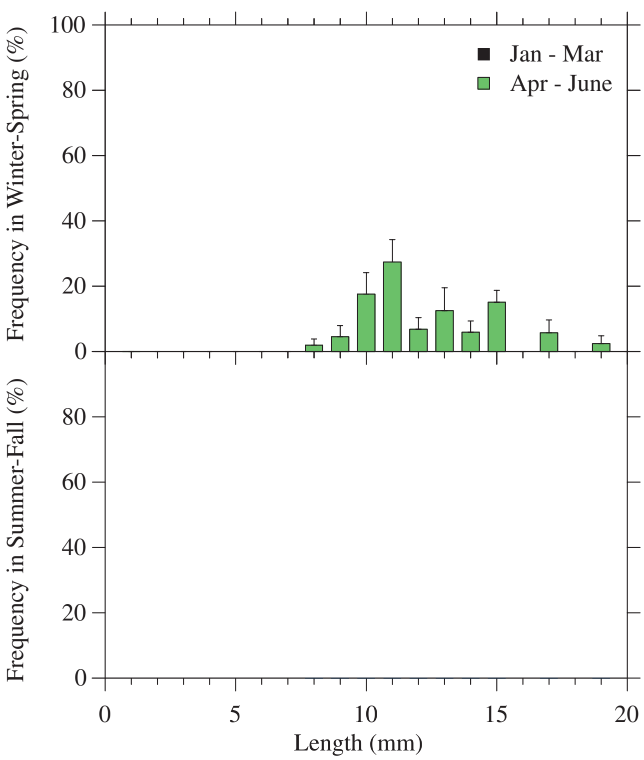

Adult Occurrence
Absent
Present

Life history *Stichaeus punctatus* are circumpolar in distribution, occurring southward to British Columbia in the North Pacific Ocean. Adult arctic shanny inhabit subtidal areas with rocky to sandy bottoms and grow to about 22 cm TL. Data on spawning and eggs are unknown, but larvae are pelagic; transformation occurs at about 25 mm SL.
[Sources include: Eschmeyer et al. (1983), Matarese et al. (1989)]

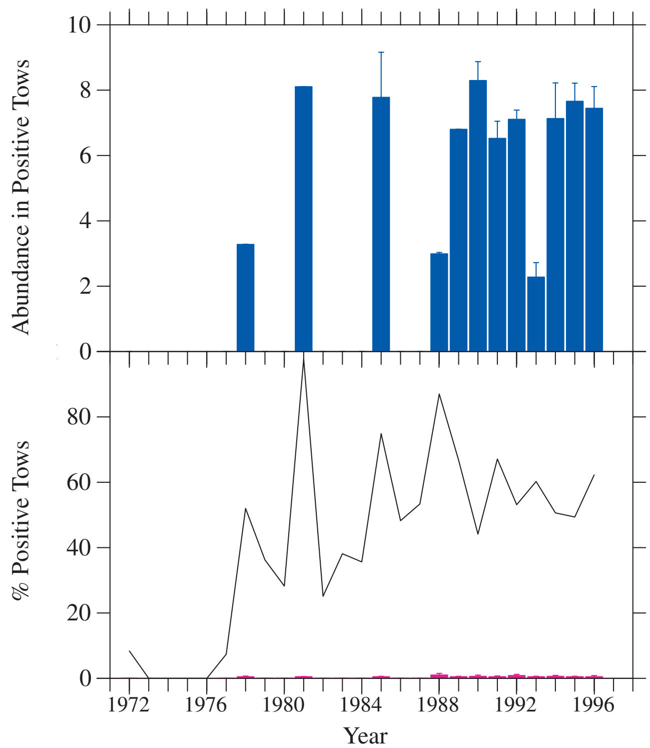
Larval distribution Arctic shanny larvae are distributed on the Bering Sea shelf near Unimak Pass and on the western Gulf of Alaska shelf along the Shelikof sea valley and Shelikof Strait to northeast of Kodiak Island. Although outside of the AFSC larval survey area, adults have been collected in Norton Sound and along the Alaskan coast of the Chukchi Sea during AFSC adult surveys. Larvae (8–19 mm SL) are found in spring April–June. Catches were small, but consistent, throughout the time series from 1978 to 1996.



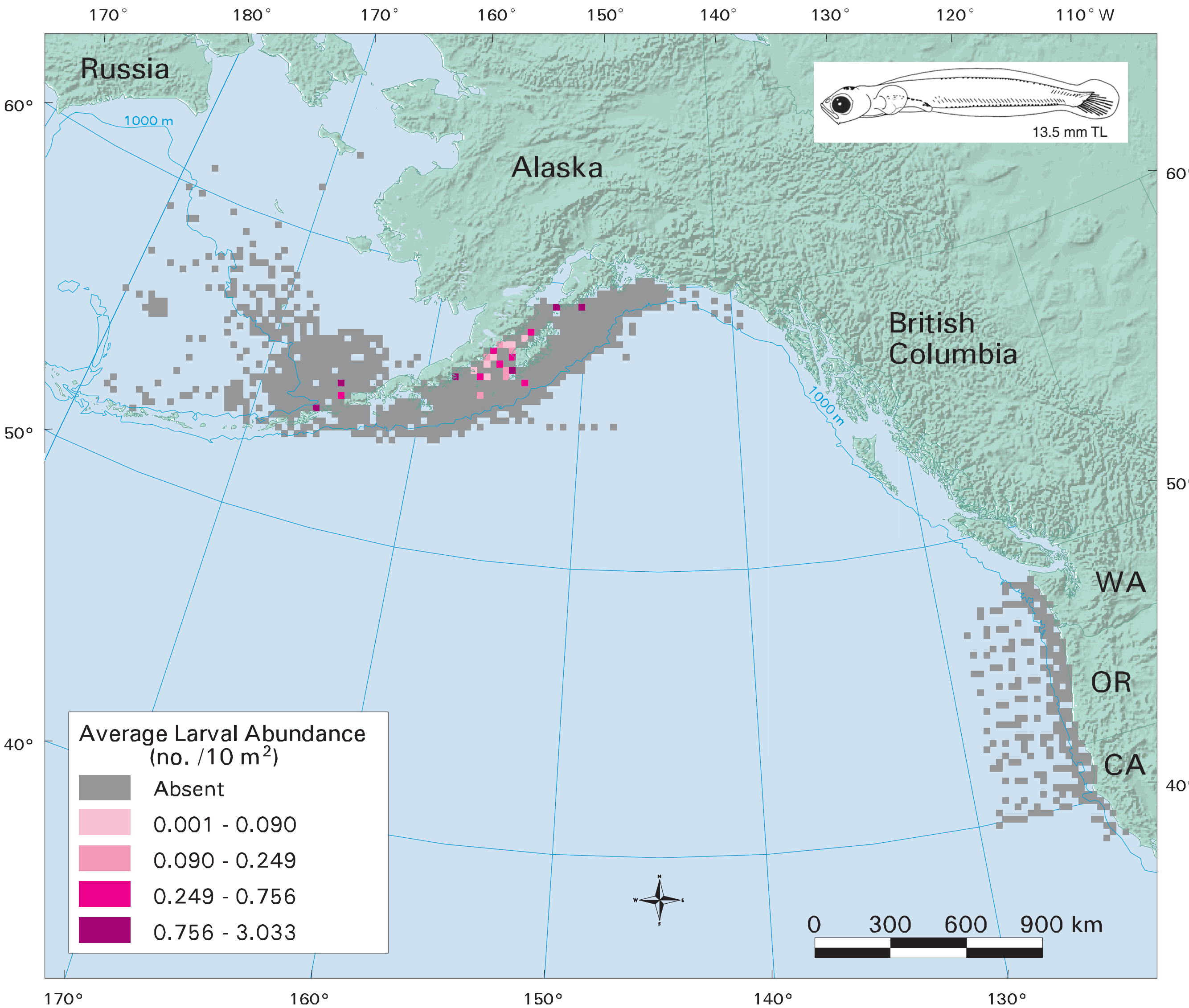
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

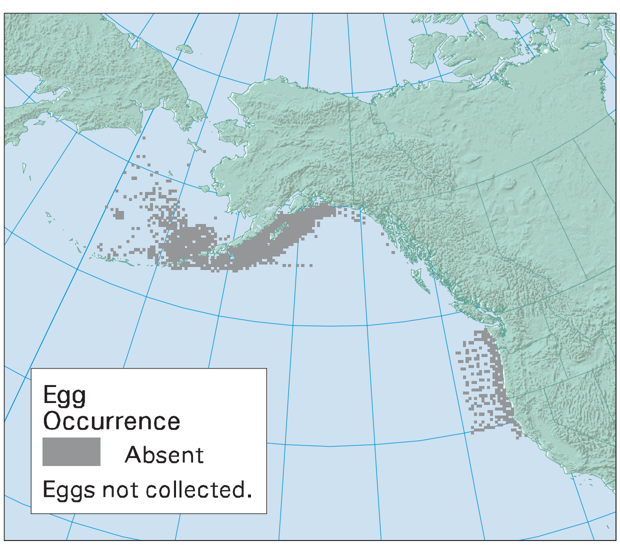


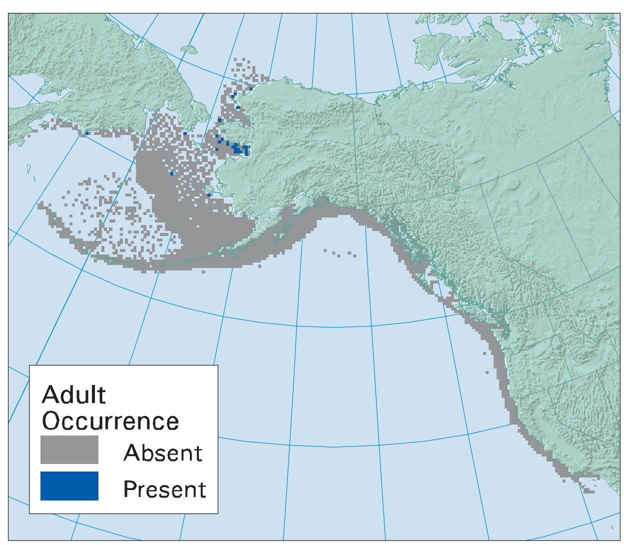
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 36 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

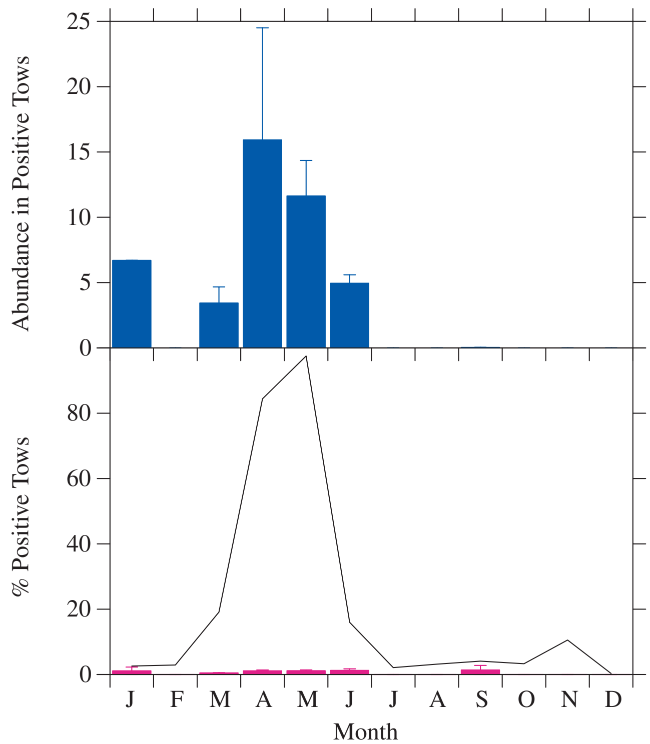

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
13.5 mm TL
British Columbia
1000 m
WA
OR
CA
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.090
0.090 - 0.249
0.249 - 0.756
0.756 - 3.033
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

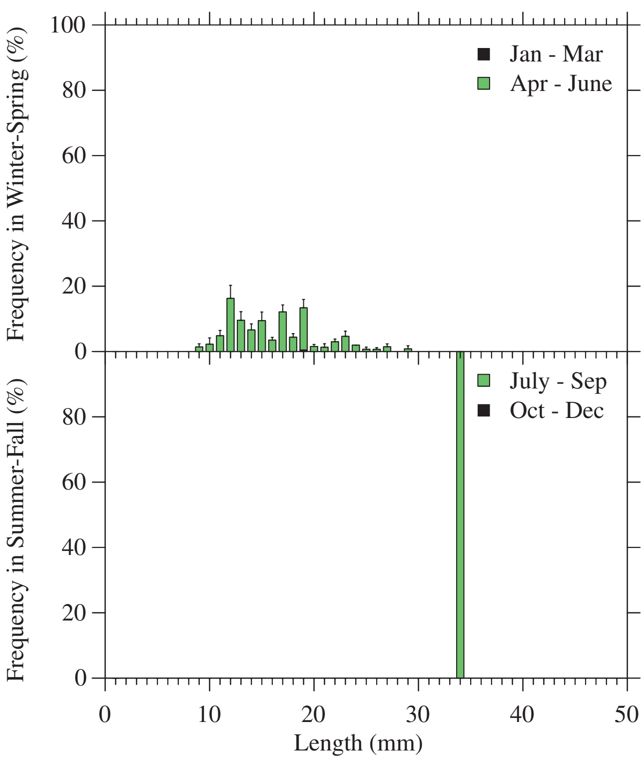

Adult Occurrence
Absent
Present

Life history The genus *Pholis* contains seven species within our study area. *Pholis fasciatus, P. gilli*, and *P. dolichogaster* are found in the Bering Sea and Aleutian Islands, *P. laeta* occurs from the Bering Sea to northern California, *P. clemensi* occurs from SE Alaska to northern California, and *P. ornata* and *P. schultzi* occur from British Columbia to central California. Adults are eel-like with long compressed bodies and are demersal, occurring in tidepools and near shore to depths of about 75 m. One or both parents guard adhesive eggs (1.4–3.0 mm) during incubation by coiling around them. Larvae are pelagic and may settle after about 50 days. Although meristic characters may be useful in separating larger *Pholis* spp. postflexion larvae and juveniles, earlier stages cannot be identified to species in our study area. Very few larval *Pholis* spp. have been taken during CalCOFI surveys, all from stations north of Point Conception. [Sources include: Matarese et al. (1989), Watson (1996d)]

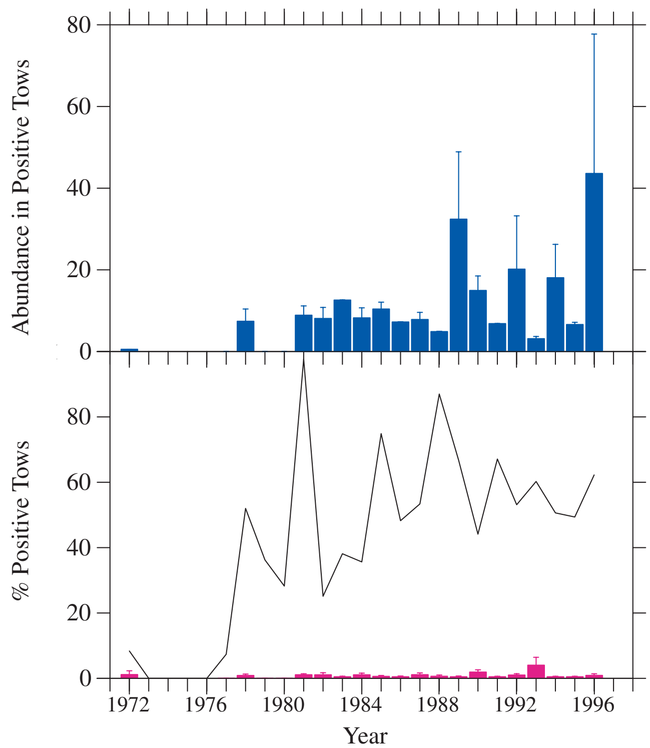
Larval distribution Larvae of the genus *Pholis* are collected from north and west of Unimak Pass in the Bering Sea, around the Kodiak Island shelf, and along the U.S. west coast off Oregon. Adults have not been collected in AFSC surveys and available data on distribution patterns is limited. Larvae are relatively abundant west and southwest of Kodiak Island. Highest catches of larvae are in April–May. Most larvae (9–29 mm SL) are found in winter–spring and only one larger individual (34 mm SL) was measured from summer–fall. Overall catch by year indicates larvae were collected in low numbers consistently throughout the time series.



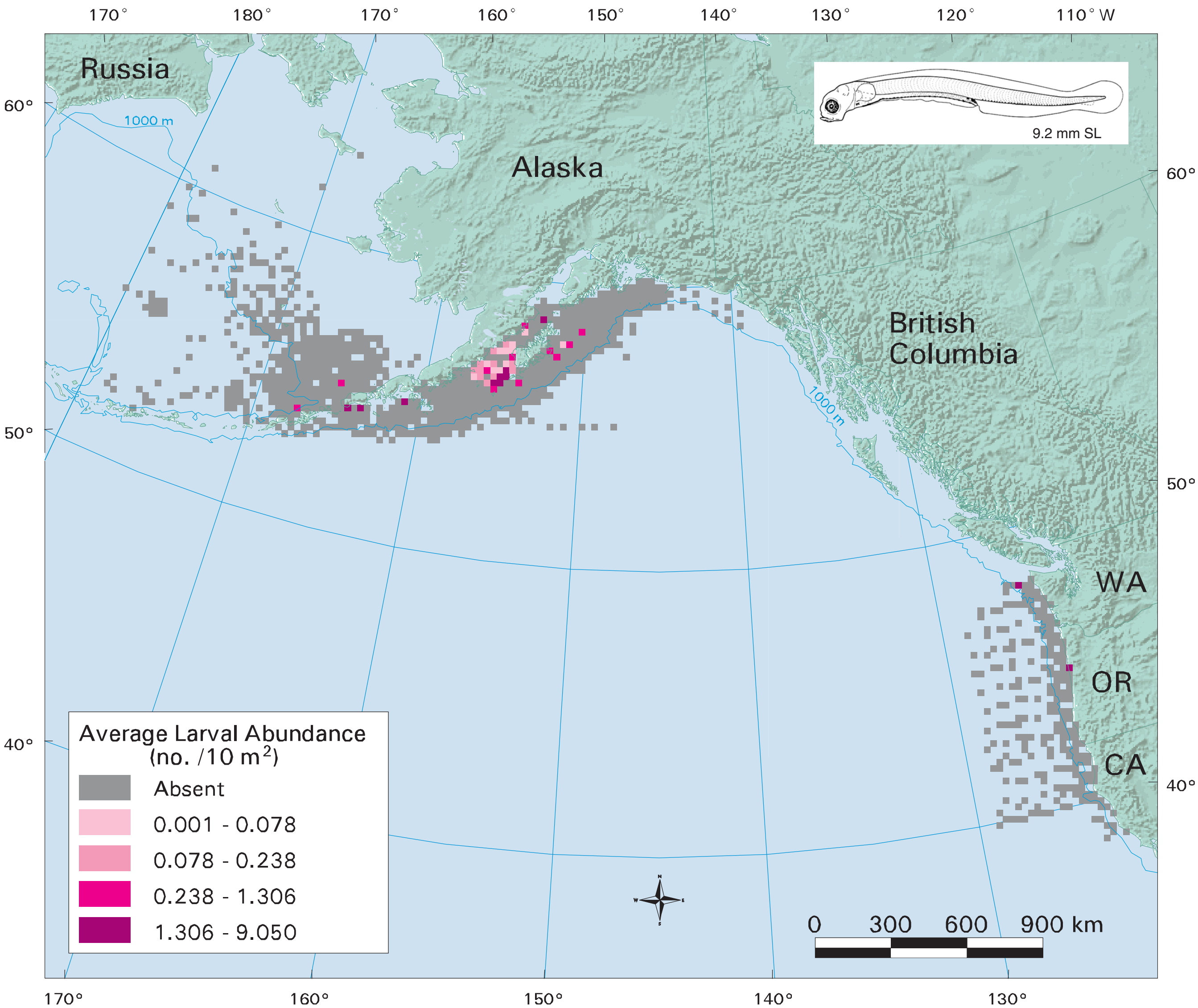
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

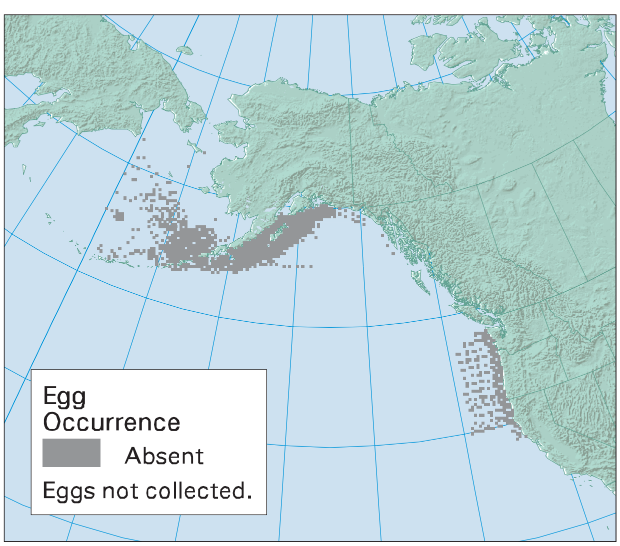


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 184 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this taxon occurred. Lower histogram: Percent of stations where taxon occurred. Black line indicates relative sampling effort.

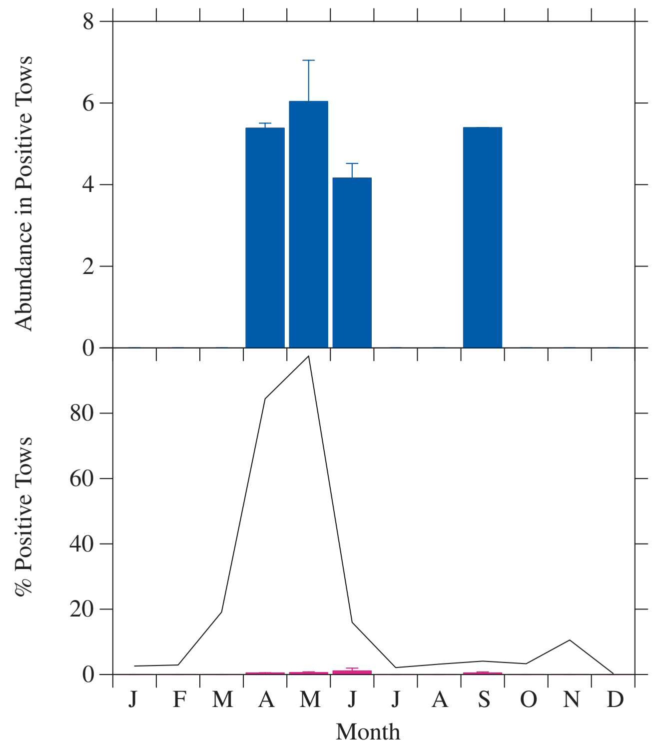

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
9.2 mm SL
Average Larval Abundance (no. /10 m2)
Absent
0.001 - 0.078
0.078 - 0.238
0.238 - 1.306
1.306 - 9.050
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

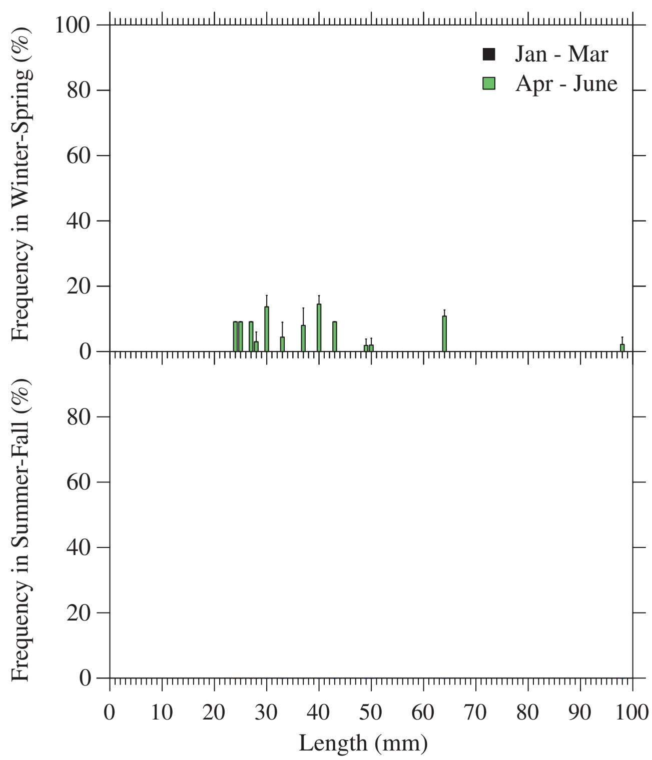

Adult Occurrence*
Present
(Occurrence only)

Life history *Ptilichthys goodei* are collected from the Bering Sea to Oregon. Adult quillfish are found along the nearshore shelf at depths of 0–80 m. Data on spawning and eggs are unknown, but larvae are pelagic with transformation occurring at sizes of about 114 mm SL. Larvae 20.3–36.0 mm SL have been collected 18 km from the coast of Oregon March–May.
[Sources include: Richardson and Dehart (1975), Matarese et al. (1989)]

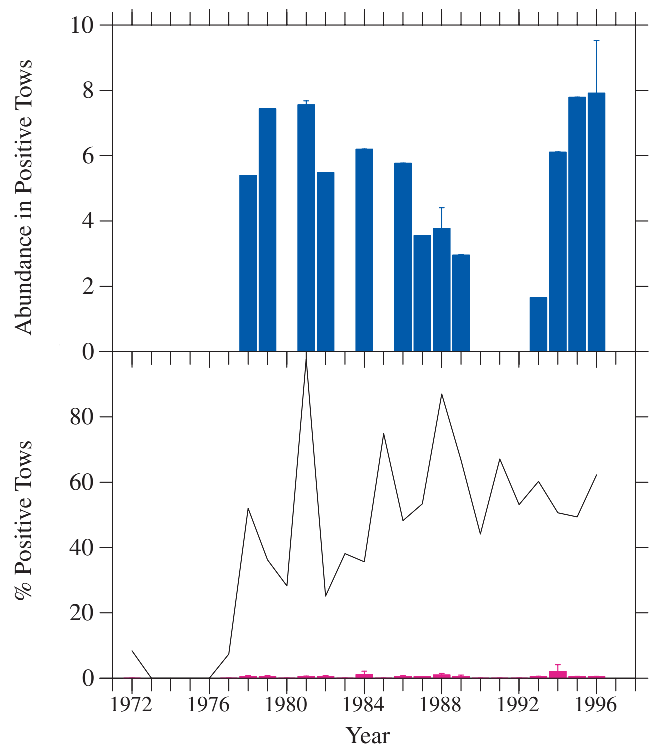
Larval distribution Quillfish larvae are infrequently found on the Bering Sea shelf near Unimak Pass, on the western Gulf of Alaska shelf along the Shelikof sea valley and around Kodiak Island, and along the U.S. west coast off Oregon. Adults have not been collected in AFSC surveys and available data on distribution patterns are limited. Larvae are most abundant southwest of Kodiak Island and are collected April–June and in September. Larvae and transitioning juveniles taken in winter–spring range in size from 25 to 140 mm SL. Larvae were uncommon, but consistently collected, throughout the time series from 1978 to 1996.



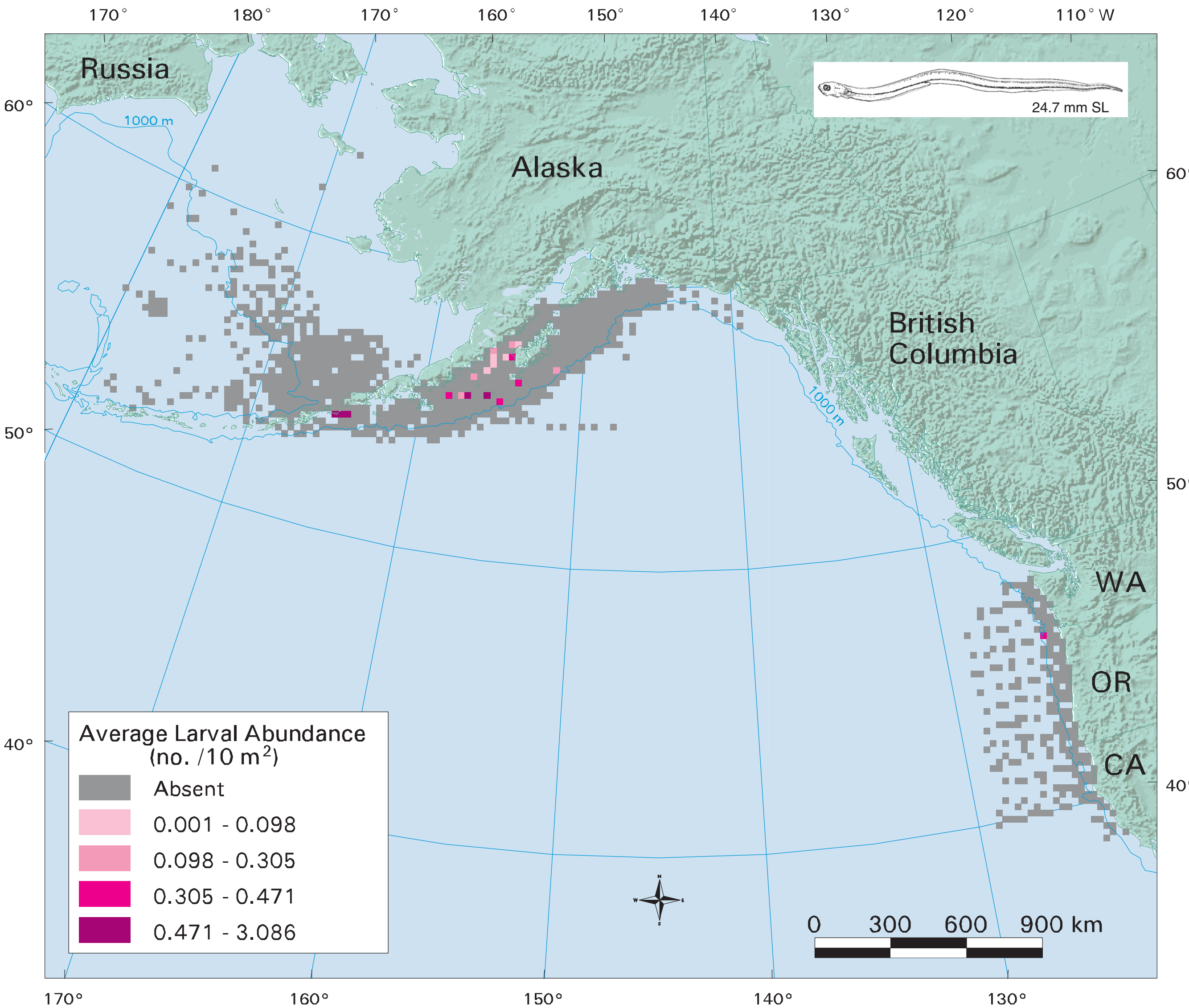
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

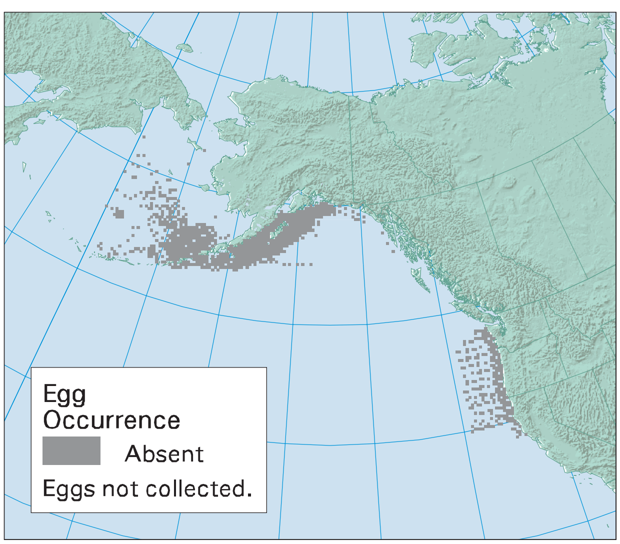


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 29 for winter–spring (Jan–June); 1 specimen >100 mm SL omitted.



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

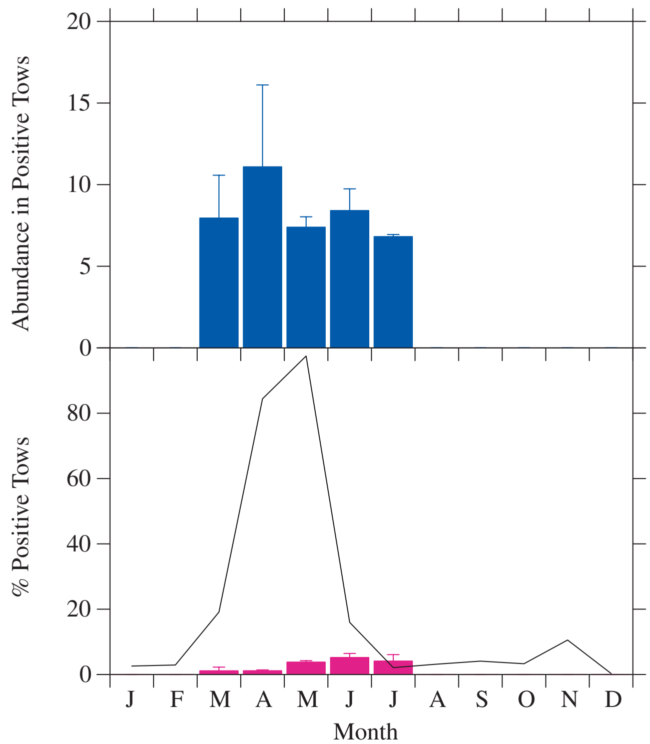

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
24.7 mm SL
60°
50°
40°
Average Larval Abundance (no. /10 m2)
Absent
0.001 - 0.098
0.098 - 0.305
0.305 - 0.471
0.471 - 3.086
0 300 600 900 km
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

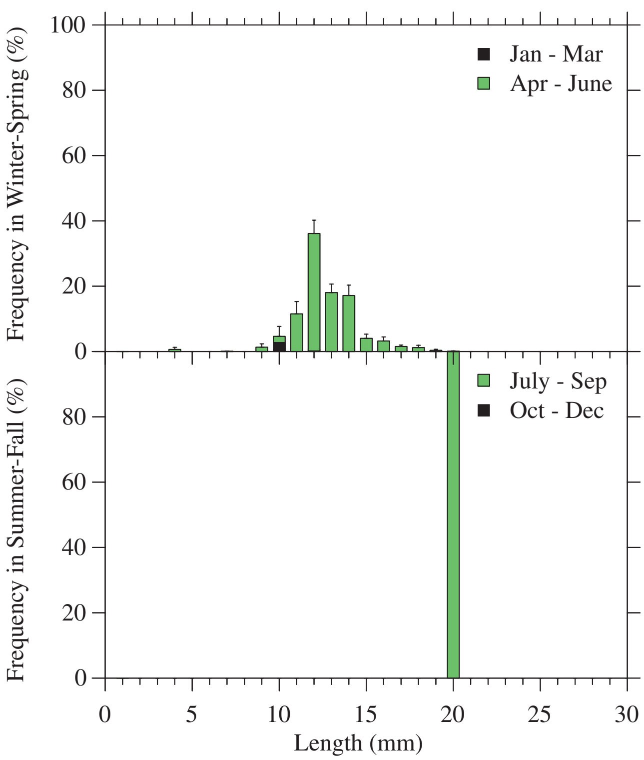

Adult Occurrence*
Present
(Occurrence only)

Life history *Zaprora silenus* are found from the Bering Sea to central California. Prowfish are benthic and occur at depths of 10–675 m. Adults grow to 88 cm TL; males are known to live up to 4 years. Larvae are pelagic and transform at about 30 mm SL. Larvae and juveniles up to 72 mm TL have been taken in plankton nets off the coast of British Columbia at depths of 29–357 m and have been found associated with jellyfish.
[Sources include: Hart (1973), Matarese et al. (1989)]

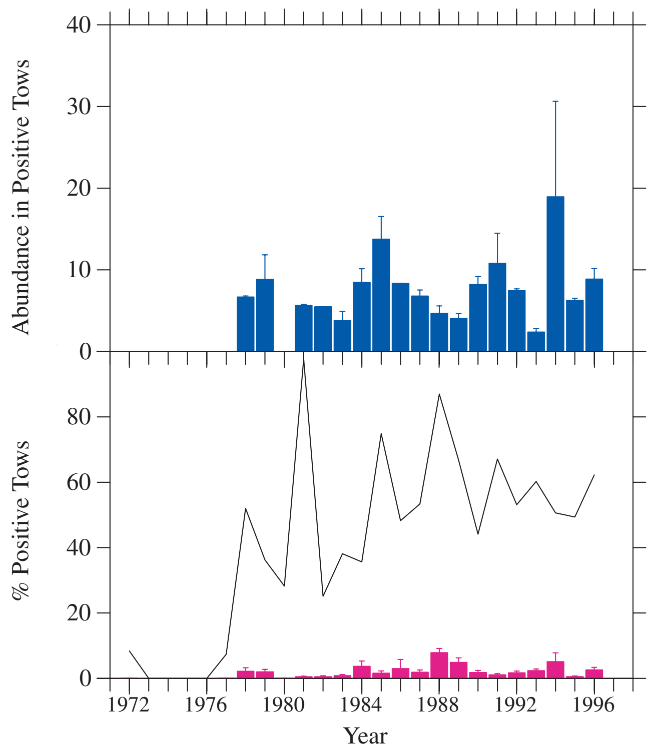
Larval distribution Prowfish larvae are collected in the Bering Sea, along the Alaska Peninsula, and southwest and northeast of Kodiak Island in the Gulf of Alaska. Although adults are present along the U.S. west coast during AFSC surveys, larvae have not been collected there. Larvae are most abundant along the outer shelf edges and consistently collected March–July. Most newly hatched and young larvae occur in winter–spring at sizes 4–19 mm SL. Overall catch by year indicates larvae were consistently collected in relatively low numbers throughout the time series.



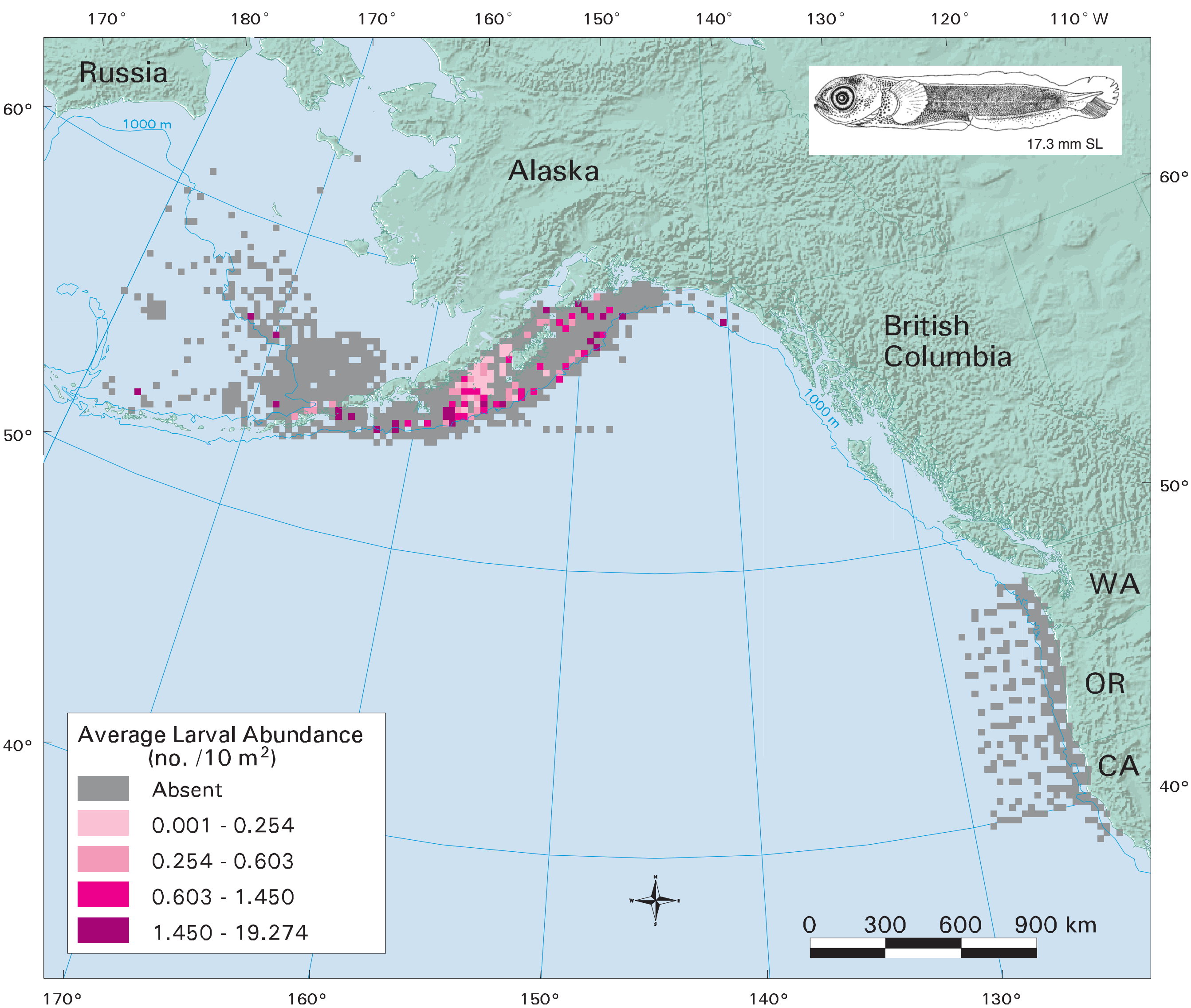
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

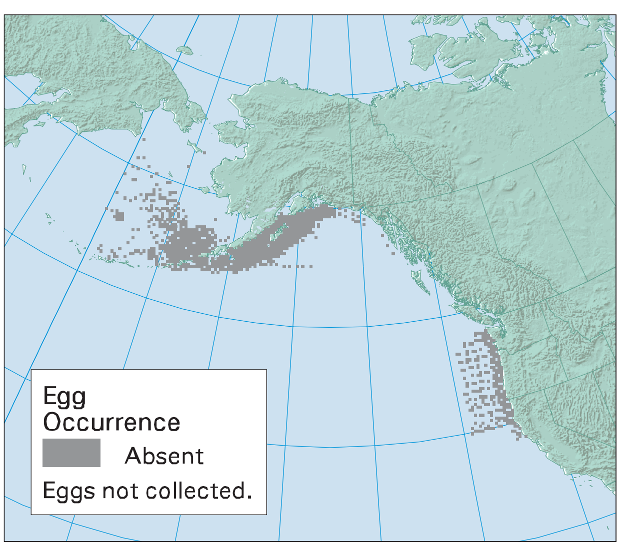


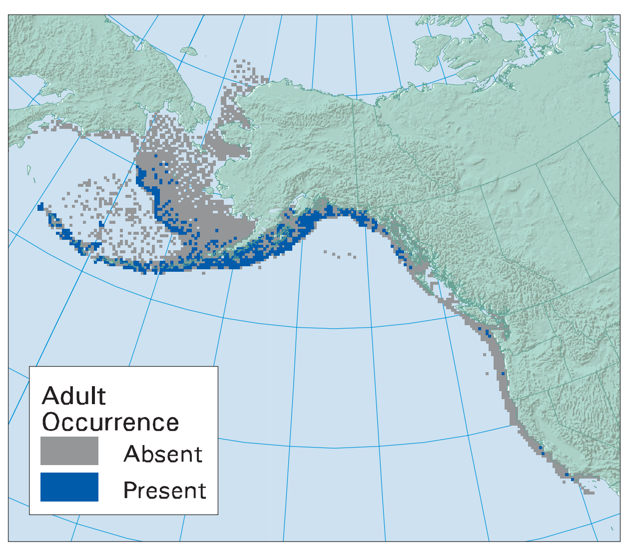
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 262 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

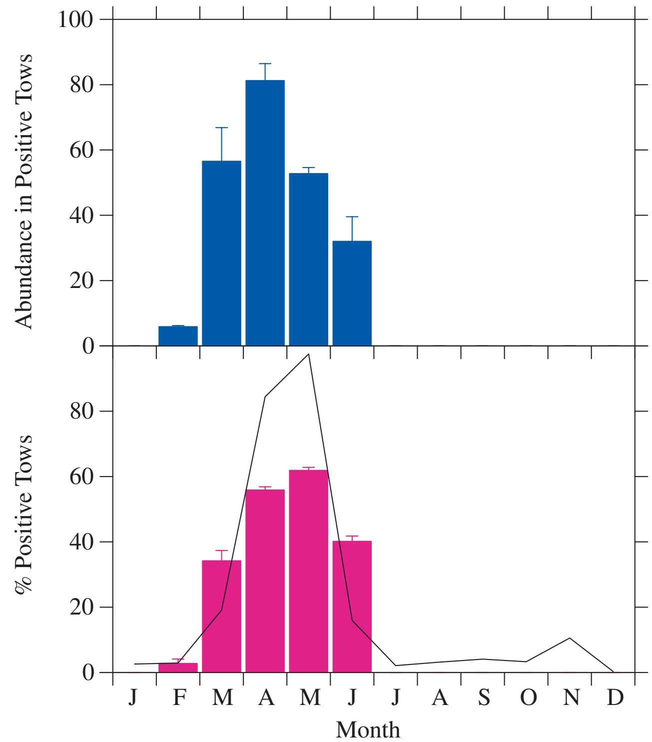

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
17.3 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.254
0.254 - 0.603
0.603 - 1.450
1.450 - 19.274
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

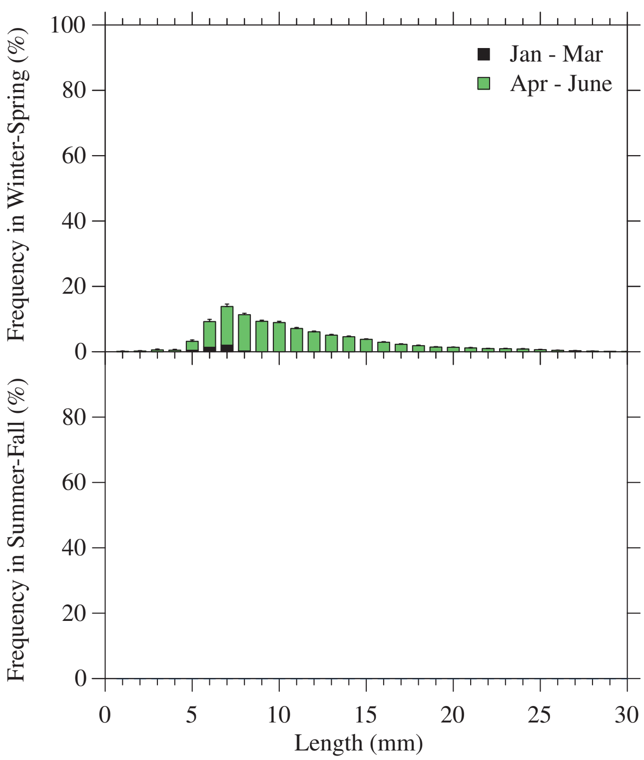

Adult Occurrence
Absent
Present

Life history *Ammodytes hexapterus* occupy a variety of habitats from the Arctic Ocean to southern California. Pacific sand lance are as likely to be swimming in large offshore schools as they are to be almost completely buried in beach sand. Females mature at 1 year and deposit up to 20,000 demersal, adhesive eggs (0.80 mm in diameter) each season; spawning occurs in areas of strong tidal currents November–February. Pelagic larvae hatch at 6–7 mm SL and transform into juveniles at 50–80 mm SL. Larvae and early juveniles >25 mm SL have been reported to be abundant in neuston collections in both AFSC Gulf of Alaska and U.S. west coast surveys. [Sources include: Hart (1973), Matarese et al. (1989), Doyle (1992), Doyle et al. (1995), Doyle[2]]

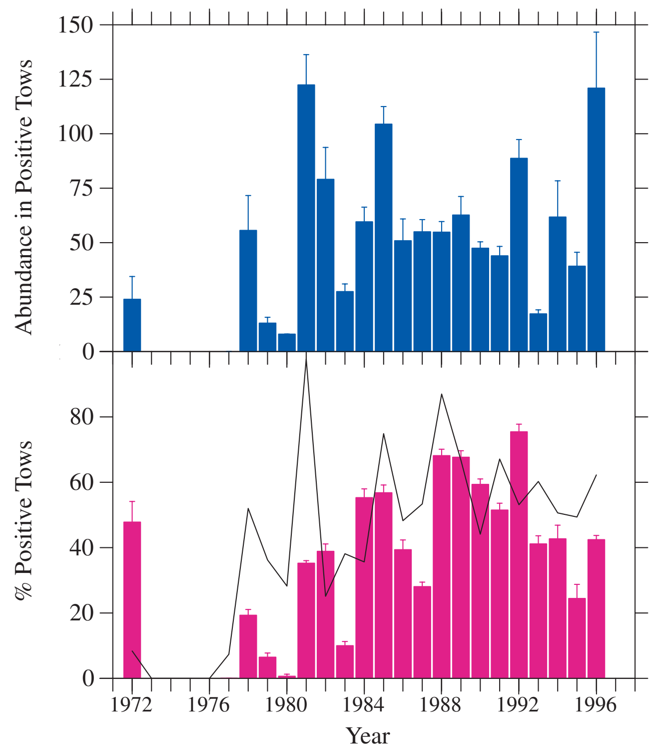
Larval distribution Pacific sand lance larvae occur primarily over the Bering Sea shelf, eastward into the Gulf of Alaska, and off Washington and Oregon. Adults have rarely been collected during AFSC surveys off the U.S. west coast. Highest abundances are found in Unimak Pass to Shelikof Strait and sea valley, and around Kodiak Island. Larvae are collected February–June, with highest abundances in spring. Early larvae (5–15 mm SL) are most abundant, but newly hatched and larger larvae (up to 25 mm SL) are also collected. Overall catch by year indicates that larvae were abundant and were routinely collected throughout the time series.



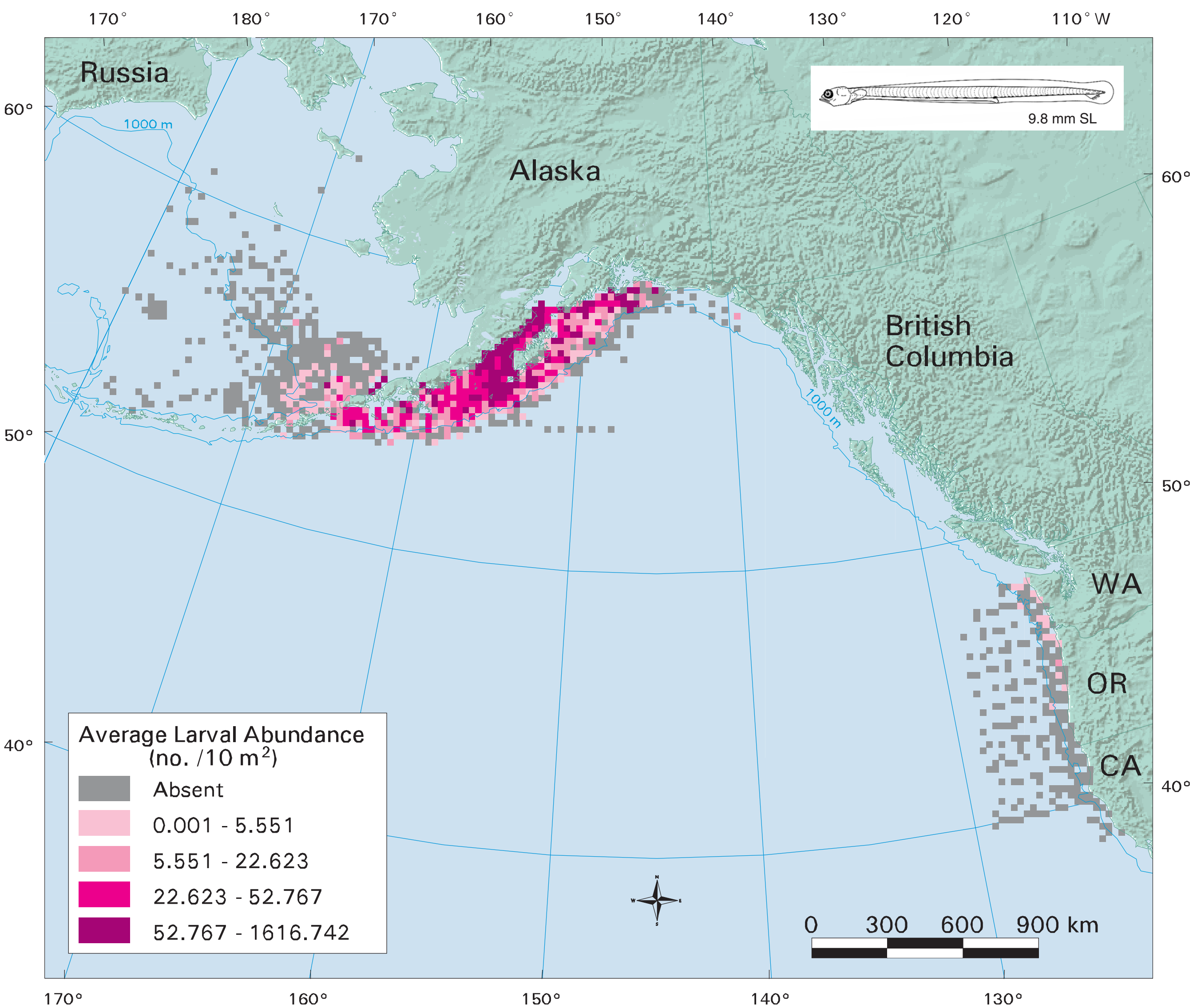
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

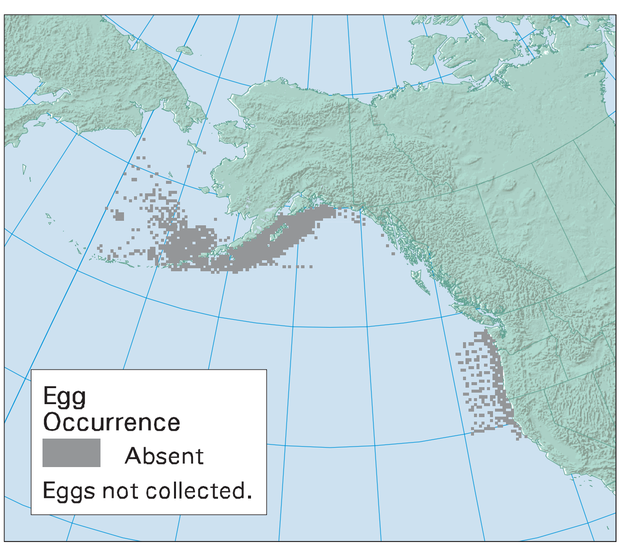


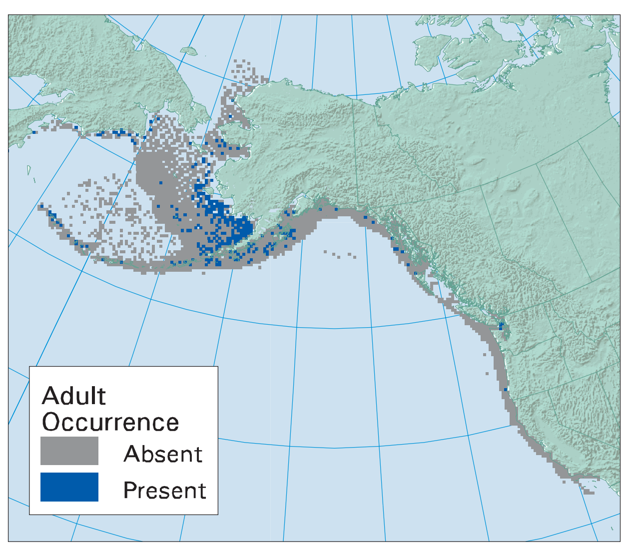
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 43,395 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

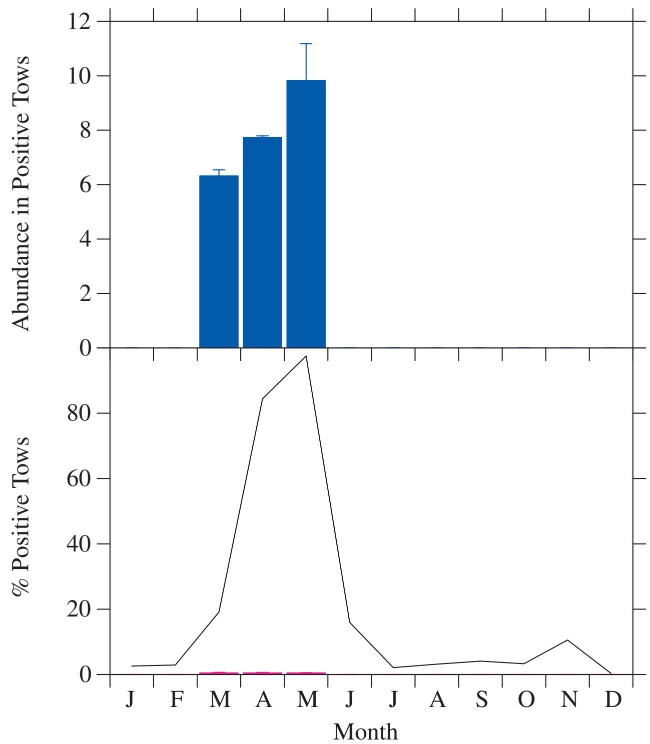

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British
Columbia
1000 m
WA
OR
CA
9.8 mm SL
Average Larval Abundance
(no. /10 m2)
Absent
0.001 - 5.551
5.551 - 22.623
22.623 - 52.767
52.767 - 1616.742
0
300
600
900 km
170°
160°
150°
140°
130°


Egg
Occurrence
Absent
Eggs not collected.

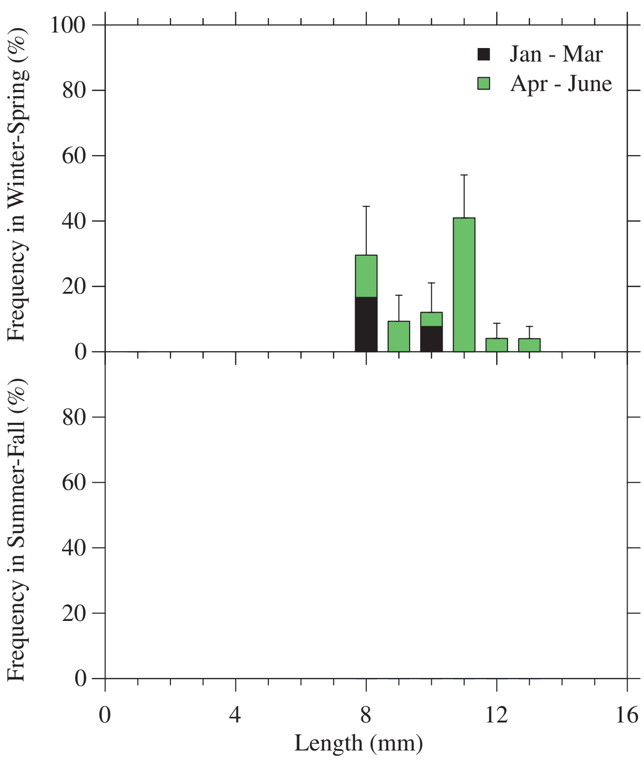

Adult
Occurrence
Absent
Present

Life history *Icosteus aenigmaticus* are found in the North Pacific Ocean from Japan eastward to the Bering Sea and along the U.S. west coast to southern California. Ragfish adults reside in the deeper shelf waters in the epi- and mesopelagic zones of the North Pacific. Spawning takes place in winter–spring when they spawn large eggs (2.8–3.1 mm in diameter) with a single large oil globule (0.42–0.60 mm, initially). Larvae hatch at about 6.5 mm SL, undergo notochord flexion at 11–17 mm SL, and undergo transformation at sizes >28.5 mm SL. In the CalCOFI area, eggs and larvae occasionally occur in small numbers primarily north of Point Conception, California, seaward of the shelf January–May.
[Sources include: Matarese et al. (1989), Watson (1996e)]

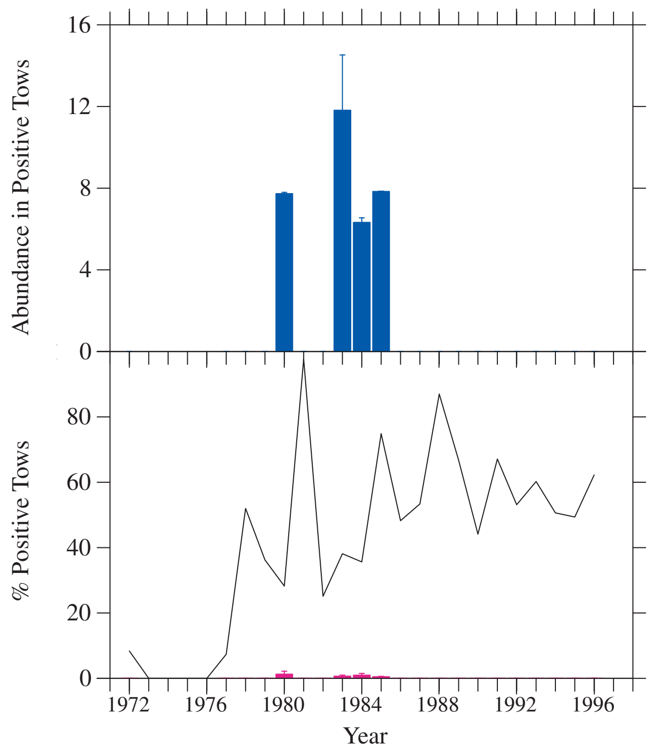
Larval distribution Ragfish larvae are collected from the U.S. west coast off Washington and Oregon. Larvae are most abundant offshore in oceanic waters. They occur in late winter and spring March–May and range in size from 7 to 13 mm SL. Although larvae have not been collected in the Bering Sea and Gulf of Alaska where adults have been found during AFSC adult surveys, eggs have been collected west of Unimak Pass in the Bering Sea. Eggs are very abundant throughout the U.S. west coast. Although larvae were uncommon, catch by year indicates that larvae were collected more frequently in the early 1980s when AFSC conducted U.S. west coast surveys.



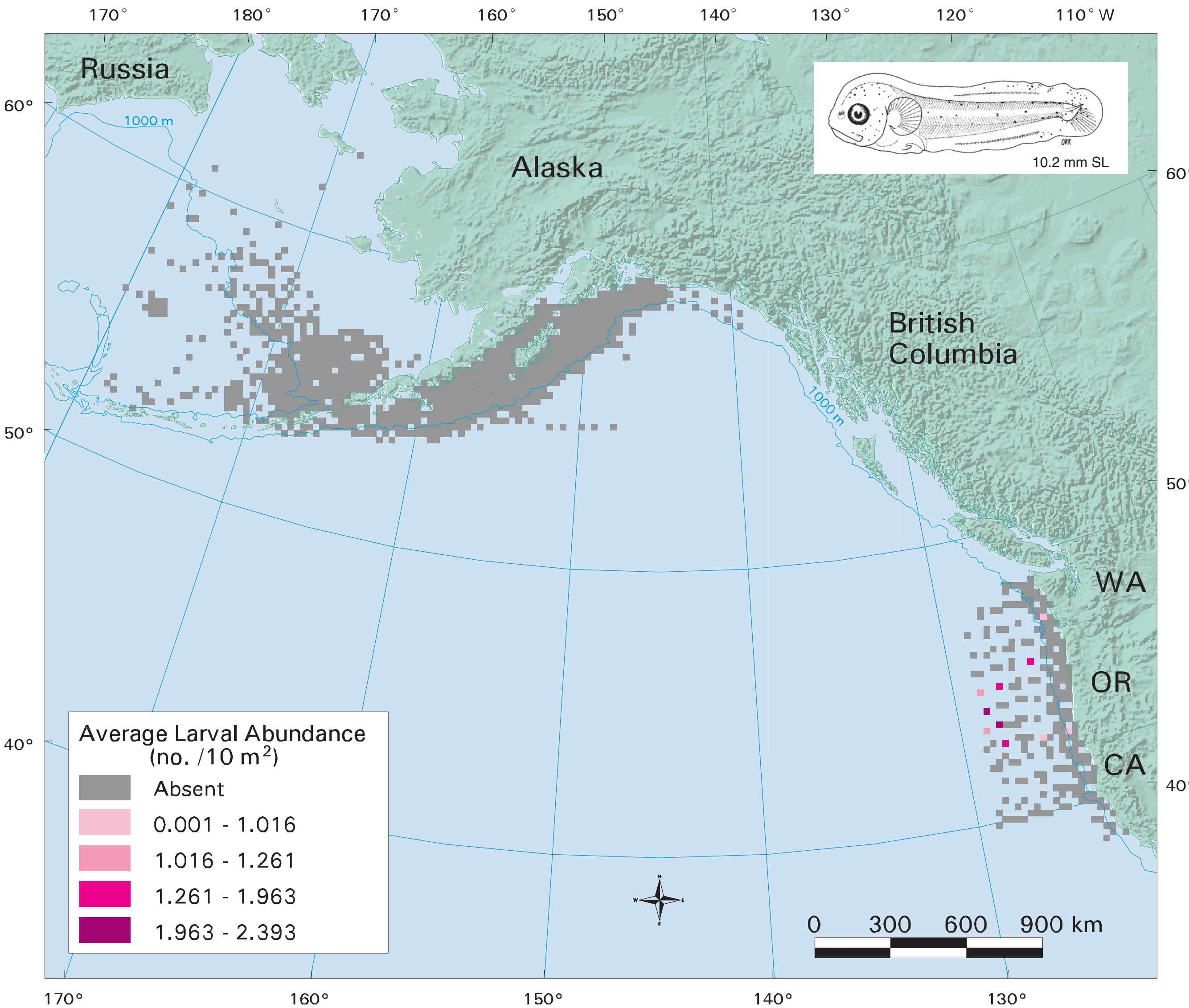
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

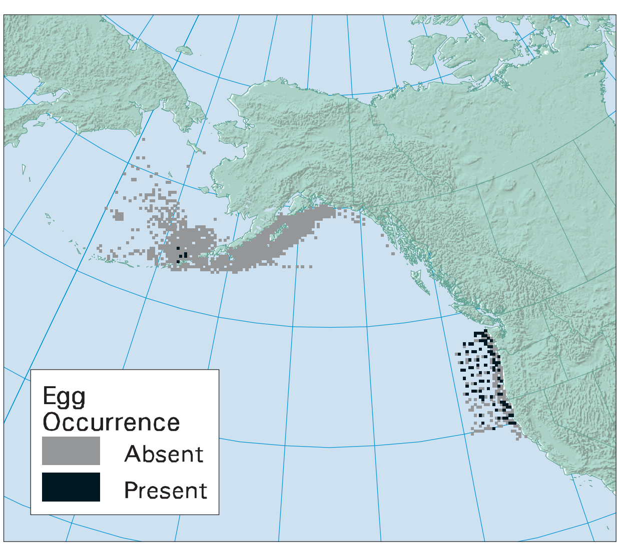


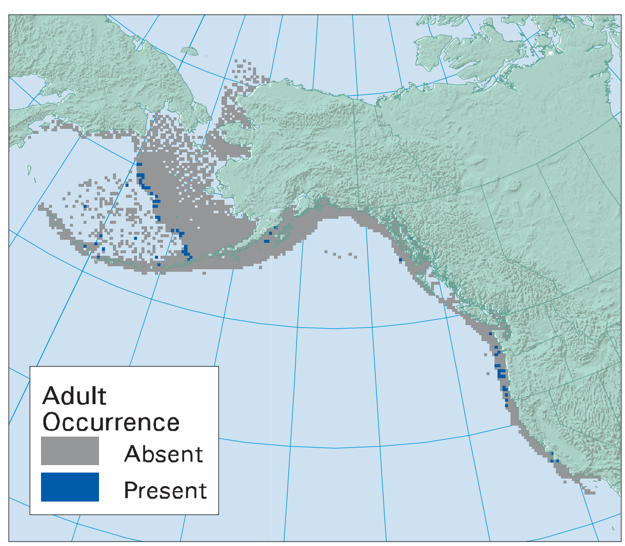
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 12 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

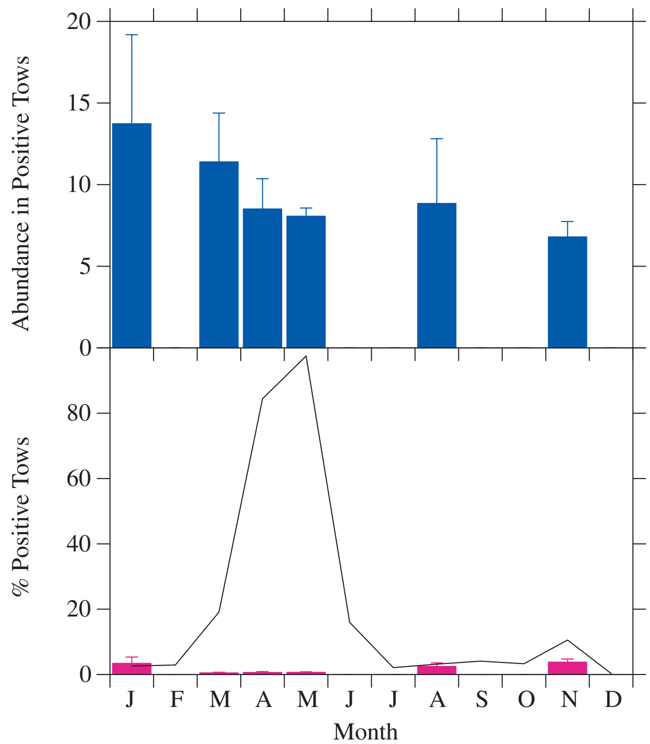

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
10.2 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 1.016
1.016 - 1.261
1.261 - 1.963
1.963 - 2.393
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

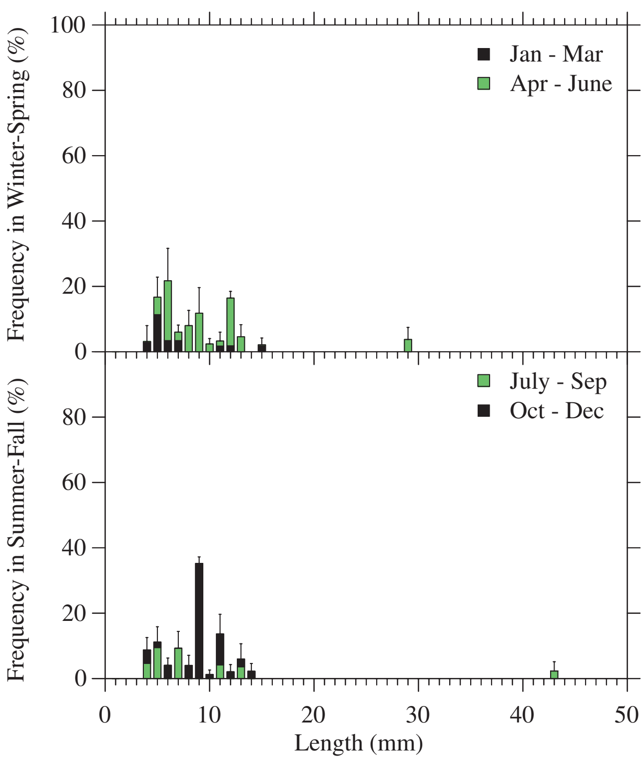

Adult Occurrence
Absent
Present

Life history *Icichthys lockingtoni* are widely distributed in the North Pacific Ocean; in the eastern Pacific they are found from the Gulf of Alaska to southern Baja California. Medusafish are epipelagic and are usually found at depths of 0–100 m. Pelagic eggs, common in AFSC U.S. west coast neuston collections, are 1.52–1.80 mm in diameter with one oil globule. Larvae hatch at about 4 mm SL, undergo notochord flexion at 9.0–13.5 mm SL, and transform at 19–20 mm SL. In the CalCOFI region, eggs and larvae are collected throughout the year. More abundant 50–200 nautical miles from shore, larvae are most abundant in spring and summer with March and June–July peaks.
[Sources include: Matarese et al. (1989), Doyle (1992), Moser et al. (1993), Watson (1996f), Doyle[2]]

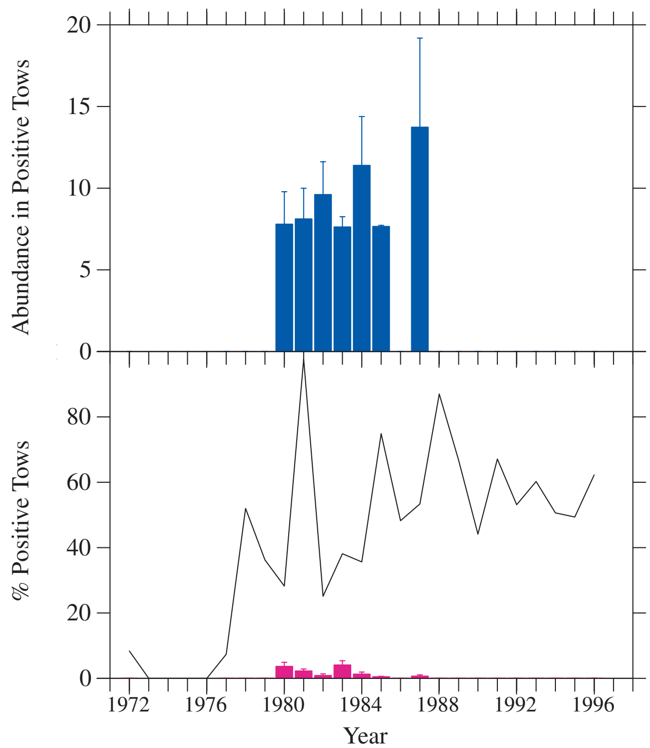
Larval distribution Medusafish larvae are distributed off the U.S. west coast from Washington to California. Adults are not collected in AFSC surveys and available data on distribution patterns is limited (Puget Sound to California). Larvae are more abundant along the shelf edge and over deep oceanic waters, and are collected intermittently throughout the year January–November. Winter–spring larvae range in size from 4 to 15 mm SL with one larger juvenile (29 mm SL) collected; similarly, summer–fall larvae range in size from 4 to 14 mm SL with one larger juvenile (43 mm SL) collected. Although larvae have not been collected in the Gulf of Alaska, eggs have been found southwest of Kodiak Island. Eggs are abundant inshore as well as offshore along the U.S. west coast. Eggs and larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



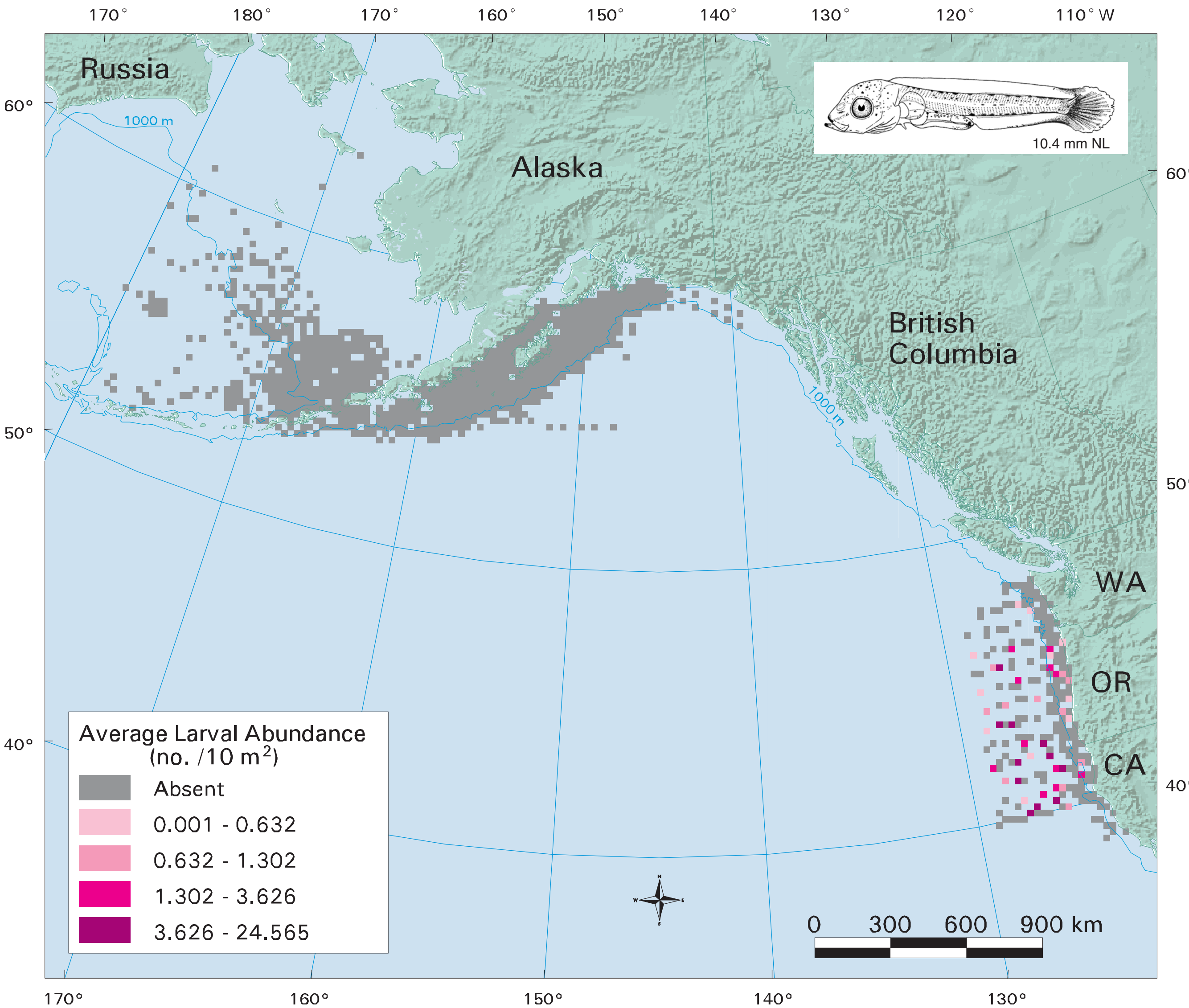
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

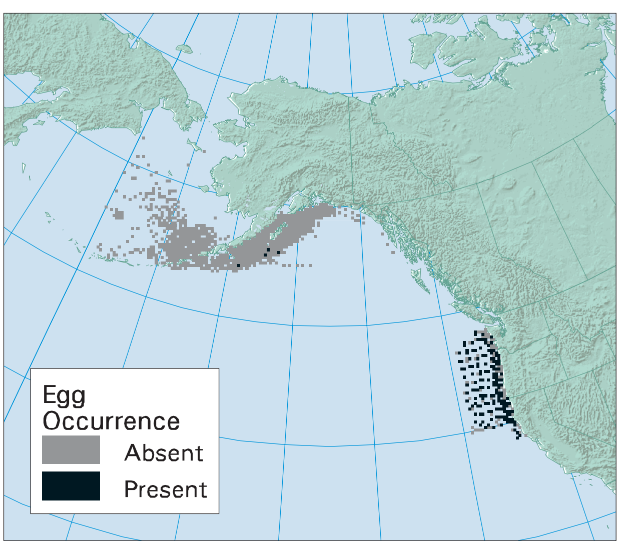


Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 32 for winter–spring (Jan–June), 26 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

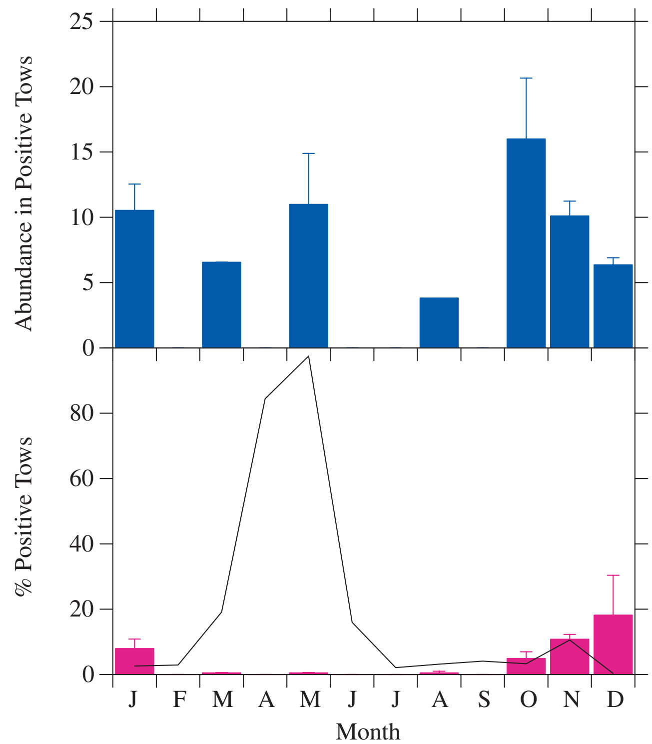

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
170°
160°
150°
140°
130°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
10.4 mm NL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.632
0.632 - 1.302
1.302 - 3.626
3.626 - 24.565
0 300 600 900 km


Egg Occurrence
Absent
Present

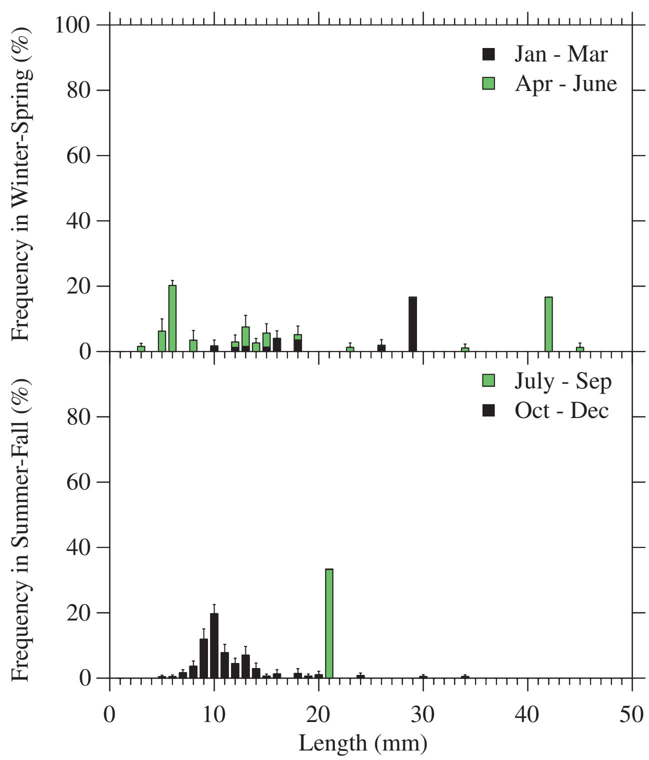

Adult Occurrence*
Present
(Occurrence only)

Life history *Citharichthys sordidus* occur from the Bering Sea to southern Baja California. Pacific sanddab adults are epi-, meso-, and bathybenthic, inhabiting areas with sandy bottoms to depths of >500 m. Data from CalCOFI surveys indicate a broad spawning period with peaks in summer or fall. Eggs are pelagic, small (0.78–0.84 mm in diameter), and possess a single oil globule. *Citharichthys* spp. eggs are collected in our study area, but not identified to species; based on Moser and Sumida (1996), most of our eggs are probably *C. sordidus.* Larvae hatch at sizes <2.6 mm SL, undergo notochord flexion at 9.3–11.2 mm SL, and transform at 25–40 mm SL. Larvae are collected year-round in the CalCOFI area, with abundance peaks in January–February and August–October.
[Sources include: Matarese et al. (1989), Moser and Sumida (1996)]

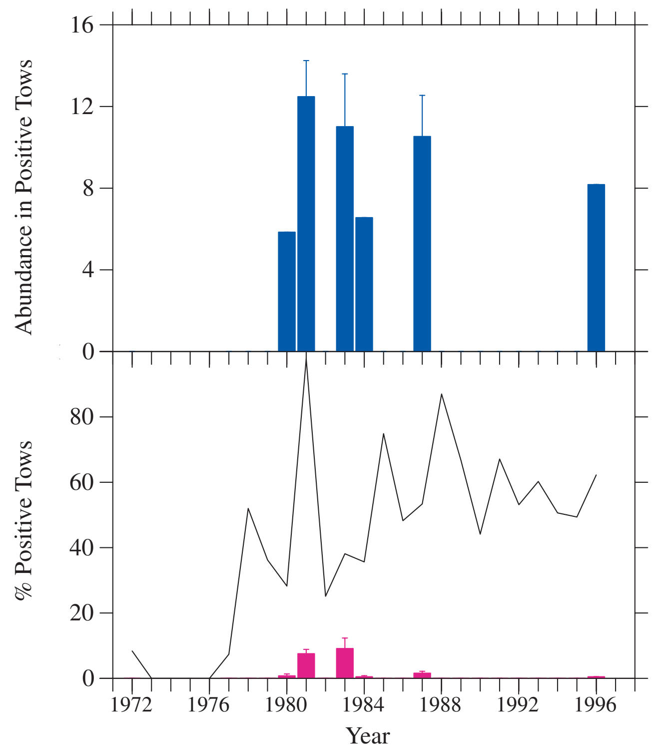
Larval distribution Pacific sanddab larvae are collected from Shelikof Strait in the Gulf of Alaska (rarely) and along the U.S. west coast. Larvae are most abundant in the outer shelf and deep oceanic waters off the Oregon and California coasts. Larvae occur sporadically throughout the year, but are more abundant in fall and winter months (November–January). The majority of larvae in summer–fall are newly hatched and small (<15 mm SL), whereas larvae from winter–spring generally occur over a wide range of sizes (3–45 mm SL). Larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



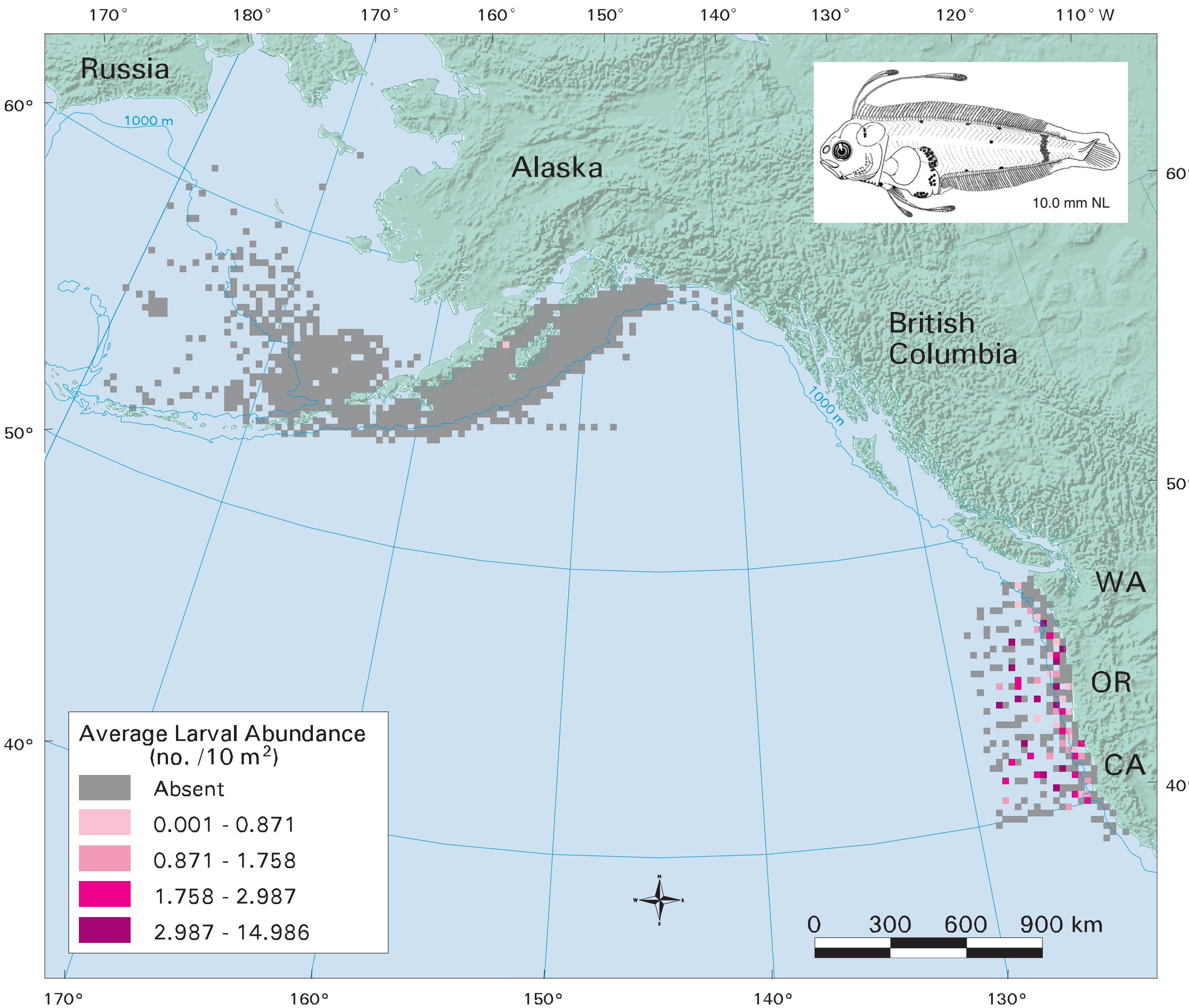
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

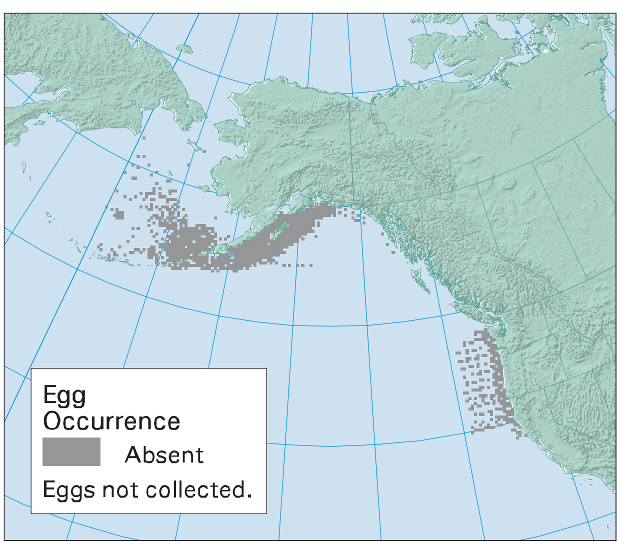


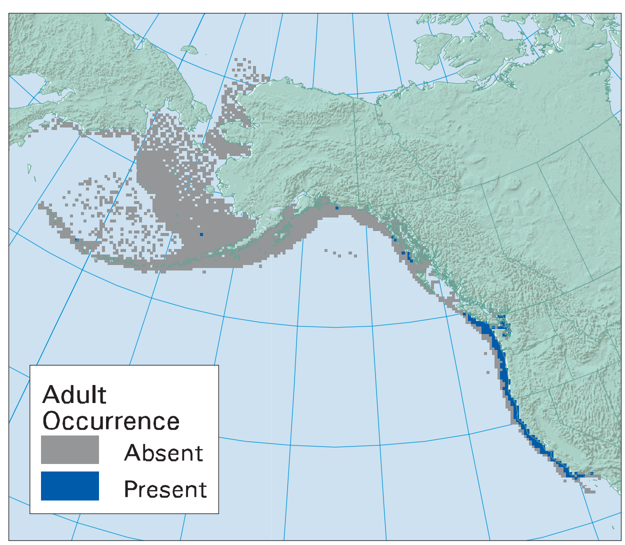
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 35 for winter–spring (Jan–June), 92 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

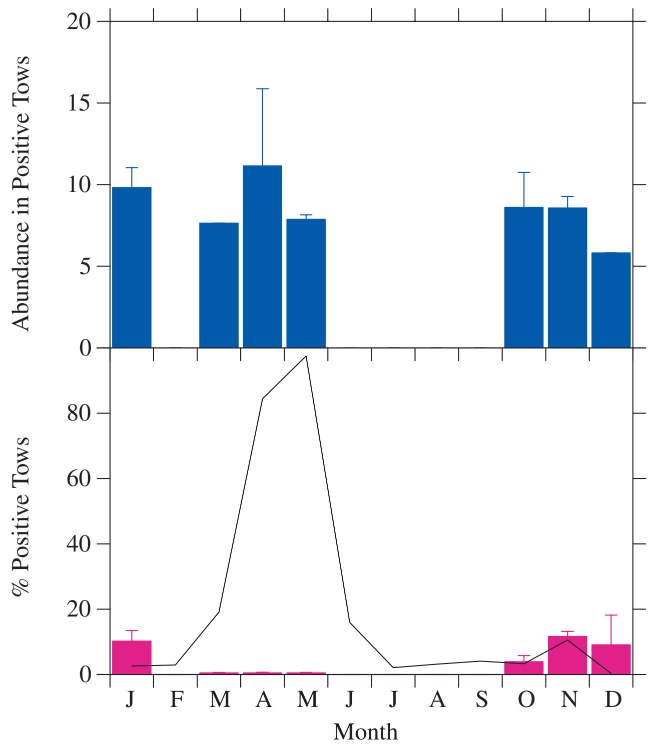

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.0 mm NL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 0.871
0.871 - 1.758
1.758 - 2.987
2.987 - 14.986
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

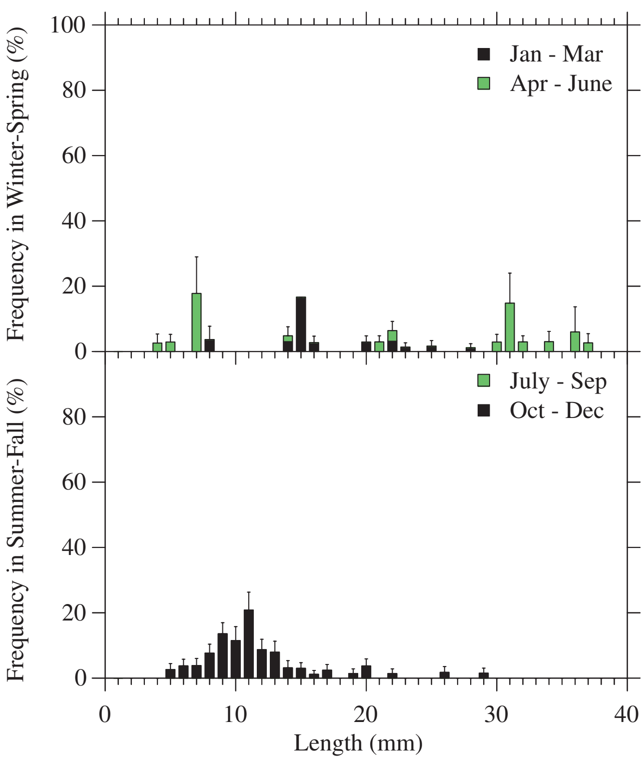

Adult Occurrence
Absent
Present

Life history *Citharichthys stigmaeus* are found from Southeast Alaska to southern Baja California. Speckled sanddab adults occur on sandy bottoms on shelf and slope areas to depths of 366 m, but are usually in water <90 m. They also reside in bays and estuaries. Data from CalCOFI surveys indicate a broad spawning period with peaks in summer or fall. Eggs are pelagic, small (0.62–0.66 mm in diameter), and possess a single oil globule. *Citharichthys* spp. eggs are collected in our study area, but not identified to species; based on Moser and Sumida (1996), most of our eggs are probably *C. sordidus*. Larvae hatch at very small sizes (about 1.3 mm SL), undergo notochord flexion at 9.3–10.5 mm SL, and transform at 24–38 mm SL. Larvae are collected year-round in the CalCOFI area, with highest abundance August–December and a peak in October.
[Sources include: Matarese et al. (1989), Moser and Sumida (1996)]

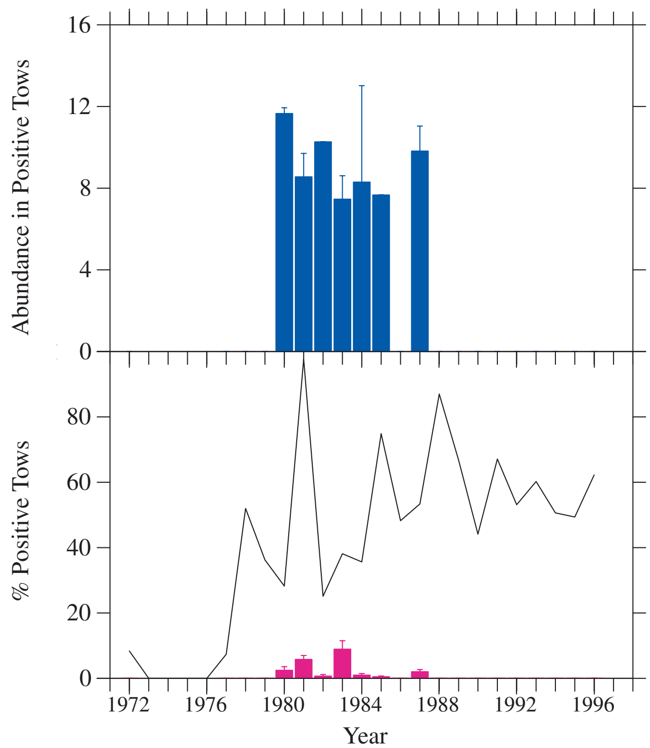
Larval distribution Speckled sanddab larvae are collected along the shelf area southwest of Kodiak Island in the Gulf of Alaska and off the U.S. west coast. Larvae are most abundant in the outer shelf and deep oceanic waters off the Washington, Oregon, and California coasts. Larvae occur in the fall, winter, and early spring and are not collected in late spring or summer. The majority of larvae in the fall are newly hatched and small (<15 mm SL), whereas larvae from winter–spring generally occur over a wide range of sizes (5–37 mm SL). Overall, larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



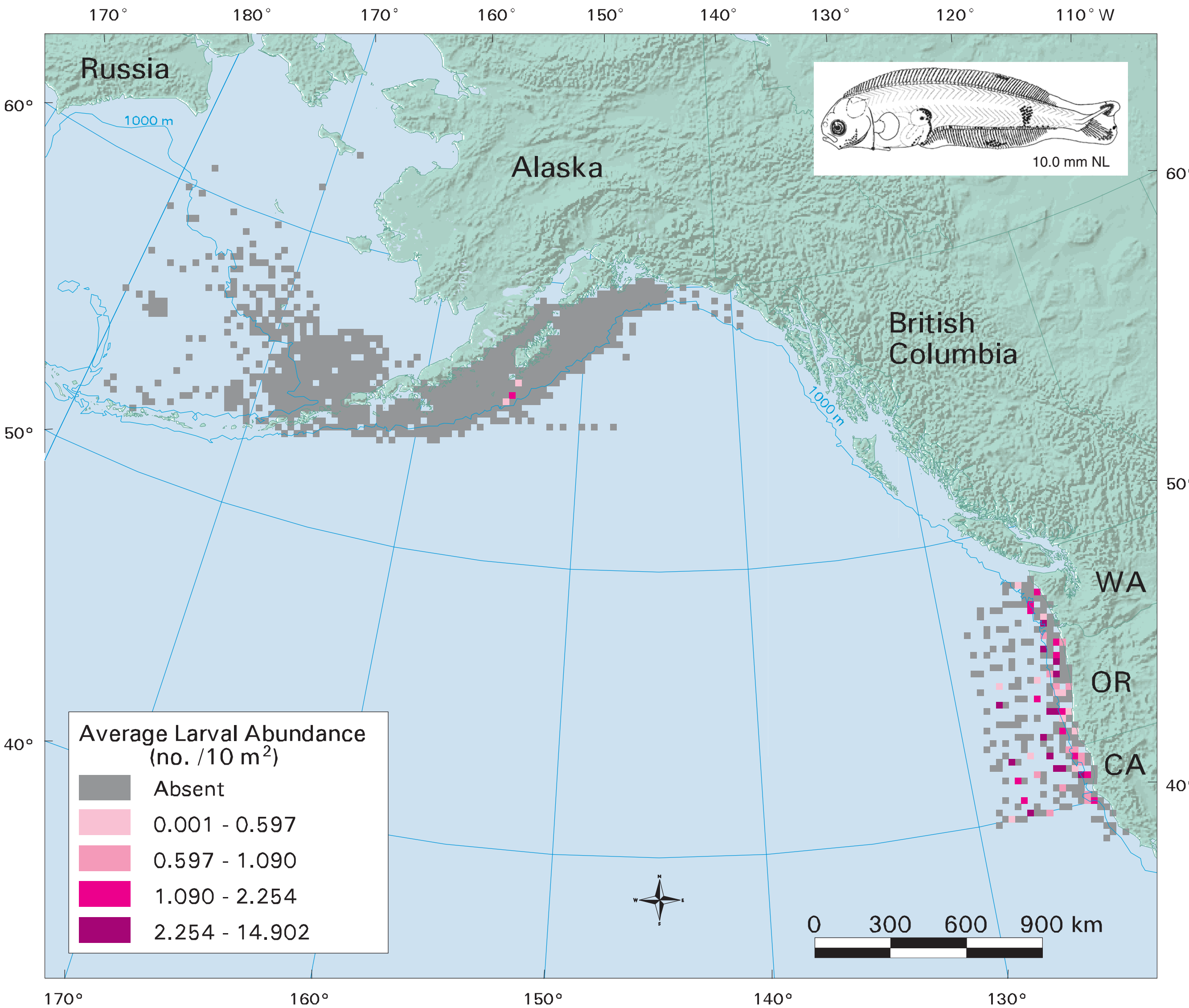
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

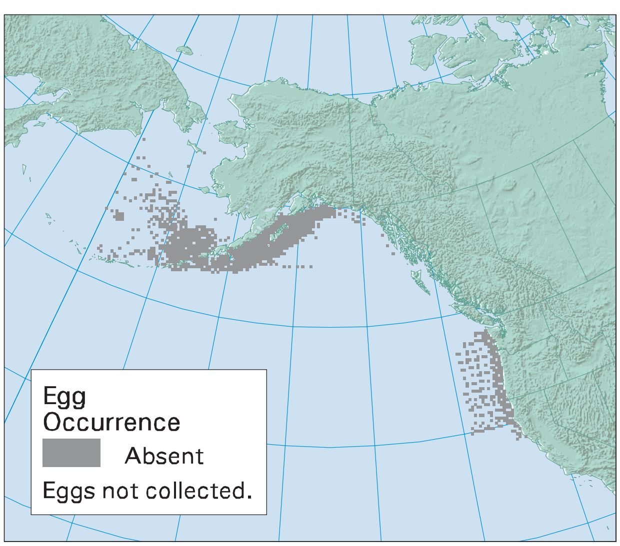


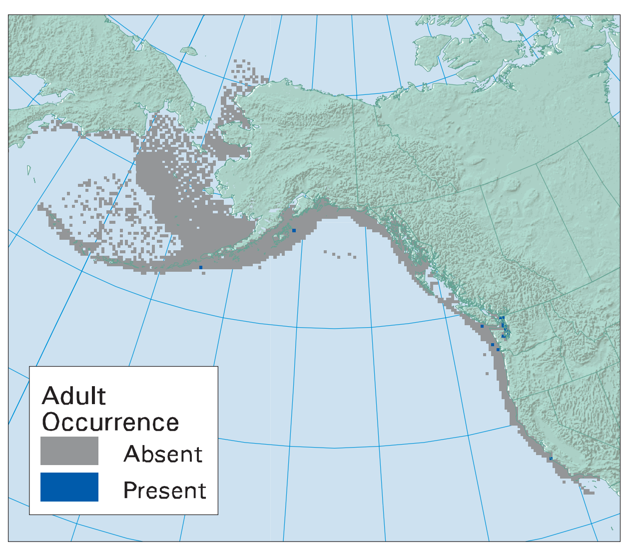
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 29 for winter–spring (Jan–June), 77 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

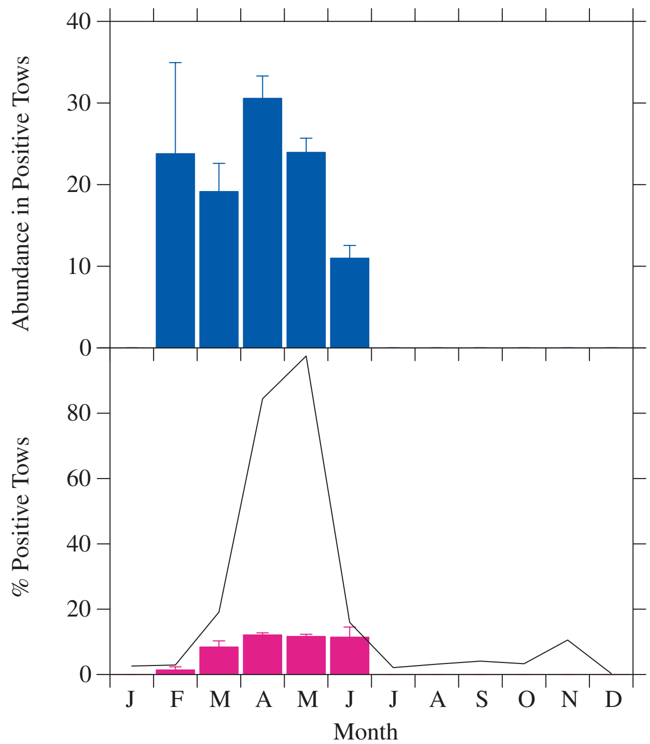

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
10.0 mm NL
British Columbia
1000 m
WA
OR
CA
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 0.597
0.597 - 1.090
1.090 - 2.254
2.254 - 14.902
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

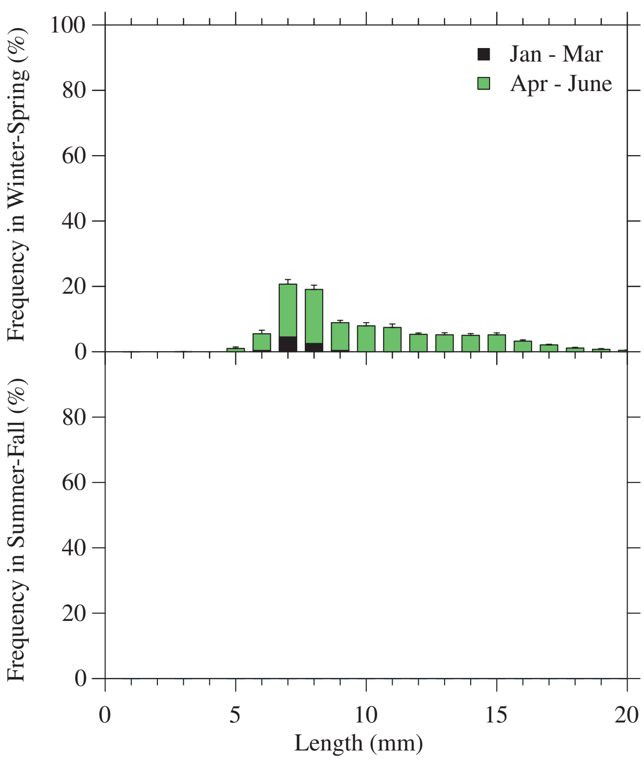

Adult Occurrence
Absent
Present

Life history *Atheresthes stomias,* found from the Bering Sea to central California, are the most abundant groundfish species in the Gulf of Alaska. Arrowtooth flounder adults inhabit areas with soft muddy bottoms up to 900 m deep and may live up to 23 years. Spawning takes place December– March in the Bering Sea; Gulf of Alaska fish spawn after September. Although eggs are pelagic, they are most likely in deeper waters than we routinely sample (depths >200 m), and thus far have not been identified. Pelagic larvae hatch at about 5 mm SL and transform into juveniles at 25.6–44 mm SL. *Atheresthes* spp. larvae are unique among pleuronectids in this region by having preopercular and supraocular spines. *Atheresthes stomias* larvae cannot be distinguished from *A. evermanni*, which occur from the Sea of Japan and eastward to the Bering Sea, Aleutian Islands, and to Shelikof Strait at depths of 33–1100 m. Larvae of *A. evermanni* have not been collected in the Gulf of Alaska.
[Sources include: Allen and Smith (1988), Matarese et al. (1989), Zimmerman (1997), Turnock et al. (2000)]

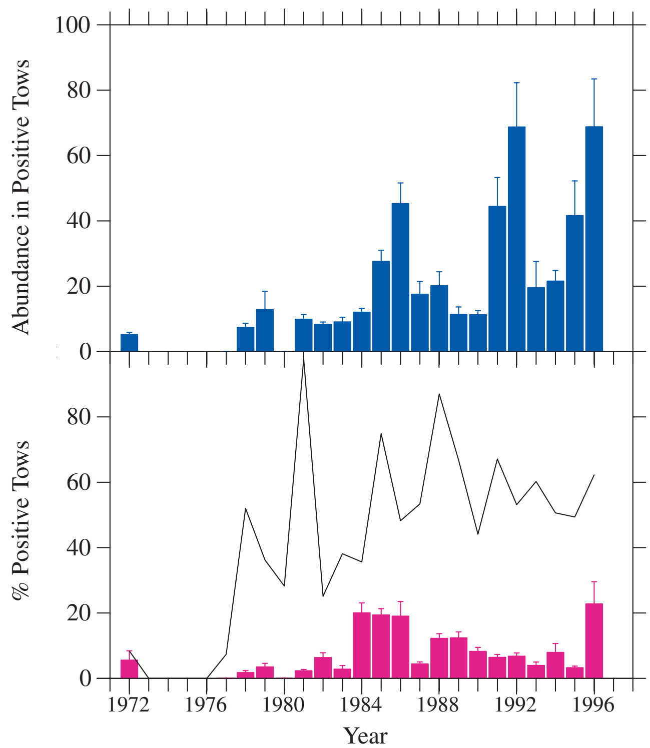
Larval distribution Arrowtooth flounder larvae are collected in the western Gulf of Alaska, around Kodiak Island, and along the U.S. west coast off Washington and Oregon. Highest abundances of larvae occur in the Gulf of Alaska along the shelf edge and over deeper waters. They are infrequently collected along the U.S. west coast. Larvae (newly hatched to up to 20 mm SL) occur in winter–spring collections and were consistently found in most years throughout the time series.



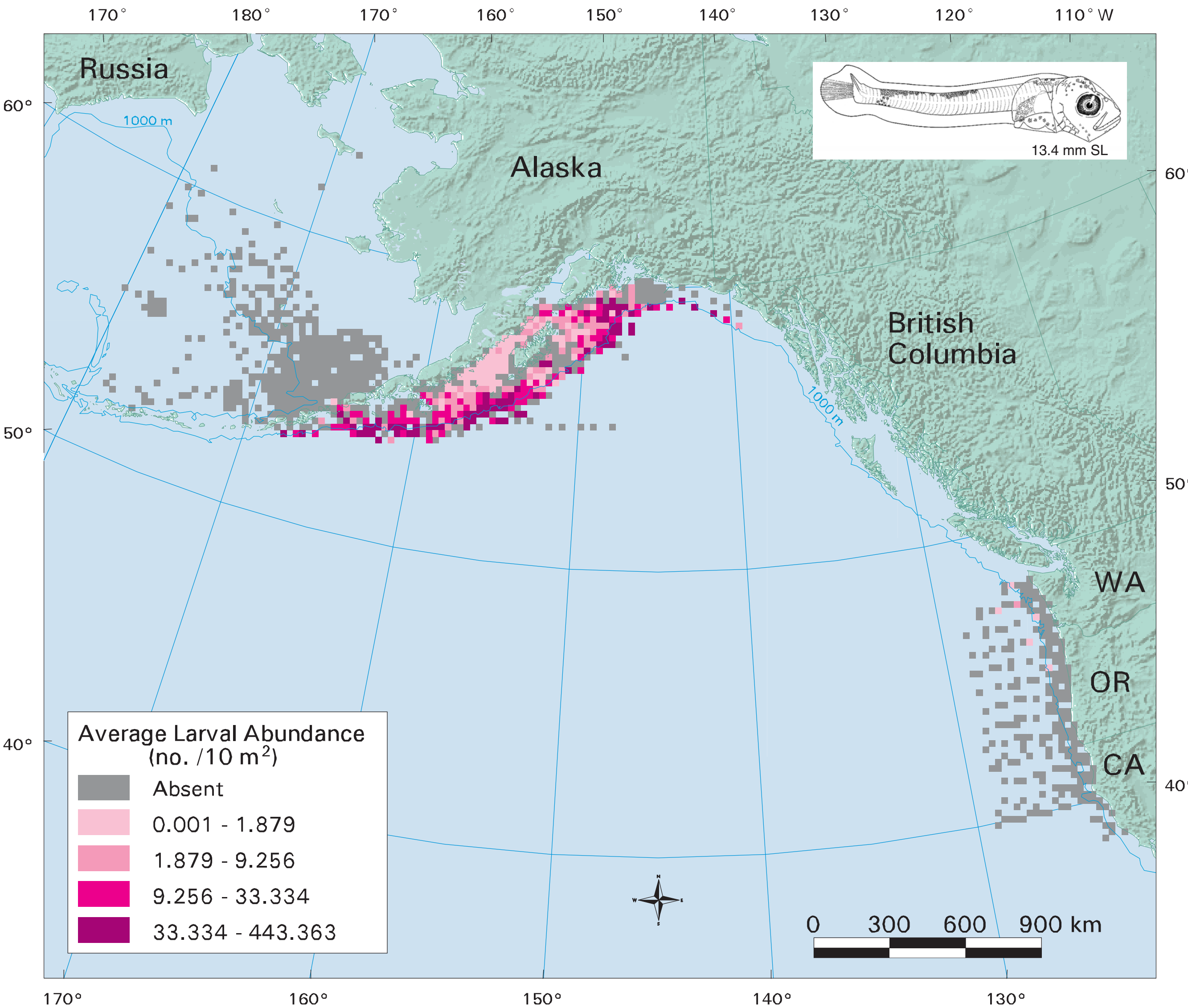
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

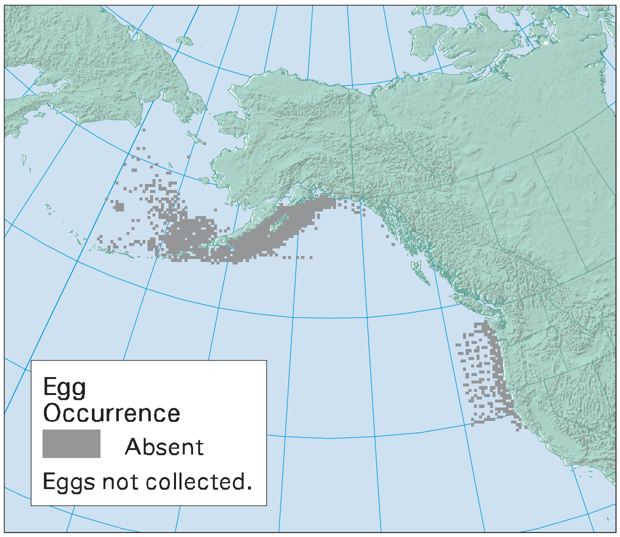


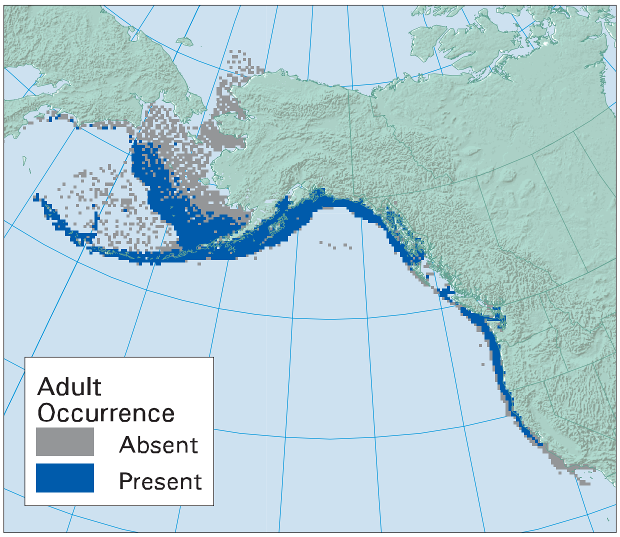
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 5772 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

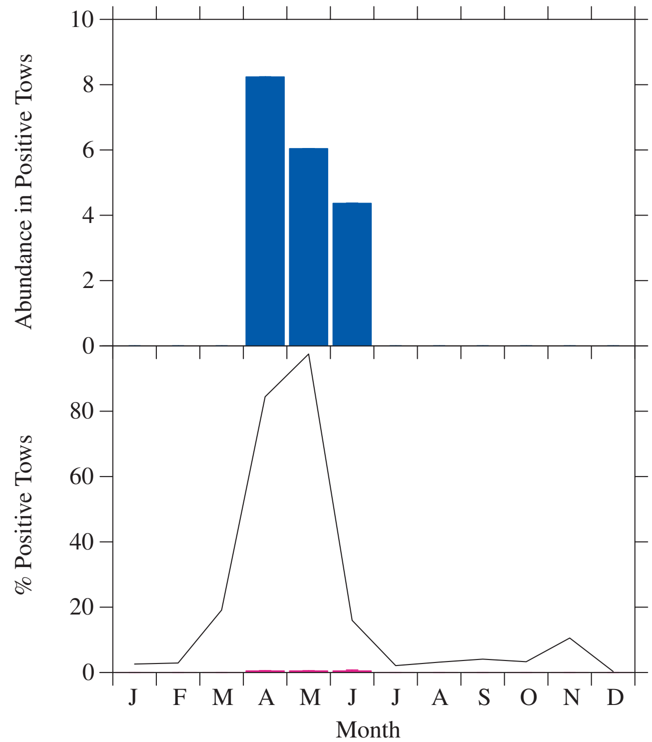

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
13.4 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 1.879
1.879 - 9.256
9.256 - 33.334
33.334 - 443.363
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

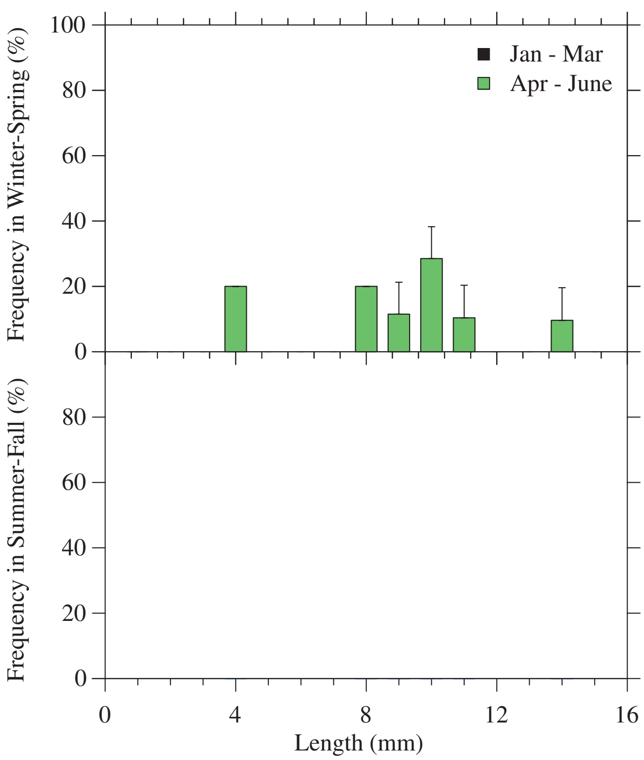

Adult Occurrence
Absent
Present

Life history *Embassichthys bathybius* range from the Bering Sea to southern California. Deepsea sole are demersal fishes, meso- and bathybenthic along the continental slope at depths of 320–1433 m. Spawning takes place during winter–spring; eggs and larvae are pelagic. Eggs are large, 2.7–3.1 mm in diameter. Larvae hatch at about 9 mm SL and undergo notochord flexion at 15.4–16.2 mm SL. Eye migration begins at sizes >16.2–20 mm SL, but prejuveniles remain pelagic until >60 mm SL. Eggs and larvae are rarely collected in the CalCOFI survey area.
[Sources include: Matarese et al. (1989), Charter and Moser (1996b)]

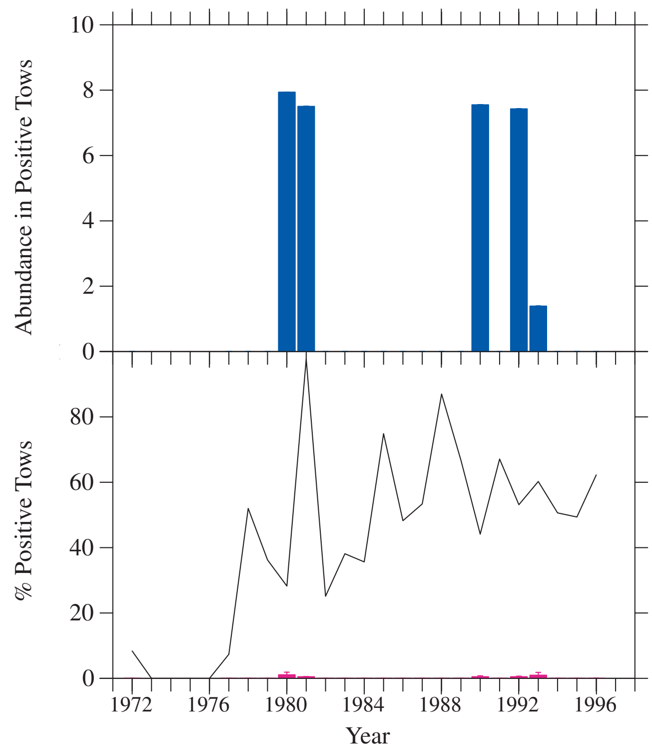
Larval distribution Deepsea sole larvae are distributed along the shelf around Kodiak Island in the Gulf of Alaska and along the U.S. west coast off Washington and Oregon in deeper oceanic waters. Larvae (4–14 mm SL) occur April–June. Although larvae are rare in AFSC samples, pelagic eggs are routinely collected throughout the range of adult distribution from the northern areas of the Bering Sea to off California. Although AFSC adult surveys do not indicate a large presence in the Gulf of Alaska, eggs are numerous west of Kodiak Island along the Shelikof sea valley. Larvae occurred sporadically in the time series from 1980 to 1993.



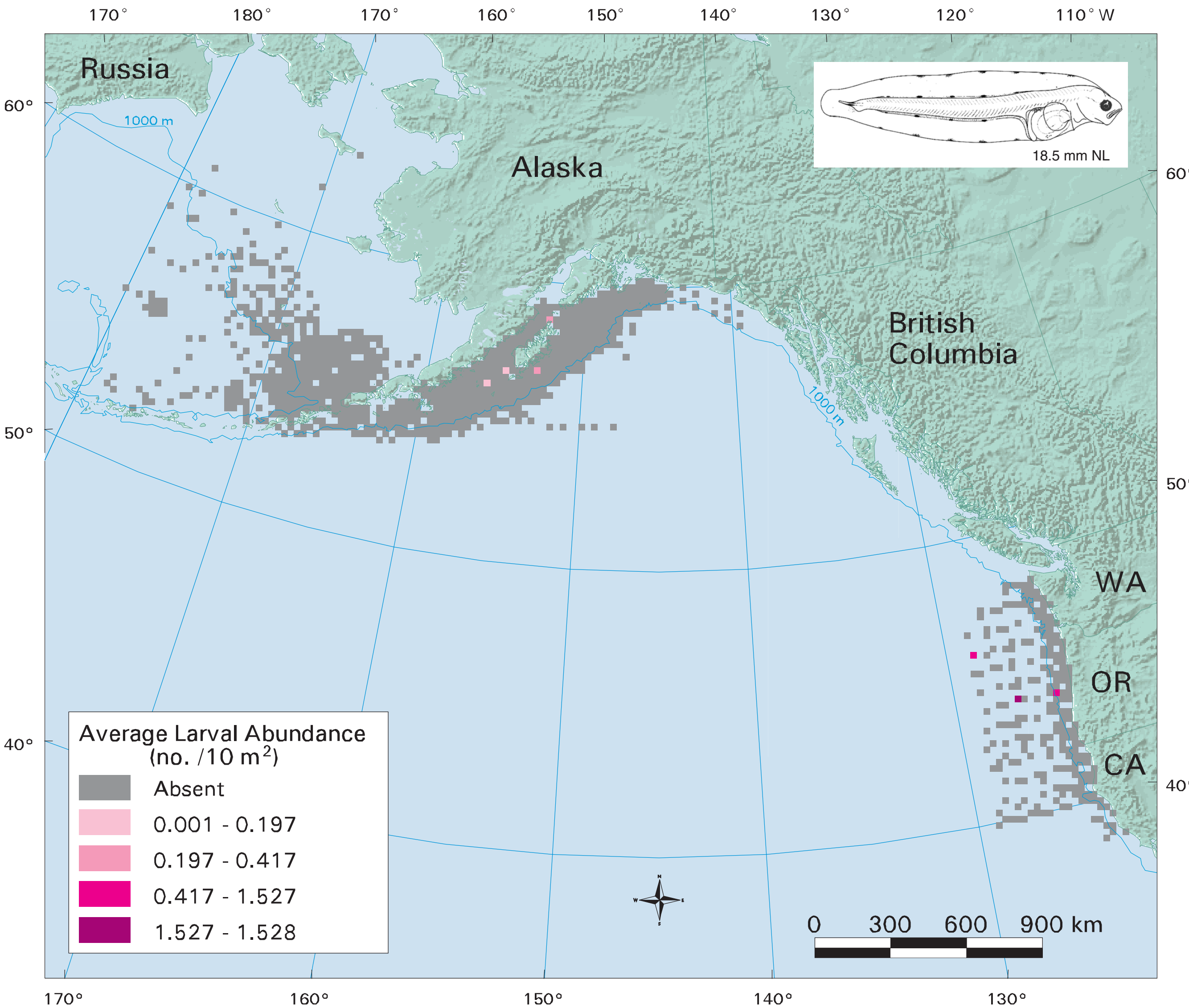
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

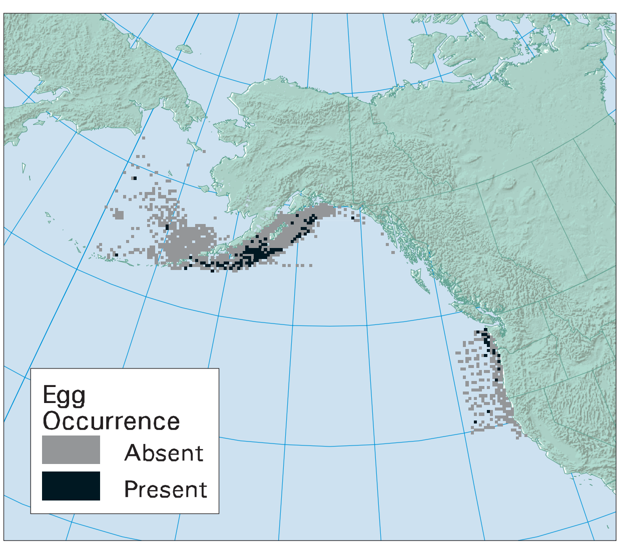


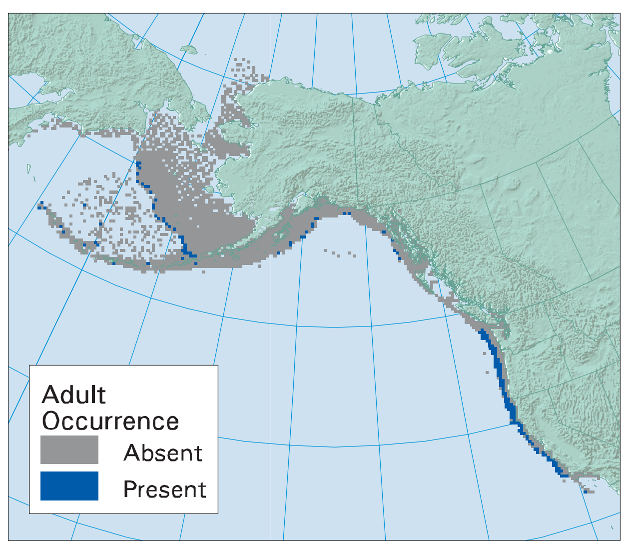
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 7 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

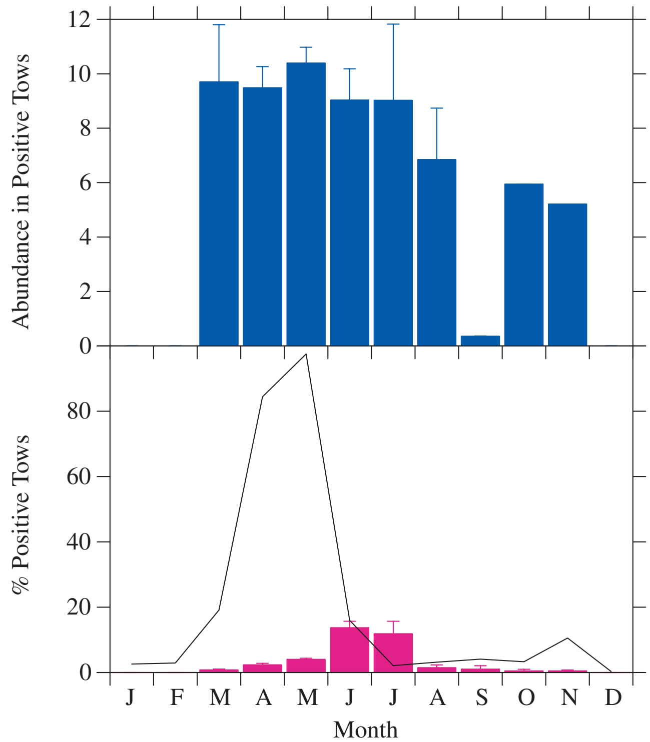

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
18.5 mm NL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.197
0.197 - 0.417
0.417 - 1.527
1.527 - 1.528
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

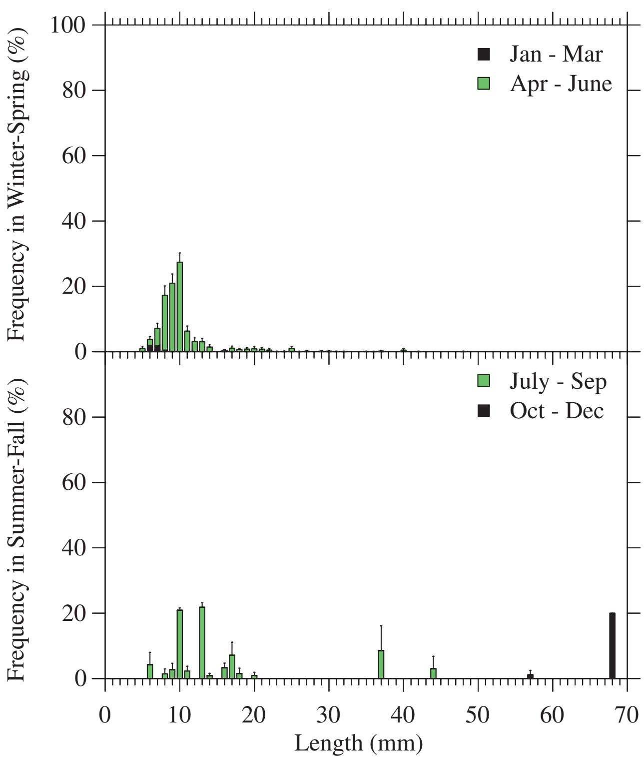

Adult Occurrence
Absent
Present

Life history *Glyptocephalus zachirus* occur in the Bering Sea, along the Aleutian Island chain, and southward to Baja California. Rex sole inhabit areas with sand or mud bottoms, from near surface to depths of 850 m. Slow-growing and living up to 24 years, males reach maturity at 3–5 years; females mature at 5–9 years. Up to 238,000 pelagic eggs are produced during the spawning season (January–June). Eggs are moderate in size (1.8–2.2 mm in diameter); late-stage embryos are long-bodied and coil three times inside the chorion. Hatching at about 5 mm SL, pelagic larvae are elongate and transform at a large size (>50 mm SL). Larvae have been collected off the California coast January–September, but have been most numerous off central California in June.
[Sources include: Hart (1973), Matarese et al. (1989), Charter and Moser (1996b)]

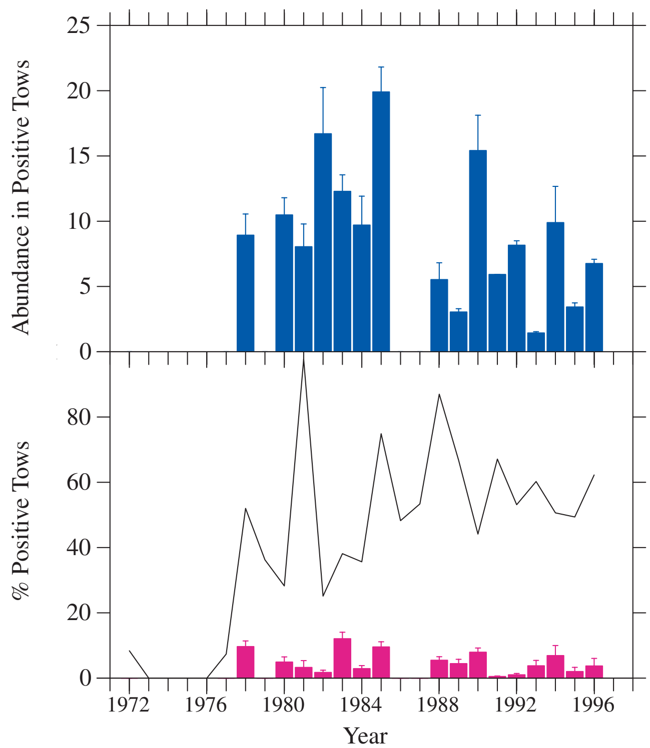
Larval distribution Rex sole larvae occur from the central Bering Sea, eastward into the Gulf of Alaska to Prince William Sound, and along the U.S. west coast. Larvae are abundant over shelf areas southwest of Kodiak Island and off the U.S. west coast. They are collected March–November, but are found in greatest numbers March–August. Whereas early larvae (<15 mm SL) predominate in winter–spring, larvae from all size ranges (6–68 mm SL) have been collected in summer–fall samples. Eggs are very abundant throughout the study area. Larvae commonly occurred throughout the time series.



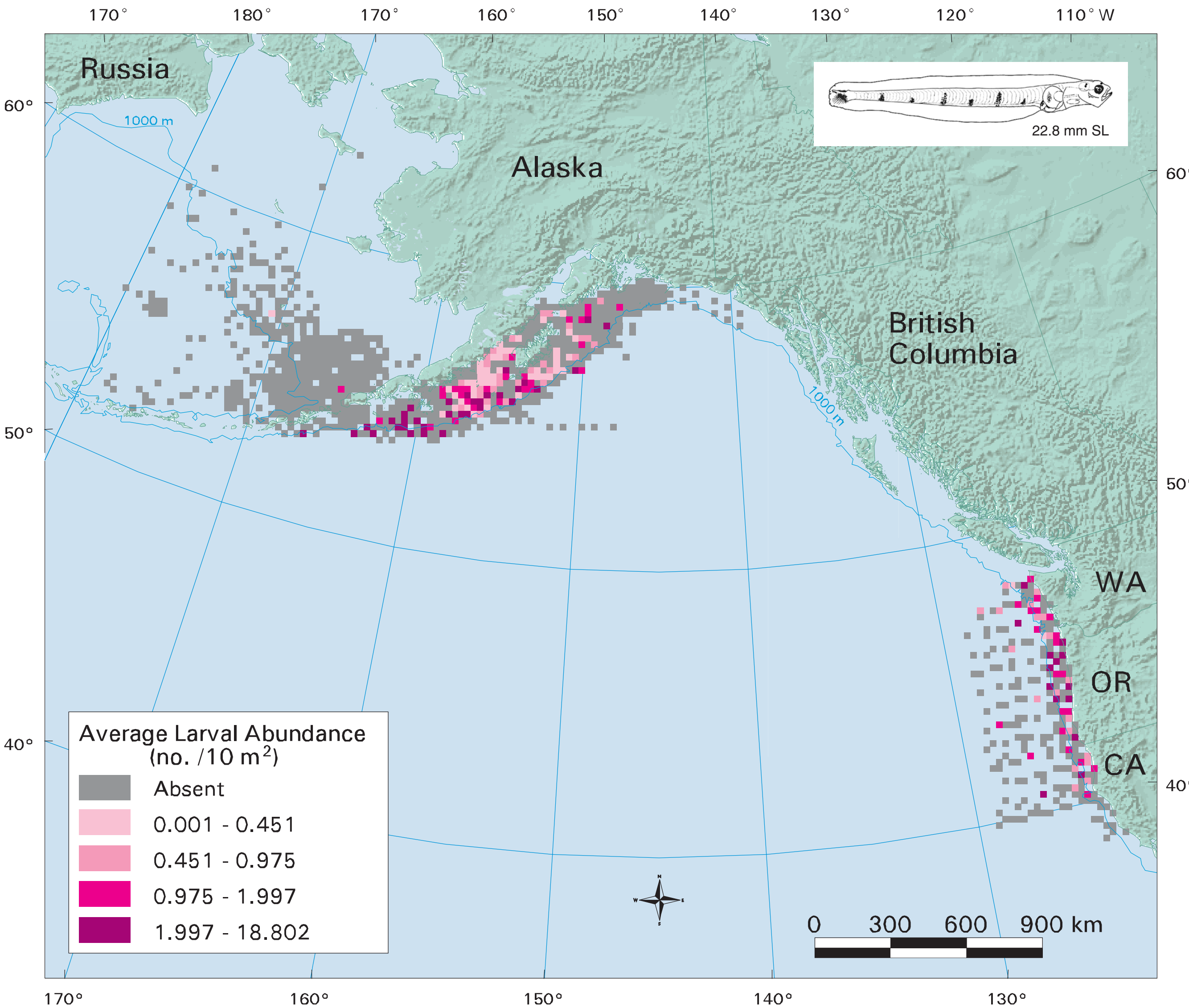
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

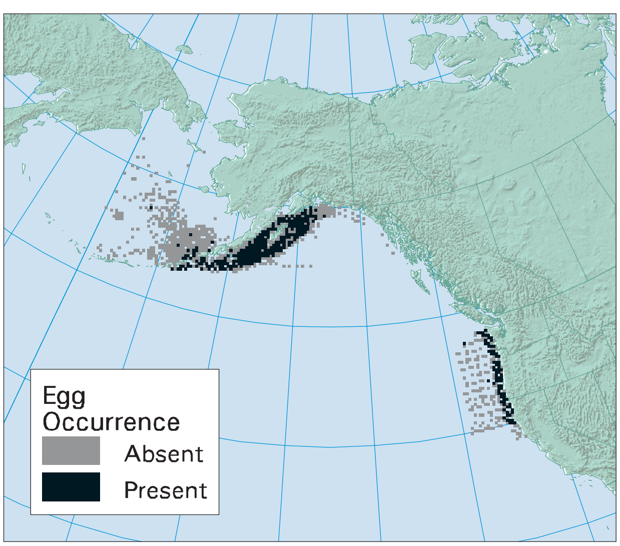


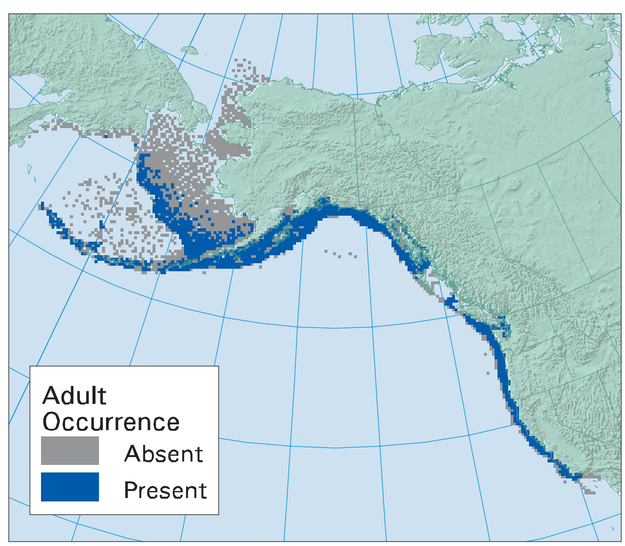
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 441 for winter–spring (Jan–June), 25 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

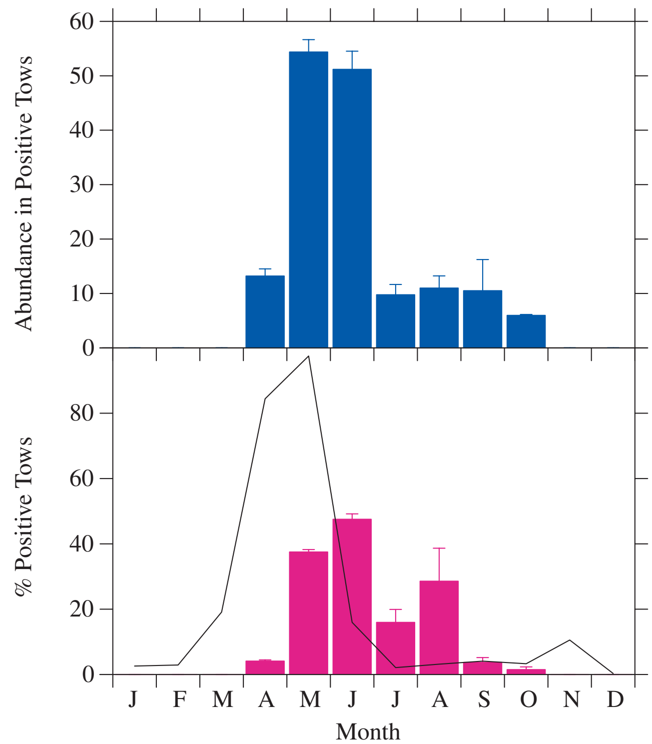

170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
22.8 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.451
0.451 - 0.975
0.975 - 1.997
1.997 - 18.802
0 300 600 900 km
170° 160° 150° 140° 130°


Egg Occurrence
Absent
Present

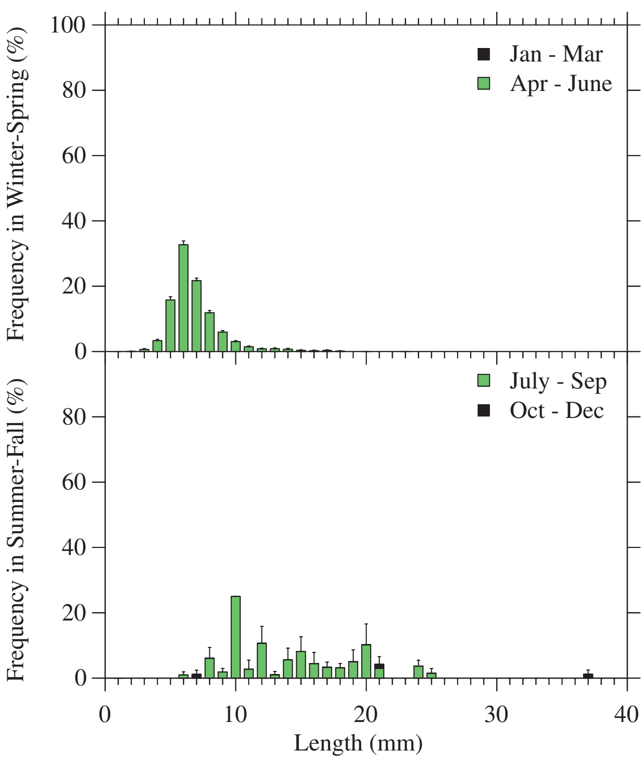

Adult Occurrence
Absent
Present

Life history *Hippoglossoides elassodon* occur from the Bering Sea to central California. Adults may be found from near surface to about 900 m, but usually stay below 150 m. Flathead sole mature as early as 1 year, but more typically at 2–3 years, and may live up to 21 years. Females produce 70,000–600,000 pelagic eggs during the spawning season, which occurs February–July; eggs are large (2.75–3.75 mm in diameter) and have a distinctively large perivitelline space. Pelagic larvae hatch at 5.3–6.9 mm SL and have a gradual transformation into juveniles (18–35 mm SL). [Sources include: Hart (1973), Matarese et al. (1989)]

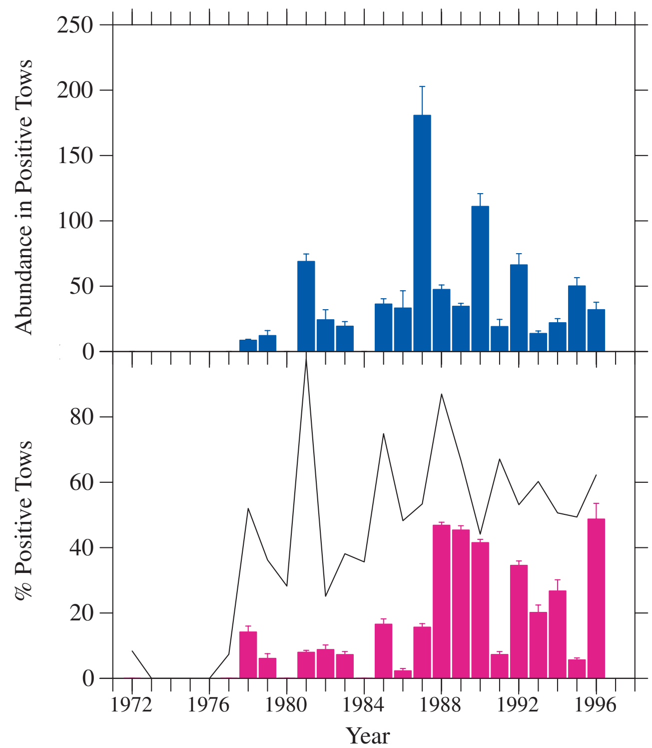
Larval distribution Flathead sole larvae are distributed from off St. Lawrence Island in the northeastern Bering Sea southward into the Aleutian Islands, Gulf of Alaska, and off Washington and Oregon. Highest abundances are found in the Shelikof Strait sea valley. Larvae are collected April–October, but highest catches occur in May and June. Newly hatched larvae (<10 mm SL) are very common in spring. Early larvae, as well as postflexion larvae up to 37 mm SL, are collected in summer–fall. Eggs are uniformly distributed from the Bering Sea shelf to east of Kodiak Island; they are infrequently collected off Washington and Oregon. Larvae were present most years in the time series; overall catch varied from year to year with larvae present in 50% of the tows for several years.



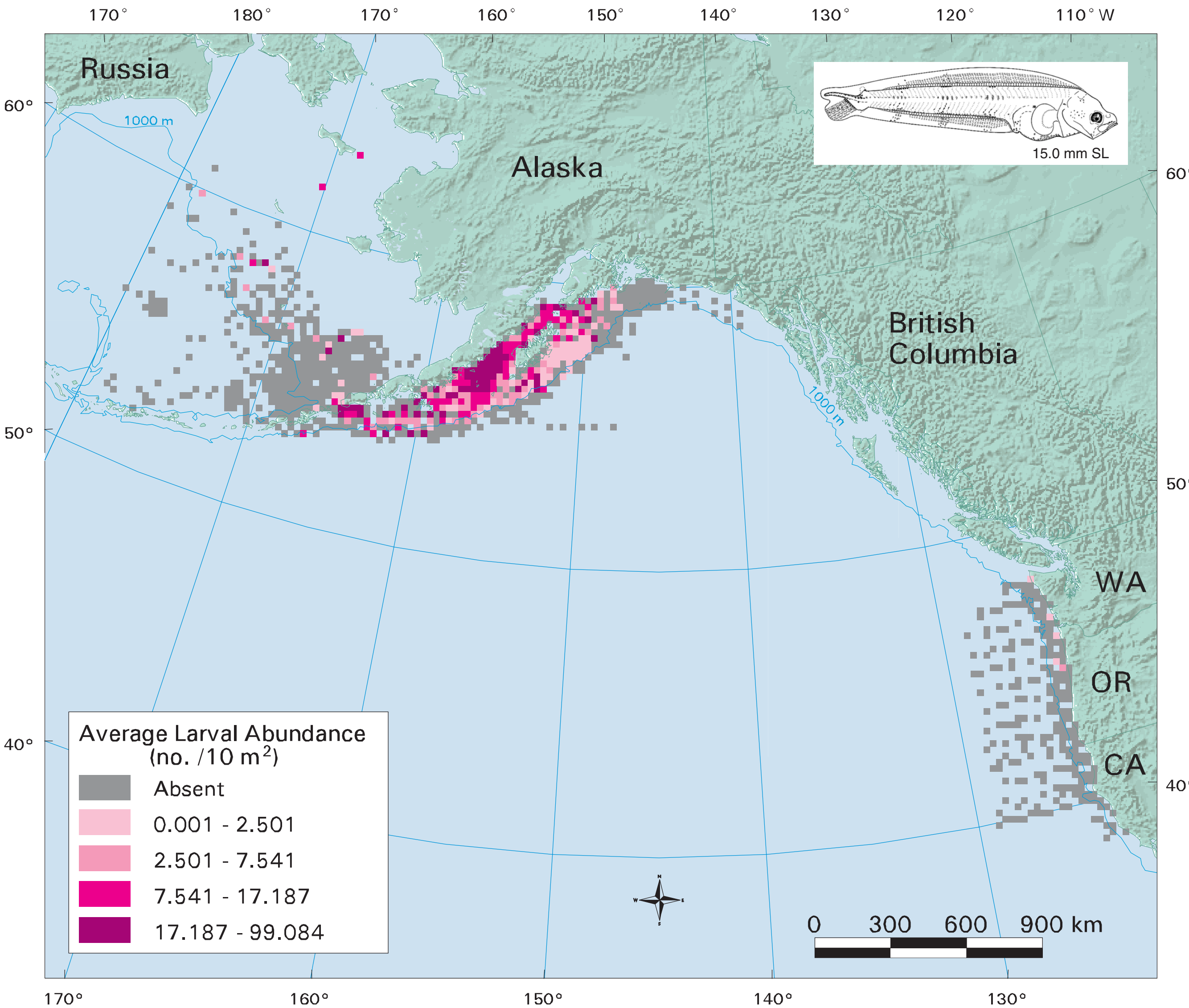
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

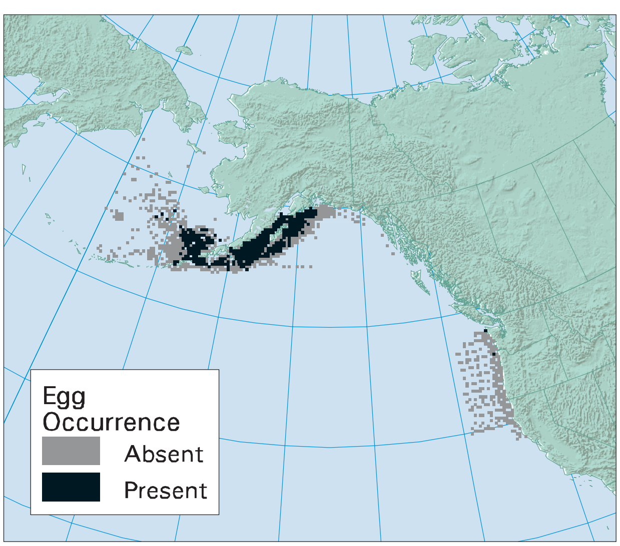


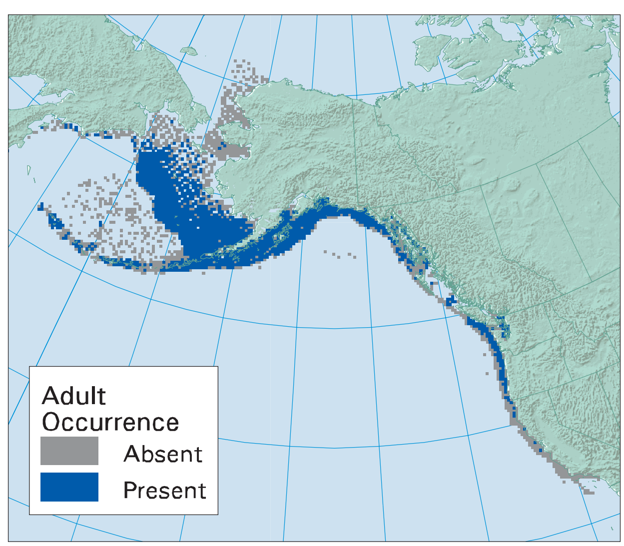
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 16,505 for winter–spring (Jan–June), 46 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

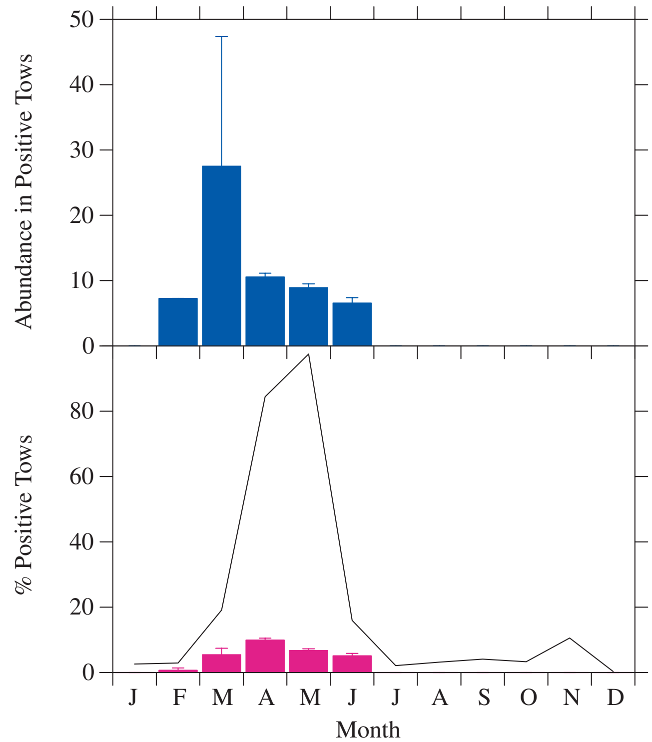

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
15.0 mm SL
60°
50°
40°
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 2.501
2.501 - 7.541
7.541 - 17.187
17.187 - 99.084
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

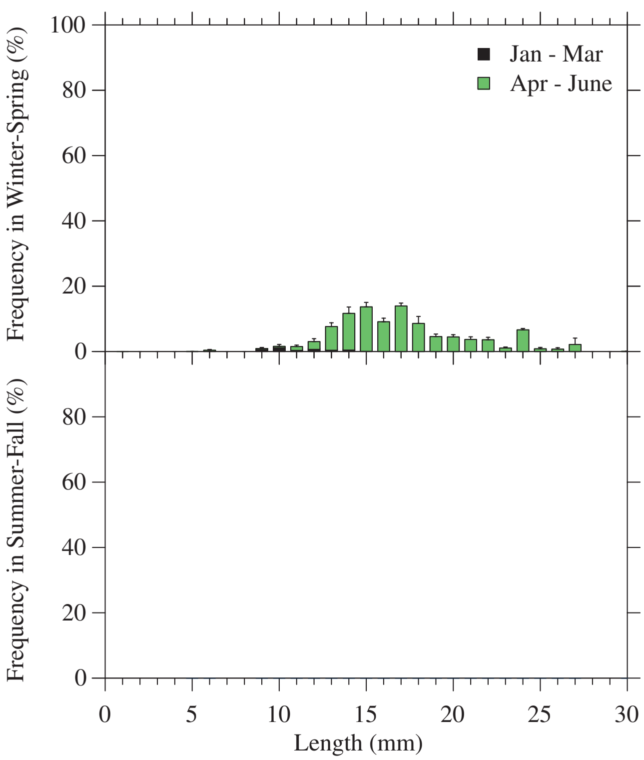

Adult Occurrence
Absent
Present

Life history *Hippoglossus stenolepis* are found from the Chukchi Sea to southern California. Occurring from near surface to depths of 1100 m, Pacific halibut spawn at depths of 180–550 m November–March. Fish reach maturity at 5–7 years; females may produce up to 4 million eggs per season. Pelagic eggs are large, 2.9–3.8 mm in diameter, with a large yolk and very fine honeycomb patterning on the chorion. Pelagic larvae are about 8 mm SL and unpigmented at hatching and remain in the plankton until about 24 mm SL.
[Sources include: Hart (1973), Matarese et al. (1989)]

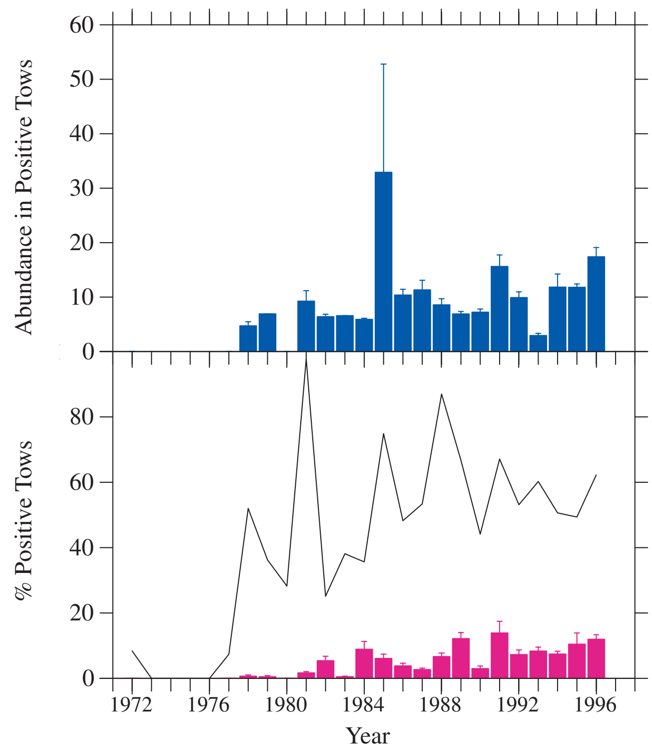
Larval distribution Pacific halibut larvae are distributed from slope waters in the central Bering Sea eastward into the Gulf of Alaska; larvae have not appeared in our collections from the southern extent of the adult distribution off the U.S. west coast. Highest average abundances occur along the western Gulf of Alaska over deep waters (about 1000 m). Larvae are collected February–June at lengths of 10–25 mm SL. Eggs have occasionally been collected in our U.S. west coast samples although newly hatched larvae (<10 mm SL) have not been; no eggs were collected in Alaskan waters during the time series. Overall catch by year indicates that Pacific halibut were consistently collected after 1980.



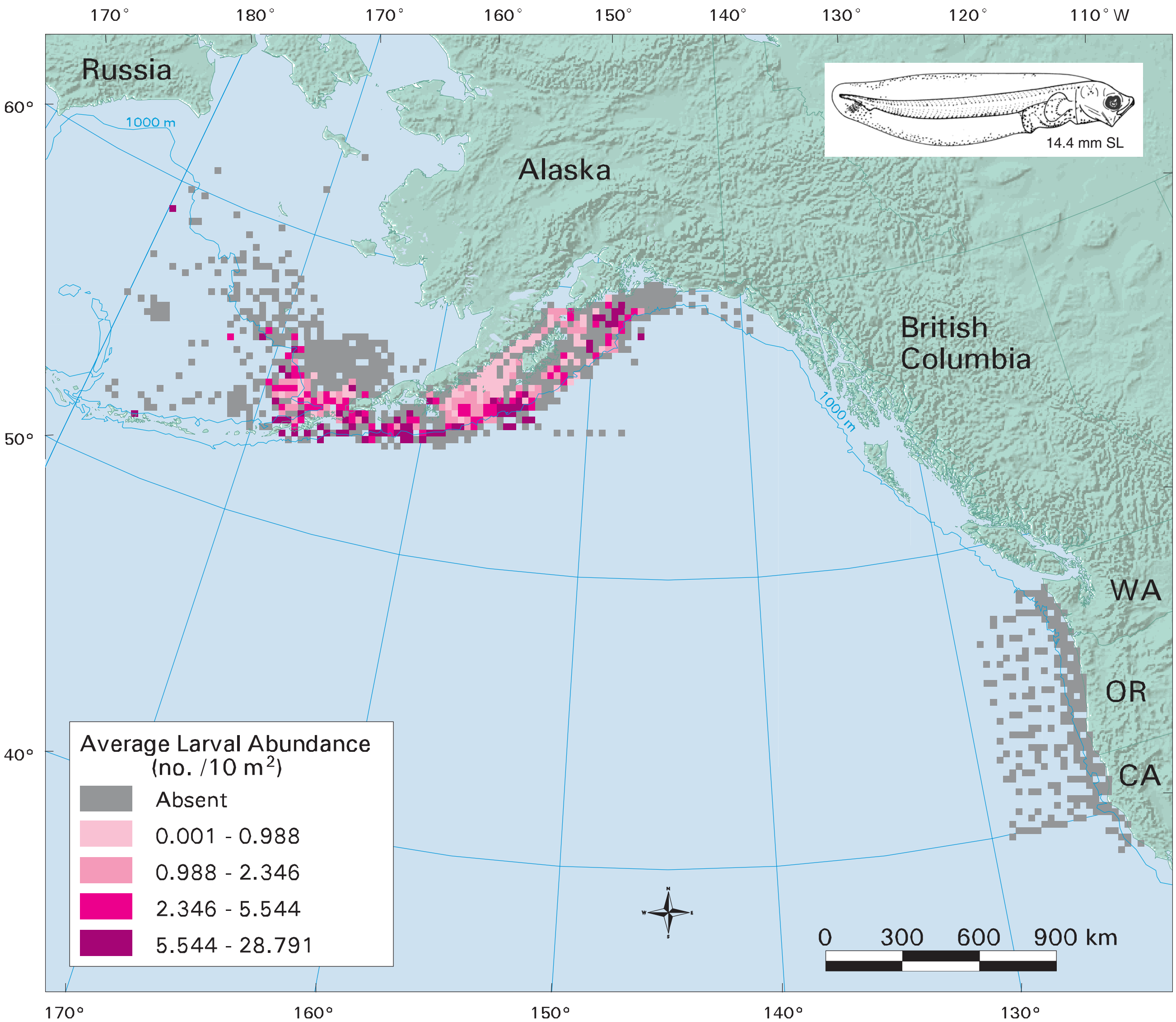
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

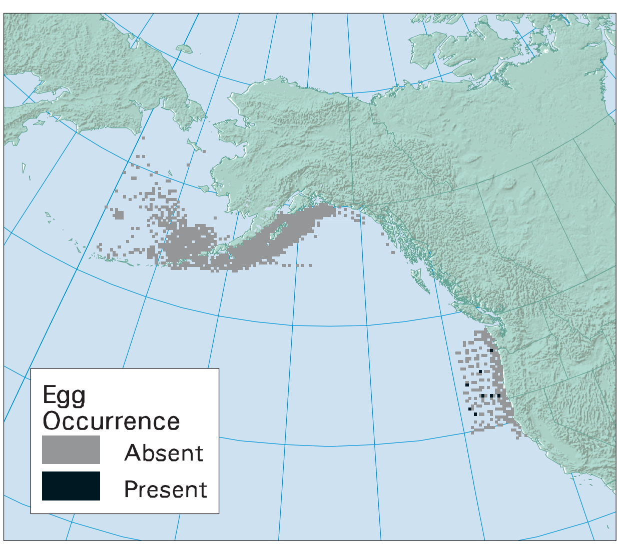


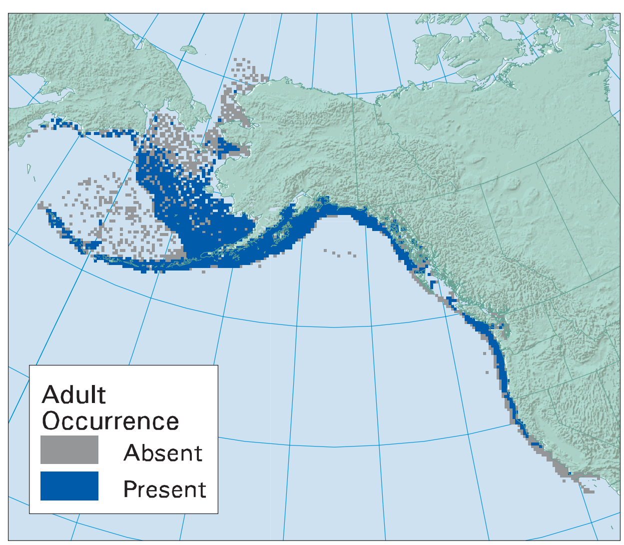
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 1183 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

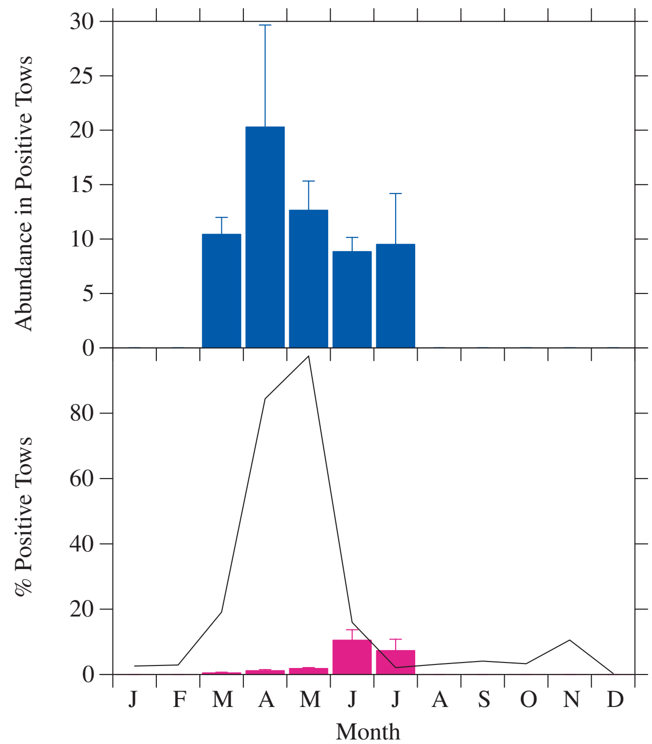

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
14.4 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.988
0.988 - 2.346
2.346 - 5.544
5.544 - 28.791
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

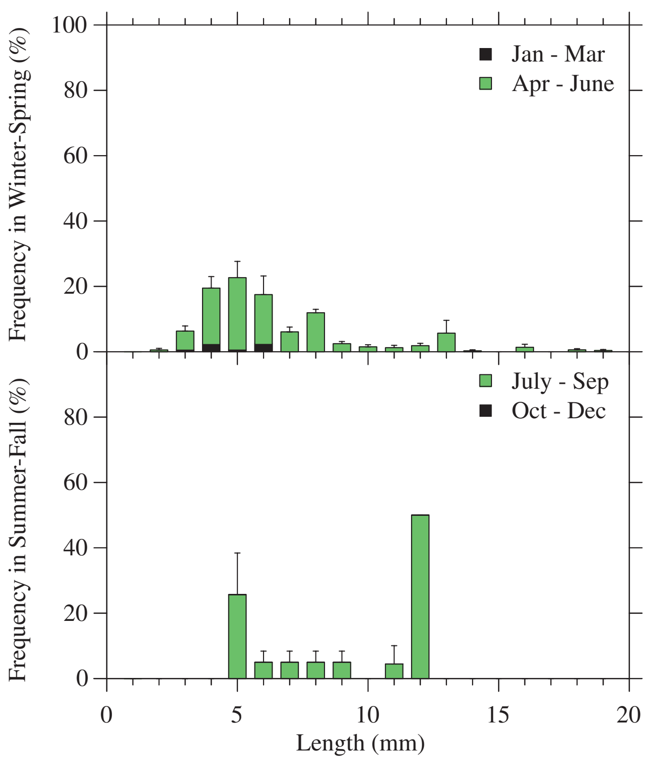

Adult Occurrence
Absent
Present

Life history *Isopsetta isolepis* occur from the Bering Sea along the Northeast Pacific coast to southern California. Butter sole are demersal and found on the shelf and upper slope at depths of 20–245 m. Spawning occurs in coastal waters February–April in the CalCOFI area. Eggs and larvae are pelagic. Eggs are small (0.84–1.10 mm in diameter) and are easily confused with other similarly-sized pleuronectid eggs (*Parophrys vetulus*, *Platichthys stellatus*, and *Psettichthys melanostictus*). Larvae hatch at 2.7–2.9 mm SL and undergo transformation at 15–>21 mm SL. Larvae are collected April, May, and July in the CalCOFI area, with peak abundance in May.
[Sources include: Matarese et al. (1989), Charter and Moser (1996b)]

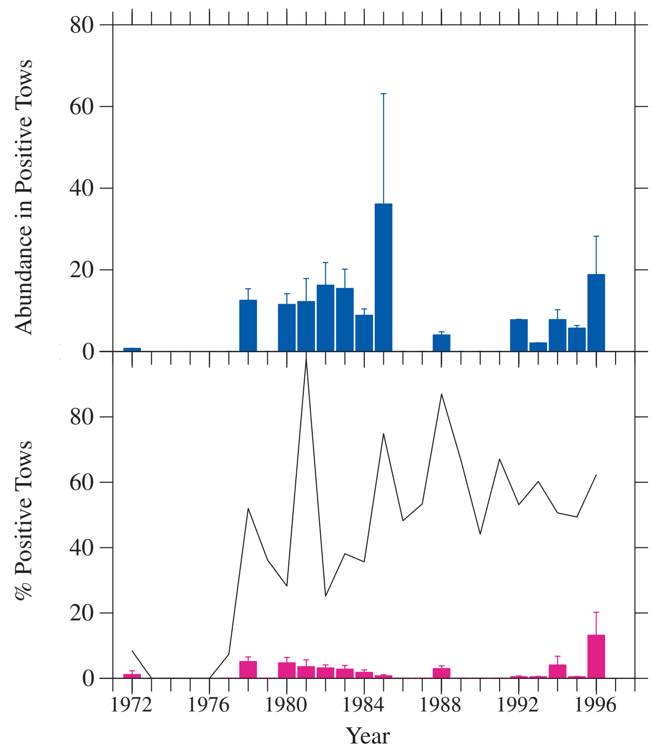
Larval distribution Butter sole larvae occur from the eastern Bering Sea, into the Gulf of Alaska around Kodiak Island, and along the U.S. west coast. Larvae are abundant in shelf areas around Kodiak Island and nearshore along the U.S. west coast. Larvae are collected March–July, with highest abundances in April. Although larvae 2–19 mm SL are collected in winter–spring, small and newly hatched larvae are more common. Larvae 5–12 mm SL are collected in summer–fall. Early and middle-stage eggs cannot be identified, but late-stage eggs are present in the Gulf of Alaska and off the U.S. west coast. Overall catch by year indicates that larvae were present commonly throughout the time series, but were most abundant during the 1980s when AFSC conducted U.S. west coast surveys, and from 1992 to the present.



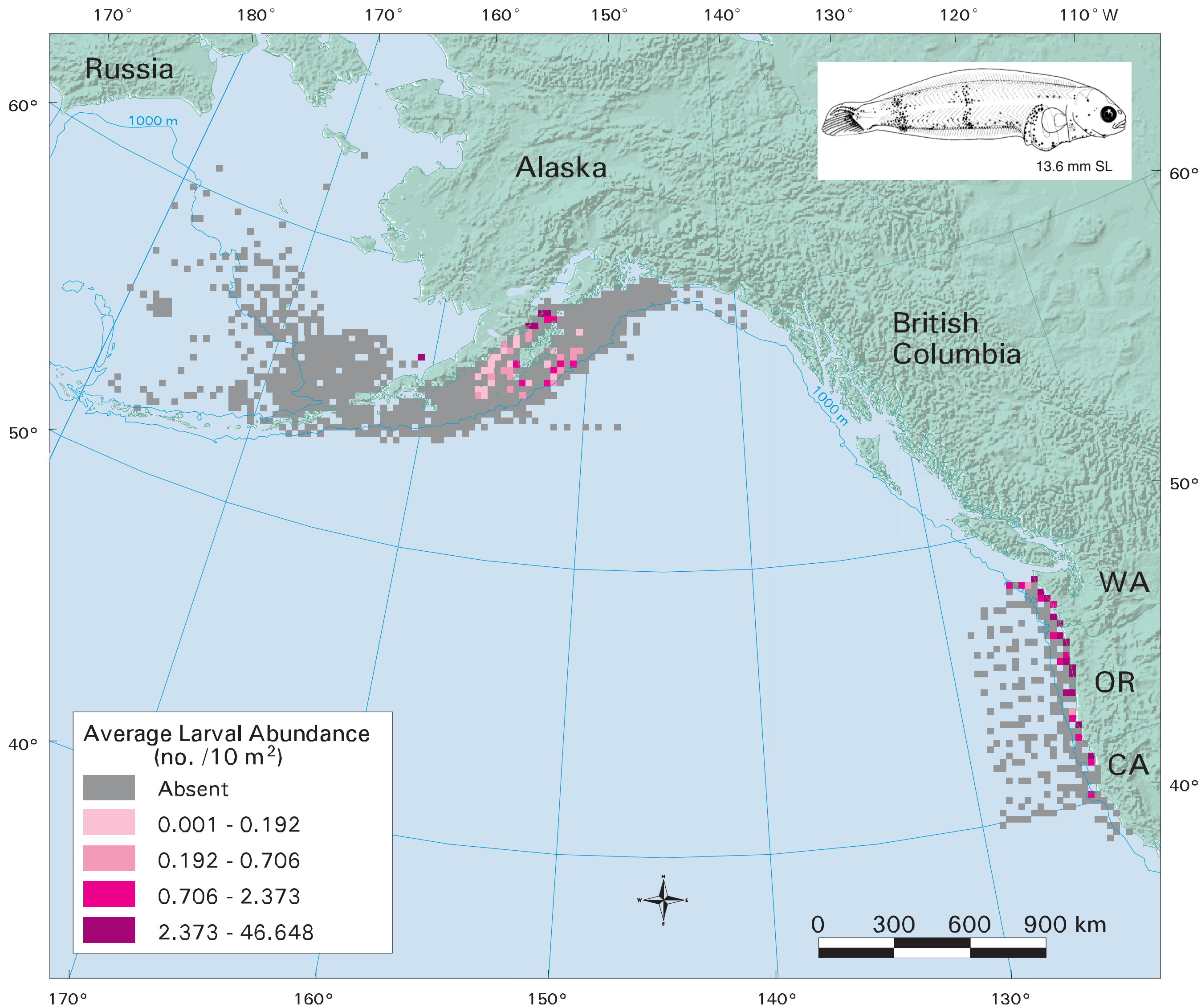
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

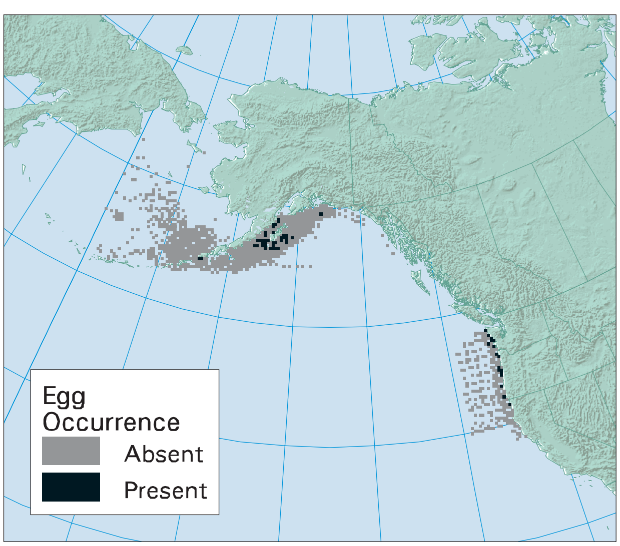


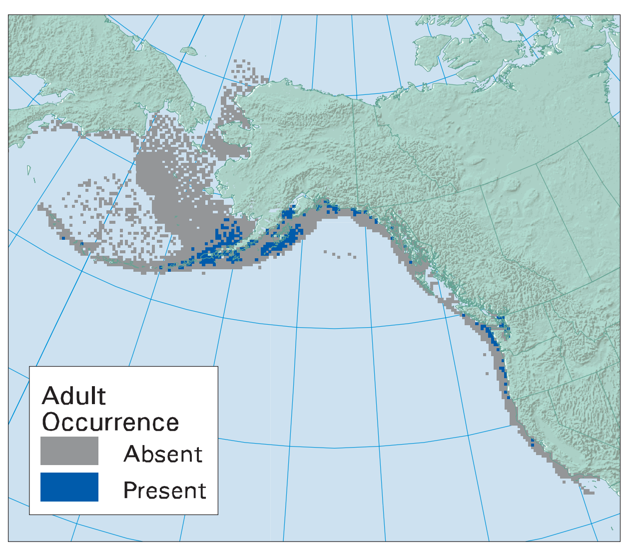
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 266 for winter–spring (Jan–June), 10 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.


170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
13.6 mm SL
British Columbia
1000 m
WA
OR
CA
Average Larval Abundance (no. /10 m2)
Absent
0.001 - 0.192
0.192 - 0.706
0.706 - 2.373
2.373 - 46.648
0 300 600 900 km
170°
160°
150°
140°
130°

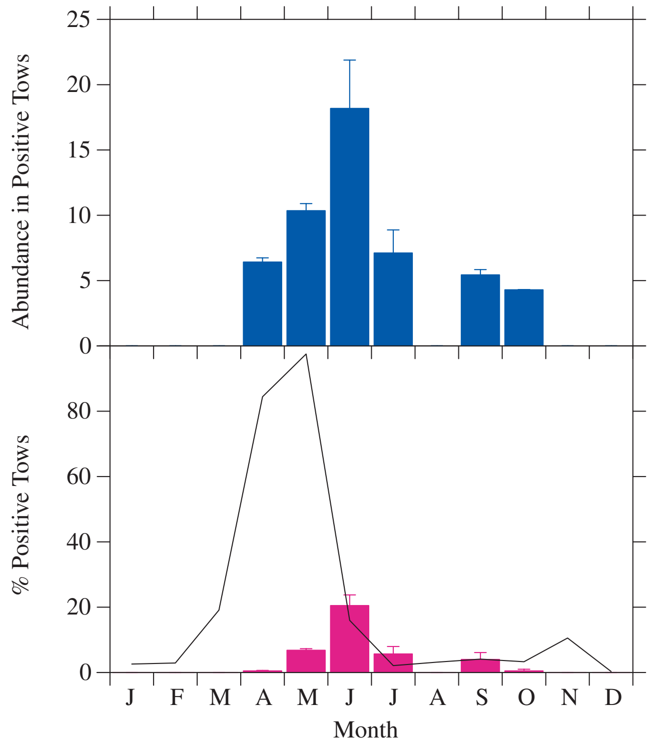

Egg Occurrence
Absent
Present


Adult Occurrence
Absent
Present

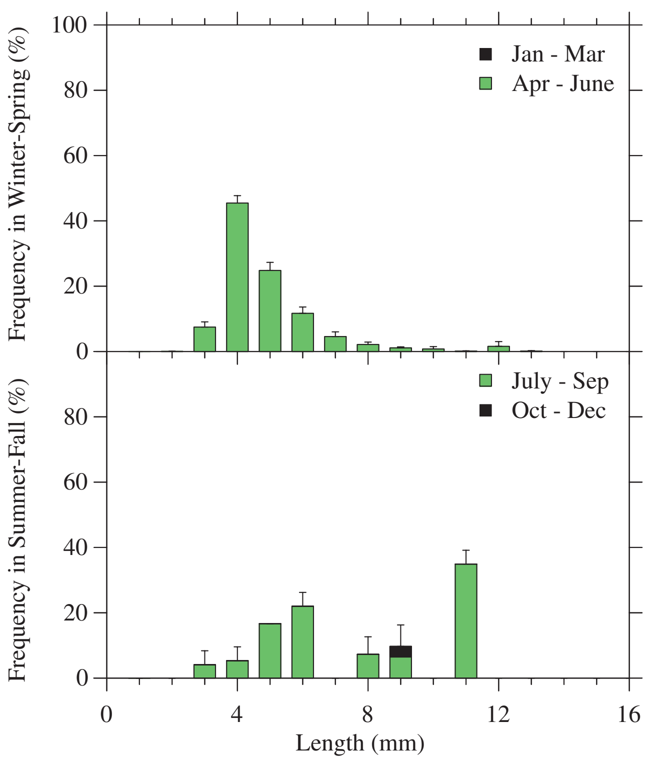
Life history *Lepidopsetta bilineata* occur from the southern Bering Sea and Aleutian Islands to Baja California and are found over the continental shelf. Southern rock sole, which may live up to 18 years, are common from the northern Gulf of Alaska to Puget Sound, Washington, and are locally abundant along the coasts of Washington, Oregon, and California. Off California, spawning occurs February–April. Demersal adhesive eggs are about 1 mm in diameter; larvae are <3 mm SL at hatch. Pelagic larvae begin eye migration as early as 10.0 mm SL, but many remain in the plankton until they are about 30 mm SL. [Sources include: Charter and Moser (1996b), Orr and Matarese (2000)]

Larval distribution Southern rock sole larvae occur throughout the western Gulf of Alaska; only two collections were made off the U.S. west coast. Highest abundances occur in Unimak Pass, Shelikof Strait and sea valley, and east of Kodiak Island. Larvae occur April–July and September–October, but are more frequently collected in June. Larvae of similar size ranges (3–12 mm SL) are collected during winter–spring and summer–fall. Although found in fewer than 20% of tows each year, larvae were collected most years after 1978.

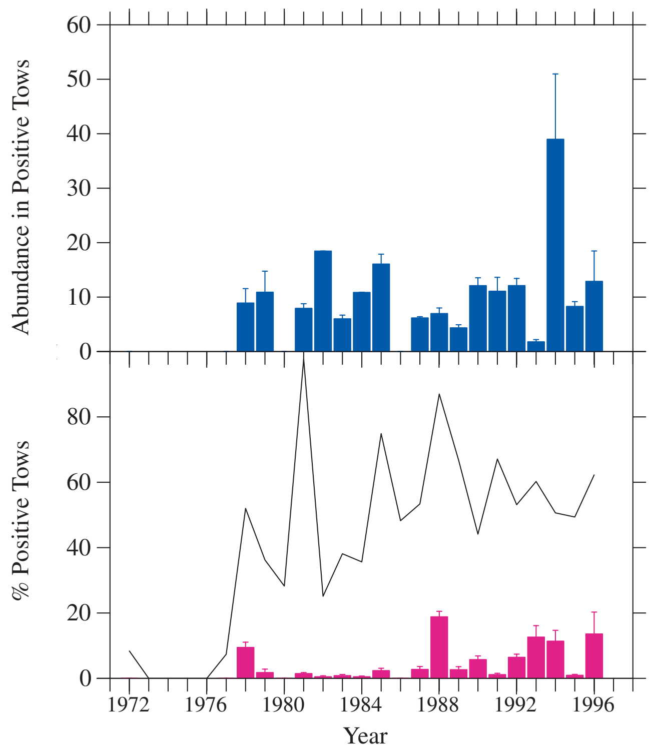
Note: Recent collections in the Bering Sea from 1998 indicate larvae occur in the Bering Sea.



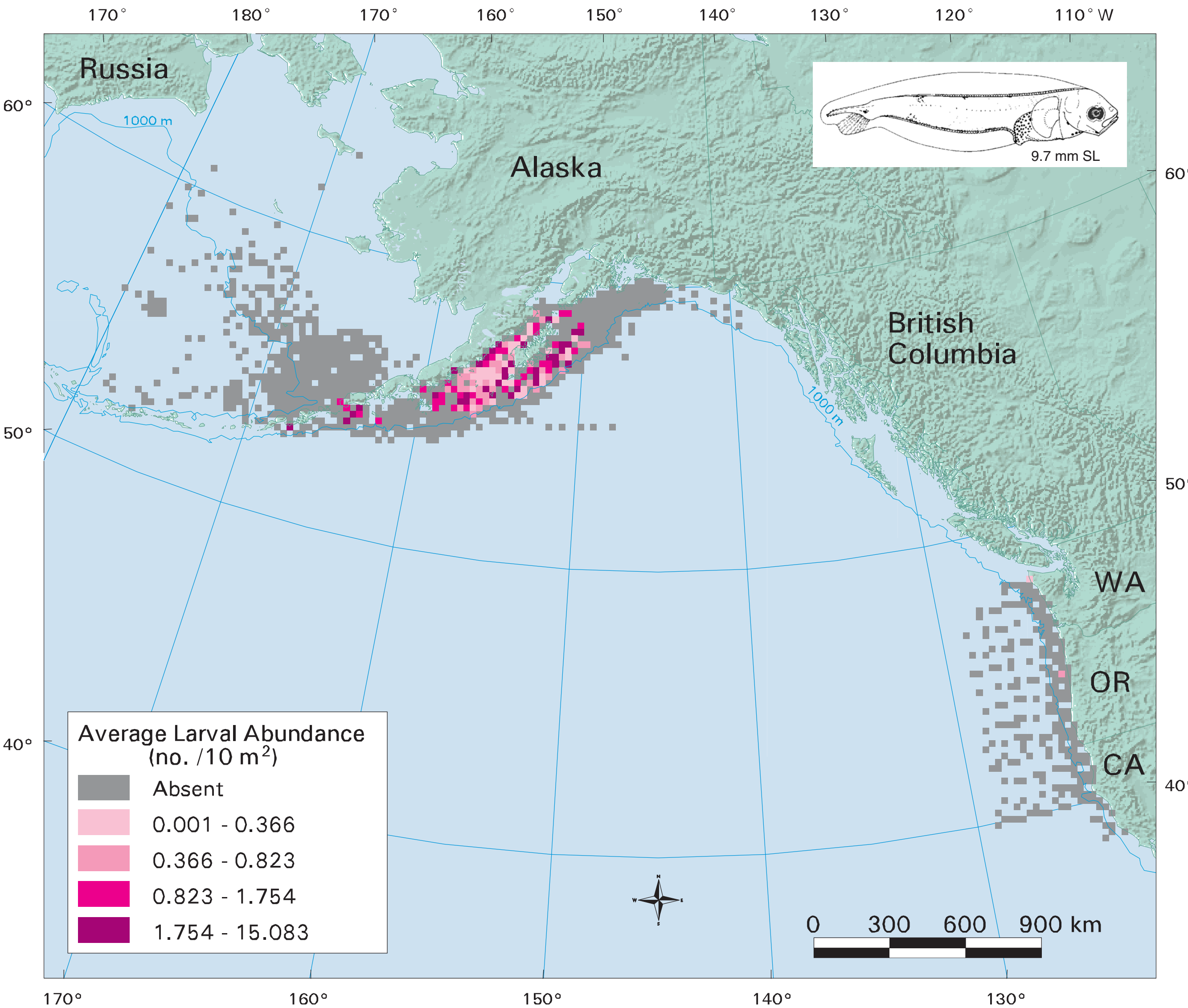
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

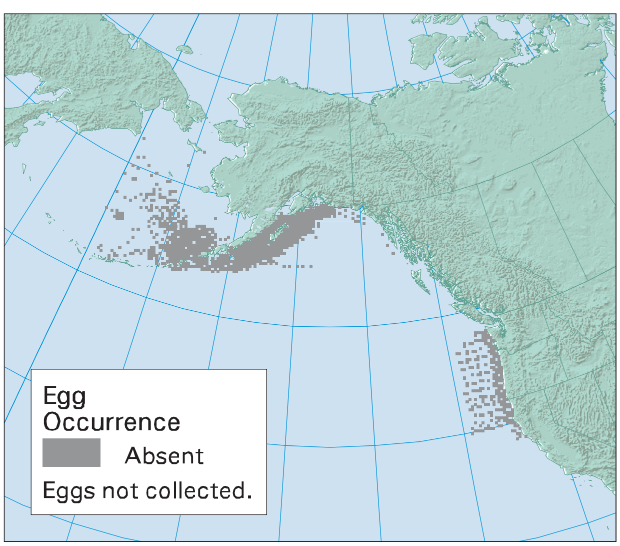


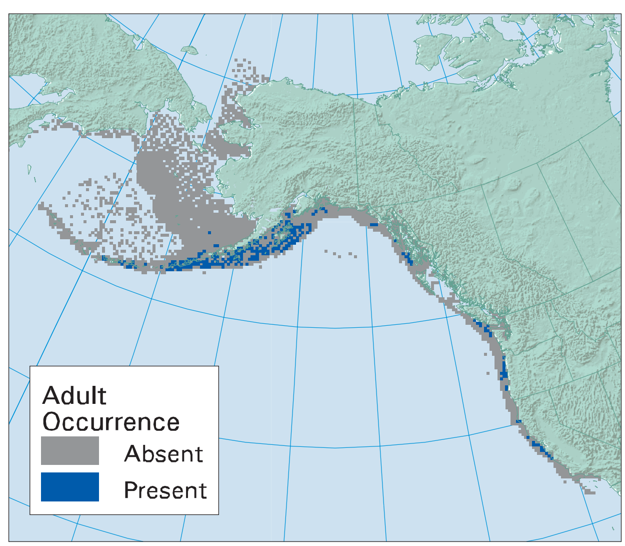
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 755 for winter–spring (Jan–June), 12 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

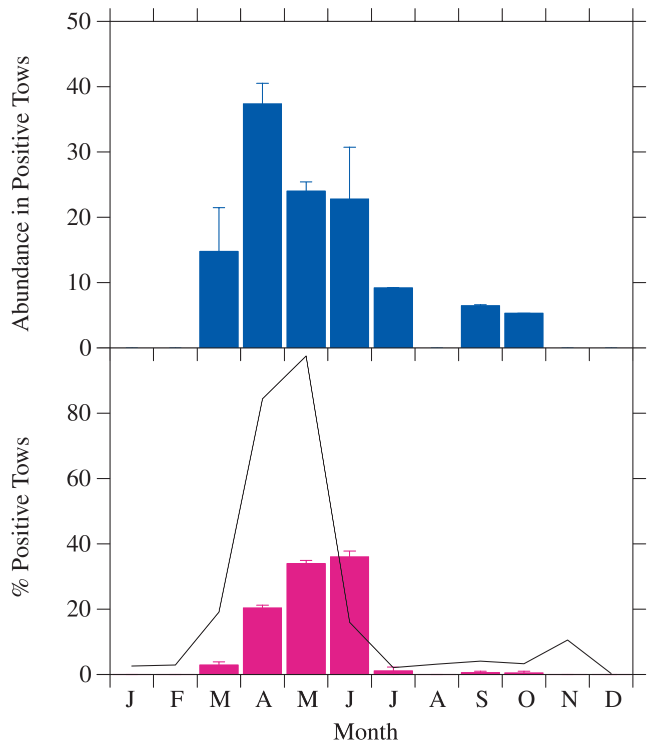

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
1000 m
WA
OR
CA
9.7 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.366
0.366 - 0.823
0.823 - 1.754
1.754 - 15.083
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

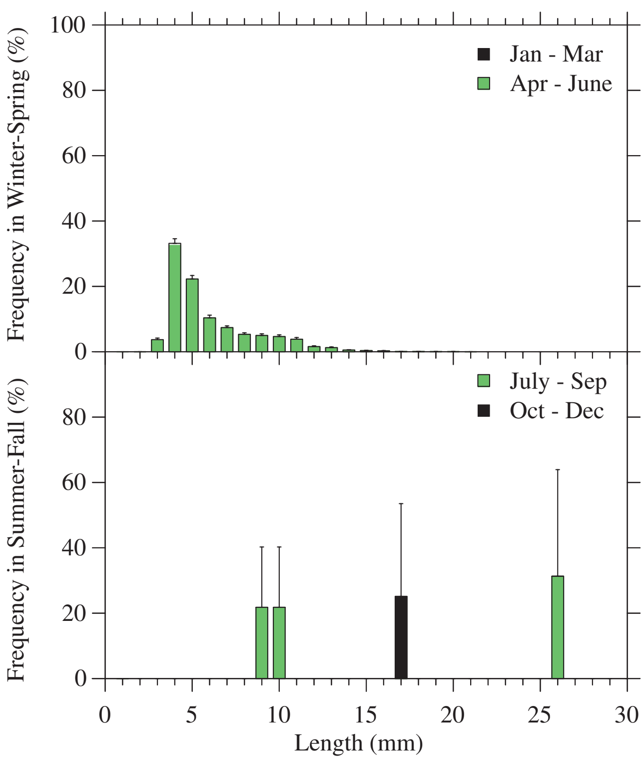

Adult Occurrence
Absent
Present

Life history Not recognized as a distinct species until recently, *Lepidopsetta polyxystra* are found from the Bering Sea to Puget Sound, Washington. Northern rock sole are distributed over the continental shelf and may live up to 18 years. Spawning peaks from early March to mid-April in the Kamchatka region and may occur as late as mid-June in the western Pacific. Demersal eggs, about 1 mm in diameter, are spawned in areas with good water circulation over hard bottoms of sand or gravel. Larvae hatch at >3 mm SL and first appear in the plankton in March. Size at eye migration and settlement of *L. polyxystra* differs from *L. bilineata*; *L. polyxystra* do not begin eye migration until 15.0 mm SL and most stay in the plankton to at least 30.0 mm SL.
[Sources include: Orr and Matarese (2000)]

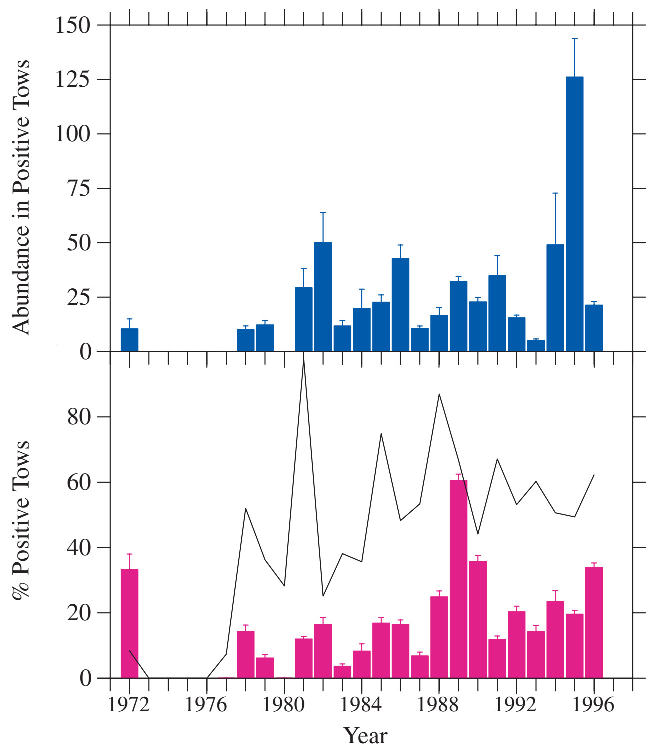
Larval distribution Northern rock sole larvae are collected throughout the Bering Sea and western Gulf of Alaska, with highest abundances over the Bering Sea shelf. Although spawning occurs as far south as Puget Sound, no larvae have been taken in AFSC U.S. west coast collections. Larvae are collected from early March–October; highest abundances occur in April. Small larvae (<10 mm SL) are common throughout winter–spring, whereas larger larvae are only rarely collected in summer–fall. Larvae were consistently present during the time series, but collections were more numerous in the late 1980s and 1990s when sampling in the Bering Sea increased.



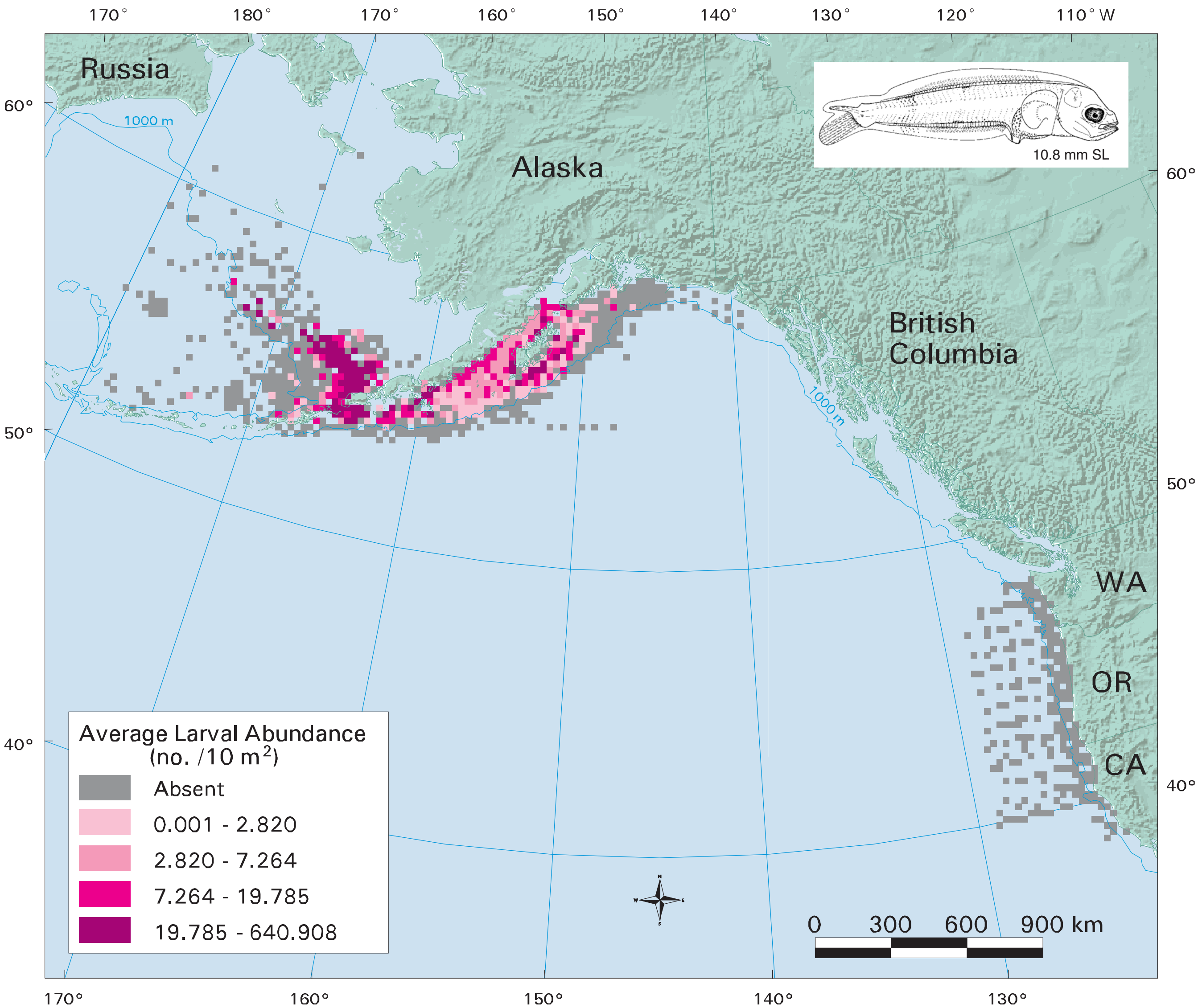
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

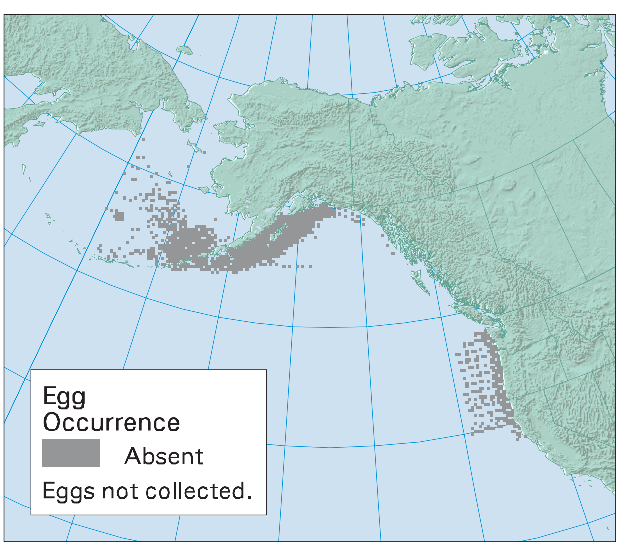


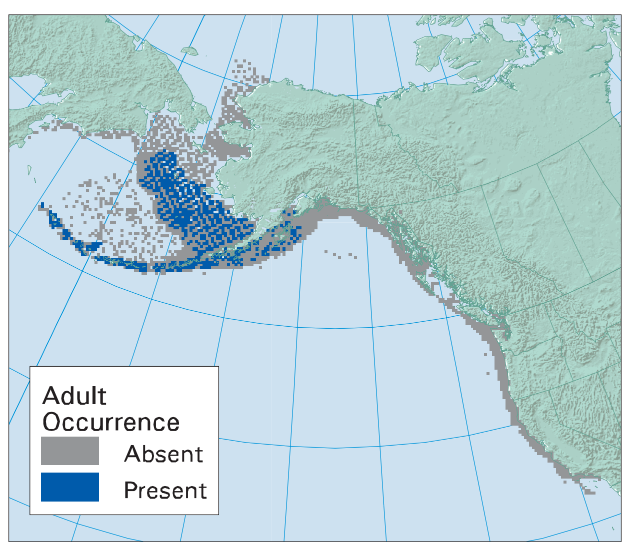
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 10,038 for winter–spring (Jan–June), 4 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

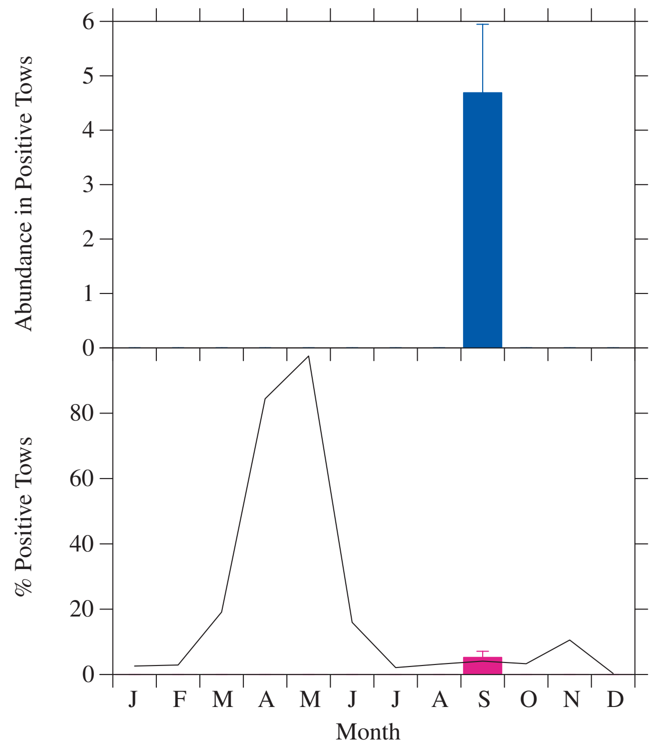

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.8 mm SL
60°
50°
40°
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 2.820
2.820 - 7.264
7.264 - 19.785
19.785 - 640.908
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Eggs not collected.

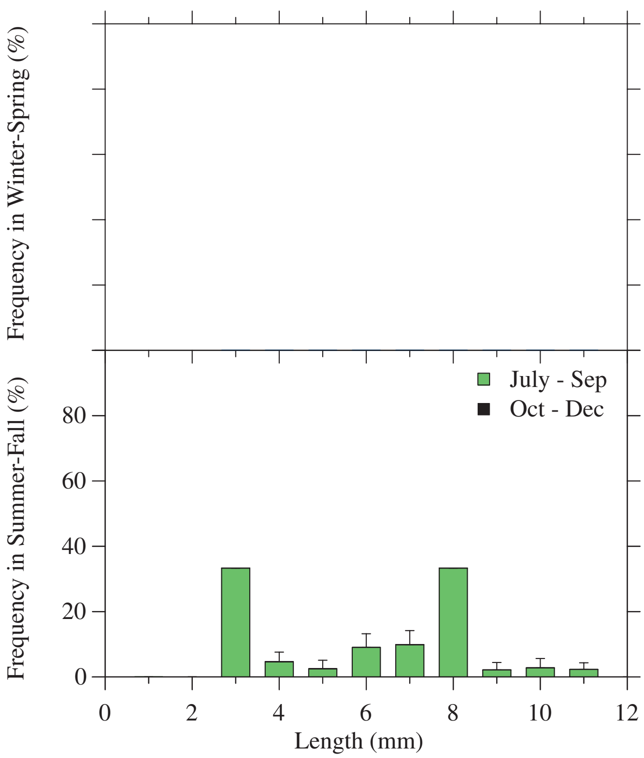

Adult Occurrence
Absent
Present

Life history *Limanda aspera* are distributed along the shelf from the Chukchi Sea to British Columbia. Yellowfin sole are epi-, meso-, and bathybenthic, occurring at depths of 10–600 m. Adults migrate during the summer to shallow inner shelf areas to spawn. Eggs are pelagic, small (0.76–0.85 mm in diameter), and spawned in large numbers (1–3 million). Pelagic larvae hatch at small sizes (2.25–2.80 mm SL) and undergo notochord flexion at 7.5–9.5 mm SL. Although transformation may begin as early as 10 mm SL, it usually occurs at sizes between 15 and 17 mm SL.
[Sources include: Matarese et al. (1989)]

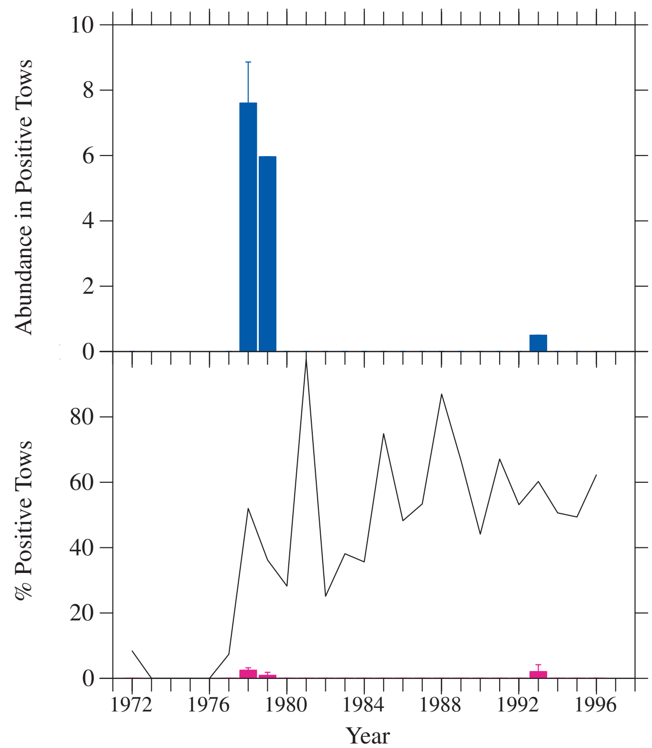
Larval distribution Yellowfin sole larvae are collected along the shelf south and east of Kodiak Island. Although adults are common in AFSC adult surveys both in the Bering Sea and western Gulf of Alaska, larvae are uncommon. All larvae were collected during September, a month not frequently sampled in the Bering Sea with bongo gear that is designed to sample small larvae. Larvae from September are small and newly hatched (3–11 mm SL). Eggs are present in the Bering Sea, southern Shelikof Strait and sea valley, and east of Kodiak Island. Larvae were collected during only three years throughout the time series: 1978, 1979, and 1993.



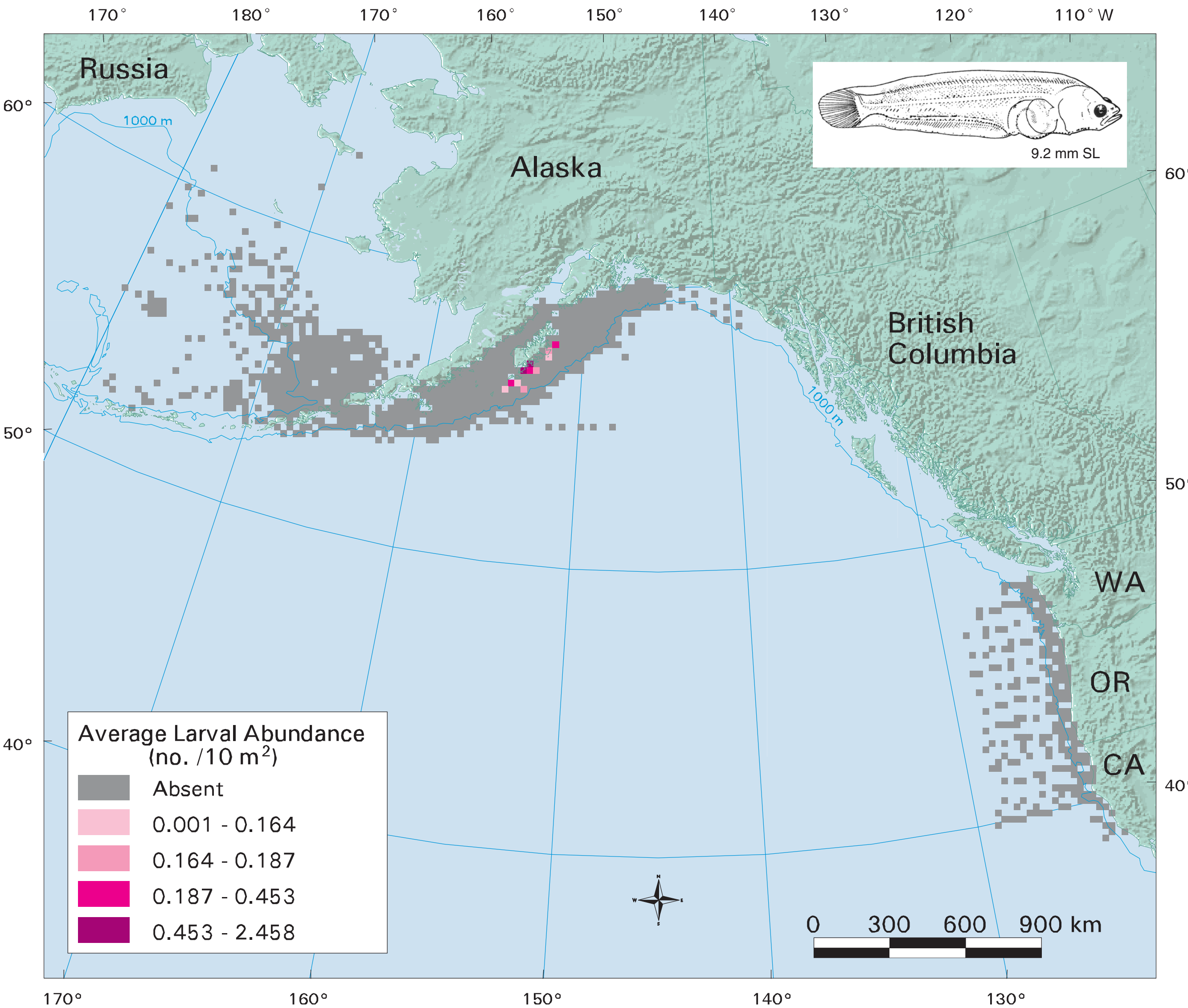
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

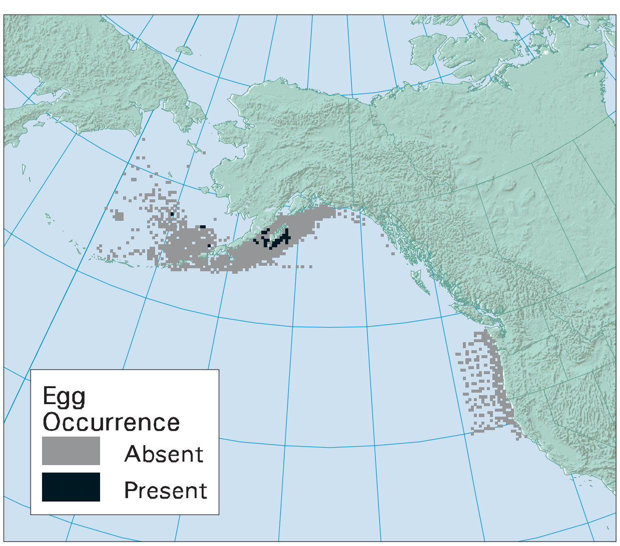


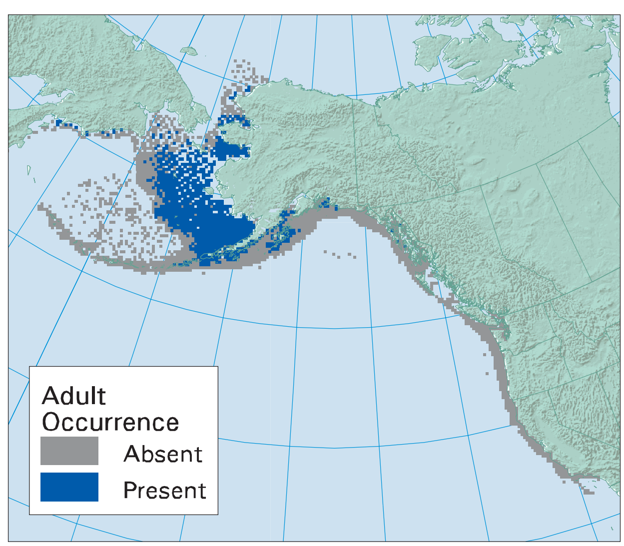
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 16 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

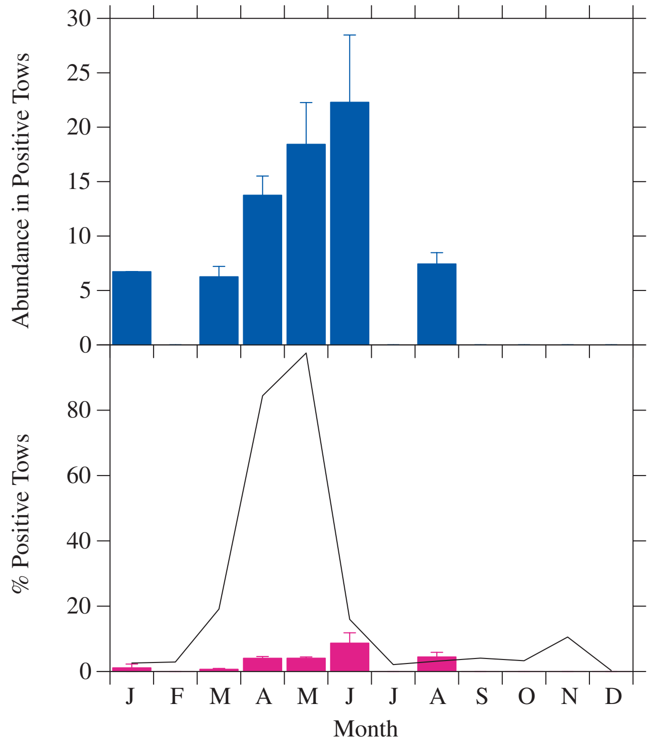

170°
180°
170°
160°
150°
140°
130°
120°
110° W
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
60°
50°
40°
9.2 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.164
0.164 - 0.187
0.187 - 0.453
0.453 - 2.458
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

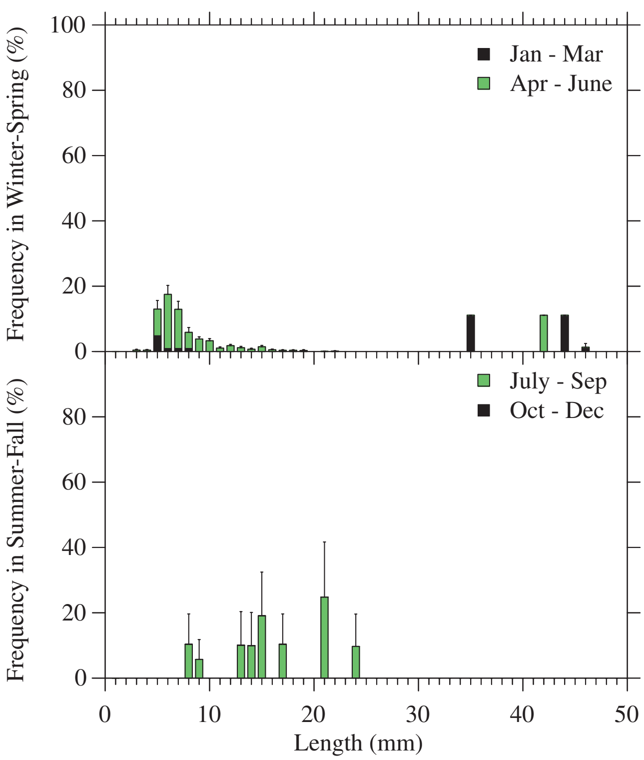

Adult Occurrence
Absent
Present

Life history *Lyopsetta exilis* range from the Gulf of Alaska to Baja California. Slender sole adults are demersal, occurring on the shelf to mid-slope at depths of 25–800 m. Spawning takes place in February and April in the CalCOFI region; eggs and larvae are pelagic. Eggs are 1.5–1.7 mm in diameter; the chorion has an irregular, finely ridged surface. Hatching occurs at 5.2–5.6 mm SL and larvae undergo transformation beginning at 15.7–16.7 mm SL through 20.6–24.7 mm SL. Larvae are collected throughout the year in the CalCOFI area with peak abundance in April.
[Sources include: Matarese et al. (1989), Charter and Moser (1996b)]

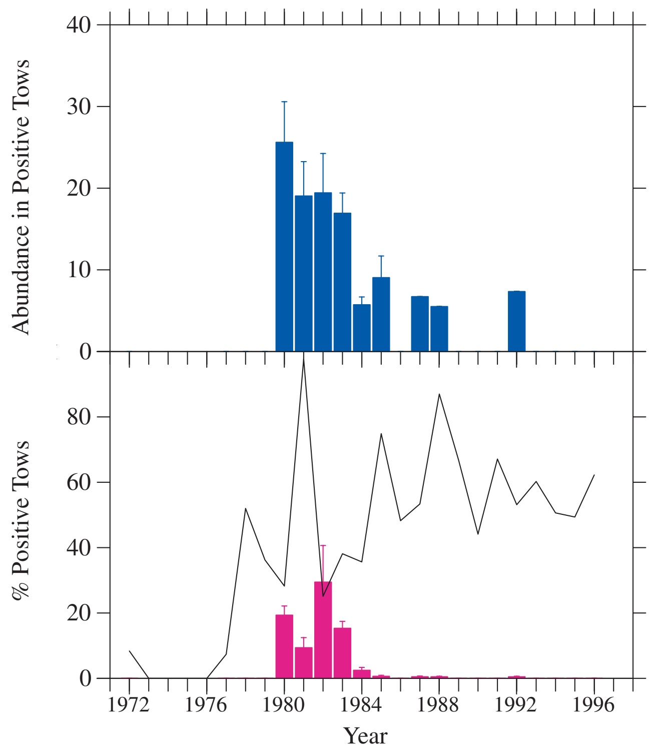
Larval distribution Slender sole larvae are found in Shelikof Strait and west of Kodiak Island in the Gulf of Alaska, off Prince William Sound, and along the U.S. west coast. Larvae are abundant in the nearshore shelf waters off Oregon and northern California. Larvae are found in January, March–June, and in August, with highest abundances in late spring. In winter–spring, larvae range in size from 3 to 46 mm SL, but small, newly hatched larvae <10 mm SL are most abundant. Larvae 8–24 mm SL are collected in summer–fall. Eggs are present in essentially the same areas as larvae with higher abundances along the U.S. west coast. Overall, larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



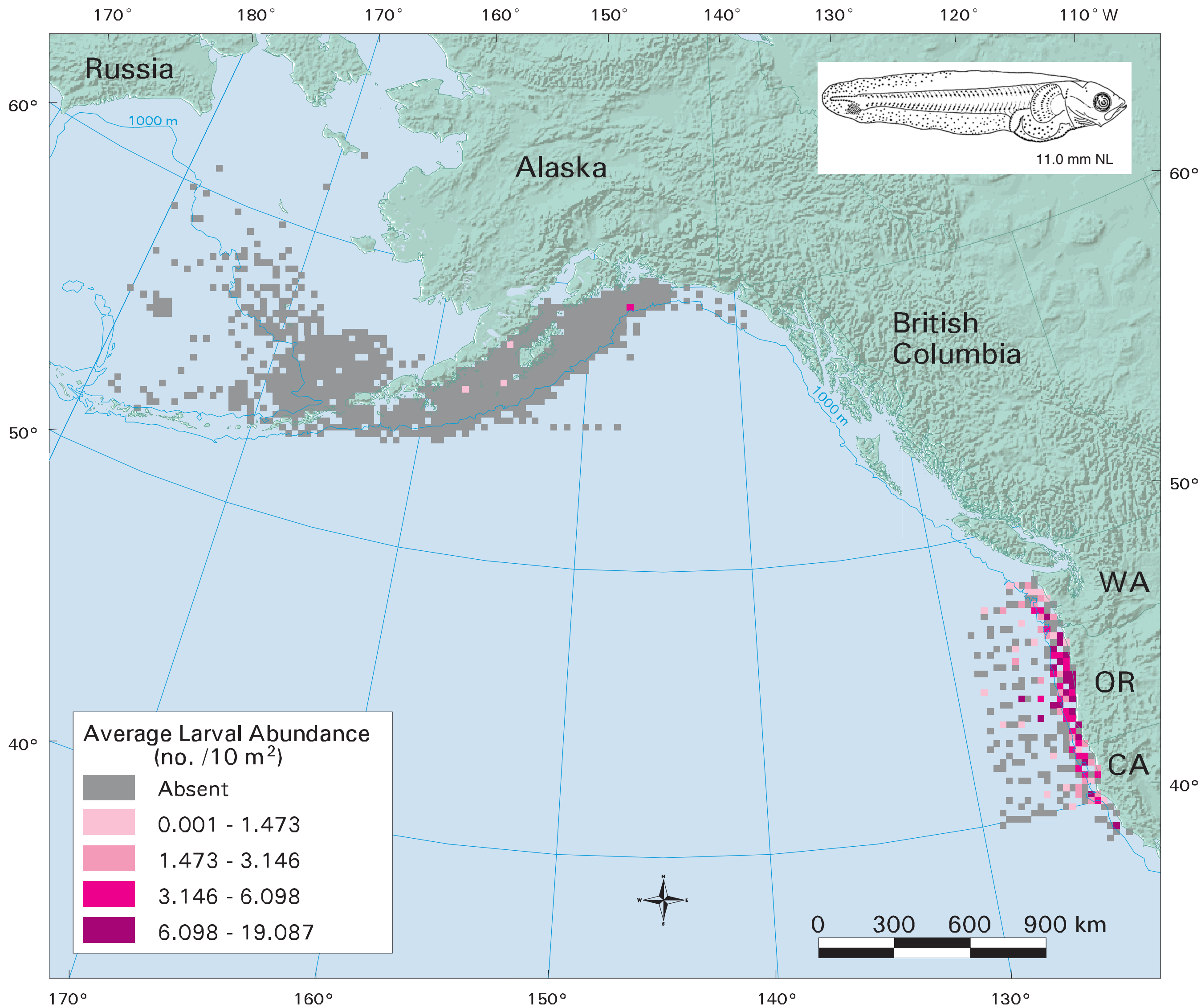
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

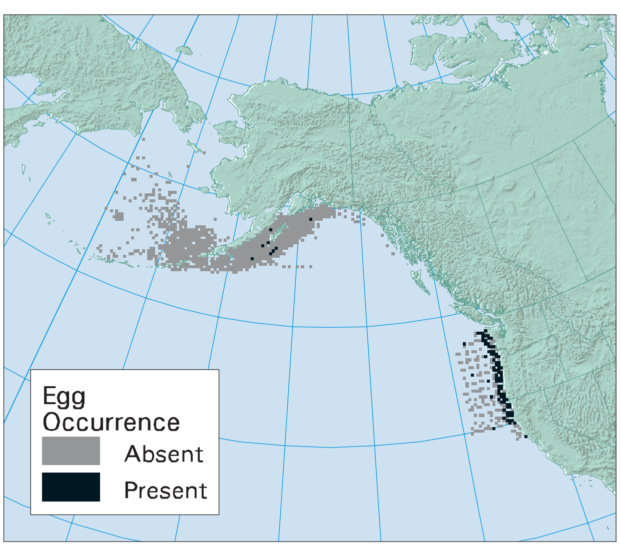


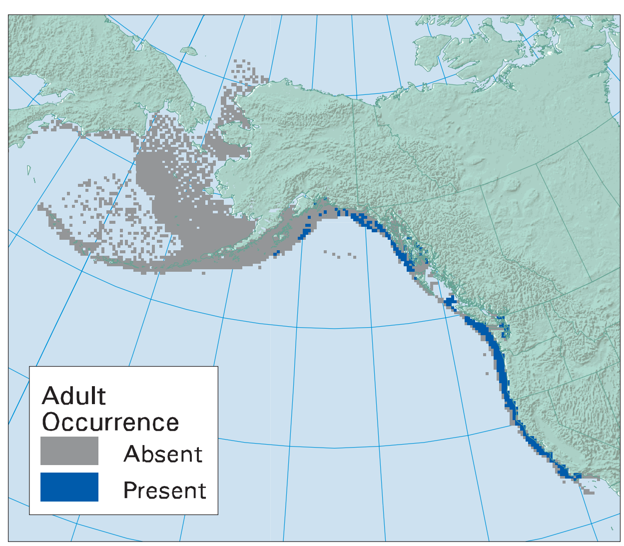
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 446 for winter–spring (Jan–June), 11 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

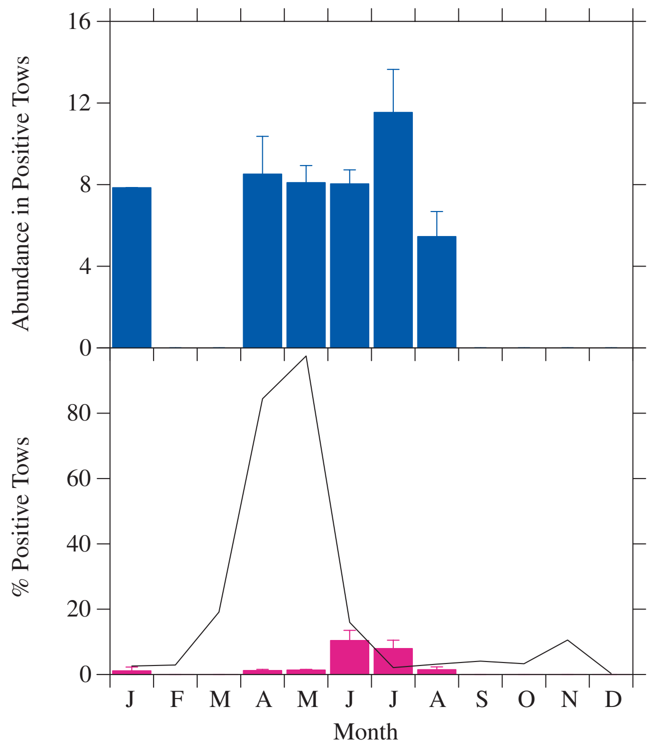

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
11.0 mm NL
British Columbia
WA
OR
CA
Average Larval Abundance (no. /10 m2)
Absent
0.001 - 1.473
1.473 - 3.146
3.146 - 6.098
6.098 - 19.087
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

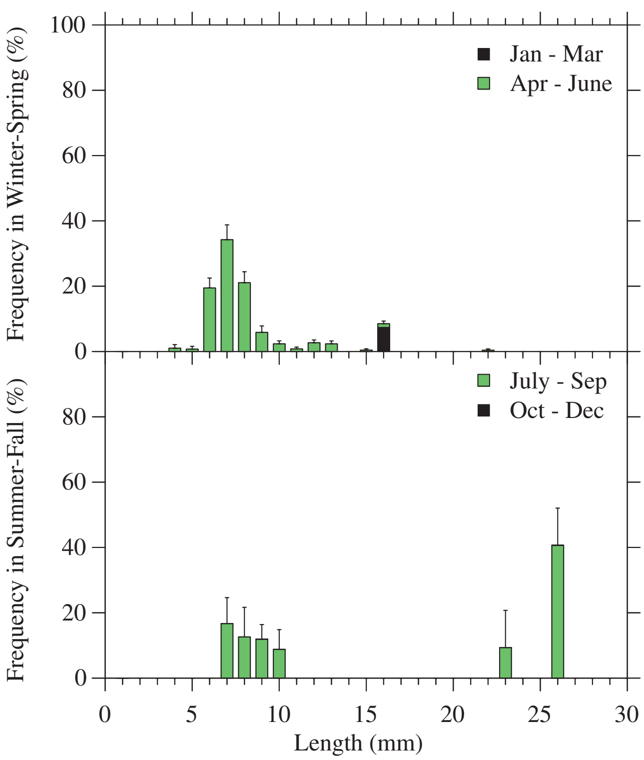

Adult Occurrence
Absent
Present

Life history *Microstomus pacificus* occur from the Bering Sea to Baja California. Adults are benthic and inhabit muddy bottoms 9–1189 m deep, typically on the continental slope. Dover sole are long-lived and may live up to 45 years; age of first maturity is 5 years. Adults migrate offshore to spawn November–February in the southern part of the range, to as late as August in the Bering Sea. Females produce 37,000–260,000 pelagic eggs that are 2.05–2.68 mm in diameter. Pelagic larvae hatch at about 6 mm SL, but metamorphosis is delayed and they may remain planktonic until close to 100 mm SL. Larvae have been collected off the coast of California year-round, but have been most numerous off northern and central California in April–June.
[Sources include: Hart (1973), Matarese et al. (1989), Charter and Moser (1996b)]

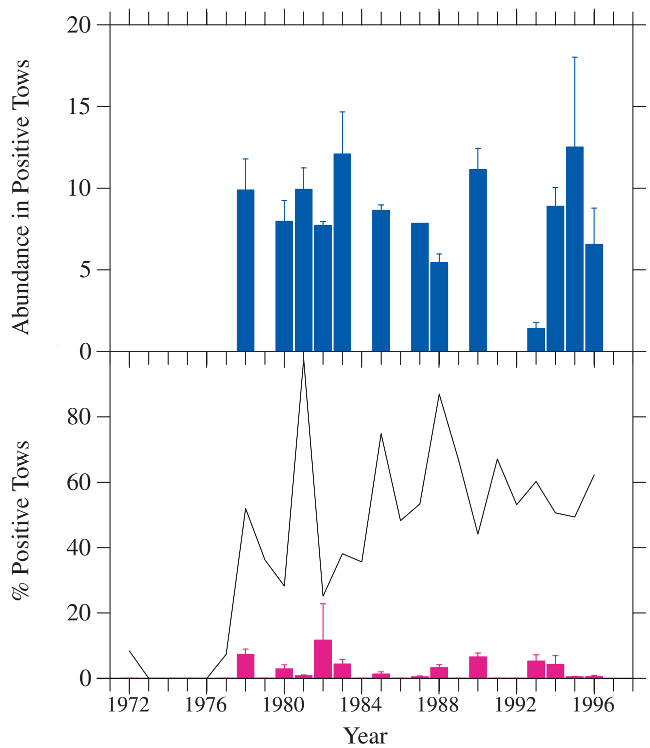
Larval distribution Dover sole eggs and larvae occur throughout the study area, but are generally more abundant in the Gulf of Alaska and off the U.S. west coast; they are rarely collected in the Bering Sea. Highest abundances occur in deeper waters along the shelf and over the slope. Larvae occur in January and April–August; highest abundances occur in July. Small larvae (<10 mm SL) are more abundant in winter–spring, whereas larger larvae (>20 mm SL) occur in summer–fall. Overall, catch was consistent during the years sampled; larvae were collected in most years sampled, but generally at fewer than 10% of the stations.



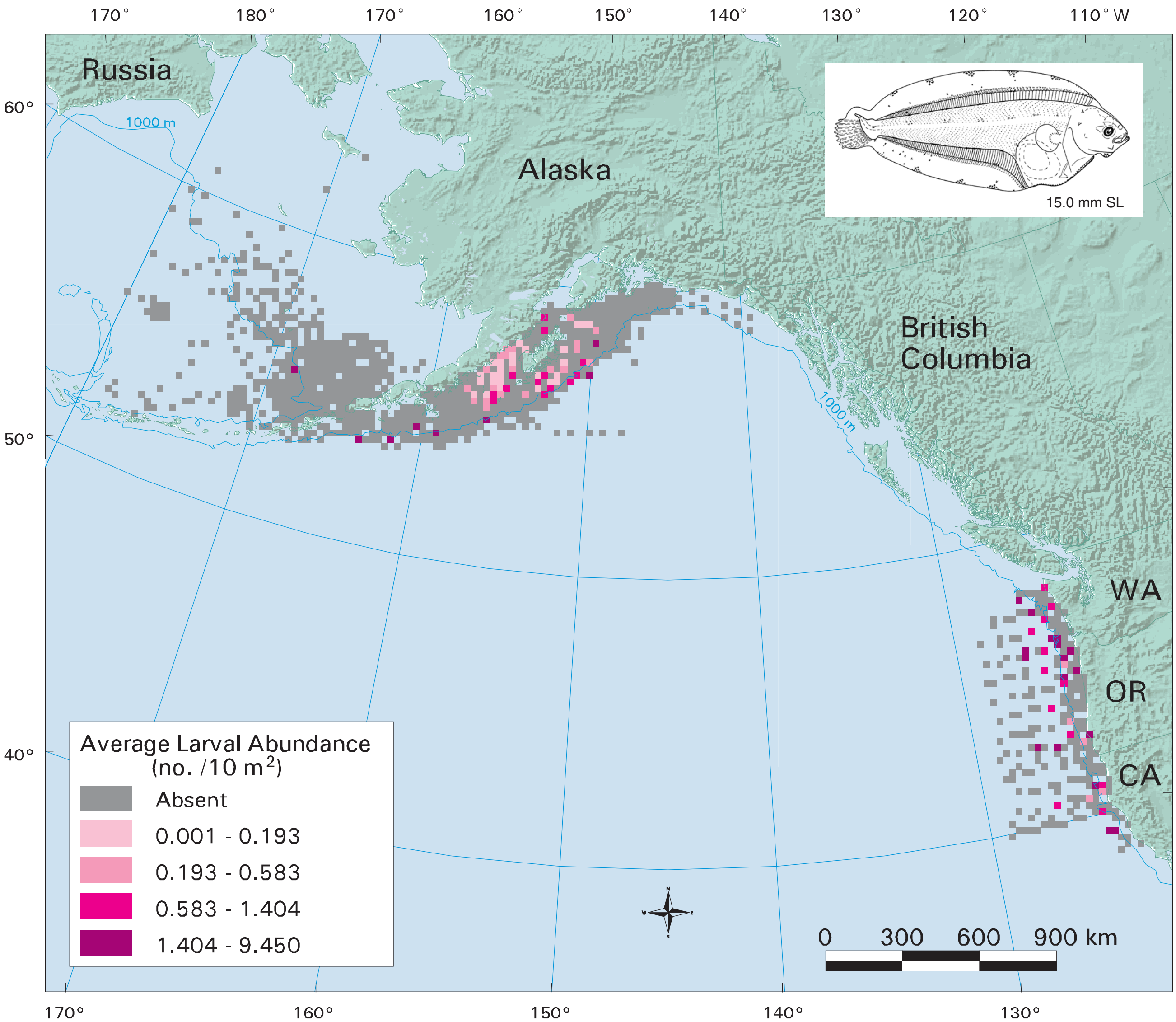
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

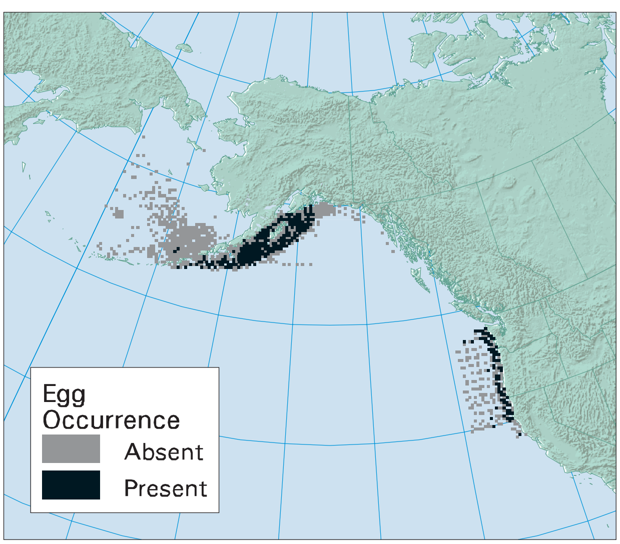


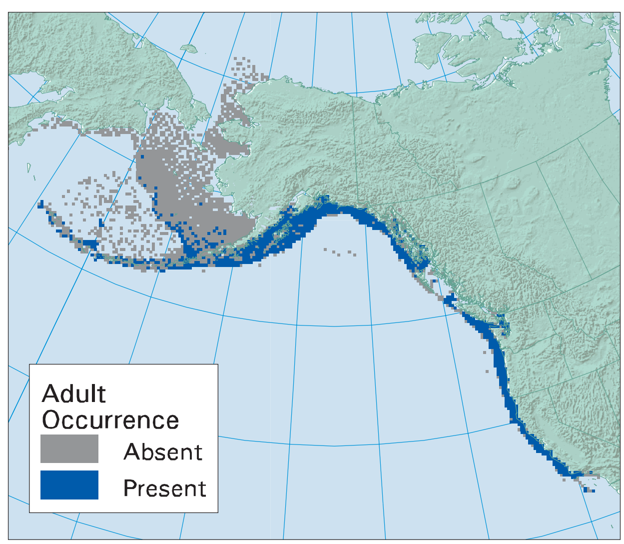
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 164 for winter–spring (Jan–June), 17 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

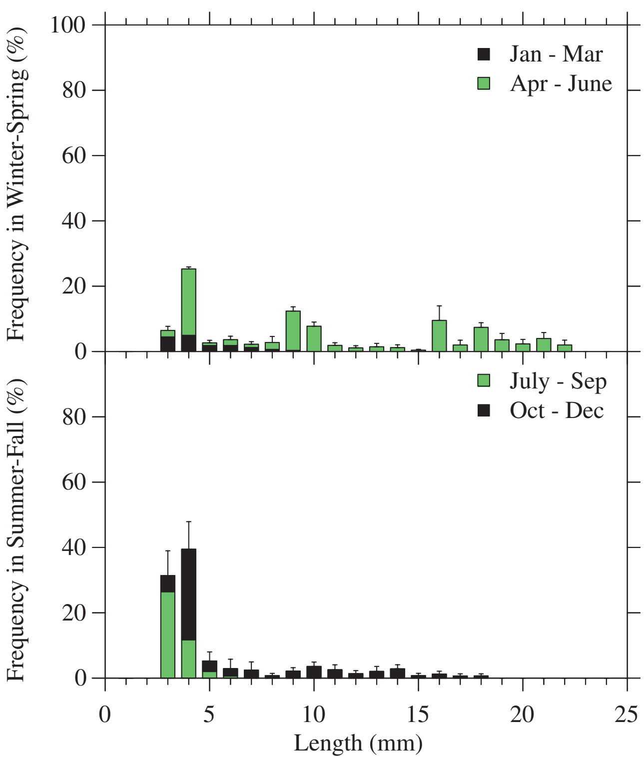

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
170°
160°
150°
140°
130°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
15.0 mm SL
Average Larval Abundance (no. /10 m2)
Absent
0.001 - 0.193
0.193 - 0.583
0.583 - 1.404
1.404 - 9.450
0 300 600 900 km


Egg Occurrence
Absent
Present

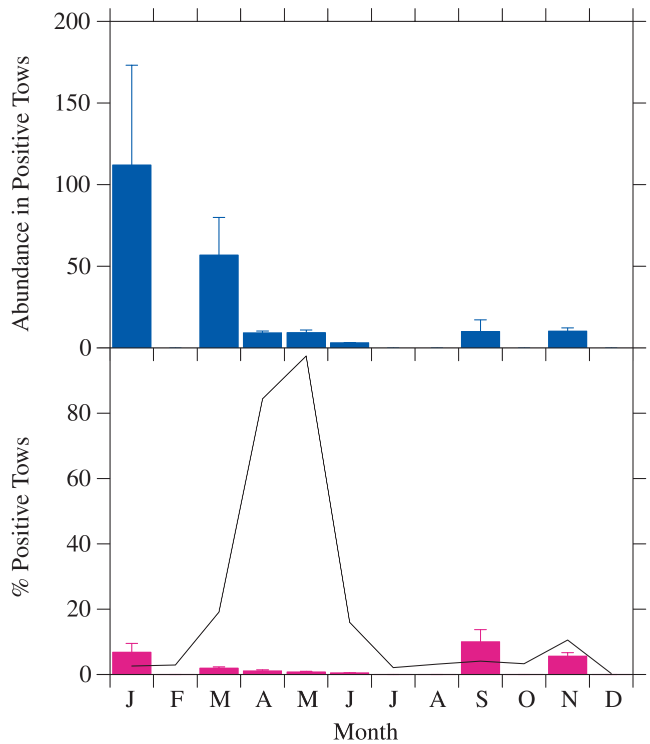

Adult Occurrence
Absent
Present

Life history *Parophrys vetulus* occur from the Bering Sea along the Northeast Pacific coast to Baja California. English sole are demersal and are found on the shelf and upper slope from intertidal areas to depths of 550 m. Adults migrate from feeding areas to spawn in sheltered waters in channels or bights. Spawning times vary with geographic area: October–May in the CalCOFI area; January–April in Puget Sound, Washington; and late spring–summer in Alaskan waters. Pelagic eggs are small (0.80–1.1 mm in diameter) and are easily confused with other similarly-sized pleuronectid eggs (*Isopsetta isolepis*, *Platichthys stellatus*, and *Psettichthys melanostictus*). Pelagic larvae hatch between 2.3 and 2.9 mm SL and undergo transformation at 16.7–17.6 mm SL.
[Sources include: Matarese et al. (1989), Charter and Moser (1996b)]

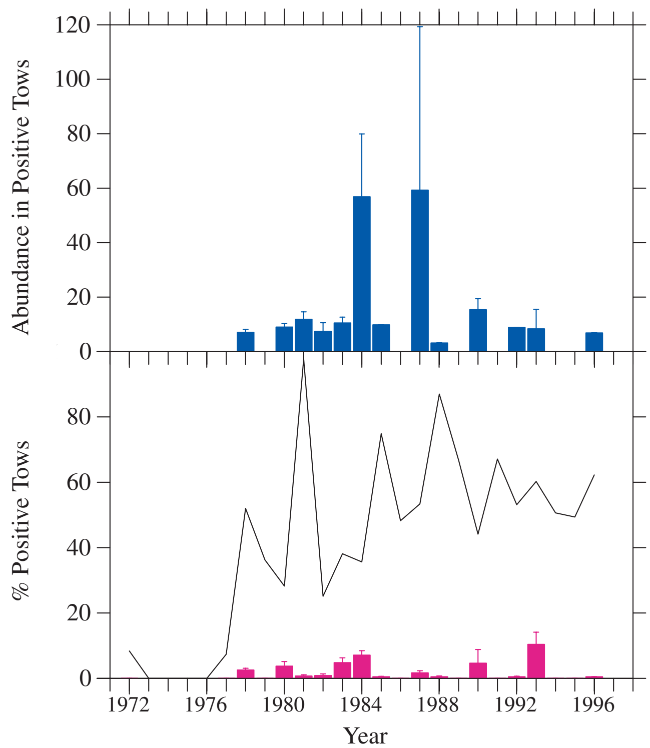
Larval distribution English sole larvae are found in the Gulf of Alaska from west of Kodiak Island to Cape St. Elias, and along the U.S. west coast. No eggs or larvae and very few adults have been collected during AFSC surveys in the Bering Sea. Based on our collections, concentrations are greatest near Prince William Sound and off Washington and Oregon. Larvae are collected sporadically January–November, but are more common in early winter. Larvae collected in winter–spring (3–22 mm SL) and summer–fall (3–18 mm SL) span a wide size range, but a greater percentage of newly hatched larvae occur in summer–fall. Early and middle-stage eggs cannot be identified, but late-stage eggs are present in the Gulf of Alaska and off the U.S. west coast. Overall, larvae occurred in <10% of the tows 1978–1996.



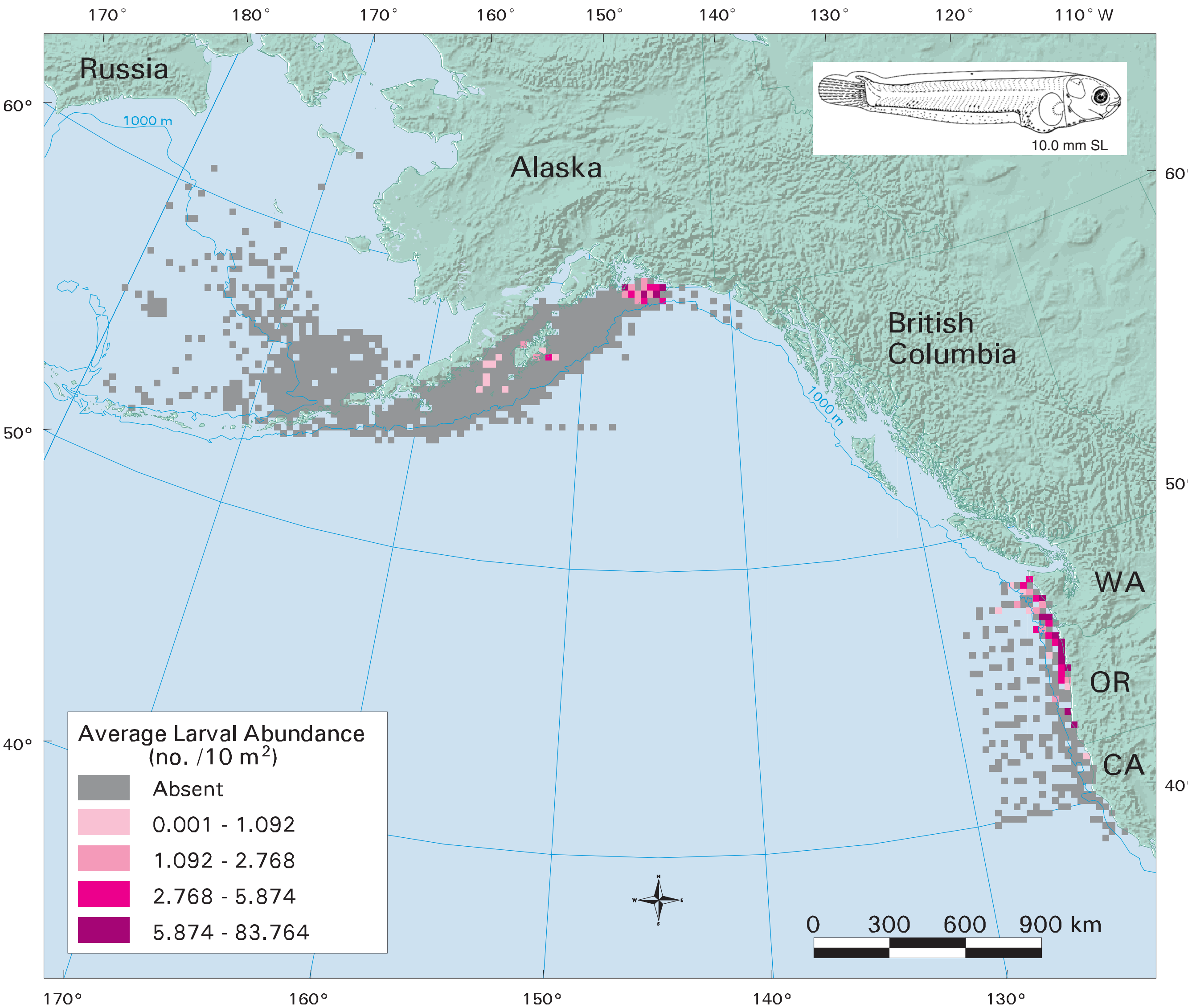
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 288 for winter–spring (Jan–June), 93 for summer–fall (July–Dec).



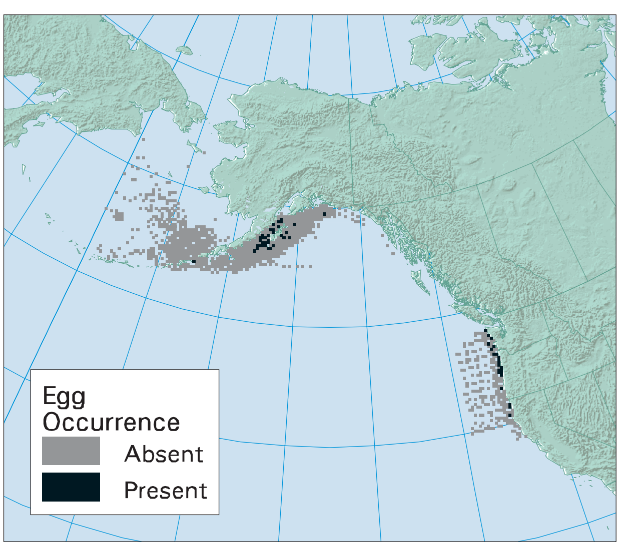
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



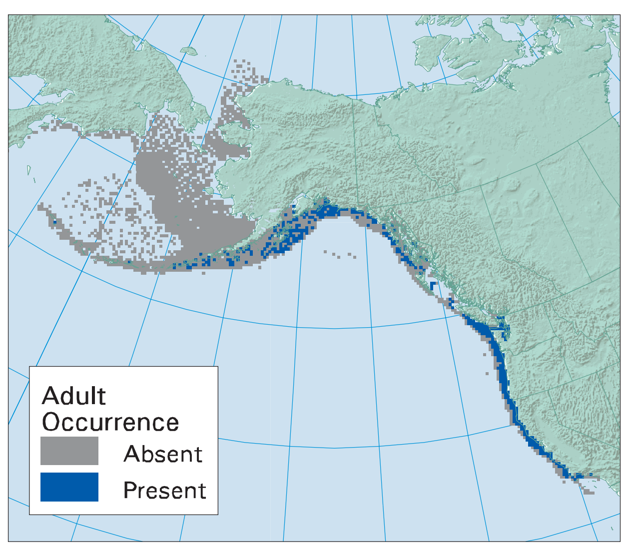
Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.



170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
10.0 mm SL
Average Larval Abundance (no. /10 m^2)
Absent
0.001 - 1.092
1.092 - 2.768
2.768 - 5.874
5.874 - 83.764
0 300 600 900 km
170° 160° 150° 140° 130°



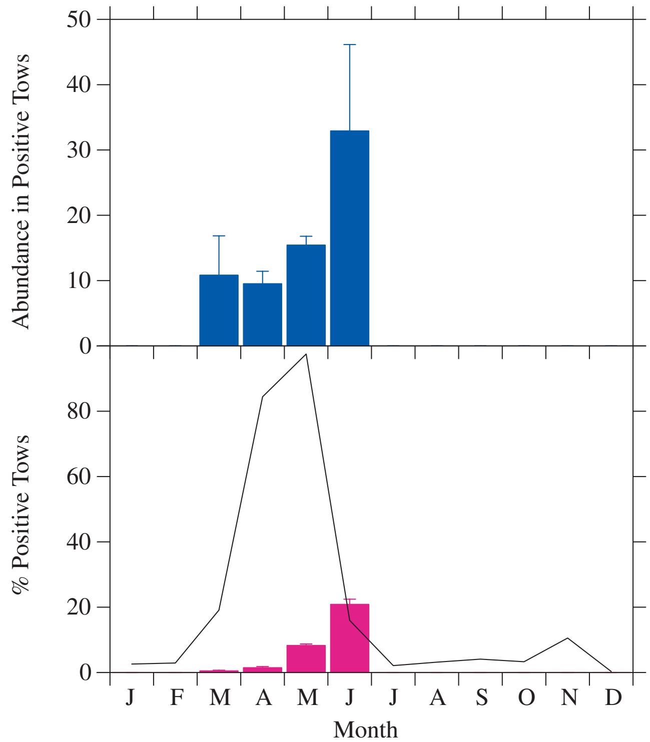
Egg Occurrence
Absent
Present



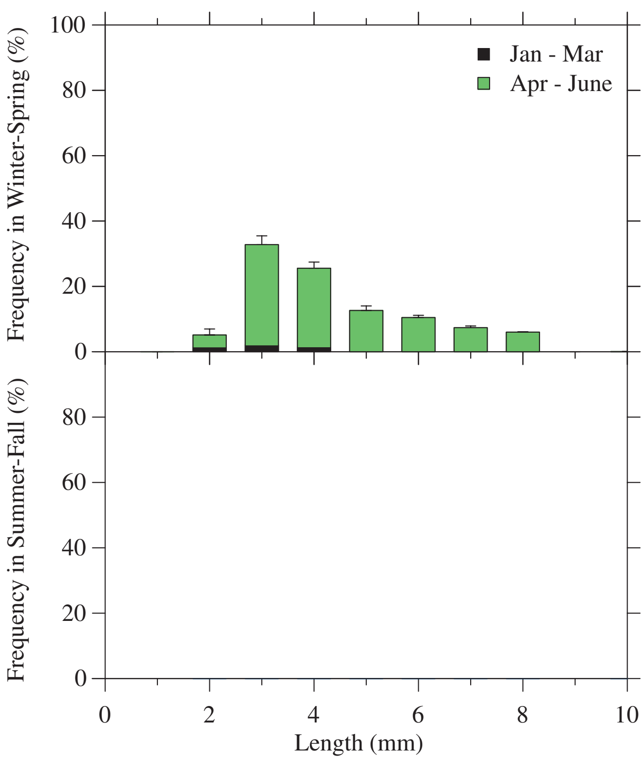
Adult Occurrence
Absent
Present

Life history *Platichthys stellatus* range from the Sea of Japan and Arctic Ocean, the Bering Sea, and along the Northeast Pacific coast to southern California. Adult starry flounder are demersal, occurring on the shelf and upper slope to depths of 375 m, and are often found in estuaries. Spawning times vary with geographic area: winter in the CalCOFI area to as late as spring in the Bering Sea. Pelagic eggs are small (0.88–1.3 mm) and easily confused with other similarly-sized pleuronectid eggs (*Isopsetta isolepis*, *Parophrys vetulus*, and *Psettichthys melanostictus*). Pelagic larvae hatch at 1.9–2.1 mm SL and undergo transformation at smaller sizes than other pleuronectids, 8.3–8.5 mm through 10.5 mm SL. Larvae are collected January–May in the CalCOFI study area, with peak abundance in March.
[Sources include: Matarese et al. (1989), Charter and Moser (1996b)]

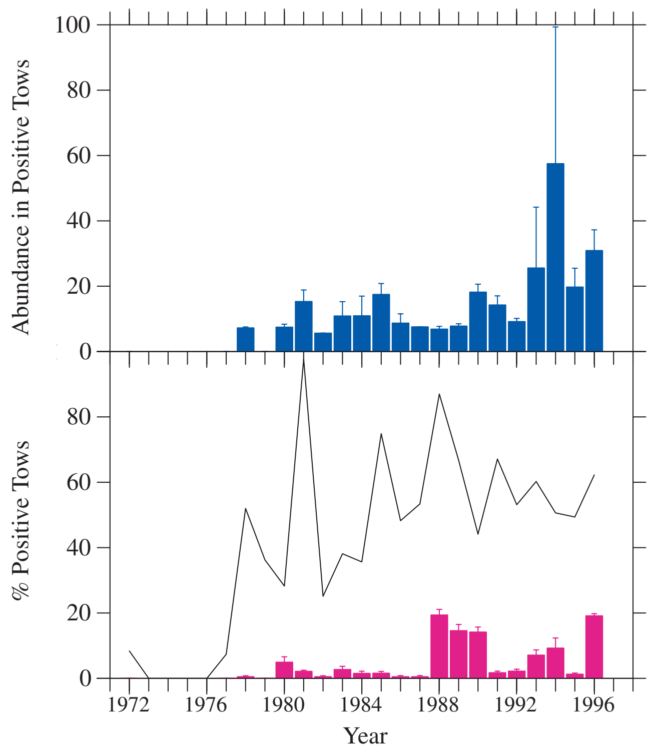
Larval distribution Starry flounder larvae are distributed from the Aleutian Islands east to near Prince William Sound in the Gulf of Alaska, and along the U.S. west coast. During AFSC surveys, adults are abundant in the eastern Bering Sea, an area not routinely sampled for eggs and larvae. Abundant in Shelikof Strait and nearshore along the U.S. west coast, larvae are collected March–June, with high abundances in June. Larvae are small (2–8 mm SL) in winter–spring and undergo an early transition to the juvenile stage. Eggs are present in the Gulf of Alaska and off the U.S. west coast. Overall catch by year indicates that larvae were present 1978–1996, but were common in tows after 1987.



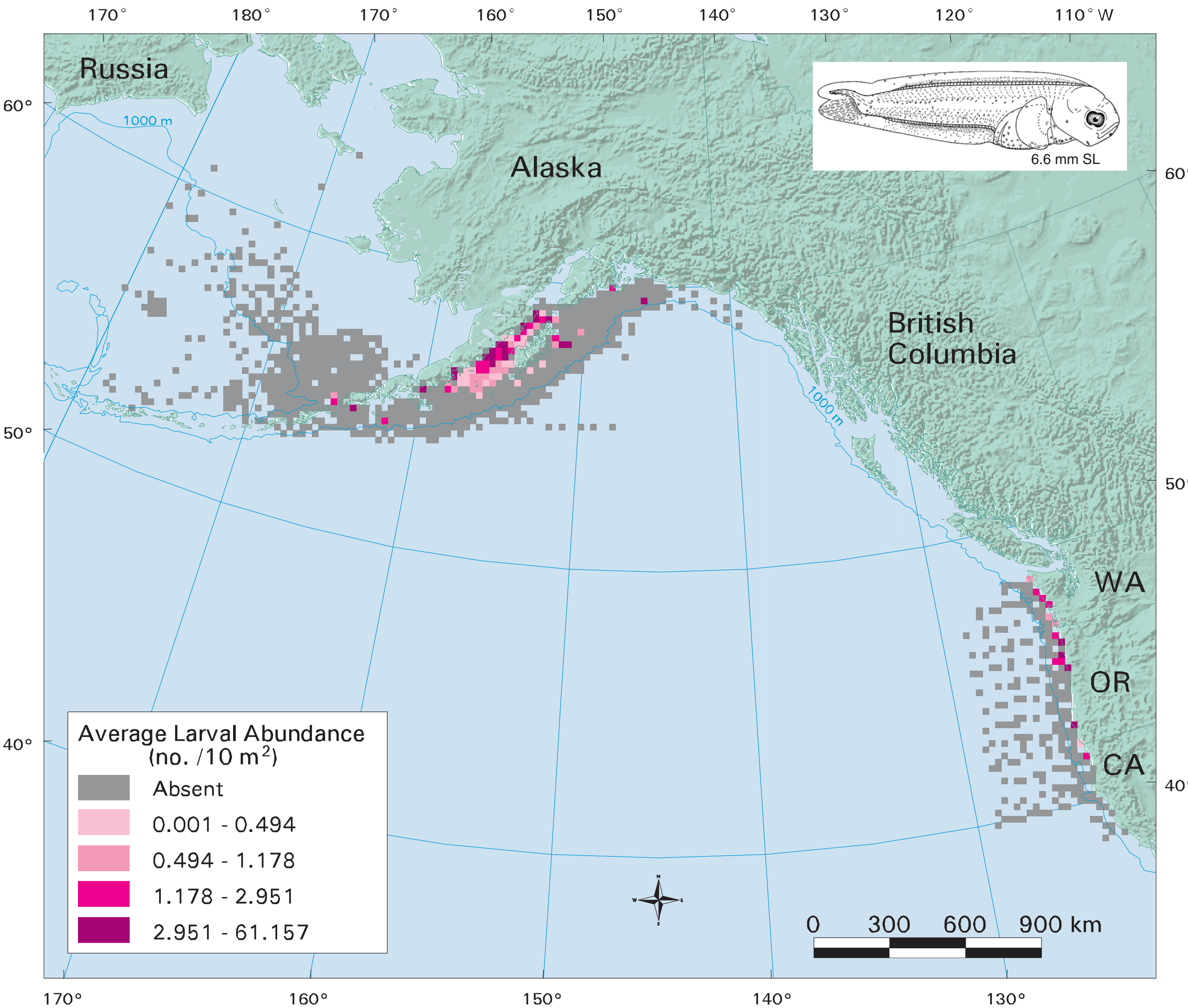
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

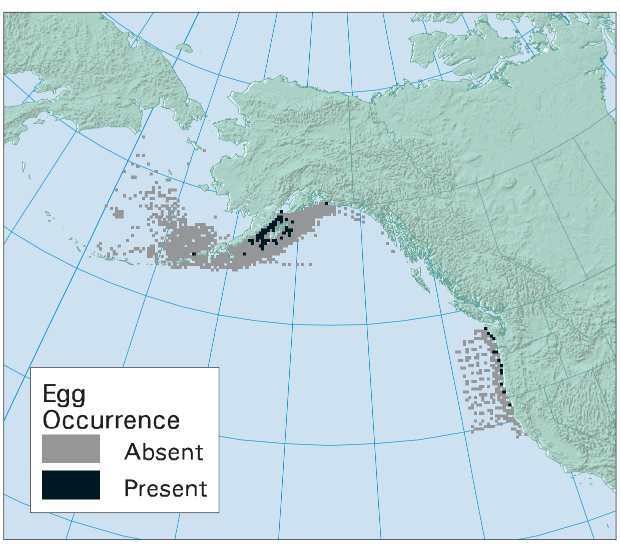


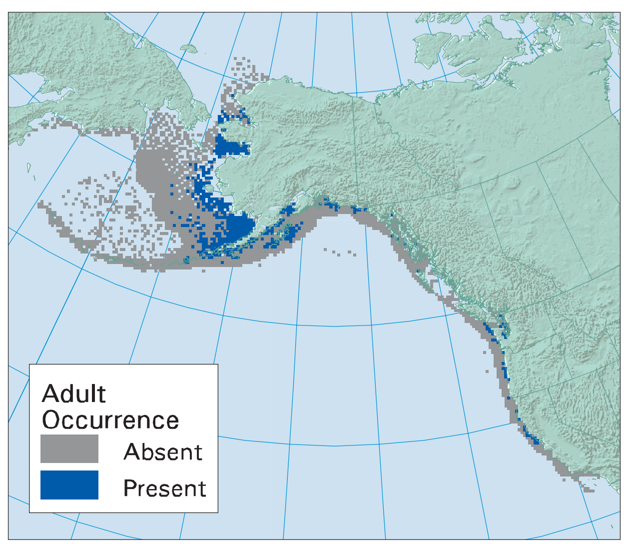
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 1466 for winter–spring (Jan–June).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

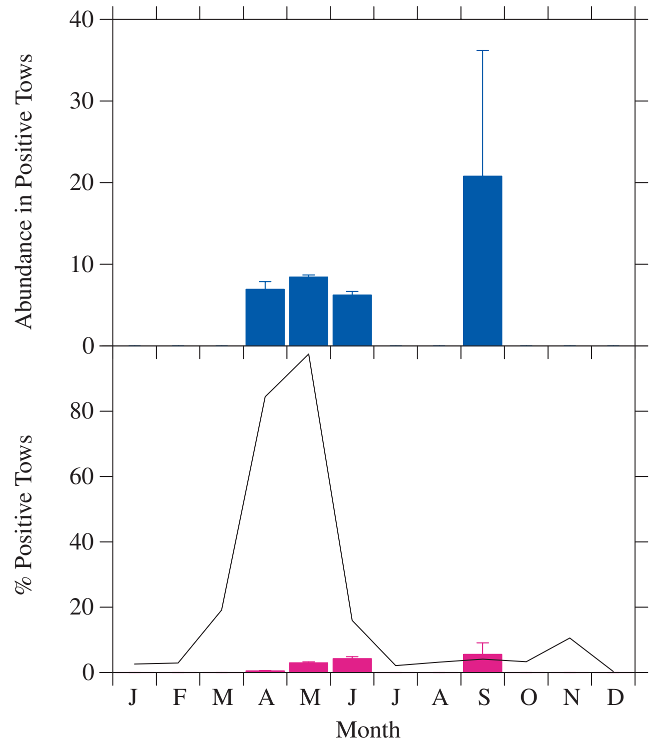

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
170°
160°
150°
140°
130°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
6.6 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.494
0.494 - 1.178
1.178 - 2.951
2.951 - 61.157
0 300 600 900 km


Egg Occurrence
Absent
Present

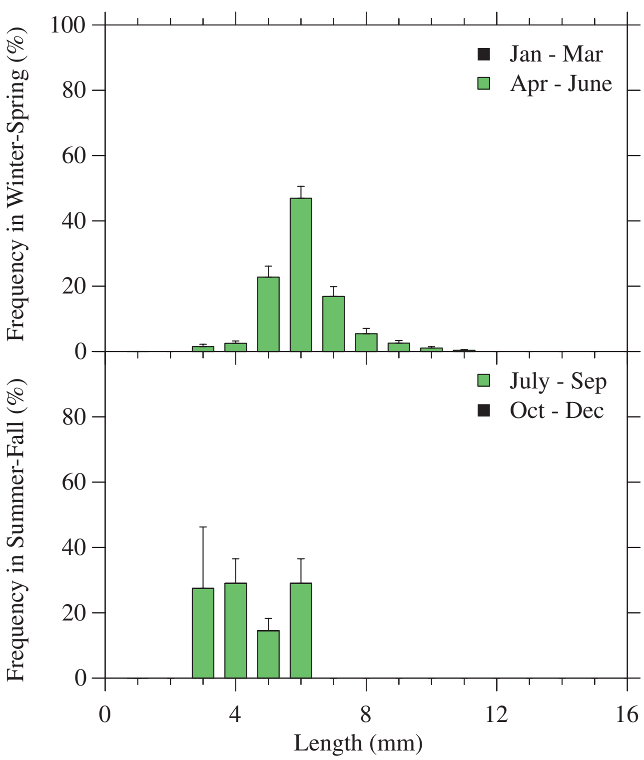

Adult Occurrence
Absent
Present

Life history *Pleuronectes quadrituberculatus* occur from the Chukchi Sea to the Gulf of Alaska. Alaska plaice are benthic and are found at depths of 6–475 m. Adults mature at four years and migrate inshore to spawn in the spring. Pelagic eggs, 1.67–2.21 mm in diameter, have a thick wavy chorion with a bronze color. Pelagic larvae hatch at 5.8 mm SL and begin transformation at 10.7 mm SL.
[Sources include: Matarese et al. (1989)]

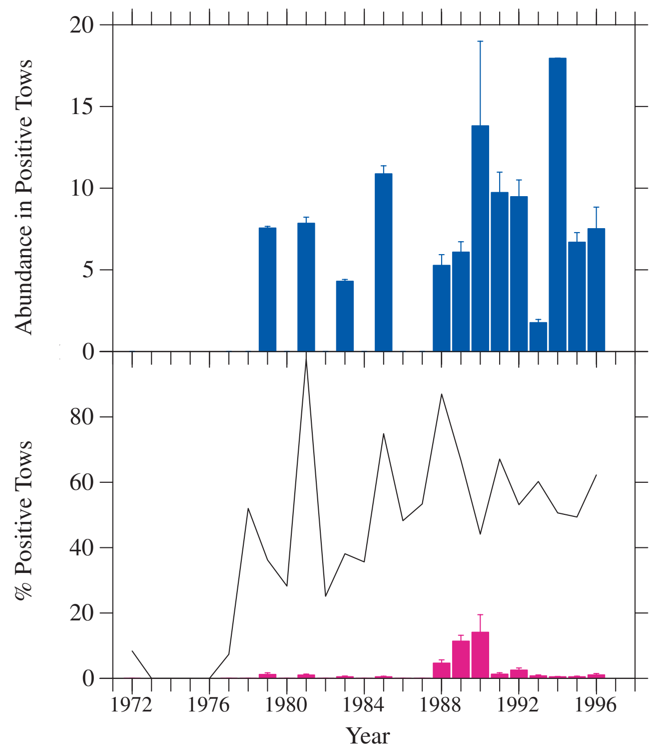
Larval distribution Alaska plaice larvae are collected along the shelf from the central Bering Sea through Unimak Pass and into Shelikof Strait and sea valley. Adults are common along the Bering Sea shelf, but larvae are rarely collected there. Larvae are found April–June and, in higher abundances, in September. Larvae collected are mostly small and newly hatched; 3–11 mm SL in winter–spring and 3–6 mm SL in summer–fall. Eggs are commonly collected throughout the shelf along their range and are more frequently encountered in the Bering Sea than larvae. Overall catch by year indicates that although larvae were collected in most years from 1979 to 1996, the majority were collected from 1988 to 1990.



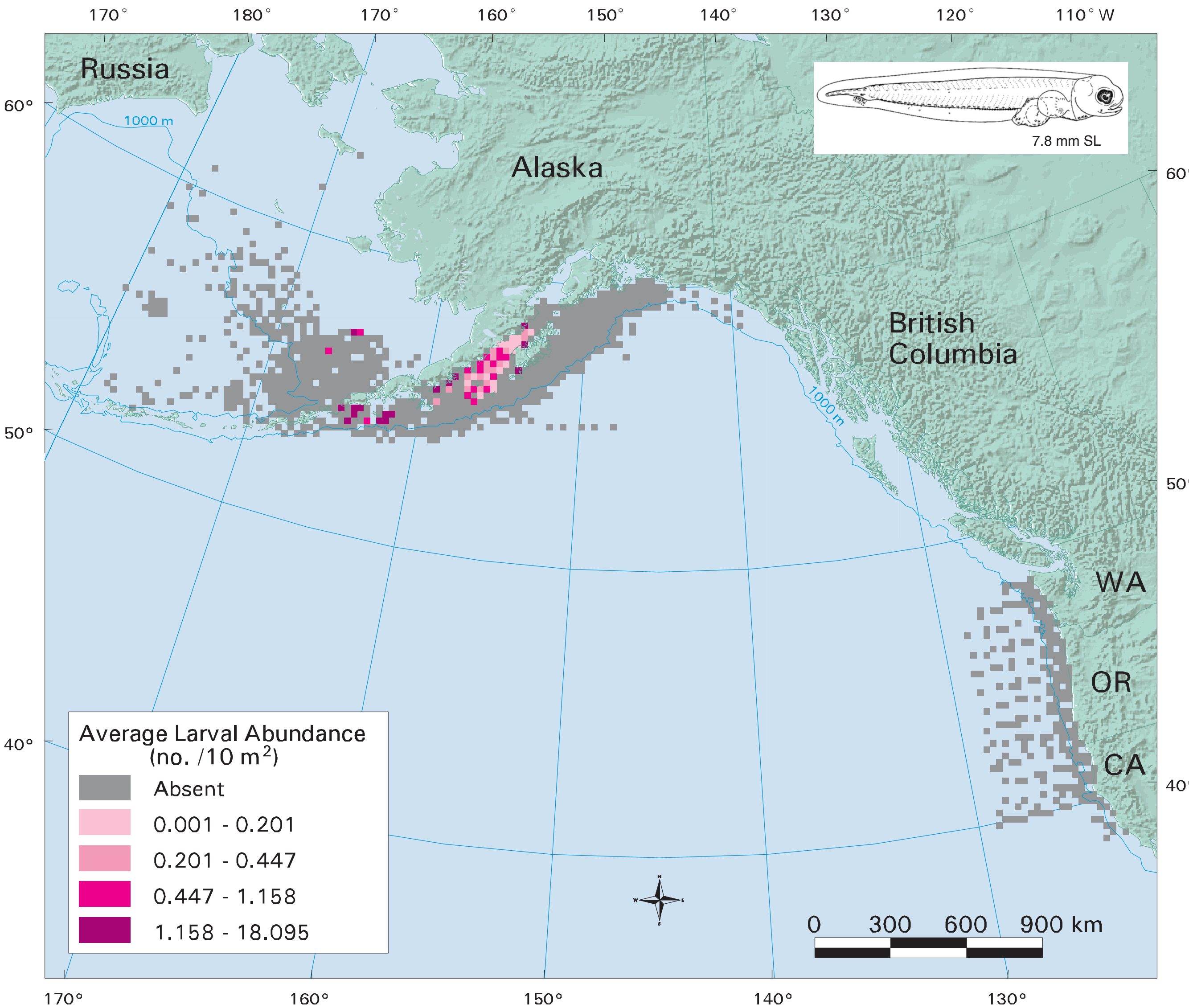
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

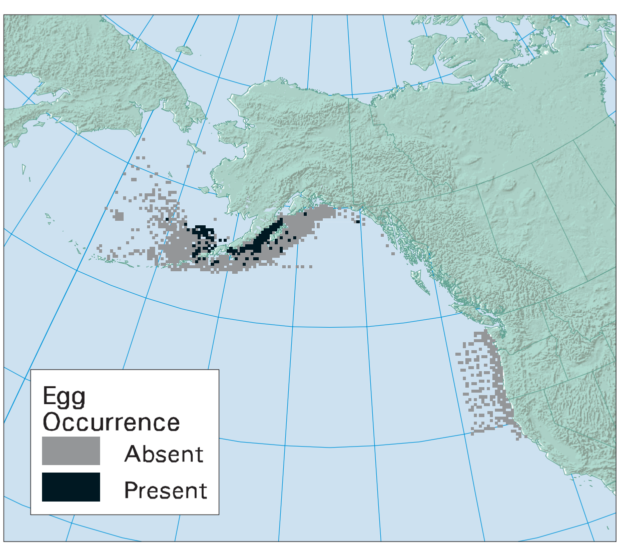


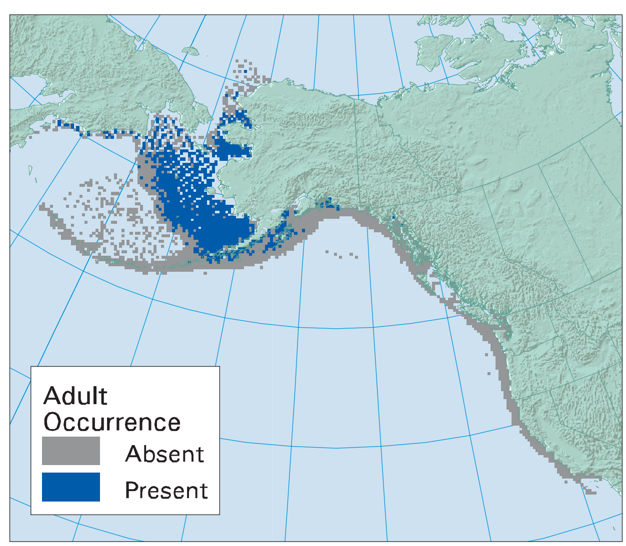
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 215 for winter–spring (Jan–June), 7 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

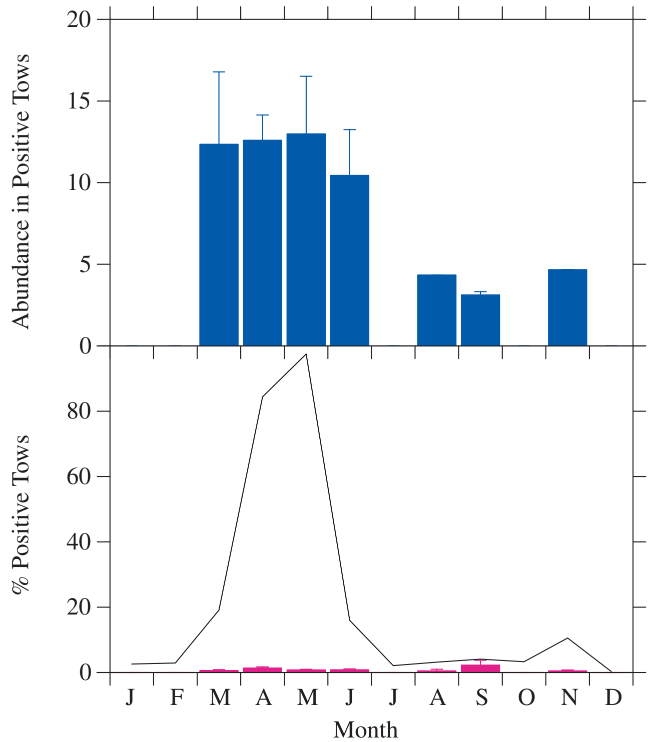

170° 180° 170° 160° 150° 140° 130° 120° 110° W
60° 50° 40°
170° 160° 150° 140° 130°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
7.8 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.201
0.201 - 0.447
0.447 - 1.158
1.158 - 18.095
0 300 600 900 km


Egg Occurrence
Absent
Present

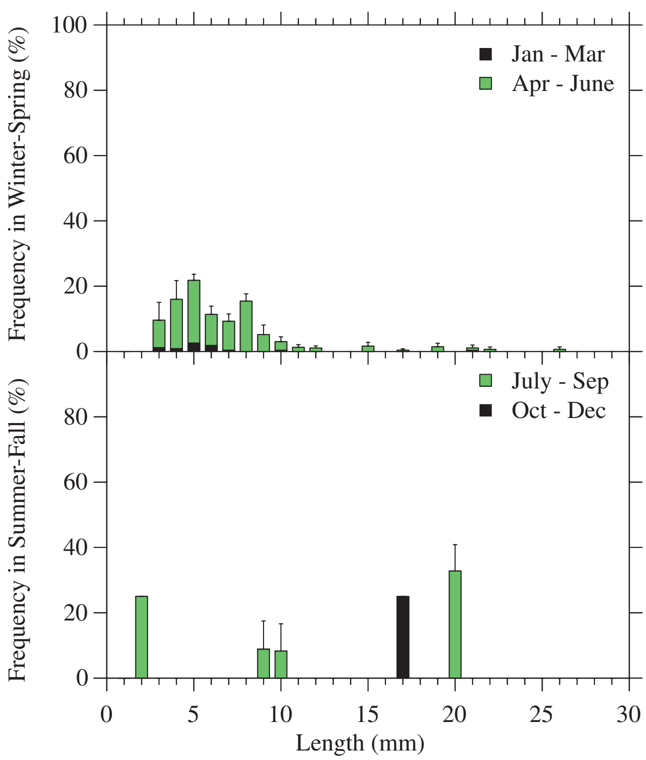

Adult Occurrence
Absent
Present

Life history *Psettichthys melanostictus* range from the Bering Sea to southern California. Sand sole are generally found inshore in shallow water with a sandy bottom, but they can be found as deep as 325 m. Adults can reach 63 cm TL and mature at 2–3 years. Spawning occurs January–March in Puget Sound, Washington, and as late as July off British Columbia. Pelagic eggs are small (0.83–1.04 mm in diameter) and are easily confused with other similarly-sized pleuronectid eggs (*Isopsetta isolepis*, *Parophrys vetulus*, and *Platichthys stellatus*). Pelagic larvae hatch at 2.1 mm SL and transform from 13.9 mm to >22.6 mm SL. Larvae have been collected January–March, July, August, and October in the CalCOFI area, with a peak abundance in March.
[Sources include: Hart (1973), Matarese et al. (1989), Charter and Moser (1996b)]

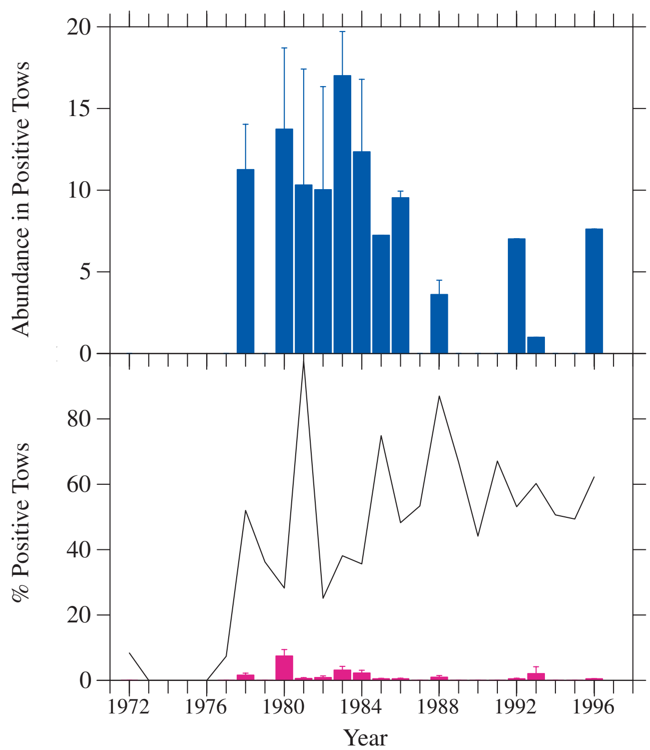
Larval distribution Sand sole larvae are distributed along the shelf around Kodiak Island and along the U.S. west coast. Larvae are most abundant along the nearshore shelf off Washington and Oregon. Larvae are collected from March to November except for July and October; highest abundances are in late winter and spring. Although larvae collected in winter–spring range in length from 3 to 26 mm SL, most are small and newly hatched (<10 mm SL). Early and middle-stage eggs cannot be identified, but late-stage eggs are present in essentially the same areas as larvae. Overall, larvae were most abundant during the 1980s when AFSC conducted U.S. west coast surveys.



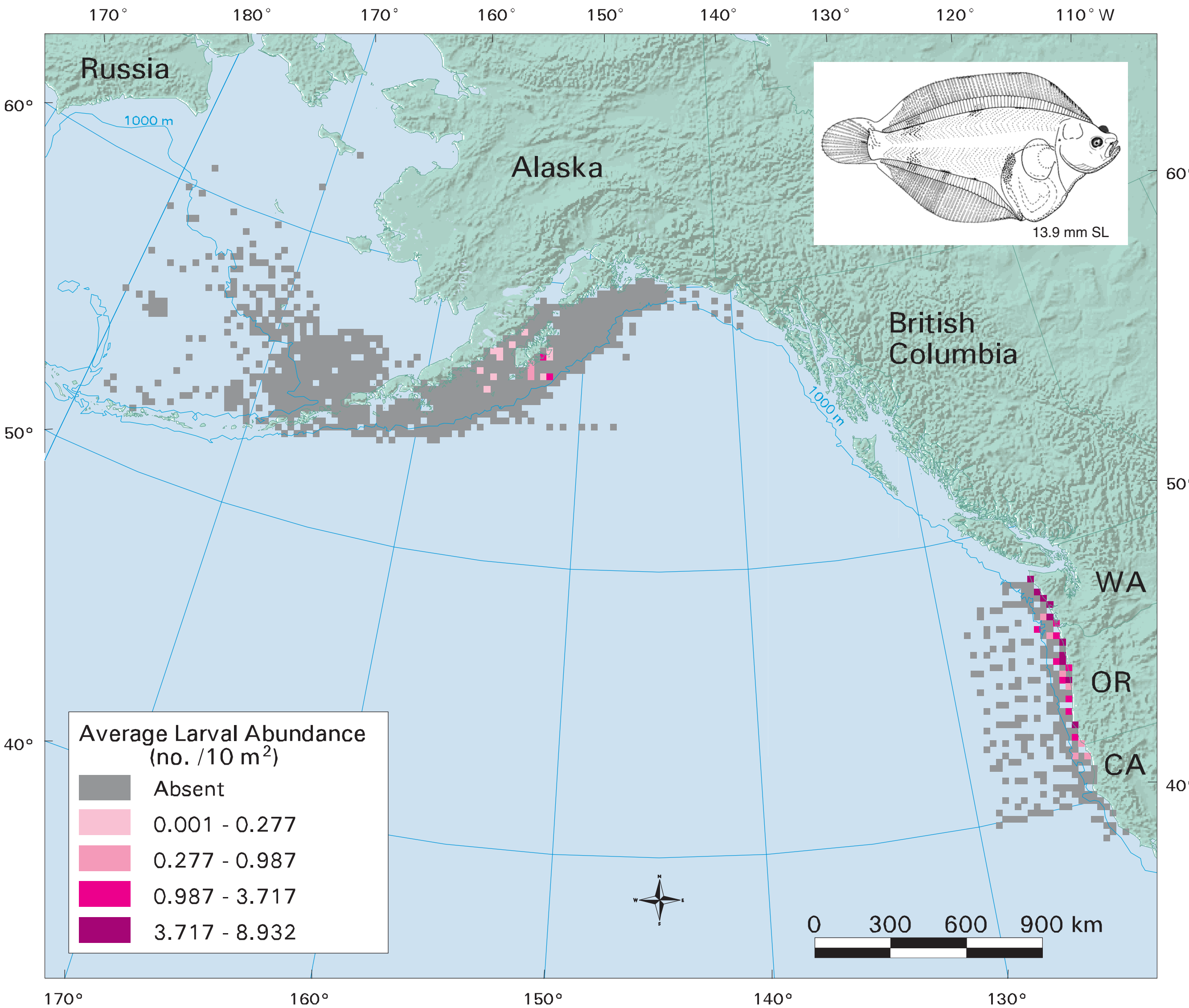
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

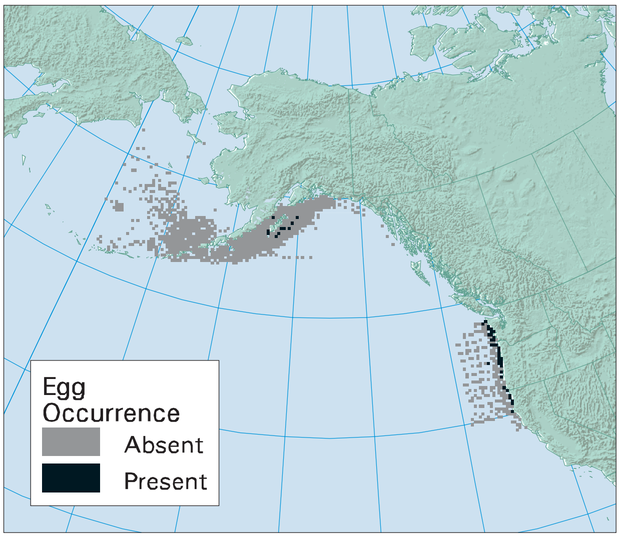


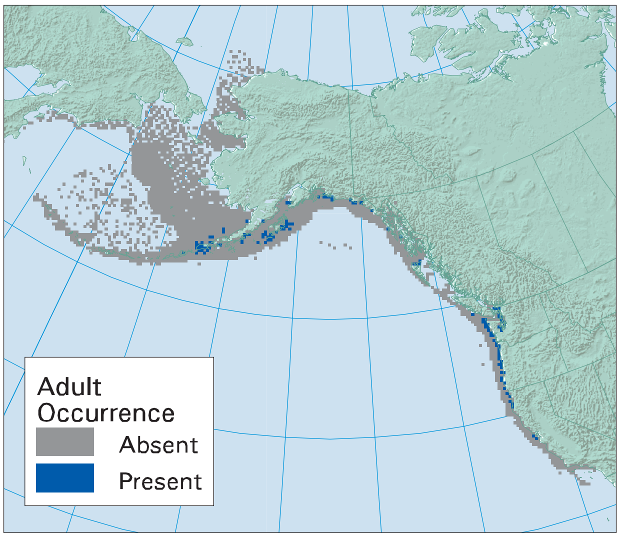
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 112 for winter–spring (Jan–June), 7 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

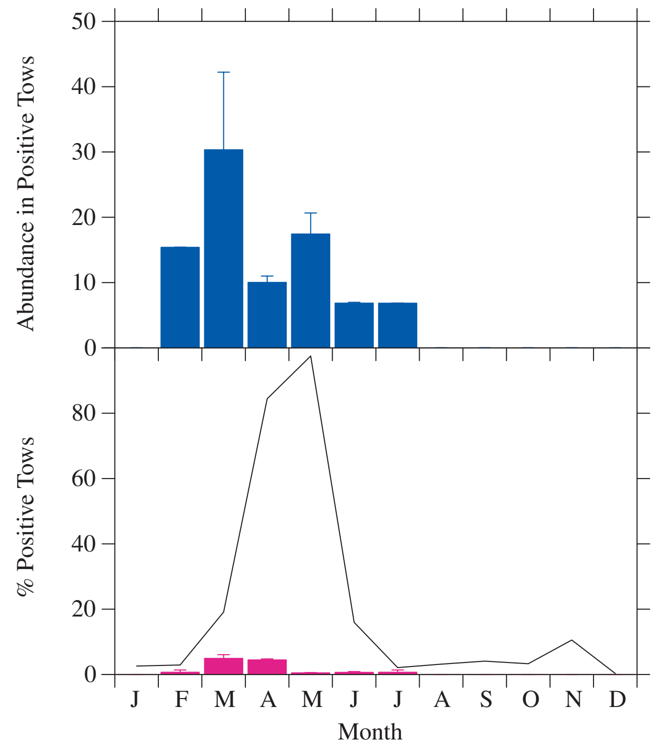

170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
Alaska
British Columbia
WA
OR
CA
1000 m
1000 m
13.9 mm SL
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 0.277
0.277 - 0.987
0.987 - 3.717
3.717 - 8.932
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present

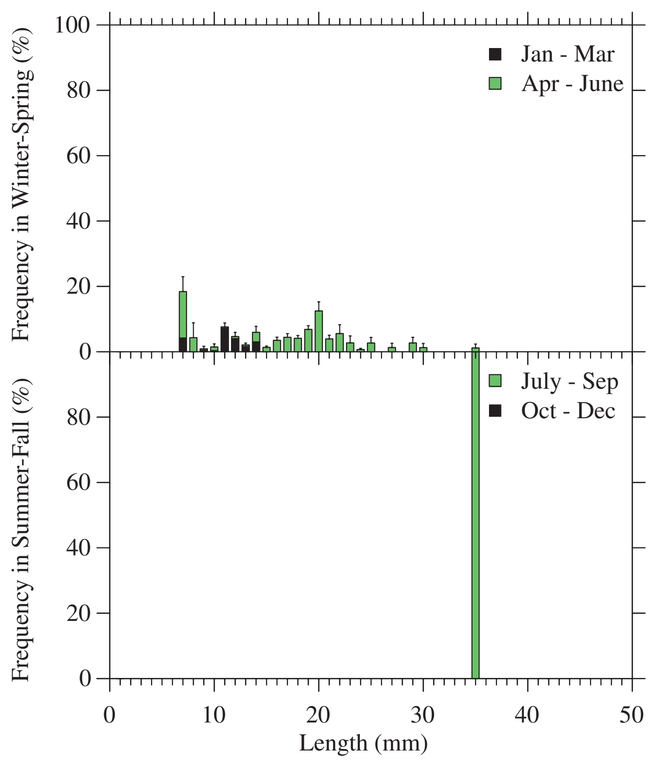

Adult Occurrence
Absent
Present

Life history *Reinhardtius hippoglossoides* occur from the Chukchi Sea to northern Baja California, but specimens caught south of Alaska can be considered strays. Although Greenland halibut have been collected as shallow as 14 m, they usually inhabit deep water and have been caught at depths of 2000 m. Adults live to be >23 years old and can grow to 91 cm TL. In the Atlantic Ocean, females mature at 13 years and spawn 15,000–215,000 eggs during the fall off the shelf break in >100 m of water. Eggs of Greenland halibut in the Atlantic Ocean are large, with a diameter of 4.0–4.5 mm and a smooth, transparent chorion. Pelagic larvae hatch at 10–16 mm SL and transform at 45–65 mm SL.
[Sources include: Jensen (1935), Hart (1973), Eschmeyer et al. (1983), Matarese et al. (1989)]

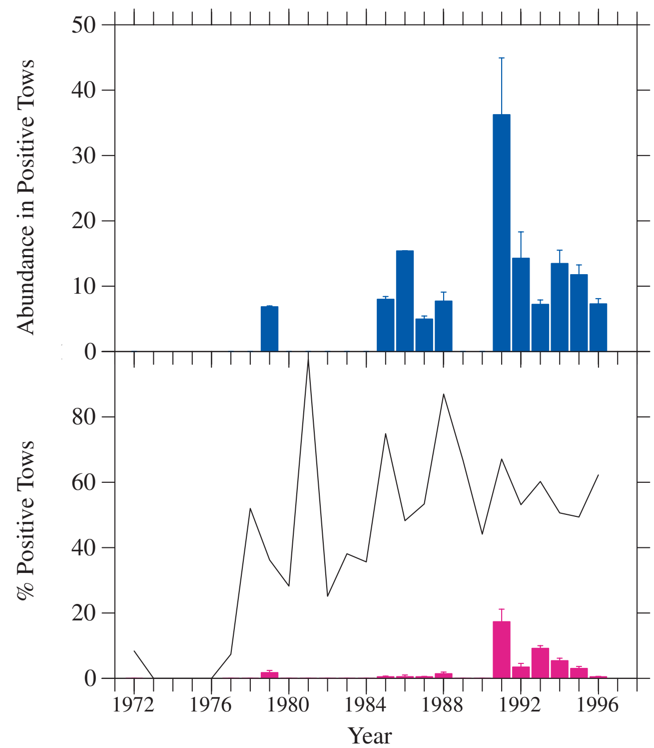
Larval distribution Greenland halibut larvae are found over the slope and outer shelf regions from the central Bering Sea, southward to Unimak Pass, and in the Gulf of Alaska to northeast of Kodiak Island. Highest abundances occur over the shelf edge and slope in the Bering Sea. Larvae are collected February–July, with highest abundances in March. Most newly hatched larvae and early juveniles (7–30 mm SL) are found in winter–spring. Eggs are present in deeper slope waters in the Bering Sea. Overall catch by year indicates that larvae were abundant in AFSC collections after 1990 when surveys in the Bering Sea were more frequent.



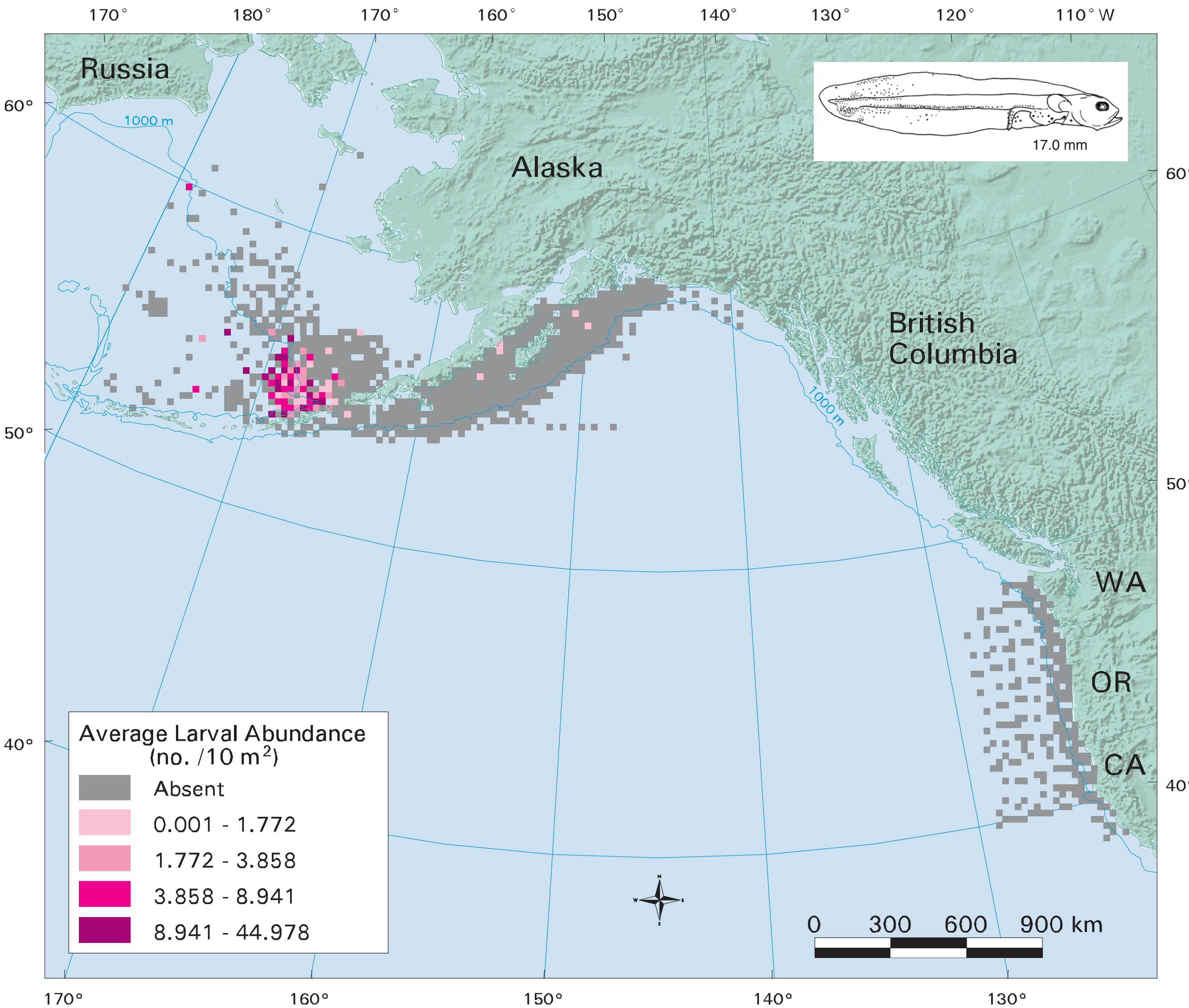
Overall catch by month. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.

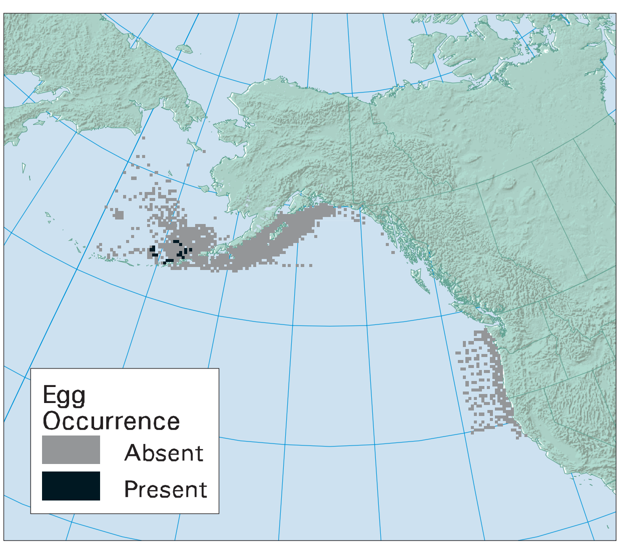


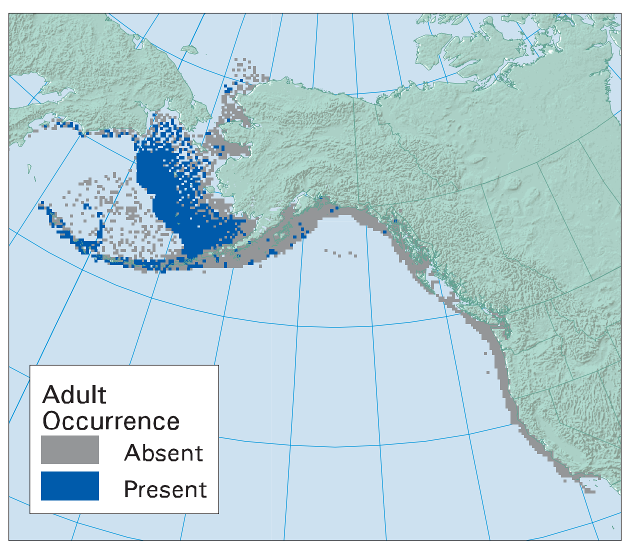
Length distribution of larvae. Shown as a percentage of total catch by season (1972–1996); bars divided into three-month intervals. Sample size = 507 for winter–spring (Jan–June), 1 for summer–fall (July–Dec).



Overall catch by year. Upper histogram: Average abundance (no./10 m^2) of larvae (with std. error bar) at stations where this species occurred. Lower histogram: Percent of stations where species occurred. Black line indicates relative sampling effort.


170°
180°
170°
160°
150°
140°
130°
120°
110° W
60°
50°
40°
Russia
1000 m
Alaska
British Columbia
WA
OR
CA
17.0 mm
Average Larval Abundance (no. /10 m²)
Absent
0.001 - 1.772
1.772 - 3.858
3.858 - 8.941
8.941 - 44.978
0 300 600 900 km
170°
160°
150°
140°
130°


Egg Occurrence
Absent
Present


Adult Occurrence
Absent
Present

Acknowledgments

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Appendix

Estimation of monthly mean abundance stratified by year:

$\bar{\bar{X}}_j$ is the stratified mean catch per 10 m^2 for month j where each year that was sampled is given equal weight. It is estimated by

$$\bar{\bar{X}}_j = \frac{\sum_{i=1}^{I} \bar{X}_{ij}}{I}$$

where j refers to the jth month,
i refers to the ith year,
I is the total number of years,

$\bar{X}_{ij} = \frac{\sum_{k=1}^{n_{ij}} X_{ijk}}{n_{ij}}$ = estimate of the mean catch per 10 m^2 for year i and month j,
k refers to the kth station,
X_{ijk} = catch per 10 m^2 for year i, month j, and station k, and
n_{ij} = number of stations in year i and month j.

$Var(\bar{\bar{X}}_j)$ is the stratified variance of the mean catch per 10 m^2 for month j. It is estimated by

$$V\hat{a}r(\bar{\bar{X}}_j) = \frac{1}{I^2}\sum_{i=1}^{I} V\hat{a}r(\bar{X}_{ij})$$

where

$$V\hat{a}r(\bar{X}_{ij}) = \frac{\sum_{k=1}^{n_{ij}} (X_{ijk} - \bar{X}_{ij})^2}{n_{ij}(n_{ij}-1)}$$

Estimation of monthly percentage of positive tows, stratified by year:

$\bar{\bar{Y}}_j$ is the stratified percentage of positive tows for month j where each year that was sampled is given equal weight. It is estimated by

$$\bar{\bar{Y}}_j = \frac{\sum_{i=1}^{I} \bar{Y}_{ij}}{I}$$

where $\bar{Y}_{ij} = 100 \times \frac{\sum_{k=1}^{n_{ij}} Y_{ijk}}{n_{ij}}$ = estimate of the percentage of positive tows for year i and month j,

$Y_{ijk} = \begin{cases} 1 \text{ if station } k \text{ in month } j \text{ and year } i \text{ is positive,} \\ 0 \text{ otherwise, and} \end{cases}$

n_{ij} = number of stations in year i and month j.

$\text{Var}(\bar{\bar{Y}}_j)$ is the stratified variance of the percentage of positive tows for month j. It is estimated by

$$V\hat{a}r(\bar{\bar{Y}}_j) = \frac{1}{I^2}\sum_{i=1}^{I} V\hat{a}r(\bar{Y}_{ij})$$

where

$$V\hat{a}r(\bar{Y}_{ij}) = \frac{\bar{Y}_{ij}(100 - \bar{Y}_{ij})}{n_{ij}}$$

Estimation of yearly mean abundance stratified by month:

$\bar{\bar{X}}_i$ is the stratified mean catch per 10 m^2 for year i where each month that was sampled is given equal weight. It is estimated by

$$\bar{\bar{X}}_i = \frac{\sum_{j=1}^{J} \bar{X}_{ij}}{J}$$

where J is the total number of months, and
$\bar{X}_{ij}$ is as defined for monthly mean abundance on page 265.

$\text{Var}(\bar{\bar{X}}_i)$ is the stratified variance of the mean catch per 10 m^2 for year i. It is estimated by

$$V\hat{a}r(\bar{\bar{X}}_i) = \frac{1}{J^2}\sum_{j=1}^{J} V\hat{a}r(\bar{X}_{ij})$$

where $V\hat{a}r(\bar{X}_{ij})$ is as defined for monthly mean abundance on page 265.

Estimation of yearly percentage of positive tows, stratified by month:

$\bar{\bar{Y}}_i$ is the stratified percentage of positive tows for year i where each month that was sampled is given equal weight. It is estimated by

$$\bar{\bar{Y}}_i = \frac{\sum_{j=1}^{J} \bar{Y}_{ij}}{J}$$

where $\bar{Y}_{ij}$ and Y_{ijk} are as defined for monthly mean percentages on page 265.

$\text{Var}(\bar{\bar{Y}}_j)$ is the stratified variance of the percentage of positive tows for month j. It is estimated by

$$V\hat{a}r(\bar{\bar{Y}}_j) = \frac{1}{J^2}\sum_{j=1}^{J} V\hat{a}r(Y_{ij})$$

where $V\hat{a}r(\bar{Y}_{ij})$ is as defined for monthly mean abundance on page 265.

Appendix Table 1

Summary of Recruitment Processes Program ichthyoplankton surveys (1972–1996) with positive tows for larvae used in this study. BS = Bering Sea, GOA = Gulf of Alaska, WC = U.S. west coast. Bongo = bongo net, neuston = neuston net, Tucker = Tucker trawl. See methods for additional data on gear types. ICHBASE data not available for years 1973–1976.

Year	Cruise	Area	Dates	Tows	Gear
1972	2KE72	GOA	4/26–5/9	67	bongo
1973					
1974					
1975					
1976					
1977	4MF77	GOA	10/30–11/14	59	bongo
	4MF77	GOA	10/31–11/14	83	neuston
1978	4DI78	GOA	3/29–4/20	85	bongo
				113	neuston
	2MF78	GOA	6/20–7/5	89	bongo
				112	neuston
	3MF78	GOA	9/9–9/21	26	bongo
				28	neuston
	4MF78	GOA	9/26–10/7	66	bongo
				45	neuston
	5MF78	GOA	10/19–11/1	19	bongo
				11	neuston
	1WE78	GOA	10/27–11/13	88	bongo
				92	neuston
	6MF78	GOA	11/8–11/16	43	bongo
				21	neuston
1979	1MF79	GOA	2/14–3/8	88	bongo
				89	neuston
	5TK79	GOA	5/16–5/24	58	bongo
	3MF79	BS	6/1–7/23	126	bongo
				130	neuston
	1PO79	GOA	9/3–9/29	18	bongo
				48	neuston
1980	1TK80	WC	4/20–5/15	125	bongo
				125	neuston
	1PO80	WC	8/1–8/25	101	bongo
				101	neuston
1981	1SH81	GOA	3/5–3/30	131	bongo
			3/5–3/27	130	neuston
	1MF81	GOA	3/12–3/20	31	bongo
	2MF81	GOA	3/30–4/8	89	bongo
	2SH81	GOA	4/16–4/24	60	bongo
				60	neuston
	3MF81	GOA	4/26–5/2	79	bongo
	1PO81	WC	5/9–6/2	131	bongo
				123	neuston
	4MF81	GOA	5/20–5/24	80	bongo
	3SH81	GOA	5/20–5/28	56	bongo
	1DA81	WC	10/24–11/21	125	bongo
				125	neuston
1982	1DA82	GOA	4/4–4/23	83	bongo
				82	neuston
	1PO82	WC	5/3–6/1	56	bongo
				124	neuston
	2DA82	GOA	5/21–5/31	62	bongo
				61	neuston
1983	1EQ83	WC	4/23–5/15	124	bongo
				124	neuston
	1CH83	GOA	5/14–5/30	68	bongo
			5/14–5/28	73	neuston

Continued

Appendix Table 1 (continued)

Year	Cruise	Area	Dates	Tows	Gear
1983 (continued)	1MF83	WC	11/12–12/2	113	bongo
				113	neuston
1984	1PO84	WC	3/11–4/5	124	bongo
				124	neuston
	3CH84	GOA	3/28	4	bongo
	1SH84	GOA	4/7–5/4	157	bongo
				157	neuston
1985	1DI85	GOA	3/11–3/28	69	bongo
	1PO85	GOA	3/29–4/21	154	bongo
				151	neuston
	1MF85	GOA	4/9	1	bongo
	1BA85	WC	4/19–5/11	124	bongo
				124	neuston
	2MF85	GOA	5/3–5/11	62	bongo
	2PO85	GOA	5/16–6/8	189	bongo
				189	neuston
1986	MF8602	BS	2/16–2/28	48	bongo
	1GI86	GOA	3/30–4/20	149	bongo
				149	neuston
	1MF86	GOA	4/4–4/12	81	bongo
	2MF86	GOA	5/2–5/18	108	bongo
1987	1MF87	WC	1/7–1/28	88	bongo
				88	neuston
	2MF87	GOA	4/4–4/16	143	bongo
	1BB87	GOA	4/9–4/27	117	bongo
	3MF87	GOA	5/19–5/27	60	bongo
	4MF87	GOA	6/20–7/11	19	bongo
1988	1OC88	BS	3/17–4/4	61	bongo
	1DN88	GOA	3/19–4/11	157	bongo
	1MF88	GOA	4/1–4/12	173	bongo
	1DN88	BS	4/11–5/8	46	bongo
	2MF88	GOA	4/17–4/30	64	bongo
	3MF88	GOA	5/6	13	bongo
	4MF88	GOA	5/20–6/7	176	Tucker
			5/21–6/7	6	bongo
1989	1MF89	GOA	4/6–4/15	128	bongo
	2MF89	GOA	4/26–5/5	92	bongo
	3MF89	GOA	5/9–5/24	211	bongo
	4MF89	GOA	5/29–6/5	99	Tucker
			6/3	4	bongo
1990	1MF90	GOA	4/8–4/13	107	bongo
	2MF90	GOA	5/7–5/15	90	bongo
	3MF90	GOA	5/18–5/24	17	bongo
	4MF90	GOA	5/28–6/5	133	bongo
	5MF90	GOA	9/8–9/20	6	bongo
1991	0MF91	BS	3/11–3/15	20	bongo
	1MF91	GOA	4/2–4/13	90	bongo
	1MP91	BS	4/14–5/8	61	bongo
	2MF91	GOA	4/16–4/27	150	bongo
	3MF91	GOA	5/1–5/13	119	bongo
	4MF91	GOA	5/17–5/25	97	bongo
1992	1MF92	GOA	4/5–4/10	94	bongo
	2MF92	BS	4/16–4/18	36	bongo
	3MF92	GOA	5/2–5/14	158	bongo
	4MF92	GOA	5/18–5/28	137	bongo
1993	2MF93	GOA	4/6–4/11	96	bongo
	3MF93	BS	4/15–4/30	119	bongo
	4MF93	GOA	5/3–5/13	141	bongo

Continued

Appendix Table 1 (continued)

Year	Cruise	Area	Dates	Tows	Gear
1993 (continued)	5MF93	GOA	5/23–6/3	114	bongo
	6MF93	GOA	9/7–9/17	12	Tucker
1994	3MF94	GOA	3/14–4/9	19	bongo
	4MF94	GOA	4/15–4/30	128	bongo
	5MF94	GOA	5/2–5/15	89	bongo
	6MF94	GOA	5/24–6/1	139	bongo
	7MF94	BS	7/17–9/6	10	neuston
	1SU94	BS	9/4–9/13	30	bongo
			9/12	2	neuston
	8MF94	BS	9/21–9/24	2	neuston
	8MF94	GOA	9/25–9/28	2	neuston
1995	1MF95	BS	2/19	1	bongo
	1MF95	BS	2/22	2	bongo
	2MF95	BS	3/8	1	bongo
	4MF95	GOA	3/17–3/24	5	bongo
	6MF95	BS	4/17–4/30	137	bongo
	7MF95	BS	5/4–5/18	134	bongo
	8MF95	GOA	5/21–5/28	99	bongo
	2SU95	BS	9/11–9/18	16	Tucker
1996	2MF96	BS	3/6	1	bongo
	5MF96	BS	4/23–4/24	4	Tucker
	1DI96	GOA	4/26–5/6	154	bongo
	6MF96	GOA	5/2–5/14	183	bongo
	6MF96	BS	5/15	5	bongo
	7MF96	BS	5/19–5/20	5	Tucker
	8MF96	GOA	5/24–6/1	130	bongo
	9MF96	BS	7/21–8/7	16	bongo
Totals				11,379	

Appendix Table 2

Ranked frequency of occurrence (FO) of larval fish taxa collected in bongo nets from Recruitment Processes Program survey cruises 1972–1996. Average catch (no./10 m^2) at positive hauls is included. Total number of 60 cm bongo tows = 8368 (includes 312 Tucker trawls). Bolded taxa are covered in this study. Shaded taxa are combined at a higher taxonomic level.

Taxon	No. positive hauls	Percent FO	Sum catch/10 m^2	Avg. catch/10 m^2
Theragra chalcogramma	4773	57.04	4984654.103	595.680
Ammodytes hexapterus	4542	54.28	358528.691	42.845
Stenobrachius leucopsarus	2581	30.84	111925.502	13.375
Lepidopsetta polyxystra	2093	25.01	72725.350	8.691
Hippoglossoides elassodon	1867	22.31	108951.468	13.020
Gadus macrocephalus	1823	21.79	98380.316	11.757
***Bathymaster* spp.**	1457	17.41	151675.355	18.126
***Sebastes* spp.**[1]	1309	15.64	59128.424	7.066
Hexagrammos decagrammus	1063	12.70	16103.647	1.924
Gadidae	1043	12.46	174694.365	20.876
Atheresthes stomias	932	11.14	40228.857	4.807
***Icelinus* spp.**	774	9.25	13974.818	1.670
Cyclopteridae	718	8.58	8550.829	1.022
Leuroglossus schmidti	690	8.25	7606.181	0.909
Hippoglossus stenolepis	643	7.68	7203.780	0.861
Bathyagonus alascanus	583	6.97	4888.797	0.584
Bathylagus pacificus	523	6.25	5284.756	0.632
Lumpenus maculatus	481	5.75	4597.007	0.549
Disintegrated	475	5.68	7990.944	0.955
Mallotus villosus	475	5.68	11348.954	1.356
Cryptacanthodes aleutensis	453	5.41	3823.550	0.457
Platichthys stellatus	448	5.35	8004.080	0.957
Protomyctophum thompsoni	446	5.33	3850.982	0.460
Hemilepidotus hemilepidotus	433	5.17	4625.840	0.553
Cottidae	417	4.98	5315.520	0.635
Tarletonbeania crenularis	389	4.65	8875.654	1.061
Lepidopsetta bilineata	385	4.60	4424.407	0.529
Atheresthes spp.	382	4.57	9245.819	1.105
***Lumpenus* spp.**	376	4.49	3302.633	0.395
Bathylagus ochotensis	373	4.46	14590.430	1.744
***Anoplarchus* spp.**	330	3.94	6140.290	0.734
Hemilepidotus spp.	311	3.72	14138.913	1.690
Glyptocephalus zachirus	288	3.44	3328.929	0.398
Protomyctophum crockeri	274	3.27	3467.119	0.414
Poroclinus rothrocki	264	3.15	3224.067	0.385
Diaphus theta	256	3.06	21918.638	2.619
Unidentified	220	2.63	3384.227	0.404
Artedius harringtoni	210	2.51	1619.195	0.193
Zaprora silenus	196	2.34	1411.285	0.169
Reinhardtius hippoglossoides	192	2.29	2372.440	0.284
Lyopsetta exilis	184	2.20	3475.021	0.415
Pleuronectes quadrituberculatus	179	2.14	1408.827	0.168
Anoplopoma fimbria	176	2.10	1777.740	0.212
Radulinus asprellus	175	2.09	1269.537	0.152
Osmeridae[2]	173	2.07	44895.193	5.365
Lumpenus sagitta	164	1.96	1321.844	0.158
Chauliodus macouni	162	1.94	1365.560	0.163
Agonidae	125	1.49	987.317	0.118
Microstomus pacificus	125	1.49	1163.814	0.139

Continued

Appendix Table 2 (continued)

Taxon	No. positive hauls	Percent FO	Sum catch/10 m^2	Avg. catch/10 m^2
Stichaeidae	123	1.47	1197.698	0.143
Lumpenella longirostris	120	1.43	1660.305	0.198
Isopsetta isolepis	112	1.34	1774.415	0.212
Ruscarius meanyi	107	1.28	756.404	0.090
Liparidae	103	1.23	1169.191	0.140
Lestidiops ringens	102	1.22	1015.174	0.121
Pleurogrammus monopterygius	96	1.15	1109.763	0.133
Parophrys vetulus	88	1.05	2481.143	0.297
***Sebastolobus* spp.**	88	1.05	1351.225	0.161
Lampanyctus ritteri	86	1.03	1049.816	0.125
***Pholis* spp.**	83	0.99	1020.082	0.122
Myoxocephalus B[3]	82	0.98	1172.842	0.140
Bathylagidae	80	0.96	1008.448	0.121
Bathyagonus infraspinatus	78	0.93	419.048	0.050
Hexagrammos lagocephalus	78	0.93	2435.621	0.291
Myoxocephalus spp.[3]	78	0.93	588.522	0.070
Macrouridae[4]	74	0.88	462.768	0.055
Citharichthys stigmaeus	73	0.87	638.370	0.076
Citharichthys sordidus	72	0.86	778.503	0.093
Nansenia candida	67	0.80	905.344	0.108
***Liparis* spp.[5]**	66	0.79	903.933	0.108
Myoxocephalus G[3]	63	0.75	529.201	0.063
Engraulis mordax	61	0.73	13876.181	1.658
Hexagrammos stelleri	59	0.71	524.865	0.063
Myctophidae	59	0.71	1800.924	0.215
Psettichthys melanostictus	59	0.71	728.765	0.087
Gymnocanthus A	58	0.69	416.647	0.050
Hemilepidotus spinosus	57	0.68	493.171	0.059
Lampanyctus spp.	57	0.68	841.834	0.101
Melamphaeidae[6]	53	0.63	526.923	0.063
Ophiodon elongatus	53	0.63	316.392	0.038
Ronquilus jordani	53	0.63	546.780	0.065
Stenobrachius spp.	52	0.62	877.596	0.105
Bryozoichthys lysimus	51	0.61	325.180	0.039
Podothecus acipenserinus	51	0.61	394.838	0.047
Pleuronectidae	49	0.59	493.858	0.059
Malacocottus zonurus 1	48	0.57	314.704	0.038
Icichthys lockingtoni	47	0.56	423.619	0.051
Citharichthys spp.	45	0.54	2026.624	0.242
Chirolophis spp.	44	0.53	361.609	0.043
Hemilepidotus jordani	41	0.49	224.907	0.027
Dasycottus setiger	40	0.48	274.199	0.033
Bathylagus milleri	39	0.47	293.025	0.035
Hexagrammos octogrammus	37	0.44	714.789	0.085
Malacocottus zonurus	37	0.44	265.162	0.032
Cryptacanthodes gigantea	36	0.43	276.190	0.033
Microgadus proximus	35	0.42	722.255	0.086
Stichaeus punctatus	35	0.42	224.049	0.027
Lampanyctus regalis	33	0.39	337.580	0.040
Tactostoma macropus	28	0.33	220.875	0.026
Clupea pallasi	26	0.31	604.672	0.072
Gymnocanthus spp.	26	0.31	254.121	0.030
Nectoliparis pelagicus	25	0.30	155.864	0.019

Continued

Appendix Table 2 (continued)

Taxon	No. positive hauls	Percent FO	Sum catch/10 m^2	Avg. catch/10 m^2
Cyclothone spp.	23	0.27	173.651	0.021
Triglops forficata	23	0.27	146.538	0.018
Triglops macellus	23	0.27	127.087	0.015
Ptilichthys goodei	22	0.26	127.541	0.015
Trachipterus altivelis	22	0.26	159.338	0.019
Leptagonus frenatus	21	0.25	143.917	0.017
Artedius fenestralis	18	0.22	147.778	0.018
Bryozoichthys marjorius	18	0.22	104.854	0.013
Hemilepidotus zapus	17	0.20	233.058	0.028
Icelinus borealis	17	0.20	146.731	0.018
Bathyagonus spp.	16	0.19	146.158	0.017
Anoplagonus inermis	14	0.17	88.207	0.011
Leptocottus armatus	14	0.17	87.974	0.011
Bathyagonus nigripinnis	13	0.16	83.579	0.010
Chirolophis decoratus	13	0.16	89.825	0.011
Hemitripterus bolini	13	0.16	73.340	0.009
Hexagrammidae	12	0.14	67.882	0.008
Limanda aspera	12	0.14	82.503	0.010
Melamphaes spp.	12	0.14	94.387	0.011
Icosteus aenigmaticus	11	0.13	97.372	0.012
Paraliparis spp.	11	0.13	108.125	0.013
Psychrolutes paradoxus	11	0.13	55.906	0.007
Scorpaenichthys marmoratus	11	0.13	60.297	0.007
Scorpaenidae	11	0.13	99.762	0.012
Zoarcidae[7]	11	0.13	189.707	0.023
Chirolophis nugator	10	0.12	72.875	0.009
Psychrolutes sigalutes	10	0.12	75.648	0.009
Artedius spp.	9	0.11	112.285	0.013
Aptocyclus ventricosus	8	0.10	29.985	0.004
Aspidophoroides monopterygius	8	0.10	42.123	0.005
Danaphos oculatus	8	0.10	52.603	0.006
Ophidiidae	8	0.10	80.564	0.010
Argyropelecus lychnus	7	0.08	44.087	0.005
Argyropelecus spp.	7	0.08	56.018	0.007
Bathyagonus pentacanthus	7	0.08	32.764	0.004
Bathylagus spp.	7	0.08	97.328	0.012
Bryozoichthys spp.	7	0.08	66.791	0.008
Embassichthys bathybius	7	0.08	41.140	0.005
Hexagrammos spp.	7	0.08	426.851	0.051
Stenobrachius nannochir	7	0.08	79.892	0.010
Triglops pingeli	7	0.08	32.262	0.004
Triglops spp.	7	0.08	45.628	0.005
Cololabis saira	6	0.07	44.147	0.005
Hypsagonus quadricornis	6	0.07	34.101	0.004
Melamphaes lugubris	6	0.07	54.892	0.007
Radulinus spp.	6	0.07	36.126	0.004
Symbolophorus californiensis	6	0.07	44.149	0.005
Anoplarchus insignis	5	0.06	73.497	0.009
Blepsias bilobus	5	0.06	41.478	0.005
Merluccius productus	5	0.06	278.533	0.033
Argyropelecus affinis	4	0.05	8.297	0.001
Hypsagonus mozinoi	4	0.05	26.157	0.003
Sebastes paucispinis	4	0.05	32.029	0.004

Continued

Appendix Table 2 (continued)

Taxon	No. positive hauls	Percent FO	Sum catch/10 m^2	Avg. catch/10 m^2
Xeneretmus latifrons	4	0.05	34.464	0.004
Brosmophycis marginata	3	0.04	21.210	0.003
Ceratoscopelus townsendi	3	0.04	20.486	0.002
Leuroglossus stilbius	3	0.04	48.511	0.006
Myctophidae B	3	0.04	20.000	0.002
Nautichthys oculofasciatus	3	0.04	16.737	0.002
Paricelinus hopliticus	3	0.04	55.382	0.007
Pholidae	3	0.04	19.138	0.002
Bathymaster 2	2	0.02	20.344	0.002
Bathymaster signatus	2	0.02	8.707	0.001
Bathymasteridae	2	0.02	7.718	0.001
Bothragonus swani	2	0.02	24.587	0.003
Clinocottus spp.	2	0.02	13.229	0.002
Cottoid type A	2	0.02	4.460	0.001
Cottus asper	2	0.02	13.562	0.002
Gasterosteus aculeatus	2	0.02	8.222	0.001
Icelus spp.	2	0.02	18.800	0.002
Lepidogobius lepidus	2	0.02	12.833	0.002
Liparis florae	2	0.02	10.477	0.001
Macropinna microstoma	2	0.02	12.351	0.001
Malacocottus zonurus 2	2	0.02	14.415	0.002
Microstoma sp.	2	0.02	14.318	0.002
Nautichthys robustus	2	0.02	10.006	0.001
Radulinus boleoides	2	0.02	15.379	0.002
Rhinoliparis barbulifer	2	0.02	16.629	0.002
Scopelosaurus spp.	2	0.02	14.583	0.002
Stellerina xyosterna	2	0.02	11.333	0.001
Tetragonurus cuvieri	2	0.02	20.072	0.002
Trachurus symmetricus	2	0.02	179.402	0.021
Triglops scepticus	2	0.02	12.652	0.002
Allosmerus elongatus	1	0.01	5.579	0.001
Anarhichas orientalis	1	0.01	9.051	0.001
Anoplarchus purpurescens	1	0.01	16.782	0.002
Argentina sialis	1	0.01	8.213	0.001
Argyropelecus sladeni	1	0.01	8.735	0.001
Aristostomias scintillans	1	0.01	5.744	0.001
Benthalbella dentata	1	0.01	7.041	0.001
Blepsias cirrhosus	1	0.01	13.313	0.002
Careproctus spp.	1	0.01	9.635	0.001
Chitonotus pugetensis	1	0.01	6.848	0.001
Clevelandia ios	1	0.01	3.996	0.000
Clinocottus acuticeps	1	0.01	39.428	0.005
Clupeiformes	1	0.01	7.759	0.001
Diogenichthys atlanticus	1	0.01	8.483	0.001
Diogenichthys spp.	1	0.01	5.303	0.001
Enophrys spp.	1	0.01	6.584	0.001
Eopsetta jordani	1	0.01	8.536	0.001
Eurypharynx spp.	1	0.01	6.539	0.001
Idiacanthus spp.	1	0.01	6.272	0.001
Leptagonus leptorhynchus	1	0.01	2.018	0.000
Liparis pulchellus	1	0.01	6.368	0.001
Loweina rara	1	0.01	15.761	0.002
Lycodapus spp.	1	0.01	7.059	0.001

Continued

Appendix Table 2 (continued)

Taxon	No. positive hauls	Percent FO	Sum catch/10 m^2	Avg. catch/10 m^2
Lycodes brevipes	1	0.01	7.626	0.001
Lycodes diapterus	1	0.01	8.758	0.001
Myoxocephalus polyacanthocephalus	1	0.01	8.047	0.001
Notolepis rissoi	1	0.01	8.415	0.001
Osmerus mordax	1	0.01	6.500	0.001
Oxylebius pictus	1	0.01	5.060	0.001
Pallisina barbata	1	0.01	6.571	0.001
Paraliparis holomelas	1	0.01	8.874	0.001
Parvilux ingens	1	0.01	8.347	0.001
Pholis laeta	1	0.01	4.129	0.000
Plectobranchus evides	1	0.01	6.232	0.001
Pleuronichthys coenosus	1	0.01	6.580	0.001
Rhamphocottus richardsoni	1	0.01	2.764	0.000
Thaleichthys pacificus	1	0.01	8.689	0.001
Trachipteridae	1	0.01	7.894	0.001
Trichodon trichodon	1	0.01	3.457	0.000
Xiphister spp.	1	0.01	5.505	0.001

[1] Species in the study area are *Sebastes aleutianus, S. alutus, S. auriculatus, S. aurora, S. babcocki, S. borealis, S. brevispinis, S. caurinus, S. chlorostictus, S. ciliatus, S. crameri, S. diploproa, S. elongatus, S. emphaeus, S. entomelas, S. flavidus, S. glaucus, S. goodei, S. helvomaculatus, S. jordani, S. maliger, S. melanops, S. melanostictus, S. miniatus, S. mystinus, S. nebulosus, S. nigrocinctus, S. paucispinis, S. pinniger, S. polyspinis, S. proriger, S. rastrelliger, S. reedi, S. ruberrimus, S. rufus, S. saxicola, S. variegatus, S. wilsoni,* and *S. zacentrus.*

[2] Species in the study area are *Allosmerus elongatus, Hypomesus pretiosus, Mallotus villosus, Osmerus mordax, Spirinchus starksi, S. thaleichthys,* and *Thaleichthys pacificus.*

[3] Species in the study area are *Myoxocephalus axillaris, M. brandti, M. jaok, M. niger, M. polyacanthocephalus, M. quadricornis, M. scorpius, M. stelleri,* and *M. verrucosus.*

[4] Species in the study area are *Albatrossia pectoralis, Coryphaenoides acrolepis, C. armatus, C. cinereus, C. filifer, C. leptolepis, C. liocephalus, C. longifilis, C. yaquinae,* and *Nezumia stelgidolepis.*

[5] Species found in the study area are *Liparis bristolensis, L. callyodon, L. catharus, L. cyclopus, L. dennyi, L. florae, L. fucensis, L. gibbus, L. grebnitzki, L. marmoratus, L. mednius, L. megacephalus, L. micraspidophorus, L. mucosus, L. ochotensis, L. pulchellus, L. rutteri,* and *L. tunicatus.*

[6] Species found in the study area are *Melamphaes lugubris, Poromitra crassiceps,* and *Scopeloberyx robustus.*

[7] Species in the study area are *Bothocara brunneum, B. hollandi, B. molle, B. pusillum, B. remigerum, Derepodichthys alepidotus, Gymnelis hemifasciatus, G. popovi, G. viridis, Krusensterniella pavlovskii, Lycenchelys altus, L. camchaticus, L. crotalinus, L. hippopotamus, L. jordani, L. longirostris, L. microporus, L. pliciferus, L. rassi, L. ratmanovi, L. roseus, L. volki, Lycodapus derjugini, L. dermatinus, L. endemoscotus, L. fierasfer, L. leptus, L. mandibularis, L. pachysoma, L. parviceps, L. poecilis, L. psarosomatus, Lycodes brevipes, L. concolor, L. cortezianus, L. diapterus, L. mucosus, L. pacifica, L. palearis, L. raridens, L. turneri, Lyconema barbatum, Melanostigma pammelas, Nalbantichtys elongatus, Opaeophacus acrogeneius, Pachycara bulbiceps, Puzanovia rubra,* and *Taranetzella lycoderma.*

Appendix Table 3

Ranked frequency of occurrence (FO) of pelagic fish egg taxa collected in bongo nets from AFSC survey cruises 1972–1996. Average catch (no./10 m^2) at positive hauls is included. Total number of 60 cm bongo tows = 8368 (includes 312 Tucker trawls). Bolded taxa covered in this study.

Taxon	No. positive hauls	Percent FO	Sum of catch/10 m^2	Avg. of catch/10 m^2
Theragra chalcogramma	4550	54.37	35278888.20	7753.60
Hippoglossoides elassodon	2864	34.23	475785.28	166.13
Glyptocephalus zachirus	1063	12.70	45043.70	42.37
Microstomus pacificus	870	10.40	65049.14	74.77
Pleuronectidae	682	8.15	44669.33	65.50
Pleuronectes quadrituberculatus	622	7.43	9336.05	15.01
Trachipterus altivelis	353	4.22	4604.84	13.04
Bathylagidae	328	3.92	11428.22	34.84
Lyopsetta exilis	245	2.93	15135.02	61.78
Unidentified	234	2.80	8267.54	35.33
Icichthys lockingtoni	231	2.76	3791.03	16.41
Chauliodus macouni	222	2.65	2603.39	11.73
Bathylagus spp.	202	2.41	3720.66	18.42
Paralichthyidae	197	2.35	44053.13	223.62
Platichthys stellatus	176	2.10	3369.03	19.14
Myctophidae	167	2.00	66279.60	396.88
Macrouridae	158	1.89	5852.28	37.04
Icosteus aenigmaticus	145	1.73	2202.99	15.19
Leuroglossus schmidti	119	1.42	4840.86	40.68
Embassichthys bathybius	115	1.37	1017.19	8.85
Disintegrated	94	1.12	4393.12	46.74
Citharichthys spp.	84	1.00	3065.76	36.50
Parophrys vetulus	82	0.98	1876.34	22.88
Bathylagus ochotensis	80	0.96	1279.03	15.99
Isopsetta isolepis	75	0.90	1386.28	18.48
Teleost type G*	65	0.78	1263.05	19.43
Psettichthys melanostictus	55	0.66	641.14	11.66
Limanda aspera	46	0.55	1820.18	39.57
Merluccius productus	35	0.42	508.12	14.52
Nansenia candida	25	0.30	276.76	11.07
***Sebastolobus* spp.**	24	0.29	674.45	28.10
Tactostoma macropus	23	0.27	668.86	29.08
Engraulis mordax	23	0.27	6792.14	295.31
Bathylagus milleri	21	0.25	392.56	18.69
Reinhardtius hippoglossoides	20	0.24	255.59	12.78
Hippoglossoides spp.	20	0.24	2075.27	103.76
Anoplopoma fimbria	19	0.23	162.16	8.53
Argentinidae	17	0.20	143.56	8.44
Pleuronichthys decurrens	15	0.18	100.99	6.73
Teleost type E*	13	0.16	112.18	8.63
Tetragonurus cuvieri	11	0.13	152.81	13.89
Cololabis saira	10	0.12	313.08	31.31
Teleost type P*	9	0.11	160.21	17.80
Hippoglossus stenolepis	8	0.10	56.96	7.12
Nansenia crassa	7	0.08	56.41	8.06
Gadus macrocephalus	6	0.07	65.49	10.91
Microstoma sp.	4	0.05	29.56	7.39

Continued

Appendix Table 3 (continued)

Taxon	No. positive hauls	Percent FO	Sum of catch/10 m^2	Avg. of catch/10 m^2
Teleost type C*	3	0.04	28.20	9.40
Pleuronichthys coenosus	2	0.02	21.18	10.59
Pleuronichthys verticalis	1	0.01	7.72	7.72
Teleost type Q*	1	0.01	7.37	7.37
Bathylagus wesethi	1	0.01	5.79	5.79
Argentina sialis	1	0.01	6.93	6.93
Trachurus symmetricus	1	0.01	79.83	79.83
Hippoglossoides robustus	1	0.01	10.84	10.84
Teleost type H*	1	0.01	6.29	6.29
Gonostomatidae	1	0.01	6.82	6.82
Pleuronectes spp.	1	0.01	3.05	3.05

*Teleost egg types are recognizable by characters but remain unidentified.

Appendix Table 4

Citations of larval illustrations

Taxon	Illustration	Size (mm)	Citation
Engraulidae	*Engraulis mordax*	11.5 SL	Kramer and Ahlstrom, 1968
Clupeidae	*Clupea pallasi*	19.0 SL	after Matarese et al., 1989
Microstomatidae	*Nansenia candida*	8.4 SL	after Ahlstrom et al., 1984a
Bathylagidae	*Bathylagus milleri*	15.0 SL	Matarese et al., 1989
	Bathylagus ochotensis	7.9 SL	Matarese et al., 1989
	Bathylagus pacificus	17.6 SL	Matarese et al., 1989
	Leuroglossus schmidti	16.1 SL	after Dunn, 1983
Osmeridae	Smelts (*Mallotus villosus*)	16.0 SL	after Fahay, 1983 (after Templeman, 1948; Atlantic specimens)
Stomiidae	*Chauliodus macouni*	45.2 SL	Kawaguchi and Moser, 1984
	Tactostoma macropus	14.3 SL	after Matarese et al., 1989
Paralepidae	*Lestidiops ringens*	16.5 SL	after Moser, 1981
Myctophidae	*Diaphus theta*	6.3 SL	after Matarese et al., 1989
	Lampanyctus regalis	7.2 SL	after Moser and Ahlstrom, 1974
	Lampanyctus ritteri	7.0 SL	Moser and Ahlstrom, 1974
	Protomyctophum crockeri	7.6 NL	after Moser and Ahlstrom, 1970
	Protomyctophum thompsoni	8.8 SL	Moser and Ahlstrom, 1970
	Stenobrachius leucopsarus	6.3 SL	after Matarese et al., 1989
	Tarletonbeania crenularis	7.5 NL	Moser and Ahlstrom, 1970
Trachipteridae	*Trachipterus altivelis*	24.0 SL	after Matarese et al., 1989
Macrouridae	*Coryphaenoides acrolepis*	3.8 HL	Stein, 1980
Merlucciidae	*Merluccius productus*	10.1 NL	Ahlstrom and Counts, 1955
Gadidae	*Gadus macrocephalus*	8.5 SL	Matarese et al., 1981
	Microgadus proximus	10.7 SL	Matarese et al., 1981
	Theragra chalcogramma	9.8 SL	AFSC unpubl. (B. Vinter)[1]
Scomberesocidae	*Cololabis saira*	7.4 SL	Matarese et al., 1989
Melamphaidae	*Melamphaes lugubris*	6.2 SL	Keene and Tighe, 1984
Scorpaenidae	*Sebastes* spp. *(S. goodei)*	6.9 SL	Sakuma and Laidig, 1995
	Sebastolobus spp. *(S. altivelis)*	6.2 SL	Moser, 1974
Anoplopomatidae	*Anoplopoma fimbria*	12.0 SL	Kendall and Matarese, 1987
Hexagrammidae	*Hexagrammos decagrammus*	13.3 SL	after Kendall and Vinter, 1984
	Hexagrammos lagocephalus	14.5 SL	after Kendall and Vinter, 1984
	Hexagrammos octogrammus	11.8 SL	Kendall and Vinter, 1984
	Hexagrammos stelleri	10.4 SL	after Kendall and Vinter, 1984
	Ophiodon elongatus	12.2 SL	after Kendall and Vinter, 1984
	Pleurogrammus monopterygius	17.4 SL	Kendall and Vinter, 1984
Cottidae	*Artedius fenestralis*	9.9 SL	Richardson and Washington, 1980
	Artedius harringtoni	9.3 SL	after Richardson and Washington, 1980
	Gymnocanthus spp. (A)	11.9 SL	Matarese et al., 1989
	Hemilepidotus jordani	10.6 SL	Matarese et al., 1989
	Hemilepidotus hemilepidotus	10.7 SL	Richardson and Washington, 1980
	Hemilepidotus spinosus	11.0 SL	after Richardson and Washington, 1980
	Hemilepidotus zapus	13.0 SL	Matarese and Vinter, 1985
	Icelinus spp.	7.9 SL	after Matarese et al., 1989 (after Washington and Richardson, unpubl.)
	Leptocottus armatus	8.1 NL	after Richardson and Washington, 1980
	Myoxocephalus spp. (B)	12.2 SL	Matarese et al., 1989
	Radulinus asprellus	12.6 SL	after Richardson and Washington, 1980
	Ruscarius meanyi	13.8 SL	after Richardson and Washington, 1980
	Scorpaenichthys marmoratus	10.4 SL	after Richardson and Washington, 1980
Agonidae	*Anoplagonus inermis*	7.7 SL	Busby, 1998
	Aspidophoroides monopterygius	10.3 SL	after Busby, 1998
	Bathyagonus alascanus	7.6 SL	Busby, 1998

Continued

Appendix Table 4 (continued)

Taxon	Illustration	Size (mm)	Citation
Agonidae (continued)	*Bathyagonus infraspinatus*	9.8 SL	Busby, 1998
	Bathyagonus nigripinnis	9.2 SL	Busby, 1998
	Bathyagonus pentacanthus	8.9 SL	Busby, 1998
	Hypsagonus quadricornis	7.6 SL	after Busby, 1998
	Hypsagonus mozinoi	8.2 SL	Busby, 1998
	Leptagonus frenatus	12.0 SL	after Busby, 1998
	Podothecus acipenserinus	8.6 SL	after Busby, 1998
	Xeneretmus latifrons	8.7 SL	Busby, 1998
Psychrolutidae	*Dasycottus setiger*	10.3 SL	after Washington et al., 1984
	Psychrolutes paradoxus	12.0 SL	after Marliave, 1975
	Psychrolutes sigalutes	13.0 SL	after Richardson, 1981a
Cyclopteridae	*Aptocyclus ventricosus*	9.9 SL	Kobayashi, 1962
Liparidae	*Liparis* spp.	15.0 SL	AFSC unpubl. (R. Cartwright)[2]
	Nectoliparis pelagicus	20.5 SL	Matarese et al., 1989
Bathymasteridae	*Bathymaster* spp. (A)	9.0 SL	Matarese et al., 1989
	Ronquilus jordani	10.4 SL	Matarese et al., 1989
Zoarcidae	*Bothrocara hollandi*	35.5 TL	Kendall et al., 1983 (after Okiyama, 1982)
Stichaeidae	*Anoplarchus* spp. *(A. purpurescens)*	9.0 SL	after Matarese et al., 1989
	Chirolophis spp. *(C. nugator)*	15.7 SL	AFSC unpubl. (B. Vinter)[3]
	Lumpenella longirostris	17.5 SL	AFSC unpubl. (B. Vinter)[4]
	Lumpenus spp. *(L. maculatus)*	13.5 TL	Fahay, 1983 (after Faber, 1976; Atlantic specimens)
	Lumpenus sagitta	17.3 SL	after Matarese et al., 1989
	Poroclinus rothrocki	18.0 SL	after Matarese et al., 1989
	Stichaeus punctatus	13.5 TL	Fahay, 1983 (after Faber, 1976; Atlantic specimens)
Cryptacanthodidae	*Cryptacanthodes aleutensis*	16.0 SL	Matarese et al., 1989
	Cryptacanthodes gigantea	17.5 SL	after Matarese et al., 1989
Pholidae	*Pholis* spp. *(P. laeta)*	9.2 SL	after Matarese et al., 1989
Ptilichthyidae	*Ptilichthys goodei*	24.7 SL	Richardson and Dehart, 1975
Zaproridae	*Zaprora silenus*	17.3 BL	Haryu and Nishiyama, 1981
Ammodytidae	*Ammodytes hexapterus*	9.8 SL	Matarese et al., 1989
Icosteidae	*Icosteus aenigmaticus*	10.2 SL	after Matarese et al., 1984
Centrolophidae	*Icichthys lockingtoni*	10.4 NL	Ahlstrom et al., 1976
Paralichthyidae	*Citharichthys sordidus*	10.0 NL	Ahlstrom and Moser, 1975
	Citharichthys stigmaeus	10.0 NL	Ahlstrom and Moser, 1975
Pleuronectidae	*Atheresthes stomias*	13.4 SL	Matarese et al., 1989
	Embassichthys bathybius	18.5 NL	Richardson, 1981b
	Glyptocephalus zachirus	22.8 SL	Ahlstrom et al., 1984b
	Hippoglossoides elassodon	15.0 SL	Matarese et al., 1989
	Hippoglossus stenolepis	14.4 SL	Matarese et al., 1989
	Isopsetta isolepis	13.6 SL	Richardson et al., 1980
	Lepidopsetta bilineata	9.7 SL	Orr and Matarese, 2000
	Lepidopsetta polyxystra	10.8 SL	Orr and Matarese, 2000
	Limanda aspera	9.2 SL	after Pertseva-Ostroumova, 1961
	Lyopsetta exilis	11.0 NL	Ahlstrom and Moser, 1975
	Microstomus pacificus	15.0 SL	Matarese et al., 1989
	Parophrys vetulus	10.0 SL	Matarese et al., 1989
	Platichthys stellatus	6.6 SL	Matarese et al., 1989
	Pleuronectes quadrituberculatus	7.8 SL	Matarese et al., 1989
	Psettichthys melanostictus	13.9 SL	Matarese et al., 1989
	Reinhardtius hippoglossoides	17.0[5]	Jensen, 1935

1 Collected May 5, 1981; cruise 4MF81; station G033A; bongo gear; haul 1; net 1; 57.31°N, 155.0933°W.

2 Collected June 26, 1998; cruise 3WE98; station 84; Methot gear; haul 1; net 1; 56.6398°N, 155.656°W.

3 Collected Feb. 26, 1992; dipnet; Manchester, WA.

4 Collected May 22, 1992; cruise 4MF92; station G071A; bongo gear; haul 1; net 1; 56.13°N, 157.4633°W.

5 Type of measurement unavailable.

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