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Chapter 3h Alaska Arctic Marine Fish Species

Chapter 3. Alaska Arctic Marine Fish Species Accounts

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Abstract

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

Purpose and Design of Species Accounts

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

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

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

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Limitations of Data

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

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

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

Operational Definitions

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

Vertical Distribution

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

Location of Shelf Break

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

Keystone Species

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

Outline of Species Accounts

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

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

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

Taxonomic—Scientific and Common Names

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

Iñupiat Name

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

Ecological Role

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

Physical Description/Attributes

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

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

Range

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

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

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

Relative Abundance

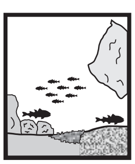
Relative abundance refers to the contribution a species makes to the total abundance of the fishery community. It is a measure that provides an index of the number of individuals present, but not the actual numbers. Relative abundance terms, such as “common,” “uncommon,” or “rare” often are used to express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

Depth Range

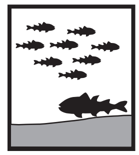
Benthic distribution refers to the spatial arrangement of a particular species at different depths over continental shelf and slope waters. The life cycle of fishes occurs in multiple dimensions in time and space and generally reflects genetically determined life history or behavior that has evolved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

Life History, Population Dynamics, and Biological Interactions

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



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



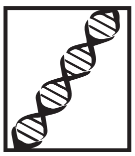
Behavior (see also Glossary [chapter 7]).—Behavior is the manner in which a fish operates or functions within its environment (that is, home range, territoriality, and many others) to procure food, orient to specific locations, or relate to other organisms. Knowing how individuals respond to the environment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

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

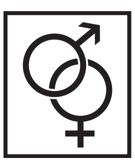
Schooling (that is, social structure of fish of the same species moving in more or less harmonious patterns in the sea) often is related to survival and reproduction. Schooling confers physical benefits to fish movement, safety against predators, search behaviors (for example, foods), population immunology,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

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

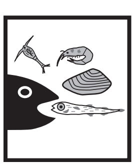
- Trophic level 1 (T1), plants and animals make their own food and are called primary producers;
- Trophic level 2 (T2), herbivores eat plants and are called primary consumers;
- Trophic level 3 (T3), carnivores eat herbivores and are called secondary consumers;
- Trophic level 4 (T4), carnivores eat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



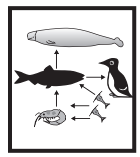
Populations or Stocks—A population often is defined as a group of organisms of the same species occupying a particular space at a particular time with the potential to breed with each other (Williams and others, 2002). Stocks are subpopulations of a particular species of fish that result from reproductive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



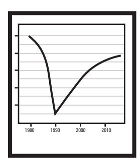
Reproduction Mode—Little information is available about the spawning times and locations, mating behaviors (breeders or nonbreeders), and genetic diversity of Arctic marine fishes. What is known is drawn largely from observations from populations studied outside the United States. For most Arctic marine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



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



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

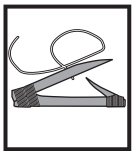


Resilience—In ecology, resilience traditionally refers to the ability of a population or biotic community to sustain or return to its former state after a disturbance. The rate of recovery is a measure of resilience determined by the population processes involved in restoring abundance to healthy, sustainable,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

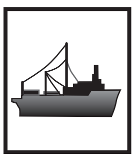
Traditional, Cultural, and Economic Values

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

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



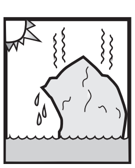
Traditional and Cultural Importance.— Several species of nearshore marine fishes are important in subsistence fisheries. The protection of traditional lifestyles and economies, including these subsistence fisheries, is a responsibility of the Federal government. Subsistence relates to resource use patterns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



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

Climate Change

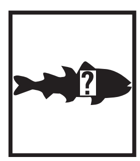
Alaska's climate is changing at more than twice the rate of the rest of the United States (Mellilo and others, 2014). Year-to-year and regional variability in air temperatures are evident and the warming trend currently is being moderated by large-scale cooling associated with the Pacific Decadal Oscillation.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



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

Research Needs

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



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

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

References Cited and Bibliography

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

Sea Tadpole to Polar Eelpout

Sea Tadpole (*Careproctus reinhardti*)

(Krøyer, 1862)

Family Liparidae

Sea Tadpole (*Careproctus reinhardti*), 170 mm TL, Chukchi Borderland, 2009. 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*.

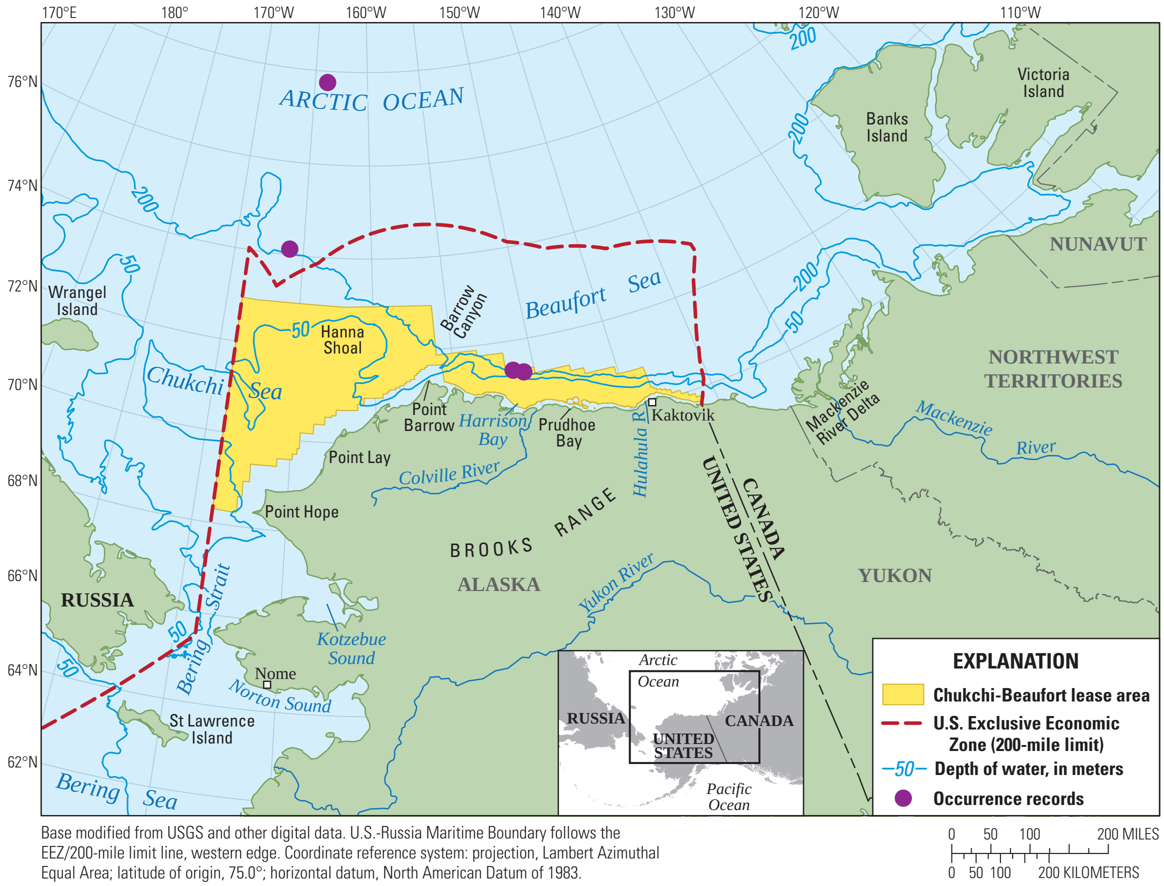
Ecological Role: Unknown, as its abundance in the Arctic is poorly understood.

Physical Description/Attributes: A gelatinous, pink-translucent snailfish with a small, recessed, pelvic adhesive disk. For diagnostic details see Nozères and others (2010, p. 88) [1]. Swim bladder: Absent [2]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *Chukchi Borderland and upper continental slope of Chukchi and Beaufort Seas (to as far eastward as 71°15'N, 150°06'W)* [5]. Worldwide, found in Arctic Ocean north of Alaska, in Baffin Bay and Davis Strait, off eastern Greenland, and Kara and Laptev Seas [5].

Relative Abundance: *Not documented in U.S. Chukchi Sea. Rare in U.S. Beaufort Sea* [3]. Has been reported to be abundant in Gulf of St. Lawrence [1, 6].

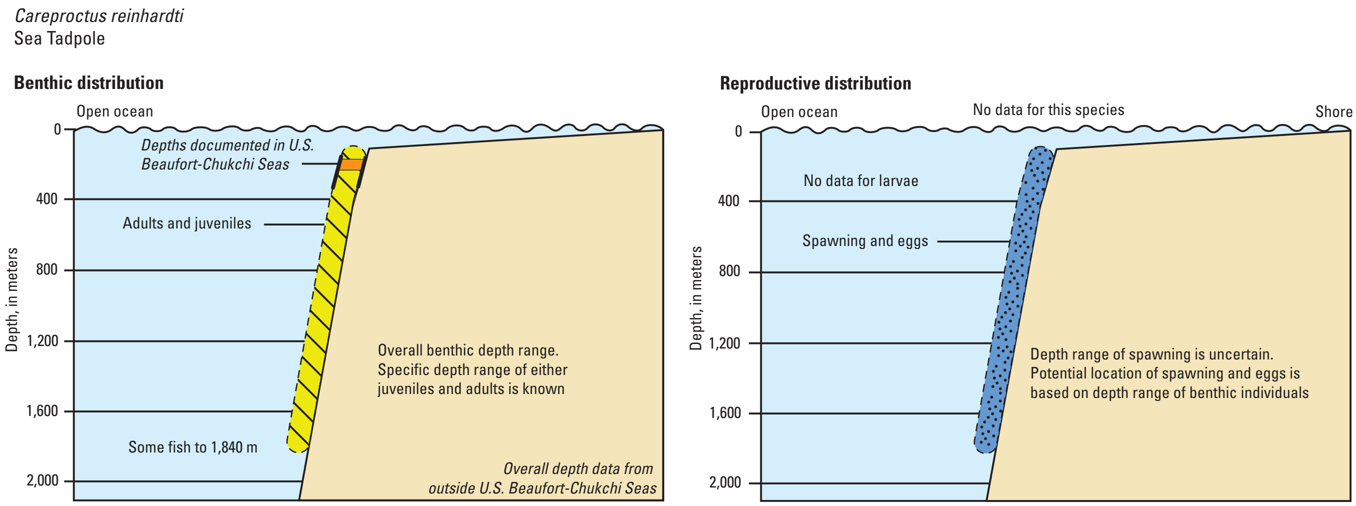
Sea Tadpole
Careproctus reinhardti



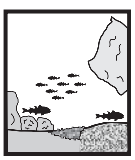
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

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

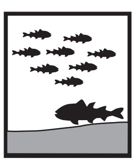
Depth Range: 100–1,840 m [3], usually 180–350 m [7]. *Taken in U.S. Beaufort Sea at 183–223 m, and north of U.S. Chukchi Sea, outside the 200-mile limit, at 227–236 m* [3, 5].



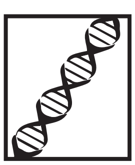
Benthic and reproductive distribution for Sea Tadpole (*Careproctus reinhardti*).



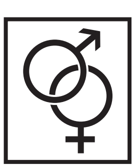
Habitats and Life History
Eggs—Size: 4.2–4.7 mm [7, 8]. Time to hatching: Unknown. Habitat: Unknown.
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Unknown.
Juveniles—Age and size: Unknown. Habitat: Unknown.
Adults—Age and size at first maturity: *Unknown*. About 120 mm TL in Atlantic Ocean [6]. Maximum age: 7 years [9]. Maximum size: 30 cm TL [10]. Habitat: Benthic and benthopelagic [7].
Substrate—Muddy bottoms [7]. Physical/chemical—Temperature: -2 to 4 °C [5, 7]. Spawning at 2–4 °C [11]. Salinity: Marine [7].



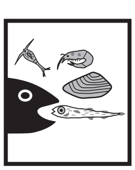
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Unknown.



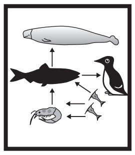
Populations or Stocks
There have been no studies.



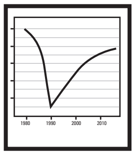
Reproduction
Mode—Separate sexes, oviparous [12].
Spawning season—Perhaps in spring and (or) summer in Canadian Arctic [13], in November in Barents Sea [8].
Fecundity—About 40–300 eggs [6, 7].



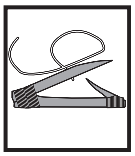
Food and Feeding
Food items—Smaller fish consumed more hyperiid and gammarid amphipods; larger fish consumed more pandalid shrimps. In general, amphipods and shrimps are major prey. Fishes and copepods also are reported in the diet [7, 10]. Trophic level—3.75 standard error 0.58 [14].



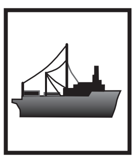
Biological Interactions
Predators—Ribbon seals eat snailfishes in the Bering Sea [16].
Competitors—Likely a range of benthic fish species, including various flatfishes, sculpins, poachers, and eelpouts.



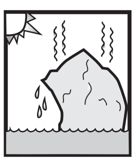
Resilience
High, minimum population doubling time: less than 15 months (Preliminary *K* or Fecundity) [14].



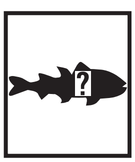
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, Sea Tadpole are not commercially harvested.



Potential Effects of Climate Change
The Sea Tadpole are an Arctic species and its distribution would be expected to shift northward with warming temperatures.



Areas for Future Research [B]
Little information is available regarding the biology and ecology of this species in the U.S. Arctic marine environment. Research needs include: (1) depth and location of 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

This species may be a species complex and genetic confirmation of phylogenetic relationships is needed [3].

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.] [7]

Chernova, N.V., 1991, Aquarium observations of the snail fishes *Careproctus reinhardti* and *Liparis liparis*: Journal of Ichthyology, v. 31, no. 9, p. 65–70. [8]

Falk-Petersen, I.-B., Frivoll, V., Gulliksen, B., Haug, T., and Vader, W., 1988, Age/size relations and food of two snailfishes, *Liparis gibbus* and *Careproctus reinhardtii* (Teleostei, Liparididae) from Spitsbergen coastal waters: Polar Biology, v. 8, no. 5, p. 353–358. [10]

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]

Nozères, C., Archambault, D., Chouinard, P.-M., Gauthier, J., Miller, R., Parent, E., Schwab, P., Savard, L., and Dutil, J.-D., 2010, Identification guide for marine fishes of the estuary and northern Gulf of St. Lawrence and sampling protocols used during trawl surveys between 2004 and 2008: Canadian Technical Report of Fisheries and Aquatic Sciences no. 2866. [1]

Bibliography

1. Nozères, C., Archambault, D., Chouinard, P.-M., Gauthier, J., Miller, R., Parent, E., Schwab, P., Savard, L., and Dutil, J.-D., 2010, Identification guide for marine fishes of the estuary and northern Gulf of St. Lawrence and sampling protocols used during trawl surveys between 2004 and 2008: Canadian Technical Report of Fisheries and Aquatic Sciences no. 2866.

2. Eastman, J.T., Hikida, R.S., and DeVries, A.L., 1994, Buoyancy studies and microscopy of skin and subdermal extracellular matrix of the Antarctic snailfish, *Paraliparis devriesi*: Journal of Morphology, v. 220, no. 1, p. 85–101.

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. Able, K.W., and Irion, W., 1985, Distribution and reproductive seasonality of snailfishes and lumpfishes in the St. Lawrence River estuary and the Gulf of St. Lawrence: Canadian Journal of Zoology, v. 63, no. 7, p. 1,622–1,628.

7. 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. Chernova, N.V., 1991, Aquarium observations of the snail fishes *Careproctus reinhardti* and *Liparis liparis*: Journal of Ichthyology, v. 31, no. 9, p. 65–70.

9. Falk-Petersen, I.-B., Frivoll, V., Gulliksen, B., Haug, T., and Vader, W., 1988, Age/size relations and food of two snailfishes, *Liparis gibbus* and *Careproctus reinhardtii* (Teleostei, Liparididae) from Spitsbergen coastal waters: Polar Biology, v. 8, no. 5, p. 353–358.

11. Muus, B.J., Nielsen, J.G., Dahlstrom, P., and Nystrom, B.O., 1999, Sea fish: Hedehusene, Denmark, Blackwell Science Limited, 340 p.

12. 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.

13. 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.

14. Able, K.W., and McAllister, D.E., 1980, Revision of the snailfish genus *Liparis* from Arctic Canada: Ottawa, Department of Fisheries and Oceans, Canadian Bulletin of Fisheries and Aquatic Sciences 208.

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

16. Frost, K.J., and Lowry, L.F., 1980, Feeding of ribbon seals (*Phoca fasciata*) in the Bering Sea in spring: Canadian Journal of Zoology, v. 58, no. 9, p. 1,601–1,607.

Nebulous Snailfish (*Liparis bathyarcticus*)

Parr, 1931

Family Liparidae

Nebulous Snailfish (*Liparis bathyarcticus*), 184 mm, Bering Strait, 2009. Photograph by C.W. Mecklenburg, Point Stephens Research.

Note on taxonomy: *Historical confusion with L. gibbus (Bean, 1881) makes distribution uncertain* [1].

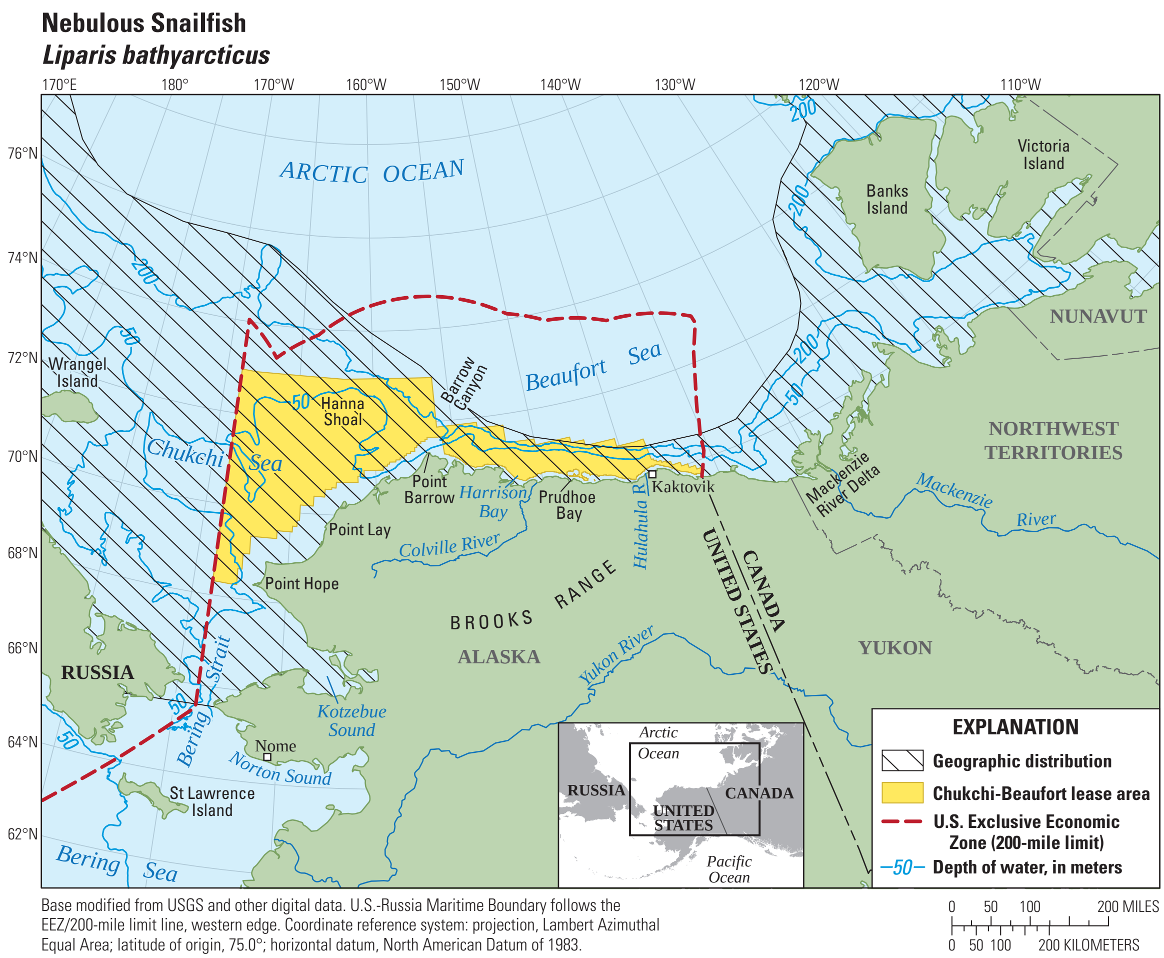
Colloquial Name: *None within U.S. Chukchi and Beaufort Seas.*

Ecological Role: The ecological significance of this species in benthic food webs is unknown, but given its widespread distribution and abundance could be regionally important.

Physical Description/Attributes: Head and body with brown mottling and metallic gold sheen; belly and underside of head white; and dorsal, anal, and caudal fins with distinct or indistinct black bands [2]. For specific diagnostic characteristics, see Parr (1931) and Chernova (2008) [3, 4]. Swim bladder: Absent [5]. Antifreeze glycoproteins in blood serum: Unknown.

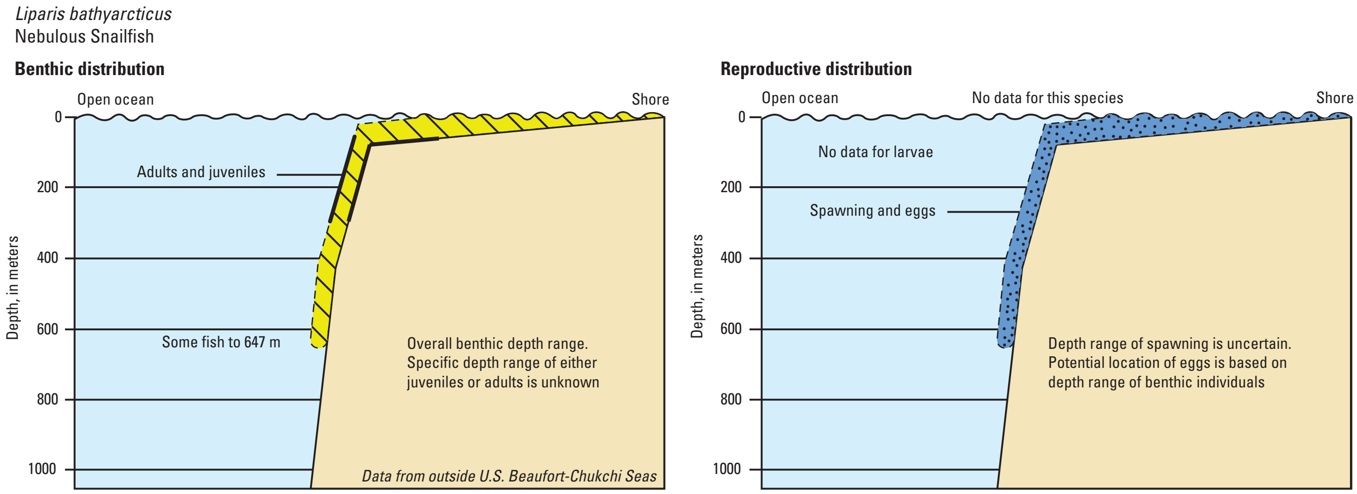
Range: *U.S. Chukchi and Beaufort Seas* [1]. Elsewhere in Alaska, to southeastern Bering Sea [3]. Worldwide, predominantly Arctic, circumpolar from west Greenland to Labrador, Greenland, Norwegian, Barents, White, and Kara Seas, and East Siberian and Chukchi Seas [1].

Relative Abundance: *Common in U.S. Chukchi and Beaufort Seas but historically confused with* L. gibbus *and other* Liparis *species* [2, 7].

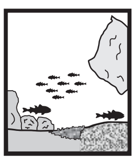


Geographic distribution of Nebulous Snailfish (*Liparis bathyarcticus*) within Arctic Outer Continental Shelf Planning Areas [6], based on review of published literature and specimens from historical and recent collections [1, 2].

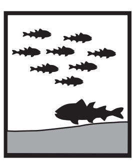
Depth Range: 8–510 m [2], typically 50–300 m [1].



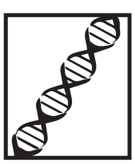
Benthic and reproductive distribution of Nebulous Snailfish (*Liparis bathyarcticus*).



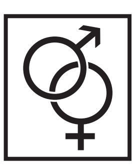
Habitats and Life History
Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Likely benthic, like other *Liparis* species [1, 9].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Likely pelagic, like other *Liparis* species [1, 9].
Juveniles—Age and size: Unknown. Habitat: Benthic [1, 9].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 27 cm [8]. Habitat: Benthic [1, 9].
Substrate—Unknown.
Physical/chemical—Temperature: -1.6–3.7 °C [2]. Salinity: Marine [2].



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

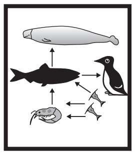


Populations or Stocks
There have been no studies.

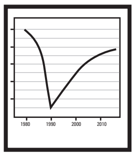


Reproduction
Mode—Separate sexes, oviparous [10].
Spawning season—Unknown.
Fecundity—Unknown.

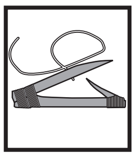
Food and Feeding
Food items—Plankton and benthic crustaceans (euphausiids, shrimps, gammarids) for juveniles. Fishes and large decapods for adults [8].
Trophic level—3.29 standard error 0.46 (based on information for *L. gibbus*) [11].



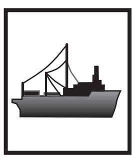
Biological Interactions
Predators—Snailfishes outside U.S. Chukchi and Beaufort Seas eaten by such predators as larger fishes and seals [12–15].
Competitors—Likely a range of benthic fish species, including various flatfishes, sculpins, poachers, and eelpouts.



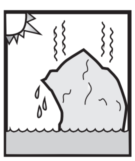
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (Fecundity=4,000-12,000) (based on information for *L. gibbus*) [11].



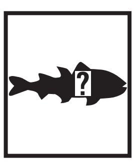
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, Nebulous Snailfish are not commercially harvested.



Potential Effects of Climate Change
As the Nebulous Snailfish are a predominantly Arctic species [1], a northward shift is distribution due to climate warming would be expected.



Areas for Future Research [B]

Little is known about the ecology and life history 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

Chernova, N.V., 2008, Systematics and phylogeny of fish of the genus *Liparis* (Liparidae, Scorpaeniformes): Journal of Ichthyology, v. 48, no. 10, p. 831–852. [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. [1]

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. [8]

Bibliography

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., 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. Chernova, N.V., 2008, Systematics and phylogeny of fish of the genus *Liparis* (Liparidae, Scorpaeniformes): Journal of Ichthyology, v. 48, no. 10, p. 831–852.
4. Parr, A.E., 1931 A study of subspecies and racial variations in *Liparis liparis* and *Liparis koefoedi*, n. sp., in northern Europe and the European Arctic waters: Bergens Museums Bibliothek, v. 6, p. 1–53.
5. Eastman, J.T., Hikida, R.S., and DeVries, A.L., 1994, Buoyancy studies and microscopy of skin and subdermal extracellular matrix of the Antarctic snailfish, *Paraliparis devriesi*: Journal of Morphology, v. 220, no. 1, p. 85–101.
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. Mecklenburg, C.W., Mecklenburg, T.A., and Thorsteinson, L.K., 2002, Fishes of Alaska: Bethesda, Maryland, American Fisheries Society, 1,116 p.
8. 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.
9. Able, K.W., and McAllister, D.E., 1980, Revision of the snailfish genus *Liparis* from Arctic Canada: Ottawa, Department of Fisheries and Oceans, Canadian Bulletin of Fisheries and Aquatic Sciences 208.
10. 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.
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. 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.
13. Wakefield, W.W., 1984, Feeding relationships within assemblages of nearshore and mid-continental shelf benthic fishes off Oregon: Corvallis, Oregon State University, Master's thesis, 102 p.
14. Frost, K.J., and Lowry, L.F., 1980, Feeding of ribbon seals (*Phoca fasciata*) in the Bering Sea in spring: Canadian Journal of Zoology, v. 58, no. 9, p. 1,601–1,607.
15. Sinclair, E.H., and Zeppelin, T.K., 2002, Seasonal and spatial differences in diet in the western stock of Steller sea lions (*Eumetopias jubatus*): Journal of Mammology, v. 83, no. 4, p. 973–990.

Gelatinous Seasnail (*Liparis fabricii*)

Krøyer, 1847

Family Liparidae

Gelatinous Seasnail (*Liparis fabricii*), 94 mm TL, western Chukchi Sea, 2004. Photograph by C.W. Mecklenburg, Point Stephens Research.

Note: *Liparis fabricii was proposed to be a species complex* [1], *but molecular analysis of specimens caught in the U.S. Chukchi and Beaufort Seas to Davis Strait in the Atlantic indicates they are the same species* [2].

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

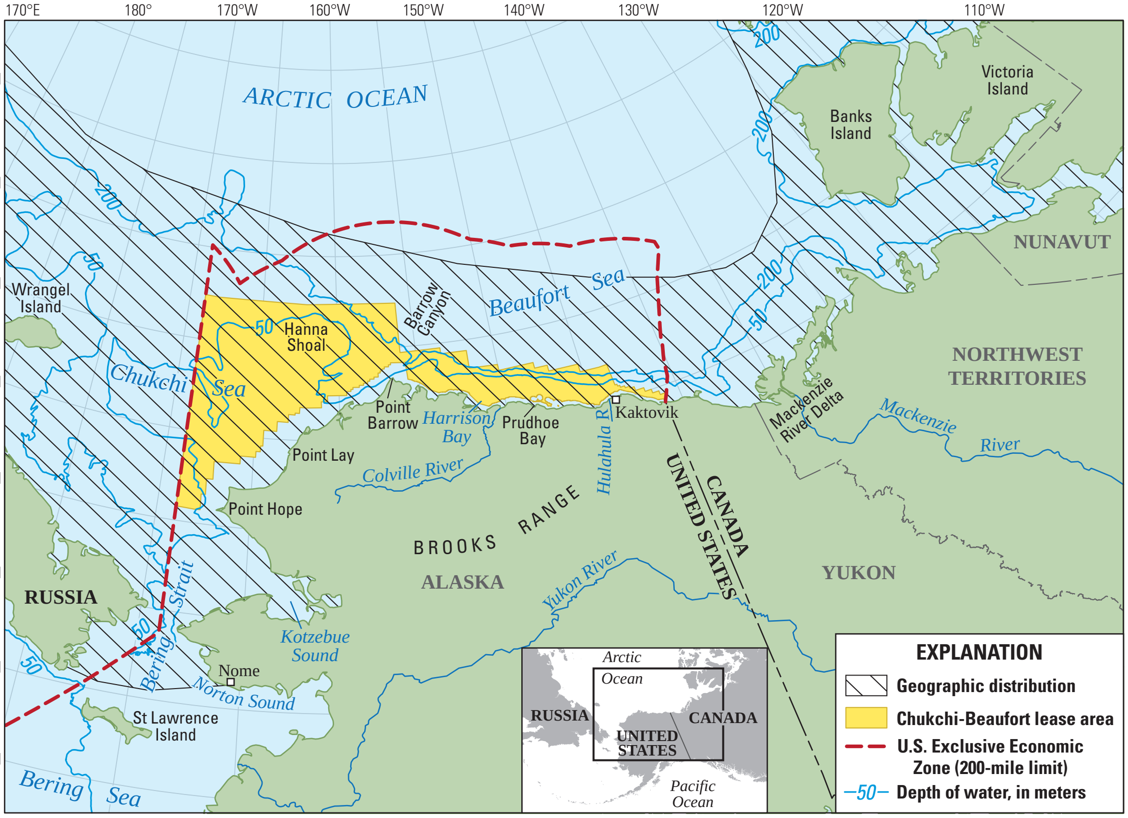
Ecological Role: Unknown, as its abundance in the Arctic is poorly understood.

Physical Description/Attributes: Tadpole shaped, soft and covered with gelatinous tissue. Head and body uniformly brown, gray, or black with a black peritoneum. For specific diagnostic characteristics, see *Fishes of Alaska* (Meckenburg and others, 2002, p. 592) [3]. Swim bladder: Absent [4]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Chukchi and Beaufort Seas, as far north as the continental slope of the Chukchi Sea outside the U.S. 200-mile limit* [2]. Elsewhere in Alaska, southward in Bering Sea to a point south of Bering Strait west of Cape Rodney and well north of St. Lawrence Island at 64°30'N, 170°26'W. Worldwide, circumpolar in the Arctic, northward to northern Ellesmere Island, southward to Georges Bank, Canada, and Iceland [2].

Relative Abundance: *Common, usually caught at one to several stations offshore on research cruises in the U.S. Chukchi and Beaufort Seas but not in great numbers* [2, 3, 7]; relatively *large catches have been made well offshore of Point Barrow* [8] as well as off Herschel Island, Canada [9].

Gelatinous Seasnail
Liparis fabricii

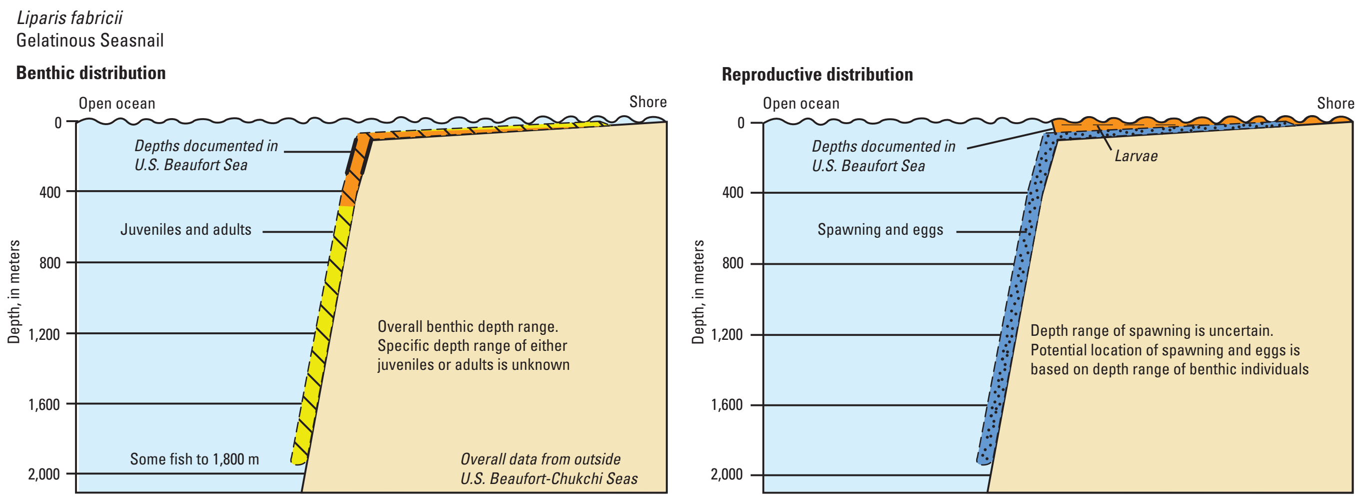


Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

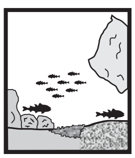
0 50 100 200 MILES
0 50 100 200 KILOMETERS

Geographic distribution of Gelatinous Seasnail (*Liparis fabricii*) within Arctic Outer Continental Shelf Planning Areas [5] based on review of published literature and specimens from historical and recent collections [2, 3, 6, 7].

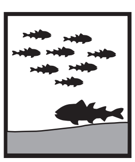
Depth Range: Less than 13 m [10] to 1,880 m, typically at 100–300 m [2, 3]. In 2004, one adult was taken at 72 m in the northwestern (Russian) Chukchi Sea [7] *and a few larvae were taken from surface to 81 m in the western and eastern Chukchi Sea* [11]. *Adults have been taken between 40–500 m in U.S. Beaufort Sea* [12].



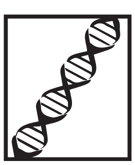
Benthic and reproductive distribution of Gelatinous Seasnail (*Liparis fabricii*).



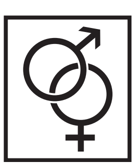
Habitats and Life History
Eggs—Size: 2.1–2.7 mm for mature eggs [13]. Ovaries can contain three sizes of eggs [13]. Time to hatching: Unknown. Habitat: Likely benthic, like other *Liparis* species [2].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: At least greater than 38 mm SL (42 mm TL) in Canadian Beaufort Sea [14]. Days to juvenile transformation: About one year [15]. Habitat: Pelagic [14]. *A few larvae were taken in midwaters in U.S. Chukchi Sea* [11].
Juveniles—Age and size: Unknown. Habitat: Benthic and pelagic [3].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 21 cm TL [15]. Habitat: Benthic and water-column species, often found swimming among ice floes [2, 16, 17]. Nearshore to beneath pack ice over bottom depths of more than 2 km. Usually more than 20 km offshore [18]. Attaches to laminarian fronds [10].
Substrate—Mud or mixed mud, sand, or detritus bottom [16].
Physical/chemical—Temperature: -1.9–3.7 °C [6, 10, 19], prefers less than 0 °C [15]. Salinity: Marine and estuarine [16, 17], but prefers 30–34 ppt [15].



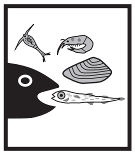
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Swims and feeds up to 1 m above sea bottom [10].



Populations or Stocks
There have been no studies.



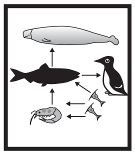
Reproduction
Mode—Oviparous; sexes are separate [20].
Spawning season—September and October in Russian Arctic [13].
Fecundity—485–735 large and medium-sized eggs per female [13].



Food and Feeding

Food items—Benthic and pelagic crustaceans (for example, mysids, euphausiids, amphipods, and shrimps), polychaetes, and fishes [13, 15, 16].

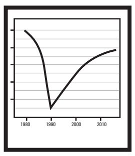
Trophic level—3.33 standard error 0.42 [21].



Biological Interactions

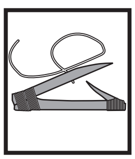
Predators—Snailfishes outside U.S. Chukchi and Beaufort Seas eaten by such predators as larger fishes and seals [22–25].

Competitors—Likely a range of benthic fish species, including various flatfishes, sculpins, poachers, and eelpouts.



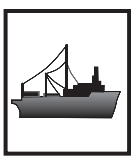
Resilience

Medium, minimum population doubling time: 1.4–4.4 years (Assuming t_{max}>3) [21].



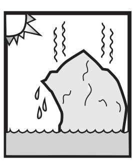
Traditional and Cultural Importance

None reported.



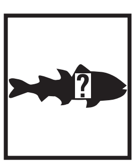
Commercial Fisheries

Currently, Gelatinous Seasnail are not commercially harvested.



Potential Effects of Climate Change

Because the Gelatinous Seasnail are an Arctic species [2] climate warming might result in a northward shift in distribution and potential decreased abundance.



Areas for Future Research [B]

Little is known about the ecology and life history 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

Able, K.W., and McAllister, D.E., 1980, Revision of the snailfish genus *Liparis* from Arctic Canada: Ottawa, Department of Fisheries and Oceans, Canadian Bulletin of Fisheries and Aquatic Sciences 208. [16]

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]

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]

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. [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. [7]

Bibliography

1. Chernova, N.V., 2008, Systematics and phylogeny of fish of the genus *Liparis* (Liparidae, Scorpaeniformes): Journal of Ichthyology, v. 48, no. 10, p. 831–852.

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

4. Eastman, J.T., Hikida, R.S., and DeVries, A.L., 1994, Buoyancy studies and microscopy of skin and subdermal extracellular matrix of the Antarctic snailfish, *Paraliparis devriesi*: Journal of Morphology, v. 220, no. 1, p. 85–101.

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. 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.

7. 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.

8. Rand, K.M., and Logerwell, E.A., 2011, The first demersal trawl survey of benthic fish and invertebrates in the Beaufort Sea since the late 1970s: Polar Biology, v. 34, no. 4, p. 475–488.

9. McAllister, D.E., 1963, Fishes of the 1960 “Salvelinus” program from western Arctic Canada: National Museum of Canada Bulletin, no.185, p. 17–39.

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.

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. Logerwell, E.A., and Rand, K.M., 2010, Beaufort Sea marine fish monitoring 2008—Pilot survey and test of hypotheses: Seattle, Washington, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Fisheries Science Center, Final Report, BOEMRE 2010-048, 262 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. Majewski, A.R., Sareault, J.E., and Reist, J., 2006, Fish catch data from offshore sites in the Mackenzie River estuary and Beaufort Sea during the open water season, August 2004 aboard the CCGS Nahidik: Winnipeg, Manitoba, Fisheries and Oceans Canada, no. 2771, 42 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. Able, K.W., and McAllister, D.E., 1980, Revision of the snailfish genus *Liparis* from Arctic Canada: Ottawa, Department of Fisheries and Oceans, Canadian Bulletin of Fisheries and Aquatic Sciences 208.

17. Morin, R., and Dodson, J.J., 1986, The ecology of fishes in James Bay, Hudson Bay and Hudson Strait, *in* Martini, I.P., ed., Canadian Inland Seas: Amsterdam, Elsevier Science Publishers B.V., p. 293–323.

18. Mecklenburg, C.W., and Mecklenburg, T.A., 2011, Gelatinous Seasnail—*Liparis fabricii* Krøyer, 1847: Arctic Ocean Diversity Web site, accessed May 2011, at http://www.arcodiv.org/Fish/Liparis_fabricii.html.

19. 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.

20. 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.

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

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. Wakefield, W.W., 1984, Feeding relationships within assemblages of nearshore and mid-continental shelf benthic fishes off Oregon: Corvallis, Oregon State University, Master's thesis, 102 p.

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25. Sinclair, E.H., and Zeppelin, T.K., 2002, Seasonal and spatial differences in diet in the western stock of Steller sea lions (*Eumetopias jubatus*): Journal of Mammology, v. 83, no. 4, p. 973–990.

Variegated Snailfish (*Liparis gibbus*)

Bean, 1881

Family Liparidae

Variegated Snailfish (*Liparis gibbus*), 183 mm TL, Bering Strait 2007. Photograph by C.W. Mecklenburg, Point Stephens Research.

Note on taxonomy: *Snailfishes in the genus* Liparis *can be difficult to distinguish from one another and* L. gibbus *has often been confused with other species, including* L. bathyarcticus *and* L. tunicatus, *making much of the available information concerning these species uncertain* [1].

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

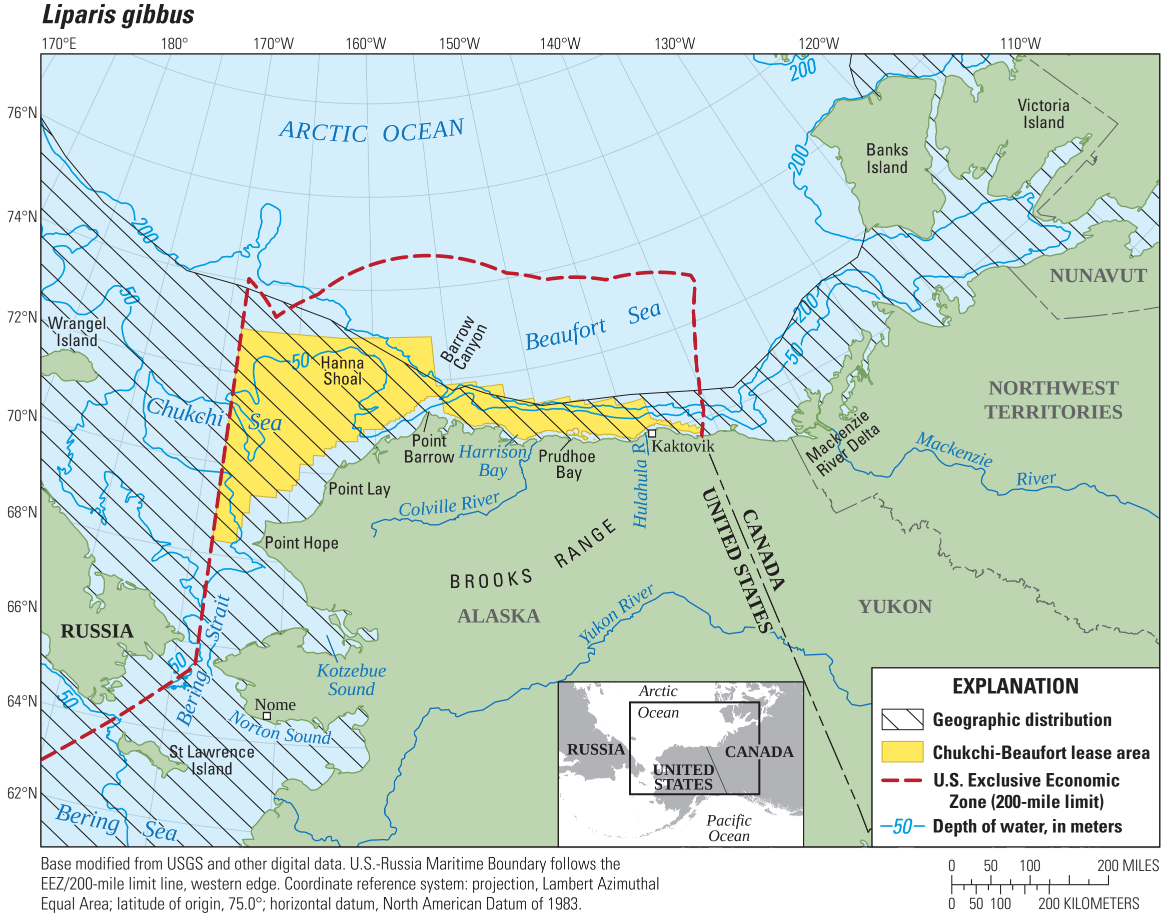
Ecological Role: It is particularly difficult to differentiate among snailfish species when found as prey. However, snailfishes are generally common and are likely of some ecological importance in the Arctic. Larval stages may be seasonally important in coastal food webs.

Physical Description/Attributes: Body tadpole shaped, soft, and covered with gelatinous tissue; and pink, with tan stripes, tan with black fin margins, or brownish with blackish spots. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 585) [2]. Swim bladder: Absent [3]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Chukchi and Beaufort Seas* [1]. Elsewhere in Alaska, in eastern Bering Sea, along Aleutian Islands, and in Gulf of Alaska south to northern British Columbia, Canada. Worldwide, circumpolar in Arctic Ocean. There are unconfirmed reports from southeastern Kamchatka Peninsula, northern Kuril Islands, Russia, and Commander Islands [1].

Relative Abundance: *Reported to be common in northeastern U.S. Chukchi Sea* [6], *but this is uncertain because of confusion with* L. bathyarcticus, *which may actually be the more abundant species in the study area* [5]. Common in eastern Bering Sea [7].

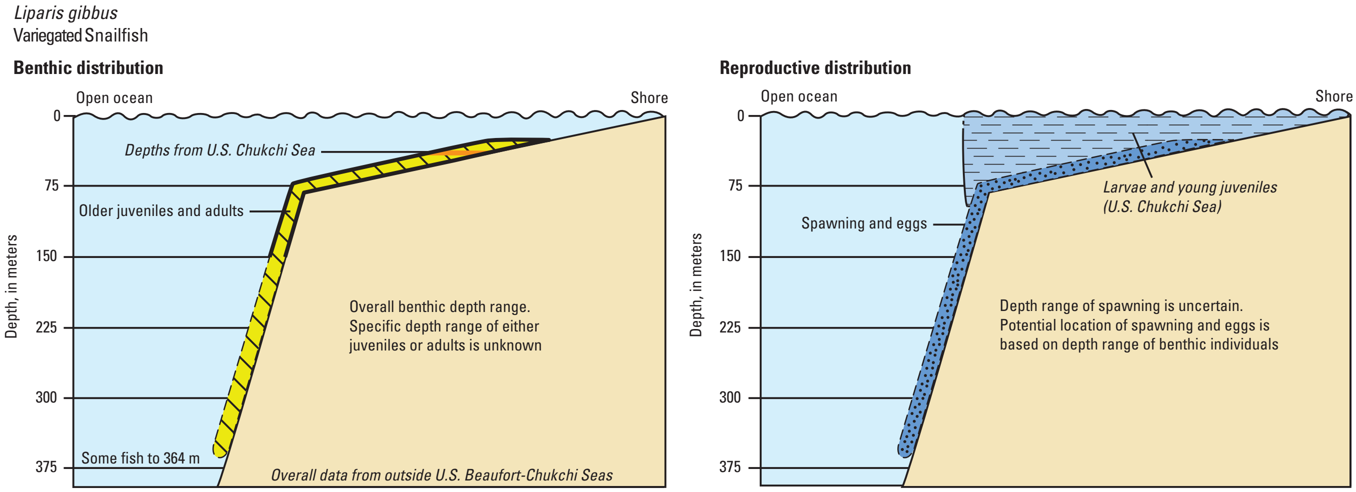
Variegated Snailfish
Liparis gibbus



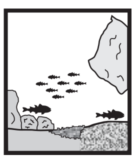
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Variegated Snailfish (*Liparis gibbus*) within Arctic Outer Continental Shelf Planning Areas [4] based on review of published literature and specimens from historical and recent collections [1, 5].

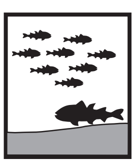
Depth Range: 25–364 m, mainly 150 m or less [1, 8]. *Three adults were taken between 48–54 m in area between Bering Strait and southern Chukchi Sea* [9]. Larvae and young juveniles were taken in midwaters of central and northern Chukchi Sea between 22–81 m and possibly as shallow as the surface [9].



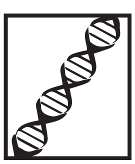
Benthic and reproductive distribution of Variegated Snailfish (*Liparis gibbus*).



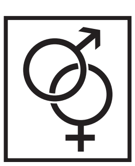
Habitats and Life History
Eggs—Size: Unknown. Time to hatching: Unknown. Habitat: Likely benthic, like other *Liparis* species [1].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: 15.2 mm SL [10]. Days to juvenile transformation: Unknown. Habitat: Pelagic [10].
Juveniles—Age and size: Unknown. Habitat: Pelagic to benthic [1, 10].
Adults—Age and size at first maturity: Unknown. Females appear to be larger at age than males [11]. Maximum age: About 6 years for both males and females. A 250 mm TL fish (much smaller than this species' maximum length) was 6 years [11]. Maximum size: 52.4 cm TL [10], but because the authors included *L. bathyacrticus* in the synonymy of *L. gibbus*, this measurement could instead pertain to *L. bathyarcticus*.
Habitat: Primarily benthic [10, 12] and possibly benthopelagic in that some large fish have been taken in midwater trawls [10].
Substrate—Soft sea floors and occasionally over rocks [10, 12].
Physical/chemical—Temperature: 0.8–10.5 °C [12, 13]. Salinity: Marine [10, 12].



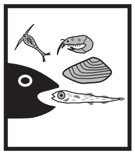
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Unknown.



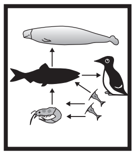
Populations or Stocks
There have been no studies.



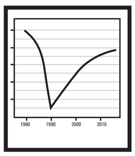
Reproduction
Mode—Separate sexes, oviparous [14].
Spawning season—Perhaps summer based on capture of small larvae in summer in St. Lawrence estuary. However, no females taken in Canadian Arctic in spring or summer had mature ovaries [10].
Fecundity—Unknown.



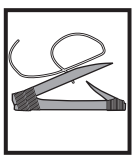
Food and Feeding
Food items—Both benthic and epibenthic, and occasionally water column prey. Crustaceans (for example, gammarid and caprellid amphipods, copepods, shrimps, and crabs), polychaetes, pteropods, and small fishes [11, 15, 16].
Trophic level—3.29 standard error 0.46 [17].



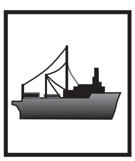
Biological Interactions
Predators—Atlantic Cod (*Gadus morhua*) in Hudson Bay [10]. Snailfishes outside U.S. Chukchi and Beaufort Seas eaten by such predators as larger fishes and seals (18–21].
Competitors—Likely a range of benthic fish species, including various flatfishes, sculpins, poachers, and eelpouts.



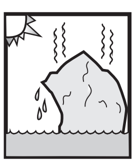
Resilience
Medium, minimum population doubling time: 1.4–4.4 years (Fecundity=4,000–12,000) [17].



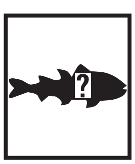
Traditional and Cultural Importance
None reported.



Commercial Fisheries
Currently, Variegated Snailfish are not commercially harvested.



Potential Effects of Climate Change
The Variegated Snailfish are a predominantly Arctic species [1] and it is possible that climate warming could cause a retraction northward of its southern populations. If industrial fishing operations ever develop in the offshore marine, the species would be vulnerable to bycatch. Changes in energy transfers through decoupling of benthic-pelagic energy pathways could affect the availability of benthic foods.



Areas for Future Research [B]
Little is known about the ecology and life history 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. It is common enough in most habitats to be considered as a potential indicator species in long term monitoring.

References Cited

Able, K.W., and McAllister, D.E., 1980, Revision of the snailfish genus *Liparis* from Arctic Canada: Ottawa, Department of Fisheries and Oceans, Canadian Bulletin of Fisheries and Aquatic Sciences 208. [10]

Falk-Petersen, I.-B., Frivoll, V., Gulliksen, B., Haug, T., and Vader, W., 1988, Age/size relations and food of two snailfishes, *Liparis gibbus* and *Careproctus reinhardtii* (Teleostei, Liparididae) from Spitsbergen coastal waters: Polar Biology, v. 8, no. 5, p. 353–358. [11]

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. [1]

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. [12]

Bibliography

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

3. Eastman, J.T., Hikida, R.S., and DeVries, A.L., 1994, Buoyancy studies and microscopy of skin and subdermal extracellular matrix of the Antarctic snailfish, *Paraliparis devriesi*: Journal of Morphology, v. 220, no. 1, p. 85–101.

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. 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.

9. 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.

10. Able, K.W., and McAllister, D.E., 1980, Revision of the snailfish genus *Liparis* from Arctic Canada: Ottawa, Department of Fisheries and Oceans, Canadian Bulletin of Fisheries and Aquatic Sciences 208.

11. Falk-Petersen, I.-B., Frivoll, V., Gulliksen, B., Haug, T., and Vader, W., 1988, Age/size relations and food of two snailfishes, *Liparis gibbus* and *Careproctus reinhardtii* (Teleostei, Liparididae) from Spitsbergen coastal waters: Polar Biology, v. 8, no. 5, p. 353–358.

12. 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.

13. 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.

14. 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.

15. Atkinson, E.G., and Percy, J.A., 1992, Diet comparison among demersal marine fish from the Canadian Arctic: Polar Biology, v. 11, no. 8, p. 567–573.

16. 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.

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

18. 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.

19. Wakefield, W.W., 1984, Feeding relationships within assemblages of nearshore and mid-continental shelf benthic fishes off Oregon: Corvallis, Oregon State University, Master's thesis, 102 p.

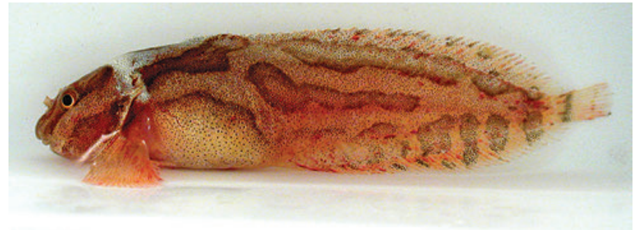
20. Frost, K.J., and Lowry, L.F., 1980, Feeding of ribbon seals (*Phoca fasciata*) in the Bering Sea in spring: Canadian Journal of Zoology, v. 58, no. 9, p. 1,601–1,607.

21. Sinclair, E.H., and Zeppelin, T.K., 2002, Seasonal and spatial differences in diet in the western stock of Steller sea lions (*Eumetopias jubatus*): Journal of Mammology, v. 83, no. 4, p. 973–990.

Kelp Snailfish (*Liparis tunicatus*)

(Reinhardt, 1836)

Family Liparidae



Kelp Snailfish (*Liparis tunicatus*), 76 mm TL, western Chukchi Sea, 2004. Photograph by C.W. Mecklenburg, Point Stephens Research.

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

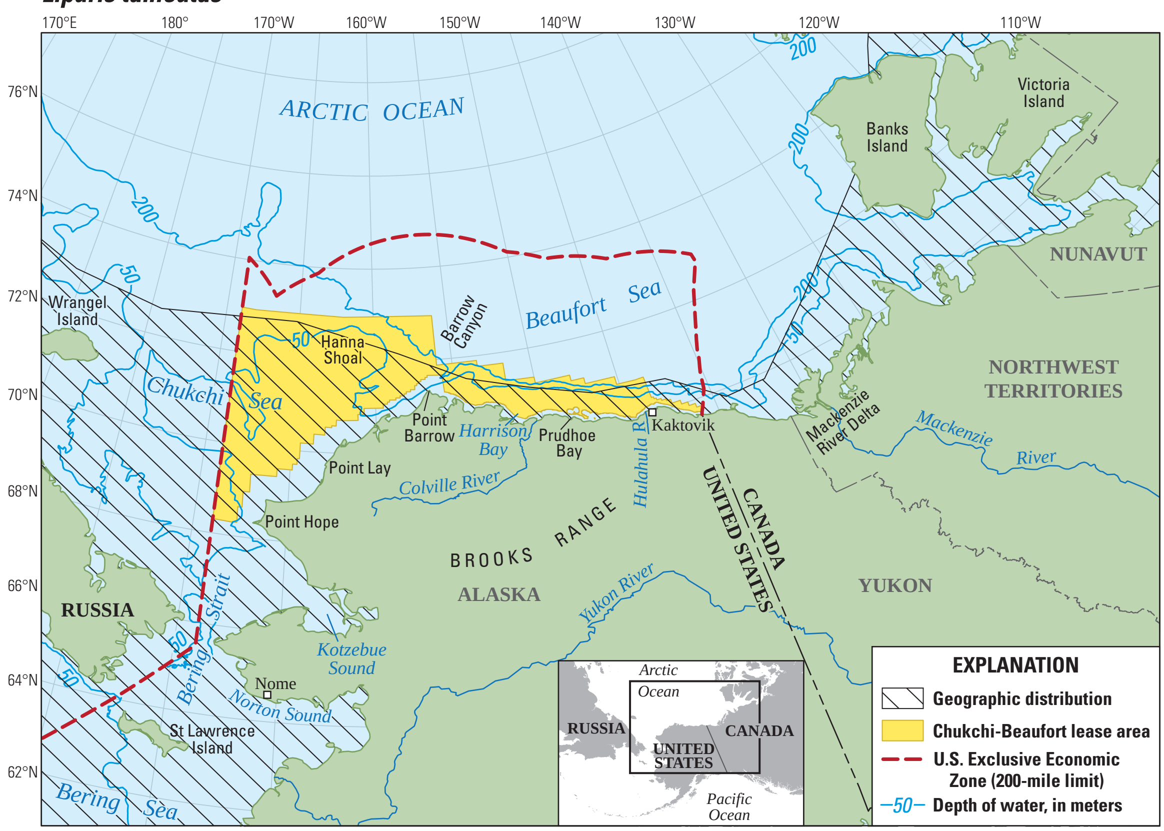
Ecological Role: Unknown. The life history and ecology of this species and its roles in regional ecosystems and food webs are poorly understood.

Physical Description/Attributes: Body tadpole shaped, soft, and covered with gelatinous tissue. Yellowish brown, plain or patterned with dark brown blotches and bars or stripes, and usually with dark bars on caudal fin. For specific diagnostic characteristics, see *Fishes of Alaska* (Mecklenburg and others, 2002, p. 589) [1]. Swim bladder: Absent [2]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *U.S. Chukchi and Beaufort Seas (as far north as 73°1'N, 174°7'W* [3]. Elsewhere in Alaska, to northern Bering Sea south of St. Lawrence Island. Worldwide, circumpolar, to as far north as 82°29'N, 62°15'W at Ellesmere Island, Canada [4]; and in Gulf of Anadyr, Russia [1].

Relative Abundance: *Patchily abundant (common) in U.S. Chukchi and Beaufort Seas* [6–8].

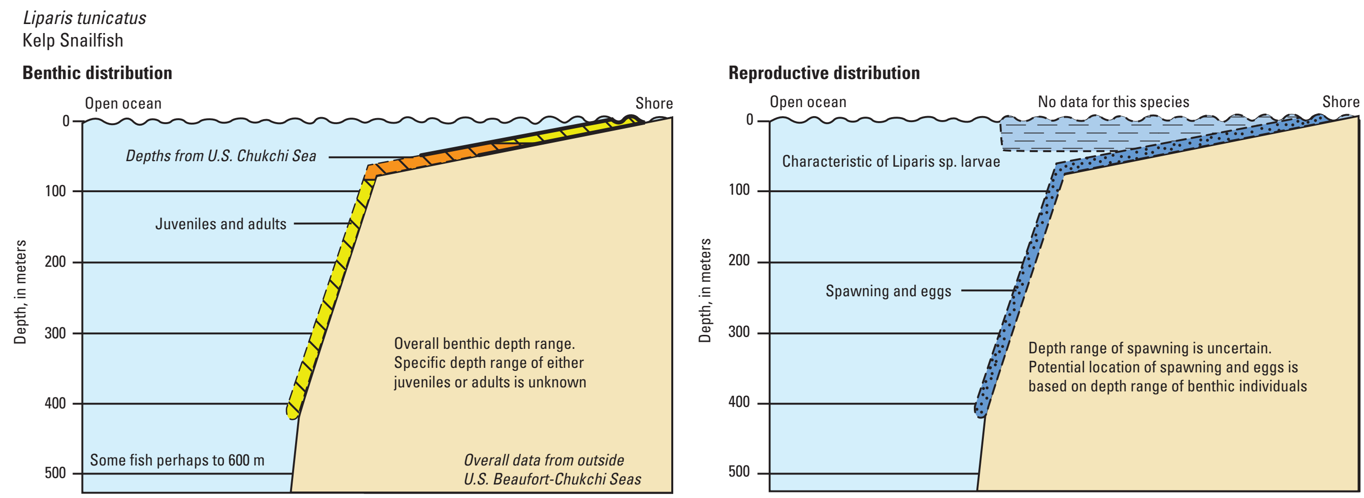
Kelp Snailfish
Liparis tunicatus



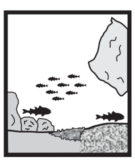
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution of Kelp Snailfish (*Liparis tunicatus*) within Arctic Outer Continental Shelf Planning Areas [5] based on review of published literature and specimens from historical and recent collections [3, 4].

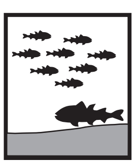
Depth Range: Intertidal, including tide pools, to 415 m [4] and perhaps to 600 m [9]. Typically shallower than 50 m [4]. In both Russian *and U.S. Chukchi Sea, 18 adults and large juveniles (68–110 mm TL) and 5 small juveniles (31–35 mm TL) were taken on the bottom between 34–72 m* [10] *and a juvenile was taken in midwaters between 51 m and the surface* [11].



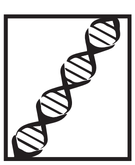
Benthic and reproductive distribution of Kelp Snailfish (*Liparis tunicatus*).



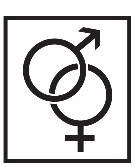
Habitats and Life History
Eggs—Size: Unknown. Time to hatching: Unknown.
Habitat: Likely benthic, like other *Liparis* species [4].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: At least 36 mm TL [12]. Days to juvenile transformation: Unknown. Habitat: Pelagic [12].
Juveniles—Age and size: Unknown. Habitat: Pelagic to benthopelagic [12].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 14.3 cm TL [3]. Habitat: Benthic to benthopelagic [1, 13]. Commonly found attached to algal blades and occasionally among rocks [14–16].
Substrate—Rock, sand, and mud [1, 10].
Physical/chemical—Temperature: -1.9–2.8 °C [10, 14]. Salinity: Marine [10, 14]; 32.41–33.52 salinity in the Chukchi Sea [10].



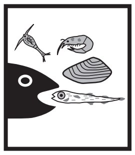
Behavior
Diel—Both juveniles and adults swim into surface waters at night [13].
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—Unknown.
Feeding—Despite their association with kelp, they have been observed feeding in the water column as much as 1 m above the substrate [15].



Populations or Stocks
There have been no studies.

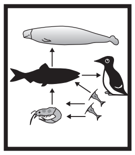


Reproduction
Mode—Unknown.
Spawning season—Unknown.
Fecundity—Unknown.



Food and Feeding

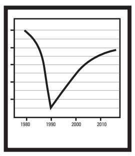
Food items—Almost entirely benthic and epibenthic crustaceans, including gammarid and lysianassid amphipods, cumaceans, cyclopoid copepods, and mysids in Canadian Arctic [17]. **Trophic level—**3.5 standard error 0.50 [18].



Biological Interactions

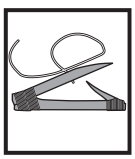
Predators—Seals in the Canadian Arctic [19]. Unknown. Snailfishes outside U.S. Chukchi and Beaufort Seas eaten by such predators as larger fishes and seals (20–23].

Competitors—Likely a range of benthic fish species, including various flatfishes, sculpins, poachers, and eelpouts.



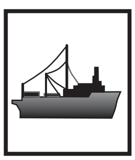
Resilience

Medium, minimum population doubling time: 1.4–4.4 years (Assuming t_{max} = 3–10) [18].



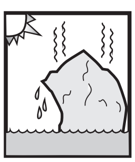
Traditional and Cultural Importance

None reported.



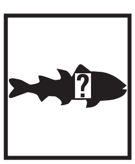
Commercial Fisheries

Currently, Kelp Snailfish are not commercially harvested.



Potential Effects of Climate Change

The Kelp Snailfish are a predominantly Arctic species [4] and climate warming could be expected to shift distributions to the north and extirpate more southern populations.



Areas for Future Research [B]

Little is known about the 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

Byers, T., and Prach, R.W., 1988, Diet of the kelp snailfish, *Liparis tunicatus*, in Jones Sound, Canadian High Arctic: The Canadian Field-Naturalist, v. 102, no. 2, p. 242–245. [17]

Majewski, A.R., Sareault, J.E., and Reist, J., 2006, Fish catch data from offshore sites in the Mackenzie River estuary and Beaufort Sea during the open water season, August 2004 aboard the CCGS Nahidik: Winnipeg, Manitoba, Fisheries and Oceans Canada, no. 2771, 42 p. [12]

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

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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. [10]

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. Eastman, J.T., Hikida, R.S., and DeVries, A.L., 1994, Buoyancy studies and microscopy of skin and subdermal extracellular matrix of the Antarctic snailfish, *Paraliparis devriesi*: Journal of Morphology, v. 220, no. 1, p. 85–101.
3. 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.
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. McAllister, D.E., 1963, Fishes of the 1960 “Salvelinus” program from western Arctic Canada: National Museum of Canada Bulletin, no.185, p. 17–39.
7. 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.
8. Wiswar, D.W., and Frugé, D.J., 2006, Fisheries investigations in western Camden Bay, Arctic National Wildlife Refuge, Alaska, 1987: Alaska Fisheries Data Series, U.S. Fish and Wildlife Service, 2006-10, 49 p.
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. 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.
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, no. 1–2, p. 57–70.

12. Majewski, A.R., Sareault, J.E., and Reist, J., 2006, Fish catch data from offshore sites in the Mackenzie River estuary and Beaufort Sea during the open water season, August 2004 aboard the CCGS Nahidik: Winnipeg, Manitoba, Fisheries and Oceans Canada, no. 2771, 42 p.

13. 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.

14. 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.

15. 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.

16. Dunton, K.H., and Schonberg, S.V., 2000, The benthic faunal assemblage of the boulder patch kelp community, *in* Truett, J.C., and Johnson, S.R., eds., The natural history of an Arctic oil field—Development and the biota: San Diego, Academic Press, p. 371–397.

17. Byers, T., and Prach, R.W., 1988, Diet of the kelp snailfish, *Liparis tunicatus*, in Jones Sound, Canadian High Arctic: The Canadian Field-Naturalist, v. 102, no. 2, p. 242–245.

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

19. Able, K.W., and McAllister, D.E., 1980, Revision of the snailfish genus *Liparis* from Arctic Canada: Ottawa, Department of Fisheries and Oceans, Canadian Bulletin of Fisheries and Aquatic Sciences 208.

20. 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.

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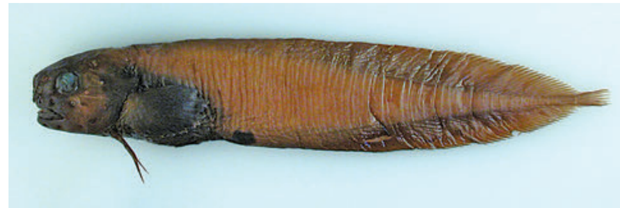
22. Frost, K.J., and Lowry, L.F., 1980, Feeding of ribbon seals (*Phoca fasciata*) in the Bering Sea in spring: Canadian Journal of Zoology, v. 58, no. 9, p. 1,601–1,607.

23. Sinclair, E.H., and Zeppelin, T.K., 2002, Seasonal and spatial differences in diet in the western stock of Steller sea lions (*Eumetopias jubatus*): Journal of Mammology, v. 83, no. 4, p. 973–990.

Black Seasnail (*Paraliparis bathybius*)

(Collett, 1879)

Family Liparidae



Black Seasnail (*Paraliparis bathybius*), 198 mm TL, 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 Chukchi and Beaufort Seas.*

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

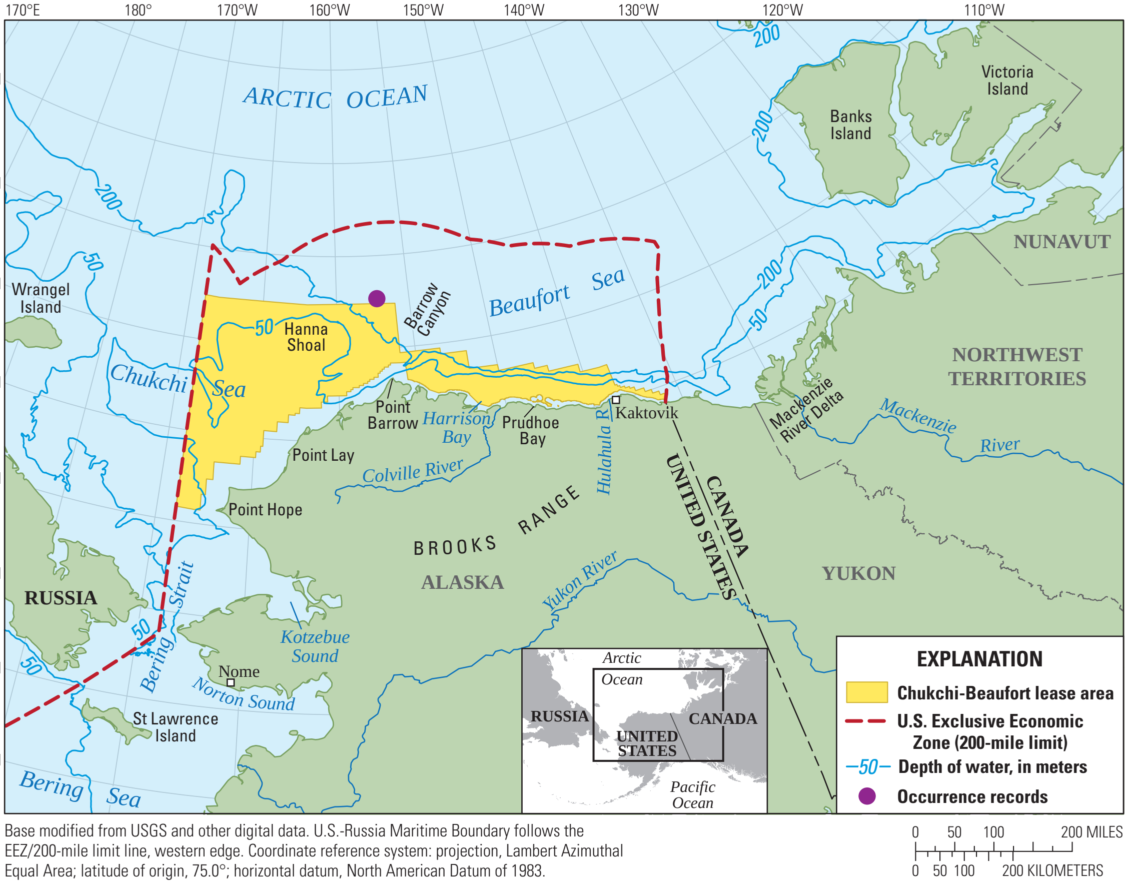
Ecological Role: Not important in shelf ecosystems of the U.S. Chukchi and Beaufort Seas. Appears to be a deeper water species, of low abundance, and limited significance to regional food webs and energy flows.

Physical Description/Attributes: Elongate, soft-bodied snailfish without adhesive pelvic disk, and with smooth loose skin and brownish black body and fins [1]. For specific diagnostic characteristics, see Coad and others, (1995, page 111) [1]. Swim bladder: Absent [2]. Antifreeze glycoproteins in blood serum: Unknown.

Range: *One record from the U.S. Chukchi Sea* [3]. Deep continental slope and basin waters offshore of U.S. Chukchi and Beaufort Seas. Worldwide, in Norwegian and Greenland Seas, Baffin Bay, central Arctic Basin, Canada Basin north of Alaska [3].

Relative Abundance: *Probably common in deep slope and basin waters adjacent to the U.S. Chukchi and Beaufort Seas.* Elsewhere, common off Greenland and Jan Mayen [3, 6]. Occurrence is rare in shelf habitats in the U.S. Chukchi and Beaufort Seas.

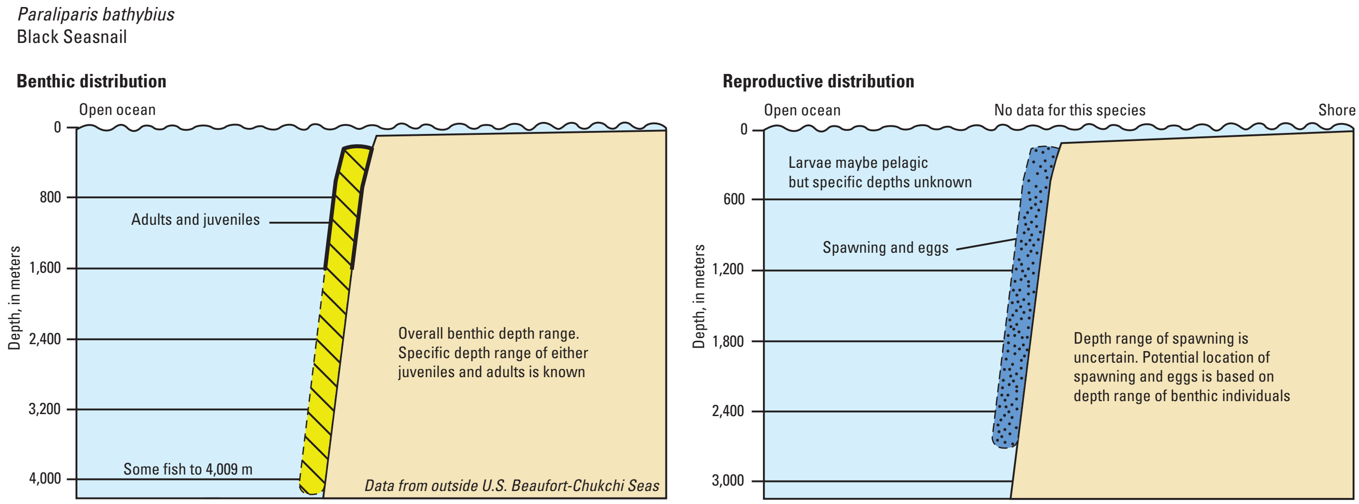
Black Seasnail
Paraliparis bathybius



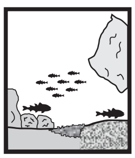
Base modified from USGS and other digital data. U.S.-Russia Maritime Boundary follows the EEZ/200-mile limit line, western edge. Coordinate reference system: projection, Lambert Azimuthal Equal Area; latitude of origin, 75.0°; horizontal datum, North American Datum of 1983.

Geographic distribution within 2008–09 lease areas [4] of Black Seasnail (*Paraliparis bathybius*) based on review of published literature and specimens from historical and recent collections [3, 5].

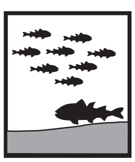
Depth Range: 545 m [3] to about 2,824 m [5], common at 545–1,600 m off northern Greenland [3].



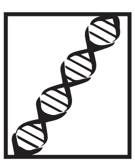
Benthic and reproductive distribution of Black Seasnail (*Paraliparis bathybius*).



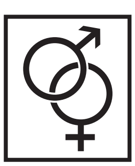
Habitats and Life History
Eggs—Size: 4 mm [6]. Time to hatching: Unknown. Habitat: Likely benthic, like those of other *Paraliparis* species [7].
Larvae—Size at hatching: Unknown. Size at juvenile transformation: Unknown. Days to juvenile transformation: Unknown. Habitat: Pelagic, like those of other *Paraliparis* species [7].
Juveniles—Age and size: Unknown. Habitat: Benthic to benthopelagic [3, 7].
Adults—Age and size at first maturity: Unknown. Maximum age: Unknown. Maximum size: 27 cm [8]. Habitat: Benthic to benthopelagic [3, 7].
Substrate—Unknown.
Physical/chemical—Temperature: -0.1–0.9 °C [5]. Salinity: Marine [7].



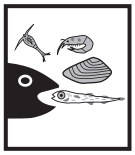
Behavior
Diel—Unknown.
Seasonal—Unknown.
Reproductive—Unknown.
Schooling—May form large schools to spawn [7].
Feeding—Unknown.



Populations or Stocks
There have been no studies.

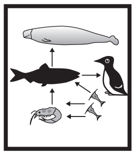


Reproduction
Mode—Oviparous; sexes are separate [9].
Spawning season—June through August off Russia [7].
Fecundity—100–434 eggs [7].



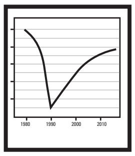
Food and Feeding

Food items—Mostly pelagic hyperiid amphipods and mysids as well as benthic gastropods [7, 10].
Trophic level—3.28 standard error 0.50 [11].



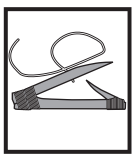
Biological Interactions

Predators—Unknown. Snailfishes outside U.S. Chukchi and Beaufort Seas eaten by such predators as larger fishes and seals [12–15].
Competitors—Likely a range of deep water benthic fish species, including various flatfishes, sculpins, poachers, and eelpouts.



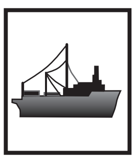
Resilience

High, minimum population doubling time: less than 15 months (Preliminary *K* or Fecundity) [11].



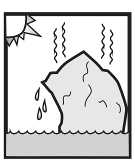
Traditional and Cultural Importance

None reported.



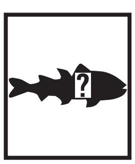
Commercial Fisheries

Currently, Black Seasnail are not commercially harvested.



Potential Effects of Climate Change

The Black Seasnail are an endemic Arctic species found in deeper and less studied waters of the region [3]. There is not enough information to make an informed assessment about potential climate 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]

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

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. [6]

Bibliography

1. Coad, B.W., Waszczuk, H., and Labignan, I., 1995, Encyclopedia of Canadian fishes: Canadian Museum of Nature and Canadian Sportfishing Productions, Inc., 928 p.
2. Eastman, J.T., Hikida, R.S., and DeVries, A.L., 1994, Buoyancy studies and microscopy of skin and subdermal extracellular matrix of the Antarctic snailfish, *Paraliparis devriesi*: Journal of Morphology, v. 220, no. 1, p. 85–101.
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. 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. 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. Wienerroither, R., Nedreaas, K., Uiblein, F., Christiansen, J., Byrkjedal, I., and Karamushko, O., 2011, The marine fishes of Jan Mayen Island, NE Atlantic—Past and present: Marine Biodiversity, v. 41, no. 3, p. 395–411
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. Bjelland, O., Bergstad, O.A., Skjæraasen, J.E., and Meland, K., 2000, Trophic ecology of deep-water fishes associated with the continental slope of the eastern Norwegian Sea: Sarsia, v. 85, no. 2, p. 101–117.
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. 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.

13. Wakefield, W.W., 1984, Feeding relationships within assemblages of nearshore and mid-continental shelf benthic fishes off Oregon: Corvallis, Oregon State University, Master's thesis, 102 p.

14. Frost, K.J., and Lowry, L.F., 1980, Feeding of ribbon seals (*Phoca fasciata*) in the Bering Sea in spring: Canadian Journal of Zoology, v. 58, no. 9, p. 1601–1607.

15. Sinclair, E.H., and Zeppelin, T.K., 2002, Seasonal and spatial differences in diet in the western stock of Steller sea lions (*Eumetopias jubatus*): Journal of Mammology, v. 83, no. 4, p. 973–990.