Table of Contents

Chapter 3i Alaska Arctic Marine Fish Species

Chapter 3. Alaska Arctic Marine Fish Species Accounts

By Milton S. Love[1], Nancy Elder[2], Catherine W. Mecklenburg[3], Lyman K. Thorsteinson[2], and T. Anthony Mecklenburg[4]

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.

---

[1]University of California, Santa Barbara.

[2]U.S. Geological Survey.

[3]California Academy of Sciences, San Francisco, and Point Stephens Research, Auke Bay, Alaska.

[4]Point Stephens Research, Auke Bay, Alaska.

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

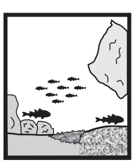
Relative abundance refers to the contribution a species makes to the total abundance of the fishery community. It is a measure that provides an index of the number of individuals present, but not the actual numbers. Relative abundance terms, such as “common,” “uncommon,” or “rare” often are used to express 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

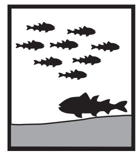
Benthic distribution refers to the spatial arrangement of a particular species at different depths over continental shelf and slope waters. The life cycle of fishes occurs in multiple dimensions in time and space and generally reflects genetically determined life history or behavior that has evolved 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.



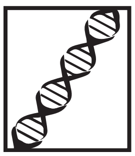
Behavior (see also Glossary [chapter 7]).—Behavior is the manner in which a fish operates or functions within its environment (that is, home range, territoriality, and many others) to procure food, orient to specific locations, or relate to other organisms. Knowing how individuals respond to the environment (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.

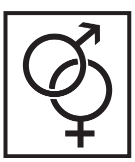
Schooling (that is, social structure of fish of the same species moving in more or less harmonious patterns in the sea) often is related to survival and reproduction. Schooling confers physical benefits to fish movement, safety against predators, search behaviors (for example, foods), population immunology,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

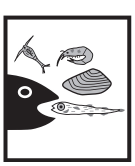
- Trophic level 1 (T1), plants and animals make their own food and are called primary producers;
- Trophic level 2 (T2), herbivores eat plants and are called primary consumers;
- Trophic level 3 (T3), carnivores eat herbivores and are called secondary consumers;
- Trophic level 4 (T4), carnivores eat 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.



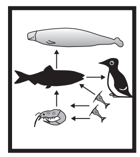
Populations or Stocks—A population often is defined as a group of organisms of the same species occupying a particular space at a particular time with the potential to breed with each other (Williams and others, 2002). Stocks are subpopulations of a particular species of fish that result from reproductive 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.



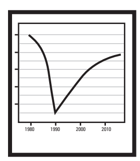
Reproduction Mode—Little information is available about the spawning times and locations, mating behaviors (breeders or nonbreeders), and genetic diversity of Arctic marine fishes. What is known is drawn largely from observations from populations studied outside the United States. For most Arctic marine 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.

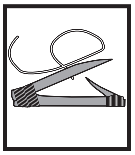


Resilience—In ecology, resilience traditionally refers to the ability of a population or biotic community to sustain or return to its former state after a disturbance. The rate of recovery is a measure of resilience determined by the population processes involved in restoring abundance to healthy, sustainable, 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.

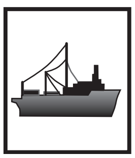
Traditional, Cultural, and Economic Values

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.



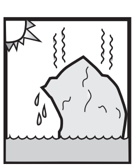
Traditional and Cultural Importance.—Several species of nearshore marine fishes are important in subsistence fisheries. The protection of traditional lifestyles and economies, including these subsistence fisheries, is a responsibility of the Federal government. Subsistence relates to resource use patterns (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

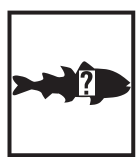
Alaska's climate is changing at more than twice the rate of the rest of the United States (Mellilo and others, 2014). Year-to-year and regional variability in air temperatures are evident and the warming trend currently is being moderated by large-scale cooling associated with the Pacific Decadal Oscillation. 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.

Halfbarred Pout (*Gymnelus hemifasciatus*)

Andriashev, 1937

Family Zoarcidae

Halfbarred Pout (*Gymnelus hemifasciatus*), male, 142 mm TL, Chukchi Sea, 2007. Photograph by C.W. Mecklenburg, Point Stephens Research.

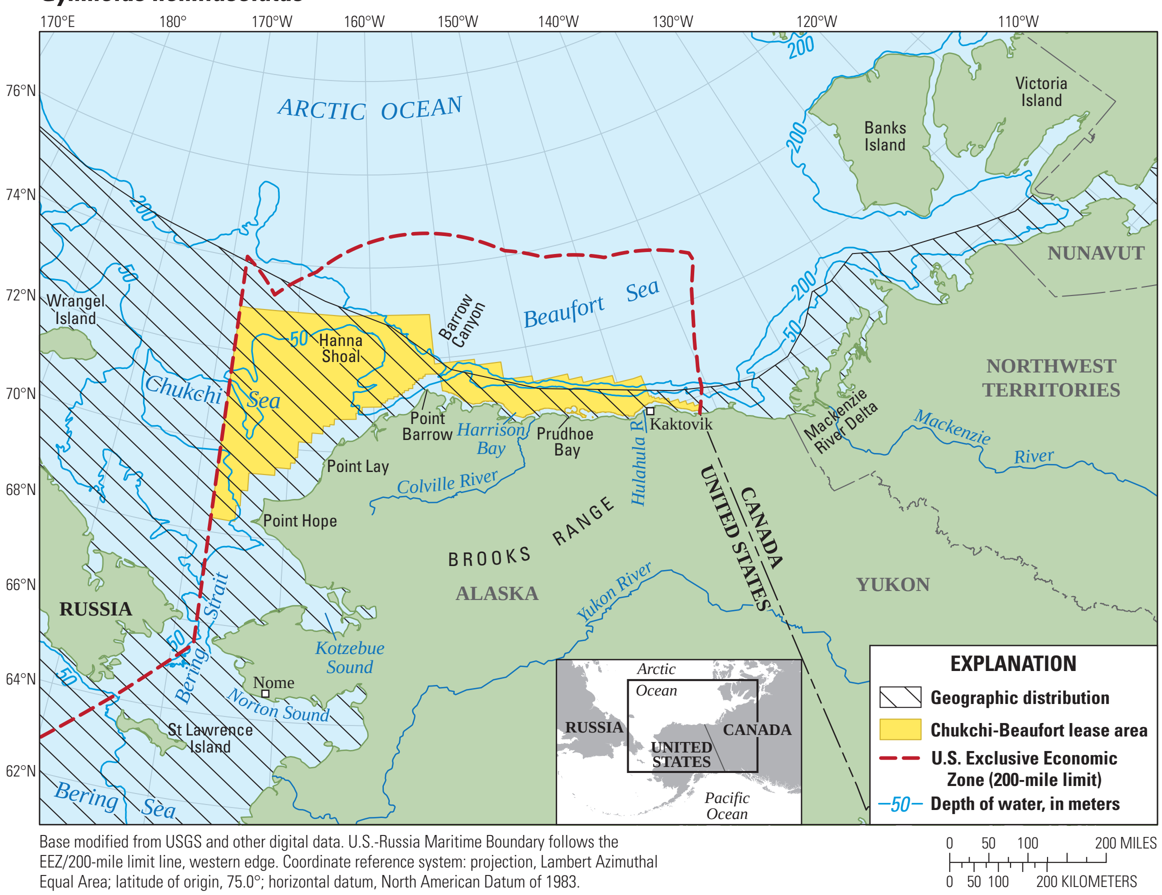
Colloquial Name: *None within U.S. Chukchi and Beaufort Seas.*

Ecological Role: The Halfbarred Pout is likely of relatively small ecological importance in the U.S. Chukchi and Beaufort Seas.

Physical Description/Attributes: An elongate body with dark bands down to lateral line or almost to anal fin on females. Dark orange bands reach anal fin on males, and anal fin changes to black [1]. For specific diagnostic characteristics, see *Fishes of Alaska*, Mecklenburg and others, 2002, p. 689) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

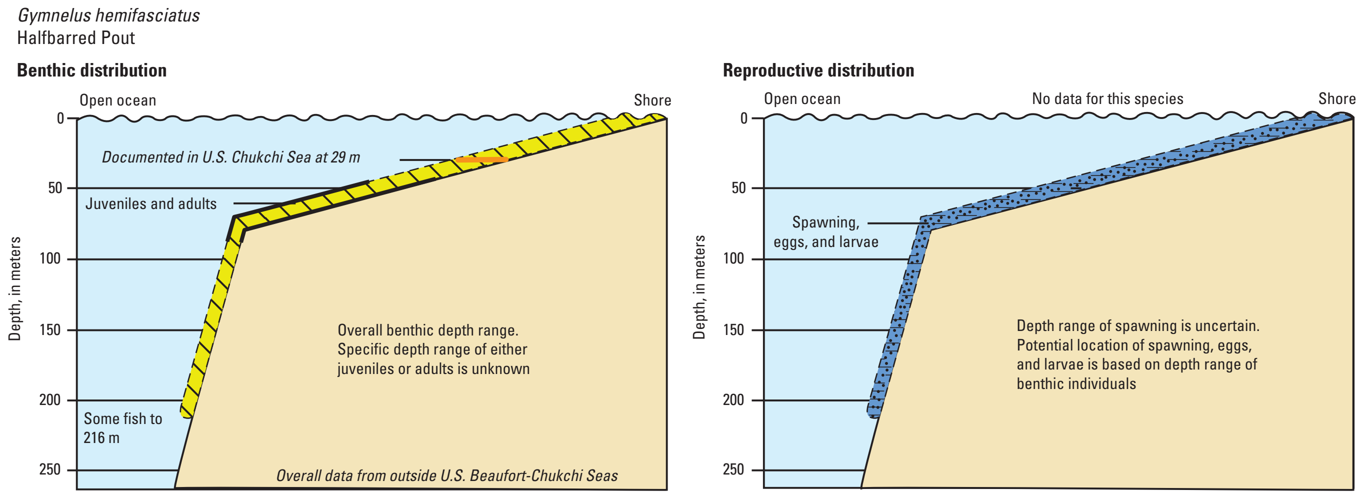
Range: *U.S. Chukchi and Beaufort Seas* [2]. Elsewhere in Alaska, Bering Sea to Prince William Sound, northern Gulf of Alaska [2]. Worldwide, Sea of Okhotsk, Commander Islands, east coast of Kamchatka Peninsula and Barents Sea [1].

Relative Abundance: *Common in U.S. Chukchi and Beaufort Seas* [4].

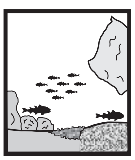


Geographic distribution of Halfbarred Pout (*Gymnelus hemifasciatus*) within Arctic Outer Continental Shelf Planning Areas [3] based on review of published literature and specimens from historical and recent collections [1, 2, 4].

Depth Range: Intertidal to 216 m, typically at 40–80 m on inner and outer shelf [2]. *Taken in U.S. Chukchi Sea off Point Lay at 29 m* [5]. In general, eelpout spawning and larvae are at same depths that adults inhabit [1].

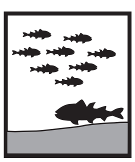


Benthic and reproduction distribution of Halfbarred Pout (*Gymnelus hemifasciatus*).



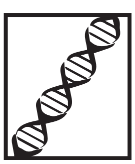
Habitats and Life History

Eggs—Size: 2.5–4.5 mm [6]. Time to hatching: Unknown. Habitat: Benthic [1]. Larvae: Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic [1].
Juveniles—Age and size: Unknown. Habitat: Benthic [1].
Adults—Age and size at first maturity: Age is unknown. Females mature at 70–80 mm SL [1]. Maximum age: Unknown. Maximum size: As long as 18 cm TL [4]. Habitat: Benthic [1].
Substrate—Mud and gravel [1].
Physical/chemical—Temperature: -1.8–10.5 °C [4]. Salinity: Unknown.



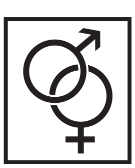
Behavior

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



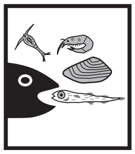
Populations or Stocks

There have been no studies. An analysis of DNA barcode and morphological data confirmed the validity of this species in the Pacific Arctic Region and suggested the possibility of two morphotypes based on ecological preferences [8].



Reproduction

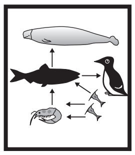
Mode—Separate sexes. Oviparous.
Spawning season—Late August to September.
Fecundity—8–26 eggs [6].



Food and Feeding

Food items—Gammarid amphipods, polychaetes, bivalves, other benthic invertebrates [6].

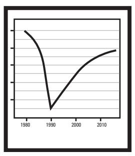
Trophic level—3.11 standard error 0.30 [7].



Biological Interactions

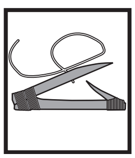
Predators—Seals, seabirds, cods and other fishes [6].

Competitors—Likely competitors include a range of small benthic-feeding fishes, including snailfishes, sculpins, flatfishes, and other eelpouts.



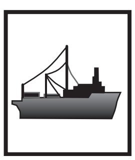
Resilience

Medium, minimum population doubling time: 1.4–4.4 years (Assuming t_{max} = 3–10) [7].



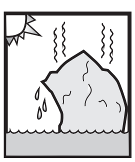
Traditional and Cultural Importance

None reported.



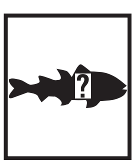
Commercial Fisheries

Currently, the Halfbarred Pout are not commercially harvested.



Potential Effects of Climate Change

Unknown. Halfbarred Pout occur in Arctic and Boreal Pacific waters. Climate warming would have little or no effect on its distribution but may affect abundance patterns.



Areas for Future Research [B]

This is a little-known species. 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.

References Cited

Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia] [6]

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

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 and Online Resource 1. [2]

Bibliography

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

2. 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. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.

4. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.

5. Fechhelm, R.G., Craig, P.C., Baker, J.S., and Gallaway, B.J., 1984, Fish distribution and use of nearshore waters in the northeastern Chukchi Sea: LGL Ecological Research Associates, Inc., Outer Continental Shelf Environmental Assessment Program, National Oceanic and Atmospheric Administration, OMPA/OCSEAP, Final Report, 190 p.

6. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]

7. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.

8. Mecklenburg, C.W., and Anderson, M.E., 2015, Reassessment of multiple species of *Gymnelus* (Teleostei: Zoarcidae) in Pacific Arctic and boreal regions: Zootaxa, v. 3948, no. 2, p. 263–278.

Fish Doctor (*Gymnelus viridis*)

(Fabricius, 1780)

Family Zoarcidae

Fish Doctor (*Gymnelus viridis*), male, 174 mm TL, Chukchi Sea, 2007. Photograph by C.W. Mecklenburg, Point Stephens Research.

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

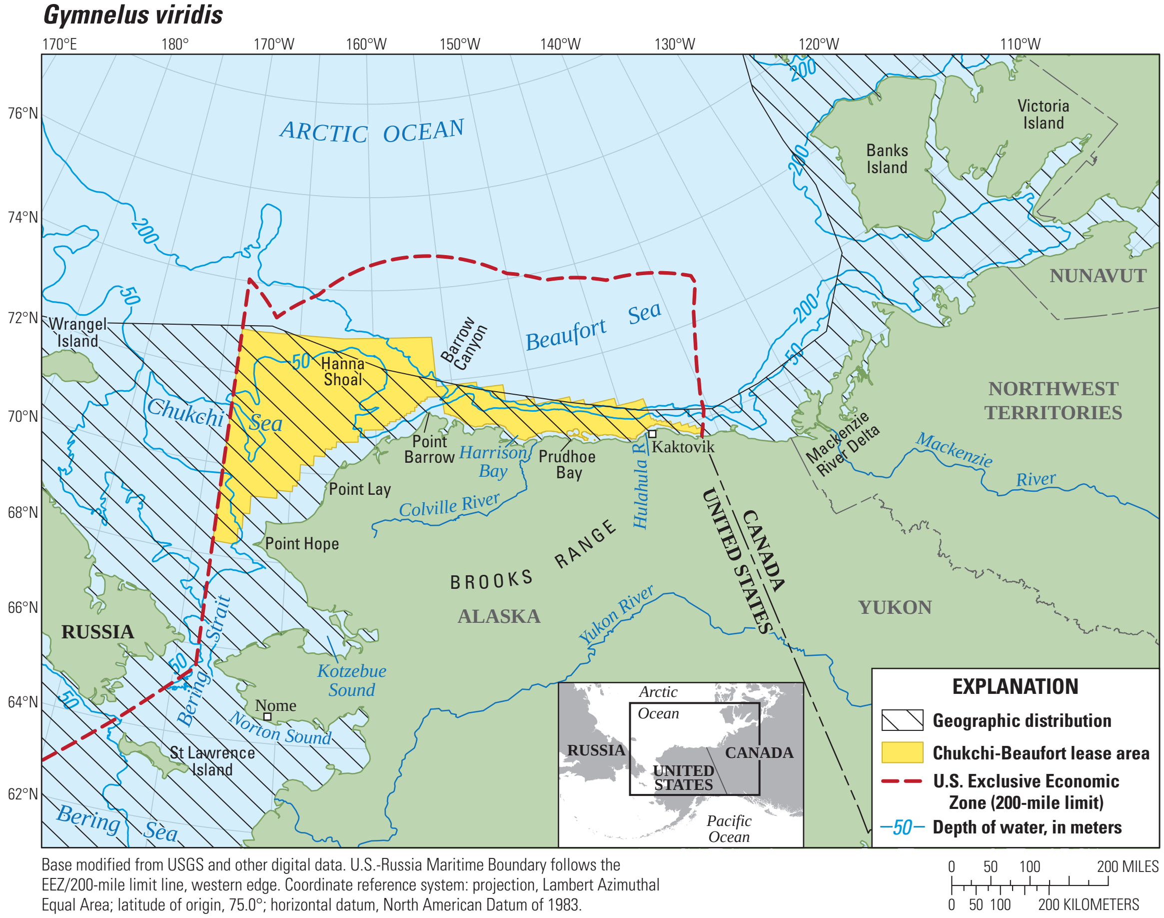
Ecological Role: Unknown, although likely of minor importance.

Physical Description/Attributes: Coloration grayish to greenish brown, varying from nearly monotone to mottled overall or with broad, mottled or solid orange or reddish brown to bluish black bands [1, 2]. In mature males, anal fin is black [3, 4]. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 690) [3]. Swim bladder: Absent [3]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Chukchi and Beaufort Seas* [5]. Elsewhere in Alaska, southward to eastern Bering Sea and Aleutian Islands [3]. Worldwide, circumpolar in Arctic Ocean and southward to Nova Scotia, Gulf of Anadyr, and southern Bering Sea [5].

Relative Abundance: *Common with patchy distributions in both U.S. Chukchi and Beaufort Seas* [7, 8].

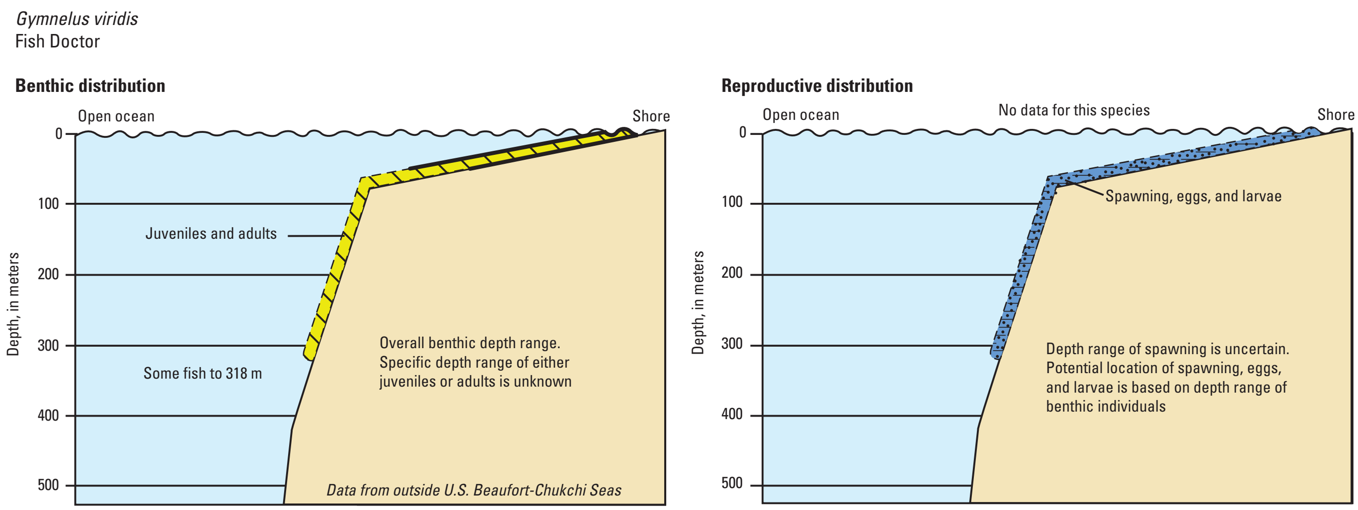
Fish Doctor
Gymnelus viridis



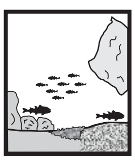
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Fish Doctor (*Gymnelus viridis*) within Arctic Outer Continental Shelf Planning Areas [6] based on review of published literature and specimens from historical and recent collections [4, 5].

Depth Range: Intertidal to 318 m, typically 50 m or less [1, 3, 9, 10]. In general, eelpouts produce eggs and larvae at same depths adults inhabit [3].

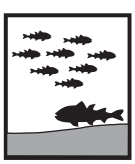


Benthic and reproductive distribution of Fish Doctor (*Gymnelus viridis*).



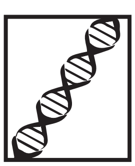
Habitats and Life History

Eggs—Size: 1.6–5.2 mm [1]. Time to hatching: Unknown. Habitat: Benthic and adhesive [1].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: 3.0 cm TL [1]. Days to juvenile transformation: Unknown. Habitat: Benthic [1].
Juveniles—Age and size: Unknown. Habitat: Benthic [1], nearshore, under debris, kelp, rocks, and other cover [2].
Adults—Age and size at first maturity: Age is unknown. *Females mature at about 9–10 cm TL* [1, 7]. Maximum age: In Northwest Territories, at least 12 years [1]. Maximum size: 26.0 cm SL, more than 26.6 cm TL. Males grow larger than females [1]. Habitat: Benthic [1], nearshore, under debris, kelp, rocks, and other cover [2].
Substrate—Boulders, cobble, and soft sea floors [1, 9–12].
Physical/chemical—Temperature: -1.9–10.5 °C [4, 12, 13]. Salinity: Mainly marine but tolerates brackish conditions with salinity as low as 27 ppt [11].



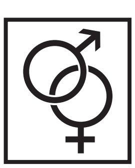
Behavior

Diel—Shelters under some form of cover, such as rocks, algae, or wood, and individuals rarely remain out in the open [1].
Seasonal—Unknown.
Reproductive—Little is known. During late summer or autumn, eggs are laid in nests and may be guarded by one or both parents [1, 14].
Schooling—Unknown.
Feeding—In Canadian Arctic, feeding activity declines in the winter [15].



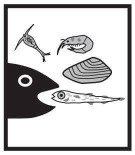
Populations or Stocks

There have been no studies. An analysis of DNA barcodes and morphological data confirmed the validity of this species in the Pacific Arctic Region [19].



Reproduction

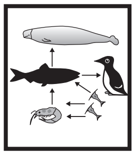
Mode—Separate sexes. Oviparous.
Spawning season—Late summer and early autumn [1, 11, 14].
Fecundity—20–106 eggs. Females may not spawn every year [1, 11, 14].



Food and Feeding

Food items—*Mainly gammarid amphipods, as well as caprellid amphipods, mysids, polychaetes, and copepods* [7]. In Canadian Arctic, a similar diet as well as clam siphons. Males tended to focus on amphipods and females on polychaetes.

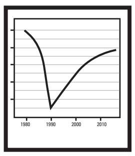
Trophic level—3.06 standard error 0.26 [16].



Biological Interactions

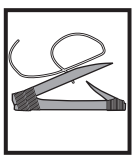
Predators—In central and eastern Canadian Arctic, cods, Thick-billed Murres, and bearded seals [17, 18].

Competitors—A range of bottom-feeding microcarnivores including sculpins, flatfishes, snailfishes, and other eelpouts.



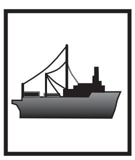
Resilience

Low, minimum population doubling time: 4.5–14 years (t_{max} = 12) [16].



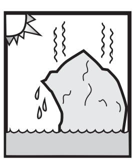
Traditional and Cultural Importance

None reported.



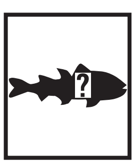
Commercial Fisheries

Currently, Fish Doctor are not commercially harvested.



Potential Effects of Climate Change

As the Fish Doctor are predominantly an Arctic species it would be expected that climate warming would shift the distribution of the species northward.



Areas for Future Research [B]

Little is known about this species in U.S. Arctic marine environment. 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.

References Cited

Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.] [11]

Frost, K.J., and Lowry, L.F., 1983, Demersal fishes and invertebrates trawled in the northeastern Chukchi and western Beaufort Seas 1976–1977: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, AA Technical Report NMFS-SSRF-764, 22 p. [7]

Green, J.M., and Mitchell, L.R., 1997, Biology of the fish doctor, an eelpout, from Cornwallis Island, Northwest Territories, Canada: American Fisheries Society Symposium 19, p. 140–174. [1]

Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p. [3]

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. [5]

Bibliography

1. Green, J.M., and Mitchell, L.R., 1997, Biology of the fish doctor, an eelpout, from Cornwallis Island, Northwest Territories, Canada: American Fisheries Society Symposium 19, p. 140–174.
2. Mecklenburg, C.W., and Mecklenburg, T.A., 2011, Fish Doctor—*Gymnelus viridis* (Fabricius, 1780): Arctic Ocean Diversity Web site, accessed June 2011 at http://www.arcodiv.org/Fish/Gymnelus_viridis.html.
3. Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,=116 p.
4. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.
5. 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.
6. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.
7. Frost, K.J., and Lowry, L.F., 1983, Demersal fishes and invertebrates trawled in the northeastern Chukchi and western Beaufort Seas 1976–1977: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, AA Technical Report NMFS-SSRF-764, 22 p.
8. Fechhelm, R.G., Craig, P.C., Baker, J.S., and Gallaway, B.J., 1984, Fish distribution and use of nearshore waters in the northeastern Chukchi Sea: LGL Ecological Research Associates, Inc., Outer Continental Shelf Environmental Assessment Program, National Oceanic and Atmospheric Administration, OMPA/OCSEAP, Final Report, 190 p.
9. Ellis, D.V., 1962, Observations on the distribution and ecology of some Arctic fish: Arctic, v. 15, no. 3, p. 179–189.
10. McAllister, D.E., 1975, Ecology of the marine fishes of Arctic Canada, *in* Proceedings of the Circumpolar Conference on Northern Ecology, September 15–18, 1975: Ottawa, National Research Council of Canada, p. II-49–II-65.
11. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]

12. Green, J.M., and Steele, D.H., 1975, Observations on marine life beneath sea ice, Resolute Bay, N.W.T., *in* Proceedings of the Circumpolar Conference on Northern Ecology, September 15–18, 1975: Ottawa, Ontario, National Research Council of Canada, p. II-77–II-86.

13. Rose, G.A., 2005, On distributional responses of North Atlantic fish to climate change: ICES Journal of Marine Science, v. 62, no. 7, p. 1,360–1,374.

14. Scott, W.B., and Scott, M.G., 1988, Atlantic fishes of Canada: Toronto, University of Toronto Press, 730 p.

15. Green, J.M., 1983, Observations on the food of marine fishes from Resolute Bay, Cornwallis Island, Northwest Territories: Astarte, v. 12, no. 2, p. 63–68.

16. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.

17. Dunbar, M.J., and Hildebrand, H.H., 1952, Contributions to the study of the fishes of Ungava Bay: Journal of the Fisheries Research Board of Canada, v. 9, no. 2, p. 83–126.

18. Gaston, A.J., Cairns, D.K., Elliot, R.D., and Noble, D.G., 1985, A natural history of Digges Sound: Canadian Government Publishing Centre, Canada Communication Group, Canadian Wildlife Service report series, no. 46, 63 p.

19. Mecklenburg, C.W., and Anderson, M.E., 2015, Reassessment of multiple species of *Gymnelus* (Teleostei: Zoarcidae) in Pacific Arctic and boreal regions: Zootaxa, v. 3948, no. 2, p. 263–278.

Adolf's Eelpout (*Lycodes adolfi*)

Nielsen & Fosså, 1993

Family Zoarcidae

Adolf's Eelpout, (*Lycodes adolfi*), 193 mm, Chukchi Borderland, 2009. Photograph by C.W. Mecklenburg, Point Stephens Research.

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

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

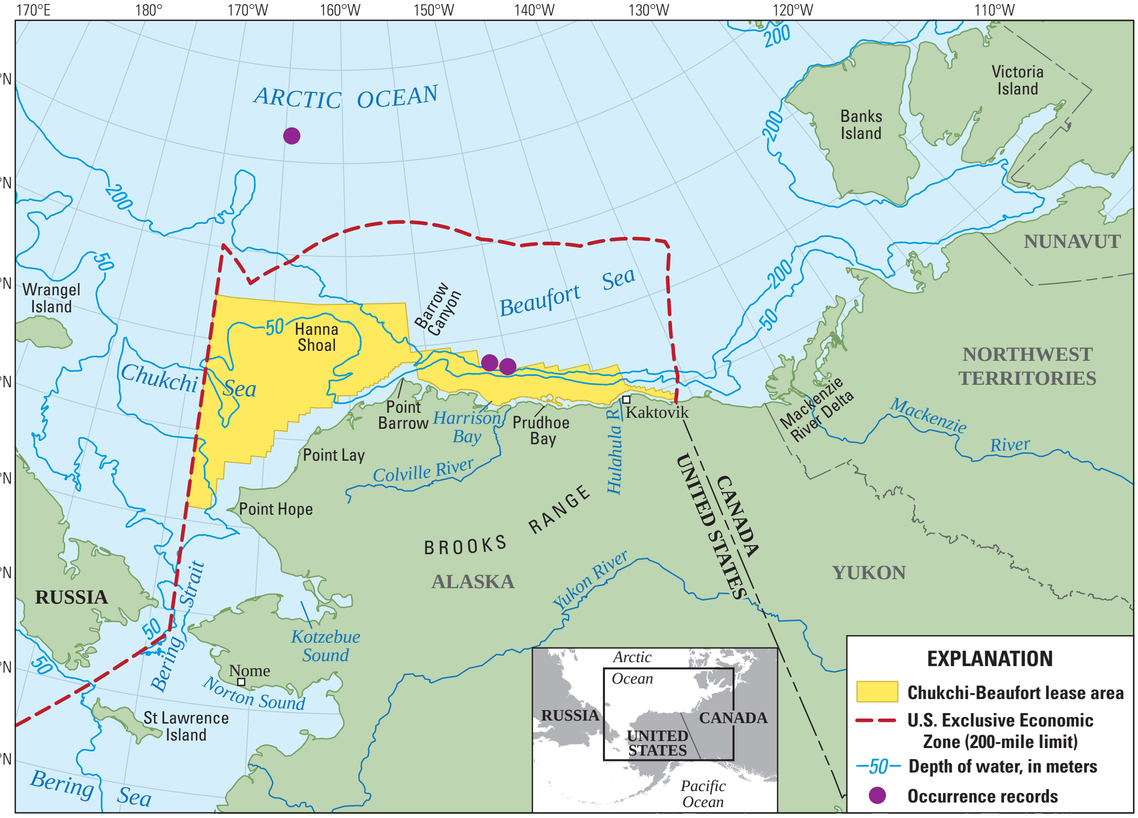
Ecological Role: This species has been reported from slope waters of the U.S. Beaufort Sea. It is rare with an unknown but suspected minimal role in regional food webs.

Physical Description/Attributes: Brown, grading from nearly black on the head to gray-brown toward the tail, without distinctive markings [1]. For specific diagnostic characteristics, see Nielsen and Fosså (1993) [2]. Swim bladder: Absent [3]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Beaufort Sea* [1]. Arctic Ocean north of the Chukchi Sea (north of the 200-mile limit); Baffin Bay off Canada and Greenland, Greenland and Norwegian Seas, and Arctic Ocean north of Spitsbergen [4].

Relative Abundance: *Common in U.S. Beaufort Sea in deep water on the continental slope, based on a few records of number of specimens per haul (as many as 36 or more)* [1]. Not found in Chukchi Sea; found far north of the Chukchi Sea, north of the 200-mile limit. Elsewhere, common in Baffin Bay [6], eastern and western sides of Greenland, eastern slope of the Yermak Plateau north of Spitsbergen, Norway [7], and Norwegian Sea [6].

Adolf's Eelpout
Lycodes adolfi

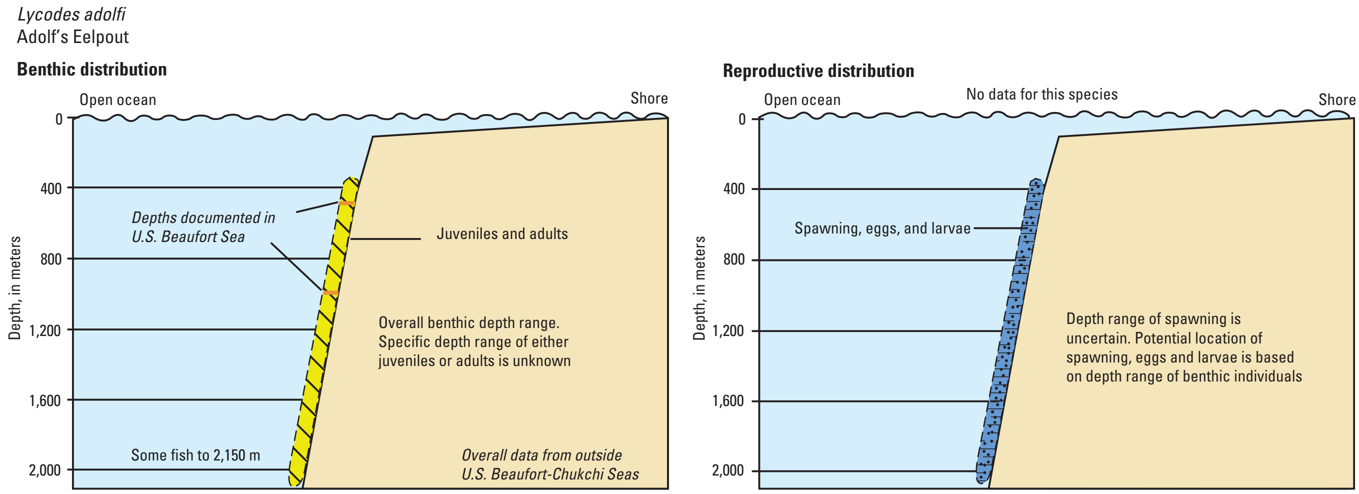


Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

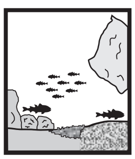
0 50 100 200 MILES
0 50 100 200 KILOMETERS

Geographic distribution of Adolf's Eelpout (*Lycodes adolfi*) within Arctic Outer Continental Shelf Planning Areas [5] based on review of published literature and specimens from historical and recent collections [1, 4].

Depth Range: Benthic, 386–2,150 m [6, 8]. *Taken on U.S. Beaufort Sea slope at 500 m and 1,000 m* [1]. In general, eelpout spawning and larvae occur at the same depths that adults inhabit [9].



Benthic and reproductive distribution of Adolf's Eelpout (*Lycodes adolfi*).



Habitats and Life History

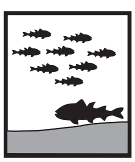
Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Benthic [3]. Larvae: Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic [3].

Juveniles—Age and size: Unknown. Immature fish from Arctic Ocean north of Chukchi Sea were 130–193 mm TL [1]. Habitat: Benthic [3].

Adults—Age and size at first maturity: Unknown. Mature fish off Greenland were 205–238 mm TL [1]. Maximum age: Unknown. Maximum size: 28.6 cm TL [12]. Habitat: Benthic, in deep waters [4].

Substrate—*Mixture of mud, gravel, and rock* [1].

Physical/chemical—Temperature: -0.9–3.7 °C off Greenland [1]. Taken at 0.8–0.9 °C in Arctic Ocean far north Chukchi Sea [1]. Salinity: Marine, taken at 34.86 ppt in the Arctic Ocean far north of Chukchi Sea [1].



Behavior

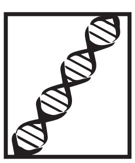
Diel—Unknown.

Seasonal—Unknown.

Reproductive—Unknown.

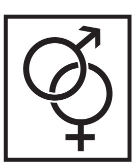
Schooling—Unknown.

Feeding—Unknown.



Populations or Stocks

There have been no studies.

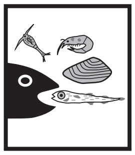


Reproduction

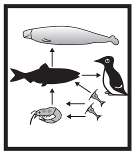
Mode—Oviparous [3].

Spawning season—Unknown.

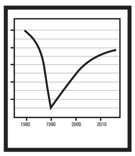
Fecundity—Unknown.



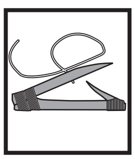
Food and Feeding
Food items—Crustaceans [10].
Trophic level—3.5 standard error **±0.50** [11].



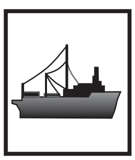
Biological Interactions
Predators—Unknown.
Competitors—Likely other benthic microcarnivores including sculpins, flatfishes, snailfishes, and other eelpouts.



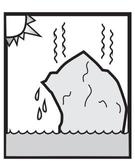
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (Preliminary *K* or Fecundity) [11].



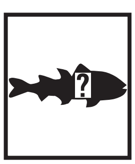
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, Adolf's Eelpout are not commercially harvested.



Potential Effects of Climate Change
Because Adolf's Eelpout are a strictly deep-water, slope-dwelling Arctic species and little is known about climate change at slope depths in the Arctic, potential effects on this species has not been estimated.



Areas for Future Research [B]
Little is known about this species' ecology and life history. 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.

References Cited

Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.

Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p. [3]

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. [4]

Nielsen, J.G., and Fosså, S.A., 1993, *Lycodes adolfi*, a new species of eelpout (Zoarcidae) from Greenland: Cybium, v. 17, p. 39–44. [2]

Bibliography

1. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.

2. Nielsen, J.G., and Fosså, S.A., 1993, *Lycodes adolfi*, a new species of eelpout (Zoarcidae) from Greenland: Cybium, v. 17, p. 39–44.

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

4. 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.

5. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.

6. Byrkjedal, I., Brattegard, T., and Møller, P.R., 2009, *Lycodes adolfi* Nielsen & Fosså, 1993 (Teleostei: Zoarcidae) recorded near Jan Mayen and in the eastern part of the Norwegian Sea: Fauna Norvegica, v. 28, p. 1–3.

7. Byrkjedal, I., Langhelle, G., Wenneck, T.d.L., and Wienerroither, R., 2011, *Lycodes adolfi* Nielsen and Fosså, 1993 (Teleostei: Zoarcidae) found in the Arctic Ocean: Polar Biology, v. 34, no. 3, p. 465–467.

8. Møller, P.D., and Gravelund, P., 2003, Phylogeny of the eelpout genus *Lycodes* (Pisces, Zoarcidae) as inferred from mitochondrial cyctochrome *b* and 12S rDNA: Molecular and Phylogenetic Evolution, v. 26, no. 3, p. 369–388.

9. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]

10. Coad, B.W., Waszczuk, H., and Labignan, I., 1995, Encyclopedia of Canadian fishes: Canadian Museum of Nature and Canadian Sportfishing Productions, Inc., 928 p.

11. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.

12. California Academy of Science, Catalog of fishes: California Academy of Sciences online database, accessed June 16, 2016, at http://www.calacademy.org/scientists/projects/catalog-of-fishes.

Doubleline Eelpout (*Lycodes eudipleurostictus*)

Jensen, 1902

Family Zoarcidae

Doubleline Eelpout, (*Lycodes eudipleurostictus*), about 255 mm TL, Svalbard Archipelago, 2011. Photograph by Arve Lynghammar, University of Tromsø, Norway.

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: Unknown, but based on occurrence, most likely of minimal importance in regional food webs.

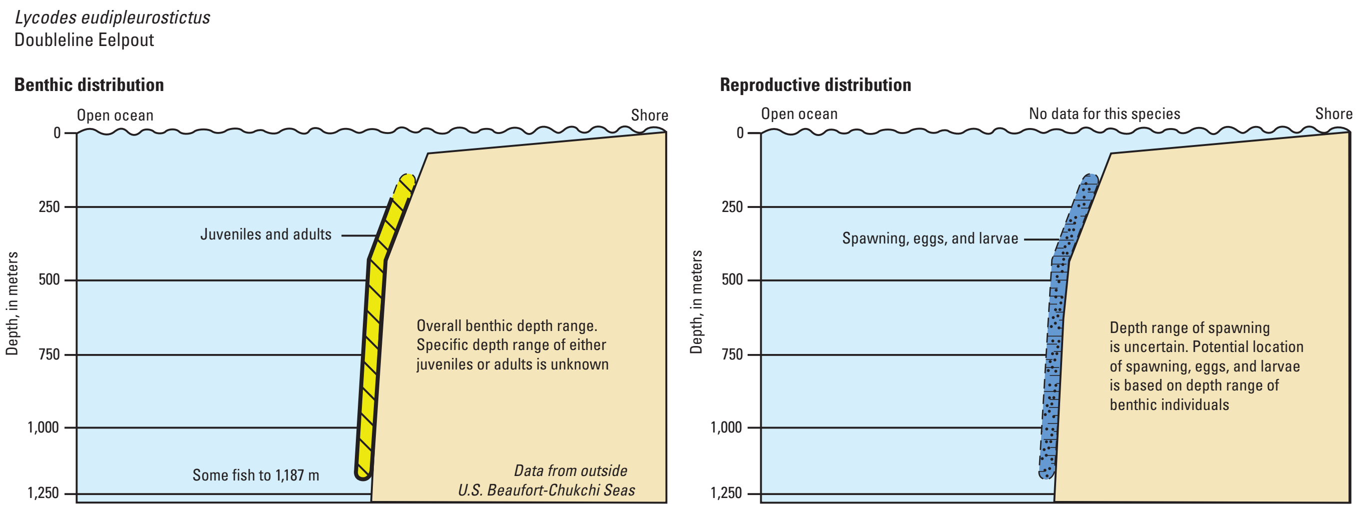
Physical Description/Attributes: Dark brown elongate body with narrow light bands passing onto dorsal fin and posteriorly onto anal fin. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, p. 723) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Beaufort Sea; three records from deep water* [4]. Elsewhere, from eastern Canadian Arctic, including Baffin Bay, to western and eastern Greenland, Iceland, and to Kara Sea, northward to Svalbard Archipelago, and north of Severnaya Zemlya, Russia [1, 2].

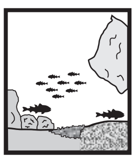
Relative Abundance: *At least occasional in U.S. Beaufort Sea* [4].Common off West Greenland [5].

Location within Arctic Outer Continental Shelf Planning Areas [3] of the one existing record of Doubleline Eelpout (*Lycodes eudipleurostictus*) [1, 2, 4].

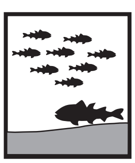
Depth Range: 54–1,280 m [2, 4], rarely less than 250 m [1]. In general, eelpout spawning and larvae occur at same depths that adults inhabit [1].



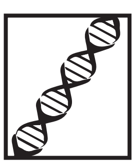
Benthic and reproductive distribution of Doubleline Eelpout (*Lycodes eudipleurostictus*).



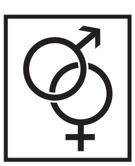
Habitats and Life History
Eggs—Size: 2.7–8 mm [5]. Time to hatching: Unknown. Habitat: Benthic [1].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic [1].
Juveniles—Age and size: Unknown. Habitat: Benthic [1].
Adults—Age and size at first maturity: Age unknown. More than 23 cm TL for females and 29 cm TL for males. Males grow larger than females. [5]. Maximum age: 9 years [6]. Maximum size: To 45 cm TL [1, 5]. Habitat: Benthic [1].
Substrate—Muddy bottoms [1, 6].
Physical/chemical—Temperature: -0.6–4.9 °C [5, 7], typically less than 2.5 °C [8]. Salinity: Marine [1, 9].



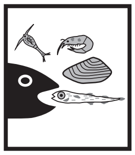
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Unknown.



Populations or Stocks
There have been no studies.



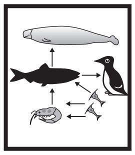
Reproduction
Mode—Separate sexes. Oviparous.
Spawning season—Unknown. In Russia, almost ripe eggs were taken in August [8].
Fecundity—120–300 orange eggs [5, 8].



Food and Feeding

Food items—Unknown. In general, smaller eelpouts eat mainly infaunal prey; larger individuals feed more on epibenthic prey [10].

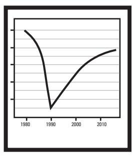
Trophic level—3.54 standard error 0.47 [10].



Biological Interactions

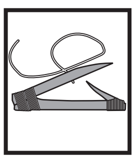
Predators—Unknown.

Competitors—Perhaps other eelpouts, as well as such other benthic feeding fishes as sculpins and flatfishes.



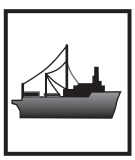
Resilience

Low, minimum population doubling time: 4.5–14 years (Preliminary *K* or Fecundity) [10].



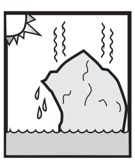
Traditional and Cultural Importance

None reported.



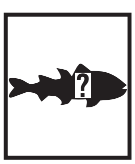
Commercial Fisheries

Currently, Doubleline Eelpout are not commercially harvested.



Potential Effects of Climate Change

Unknown.



Areas for Future Research [B]

Little is known about the life history and ecology of this species. 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.

References Cited

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

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 and Online Resource 1. [2]

Møller, P.R., and Jørgensen, O.A., 2000, Distribution and abundance of eelpouts (Pisces, Zoarcidae) off West Greenland: Sarsia, v. 85, no. 1, p. 23–48. [5]

Bibliography

1. Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p.
2. 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. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.
4. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.
5. Møller, P.R., and Jørgensen, O.A., 2000, Distribution and abundance of eelpouts (Pisces, Zoarcidae) off West Greenland: Sarsia, v. 85, no. 1, p. 23–48.
6. Wienerroither, R., Johannesen, E., Langøy, H., Børve Eriksen, K., de Lange Wenneck, T., Høines, Å., Bjelland, O., Aglen, A., Prokhorova, T., Murashko, P., Prozorkevich, D., Konstantin, Byrkjedal, I., Langhelle Drevetnyak, and G., Smirnov, O., 2011, Atlas of the Barents Sea fishes: IMR/PINRO Joint Report Series 1-2011, ISSN 1502-8828, 274 p.
7. Christiansen, J.S., ed., 2003, TUNU-1 Expedition—The fish fauna of the NE Greenland fjord systems—Technical report: Tromsø, Norway, University of Tromsø, Norwegian College of Fishery Science, Institute of Aquatic Resources, 33 p.
8. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]
9. Coad, B.W., and Reist, J.D., 2004, Annotated list of the Arctic marine fishes of Canada: Canadian Manuscript Report of Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, no. 2674, 112 p.
10. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.

Glacial Eelpout (*Lycodes frigidus*)

Collett, 1879

Family Zoarcidae

Glacial Eelpout, (*Lycodes frigidus*), *juvenile*, 76 mm, Canada Basin, 2005. 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.*

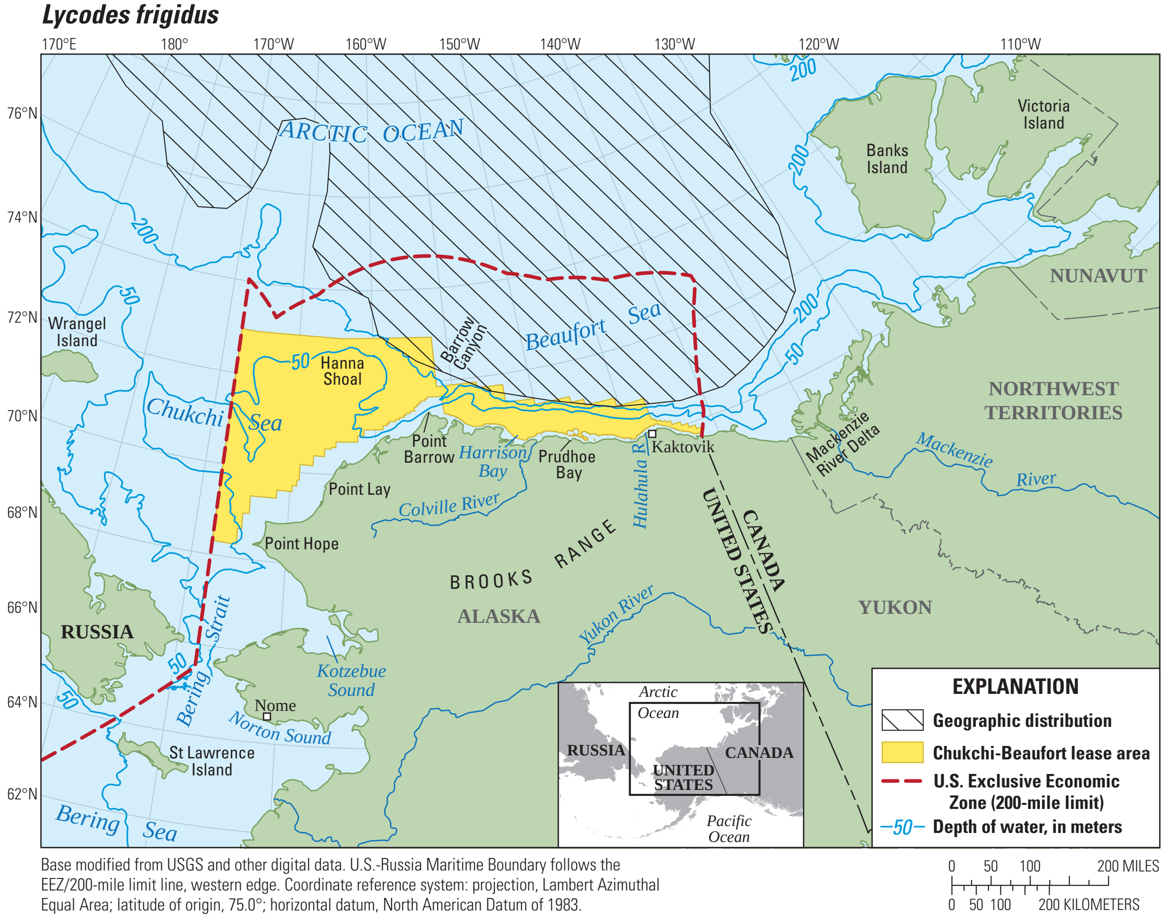
Ecological Role: Unknown, although likely of minor importance in the study area. This is possibly the most abundant eelpout in the Arctic Basin and thus is ecologically significant there.

Physical Description/Attributes: An elongate, tapering body with a large head (22–28 percent of body) and all ages uniformly colored dark brownish gray, brown, or gray-violet. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 726) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Chukchi and Beaufort Seas* [4]. Circumpolar on Arctic Ocean continental rises and basins, including Makarov Basin north of eastern Siberia, *Canada Basin north of Alaska*, Eurasian Arctic Basin, and Norwegian and Greenland Seas [2].

Relative Abundance: *Unknown, but may be common in very deep waters of U.S. Chukchi and Beaufort Seas* [2]. Common in deep part (>1,500 m) of Norwegian Sea [2].

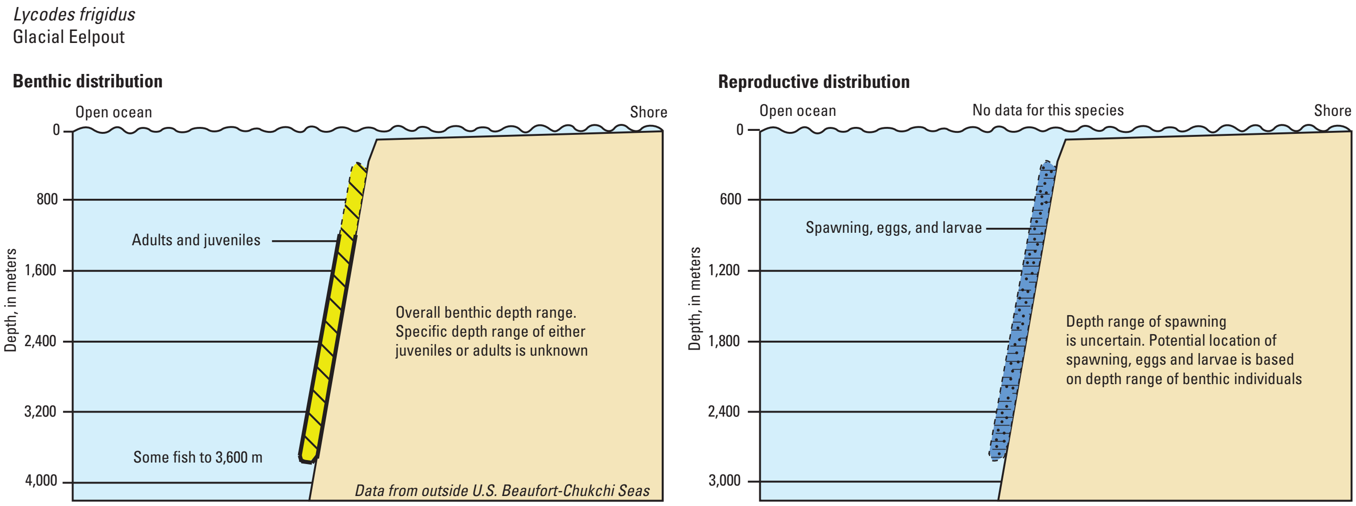
Glacial Eelpout
Lycodes frigidus



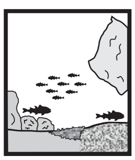
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Glacial Eelpout (*Lycodes frigidus*) within Arctic Outer Continental Shelf Planning Areas [3] based on review of published literature and specimens from historical and recent collections [1, 2, 4].

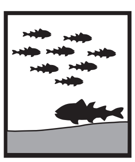
Depth Range: 475–3,600 m [2, 5], rarely at less than 1,000 m [2, 6]. *Taken in U.S. Chukchi Sea north-northwest of Point Barrow at 2,500 m* [2]. In general, eelpout spawning and larvae occur at the same depths that adults inhabit [6].



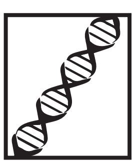
Benthic and reproductive distribution of Glacial Eelpout (*Lycodes frigidus*).



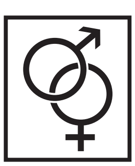
Habitats and Life History
Eggs—Size: 7 mm [6]. Time to hatching: Unknown. Habitat: Benthic [2, 6].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic [2, 6].
Juveniles—Age and size: Unknown. Habitat: Benthic [2, 6].
Adults—Age and size at first maturity: Unknown. One ripe female was 50 cm long TL [6]. Maximum age: 33 years [7]. Maximum size: 69.0 cm TL [1]. Habitat: Benthic [2, 6].
Substrate—Mud bottoms [1].
Physical/chemical—Temperature: Off Russia, found almost always at -0.6–1.6 °C [6]. Spawns from -2 to -0.6 °C [8, 9]. Salinity: Marine.



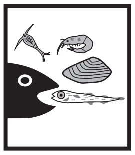
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Moves along bottom, stirring up small prey [10].



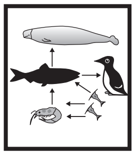
Populations or Stocks
There have been no studies.



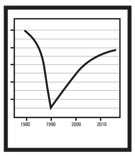
Reproduction
Mode—Separate sexes. Oviparous [11].
Spawning season—Perhaps autumn or winter [7].
Fecundity—One female taken near the Faroe Islands contained 500 ripe eggs [6].



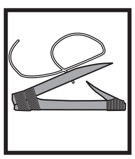
Food and Feeding
Food items—Eats various crustaceans including amphipods and shrimps, as well as fishes, brittle stars, cephalopods, sipunculids [6].
Trophic level—3.84 standard error 0.51 [12].



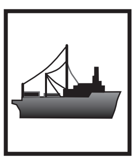
Biological Interactions
Predators—Unknown.
Competitors—Unknown, but likely other deeper water eelpouts, as well as flatfishes.



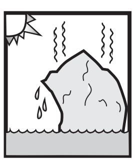
Resilience
Low, minimum population doubling time: 4.5–14 years (Preliminary *K* or Fecundity) [12].



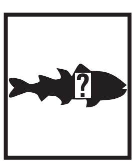
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, Glacial Eelpout are not commercially harvested.



Potential Effects of Climate Change
As Glacial Eelpout are predominantly Arctic species, climate effects might result in a northward shift in its distribution.



Areas for Future Research [B]
There is very little known about this species biology or ecology 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.

References Cited

Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.] [6]

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

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]

Bibliography

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

2. 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. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.

4. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.

5. Bergmann, M., Dannheim, J., Bauerfeind, E., and Klages, M., 2009, Trophic relationships along a bathymetric gradient at the deep-sea observatory HAUSGARTEN: Deep-Sea Research I, v. 56, no. 3, p. 408–424.

6. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]

7. Hildebrandt, N., Bergmann, M., and Knust, R., 2011, Longevity and growth efficiency of two deep-dwelling Arctic zoarcids and comparison with eight other zoarcid species from different climatic regions: Polar Biology, v. 34, no. 10, p. 1,523–1,533.

8. Rose, G.A., 2005, On distributional responses of North Atlantic fish to climate change: ICES Journal of Marine Science, v. 62, no. 7, p. 1,360–1,374.

9. Wienerroither, R., Johannesen, E., Langøy, H., Børve Eriksen, K., de Lange Wenneck, T., Høines, Å., Bjelland, O., Aglen, A., Prokhorova, T., Murashko, P., Prozorkevich, D., Konstantin, Byrkjedal, I., Langhelle Drevetnyak, and G., Smirnov, O., 2011, Atlas of the Barents Sea fishes: IMR/PINRO Joint Report Series 1-2011, ISSN 1502-8828, 274 p.

10. Mecklenburg, C.W., and Mecklenburg, T.A., 2011, Glacial Eelpout—*Lycodes frigidus* Collett, 1879: Arctic Ocean Diversity Web site, accessed June 2011, at http://www.arcodiv.org/Fish/Lycodes_frigidus.html.

11. Love, M.S., 2011, Certainly more than you wanted to know about the fishes of the Pacific Coast: Santa Barbara, California, Really Big Press, 649 p.

12. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.

Shulupaoluk (*Lycodes jugoricus*)

Knipowitsch, 1906

Family Zoarcidae

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: Rarely observed in U.S. Beaufort Sea. Of potential ecological importance in brackish shallow waters of and near river mouths.

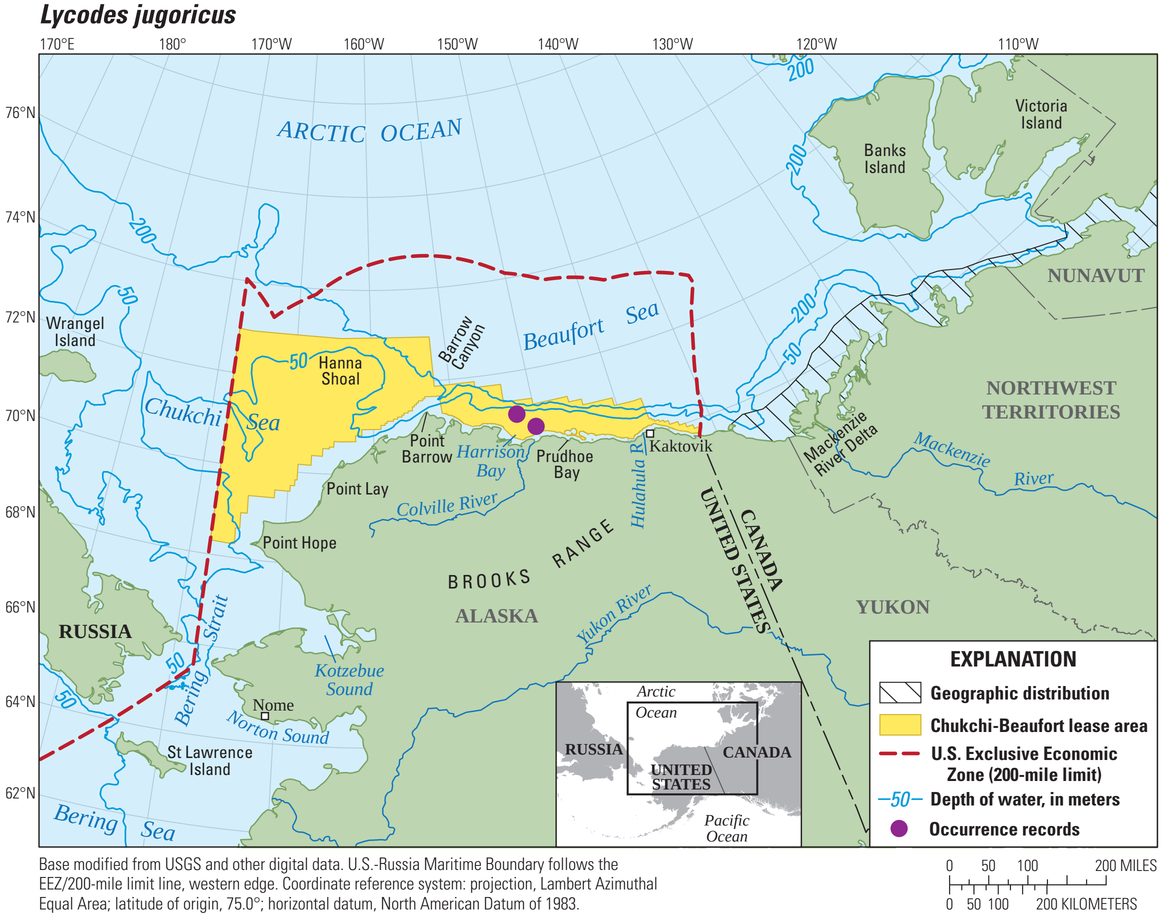
Shulupaoluk, (*Lycodes jugoricus*),156 mm, Beaufort Sea. Photograph by C.W. Mecklenburg, Point Stephens Research.

Physical Description/Attributes: Slender, elongate body, white ventrally and yellowish laterally, with wedge-shaped dark bands widening dorsally and extending onto dorsal fins. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, p. 706) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Beaufort Sea* [2]. Worldwide, in White, Kara, Laptev, and East Siberian Seas; and Canadian Beaufort Sea to Boothia Peninsula, Canada [1, 3].

Relative Abundance: *Possibly common in freshened nearshore waters of the U.S. Beaufort Sea but generally overlooked because of confusion with similar looking species* [2].Common in Canadian Beaufort Sea at Tuktoyaktuk Harbor [5].

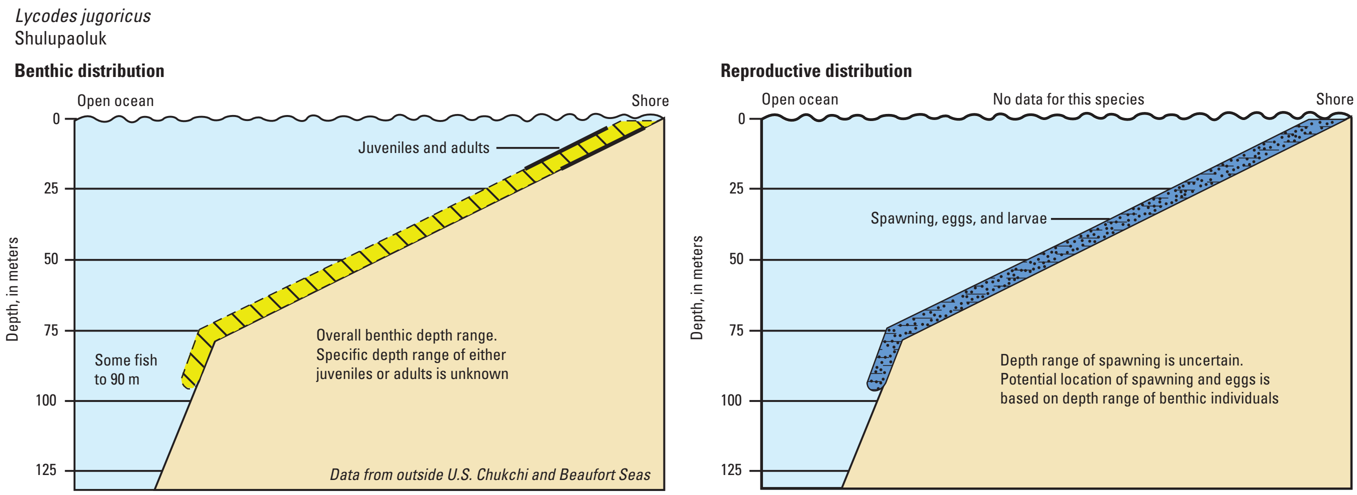
Shulupaoluk
Lycodes jugoricus



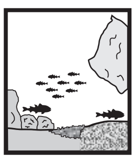
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Shulupaoluk (*Lycodes jugoricus*) 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: 3–90 m [3], typically 7–15 m [1, 5]. In general, eelpout spawning and larvae are at same depths where adults reside [1].

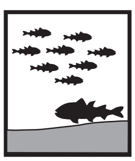


Benthic and reproductive distribution of Shulupaoluk (*Lycodes jugoricus*).



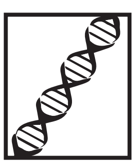
Habitats and Life History

Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Benthic, nearshore [1].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic, nearshore [1].
Juveniles: Age and size: Unknown. Habitat: Benthic, nearshore [1].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: To 40.0 cm TL [1], reported without documentation to 52.1 cm TL [6]. Habitat: Benthic, nearshore [1, 3].
Substrate—Soft bottoms [7].
Physical/chemical—Temperature: Below 0 to 4.5 °C [8]. Salinity: Brackish waters of about 15–27 ppt [7, 8].



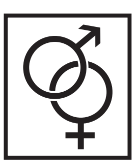
Behavior

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



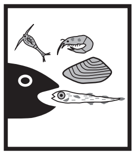
Populations or Stocks

There have been no studies.



Reproduction

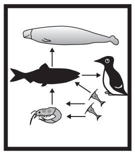
Mode—Separate sexes. Oviparous [9].
Spawning season—Unknown.
Fecundity—Unknown.



Food and Feeding

Food items—Isopods, mysids, polychaetes, bivalves, and fishes [6, 7, 10].

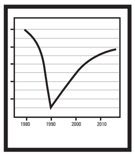
Trophic level—3.16 standard error 0.38 [7].



Biological Interactions

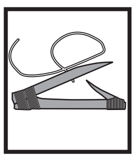
Predators—Unknown.

Competitors—Unknown, but likely other shallow-water eelpouts, sculpins, and flatfishes.



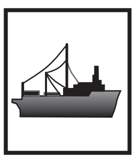
Resilience

Medium, minimum population doubling time: 1.4–4.4 years (Preliminary *K* or Fecundity) [7].



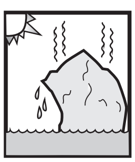
Traditional and Cultural Importance

None reported.



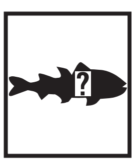
Commercial Fisheries

Currently, Shlupaoluk are not commercially harvested.



Potential Effects of Climate Change

Shulupaoluk are an Arctic nearshore species inhabiting low-salinity, cold water habitats. If they are unable to adapt to warmer, brackish conditions, their population could be extremely vulnerable to effects associated with high discharges of warm freshwater to the coast.



Areas for Future Research [B]

Little is known about the biology and ecology 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.

References Cited

Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.] [8]

Hopky, G.E., and Ratynski, R.A., 1983, Relative abundance, spatial and temporal distribution, age and growth of fishes in Tuktoyaktuk Harbour, N.W.T., 28 June to 5 September, 1981: Canadian Manuscript Report of Fisheries and Aquatic Sciences 1983, 77 p. [5]

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

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]

Bibliography

1. Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p.
2. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.
3. 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.
4. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.
5. Hopky, G.E., and Ratynski, R.A., 1983, Relative abundance, spatial and temporal distribution, age and growth of fishes in Tuktoyaktuk Harbour, N.W.T., 28 June to 5 September, 1981: Canadian Manuscript Report of Fisheries and Aquatic Sciences 1983, 77 p.
6. Lacho, G., 1991, Stomach content analyses of fishes from Tuktoyaktuk Harbour, N.W.T., 1981: Winnipeg, Manitoba, Canadian Data Report of Fisheries and Aquatic Sciences, Central and Arctic Region, Department of Fisheries and Oceans, no. 853, 15 p.
7. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.
8. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]
9. Love, M.S., 2011, Certainly more than you wanted to know about the fishes of the Pacific Coast: Santa Barbara, California, Really Big Press, 649 p.
10. Stewart, D.B., Ratynski, R.A., Bernier, L.M.J., and Ramsey, D.J., 1993, A fishery development strategy for the Canadian Beaufort Sea-Amundsen Gulf area: Canadian Technical Report Fisheries and Aquatic Sciences 1910, 135 p.

White Sea Eelpout (*Lycodes marisalbi*)
Knipowitsch, 1906

Family Zoarcidae

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

Note on taxonomy: *Once classified as a subspecies of Lycodes pallidus but recently resurrected as a valid species* [1].

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

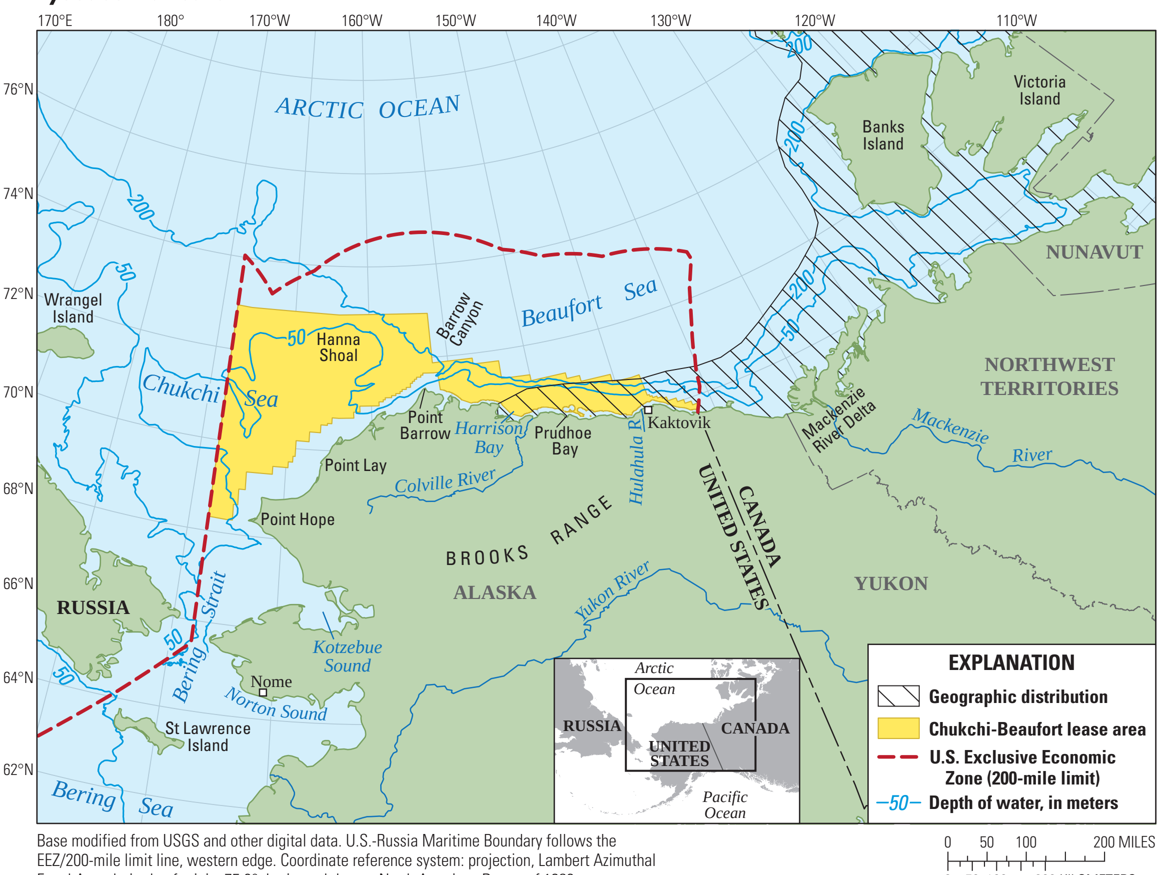
White Sea Eelpout, (*Lycodes marisalbi*), 135 mm, Beaufort Sea, 2011. Photograph by C.W. Mecklenburg, Point Stephens Research.

Ecological Role: This species appears to be rare in the U.S. Arctic and thus is likely to be of limited ecological importance.

Physical Description/Attributes: An elongate, tapering body either brownish with 6–11 white bars along each side and dorsal fin or uniformly brown. Peritoneum speckled. For specific diagnostic characteristics, see Møller (2000) [1] and *Fishes of Alaska*, (Mecklenburg and others, 2002, page 721, as *L. pallidus*) [2]. Swim bladder: Absent [2]. Antifreeze glycoproteins in blood serum: Unknown.

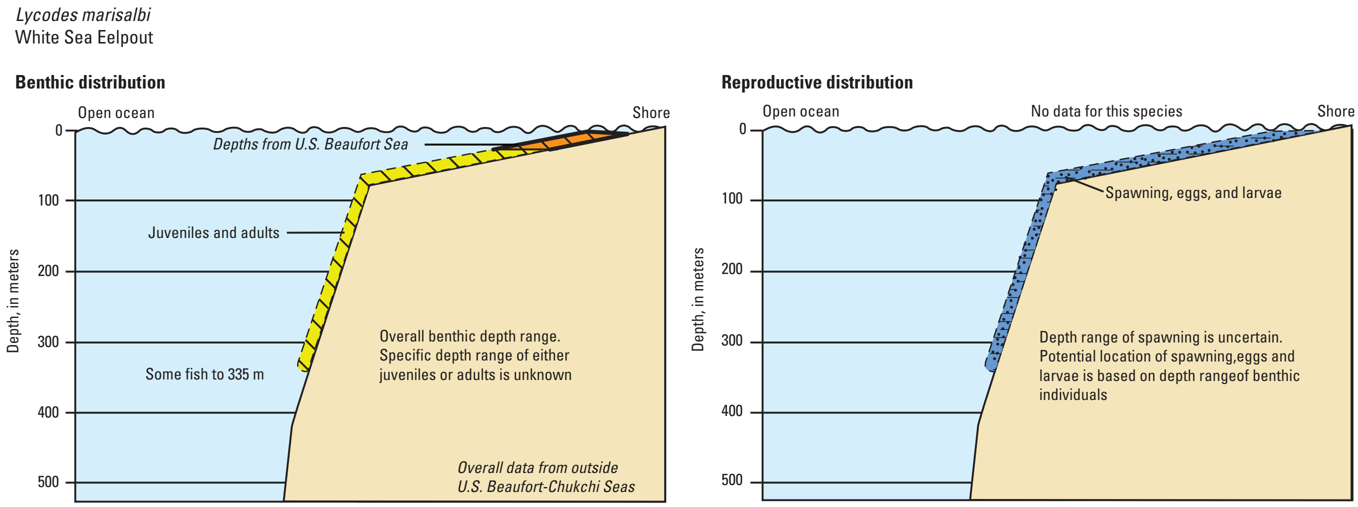
Range: *Central and eastern U.S. Beaufort Sea* [2, 3]. Elsewhere, in Canadian Arctic at Mould Bay, Prince Patrick Island, to Mackenzie Bay and eastward to Dease Strait, Bathurst Inlet; disjunct population in White Sea [1].

Relative Abundance: *Occasional, although previously misidentified as* L. pallidus, *in U.S. Beaufort Sea* [3]. Common in southeastern part of Canadian Beaufort Sea [1].

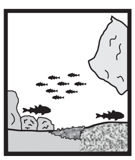


Geographic distribution of White Sea Eelpout (*Lycodes marisalbi*) within Arctic Outer Continental Shelf Planning Areas [4] based on review of published literature and specimens from historical and recent collections [2, 3, 5].

Depth Range: 6–335 m [1, 3]. *Mostly less than 50 m in U.S. Beaufort Sea* [3]. In general, eelpout spawning and larvae occur at same depths that adults inhabit [2].

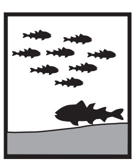


Benthic and reproductive distribution of White Sea Eelpout (*Lycodes marisalbi*).



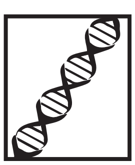
Habitats and Life History

Eggs—Size: 2–2.5 mm [1]. Time to hatching: Unknown. Habitat: Benthic [1, 3].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic [1, 3].
Juveniles—Age and size: Unknown. Habitat: Benthic [1, 3].
Adults—Age and size at first maturity: Age unknown. At least 11.9 cm SL in females [1]. Maximum age: Unknown. Maximum size: 21.3 cm SL [1]. Habitat: Benthic [1, 3], in shallow waters influenced by major Arctic rivers [1].
Substrate—Mud or clay and stone bottoms [2].
Physical/chemical—Temperature: -1.4–3 °C [1, 5]. Salinity: Marine to slightly brackish; 27–32 ppt [1].



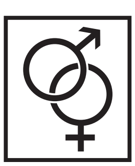
Behavior

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



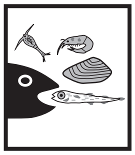
Populations or Stocks

There have been no studies.

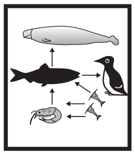


Reproduction

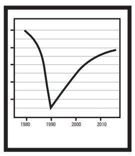
Mode—Separate sexes. Oviparous.
Spawning season—Unknown.
Fecundity—32–38 orange eggs [1].



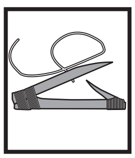
Food and Feeding
Food items—Unknown.
Trophic level—3.45 standard error 0.45 [6].



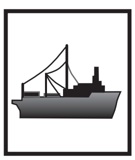
Biological Interactions
Predators—Unknown.
Competitors—Unknown.



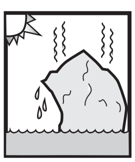
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (Preliminary *K* or Fecundity) [6].



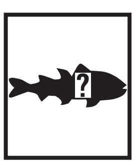
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, White Sea Eelpout are not commercially harvested.



Potential Effects of Climate Change
Unknown.



Areas for Future Research [B]
Virtually nothing is known about 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.

Bibliography

1. Møller, P.R., 2000, Restoration of the taxon *Lycodes marisalbi*, with notes on its disjunct Arctic distribution: Journal of Fish Biology, v. 57, no. 6, p. 1,404–1,415.

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

3. 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.

4. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.

5. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.

6. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.

Saddled Eelpout (*Lycodes mucosus*)
Richardson, 1855

Family Zoarcidae

Saddled Eelpout (*Lycodes mucosus*), 229 mm TL, northeastern Bering Sea, 2007. Photograph by C.W. Mecklenburg, Point Stephens Research.

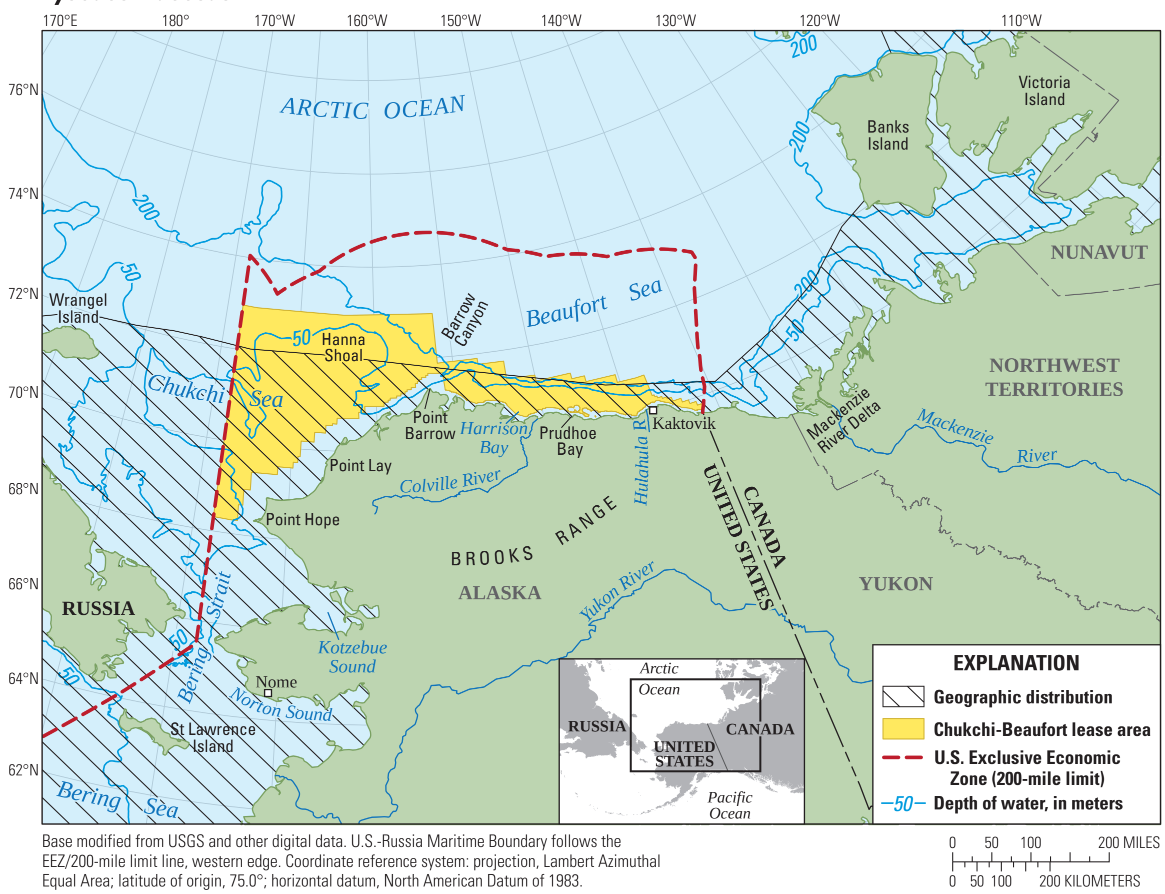
Colloquial Name: *None within U.S. Chukchi and Beaufort Seas.*

Ecological Role: Due to a lack of data on this species, it is difficult to make an assessment of its ecological role. However, it is commonly encountered in the U.S. Chukchi Sea and therefore may be of moderate significance in marine ecosystem functioning there.

Physical Description/Attributes: Elongate, cream-colored body with dark brown U- and Y-shaped marks and white underside. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 708) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

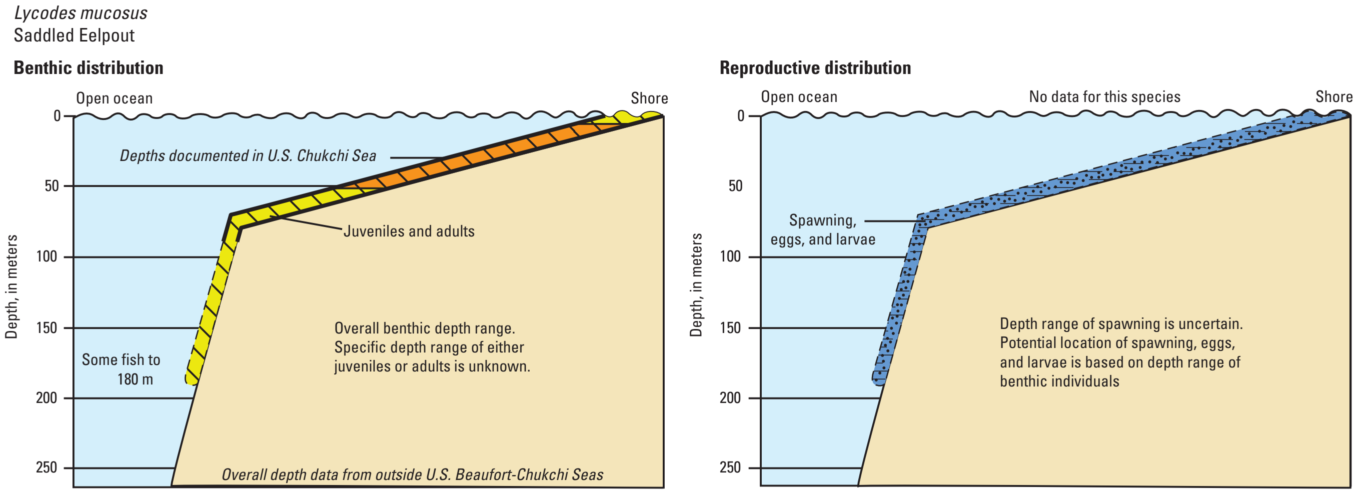
Range: *U.S. Chukchi and Beaufort Seas* [2, 3]. Elsewhere in Alaska, south in Bering Sea to near St. Matthew I. (60°N) [3]. Worldwide, Canadian High Arctic eastward to Hudson Strait and northwest Greenland; Russian Arctic southward to Gulf of Anadyr [3].

Relative Abundance: *Common in U.S. Chukchi Sea and U.S. Beaufort Sea* [3].

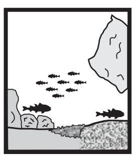


Geographic distribution of Saddled Eelpout (*Lycodes mucosus*) within Arctic Outer Continental Shelf Planning Areas [4] based on review of published literature and specimens from historical and recent collections [1, 3, 5].

Depth Range: 0–180 m, typically less than 80 m [3]. *Documented in U.S. Chukchi Sea 20–59 m* [2, 6, 7]. In general, eelpout spawning and larvae occur at the same depths that adults inhabit [1].

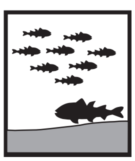


Benthic and reproductive distribution of Saddled Eelpout (*Lycodes mucosus*).



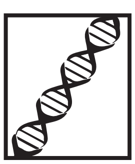
Habitats and Life History

Eggs—Size: 3 mm for almost ripe eggs [2, 8]. Time to hatching: Unknown. Habitat: Benthic [1]. **Larvae—**Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic [1].
Juveniles—Age and size: Unknown. Habitat: Benthic [1].
Adults—Age and size at first maturity: Age unknown. 24–35 cm TL for females [8]. Maximum age: Unknown. Maximum size: About 49 cm TL [1, 8]. Habitat: Benthic [1], sometimes at entrance to burrows or under debris [9]. Have been found in intertidal rock pools in Greenland [3].
Substrate—Mostly on mud, also found on shell hash, mixed gravel, sand and mud, and gravel and rock [2].
Physical/chemical—Temperature: -1.9–10.5 °C [2, 9]. Salinity: Marine.



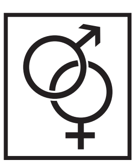
Behavior

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



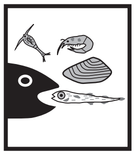
Populations or Stocks

There have been no studies.

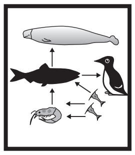


Reproduction

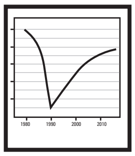
Mode—Separate sexes. Oviparous.
Spawning season—In Russia, likely in the autumn [8].
Fecundity—Unknown.



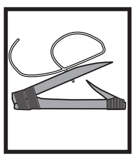
Food and Feeding
Food items—Mysids, copepods, ostracods, polychaetes [10].
Trophic level—3.92 standard error 0.64 [11].



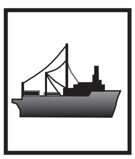
Biological Interactions
Predators—Unknown.
Competitors—Likely such benthic microcarnivores as flatfishes, sculpins, snailfishes, and other eelpouts.



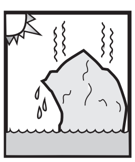
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (Preliminary *K* or Fecundity) [11].



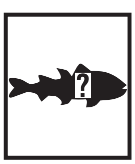
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, Saddled Eelpout are not commercially harvested.



Potential Effects of Climate Change
The Saddled Eelpout is an Arctic species. Shifts in range and abundance are possible effects.



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.

References Cited

Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.] [8]

Green, J.M., and Steele, D.H., 1975, Observations on marine life beneath sea ice, Resolute Bay, N.W.T., *in* Proceedings of the Circumpolar Conference on Northern Ecology, September 15–18, 1975: Ottawa, Ontario, National Research Council of Canada, p. II-77–II-86. [9]

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

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]

Mecklenburg, C.W., Stein, D.L., Sheiko, B.A., Chernova, N.V., Mecklenburg, T.A., and Holladay, B.A., 2007, Russian–American long-term census of the Arctic—Benthic fishes trawled in the Chukchi Sea and Bering Strait, August 2004: Northwestern Naturalist, v. 88, no. 3, p. 168–187. [2]

Bibliography

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

2. Mecklenburg, C.W., Stein, D.L., Sheiko, B.A., Chernova, N.V., Mecklenburg, T.A., and Holladay, B.A., 2007, Russian–American long-term census of the Arctic—Benthic fishes trawled in the Chukchi Sea and Bering Strait, August 2004: Northwestern Naturalist, v. 88, no. 3, p. 168–187.

3. 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.

4. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.

5. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.

6. Fechhelm, R.G., Craig, P.C., Baker, J.S., and Gallaway, B.J., 1984, Fish distribution and use of nearshore waters in the northeastern Chukchi Sea: LGL Ecological Research Associates, Inc., Outer Continental Shelf Environmental Assessment Program, National Oceanic and Atmospheric Administration, OMPA/OCSEAP, Final Report, 190 p.

7. Norcross, B.L., Holladay, B.A., Busby, M.S., and Mier, K.L., 2009, Demersal and larval fish assemblages in the Chukchi Sea: Deep-Sea Research II, v. 57, no. 1–2, p. 57–70.

8. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]

9. Green, J.M., and Steele, D.H., 1975, Observations on marine life beneath sea ice, Resolute Bay, N.W.T., *in* Proceedings of the Circumpolar Conference on Northern Ecology, September 15–18, 1975: Ottawa, Ontario, National Research Council of Canada, p. II-77–II-86.

10. Green, J.M., 1983, Observations on the food of marine fishes from Resolute Bay, Cornwallis Island, Northwest Territories: Astarte, v. 12, no. 2, p. 63–68.

11. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.

Wattled Eelpout (*Lycodes palearis*)

Gilbert, 1896

Family Zoarcidae

Wattled Eelpout (*Lycodes palearis*), 152 mm TL, Chukchi Sea, 2007. Photograph by C.W. Mecklenburg, Point Stephens Research.

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

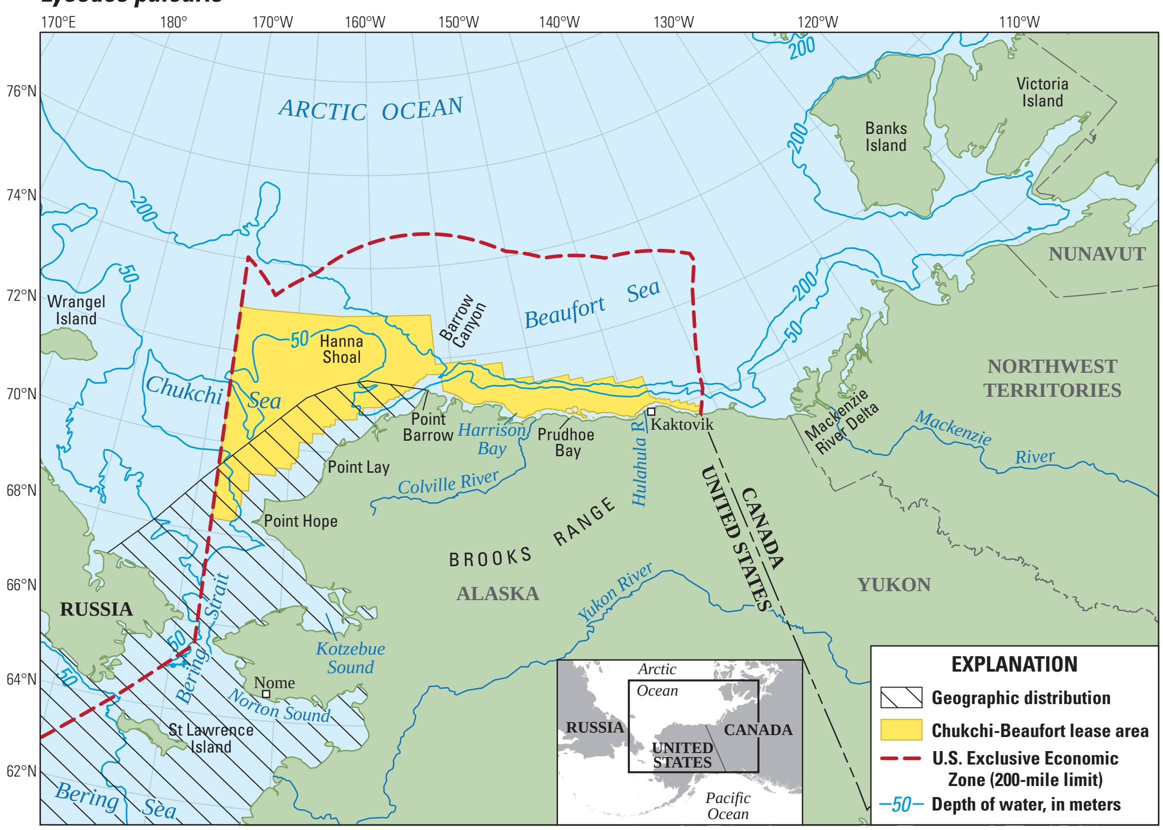
Ecological Role: Poorly understood, although based on studies outside the Arctic Ocean, may be of moderate importance as food for larger fishes.

Physical Description/Attributes: Elongate brown or reddish brown body and fins with narrow, creamy white bands on upper body and dorsal fin; bands fade with growth. For specific diagnostic characteristics, see *Fishes of Alaska* (Meckenburg and others, p. 719) [1]. Swim bladder: Absent [1]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Chukchi Sea as far north as 71°17'N, 156°48'W near Barrow and western U.S. Beaufort Sea near Point Barrow at 71°22'N, 156°19'W* [2]. Elsewhere, in Bering Sea, along the Aleutian Islands and Gulf of Alaska south to Oregon, and to southeastern Kamchatka Peninsula, Russia [2, 3].

Relative Abundance: *Common as far north as northeastern U.S. Chukchi Sea* [6]. Common at least in eastern Bering Sea [7]. Uncommon in southeastern Bering Sea [8] and rare in Sea of Japan [9].

Wattled Eelpout
Lycodes palearis

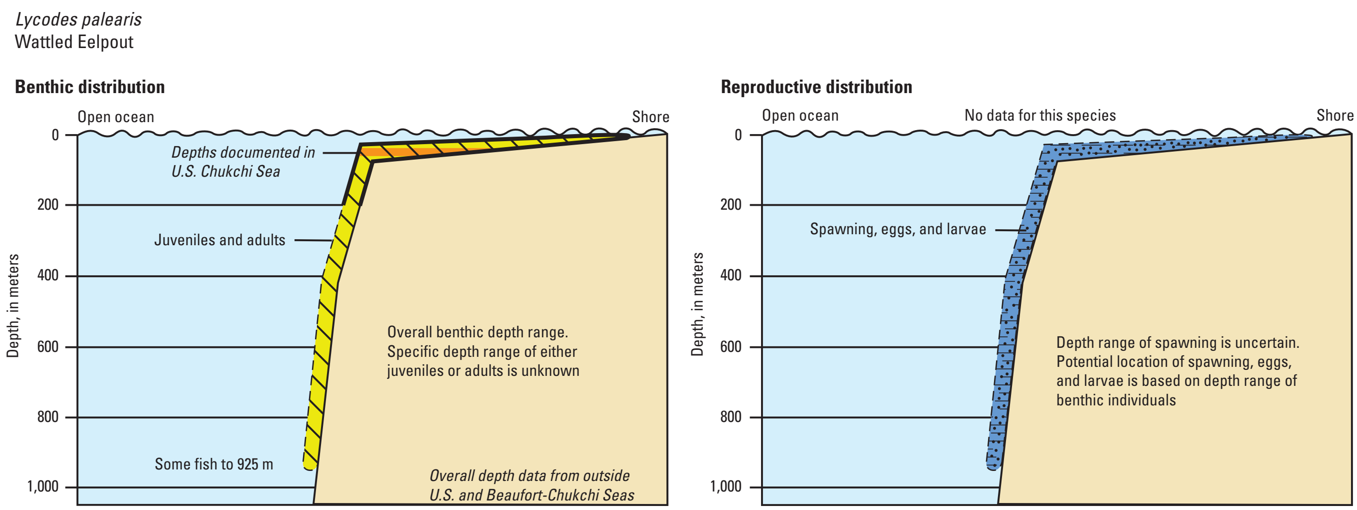


Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

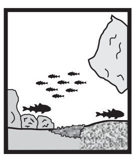
0 50 100 200 MILES
0 50 100 200 KILOMETERS

Geographic distribution of Wattled Eelpout (*Lycodes palearis*) within Arctic OCS Planning Areas [4] based on review of published literature and specimens from historical and recent collections [1, 2, 5].

Depth Range: 2–925 m, almost always less than 200 m [10]. *Taken in U.S. Chukchi Sea at 30–54 m* [3, 6, 11]. In general, eelpout spawning and larvae occur at the same depths that adults inhabit [1].

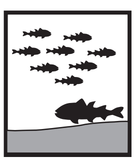


Benthic and reproductive distribution of Wattled Eelpout (*Lycodes palearis*).



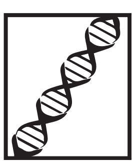
Habitats and Life History

Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Benthic [1].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic [1].
Juveniles—Age and size: Unknown. Habitat: Benthic [1].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 62.0 cm TL [12]. Habitat: Benthic [1].
Substrate—Mud or sand [1, 3, 13].
Physical/chemical—Temperature: –1.7–14.6 °C [3, 5, 13, 14]. Salinity: Marine [3, 13].



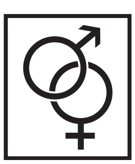
Behavior

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



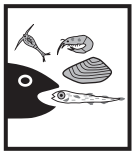
Populations or Stocks

There have been no studies.



Reproduction

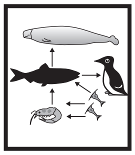
Mode—Separate sexes, oviparous.
Spawning season—Unknown.
Fecundity—Unknown.



Food and Feeding

Food items—In eastern Bering Sea and Gulf of Alaska, a wide range of benthic and epibenthic prey. Crustaceans (for example, gammarid amphipods, crabs, and shrimps) and fishes are often consumed, along with polychaetes, brittle stars, echiuroids, and clam siphons [15–17]. Larger Wattled Eelpouts feed more heavily on fishes than do smaller individuals [16].

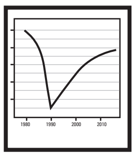
Trophic level—3.6 [18].



Biological Interactions

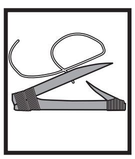
Predators—Arrowtooth Flounder, Great Sculpin, Greenland Halibut, Pacific Cod, and Pacific Halibut in eastern Bering Sea, Gulf of Alaska, and off Kamchatka Peninsula, Russia [19–22].

Competitors—Likely a range of moderate-sized benthic fishes, including flatfishes, gadids, and sculpins.



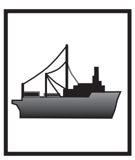
Resilience

Low, minimum population doubling time: 4.5–14 years (Preliminary *K* or Fecundity) [23].



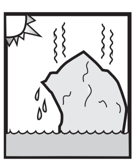
Traditional and Cultural Importance

None reported.



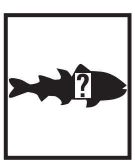
Commercial Fisheries

Wattled Eelpout are not commercially harvested currently.



Potential Effects of Climate Change

The Wattled Eelpout is a predominantly Boreal Pacific species which would be expected to become more abundant in the Chukchi Sea and possibly expand its range farther 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.

References Cited

Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.] [13]

Barber, W.E., Smith, R.L., Vallarino, M., and Meyer, R.M., 1997, Demersal fish assemblages of the northeastern Chukchi Sea, Alaska: Fishery Bulletin, v. 95, no. 2 p. 195–209. [6]

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

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]

Mecklenburg, C.W., Stein, D.L., Sheiko, B.A., Chernova, N.V., Mecklenburg, T.A., and Holladay, B.A., 2007, Russian–American long-term census of the Arctic—Benthic fishes trawled in the Chukchi Sea and Bering Strait, August 2004: Northwestern Naturalist, v. 88, no. 3, p. 168–187. [3]

Bibliography

1. Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p.
2. 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. Mecklenburg, C.W., Stein, D.L., Sheiko, B.A., Chernova, N.V., Mecklenburg, T.A., and Holladay, B.A., 2007, Russian–American long-term census of the Arctic—Benthic fishes trawled in the Chukchi Sea and Bering Strait, August 2004: Northwestern Naturalist, v. 88, no. 3, p. 168–187.
4. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.
5. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.
6. Barber, W.E., Smith, R.L., Vallarino, M., and Meyer, R.M., 1997, Demersal fish assemblages of the northeastern Chukchi Sea, Alaska: Fishery Bulletin, v. 95, no. 2, p. 195–209.
7. Hoff, G.R., 2006, Biodiversity as an index of regime shift in the eastern Bering Sea: Fishery Bulletin, v. 104, no. 2, p. 226–237.
8. Acuna, E.I., Goddard, P., and Kotwicki, S., 2003, 2002 bottom trawl survey of the eastern Bering Sea continental shelf: National Marine Fisheries Service, Alaska Fisheries Science Center, Processed Report 2003-01.
9. Sokolovskaya, T.G., Sokolovskii, A.S., and Sobolevskii, E.I., 1998, A list of fishes of Peter the Great Bay (the Sea of Japan): Journal of Ichthyology, v. 38, no. 1, p. 1–11.
10. Allen, M.J., and Smith, G.B., 1988, Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific: National Oceanic and Atmospheric Administration Technical Report NMFS 66, 151 p.
11. Norcross, B.L., Holladay, B.A., Busby, M.S., and Mier, K.L., 2009, Demersal and larval fish assemblages in the Chukchi Sea: Deep-Sea Research II, v. 57, nos. 1–2, p. 57–70.

12. Love, M.S., Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2005, Resource inventory of marine and estuarine fishes of the West Coast and Alaska—A checklist of North Pacific and Arctic Ocean species from Baja California to the Alaska-Yukon border: Seattle, Washington, U.S. Department of the Interior, U.S. Geological Survey, Biological Resources Division, OCS Study MMS 2005-030 and USGS/NBII 2005-001, 276 p.

13. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]

14. Mueter, F.J., University of Alaska-Fairbanks, written commun., 2010.

15. Brodeur, R.D., and Livingston, P.A., 1988, Food habits and diet overlap of various Eastern Bering Sea fishes: National Oceanic and Atmospheric Administration Technical Memorandum NMFS F/NWC-127, 76 p.

16. Mito, K.-I., Nishimura, A., and Yanagimoto, T., 1999, Ecology of groundfishes in the eastern Bering Sea, with emphasis on food habits, *in* Loughlin, T.R., and Ohtani, K., eds., Dynamics of the Bering Sea: Fairbanks, University of Alaska Sea Grant, p. 537–580.

17. Yang, M.-S., Dodd, K., Hibpshman, R., and Whitehouse, A., 2006, Food habits of groundfishes in the Gulf of Alaska in 1999 and 2001: U.S. Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum, NMFS-AFSC-164, 189 p.

18. Mueter, F.J., and Litzow, M.A., 2008, Sea ice retreat alters the biogeography of the Bering Sea continental shelf: Ecological Applications, v. 18, no. 2, p. 309–320.

19. Tokranov, A.M., 1981, Distribution of sculpins (Pisces, Cottidae) on the west Kamchatka shelf in summer: Zoologicheskii Zhurnal, v. 60, no. 2, p. 229–237.

20. Kihara, K., and Shimada, A.M., 1988, Prey-predator interactions of Pacific cod *Gadus macrocephalus* and water temperature: Nippon Suisan Gakkaishi, v. 54, no. 12, p. 2,085–2,088.

21. Lang, G.M., Livingston, P.A., Pacunski, R.E., Parkhurst, J., and Yang, M.-S., 1991, Groundfish food habits and predation on commercially important prey species in the eastern Bering Sea from 1984 to 1986: Seattle, Washington, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS F/NWC-207, 240 p.

22. Yang, M.-S., and Nelson, M.W., 2000, Food habits of the commercially important groundfishes in the Gulf of Alaska in 1990, 1993, and 1996: Seattle, Washington, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-AFSC-112, 174 p.

23. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.

Polar Eelpout (*Lycodes polaris*)

(Sabine, 1824)

Family Zoarcidae

Polar Eelpout (*Lycodes polaris*), 180 mm TL, Chukchi Sea, 2004. Photograph by C.W. Mecklenburg and B.A. Sheiko, Point Stephens Research and Russian Academy of Sciences.

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

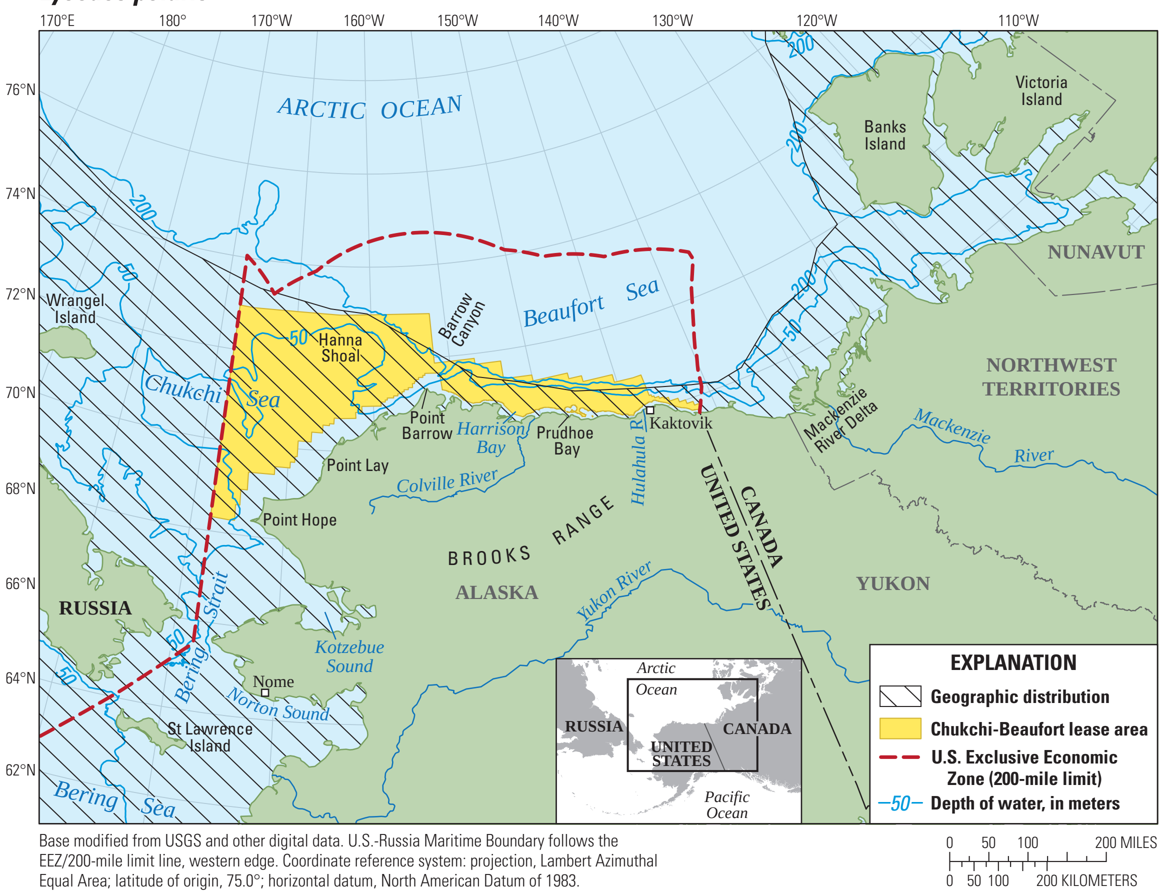
Ecological Role: Based on food habits research outside the U.S. Arctic [1, 2], Polar Eelpout may be of moderate ecological importance.

Physical Description/Attributes: Slender, elongate orange to light brown body with by 9–11 dark brown bands extending from sides onto dorsal fin. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 710) [3]. Swim bladder: Absent [3]. Antifreeze glycoproteins in blood serum: Present [4].

Range: *U.S. Chukchi and Beaufort Seas (in Chukchi Sea, northward to at least 73°32'N)* [5]. Elsewhere in Alaska, southward in eastern Bering Sea to between Hall Island and St. Lawrence Island. Worldwide, nearly circumpolar in Arctic seas; in western Bering Sea southward to Glubokaya Bay on the Koryak Coast, Russia (about 61°N) [5–7] and in the western North Atlantic to the Gulf of St. Lawrence [7].

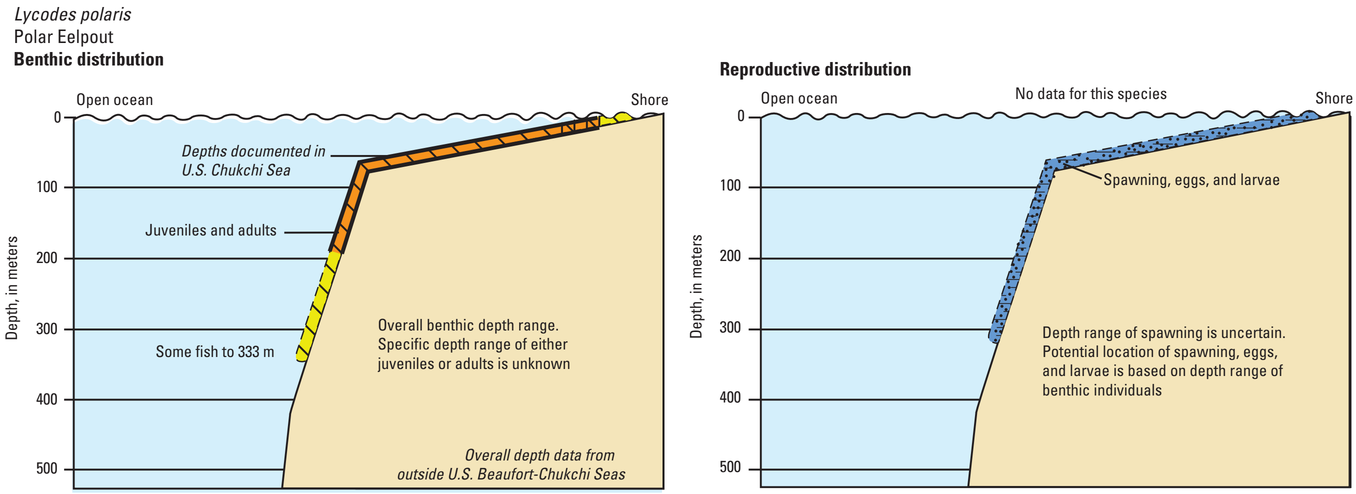
Relative Abundance: *Common in both U.S. Chukchi and Beaufort Seas* [5, 10, 11], and eastward to at least Cornwallis Island, Nunavut, Canada [12, 13].

Polar Eelpout
Lycodes polaris

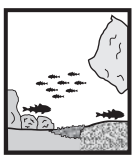


Geographic distribution of Polar Eelpout (*Lycodes polaris*) within Arctic OCS Planning Areas [8] based on review of published literature and specimens from historical and recent collections [3, 7, 9].

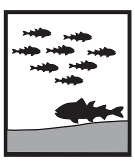
Depth Range: 0–333 m [14], typically 30–150 m [7]. *Taken in U.S. Chukchi and Beaufort Seas from 17 to 183 m* [9]. In general, eelpout spawning and larvae occur at the same depths that adults inhabit [3].



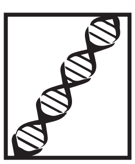
Benthic and reproductive distribution of Polar Eelpout (*Lycodes polaris*).



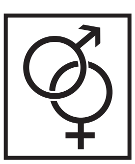
Habitats and Life History
Eggs—Time to hatching: Unknown. Size: Large (about 4–5 mm) [6]. Habitat: Benthic [3].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Benthic [3]. Juveniles: Age and size: Unknown. Habitat: Benthic [3].
Adults—Age and size at first maturity: Age unknown. *Probably around 15.5 cm TL* [10]. Maximum age: *At least 5 years* [10]. Maximum size *33.3 cm in U.S. Beaufort Sea* [9]. Habitat: Benthic [3].
Substrate—Mud and sandy mud [5, 6, 12].
Physical/chemical—Temperature:-1.9–2.5 °C [5, 12], usually 0 °C or less [6]. Salinity: Predominantly marine, occasionally estuarine (as low as 25.3 ppt) [6].



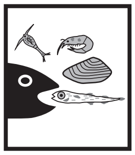
Behavior
Diel—Lives in burrows in upper layers of sediment and has been observed entering them tail first [6, 12].
Seasonal— Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Unknown.



Populations or Stocks
There have been no studies.



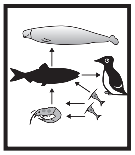
Reproduction
Mode—Separate sexes, oviparous.
Spawning season—*Likely in autumn or early winter* [6, 10].
Fecundity—*66–200 eggs* [1, 6, 10].



Food and Feeding

Food items—*Primarily gammarid amphipods and polychaetes, along with smaller amounts of cumaceans, caprellid amphipods, isopods, mysids, shrimps, brittle stars, and occasionally fishes* [10], including Arctic Cod [1]. A similar diet has been reported from Russian Arctic [6].

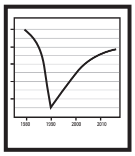
Trophic level—3.32 standard error 0.38 [16].



Biological Interactions

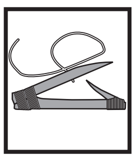
Predators—Seabirds [1]. Commonly eaten by bearded seals in Canadian High Arctic [2].

Competitors—Likely other benthic and epibenthic feeding fishes, including flatfishes, sculpins, and other eelpouts.



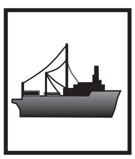
Resilience

Medium, minimum population doubling time: 1.4–4.4 years (Preliminary *K* or Fecundity) [16].



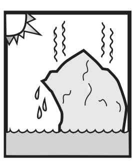
Traditional and Cultural Importance

None reported.



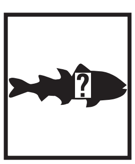
Commercial Fisheries

Polar Eelpout are not commercially harvested currently.



Potential Effects of Climate Change

The Polar Eelpout is an Arctic species inhabiting the continental shelf and upper slope. It is possible that climate warming could cause extirpation of local populations as distributions shift to more northern, deeper, and colder waters.



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.

Remarks

One of the most widespread, abundant, and northerly distributed continental shelf eelpouts [1].

References Cited

Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.] [6]

Frost, K.J., and Lowry, L.F., 1983, Demersal fishes and invertebrates trawled in the northeastern Chukchi and western Beaufort Seas 1976–1977: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, AA Technical Report NMFS-SSRF-764, 22 p. [10]

Green, J.M., and Steele, D.H., 1975, Observations on marine life beneath sea ice, Resolute Bay, N.W.T., *in* Proceedings of the Circumpolar Conference on Northern Ecology, September 15–18, 1975: Ottawa, Ontario, National Research Council of Canada, p. II-77–II-86. [12]

Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p. [3]

Mecklenburg, C.W., Stein, D.L., Sheiko, B.A., Chernova, N.V., Mecklenburg, T.A., and Holladay, B.A., 2007, Russian–American long-term census of the Arctic—Benthic fishes trawled in the Chukchi Sea and Bering Strait, August 2004: Northwestern Naturalist, v. 88, no. 3, p. 168–187. [5]

Bibliography

1. Mecklenburg, C.W., and Mecklenburg, T.A., 2011, Polar Eelpout—*Lycodes polaris* (Sabine, 1824): Arctic Ocean Diversity Web site, accessed 2011, at http://www.arcodiv.org/Fish/Lycodes_polaris.html.
2. Finley, K.J., and Evans, C.R., 1983, Summer diet of the bearded seal (*Erignathus barbatus*) in the Canadian High Arctic: Arctic, v. 36, no. 1, p. 82–89.
3. Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p.
4. Power, G., 1997, A review of fish ecology in Arctic North America: American Fisheries Society Symposium, no. 19, p. 13–39.
5. Mecklenburg, C.W., Stein, D.L., Sheiko, B.A., Chernova, N.V., Mecklenburg, T.A., and Holladay, B.A., 2007, Russian–American long-term census of the Arctic—Benthic fishes trawled in the Chukchi Sea and Bering Strait, August 2004: Northwestern Naturalist, v. 88, no. 3, p. 168–187.
6. Andriashev, A.P., 1954, Fishes of the northern seas of the U.S.S.R.—Keys to the fauna of the U.S.S.R.: Academy of Sciences of the U.S.S.R., Zoological Institute, no. 53, 566 p. [In Russian, translation by Israel Program for Scientific Translation, Jerusalem, 1964, 617 p., available from U.S. Department of Commerce, Springfield, Virginia.]
7. 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.
8. Minerals Management Service, 2008, Beaufort Sea and Chukchi Sea planning areas—Oil and Gas Lease Sales 209, 212, 217, and 221: U.S. Department of the Interior, Minerals Management Service Alaska OCS Region, OCS EIS/EA, MMS 2008-0055, 538 p.
9. Mecklenburg, C.W., Mecklenburg, T.A., Sheiko, B.A., and Steinke, D., 2016, Pacific Arctic marine fishes: Akureyri, Iceland, Conservation of Arctic Flora and Fauna, Monitoring Series Report No. 23, 406 p., accessed May 10, 2016, at http://caff.is/monitoring-series/370-pacific-arcticmarine-fishes.
10. Frost, K.J., and Lowry, L.F., 1983, Demersal fishes and invertebrates trawled in the northeastern Chukchi and western Beaufort Seas 1976–1977: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, AA Technical Report NMFS-SSRF-764, 22 p.
11. Barber, W.E., Smith, R.L., Vallarino, M., and Meyer, R.M., 1997, Demersal fish assemblages of the northeastern Chukchi Sea, Alaska: Fishery Bulletin, v. 95, no. 2 p. 195–209.

12. Green, J.M., and Steele, D.H., 1975, Observations on marine life beneath sea ice, Resolute Bay, N.W.T., *in* Proceedings of the Circumpolar Conference on Northern Ecology, September 15–18, 1975: Ottawa, Ontario, National Research Council of Canada, p. II-77–II-86.

13. Arctic Laboratories Limited, 1987, Beaufort ocean dumpsite characterization: Prepared for Environment Protection, Conservation and Protection, Environment Canada, Yellowknife, Northwest Territories, by Arctic Laboratories Limited and LGL Limited.

14. Christiansen, J.S., ed., 2003, TUNU-1 Expedition—The fish fauna of the NE Greenland fjord systems—Technical report: Tromsø, Norway, University of Tromsø, Norwegian College of Fishery Science, Institute of Aquatic Resources, 33 p.

15. Wienerroither, R., Johannesen, E., Langøy, H., Børve Eriksen, K., de Lange Wenneck, T., Høines, Å., Bjelland, O., Aglen, A., Prokhorova, T., Murashko, P., Prozorkevich, D., Konstantin, Byrkjedal, I., Langhelle Drevetnyak, and G., Smirnov, O., 2011, Atlas of the Barents Sea fishes: IMR/PINRO Joint Report Series 1-2011, ISSN 1502-8828, 274 p.

16. Froese, R., and Pauly, D., eds., 2012, FishBase—Global information system on fishes: FishBase database, accessed July 8, 2012, at http://www.fishbase.org.