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Chapter 3e Alaska Arctic Marine Fish Species

Chapter 3. Alaska Arctic Marine Fish Species Accounts

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Abstract

Species accounts provide brief, but thorough descriptions about what is known, and not known, about the natural life histories and functional roles of marine fishes in the Arctic marine ecosystem. Information about human influences on traditional names and resource use and availability is limited, but what information is available provides important insights about marine ecosystem status and condition, seasonal patterns of fish habitat use, and community resilience. This linkage has received limited scientific attention and information is best for marine species occupying inshore and freshwater habitats. Some species, especially the salmonids and coregonids, are important in subsistence fisheries and have traditional values related to sustenance, kinship, and barter. Each account is an autonomous document providing concise information about a species zoogeography, western and Alaska Native taxonomy, life history, niches, and life requirements. Each account is fully referenced with the identification of the most critical literature for Alaska and a more comprehensive listing of referencing from which biological and ecological information was drawn. New-to-science narratives, distributional maps, and vertical profiles, provide quick, reliable sources of information about fish life history and habitat requirements for this segment of the Arctic fauna.

Purpose and Design of Species Accounts

Individual species accounts were prepared for 104 of the 109 confirmed marine fishes for which adequate biological information was available from the U.S. Chukchi and Beaufort Seas. These descriptions are an important source of documentation about Arctic Alaska's marine fish fauna. Although tailored to address the specific needs of BOEM Alaska OCS Region NEPA analysts, the information presented in each species account also is meant to be useful to other users including state and Federal fisheries managers and scientists, commercial and subsistence resource communities, and Arctic residents. Readers interested in obtaining additional information about the taxonomy and identification of marine Arctic fishes are encouraged to consult the *Fishes of Alaska* (Mecklenburg and others, 2002) and *Pacific Arctic Marine Fishes* (Mecklenburg and others, 2016). By design, the species accounts enhance and complement information presented in the *Fishes of Alaska* with more detailed attention to biological and ecological aspects of each species' natural history and, as necessary, updated information on taxonomy and geographic distribution.

Each species account includes a concise summary of the natural history, population dynamics, functional roles, and traditional and economic values of the marine fish found off Alaska. An initial organizational task was to create a standard format for effective information delivery. The species descriptions by Ehrlich and others (1988) were provided to the USGS by BOEM as an example of a creative template for information transfer. Four pilot species accounts, representing well known to poorly known species, were developed, reviewed, and repeatedly revised for improvements, interagency approval, and selection of the final layout and design. Final decisions about content represented the priority needs of BOEM.

More than 1,200 individual scientific publications relevant to Arctic marine fishes were reviewed in preparation of the species accounts. In each species account, the most relevant literature for each species is cited. A shorter list (about 5–10 articles) identifies key Alaskan information sources that, in our opinion, have had the greatest scientific effect on understanding the species of the Arctic area of the United States.

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Limitations of Data

The species accounts reveal many gaps in the biological information needed to conduct vulnerability assessments of the marine fishes of the Beaufort and Chukchi Seas to human interventions. Part of this problem relates to the geographic coverage of existing research and surveys in Alaska as, in many instances, we were required to incorporate the results of investigations conducted outside the region. This raises an important caution because, even though the best available information was used in preparing the species accounts, our reliance on data and information from outside Alaska will introduce uncertainty to EIS expectations. Ideally, and with respect to oil and gas activities, baseline information for fishery resources should be collected from the potentially affected environment to appropriately evaluate the potential effects of oil spills or other possible industrial-related disturbances. However, as has been widely noted (for example, Bluhm and others, 2011), systematic and methodologically comparable data typically are not available from Arctic Alaska marine ecosystems. Evaluating change in populations and communities from natural and anthropogenic stressors is limited by the variable quality and lack of quantitative reports on abundance, distribution, community structure, and demographics for Arctic marine fishes.

In each species account, an attempt was made to incorporate the most reliable baseline information available and offer impressions of information needs. Important ongoing studies sponsored by BOEM, and others, may be addressing some of these needs. The needs assessments for this study considered these efforts to the extent that oral and (or) written communications and preliminary results allowed. The focus of this study was on impressions of the population parameters (Williams and others, 2002) and environmental measurements needed to detect changes in marine fish populations (Reist and others, 2006; Wassmann and others, 2011) and their resilience to a variable and rapidly changing environment (Holland-Bartels and Pierce, 2011). For key marine fish species, examples might include changes in range, community structure, abundance, phenology, behavior, and population growth and survival.

Each species account is designed as a self-contained article; therefore, no references to other accounts are included. Additionally, to reduce complexity in the presentations, only common names were used to identify the major predator and prey species for the marine fish described. Because this document was meant to be a companion document to the *Fishes of Alaska* (Mecklenburg and others, 2002), interested readers are encouraged to consult this book or Page and others (2013) and Mecklenburg and others (2016) for more complete information about the scientific authorities and literature citations associated with the original descriptions of each species. Readers are directed to the references cited in each species account for additional information on the species.

Operational Definitions

In chapter 1, several concepts about the temporal and spatial habitat requirements for Arctic marine fish were introduced. More information is presented in this chapter to explain the vertical distribution and the location of shelf break, as used in this report.

Vertical Distribution

The conceptual design of the species depth profiles (vertical structure by life history stage) was patterned after the “coastal marine life zones” of Allen and Smith (1988). The goal of the profiles is to visualize what is known about a species occurrence and reproductive ecology by depth and location. An idealized characterization of Arctic shelves was designed to visualize these relationships. Additional detail about origins of data was included in the depth profiles to reflect Alaskan records or collections from other Arctic regions. This is important because actual field collections and observations are limited from this region. In many instances, the actual presence of a life stage remains unverified by field sampling. Thus, for many of species, the depth of a fish’s life cycle should be considered untested hypotheses in need of additional testing.

Location of Shelf Break

Early versions of the depth profiles were modified at the request of BOEM with respect to the depiction of the continental shelf break. As a special effect for the Arctic, the species depth profiles were redrawn to depict the change in bathymetry that typically occurs at depths of about 75 m throughout the Chukchi and western Beaufort Seas. This depiction is not an attempt to redefine the oceanographic definition of shelf break. Instead, it highlights the relatively sharp gradient in depths that often occurs near 70- to 80-m contours over much of the region. Although species depth profiles in this report depict an apparent “break” at 75-m, three factors were considered: (1) this is a generalization and the actual shelf break may be geographically close but at a slightly greater depth; (2) shelf edge effects on fish distribution at depths occurring between 75-, 150-, or 200-m are likely negligible due to the gradient and area involved; and (3) the conceptual depictions of depth distributions by life history stage are consistent with accepted oceanographic conventions for continental shelf and slope (despite the magnified view at 75-m) and thus are compatible to the import of biological data obtained elsewhere.

Keystone Species

The concept of keystone species describes the critical role certain organisms are perceived to have in maintaining the structure of biological communities and resilience of ecosystem dynamics (Paine, 1966). Arctic Cod (*Boreogadus saida*) are widely distributed in the Arctic Ocean and by virtue of their abundance and intermediate trophic position between invertebrates and higher-level predators are integral to the movement of nutrients in marine food webs. For this reason, Arctic Cod are considered a keystone species in the Arctic marine (Bradstreet and others, 1986; Walkusz and others, 2011). Arctic Cod are common in United States waters of the Beaufort and Chukchi Seas being considered for energy exploration and development and are an ecological focus of BOEM fishery studies to understand potential effects on the species (Maule and Thorsteinson, 2012).

Outline of Species Accounts

The species accounts are scientifically accurate descriptions of the life histories, populations, habitats, and community values of individual species in the Arctic marine ecosystem. The mix of quantitative and qualitative information presented reflects state-of-the-art knowledge, a faunal assessment of information gaps, and prioritization of priority needs for population and process understanding. Limited information for many Alaskan species required that relevant observations from other geographic locales be included. Each species account attempts to be clear about the geographic origins of data and information, through scientific referencing or special notations in graphics. As an example, *italics* are used in the species accounts to highlight data collections from the Alaska study area. In several instances, species information was so lacking that inferences from a closely related species were required.

The generic species account includes a comprehensive accounting of scientific and cultural information in a standard format. The scientific information addresses multiple disciplinary areas including taxonomy, life history and habitats, ecological relationships including predator-prey interactions and environmental preferences, and population ecology. The population information is critical to evaluations of population status and health, resilience, and vulnerability to natural and anthropogenic changes in the marine environment. Each species account includes a photograph of an adult specimen (or line drawing if an image was not available); distribution maps (horizontal and vertical); and concise descriptions of abundance, life history, and ecology (11 life history categories); major stressors; research needs; and key references. To assist users, a suite of easily recognized icons was developed to provide quick access to specific life history information. In addition, some species attributes regarding life history, population dynamics, and biological interactions are defined in the Glossary (chapter 7).

Information presented in each species account is outlined and described as:

Taxonomic—Scientific and Common Names

The format of the species accounts was, by design, intended to link the biologic and ecologic information presented in this document directly to the species identification guides contained in the "*Fishes of Alaska*." This connection was established by adherence to naming conventions as described by Mecklenburg and others, 2002 (p. 25 and 26). The common names of each marine fish are presented first, followed by scientific and family names. Each scientific name includes a reference to the name of the person (author) who formally described and named the species in the ichthyological literature. The bibliographic data for the authors and dates of publication of scientific names can be found in Eschmeyer's Catalog of Fishes online (http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp) and are not reported here. In some instances, a *Note* (italicized) has been included to describe exceptional details about existing biological data, morphology, nomenclature, taxonomic status, life history strategy, or occurrence of a species in the United States Chukchi and Beaufort Seas.

Iñupiat Name

The existence of colloquial Iñupiat (Iñupiaq) names for the Arctic's marine fish fauna by indigenous peoples is an important component of traditional ecological knowledge. Relatively few marine fish species are abundant or susceptible enough to subsistence fisheries to have received special names. For those species having Iñupiat names, this information is reported to assure that a common vocabulary can facilitate future exchanges of ideas and knowledge across disciplinary boundaries. In this manner, colloquial names can provide a cultural link between local marine resources and science supporting sustainability of Arctic communities and ecosystems.

Ecological Role

Fishes play a pivotal role in marine ecosystems as secondary and higher-level consumers in many marine food webs. In many instances, information about predator-prey relationships is so limited that only preliminary, qualitative assessments of the relative role of each species are possible. The ecological niche describes how an organism or population responds to resources and competitors. Importance or significance descriptors do not diminish the fact that all organisms contribute in ways large or small to the provision of ecosystem goods and services. These descriptors however, may provide useful information about the relative importance of a particular species as an indicator of ecosystem condition and trajectories of change associated with climate change, habitat fragmentation, ecosystem stress, effect of pollutants, or other anthropogenic effects.

Physical Description/Attributes

A brief physical description of the species is summarized from information presented by Mecklenburg and others, (2002) in the *Fishes of Alaska*; the relevant page number is included for quick referral to more comprehensive morphological information. An image of the adult form of each fish is presented with appropriate attribution. High-quality images were selected to highlight the key identifying features of a particular species.

Information about the presence of a swim bladder and antifreeze glycoproteins is included because of its relevance to geo-seismic oil and gas exploration, climate change issues, and evolutionary life history.

Range

The geographic occupancy of the species in United States sectors of Chukchi and Beaufort Seas and adjacent waters is presented in brief narratives and depicted on maps. Known occurrence in the Arctic OCS Planning Areas is highlighted by symbols indicating locations of valid species identifications from properly archived voucher specimens on each map. Although the symbols on the maps may suggest that some of the species are rare in the region, the study of historical collections from the United States and Canadian sectors of the Beaufort Sea, as well as the collections from BOEM surveys in the Beaufort in 2011 and 2012, is still in progress and may reveal that these species are more abundant in deep sectors of the study area than the maps suggest. Definitions of zoogeographic pattern are from the Online Resource 1 (electronic supplemental to Mecklenburg and others, 2011), Mecklenburg and Steinke (2015), and Mecklenburg and others (2016) and relate to ranges of population viability (see chapter 2).

Depth profiles in each species account graphically summarize existing information about the benthic and reproductive distributions of each marine fish. In both depth profiles, the width of areas depicted confers species information about horizontal (onshore-offshore) patterns of distribution. The italicized captions in the depth profiles highlight species information germane to the study area. Areas in the graphs denoted by the orange coloration represent understanding from data collection within the United States Chukchi and Beaufort Seas; olive colors represent data collection outside the study area. For benthic distributions, solid lines in the depth profiles represent species for which no specific information is available about its preferred depth range. Solid lines represent a synthesis of understanding that includes information not necessarily specific to the study area. In some instances, only one record of a species occurrence by depth was available and coding in orange was not meaningful. In these cases, an explanatory comment, in italicized font, with a line pointing to the appropriate depth was included in the graph (for example, see the species account for *Megalocottus platycephalus*). Highlighted depths as indicated through “bolded” (dark black) and dashed segments, represent most common depths where the species has been detected, and depth distribution as has been reported throughout the species range, respectively. Areas denoted with diagonal cross-hatching represents depth distribution of juveniles (immature); adult distributions are not cross-hatched and age-related habitat overlaps, are informed by captioning in the figures.

For reproductive distribution, eggs and larvae (pre-juvenile life stages) of marine fishes are represented with respect to depth and distance from the coast. Orange areas in the reproductive distribution profiles represent data collection in the study area. In many instances, information about spawning habitats and egg and larval distributions is summarized from information reported from throughout a species range. In these cases, dark blue represents species distributions in spawning habitats; light blue represents the geographic distributions of eggs and larvae; and light green is used to highlight areas of substantial habitat overlap (for example, see the species account for *Hippoglossus stenolepsis*). Distribution patterns of eggs and larvae are symbolized by “dots” and “horizontal dashes,” respectively, in the graphs. As for benthic distribution, solid lines represent species-specific information from data collections from throughout the species entire range. Highlighted (dark black lines) segments of solid lines indicate the most common depths where egg and larvae samples have been collected. Dashed lines represent areas of hypothesized distributions for species for which no information is available about egg or larval occurrence. In these instances the hypothesized distributions are based on known patterns for closely related species; the lack of data is stated in captions above the graph.

Relative Abundance

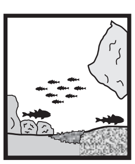
Relative abundance refers to the contribution a species makes to the total abundance of the fishery community. It is a measure that provides an index of the number of individuals present, but not the actual numbers. Relative abundance terms, such as “common,” “uncommon,” or “rare” often are used to express the general population status of a given species, but are most useful when they are defined by something that is measured or estimated in a manner that makes comparison meaningful.

Depth Range

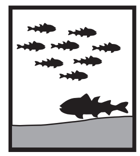
Benthic distribution refers to the spatial arrangement of a particular species at different depths over continental shelf and slope waters. The life cycle of fishes occurs in multiple dimensions in time and space and generally reflects genetically determined life history or behavior that has evolved to maximize fitness (life time reproductive success, see Gross [1987]). Benthic distribution profiles for each species represent the location of important habitats as they are presently known for juvenile and marine fishes. Reproductive distributions depict important habitats for spawning and early life history development.

Life History, Population Dynamics, and Biological Interactions

Life history theory holds that the schedule and duration of key events in a species' lifetime are shaped by natural selection to produce the largest possible number of surviving offspring. These events, notably juvenile development, age of sexual maturity, first reproduction, number of offspring and level of parental investment, senescence, and death, depend on the abiotic and biotic environment of the organism. Specific information about these traits informs understanding of a species' adaptive capacity including major influences on population abundance. A number of fisheries models use basic length-weight and age-at-size relationships to describe the growth and dynamics of fishery populations (for example, von Bertalanffy and Gompertz, growth models and derivatives [Ricker, 1975]). Ecological models estimate transfer of energy or matter along the trophic chain (Gamito, 1998). The parameters that are estimated in these models are individually important indicators of population condition and may be used with other indicators to derive quantitative information about compensatory responses and resilience. Much of this information, including population parameters, has been compiled in FishBase for the Arctic marine fish (Froese and Pauly, 2012).



Habitats and Life History—Basic information about the life history (for example, body size, reproductive ecology, growth) and ecology (for example, mobility, growth, habitat) of a species and the environmental area inhabited by that species is foundational to effective resource management. Habitat is the natural environment that influences and is used by a species population. Information about abiotic (that is, temperature, salinity, other physiochemical factors, depth, and substrate types) and biotic (that is, type and abundance of food, presence of other biota) often are used to describe fish habitats and provide insights about a species environmental preferences and habitat associations (for example, water masses). Maximum body size often is reported and can be an important surrogate of different life history traits (for example, age at maturity, growth, and reproductive output). In population dynamics studies, the relationships between length and weight and size and age form the basis for population growth and production models and quantitative analysis of environmental effects. Length measurements are reported as standard length (SL), total length (TL), and fork length (FL) in fisheries studies.



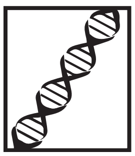
Behavior (see also Glossary [chapter 7]).—Behavior is the manner in which a fish operates or functions within its environment (that is, home range, territoriality, and many others) to procure food, orient to specific locations, or relate to other organisms. Knowing how individuals respond to the environment (physical, chemical, and biological cues) is critical to understanding population processes such as distribution, survival, and reproduction and recruitment and for managing fisheries. Many behaviors are evolutionary adaptations to the physiological and reproductive requirements for a species' survival. For example, migration involves the regular movement of animals between different geographic locations. Migrations can be extensive in terms of time and distance involved (anadromous model) or seasonal (amphidromous and marine models). Each of these models reflects a life strategy adapted for age and growth at sea. Diel relates to daily changes in water column position due to changes in light, temperature, and food supply.

Migratory behaviors are rooted in physiological requirements for food, growth, reproductive, and survival ("scope for growth"). Movement behaviors are more tactical responses to local environmental conditions (for example, variable hydrographic conditions in the nearshore Beaufort Sea). Fish movement can be active or passive and involve large distances in search of suitable habitats and foods. The seasonal nature of migration and movement behaviors are typically related to life history stage, predator-prey distributions, or energetic requirements for growth.

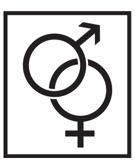
Schooling (that is, social structure of fish of the same species moving in more or less harmonious patterns in the sea) often is related to survival and reproduction. Schooling confers physical benefits to fish movement, safety against predators, search behaviors (for example, foods), population immunology, and reproduction.

The functional feeding morphology of a fish relates to its anatomical adaptations (for example, body size, gape sizes, shape, and body form) to environmental conditions especially food preferences. The adage "function determines morphology and morphology determines way of life" is an important evolutionary concept as it applies to fish feeding behavior, dietary preferences, habitat selection, and trophic stature. Trophic position (within categories of trophic levels) expresses the "tendency of larger (less abundant) fishes feeding on smaller (more abundant) fishes, which themselves feed on zooplankton and all these animals resting upon primary producers" (from Pauly and Watson, 2005). Categories of trophic levels are:

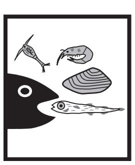
- Trophic level 1 (T1), plants and animals make their own food and are called primary producers;
- Trophic level 2 (T2), herbivores eat plants and are called primary consumers;
- Trophic level 3 (T3), carnivores eat herbivores and are called secondary consumers;
- Trophic level 4 (T4), carnivores eat other carnivores and are called tertiary consumers; and
- Trophic level 5 (T5), apex consumers, which have no predators, are at the top of the food chain.



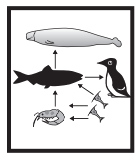
Populations or Stocks—A population often is defined as a group of organisms of the same species occupying a particular space at a particular time with the potential to breed with each other (Williams and others, 2002). Stocks are subpopulations of a particular species of fish that result from reproductive isolation and subdivisions within the biological range. The current state of knowledge about local stocks and their genetic population structure is reported. Grossberg and Cunningham (2001) described the combined effects of demographic, behavioral, genetic, oceanographic, climate, and tectonic processes as major determinants of population structure. These mechanisms act across a range of temporal and spatial scales to determine the rates and patterns of dispersal of different life stages of marine fishes. Dispersal, combined with the successful reproduction and survival of immigrants, control the scale and rate of processes that build or erode structure within and among groups of individuals.



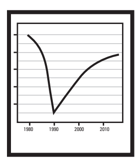
Reproduction Mode—Little information is available about the spawning times and locations, mating behaviors (breeders or nonbreeders), and genetic diversity of Arctic marine fishes. What is known is drawn largely from observations from populations studied outside the United States. For most Arctic marine fish species, there is no information about population or stock structure (for example, age structure, reproductive behavior, sex ratios, age-at-maturity, fecundity, and genetic). These are key population parameters needed for understanding reproductive ecology, population dynamics (for example, growth, survival, and mortality), and assessments of resiliency (response to disturbance).



Food and Feeding—Dietary information is summarized from literature and, unless in italics, is reported from other regions. Fish communities can affect the ecological characteristics of marine ecosystems in response to productivity and abundance patterns, the mobility and migratory behavior of species, and through food influences in different habitats (for example, Grebmeier and others, 2006b). Trophic Index (T) values are reported from FishBase (Froese and Pauly, 2012). The T values for Arctic marine fishes are largely derived from stomach contents analyses, which have correlated well with stable isotopes of nitrogen in tissues. The fractional values (between 1 and 5) realistically address complexities of consumer feeding behaviors (omnivory and feeding across multiple trophic levels) and predator-prey relationships. For example, the mean T value for Blackline Prickleback (*Acantholumpenus mackayi*) is 3.1 (±0.31). This mid food web value is indicative of a primary carnivore that feeds across trophic levels, in this case on lower level herbivores.



Biological Interactions.—The effects organisms in a community have on one another. Competition and consumption (predation, herbivory, or cannibalism) are the best known of the major ecological processes affecting resource abundance, community composition, and ecosystem function. Competition involves interactions between individuals of the same species (intraspecific) or different species (interspecific) in which the fitness of one is lowered by the presence of another. Competition often is related to food and habitat requirements and reproductive behavior. Interspecific competition for foods is greatest for species occupying similar trophic positions in relatively short food chains and for animals living in regions of low biological productivity.

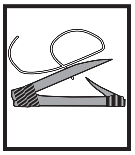


Resilience—In ecology, resilience traditionally refers to the ability of a population or biotic community to sustain or return to its former state after a disturbance. The rate of recovery is a measure of resilience determined by the population processes involved in restoring abundance to healthy, sustainable, or pre-disturbance levels. Four categories of productivity (high, medium, low, and very low) are used to classify reliance in marine fish populations (Musick, 1999). These categories are based on a combination of population parameters for intrinsic rate of growth, growth coefficient, fecundity, age at maturity, and maximum age. Because population parameters were unavailable, resiliency is defined here based on estimated population doubling time where high = <15 months, medium = 1.4–4.4 years, and low = 4.5–14 years.

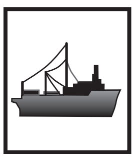
Traditional, Cultural, and Economic Values

In August 2009, the U.S. Secretary of Commerce approved a Fishery Management Plan for the Arctic Management Area. The plan covers U.S. Arctic waters in the

Chukchi and Beaufort Seas, and acknowledges that changing climate may potentially favor the development of commercial fisheries. However, until adequate fisheries resource assessments are completed, the region remains closed to commercial fishing in federal waters. A small salmon fishery exists in Kotzebue Sound; in 2010, a small commercial fishery for Arctic Ciscoes in the Colville River was terminated.



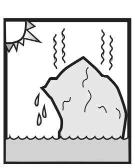
Traditional and Cultural Importance.—Several species of nearshore marine fishes are important in subsistence fisheries. The protection of traditional lifestyles and economies, including these subsistence fisheries, is a responsibility of the Federal government. Subsistence relates to resource use patterns (for example, seasonal round) and values (that is, sustenance, kinship, and barter) in coastal communities of northern Alaska.



Commercial Fisheries.—Currently (2016) there are no offshore marine fisheries in the U.S. Chukchi and Beaufort seas. Changing Arctic environmental conditions and shifting distributions of species in response to warming suggest that there may be fisheries in the future. A precautionary approach by fishery managers has been adopted that requires the collection of reliable baseline information for decision-making and ecosystem management (North Pacific Fishery Management Council [North Pacific Fishery Management Council, 2009; Wilson and Ormseth, 2009]).

Climate Change

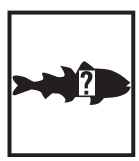
Alaska’s climate is changing at more than twice the rate of the rest of the United States (Mellilo and others, 2014). Year-to-year and regional variability in air temperatures are evident and the warming trend currently is being moderated by large-scale cooling associated with the Pacific Decadal Oscillation. Even so, climate effects are pronounced and are being seen in changes in sea ice, timing of snowmelt, widespread glacier retreat, and changes in hydrology (runoff) and coastal processes, such as erosion (Markon and others, 2012). The effects of rising ocean temperatures and ocean acidification on marine food webs are of growing regional concern with respect to the condition and trends in marine ecosystems and human community resilience are of concern. Climate changes potentially can affect marine fish in numerous ways, leading to distributional changes, increased or decreased mortality rates, changes in growth rates, and by altering the timing in reproduction (Clow and others, 2011).



Potential Effects of Climate Change.—A pole-ward shift of many fish distributions is possible as is a reduction or extinction of species that are narrowly adapted to Arctic environments. Generally, the species are expected to increase in abundance if they are currently present in the Bering Sea and decrease if they have very low tolerance for temperatures greater than 1.5–2.0 °C. However, it is hypothesized in current climate projections that temperatures near the ocean floor in the northern Bering Sea will remain cold (<2 °C) due to persistence of winter sea ice (Sigler and others, 2011). Cold-water conditions and other marine ecosystem effects related to seasonal sea ice extent and timing of retreat may effectively block northward migrations and production of exploitable quantities of species, such as pollock and cod, for several decades. Shifts in range and other possible climate-related effects, such as increased predation or competition for food, are identified in the species accounts. Only “loose qualitative generalizations” are presently possible (Reist and others, 2006).

Research Needs

The compilation and review of species information for species in U.S. Arctic waters revealed many gaps in life history understanding and environmental relations. These are evaluated on the basis of a species current fishery and community values and ecological significance in marine ecosystem structure and function. The needs reflect the researcher’s perceptions and their understanding that new fishery information is becoming available for the Arctic region and that, although Arctic research is currently a national priority, some aspects of population ecology will take many years of data collection to accurately assess.



Areas for Future Research.—The preparation of individual accounts led to the identification of many information gaps in knowledge about the biology and ecology of marine species including life history, population dynamics, and community associations. Generally, species life history and ecology gaps are most pronounced with respect to: (1) depth and location of pelagic larvae; (2) depth, location, and timing of young-of-the-year habitats; (3) preferred depth ranges for juveniles and adults; (4) spawning seasons; (5) seasonal and ontogenetic movements; (6) population genetics and dynamics; (7) prey–predator relationships and food web relationships; and (8) environmental health (multiple stressor effects on fitness). Behavioral studies for all life stages are virtually non-existent. New information is being developed and, for the lesser-known species, gaps may be slowly addressed over time. Priority needs, for species having special significance in subsistence fisheries and marine food webs or that may be indicator species are emphasized in the species accounts. One of two categories of identified research need is identified for each species. The meaning of the categories **[A]** and **[B]** is as follows:

- **[A]** Many gaps in our understanding of the species life history and ecology remain in Alaska (for example, research areas 1 through 8). These are high profile species in terms of ecological, subsistence, or potential fisheries values. Specific research priorities are briefly discussed.
- **[B]** Most aspects of the species life history and ecology are unknown for Alaska (for example, research areas 1 through 8). Species information will likely accumulate over time and focused studies are not warranted at this time.

References Cited and Bibliography

A thorough review of scientific literature was done in the preparation of the species account. A list of references (References Cited [chapter 8]) is provided for each species for readers seeking additional information. This list identifies key sources of information that make the greatest contributions to current knowledge (2014) and understanding. The Bibliography section provides a full accounting of all scientific literature cited in each species account. For a small number of species from the family Cottidae, only a Bibliography was possible to provide and this is indicative of the lack of information available. Citations are not always in numerical order in species accounts because new information became available during the production phase of this publication and were incorporated into the species accounts as appropriate.

Belligerent Sculpin (*Megalocottus platycephalus*)

(Pallas, 1814)

Family Cottidae

Belligerent Sculpin (*Megalocottus platycephalus*). Photograph by Doyne W. Kessler, National Marine Fisheries Service.

Colloquial Name: *None within U.S. Chukchi and Beaufort Seas.*

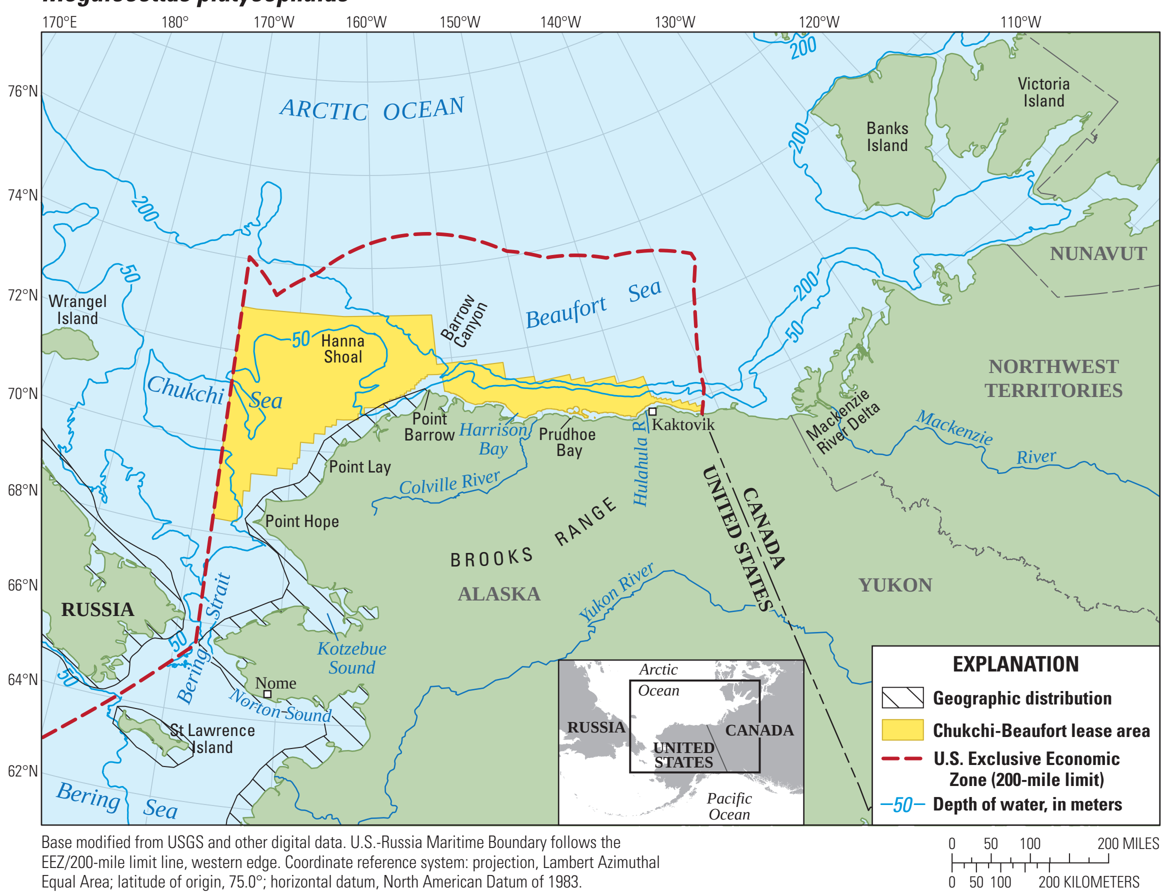
Ecological Role: Unknown but likely minimal, especially in the U.S. Beaufort Sea.

Physical Description/Attributes: Olive-brown or gray-brown with white or yellow markings. Lower sides have a series of light spots, the belly is white, the underside of head dark, and all fins are spotted and barred. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 475) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

Ranges: *U.S. Chukchi Sea to western U.S. Beaufort Sea off Point Barrow, Alaska, at about 71°22'N, 156°19'W* [2]. Elsewhere in Alaska, in eastern Bering Sea south to Herendeen Bay [1]. Worldwide, from Sea of Japan at Peter the Great Bay to Sea of Okhotsk and western Bering Sea [1, 3–5].

Relative Abundance: *Common in eastern U.S. Chukchi Sea* [7] *and rare in U.S. Beaufort Sea* [1, 2]. Common in Sea of Japan, Sea of Okhotsk, and parts of Bering Sea [3–5].

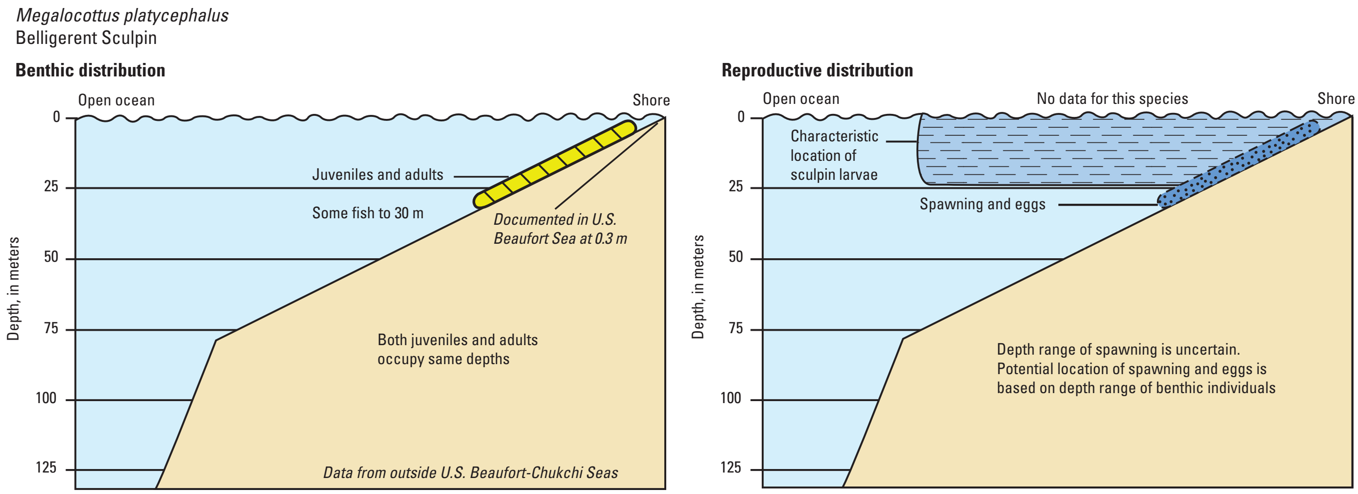
Belligerent Sculpin
Megalocottus platycephalus



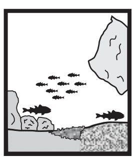
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Belligerent Sculpin (*Megalocottus platycephalus*) within Arctic Outer Continental Shelf Planning Areas [6] based on review of published literature and specimens from historical and recent collections [1, 2, 7].

Depth Range: *Documented in U.S. Beaufort Sea at 0.3 m* [2]. Juveniles and adults are found from shallow subtidal to 40 m [1, 7, 9].

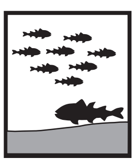


Benthic and reproductive distribution of Belligerent Sculpin (*Megalocottus platycephalus*).



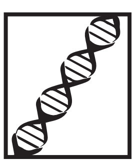
Habitats and Life History

Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Benthic [9].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Pelagic [9].
Juveniles—Age and size: Unknown. Habitat: Benthic, shallow nearshore waters [9].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 42 cm TL [5]. Habitat: Benthic, shallow coastal waters, estuaries, and occasionally lower parts of rivers [3, 9].
Substrate—Unknown.
Physical/chemical—Temperature: 2.6–12.6 °C [7]. Salinity: Brackish to marine waters [9].



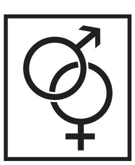
Behavior

Diel—Unknown. **Seasonal**—Along western Kamchatka Peninsula (Russia) coast, lives in coastal waters in winter and spring and ascends well up estuaries and short distances up rivers in summer and fall [5].
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Unknown.



Populations or Stocks

There have been no studies.

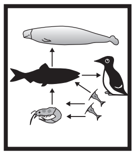


Reproduction

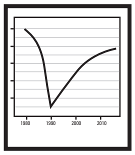
Mode—Separate sexes; oviparous [10].
Spawning season—Unknown.
Fecundity—Unknown.

Food and Feeding

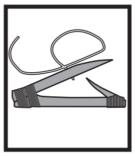
Food items—Off western Kamchatka Peninsula, smaller fish feed on algae, and crustaceans such as copepods, cumaceans, amphipods, and mysids. Larger fish feed on similar prey as well as small fishes [11].
Trophic level—4.08 standard error 0.70 [12].



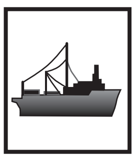
Biological Interactions
Predators—Unknown.
Competitors—Presumably a wide range of other zoobenthic feeders such as Arctic Cod, Walleye Pollock, other sculpins, and eelpouts.



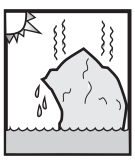
Resilience
Low, minimum population doubling time: 4.5–14 years (assuming fecundity = 10–100) [12].



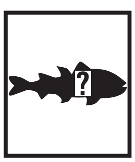
Traditional and Cultural Importance
Historically, an important subsistence species in northeastern Bering Sea and *U.S. Chukchi Sea* [13, 14].



Commercial Fisheries
Currently, Belligerent Sculpin are not commercially harvested.



Potential Effects of Climate Change
A predominantly Boreal Pacific species [2] that appears to be common in parts of the Bering Sea and uncommon in the U.S. Chukchi Sea. Belligerent Sculpin would be expected to increase in abundance in the U.S. Chukchi Sea and potentially the Beaufort Sea as waters warm.



Areas for Future Research [B]
Little is known about the biology and ecology of this species from the region. Research needs include: (1) depth and location of pelagic larvae, (2) depth, location, and timing of young-of-the-year benthic recruitment, (3) preferred depth ranges for juveniles and adults, (4) spawning season, (5) seasonal and ontogenetic movements, (6) population studies, (7) prey, and (8) predators.

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Mecklenburg, C.W., Møller, P.R., and Steinke, D., 2011, Biodiversity of Arctic marine fishes—Taxonomy and zoogeography: Marine Biodiversity, v. 41, no. 1, p. 109–140, Online Resource 1. [2]

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Brightbelly Sculpin (*Microcottus sellaris*)

(Gilbert, 1896)

Family Cottidae

Brightbelly Sculpin (*Microcottus sellaris*). Photograph by Doyne W. Kessler, National Marine Fisheries Service.

Colloquial Name: *None within U.S. Chukchi and Beaufort Seas.*

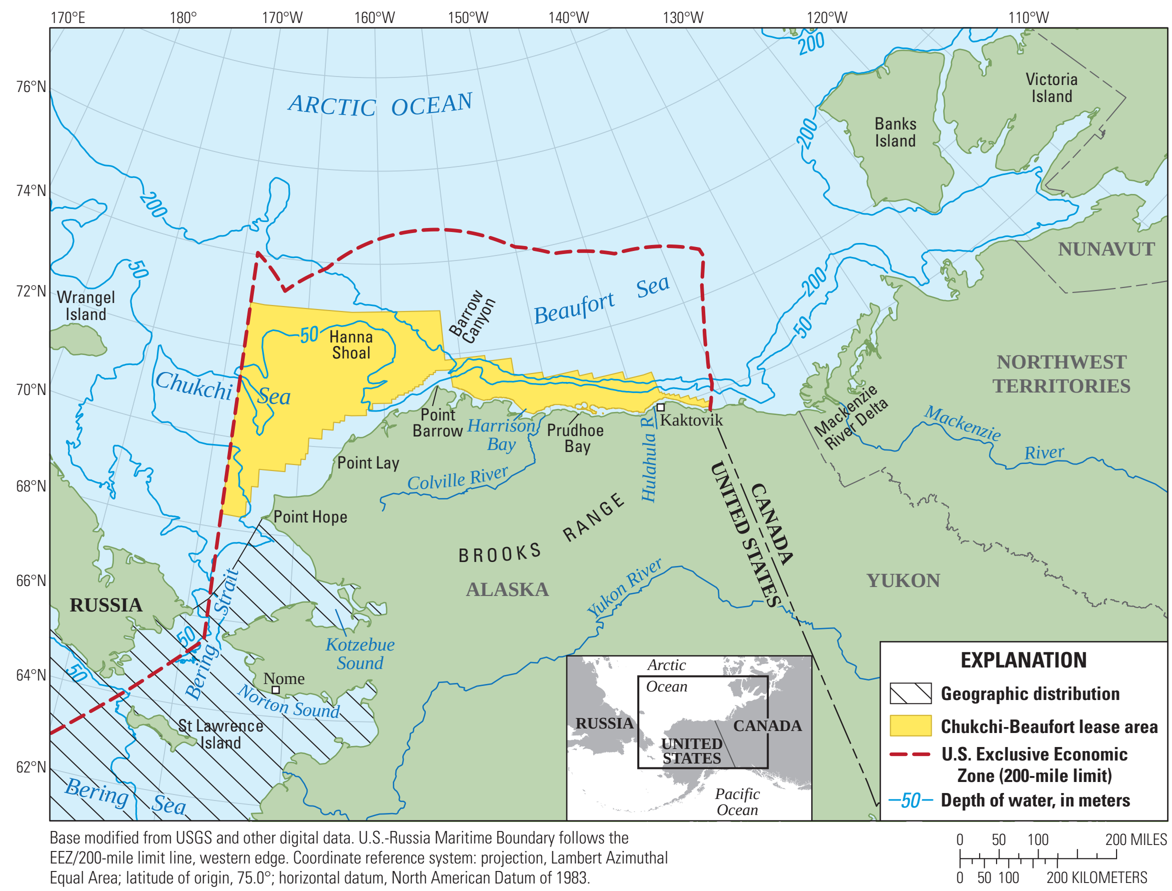
Ecological Role: Unknown in benthic ecosystems over the continental shelf.

Physical Description/Attributes: Purplish body spotted and mottled with either black and white or with red or black. Body has two or more white bars and bright yellow belly. Pelvic fins have black or red spots along rays. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 483) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

Ranges: *Southern U.S. Chukchi Sea* [2–4]. Elsewhere in Alaska, to southern Bering Sea and Commander–Aleutian Islands chain. Worldwide: From Gulf of Anadyr southward to the northern Sea of Japan, southern Okhotsk Sea, and Kuril Islands, Russia [1].

Relative Abundance: *Rare in U.S. Chukchi Sea* [2–4]; absent from the U.S Beaufort Sea. Common as far north as Norton Sound, eastern Bering Sea and southward to Sea of Japan and Kamchatka Peninsula, Russia [6–8].

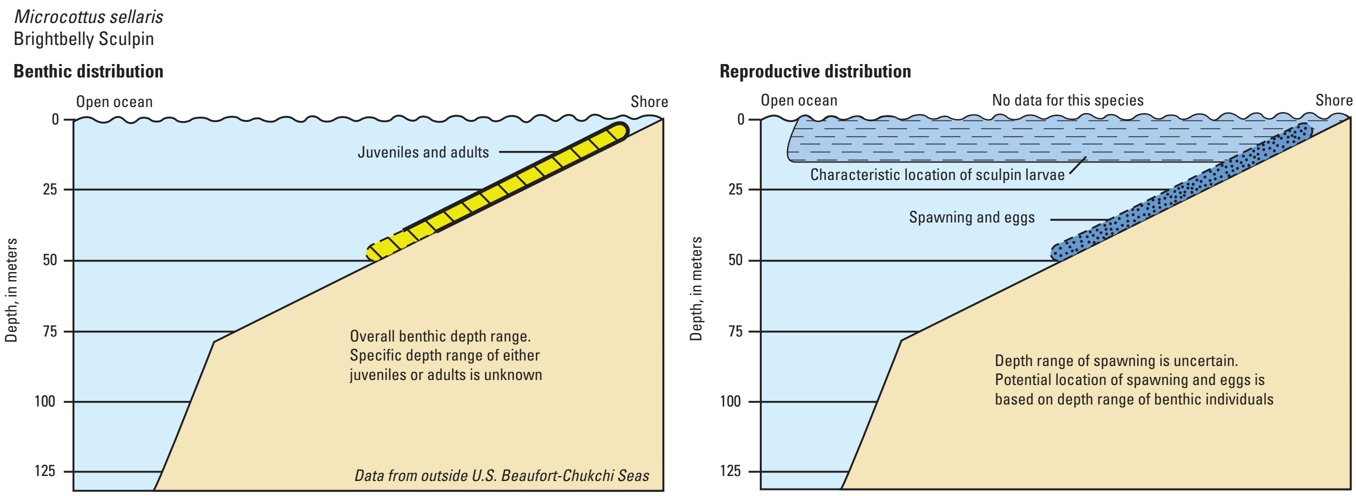
Brightbelly Sculpin
Microcottus sellaris



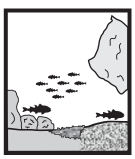
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Brightbelly Sculpin (*Microcottus sellaris*) within Arctic Outer Continental Shelf Planning Areas [5] based on review of published literature and specimens from historical and recent collections [1, 3, 4].

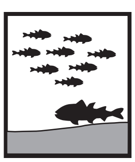
Depth Range: Coastal, shallow waters down to 50 m, most often from shallow subtidal to about 40 m [1, 6, 9–11]. Some juveniles are found in nearshore waters [6].



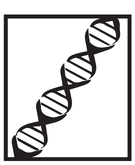
Benthic and reproductive distribution of Brightbelly Sculpin (*Microcottus sellaris*).



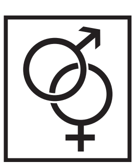
Habitats and Life History
Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Likely benthic, based on other members of this family [1, 9].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Likely pelagic, based on other members of this family [1].
Juveniles—Age and size: Unknown. Habitat: Likely benthic, based on other members of this family [1, 9]. Some juveniles are found in nearshore eelgrass beds [6].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 17 cm TL [15]. Habitat: Likely benthic, based on other members of this family [1, 9].
Substrate—Unknown.
Physical/chemical—Temperature: 2–10 °C in summer off western Kamchatka Peninsula, primarily 6–8 °C [7]. Salinity: Marine and estuarine fish [9].



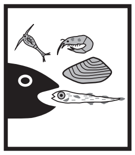
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—At night may move off bottom to feed [6].



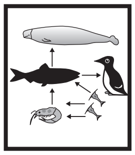
Populations or Stocks
There have been no studies.



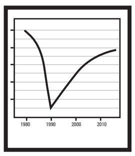
Reproduction
Mode—Separate sexes; oviparous [12].
Spawning season—Unknown.
Fecundity—Unknown.



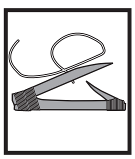
Food and Feeding
Food items—Juveniles living in eelgrass beds in eastern Bering Sea feed on polychaetes, amphipods and other crustaceans, snails, eelgrass, and fishes [6, 13].
Trophic level—3.4 standard error 0.53 [14].



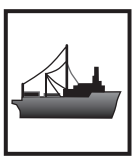
Biological Interactions
Predators—Unknown.
Competitors—Presumably a wide range of other zoobenthic feeders such as Arctic Cod, Walleye Pollock, poachers, eelpouts, and other sculpins.



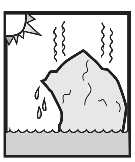
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (Preliminary *K* or Fecundity) [14].



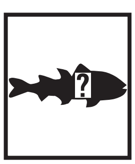
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, Brightbelly Scuplin are not commercially harvested.



Potential Effects of Climate Change
As a predominantly Boreal Pacific species that appears to be common in the eastern Bering Sea and relatively rare in the Chukchi Sea, Brightbelly Sculpin could be expected to increase in abundance in the U.S. Chukchi Sea and perhaps to expand their distribution into the Beaufort Sea as waters warm.



Areas for Future Research [B]
Little is known about the biology and ecology of this species from the region. Research needs include: (1) depth and location of pelagic larvae, (2) depth, location, and timing of young-of-the-year benthic recruitment, (3) preferred depth ranges for juveniles and adults, (4) spawning season, (5) seasonal and ontogenetic movements, (6) population studies, (7) prey, and (8) predators.

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Mecklenburg, C.W., Møller, P.R., and Steinke, D., 2011, Biodiversity of Arctic marine fishes—Taxonomy and zoogeography: Marine Biodiversity, v. 41, no. 1, p. 109–140, Online Resource 1. [3]

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Plain Sculpin (*Myoxocephalus jaok*)

(Cuvier, 1829)

Family Cottidae

Colloquial Name: *None within U.S. Chukchi and Beaufort Seas.*

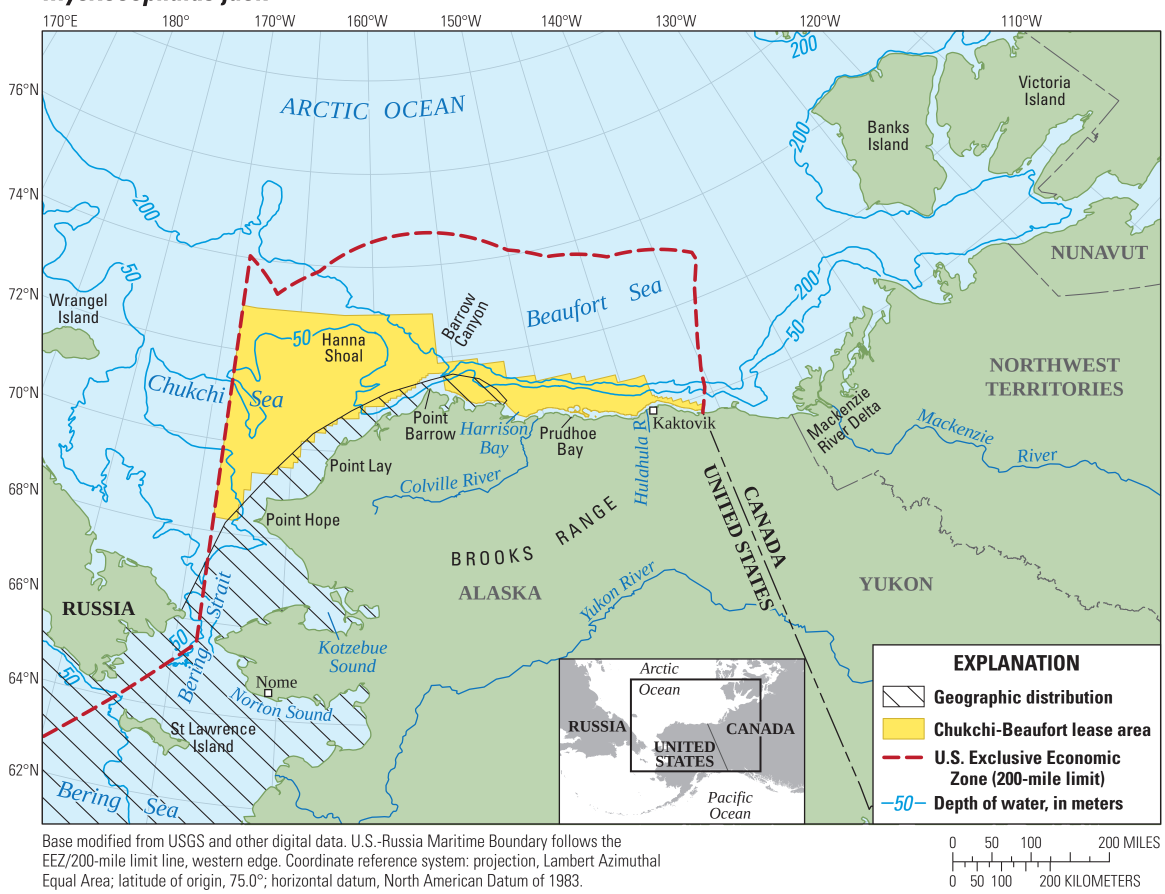
Ecological Role: Plain Sculpin have been only rarely observed. There ecological significance is suspected to be of minor importance in nearshore and shelf habitats.

Physical Description/Attributes: Gray-brown body covered in small black spots. Lower sides have white spots. Fins are barred and spotted. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 481) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

Plain Sculpin (*Myoxocephalus jaok*) 133 mm, northeastern Chukchi Sea, 2007. Photograph by C.W. Mecklenburg, Point Stephens Research.

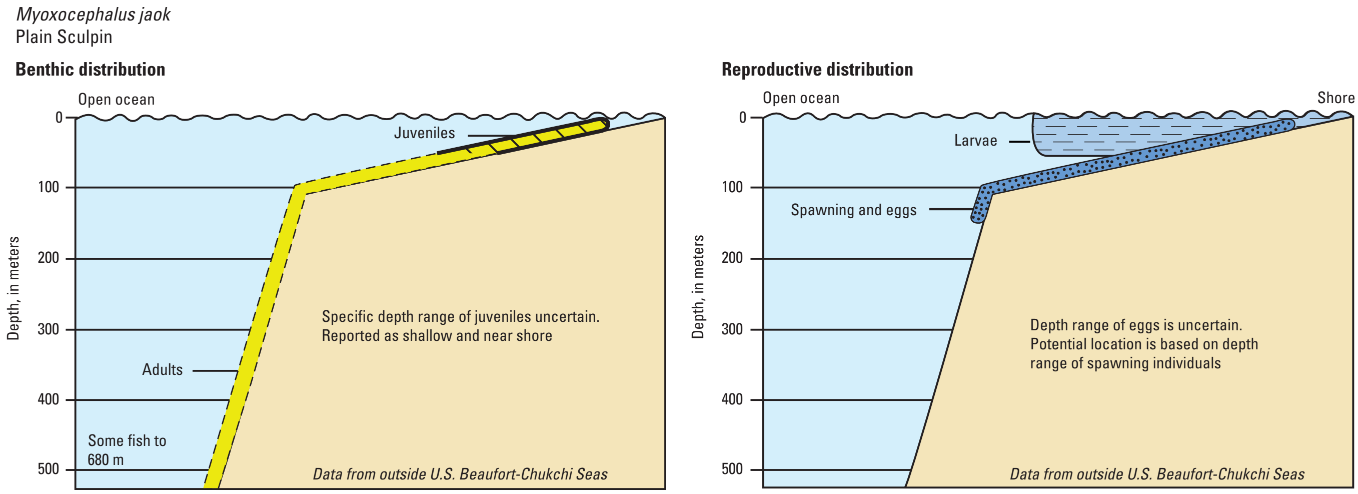
Ranges: *U.S. Chukchi Sea and western Beaufort Sea eastward to at least 71°N, 153°W* [1, 2]. Elsewhere in Alaska, throughout Bering Sea to eastern Gulf of Alaska at Limestone Inlet [1] and Glacier Bay [3]. Worldwide, from Sea of Japan off North Korea to Sea of Okhotsk [1].

Relative Abundance: *Uncommon in U.S. Chukchi Sea and western Beaufort Sea* [2, 5]. Common throughout eastern Bering Sea as far north as Norton Sound and southwards to about Kodiak Island, Alaska, and westwards to Sakhalin Island (Russia), Sea of Okhotsk [6–10].

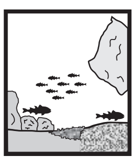


Geographic distribution of Plain Sculpin (*Myoxocephalus jaok*), within Arctic Outer Continental Shelf Planning Areas [4] based on review of published literature and specimens from historical and recent collections [1, 2, 5].

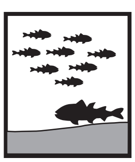
Depth Range: Intertidal to 680 m, mainly less than depth of 50 m off North America [6] and deeper than 5 m in western Pacific Ocean [11]. Larvae live over coastal and continental shelf waters [12]. Juveniles are in shallow nearshore waters [11, 13]. Spawning has been noted at nearshore at 6–8 m and on mid-continental shelf at 80–130 m [14].



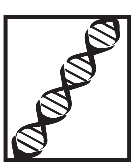
Benthic and reproductive distribution of Plain Sculpin (*Myoxocephalus jaok*).



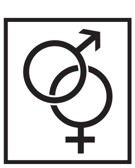
Habitats and Life History
Eggs—Size: 1.9–2.4 mm [14, 15]. Time to hatching: Unknown. Habitat: Benthic and adhesive [14].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: 1.3–2.0 cm SL [13, 16]. Days to juvenile transformation: About two months in Peter the Great Bay [15]. Habitat: Pelagic [12].
Juveniles—Age and size: Unknown. Habitat: Benthic [1, 6].
Adults—Age and size at first maturity: Few males mature at 3 years and most by 6 years. Females mature later, some as early as 5 years and most by 8 years [14, 15]. Maximum age: At least 15 years in Sea of Japan and western Pacific Ocean. Females may live longer than males [14, 15]. Maximum size: 70 cm TL [17]. Females grow faster than males [14, 15]. Habitat: Benthic [1, 6].
Substrate—Sand and mud bottoms [1].
Physical/chemical—Temperature: -1.9–13.1 °C [2]. Off Kamchatka Peninsula, most common at 2–4 °C [17]. Salinity: Marine waters [18–20].



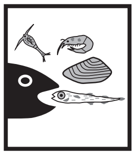
Behavior
Diel—Unknown.
Seasonal—Young-of-the-year settle into shallow nearshore waters as early as May [13]. Some adults occupy shallower shelf waters in summer and retreat to continental slope during winter [17, 21].
Reproductive—Females lay eggs in shallow waters on plants and mussel clusters. Males guard nests until the ova hatch [14]. Schooling: Unknown.
Feeding—Off Kamchatka Peninsula, fish feed most heavily during summer months [22].



Populations or Stocks
There have been no studies.



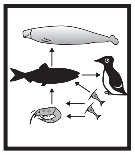
Reproduction
Mode—Separate sexes; oviparous [23].
Spawning season—December–March [14, 15, 24].
Fecundity—From 25,411–147,029 eggs, however it is unclear if all eggs are deposited at one time [14].



Food and Feeding

Food items—A wide range of benthic and water column prey. Fishes and crabs often are most important prey, but in eastern Bering Sea, shrimps, hermit crabs, brittle stars, polychaetes, clams, squids, copepods, mysids, gammarid amphipods, and euphausiids also are consumed [22, 25, 26].

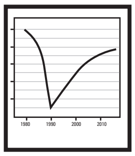
Trophic level—4.2 standard error 0.73 [27].



Biological Interactions

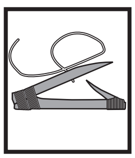
Predators—Mostly unknown. Great Sculpins [22] and probably river otters [28].

Competitors—Presumably a wide range of other zoobenthic feeders such as Arctic Cod, Walleye Pollock, poachers, eelpouts, and other sculpins.



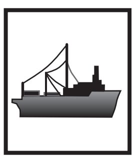
Resilience

Low, minimum population doubling time: 4.5–14 years (assuming fecundity = 10–100) [27].



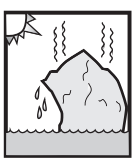
Traditional and Cultural Importance

Historically, this species was caught as a food fish in the northeastern Bering Sea and southeastern U.S. Chukchi Sea [29]. Like other nearshore species, they were taken mainly by elderly men and women who were not able to go great distances to procure other food [30].



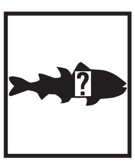
Commercial Fisheries

Currently, Plain Sculpin are not commercially harvested.



Potential Effects of Climate Change

A predominantly Boreal Pacific species that appears to be common in the eastern Bering Sea but uncommon in the Chukchi Sea. Plain Sculpin could be expected to increase in abundance in the Chukchi Sea and perhaps to expand their range into the Beaufort Sea.



Areas for Future Research [B]

Little is known about the biology and ecology of this species from the region. Research needs include: (1) depth and location of pelagic larvae, (2) depth, location, and timing of young-of-the-year benthic recruitment, (3) preferred depth ranges for juveniles and adults, (4) spawning season, (5) seasonal and ontogenetic movements, (6) population studies, (7) prey, and (8) predators.

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Great Sculpin (*Myoxocephalus polyacanthocephalus*)
(Pallas, 1814)

Family Cottidae

Great Sculpin (*Myoxocephalus polyacanthocephalus*) 146 mm, Semidi Islands, western Gulf of Alaska, 2007. Photograph by C.W. Mecklenburg, Point Stephens Research.

Note: *Except for geographic range data, all information is from areas outside of the study area.*

Colloquial Name: *None within U.S. Chukchi and Beaufort Seas.*

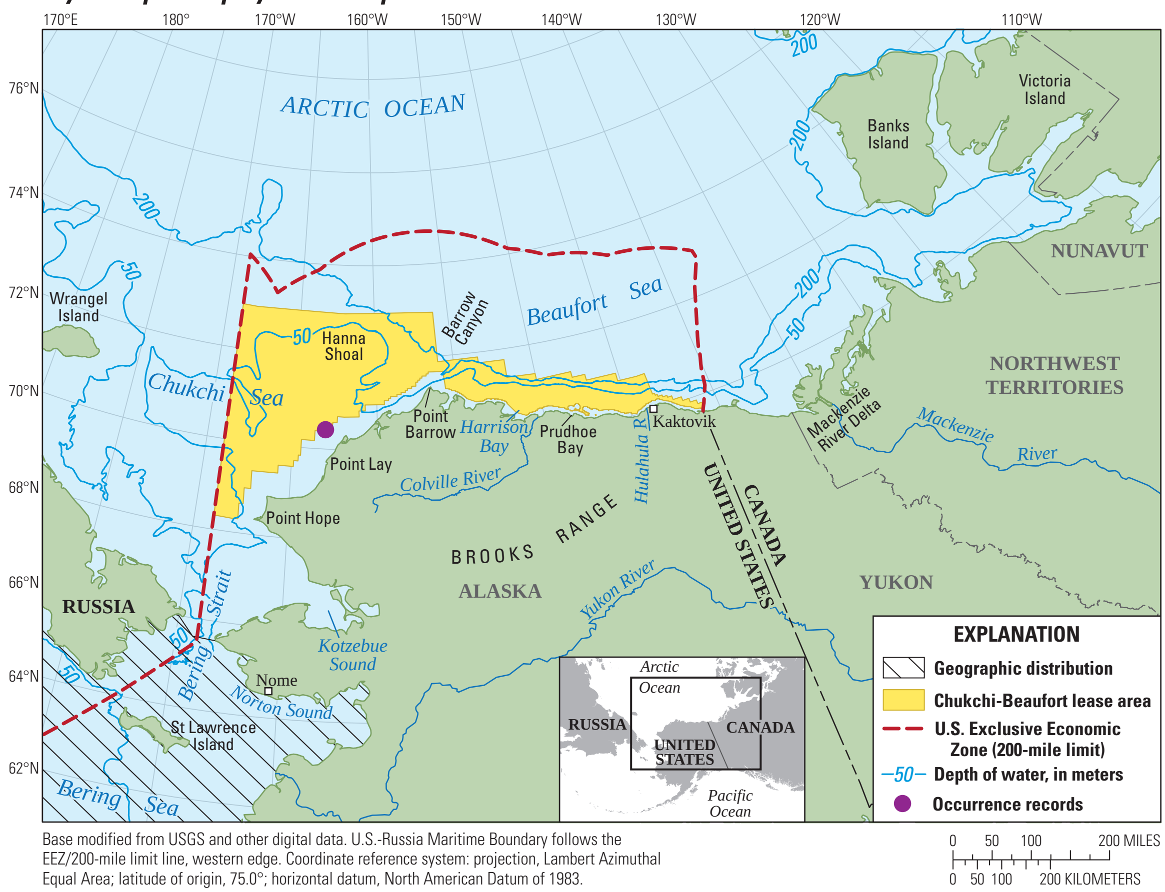
Ecological Role: Minor role. Great Sculpin are rare within the U.S. Chukchi Sea and absent from the Beaufort Sea.

Physical Description/Attributes: Brown or gray with three darker saddles. Belly and lower sides have small white spots, and fins are barred and spotted. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 482) [1]. Swim bladder absent [1]. Antifreeze glycoproteins in blood serum: Unknown. Unlike that of Arctic and shorthorn sculpins, blood serum is clear, rather than blue or green [2].

Ranges: *One record from northeastern Chukchi Sea near Icy Cape at 70°20'N, 163°06'W* [3]. Elsewhere in Alaska, throughout Bering Sea, Aleutian Islands and entire southeastern coast. Worldwide, in western Pacific Ocean, Gulf of Andyr to sea of Okhotsk Sea and eastern Sea of Japan and in eastern Pacific Ocean to southern Puget Sound, Washington [4–7].

Relative Abundance: *Rare in eastern U.S. Chukchi Sea* [3, 9, 10]. Elsewhere in Alaska, uncommon in northern most Bering Sea [10, 11] and common along Aleutian Islands, in eastern Bering Sea, and to at least southeastern Alaska [6, 7]. Worldwide, common in Sea of Japan eastwards along eastern Kuril Island and Kamchatka Peninsula, Russia [4, 5].

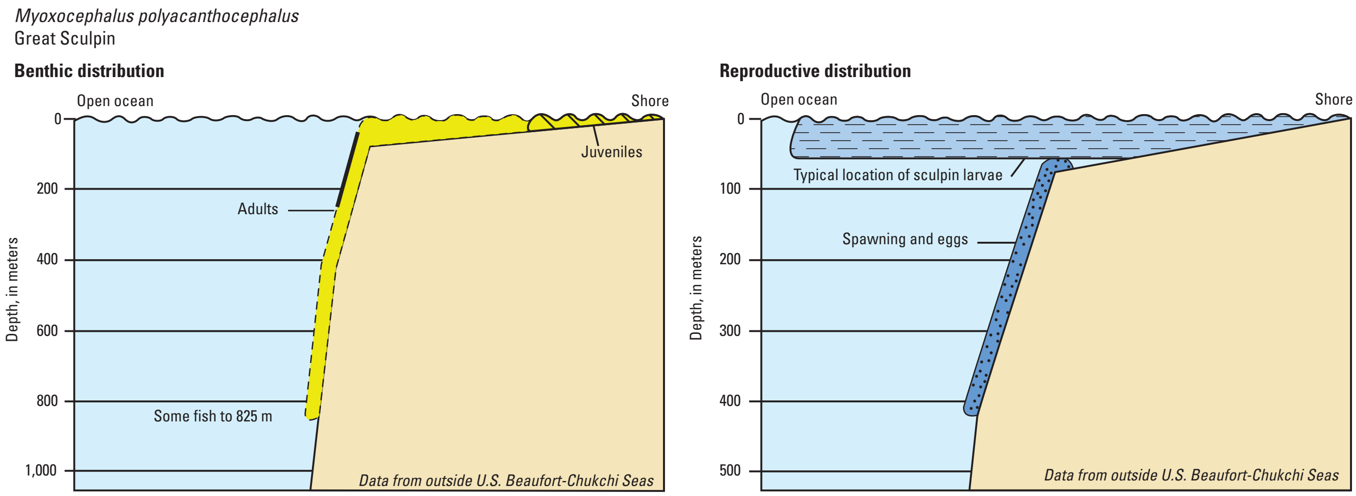
Great Sculpin
Myoxocephalus polyacanthocephalus



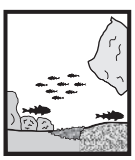
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Great Sculpin (*Myoxocephalus polyacanthocephalus*) within Arctic Outer Continental Shelf Planning Areas [8] based on review of published literature and specimens from historical and recent collections [1, 3, 9].

Depth Range: Intertidal to 825 m, primarily 20–250 m [12–17]. Adults occasionally taken in subtidal nearshore waters [18]. Larvae are found over coastal and continental shelf waters [19]. Juveniles usually 20 m or less [7, 20]. Spawning occurs on lower continental shelf and upper continental slope [4, 21]. Found spawning on slope at depths of 415 m off Sakhalin Island, Russia [21].

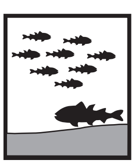


Benthic and reproductive distribution of Great Sculpin (*Myoxocephalus polyacanthocephalus*).



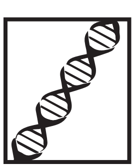
Habitats and Life History

Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Benthic and adhesive [4].
Larvae—Size at hatching: As small as 1.1 cm SL [22]. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Pelagic [19, 23].
Juveniles—Age and size: Unknown. Habitat: Benthic, neritic [20, 24], complex habitats such as rocks, cobbles, eelgrass, and other aquatic plants, and over soft sea floors [5–7, 20, 25, 26].
Adults—Age and size at first maturity: In Sea of Okhotsk, males first mature at 5 years (33–34 cm TL), fifty percent at 6 years (40 cm TL), and all at 8 years (50 cm TL). Females mature when older and larger, first at 7 years (49–50 cm), fifty percent at 8 years (55 cm) and all at 9 years (65 cm TL). Maximum age: 16 years, off North America [27]. Maximum size: 76 cm TL [1] and more than 9 kg [12, 28]. Habitat: Benthic, neritic to oceanic [12–14, 16, 17]. Complex habitats, such as rocks, cobbles, eelgrass, and other aquatic plants as well as soft sea floors [5–7, 20, 25, 26].
Substrate—Rocks, cobbles, eelgrass, other aquatic plants and soft sea floors [5–7, 20, 25, 26].
Physical/chemical—Temperature: -0.5–12 °C, most abundant in 8 °C or less [4, 7, 12, 29, 30]. In Sea of Okhotsk spawning occurs between 0.8 and 1.9 °C [4, 21]. Salinity: Marine, or slightly estuarine waters [4, 7, 12, 29, 30].



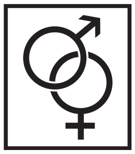
Behavior

Diel—Unknown.
Seasonal—Beginning in May, young-of-the-year recruit from plankton to intertidal and shallow subtidal waters [23, 31]. In western Pacific Ocean and Sea of Japan, adults migrate into deeper waters in winter [15, 21].
Reproductive—Sea of Okhotsk fish spawn over cobble sea floors [4, 21].
Schooling—Little is known although adults have been noted forming dense aggregations in Sea of Okhotsk [4].
Feeding behavior—In western Pacific Ocean, feeding is heavier during summer [28, 29].

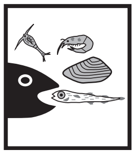


Populations or Stocks

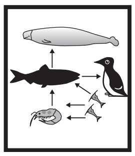
There have been no studies.



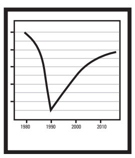
Reproduction
Mode—Unknown.
Spawning season—January–February in Sea of Okhotsk [4].
Fecundity—48,000–423,000 adhesive and yellowish-orange to red eggs [4, 21].



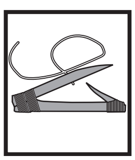
Food and Feeding
Food items—In eastern Bering Sea, a wide range of benthic and epibenthic prey. Fishes (for example, Capelin, Pacific Cod, Walleye Pollock, snailfishes, and flatfishes) and crabs are most important, followed by polychaetes, clams, octopi, mysids, gammarid and caprellid amphipods, isopods, euphausiids, shrimps, hermit crabs, brittle stars, and echiuroids [31–33]. Under certain circumstances, adults prey on eggs of conspecifics [28]. Smaller fish feed primarily on invertebrates and larger individuals on fishes [29, 34, 35].
Trophic level—4.1 standard error 0.67 [36].



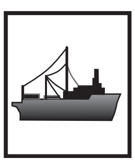
Biological Interactions
Predators—In northeastern Pacific Ocean and Bering Sea, a wide range including other Great Sculpin, Pacific Cod, Pacific Halibut, Pink Salmon, Red Irish Lord, Rock Greenling, Walleye Pollock, Pigeon Guillemot, mink, harbor seals, and Steller sea lions [26, 35, 37–41].
Competitors—Presumably a wide range of other zoobenthic feeders such as Arctic Cod, Walleye Pollock, poachers, eelpouts, and other sculpins.



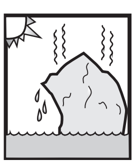
Resilience
Low, minimum population doubling time: 4.5–14 years (t_m=6–8; t_{max}=9–13; K=0.08–0.21; Fecundity = 2,00–10,000) [36].



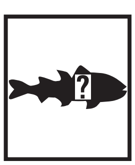
Traditional and Cultural Importance
Historically, Great Sculpin were an important subsistence fish in Alaskan waters [42]. Currently, they are an unmarketed bycatch in Russian trawl fisheries [43].



Commercial Fisheries
Currently, Plain Sculpin are not commercially harvested.



Potential Effects of Climate Change
A Boreal Pacific species [9], Great Sculpin would be expected to increase in abundance in the U.S. Chukchi Sea and possibly expand their range into the Beaufort Sea.



Areas for Future Research [B]
Little is known about the biology and ecology of this species from the region. Research needs include: (1) depth and location of pelagic larvae, (2) depth, location, and timing of young-of-the-year benthic recruitment, (3) preferred depth ranges for juveniles and adults, 4) spawning season, (5) seasonal and ontogenetic movements, (6) population studies, (7) prey, and (8) predators.

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Fourhorn Sculpin (*Myoxocephalus quadricornis*)
(Linnaeus, 1758)

Family Cottidae

Fourhorn Sculpin (*Myoxocephalus quadricornis*)
Photograph by Doyne W. Kessler, National Marine Fisheries Service.

Colloquial Names: Iñupiat: Kanaiok [1]; Kanayuq [2].

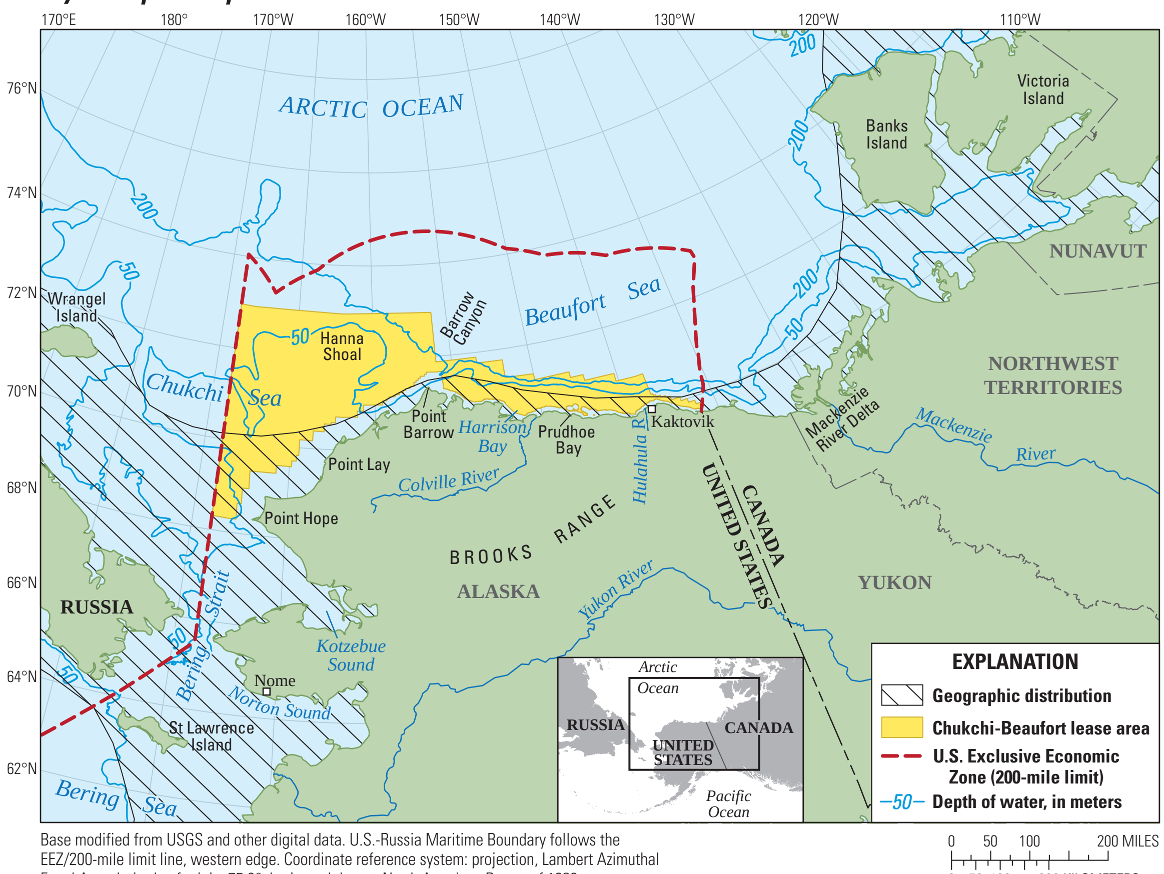
Ecological Role: This species is ubiquitous in the shallow nearshore waters of the U.S. Beaufort and Chukchi Seas. Found in the nearshore throughout the year, it is consumed by a wide variety of fishes, birds, and mammals.

Physical Description/Attributes: Dark gray on backs and sides and lighter on belly. Saddles on the back and bars on the fins. Elongate, tapering body with dorsally compressed head. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 477) [3]. Swim bladder: Absent [3]. Antifreeze glycoproteins in blood serum: Unknown.

Ranges: *In shallow waters of the U.S. Chukchi and Beaufort Seas.* Elsewhere, Arctic; Circumpolar; southward to Gulf of Anadyr, St. Lawrence Island, and northern Bristol Bay, Bering Sea, and to northern Greenland and Baltic Sea in the Atlantic [4].

Relative Abundance: *Common throughout shallow waters of U.S. Beaufort Sea* [7–9] *and Chukchi Sea to Point Lay* [10, 11]. *Abundance south of Point Lay is unknown.* Extremely abundant in shallow waters in Canadian Beaufort Sea eastwards to Tuktoyaktuk Peninsula, Canada [9, 12, 13].

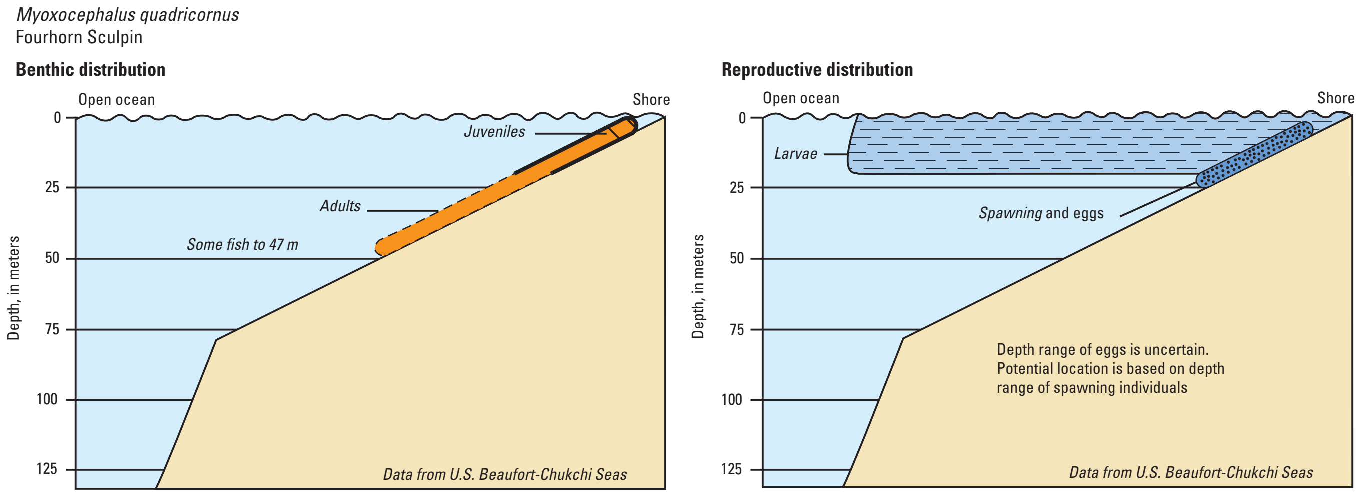
Fourhorn Sculpin
Myoxocephalus quadricornis



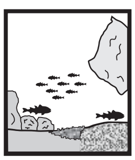
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Fourhorn Sculpin (*Myoxocephalus quadricornis*) within Arctic Outer Continental Shelf Planning Areas [5] based on review of published literature and specimens from historical and recent collections [3, 4, 6].

Depth Range: *Intertidal to 47 m, mainly 15–20 m or less* [10, 14]. Elsewhere, in Baltic Sea common to at least 40 m [15]. *Spawning occurs nearshore as shallow as 4 m* [16–18]. In northeast Pacific Ocean, larvae are pelagic in coastal and continental shelf waters [19]. *Juveniles are found in very shallow waters, often 1 m or less* [16].



Benthic and reproductive distribution of Fourhorn Sculpin (*Myoxocephalus quadricornis*).



Habitats and Life History

Eggs—Size: 1.5–2.9 mm [15, 20, 21]. Color can be green, yellow, or brown according to type of prey eaten by females [22]. Time to hatching: Baltic Sea eggs hatched in 97 days at 1.5 °C and 55 days at 4.7 °C, and no eggs hatched at 10.5 °C [23]. Habitat: Benthic and adhesive [15, 20, 21].

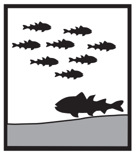
Larvae—Size at hatching: Unknown. Size at juvenile transformation: *10–12 mm FL* [16, 17, 24–28]. Days to juvenile transformation: Unknown. Habitat: Pelagic in coastal and continental shelf waters [19].

Juveniles—Age and size: 10–12 mm to 100–250 mm FL [12, 16, 17, 24–30]. Habitat: Same as adults.

Adults—Age and size at first maturity: Varies with location. *In Simpson Lagoon (near Colville River), males matured between 2–4 years and females between 4–6 years* [16]. On Yukon Coast a few of both sexes were mature at 5 years, all males at 7 years, and all females at 10 years [29]. Generally, few fish mature at 100 mm FL and all by 250 mm FL [12, 16, 17, 25, 29, 30]. Growth rates are variable between locations and females tend to grow larger at age than males [12, 18, 29]. A comparison of growth rates at two Baltic Sea locations indicated that growth was faster at higher ambient temperatures [31]. Maximum age: 16 years [17] and females may live longer [12, 18, 29]. Maximum size: 36.5 cm TL [3]. Habitat: *Benthic habitats in protected, nearshore waters of river mouths, bay and inlets, and along open coasts* [7, 29]. Occasionally, travels upstream in rivers and occupies lakes; reported in Mackenzie River as far upstream as 193 km, in Meade River as far upstream as 129 to 145 km [14] and in deep, cold Scandinavian lakes [32]. Eelgrass [33].

Substrate—Mud sea floors [23, 34, 35].

Physical/chemical—*In U.S. Beaufort Sea, most abundant in colder, more saline marine waters* [36, 37]. Temperature: *In Alaskan and Canadian waters fish have been found at water temperatures between -2.0 and 15 °C* [14, 38]. *Spawning occurs often at temperatures of less than 0 °C* [16–18]. In Baltic Sea, upper lethal temperatures are between 17.5 to 25.5 °C [39]. Salinity: *Fresh waters to 32 ppt* [16, 27]. In a saline lake on Cornwallis Island, Canadian Arctic, fish survive in hypersaline conditions of as much as 36 ppt [40].



Behavior

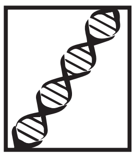
Diel—*Only limited coastal movements occur aside from seasonal, ice-related, inshore-offshore excursions* [16, 41, 42]. At night, small individuals may rise up into water column to feed [43].

Seasonal—*In U.S. Beaufort Sea, fish over winter along shallow, bottom ice-free coastlines* [12, 13, 16, 18, 25, 44] *and river deltas* (for example, Colville and Sagavanirktok) [13, 45, 46]. *In June and early July, after inshore bottom ice melts, migrations occur from just offshore into shallow waters* [16, 28]. *Young-of-the-year recruit to very shallow waters from June to August* [16, 17, 24–28].

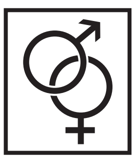
Reproductive—*Females spawn annually* [16] and may spawn more than one batch per season [30]. In Baltic Sea, males become territorial a few months before spawning and prepare nests by digging holes in mud sea floors. Females lay eggs in these depressions and males guard eggs until they hatch by lying on or next to eggs and fanning them with pectoral fins. Along with raising and opening fins, guarding males also make warning sounds and bite intruders. In aquaria, harassed males will move eggs to another location by pushing them, tucking them into the angle between head and pectoral fin, or taking eggs into their mouths [23, 34, 35].

Schooling—Probably does not school.

Feeding—Smaller fish prey primarily on invertebrates, whereas larger ones add fishes to their diets [29].



Populations or Stocks: There have been no studies, although genetic research in the Canadian Arctic suggests little population structure in this region [47].



Reproduction

Mode—Though described as having external fertilization, a number of females containing fertilized eggs have been found [23].

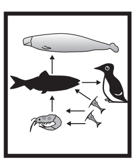
Spawning season—*January–March in U.S. Beaufort Sea*, [12, 17, 18] *and occasionally during summer months* [30].

Fecundity—792–6,150 [15, 48] or as much as 18,000 eggs [49].

Food and Feeding

Food items—*Benthic and epibenthic organisms. Dominant prey are crustaceans, primarily isopods and amphipods, and fishes (for example, Fourhorn Sculpin, Saffron Cod, and Arctic Cod). Other prey include polychaetes, insects, ascidians, fish eggs, clams, plant material, copepods, and shrimps* [10, 11, 13, 17, 50].

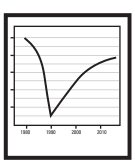
Trophic level—3.7 standard error 0.59 [51].



Biological Interactions

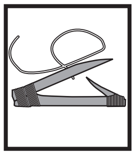
Predators—A wide range of fishes, such as Arctic Cisco, Arctic Sculpin, Dolly Varden, Fourhorn Sculpin, Pacific Herring, Arctic Smelt, Saffron Cod, Shorthorn Sculpin, various eelpouts, as well as grebes, herons, loons, mergansers, Mew Gulls, Thick-billed Murres, ringed and probably bearded seals, and polar bears [10, 18, 27, 29, 40, 52–55].

Competitors—Presumably a wide range of other zoobenthic feeders such as Arctic Cod, Walleye Pollock, poachers, eelpouts, and other sculpins.



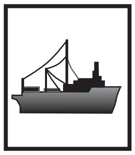
Resilience

Low, minimum population doubling time: 4.5–14 years (t_m=3–5; t_{max}=14; Fecundity=792) [51].



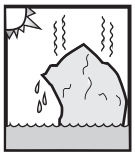
Traditional and Cultural Importance

Generally, although they are widely taken as bycatch in a number of Canadian Arctic subsistence fisheries, Fourhorn Sculpin only are occasionally consumed [11, 56, 57]. In the past, particularly during times of poor fishing, they were more often targeted and eaten [1, 58]. Hudson Bay Inuits reportedly catch and consume in moderate numbers [59].



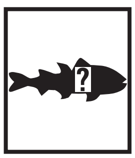
Commercial Fisheries

Currently, Fourhorn Sculpin are not commercially harvested.



Potential Effects of Climate Change

It is unclear what effects climate change will have on this species. This species appears to be somewhat eurythermal, implying that it would not be negatively affected by warming temperatures. However, its apparent rarity south of the Bering Strait suggests (1) physiological adaptation to colder water or (2) a competitive advantage for cold-temperate species, or both. If these assumptions are true, climate change effects might include a northerly shift in the distribution of the species and increased interactions with other marine species.



Areas for Future Research [A]

The Fourhorn Sculpin is one of the more dominant species in the U.S. Beaufort Sea nearshore , as it is relatively well-studied in coastal monitoring programs. It is a potential indicator species and, as such, information needs include: (1) depth and location of pelagic larvae, (2) depth, location, and timing of young-of-the-year benthic recruitment, (3) preferred depth ranges for juveniles and adults, (4) seasonal and ontogenetic movements, and (5) population dynamics.

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Arctic Sculpin (*Myoxocephalus scorpioides*)

(Fabricius, 1780)

Family Cottidae

Colloquial Name: Iñupiat: *Tivaqiq* (Coronation Gulf) [1].

Ecological Role: Largely unknown. However, Arctic Sculpin are unlikely to represent a significant prey resource to other fish, birds, or mammals.

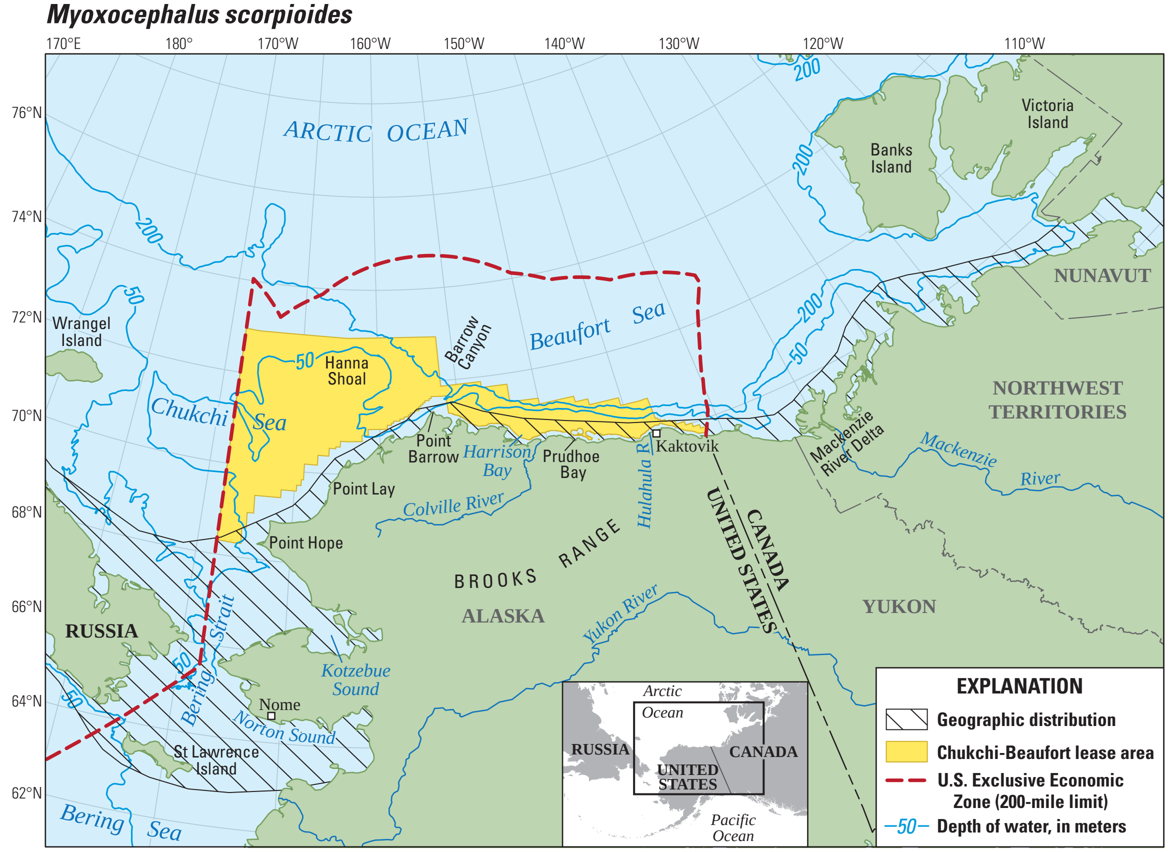
Physical Description/Attributes: Purplish-blue or blackish body with dark bands, white mottling and spots, and with barred and spotted fins. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 479) [2]. Swim bladder: Absent [2]. Antifreeze glycoproteins in blood serum: Unknown. Blood serum is green to blue-green in color, likely caused by biliverdin build-up [3].

Arctic Sculpin (*Myoxocephalus scorpioides*). Photograph by Andrey Vinnikov, Chukotka Branch, Pacific Research Institute of Fisheries and Oceanography.

Range: *Along coasts of U.S. Chukchi and Beaufort Seas.* Elsewhere in Alaska, in Bering Sea south to Norton Sound and St. Lawrence Island. Worldwide, in western Bering Sea south to Gulf of Anadyr; from East Siberian Sea and along Arctic Canadian coast eastward to Greenland and Gulf of St. Lawrence in the Atlantic [4–7].

Relative Abundance: *Uncommon in U.S. Chukchi and Beaufort Seas* [4].Reported as common in Canadian Arctic Ocean but likely misidentified, confused with the more numerous *M. scorpius* [4].

Arctic Sculpin
Myoxocephalus scorpioides

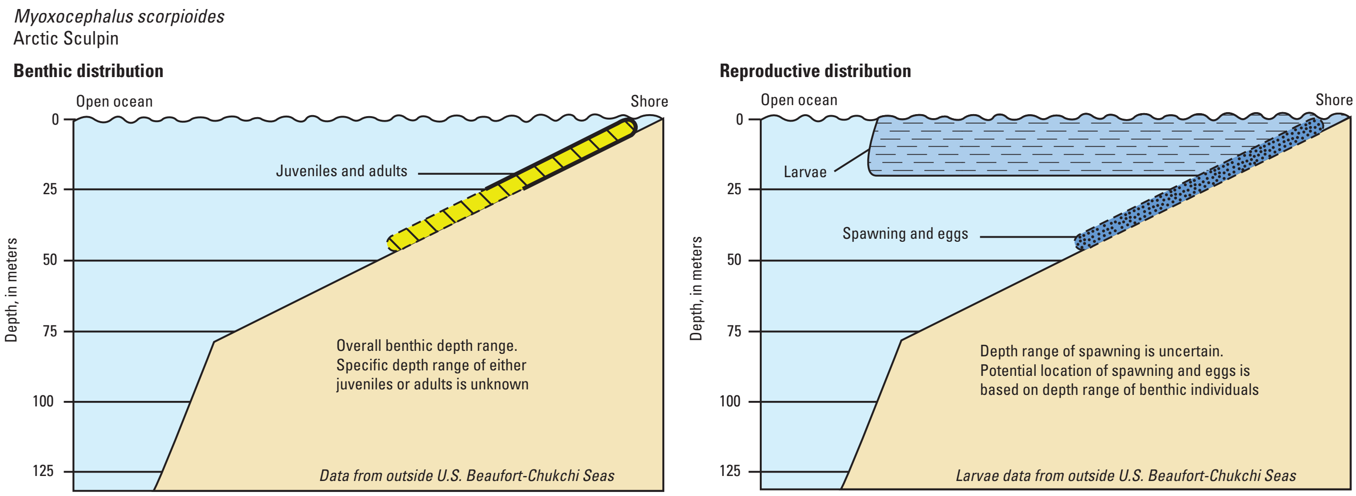


Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

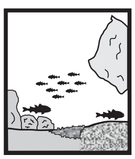
0 50 100 200 MILES
0 50 100 200 KILOMETERS

Geographic distribution of Arctic Sculpin (*Myoxocephalus scorpioides*) within Arctic Outer Continental Shelf Planning Areas [8] based on review of published literature and specimens from historical and recent collections [4, 9].

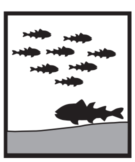
Depth Range: Shallow nearshore to depth of 40 m off Alaska [2, 21] and to 40 m elsewhere [10]. Larval *Myoxocephalus* spp. live in coastal and continental shelf waters [11].



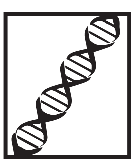
Benthic and reproductive distribution of Arctic Sculpin (*Myoxocephalus scorpioides*).



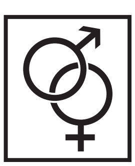
Habitats and Life History
Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Likely benthic, based on other members of this family [2].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Pelagic [11].
Juveniles—Age and size: Unknown. Habitat: Benthic [12].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 23.8 cm TL [2]. Habitat: Benthic [11, 12].
Substrate—Rock and algae [13].
Physical/chemical—Temperature: Below 0 to 8 °C or higher [14]. Salinity: Marine and estuarine waters as low as 6 ppt [7, 14–17].



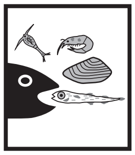
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown. **Schooling**—Unknown.
Feeding—Unknown.



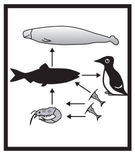
Populations or Stocks
There have been no studies.



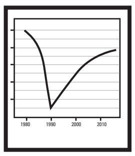
Reproduction
Mode—Unknown.
Spawning season—Autumn, in Russian Arctic Ocean [14].
Fecundity—Unknown.



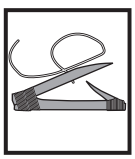
Food and Feeding
Food items—Amphipods [12, 14].
Trophic level—3.39 standard error 0.52 [18].



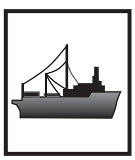
Biological Interactions
Predators—Black Guillemots and possibly bearded seals in Canadian Arctic Ocean [19, 20].
Competitors—Presumably a wide range of other zoobenthic feeders such as Arctic Cod, Walleye Pollock, poachers, eelpouts, and other sculpins.



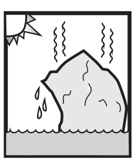
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (Preliminary *K* or Fecundity) [18].



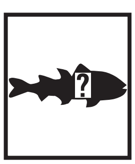
Traditional and Cultural Importance
None reported. Not commonly caught and retained in subsistence fisheries [12].



Commercial Fisheries
Currently, Arctic Scuplin are not commercially harvested.



Potential Effects of Climate Change
The Arctic Sculpin is an endemic species that lives in shallow waters close to shore. A distributional shift to the north, in this case contraction from the northern Bering Sea, and increased species abundance in coastal waters are likely outcomes of climate warming.



Areas for Future Research [B]
Little is known about the biology and ecology of this species from the region. Research needs include: (1) depth and location of pelagic larvae, (2) depth, location, and timing of young-of-the-year benthic recruitment, (3) preferred depth ranges for juveniles and adults, (4) spawning season, (5) seasonal and ontogenetic movements, (6) population studies, (7) prey, and (8) predators.

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Shorthorn Sculpin (*Myoxocephalus scorpius*)

(Linnaeus, 1758)

Family Cottidae

Shorthorn Sculpin (*Myoxocephalus scorpius*) 237 mm, Bering Strait, 2006. Photograph by C.W. Mecklenburg, Point Stephens Research.

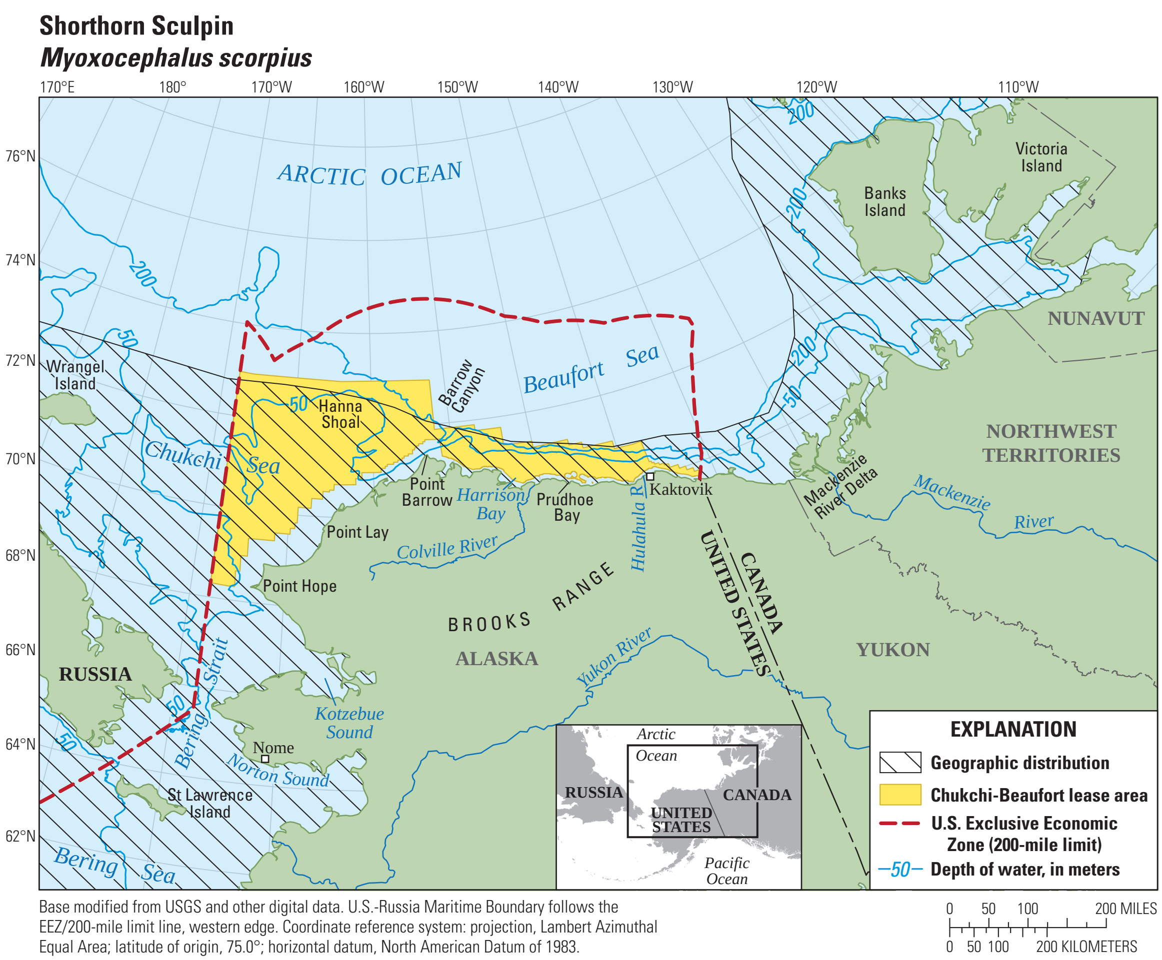
Colloquial Name: *None within U.S. Chukchi and Beaufort Seas*.

Ecological Role: Shorthorn Sculpin is one of the most common benthic species in the shallower waters of the U.S. Chukchi Sea and is common in the Beaufort Sea. Although research is lacking, available information implies that this species is likely of moderate ecological importance as prey for some marine mammals and sea birds.

Physical Description/Attributes: Body variably colored from black to greenish brown to pale olive with yellow and orange tinges and dark mottling. Belly is white, red (particularly in males), yellow, orange, or brown. Fins are brown, green, or yellow, with paler spots and bars [1–3]. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 478) [3]. Swim bladder: Absent [3]. Antifreeze glycoproteins in blood serum: Present [4, 5]. Blood serum is colored blue-green, likely due to biliverdin build-up [6].

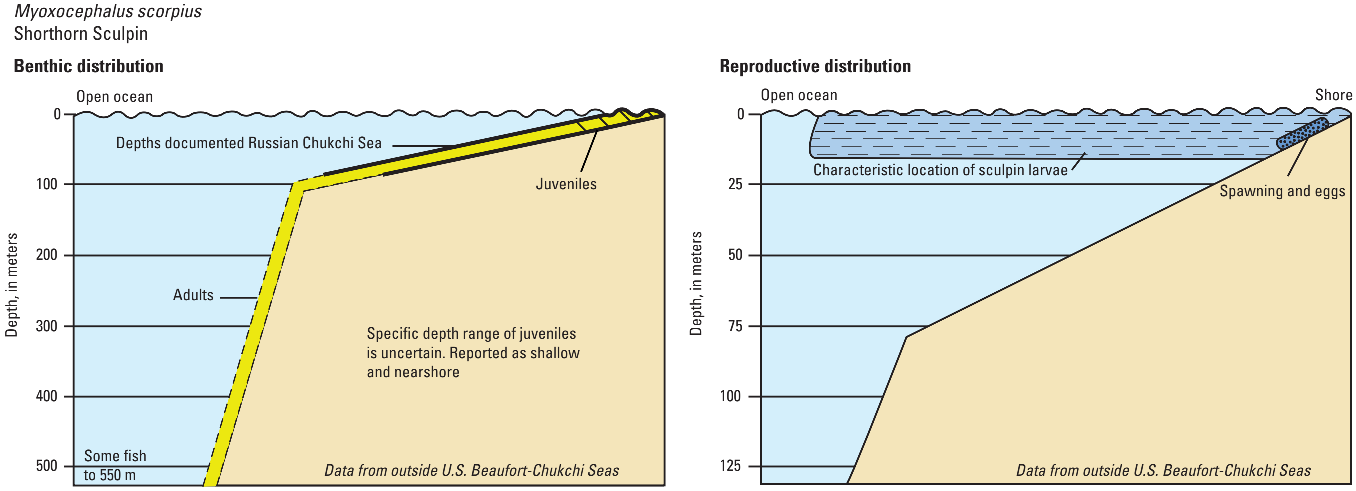
Ranges: *U.S. Chukchi and Beaufort Seas*. Elsewhere in Alaska, southward through Bering Sea and Commander–Aleutian Islands chain and all southeastern Gulf of Alaska. Worldwide, circumpolar; southward to Gulf of Maine, Bay of Biscay, southwestern Kamchatka Peninsula, Russia, and northern British Columbia, Canada [7].

Relative Abundance: *Common throughout much of the Chukchi Sea [10] (to at least 71°55'N, 175°18'W [11], and in U.S. Beaufort Sea* [12–14]. Common in eastern Bering Sea and Norton Sound [15, 16] along with James Bay, Hudson Bay, and Hudson Strait, Canada [17].

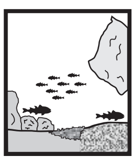


Geographic distribution of Shorthorn Sculpin (*Myoxocephalus scorpius*) within Arctic Outer Continental Shelf Planning Areas [8] based on review of published literature and specimens from historical and recent collections [3, 7, 9].

Depth Range: In Russian Chukchi Sea to at least 84 m [10, 11, 13]. Overall, intertidal (juveniles) [18] to 550 m, mainly less than 70 m [3]. Off Newfoundland, adults have been observed at less than 3 m [19]. Spawning occurs between 3 and 11 m [2, 20]. Larval *Myoxocephalus* spp. live in coastal and continental shelf waters [21].



Benthic and reproductive distribution of Shorthorn Sculpin (*Myoxocephalus scorpius*).



Habitats and Life History

Eggs—Size: 1.8–2.5 mm [22]. Time to hatching: 7–8 weeks at 3.3 °C [23] and less than 3 months at -1.5–0 °C [2, 20]. Habitat: Benthic and adhesive, in crevices of boulders and other rocky formations [2, 20].

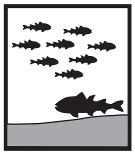
Larvae—Size at hatching: 6.0–8.8 mm [23]. Size at juvenile transformation: 1.0–2.0 cm TL, [24, 25]. Days to juvenile transformation: Unknown. Habitat: Pelagic, in coastal and continental shelf waters [21].

Juveniles—Age and size: 1–2 to 21–39 cm TL [24, 25]. Age unknown. Habitat: Young juveniles are pelagic and neritic [21], and older juveniles are benthic and neritic [3].

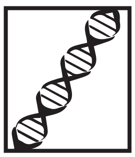
Adults—Age and size at first maturity: Off Newfoundland, a few of both sexes mature at 3 years (21 cm TL), all males at 6 years (30 cm TL); 60 percent of females at 6 years (34–35 cm TL), and all by 8 years (39 cm TL). Females grow larger than males and males mature at a slightly younger age and smaller size [2, 19, 20]. In European waters, males mature at 1 year (8–14 cm TL) and all females at 3 years (20 cm) [26]. In Russian Arctic Ocean, both sexes mature at 2–4 years and 15 cm TL (males) and 20 cm (females) long TL [25]. Egg development within female may take as long as 2.5 years in Newfoundland waters [20] and 1 year in European waters [27]. Generally, Newfoundland fish live much longer, grow more slowly, and mature later in life than do those across the Atlantic Ocean [19, 20, 28]. Based on Baltic Sea research, fish on both sides of the Atlantic Ocean appear to weigh about the same at length with females heavier at length than males [27]. Maximum age: 15 years [2] (rarely more than 6 years in Europe) [26]. Maximum size: 60 cm TL [3] and 1.1 kg [29]. Habitat: Benthic, mainly shallow shelf waters [3, 25, 30].

Substrate—A wide range, including sand, mud, boulder, cobble, and algal beds [2, 11, 12, 31].

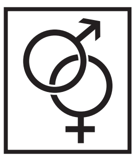
Physical/chemical—Temperature: -1.8–18.9 °C [11, 32], most commonly less than 0 °C [25]. Salinity: From 5 ppt to full sea water [25, 32, 33].



Behavior
Diel—Off Newfoundland, juveniles move into shallower waters (less than 1–2 m) at night. [34].
Seasonal—Young-of-the-year recruit to shallow, often estuarine, waters [1] *and some stay nearshore year round* [13]. Off Newfoundland, seasonal inshore-offshore movements of juveniles (shallow in summer and deeper depths in winter) have been reported [20].
Reproductive—Spawning occurs in shallow waters. Adhesive eggs are laid in crevices of boulders and other rocky formations. Nests are 1–4 m apart and may contain clutches of more than one female. Males aggressively guard eggs until hatching. After spawning, females move into deep waters (likely deeper than 100 m) and return in April and May after eggs hatch [2, 20].
Schooling—Unknown.
Feeding—Semi-sedentary, lies in wait for prey [7]. When drifting ice darkens the waters, diets shifts from drabber benthic prey to brightly colored midwater amphipods [35]. Females feed less just before and after spawning [2].

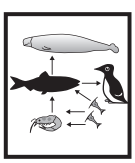


Populations or Stocks
There have been no studies.

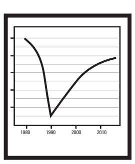


Reproduction
Mode—Unknown.
Spawning season—November and December in Newfoundland [2, 20] and as late as March in Europe [23].
Fecundity—4,205–60,976 (as few as 1,200 in Norway) [23], pink, orange, or red colored eggs [20, 23].

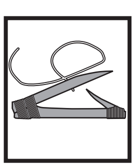
Food and Feeding
Food items—A diverse array of vertebrate and invertebrate prey. In Newfoundland, the Canadian Arctic Ocean, eastern and western Bering Sea, and Norway, fishes and crabs are often most important in the diet, although many other crustaceans (for example, isopods, amphipods, and shrimps), polychaetes, snails, sea urchins, brittle stars, and sea cucumbers also are consumed [2, 23, 35–37].
Trophic level—3.9 standard error 0.40 [38].



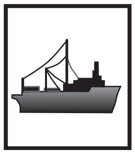
Biological Interactions
Predators—*Ringed seals in U.S. Chukchi Sea* [39]. Black Guillemots, Thick-billed Murres, and bearded seals in Canadian Arctic Ocean [40–42]. River otters in southeastern Alaska [43].
Competitors—Presumably a wide range of other zoobenthic feeders such as Arctic Cod, Walleye Pollock, poachers, eelpouts, and other sculpins.



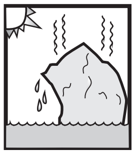
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (t_m=2; Fecundity=2,742) [38].



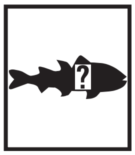
Traditional and Cultural Importance
Seem to have relatively little importance in the U.S. Chukchi and Beaufort Seas. Historically, this was a fairly important species to the Inuits of the Canadian Arctic where it is frequently used as food if other sources are in short supply and used as dog-feed [1].



Commercial Fisheries
Currently, Shorthorn Sculpin are not commercially harvested.



Potential Effects of Climate Change
The Shorthorn Sculpin reproduces and is common in Arctic and Boreal waters [7] and the possible effects of warming on its distribution are difficult to predict. This species has already reestablished the circumpolar distribution it had in pre-Wisconsinan glacial and Bering Land Bridge times [7].



Areas for Future Research [B]
Although there has been substantial life history work conducted off Newfoundland [2, 19, 20] and in European waters [23, 26, 27] little is known about the ecology and life history of this species in the study area. Research needs include: (1) depth and location of pelagic larvae, (2) depth, location, and timing of young-of-the-year benthic recruitment, (3) preferred depth ranges for juveniles and adults, (4) spawning season, (5) seasonal and ontogenetic movements, (6) population studies, (7) prey, and (8) predators. The distribution of the species in regional habitats suggests its potential suitability as an indicator species for monitoring changes associated with global warming.

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Hairhead Sculpin (*Trichocottus brashnikovi*)

Soldatov & Pavlenko, 1915

Family Cottidae

Hairhead Sculpin (*Trichocottus brashnikovi*) 164 mm TL, northeastern Bering Sea, 2006. Photograph by C.W. Mecklenburg, Point Stephens Research.

Note: *Except for physical description, relative abundance, and geographic range data, all information is from areas outside of the study area.*

Colloquial Name: *None within U.S. Chukchi and Beaufort Seas*.

Ecological Role: Largely unknown. However, Hairhead Sculpin are unlikely to represent a significant prey resource to higher level organisms except for the possibility of greater importance in the southeastern Chukchi Sea.

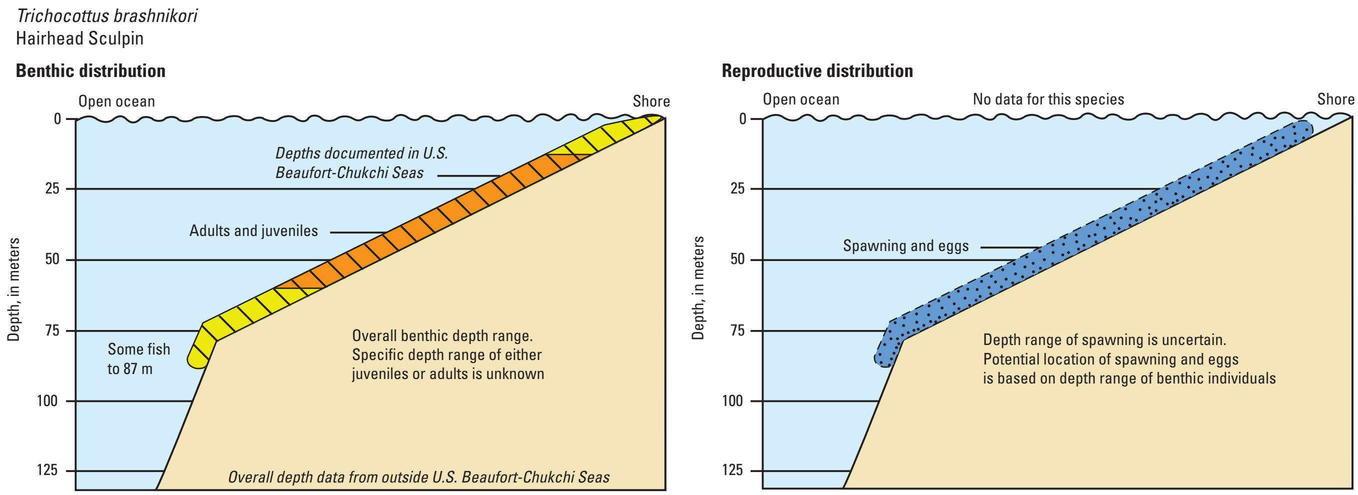
Physical Description/Attributes: Head and body mottled reddish and blackish brown with vague dark saddles; numerous white spots make pattern indistinct; white underside, and white band around caudal peduncle [1]. Swim bladder: Absent [2]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Chukchi Sea [3] and U.S. Beaufort Sea eastward at least to 72°N, 155°W, northeast of Dease Inlet* [1]. Elsewhere in Alaska, in northeastern Bering Sea from Seward Peninsula south to St Lawrence Island. Worldwide, from western Bering Sea off Cape Navarin, Russia, south to Sea of Okhotsk and northern Sea of Japan [2].

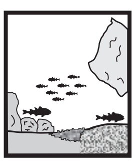
Relative Abundance: *Common, although perhaps not abundant, in U.S. Chukchi Sea and present but uncommon in U.S. Beaufort Sea* [1, 3].

Geographic distribution of Hairhead Sculpin (*Trichocottus brashnikovi*), within Arctic Outer Continental Shelf Planning Areas [4] based on review of published literature and specimens from historical and recent collections [1-3].

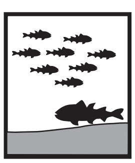
Depth Range: 7–87 m [2]. *Documented in U.S. Chukchi and Beaufort Seas at 13–60 m* [1, 3].



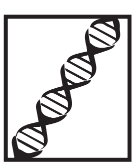
Benthic and reproductive distribution of Hairhead Sculpin (*Trichocottus brashnikovi*).



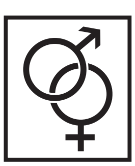
Habitats and Life History
Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Likely benthic, based other members of this family [2].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Likely pelagic, based other members of this family [2].
Juveniles—Age and size: Unknown. Habitat: Benthic [2].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 22.5 cm [2]. Habitat: Benthic [2].
Substrate—Sandy bottoms [2].
Physical/chemical—Temperature: -1.2–6.5 °C [1]. Salinity: Marine [2].



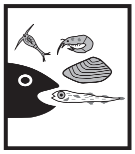
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Unknown.



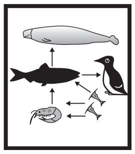
Populations or Stocks
There have been no studies.



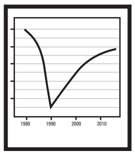
Reproduction
Mode—Unknown.
Spawning season—Unknown.
Fecundity—Unknown.



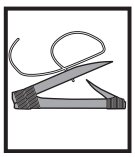
Food and Feeding
Food items—Unknown.
Trophic level—3.45 standard error 0.48 [5].



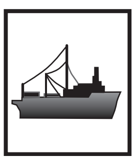
Biological Interactions
Predators—Unknown.
Competitors—Presumably a wide range of other zoobenthic feeders such as Arctic Cod, Walleye Pollock, other sculpins, poachers, and eelpouts.



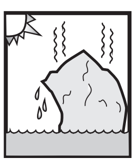
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (Preliminary *K* or Fecundity) [5].



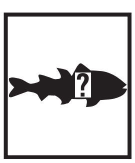
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, Hairhead Sculpin are not commercially harvested.



Potential Effects of Climate Change
As a Boreal Pacific species, a northerly shift in distribution and increased abundance are probable expectations of warming. The effects of increased abundance on biological interactions, especially competition with similar species, presently cannot be assessed.



Areas for Future Research [B]
Little is known about the biology and ecology of this species from the region. Research needs include: (1) depth and location of pelagic larvae, (2) depth, location, and timing of young-of-the-year benthic recruitment, (3) preferred depth ranges for juveniles and adults, (4) spawning season, (5) seasonal and ontogenetic movements, (6) population studies, (7) prey, and (8) predators.

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2. Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p.

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