Appendix 3
Essential Fish Habitat Text Descriptions
Adult Summer EFH Maps
Habitat associations, biological associations, predator/prey associations, and life histories of crabs in the Bering Sea and Aleutian Islands King and Tanner Crab Fishery Management Plan

Essential Fish Habitat Descriptions

General

Essential Fish Habitat (EFH) is defined in the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH is described for FMP-managed species by life stage using guidance from the EFH Final Rule (50 CFR 600.815), including the EFH Level of Information definitions. New analytical tools are used and recent scientific information is incorporated for each life history stage from updated scientific habitat assessment reports. EFH descriptions include both text and maps, if information is available for a species' particular life stage. These descriptions are risk averse, supported by scientific rationale, and account for changing oceanographic conditions, regime shifts, and the seasonality of migrating fish stocks. EFH descriptions are interpretations of the best scientific information.

Essential Fish Habitat

Essential Fish Habitat (EFH) is defined in the Magnuson-Stevens Fishery Conservation and Management Act as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat: water includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and a healthy ecosystem; and spawning, breeding, feeding, or growth to maturity covers a species full life cycle.

EFH is the general distribution of a species described by life stage. General distribution is a subset of a species population and is 95 percent of the population for a particular life stage, if life history data are available for the species. Where information is insufficient and a suitable proxy cannot be inferred, EFH is not described. General distribution is used to describe EFH for all stock conditions whether or not higher levels of information exist, because the available higher level data are not sufficiently comprehensive to account for changes in stock distribution (and thus habitat use) over time.

EFH is described for FMP-managed species by life stage as general distribution using guidance from the EFH Final Rule (67 FR 2343), such as the EFH Level of Information definitions. Analytical tools are used and recent scientific information is incorporated for each life history stage from scientific habitat assessment reports. EFH descriptions include both text and maps, if information is available for a species/particular life stage. These descriptions are risk averse, supported by scientific rationale, and account for changing oceanographic conditions, regime shifts, and the seasonality of migrating crab stocks. The methodology and data sources for the EFH descriptions are described in Appendix D to the EFH EIS (NMFS 2005).

Description of Essential Fish Habitat

EFH descriptions are based upon the best available scientific information. In support of this information, a thorough review of FMP species is contained in this Appendix and in the EFH EIS (NMFS 2005). A summary of the habitat information levels for each species, as described in the EFH regulations at 50 CFR 600.815(a)(1)(iii), is listed in Table 8.1. An ”x“ means that insufficient information is available to determine EFH for the life stage and a”1" means information is available to determine EFH.

Table.

Table 1 EFH information levels currently available for BSAI crab, by life history stage.

BSAI Crab Species	Egg	Larvae	Early Juvenile	Late Juvenile	Adult
Red king crab	inferred	x	1	1	1
Blue king crab	inferred	x	1	1	1
Golden king crab	inferred	x	x	1	1
Tanner crab	inferred	x	x	1	1
Snow crab	inferred	x	x	1	1

x indicates insufficient information is available to describe EFH
1 indicates general distribution data are available for some or all portions of the geographic range of the species
2 indicates quantitative data (density or habitat-related density) are available for the habitats occupied by a species or life stage

Red King Crab

Eggs

Essential fish habitat of the red king crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined

Insufficient information is available.

Early Juveniles-

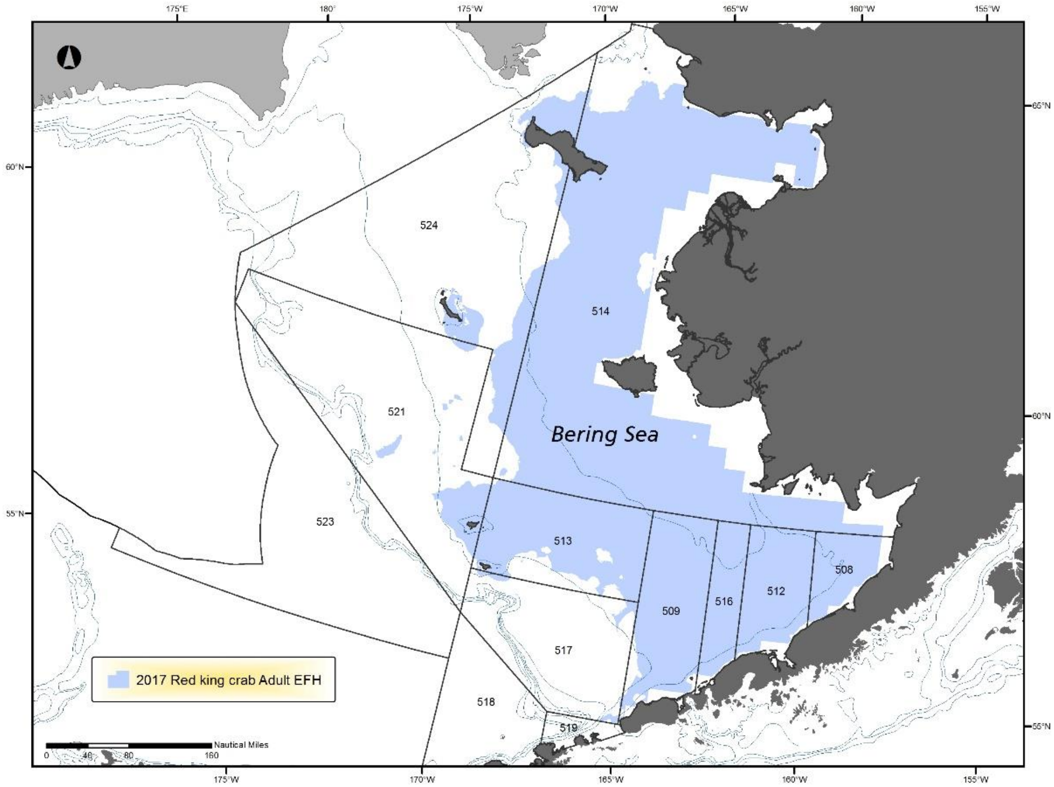
EFH for early juvenile red king crab is the general distribution area for this life stage, located in demersal habitat along the intertidal and subtidal zones, and inner and middle shelf (0 to 100 m). Early juveniles have specific habitat requirements based on their anti-predator strategy and can only occur in places where there is significant habitat structure either in the form of substrates such as rock, cobble, and gravel, or biogenic habitats such as bryozoans, ascidians, hydroids, or shell hash. In the BS, these habitats generally only occur in nearshore areas along the north side of the AI and the Alaskan Peninsula, around Bristol Bay, around the Pribilof Islands, and in nearshore areas of Norton Sound.

Late Juveniles

EFH for late juvenile red king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of rock, cobble, and gravel and biogenic structures such as *Boltenia* spp., bryozoans, ascidians, and shell hash.

Adults

EFH for adult red king crab is the general distribution area for this life stage, located in bottom habitats along the nearshore (spawning aggregations) and the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of sand, mud, cobble, and gravel.


524
514
521
Bering Sea
523
513
508
509
516
512
517
518
519
2017 Red king crab Adult EFH
Nautical Miles

Blue King Crab

Eggs

Essential fish habitat of the blue king crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined

Insufficient information is available.

Early Juveniles-

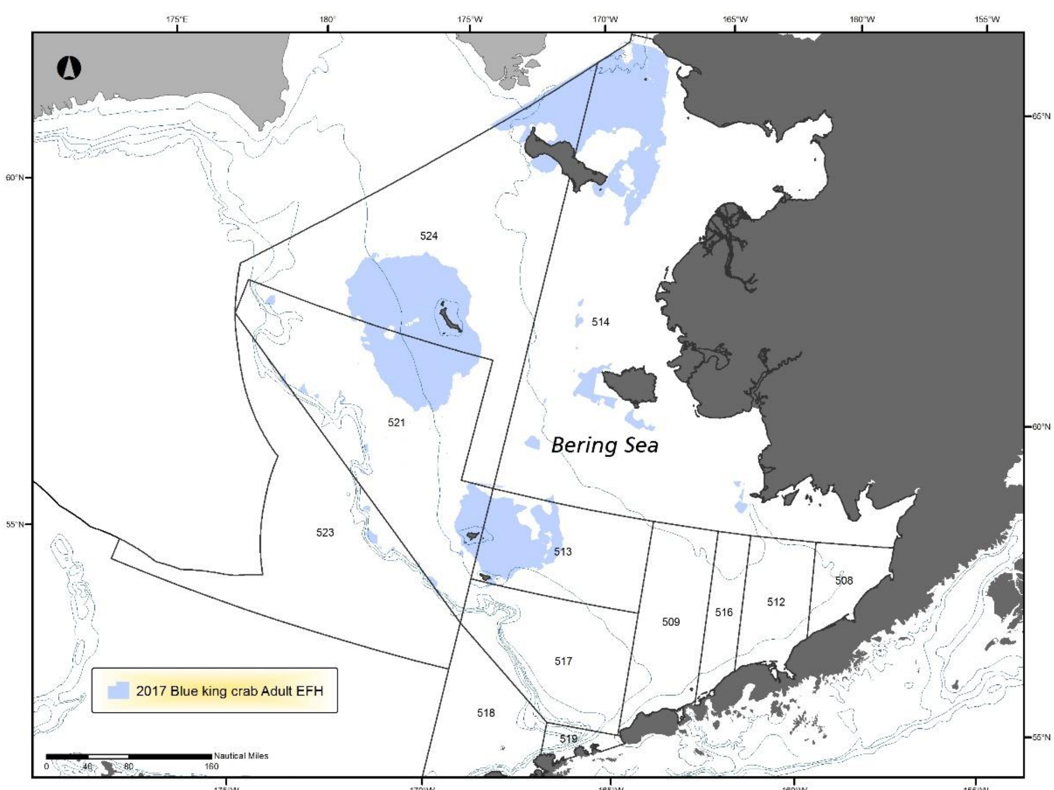
EFH for early juvenile blue king crab is the general distribution area for this life stage, located in demersal habitat along the intertidal and subtidal zones, and inner and middle shelf (0 to 100 m). Early juveniles require specific habitat types to avoid predation. In particular, they require either rock or cobble substrates or shell hash beds. Within the range of blue king crab, this only occurs in nearshore areas around the Pribilof Islands, St. Matthew Island, and St. Lawrence Island.

Late Juveniles

EFH for late juvenile blue king crab is the general distribution area for this life stage, located in bottom habitats along the nearshore where there are rocky areas with shell hash and the inner (0 to 50), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of rock, cobble, and gravel.

Adults

EFH for adult blue king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of sand and mud adjacent to rockier areas and areas of shell hash.



Golden King Crab

Eggs

Essential fish habitat of golden king crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined

Insufficient information is available.

Early Juveniles-No EFH Description Determined

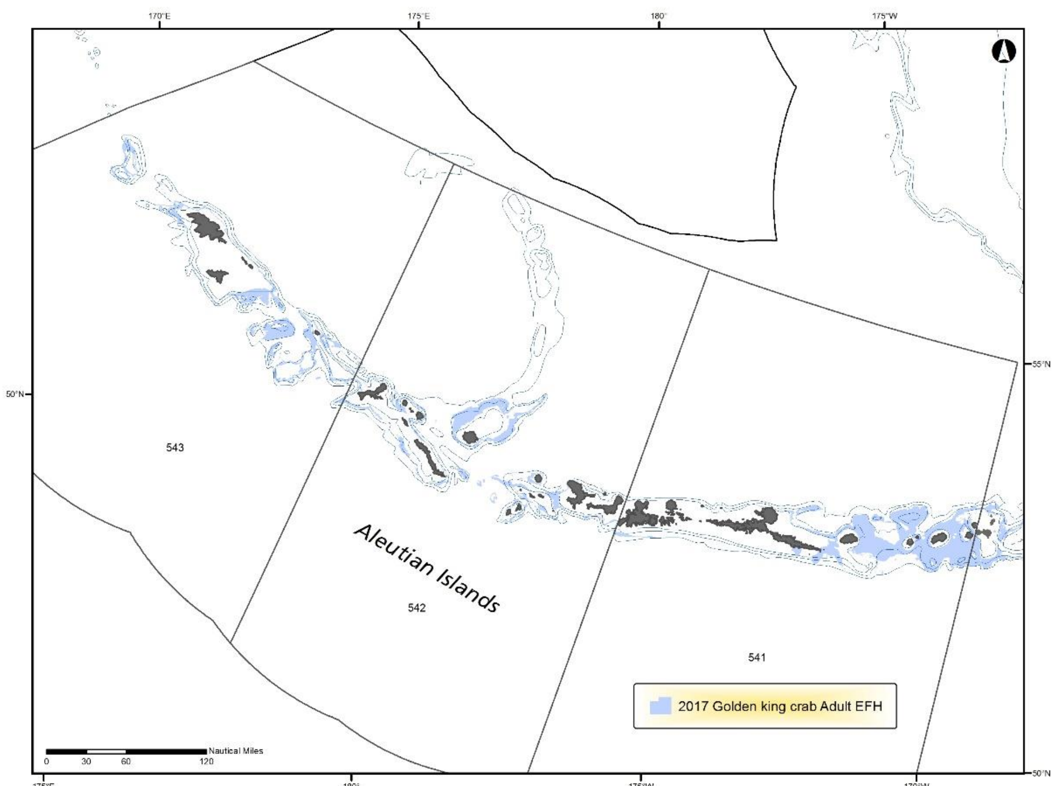
Insufficient information is available.

Late Juveniles

EFH for late juvenile golden king crab is the general distribution area for this life stage, located in bottom habitats along the along the upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high-relief living habitats, such as coral, and vertical substrates, such as boulders, vertical walls, ledges, and deep water pinnacles.

Adults

EFH for adult golden king crab is the general distribution area for this life stage, located in bottom habitats along the along the outer shelf (100 to 200 m), upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high relief living habitats, such as coral, and vertical substrates such as boulders, vertical walls, ledges, and deep water pinnacles.



Tanner Crab

Eggs

Essential fish habitat of Tanner crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined

Insufficient information is available.

Early Juveniles-No EFH Description Determined

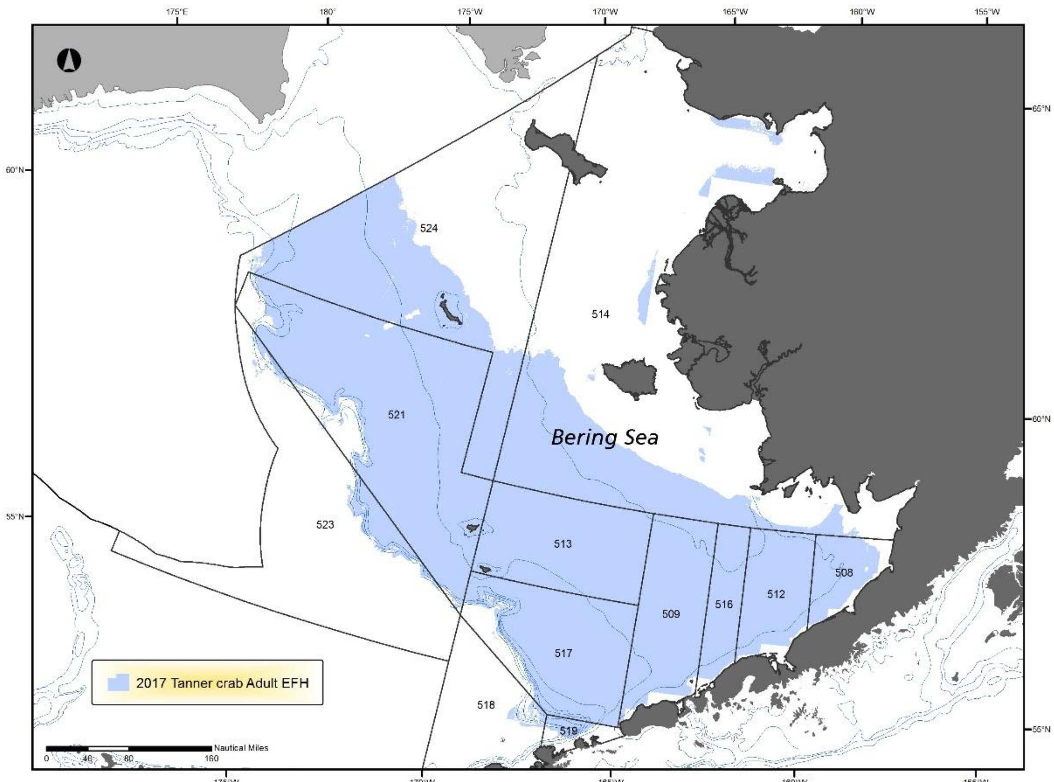
Insufficient information is available.

Late Juveniles

EFH for late juvenile Tanner crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud.

Adults

EFH for adult Tanner crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud.



Snow Crab

Eggs

Essential fish habitat of snow crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined

Insufficient information is available.

Early Juveniles-No EFH Description Determined

Insufficient information is available.

Late Juveniles

EFH for late juvenile snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud.

Adults

EFH for adult snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud.

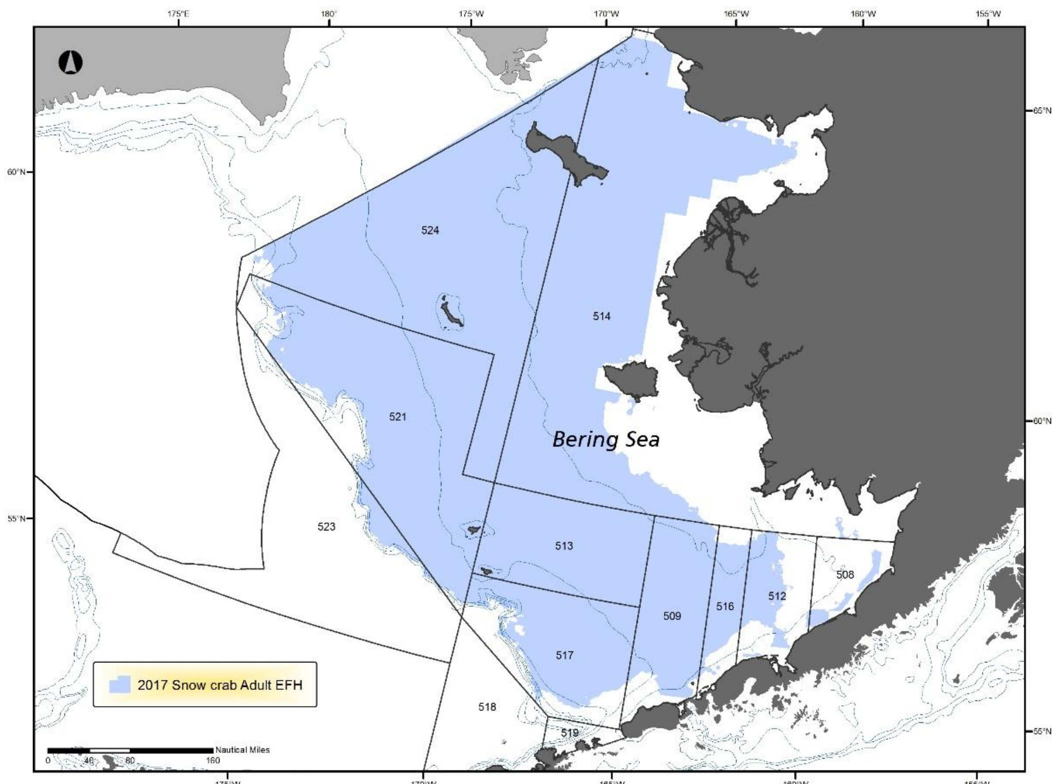


Table 2 Summary of habitat associations for BSAI crab.

BSAI Crab Species	Life Stage	Nearshore				Shelf: Inner	Shelf: Middle	Shelf: Outer	Slope: Upper		Slope: Inter-mediate		Slope: Lower	Slope: Basin	Stratum Reference						
		Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully
Blue King Crab	M					x	x	x													
	LJ					x	x	x													
	EJ			x	x	x	x														
	L					x	x														
	E					x	x	x													
Golden King Crab	M							x	x	x	x	x				x		x			
	LJ												x	x				x			
	EJ												x	x							
	L																				
	E							x	x	x	x							x			
Red King Crab	M					x	x	x													
	LJ					x	x	x													
	EJ			x	x	x	x														
	L					x	x														
	E					x	x	x													
Snow Crab	M					x	x	x													
	LJ					x	x	x													
	EJ					x	x														
	L					x	x														
	E					x	x	x													
Tanner Crab	M					x	x	x	x	x	x						x	x			
	LJ			x	x	x	x	x	x	x								x			
	EJ			x	x	x	x	x	x	x								x			
	L		x	x	x	x	x														
	E				x	x	x	x	x	x	x	x									

BSAI Crab Species	Life Stage	Location				Pelagic			Physical Oceanography					Substrate												
		Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock
Blue King Crab	M				x											x	x								x	x
	LJ				x											x	x								x	x
	EJ				x																				x	x
	L					x																				
	E				x											x	x								x	x
Golden King Crab	M				x											x	x								x	x
	LJ				x											x	x								x	x
	EJ				x																					
	L																									
	E				x											x	x								x	x
Red King Crab	M				x									x	x	x	x	x	x	x	x	x	x	x		
	LJ				x									x	x	x	x	x	x	x	x	x	x	x		
	EJ				x												x								x	x
	L					x																				
	E				x									x	x	x	x	x	x	x	x	x	x	x		
Snow Crab	M				x									x	x	x	x	x	x	x	x	x	x	x		
	LJ				x									x	x	x	x	x	x	x	x	x	x	x		
	EJ				x									x	x	x	x	x	x	x	x	x	x	x		
	L					x																				
	E				x									x	x	x	x	x	x	x	x	x	x	x		
Tanner Crab	M				x							x		x	x	x	x	x	x	x	x	x	x	x	x	
	LJ				x						x	x		x	x	x	x	x	x	x	x	x	x	x	x	
	EJ				x									x	x	x	x	x	x	x	x	x	x	x	x	
	L					x						x	x													
	E				x							x		x	x	x	x	x	x	x	x	x	x	x	x	

BSAI Crab Species	Life Stage	Structure										Community Associations												Oceano-graphic Properties			
		Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Blue King Crab	M			x	x	x	x		x	x			x	x	x		x			x							M
	LJ			x	x	x	x		x	x			x	x	x		x			x							LJ
	EJ																x										EJ
	L																										L
	E			x	x	x	x		x	x			x	x	x		x			x							E
Golden King Crab	M			x	x	x	x	x	x	x			x	x	x		x			x				<5	>30		M
	LJ			x	x	x	x		x	x			x	x	x		x			x				<5	>30		LJ
	EJ																							<5	>30		EJ
	L																							<5	>30		L
	E			x	x	x	x		x	x			x	x	x		x			x				<5	>30		E
Red King Crab	M												x	x	x		x			x							M
	LJ												x	x	x		x			x							LJ
	EJ											x					x			x		x					EJ
	L																										L
	E												x	x	x		x			x							E
Snow Crab	M																										M
	LJ																										LJ
	EJ																										EJ
	L																										L
	E																										E
Tanner Crab	M	x	x	x	x			x			x		x	x	x	x	x	x	x	x		x	x	>4	>30		M
	LJ	x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		LJ
	EJ	x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		EJ
	L																							>4	>30		L
	E	x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		E

Table 3 Summary of reproductive traits of BSAI crab

BSAI Crab Species	Life Stage	Age at Maturity: Female 50%	Age at Maturity: Female 100%	Age at Maturity: Male 50%	Age at Maturity: Male 100%	Fertilization/Egg Development: External	Internal	Oviparous	Ovoviviparous	Viviparous	Spawning Behavior: Batch Spawner	Broadcast Spawner	Egg Case Deposition	Nest Builder	Egg/Young Guarder	Egg/Young Bearer	Spawning Season: January	February	March	April	May	June	July	August	September	October	November	December
Blue King Crab	M	6+		6+		x		x								x	x	x	x	x	x	x	x					
	LJ																											
	EJ																											
	L																											
	E																											
Golden King Crab	M	6+			6+	x		x								x	x	x	x	x	x	x	x	x	x	x	x	x
	LJ																											
	EJ																											
	L																											
	E																											
Red King Crab	M	7 to 8		7 to 10		x		x								x	x	x	x	x	x	x	x					
	LJ																											
	EJ																											
	L																											
	E																											
Snow Crab	M	5 to 6		6 to 8		x	x	x								x	x	x	x	x	x	x						
	LJ																											
	EJ																											
	L																											
	E																											
Tanner Crab	M	6 to 8		6 to 8		x	x	x								x	x	x	x	x	x	x						
	LJ																											
	EJ																											
	L																											
	E																											

Snow and tanner crab fertilization is internal. Eggs are extruded and carried externally until hatching.
King crab fertilization and egg carrying are external.

Table 4 Summary of predator/prey associations for BSAI crab

Predator to

BSAI Crab Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Other - Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Salmon	Cod	Pollock	Halibut
Blue King Crab	M								x			x	x			x	x	x	x	x										
	LJ								x			x	x			x	x	x	x	x										
	EJ																													
	L			x	x																									
	E																													
Golden King Crab	M								x			x	x			x	x	x	x											
	LJ								x			x	x			x	x	x												
	EJ																													
	L																													
	E																													
Red King Crab	M								x			x	x			x	x	x	x	x										
	LJ								x			x	x			x	x	x	x	x										
	EJ	x				x	x			x	x		x																	
	L			x	x																									
	E																													
Snow Crab	M												x			x	x	x	x	x										
	LJ								x				x			x	x	x	x	x										
	EJ								x	x			x					x												
	L			x	x																									
	E																													
Tanner Crab	M								x			x	x			x	x	x		x										
	LJ								x			x	x			x	x	x		x										
	EJ																													
	L	x		x	x	x																								
	E																													

Prey of

BSAI Crab Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pac fic Cod	Ling Cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Skate	Halibut	Cottidae (sculpins)	Eel pouts	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Blue King Crab	M								x								x																
	LJ				x				x								x																
	EJ				x				x								x																
	L																																
	E																																
Golden King Crab	M								x								x																
	LJ								x								x																
	EJ								x								x																
	L																																
	E																																
Red King Crab	M							x	x								x																
	LJ				x			x	x			x	x	x	x	x	x																
	EJ				x			x	x			x	x	x	x	x	x	x															
	L																																
	E																																
Snow Crab	M				x				x									x															
	LJ				x				x			x	x		x	x	x	x	x														
	EJ				x				x									x	x														
	J																																
	L																																
Tanner Crab	M				x				x									x	x														
	LJ				x			x	x		x	x	x	x	x	x	x	x	x														
	EJ				x			x	x		x	x	x		x	x	x	x	x														
	L	x		x		x	x	x						x																			
	E																																

Life History Features and Habitat Requirements of FMP Species

This section describes habitat requirements and life histories of the crab species managed by this FMP. Information contained in this appendix details life history information for federally managed crab species. Each species or species group is described individually. Habitat summary tables that denote habitat associations, reproductive traits, and predator and prey associations are also provided. In each section, a species-specific table summarizes habitat requirements.

Habitat Types

Bering Sea

The Bering Sea is a semi-enclosed, high-latitude sea. Of its total area of 2.3 million sq. km, 44 percent is continental shelf, 13 percent is continental slope, and 43 percent is deep-water basin. Its broad continental shelf is one of the most biologically productive areas of the world. The Eastern Bering Sea (EBS) contains approximately 300 species of fish, over 150 species of crustaceans and mollusks, 50 species of seabirds, and 26 species of marine mammals (Livingston and Tjelmeland 2000).

The dominant circulation of the water begins with the passage of North Pacific water (the Alaska Stream) into the EBS through the major passes in the Aleutian Islands (AI) (Favorite et al. 1976). The net current flows eastward along the north side of the AI and turns northward at the continental shelf break and at the eastern perimeter of Bristol Bay. Eventually EBS water exits northward through the Bering Strait, or westward and south along the Russian coast, entering the western North Pacific via the Kamchatka Strait. Some resident water joins new North Pacific water entering Near Strait, which sustains a permanent cyclonic gyre around the deep basin in the central Bering Sea (BS).

The EBS sediments are a mixture of the full range of potential grain sizes of mud (subgrades clay and silt), sand, and gravel. The proportion of each constituent determines the sediment type at any one location (Smith and McConnaughey 1999). Sand and silt are the primary components over most of the seafloor, with sand predominating in waters with a depth less than 60 m. In general, the fraction of finer-grade sediments increases (i.e. the average grain size decreases) with increasing depth and distance from shore. This grading is particularly noticeable on the southeastern BS continental shelf in Bristol Bay and immediately westward. The condition occurs because settling velocity of particles decreases with particle size (Stokes Law). Because the kinetic energy of sea waves reaching the bottom decreases with increasing depth, terrigenous grains entering coastal shallows drift with water movement until they are deposited at the depth at which water speed can no longer transport them. However, there is considerable fine-scale deviation from the graded pattern, especially in shallower coastal waters and offshore of major rivers, due to local variations in the effects of waves, currents, and river input (Johnson 1983).

The distribution of benthic sediment types in the EBS shelf is related to depth (Figure 2). Considerable local variability occurs in areas along the shore of Bristol Bay, the north coast of the Alaska Peninsula, and west and north of Bristol Bay, especially near the Pribilof Islands. In general, nearshore sediments in the east and southeast on the inner shelf (0 to 50 m depth) are sandy gravel and gravelly sand, transitioning to plain sand farther offshore and west. On the middle shelf (50 to 100 m), sand transitions to muddy sand and sandy mud, which continue over much of the outer shelf (100 to 200 m) to the the continental slope. Sediments on the central and northeastern shelf (including Norton Sound) have not been extensively sampled, but Sharma (1979) reports that, although sand is dominant in places, as it is in the southeast, there are deposits of silt both in shallow nearshore waters and in deep areas near the shelf slope. In addition, there are areas of exposed relic gravel, possibly deposited by glaciers. These departures from a classic seaward decrease in grain size are due to the large input of fluvial silt from the Yukon River and to flushing and scouring of sediment through the Bering Strait by the net northerly current.

McConnaughey and Smith (2000) and Smith and McConnaughey (1999) describe the available sediment data for the EBS shelf. These data were used to describe four habitat types. The first, situated around the shallow eastern and southern perimeter and near the Pribilof Islands, has primarily sand substrates with a little gravel. The second, across the central shelf out to the 100 m contour, has mixtures of sand and mud. A third, west of a line between St. Matthew and St. Lawrence islands, has primarily mud (silt) substrates, with some sand. Finally, the areas north and east of St. Lawrence Island, including Norton Sound, have a complex mixture of substrates.

Important water column properties in the EBS include temperature, salinity, and density. These properties remain constant with depth in the near-surface mixed layer, which varies from approximately 10 to 30 m in summer to approximately 30 to 60 m in winter (Reed 1984). The inner shelf (less than 50 m) is, therefore, one layer and is well mixed most of the time. On the middle shelf (50 to 100 m), a two-layer temperature and salinity structure exists because of downward mixing of wind and upward mixing due to relatively strong tidal currents (Kinder and Schumacher 1981). On the outer shelf (100 to 200 m), a three-layer temperature and salinity structure exists due to downward mixing by wind, horizontal mixing with oceanic water, and upward mixing from the bottom friction due to relatively strong tidal currents. Oceanic water structure is present year-round beyond the 200-m isobath.

Three fronts, the outer shelf, mid-shelf, and inner shelf, follow along the 200-, 100-, and 50-m bathymetric contours, respectively; thus, four separate oceanographic domains appear as bands along the broad EBS shelf. The oceanographic domains are the deep water (more than 200 m), the outer shelf (200 to 100 m), the mid-shelf (100 to 50 m), and the inner shelf (less than 50 m).

The vertical physical system regulates the biological processes leading to different cycles of nutrient regeneration. The source of nutrients for the outer shelf is the deep oceanic water; for the mid-shelf, it is the shelf-bottom water. In winter, surface waters across the shelf are high in nutrients. Spring surface heating stabilizes the water column, the spring bloom follows and consumes the nutrients. Steep seasonal thermoclines over the deep EBS (30 to 50 m), the outer shelf (20 to 50 m), and the mid-shelf (10 to 50 m) restrict vertical mixing of water between the upper and lower layers. Below these seasonal thermoclines, nutrient concentrations in the outer shelf water are higher than those in the deep EBS water with the same salinity. Winter values for nitrate-N/phosphate-P are similar to the summer ratios, which suggests that, even in winter, the mixing of water between the mid-shelf and the outer shelf domains is substantially restricted (Hattori and Goering 1986).

Effects of a global warming climate should be greater in the EBS than in the GOA. Located further north than the GOA, the seasonal ice cover of the EBS lowers albedo effects. Atmospheric attributes that are predicted to change ocean conditions include increased air temperature, pCO_2, storm intensity, storm frequency, southerly wind, humidity, and precipitation. Increased precipitation, plus snow and ice melt, would lead to increased freshwater runoff. The predicted decrease in sea level pressure is associated with the northward shift in the storm track. Although the location of the maximum in the mean wind stress curl will probably shift poleward, how the curl is likely to change is unknown. The net effect of the storms largely determines the curl, and there is likely to be compensation between changes in storm frequency and intensity.

Ocean circulation decreases are likely to occur in the major current systems: the Alaska Stream, Near Strait Inflow, Bering Slope Current, and Kamchatka Current. Competing effects make changes in the Unimak Pass inflow, the shelf coastal current, and the Bering Strait outflow difficult to predict. Changes in hydrography should include increases in sea level, sea surface temperature, shelf bottom temperature, pCO_2 (with an accompanying decrease in pH), and basin stratification. Decreases should occur in mixing energy and shelf break nutrient supply, while competing effects make changes in shelf stratification and eddy activity unknown. Ice extent, thickness, and brine rejection are all expected to decrease.

Temperature anomalies in the EBS illustrate a relatively warm period in the late 1950s, followed by cooling, especially in the early 1970s, and then by a rapid temperature increase in the latter part of that decade. For more information on the physical environment of the EBS, refer to the Alaska Groundfish Fisheries Programmatic Supplemental EIS (NMFS 2004).

Aleutian Islands

The Aleutian Islands lie in an arc that forms a partial geographic barrier to the exchange of northern Pacific marine waters with EBS waters. The AI continental shelf is narrow compared with the EBS shelf, ranging in width on the north and south sides of the islands from less than 4 km to 46 km; the shelf broadens in the eastern portion of the AI arc. The AI comprises approximately 150 islands and extends about 2,260 km in length.

Bowers Ridge in the AI is a submerged geographic structure forming a ridge arc off the west-central AI, approximately 550 km long and 75 to 110 km wide. The summit of the ridge is 150 to 200 m deep in the southern portion, deepening northward to about 800 to 1,000 m at its northern edge.

The AI region has complicated mixes of substrates, including a significant proportion of hard substrates (pebbles, cobbles, boulders, and rock), but data are not available to describe the spatial distribution of these bottom types. The patterns of water density, salinity, and temperature are similar to the GOA. Along the edge of the shelf in the Alaska Stream, a low salinity (less than 32.0 ppt) tongue-like feature protrudes westward. On the south side of the central AI, nearshore surface salinities can reach as high as 33.3 ppt, as the higher salinity EBS surface water occasionally mixes southward through the AI. Proceeding southward, a minimum of approximately 32.2 ppt is usually present over the slope in the Alaska Stream; values then rise to above 32.6 ppt in the oceanic water offshore. Whereas surface salinity increases toward the west as the source of fresh water from the land decreases, salinity values near 1,500 m decrease very slightly. Temperature values at all depths decrease toward the west.

Climate change effects on the AI area are similar to the effects described for climate change in the EBS. For more information on the physical environment of the AI, refer to the Alaska Groundfish Fisheries Programmatic Supplemental EIS (NMFS 2004).

General Life History Information for Crabs

Shallow inshore areas (less than 50 m depth) are very important to king crab reproduction as the adults move onshore to molt and mate. Tanner crabs also occupy shallower depths during molting and mating. All BSAI crab are highly vulnerable to predation and damage during molting when they shed their exoskeleton. Female king crab molt annually and must mate annually while Tanner and snow crab have a terminal molt to maturity and can store sperm internally for future clutch fertilization. The habitat occupied by molting and mating crab differs from that occupied by mature crabs during the remainder of the year. The EFH EIS crab technical team noted protection of crab in molting mating habitat during this sensitive life history stage as important.

Larval stages are planktonic for 2-3 months and their vertical distribution in the water column is determined by swimming behavior, currents, vertical mixing, or water column stratification. Generally, the larval stages are thought to occupy the upper 40 m of the water column, within the mixed layer. After molting through multiple larval stages, post-larvae settle on the ocean bottom. Habitat with adequate shelter, food, and temperature is imperative to survival of newly settling crabs. Young of the year red and blue king crabs require habitat with crevice spaces (e.g., structural invertebrates, macroalgae, shell hash, cobble, shale) that offers protection, which typically occurs in nearshore areas. Both species rely on cryptic behavior in complex habitat to reduce predation risk. Early juvenile stage Tanner and snow crab also occupy shallow waters and are found on mud habitat. Late juvenile stage crab are most active at night when they feed and molt.

Egg Stage
Female king and Tanner crabs extrude eggs, carry and nurture them outside the maternal body under their abdominal flap. Thus the habitat for eggs is the same as for egg-bearing females. The number of eggs produced by the female increases with body size.

Larval Stage
Successful hatch of king and Tanner crab larvae is a function of temperature and concentration of diatoms, so presence of larvae in the water column can vary accordingly. Crab larvae are planktonic: horizontal swimming is inconsequential compared to horizontal advection by oceanographic conditions. Larvae vertically migrate in the water column, which impacts the extent of horizontal transport as current direction and strength can vary with depth. Behaviors such as diel vertical migration may be a retention mechanism to transport larvae inshore.

Early Juvenile Stage
The early juvenile stage includes crabs first settling on the bottom as post-larvae (glaucothoe and megalopae) up to approximate size at age 2. Habitat complexity is obligatory for red and blue king crabs of this life stage and individuals less than 20 mm carapace length (CL) are typically distributed in nearshore waters among niches provided by sea star arms, anemones, shell hash, rocks and other complex habitat types. Early juvenile Tanner crab settle on mud, occur there during summer, but are not easily found in this habitat in winter.

Late Juvenile Stage
The late juvenile stage for crab is defined as the size at about age 2 to the first size of functional maturity. Late juvenile crabs are typically found further offshore in cooler water than early juvenile crabs. Smaller red king crabs of this life stage form pods during the day that break apart during the night when the crabs forage and molt. As these crabs increase in size, podding behavior declines and the animals forage throughout the day.

Mature Stage
Mature crabs are defined as those crabs of a size that is functionally mature. Functional maturity is based on size observed in mating pairs of crabs. This maturity definition differs from morphometric maturity based on chela height and physiological maturity when spermatophores or oocytes can be produced. The mature stage includes crabs from the first size of functional maturity to senescence.

Location

ICS =	inner continental shelf (1-50 m)	USP =	upper slope (200-1000 m)
MCS =	middle continental shelf (50-100 m)	LSP =	lower slope (1000-3000 m)
OCS =	outer continental shelf (100-200 m)	BSN=	basin (>3000 m)
BCH =	beach (intertidal)		
BAY =	nearshore bays, give depth if appropriate (e.g., fjords)		
IP =	island passes (areas of high current), give depth if appropriate		

Water column

D =	demersal (found on bottom)
SD/SP =	semi-demersal or semi-pelagic if slightly greater or less than 50% on or off bottom
P =	pelagic (found off bottom, not necessarily associated with a particular bottom type)
N =	neustonic (found near surface)

Bottom Type

M = mud	S = sand	R = rock
SM = sandy mud	CB = cobble	C = coral
MS = muddy sand	G = gravel	K = kelp
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)		

Oceanographic Features

UP = upwelling	G = gyres	F = fronts	E = edges
CL = thermocline or pycnocline			

General

U = Unknown	N/A = not applicable

Habitat Description for Red King Crab (*Paralithodes camtschaticus*)

Abbreviations used in the habitat tables to specify location, position in the water column, bottom type, and other oceanographic features are provided in Table 1.

Life History and General Distribution

Red king crab (*Paralithodes camtschaticus*) is widely distributed throughout the BS and AI, GOA, Sea of Okhotsk, and along the Kamchatka shelf, typically at depths <100 fathoms (fm). King crab molt multiple times per year through age 3 after which molting is annual. At larger sizes, king crab may skip molt as growth slows. Females grow more slowly than and do not get as large as males. In Bristol Bay, 50 percent maturity is attained by males at approximately 12 cm CL and 9 cm CL by females (about 7 years). Female red king crab in the Norton Sound area reach 50 percent maturity at approximately 7 cm and do not attain maximum sizes found in other areas. Size at 50 percent maturity for females in the western Aleutians is 8.9 cm CL. Natural mortality of adult red king crab is assumed to be about 18 percent per year (M=0.2), due to old age, disease, and predation.

The EFH EIS crab technical team emphasized the importance of shallow areas to all early juvenile stage crabs and in particular the importance to red and blue king crabs of high relief habitat nearshore with extensive biogenic assemblages. The area north and adjacent to the Alaska peninsula (Unimak Island to Port Moller), the eastern portion of Bristol Bay, and nearshore areas of the Pribilof and Saint Matthew Islands are locations known to be particularly important for king crab spawning and juveniles.

Fishery

The red king crab fisheries are prosecuted using mesh covered pots (generally 7 or 8 feet square) set on single lines. Mean age at recruitment to the fishery is about 8 to 9 years. Two discrete populations of red king crab are actively fished in the BSAI region: Bristol Bay and Norton Sound. A third population surrounding the AI was managed separately as Western Aleutian Islands and Dutch Harbor stocks until 1996 when the management areas were combined. The fishery on the Adak stock was closed in 1996, and the fishery on the Dutch Harbor stock has been closed since the 1983 to 1984 season. These fisheries historically occurred in the winter and spring. Red king crab are allowed as bycatch during golden king crab fisheries in those areas. Other populations of red king crab are fished in the Pribilof Islands, St. Matthew, and St. Lawrence Island areas, but are managed in conjunction with the predominant blue king crab fisheries. All red king crab fisheries are male only and stocks are managed separately to accommodate different life histories and fishery characteristics. The minimum legal size is 16.5 cm CL in Bristol Bay, the Pribilof Islands, and AI, and 12 cm CL in Norton Sound, St. Matthew and, St. Lawrence Island. The season in Bristol Bay begins on October 15 with fishing continuing through January 15 in recent years. Bycatch in red king crab fisheries consists primarily of Tanner crab and non-legal red king crab. The commercial fishery for red king crab in Norton Sound occurs in the summer, opening July 1, and a winter through-the-ice fishery opens November 15 and closes May 15.

Relevant Trophic Information

Pacific cod is a known predator on adult red king crabs and likely primarily targets newly molted softshell crabs. Walleye pollock, yellowfin sole, and Pacific halibut are minor consumers of pelagic larvae, settling larvae, and larger crabs, respectively. Juvenile crab may be cannibalistic. Other known predators of juveniles in the GOA include hermit crabs, Alaskan ronquil, Arctic shanny, northern rock sole, sculpins, and kelp greenling. It is likely that other similar crustaceans and fish are predators but data is limited.

Approximate Upper Size Limit of Juvenile Crab (in cm): The size at 50 percent maturity is approximately 7 and 9 cm CL for female and male red king crabs, respectively, from Norton Sound and St. Matthew and St. Lawrence Islands; it is approximately 9 cm for females and 12 cm for males in Bristol Bay and the Pribilof and Aleutian Islands.

Habitat and Biological Associations

Egg: In southeast Alaska egg hatch of larvae is synchronized with the spring phytoplankton bloom suggesting temporal sensitivity in the transition from benthic to planktonic habitat. Also see mature phase description; eggs are carried by adult female crab.

Larvae: Red king crabs spend 2 to 3 months in pelagic larval stages before settling to the benthic life stage. In the BS, larvae are thought to undergo diel vertical migration, which may serve to balance feeding opportunities and predator avoidance.

Early Juvenile: Early juvenile stage red king crabs are solitary and need complex habitat, consisting of coarse substrate (i.e., boulders, cobble, shell hash) or structural invertebrates (e.g., bryozoans, stalked ascidians). Young-of-the-year crabs occur at depths of 50 m or less.

Late Juvenile: Late juvenile stage red king crabs of 2 and 4 years exhibit decreasing reliance on complex habitat and a tendency for the crab to form pods consisting of hundreds to thousands of crabs. Late juvenile crab associate with deeper waters and migrate to shallower water for molting and mating in the spring. Aggregation behavior continues into adulthood.

Mature: Mature red king crabs exhibit seasonal migration to shallow waters for reproduction. The remainder of the year, red king crabs are found in deeper waters. In Bristol Bay, red king crabs mate when they enter shallower waters (<50 m). Timing of mating is variable, depending on water temperature, and can occur January through June. Males grasp females just prior to female molting, after which the eggs

(43,000 to 500,000 eggs) are extruded and fertilized on the female's abdomen. The female red king crab carries the eggs for approximately 10-12 months before they hatch, generally in April.

SPECIES: Red king crab, *Paralithodes camtschaticus*

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	10-12 mo	NA	Jan-April	NA	NA	NA	F	
Larvae	3-5 mo	Diatoms, Phytoplankton Copepod nauplii	April-August	MCS, JCS	P	NA	F	
Juveniles	1 to 5-6 yrs	Diatoms Hydroids	All year	ICS, MCS, BCH, BAY	D	(epifauna), R, CB, G	F	Found among biogenic assemblages (sea onions, tube worms, bryozoans, ascidians, sea stars)
Adults	5-6+ yrs	Mollusks, echinoderms, polychaetes, decapod, crustaceans, Algae, urchins, hydroids, sea stars	Spawning Jan-June	MCS, ICS, BAY, BCH	D	S, M, CB, G	F	

Habitat Description for Blue King Crab *(Paralithodes platypus)*

Life History and General Distribution

Blue king crab (*Paralithodes platypus*) has a discontinuous distribution throughout its range (Hokkaido, Japan to Southeast Alaska). In the BS, discrete populations exist in the cooler waters around the Pribilof Islands, St. Matthew Island, and St. Lawrence Island. Smaller populations have been found in Herendeen Bay and around Nunivak and King Island, as well as isolated populations in the GOA. Blue king crab molt multiple times as juveniles. In the Pribilof area, 50 percent maturity of females is attained at approximately 9.6 cm CL, which occurs at about 5 years of age. Blue king crab in the St. Matthew area mature at smaller sizes (50 percent maturity at approximately 8.1 cm CL for females) and do not get as large overall. Skip molting occurs with increasing probability for those males larger than 10 cm CL and is more prevalent for St. Matthew Island crab. Larger female blue king crab have a biennial ovarian cycle and a 14-month embryonic period. Adult male blue king migrate offshore to deeper waters and soft-bottomed habitats.

Fishery

The blue king crab fisheries are prosecuted using mesh covered pots (generally 7 or 8 feet square) set on single lines. Two discrete stocks of blue king crab have been fished: the Pribilof Islands and the St. Matthew Island stocks, but the Pribilof Islands stock has been closed to fishing since 1999. The St. Matthew Island blue king crab fishery has occurred in September in recent years. Bycatch in the blue king crab fisheries consist almost entirely of non-legal blue king crabs. The fisheries are male only and the minimum size is 16.5 cm carapace width (CW) in the Pribilof Islands and 140 in the St. Matthew Islands fishery. The Pribilof Islands Habitat Conservation Zone is closed to bottom trawl gear and pot fishing for Pacific cod.

Bottom trawls and dredges could disrupt nursery, adult feeding, and spawning areas.

Relevant Trophic Information

Pacific cod is a predator on blue king crabs.

Approximate Upper Size Limit of Juvenile Crab (in cm): The size at 50 percent maturity is 10- and 12-cm CL for female and male crabs from the Pribilof Islands, and 8- and 10.5-cm CL for St. Matthew Island.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Blue king crab larvae spend 3.5 to 4 months in pelagic larval stages before settling to the benthic life stage. Larvae are found in waters between 40 to 60 m deep. There is some evidence that blue king crab larvae exhibit diel vertical migration, but data is limited.

Early Juvenile: Early juvenile blue king crabs require ample crevice spaces for refuge from predators and foraging opportunities. Such substrates are typically characterized by gravel and cobble overlaid with shell hash and sponge, hydroid, and barnacle assemblages, which have been observed around the Pribilof Islands at 40 to 60 m depths. Early juveniles also occur in shallower water up to the intertidal in Herendeen Bay in rocky substrates and they may occur in similar habitats in other areas.

Late Juvenile: Late juvenile blue king crab are found in nearshore rocky habitat with shell hash.

Mature: Mature blue king crabs occur most often between 45 and 75 m deep on mud-sand substrate adjacent to gravel rocky bottom. Female crabs are found in a habitat with a high percentage of shell hash. Mating occurs in mid-spring. Larger older females reproduce biennially, while small females tend to reproduce annually. Fecundity of females range from 50,000 to 200,000 eggs per female. Spawning may depend on the availability of nearshore rocky-cobble substrate for protection of females. Larger older crabs disperse farther offshore and are thought to migrate inshore for molting and mating.

SPECIES: Blue king crab, *Paralithodes platypus*

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14 mo.	NA	Starting April-May	NA	NA	NA	F	
Larvae	3.5 to 4 mo.		April-July	MCS, ICS	P	NA	F	
Juveniles	to about 5 years		All year	MCS, ICS, BAY, BCH	D	CB, G, R	F	
Adults	5+ years		Spawning Feb-Jun	MCS, ICS	D	S, M, CB, G, R	F	

Habitat Description for Golden King Crab *(Lithodes aequispina)*

Life History and General Distribution

Golden king crab (*Lithodes aequispina*), also called brown king crab, range from Japan to British Columbia. In the BS and AI, golden king crab are found at depths from 100 to 1,000 m, generally in high relief habitat such as inter-island passes, and they are usually slope-dwelling. Size at sexual maturity depends on latitude and ranges from 9.2 to 12.5 cm CL, with crabs in the northern areas maturing at smaller sizes. Females carry up to 20,000 eggs, depending on their size. Spawning appears to be non-synchronous and to occur throughout the year. Larvae are lecithotrophic and are pelagic for 3-5 months, but nothing is known about where they reside in the water column.

Fishery

The golden king crab fisheries are prosecuted using mesh covered pots set on longlines to minimize gear loss. The primary fishery is in the AI, with minor catches coming from localized areas in the BS and GOA. Until 1996, the golden king crabs in the AI were managed as two separate stocks: Adak and Dutch Harbor. The fishing season opens August 15 and continues through May 15. Male crab >15.2 cm are harvested. Golden king crab are harvested in the BS under conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game. Bycatch consists almost exclusively of non-legal golden king crab. Escape rings were adopted by the Alaska Board of Fisheries in 1996 to reduce capture and handling mortality of non-target crab; a minimum of four 5.5-inch rings are required on pots used in golden king crab fisheries.

Relevant Trophic Information

Unknown

Approximate Upper Size Limit of Juvenile Crab (in cm): The size (CL) at 50 percent maturity for females and males: Aleutians 11 and 12.5 cm, Pribilofs 10 and 10.7 cm, Northern BS 9.8 and 9.2 cm.

Habitat and Biological Associations

Golden king crabs occur on hard bottom, over steep rocky slopes, and on narrow ledges. Strong currents are prevalent. Golden king crabs coexist with abundant quantities of epifauna: sponges, hydroids, coral, sea stars, bryozoans, and brittle stars.

Egg: Information is limited. See mature phase description; eggs are carried by adult female crab.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Late juvenile golden king crabs are found throughout the depth range of the species. Abundance of late juvenile crab increases with depth, and these crab are most abundant at depths >548 m.

Mature: Mature golden king crabs occur at all depths within their distribution. Males tend to congregate in somewhat shallower waters than females, and this segregation appears to be maintained throughout the year. Legal male crabs are most abundant between 274 and 639 m. Abundance of sub-legal males increases at depth >364 m. Female abundance is greatest at intermediate depths between 274 and 364 m.

SPECIES: Golden king crab, *Lithodes aequispina*

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	15 mo.	n/a	all year	LSP	D	N/A		
Larvae	3-5 mo.	lecithotrophic	all year	U	P	N/A		
Juveniles		U	all year		D			
Adults		Ophiuroids, sponges, fish, plants, crustaceans	Spawning all year	LSP, BSN	D	R		

Habitat Description for Scarlet King Crab *(Lithodes couesi)*

Life History and General Distribution

Little information is available on the biology of the scarlet king crab (*Lithodes couesi*), found in the BS and AI area. Based on data from the GOA, this species occurs in deep water, primarily on the continental slope. Spawning may be asynchronous. Females can produce up to 5,000 eggs, depending on female size. Larvae are lecithotrophic pelagic, but nothing is known about where they reside in the water column or about the duration of larval development.

Fishery

Scarlet king crab are harvested by longlining mesh covered pots. Directed fishing may occur only under conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game. Scarlet king crab are also taken incidentally in the golden king crab fishery.

Relevant Trophic Information

Unknown

Approximate Upper Size Limit of Juvenile Crab (in cm): The size (CL) of 50 percent maturity for female and males is 8 cm and 9.1 cm.

Habitat and Biological Associations

Scarlet king crab are associated with steep rocky outcrops and narrow ledges. Strong currents are prevalent.

Egg: Information is limited. See mature phase description; eggs are carried by adult female crab.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Information is not available.

Mature: Information is limited. Mature scarlet king crabs are caught incidentally in the golden king crab and *C. tanneri* fisheries.

Habitat Description for Tanner Crab (*Chionoecetes bairdi*)

Life History and General Distribution

Tanner crab (*Chionoecetes bairdi*) are distributed on the continental shelf of the North Pacific Ocean and BS from Kamchatka to Oregon. Off Alaska, Tanner crab are concentrated around the Pribilof Islands and immediately north of the Alaska Peninsula. They occur in lower abundance in the GOA. Size at 50 percent maturity is variable, but approximately 11 cm for males and 9 cm carapace width (CW) for females in the BS. The age of maturity for male Tanner crab is estimated at 6 to 8 years. Mature male Tanner crabs may skip a year of molting as they attain maturity. Natural mortality of adult Tanner crab is assumed to be about 25 percent per year (M=0.3).

Fishery

Tanner crab fisheries are prosecuted on stocks in the EBS, eastern AI, western AI, and GOA. However, only the EBS fisheries are regulated by NMFS; the GOA and AI fisheries are inshore and much smaller than the EBS fisheries, and are regulated solely by the State of Alaska. The directed fisheries for Tanner crab in the EBS are co-managed with NMFS by the State of Alaska based on two management areas, one east and one west of 166ºW longitude. Minimum legal sizes are 4.8 inches CW east of 166ºW longitude and 4.4 inches CW west of 166ºW longitude. Only male crab may be landed. The fishery officially opens on October 15, but fishing generally begins shortly after closure of the Bristol Bay red king crab fishery in early November. Retention of Tanner crab up to 5% of the target weight is allowed in both the Bristol Bay red king crab and snow crab fisheries. Bycatch in the directed fishery consists of primarily of non-legal Tanner crab and red king crab. The directed fishery in the EBS was closed from 1996 to 2004, and again from 2010 to 2012, due to low biomass. Tanner crab fisheries are prosecuted using mesh covered pots (generally 7 or 8 feet square, but less than 10 feet square) set on single lines. Estimated mean age at recruitment to the fishery is 8 to 9 years. A 5-inch maximum tunnel height opening for Tanner crab pots is required to inhibit the bycatch of red king crab. Also, escape rings are required to reduce capture and handling mortality of all non-target crab; a minimum of four 5-inch rings are required on pots used in Tanner crab fisheries.

Relevant Trophic Information

Pacific cod is the main predator on Tanner crabs in terms of biomass. Predators consume primarily age 0 and 1 juvenile Tanner crab with a less than 7 cm CW. However, flathead sole, rock sole, halibut, skates, and yellowfin sole are important in terms of numbers of small crab. Larval predators include salmon, herring, jellyfish, and chaetognaths. Cannibalism is also common.

Approximate Upper Size Limit of Juvenile Crab (in cm): The size at 50 percent maturity is 9- and 11-cm CW for female and male crabs.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Larvae of *C. bairdi* Tanner crabs are typically found in the BSAI water column from 0 to 100 m in early summer but mostly above 20m. They usually stay near the depth of the chlorophyll maximum and in the BS there is no evidence of diel migration. The last larval stage settles onto the bottom mud.

Early Juvenile: Early juvenile *C. bairdi* Tanner crabs occur at depths of 10 to 70 m in mud habitat in summer and are known to burrow or associate with many types of cover. Early juvenile *C. bairdi* Tanner crabs are not easily found in winter.

Late Juvenile: The preferred habitat for late juvenile *C. bairdi* Tanner crabs is mud. Late juvenile Tanner crab migrate offshore of their early juvenile nursery habitat.

Mature: Mature *C. bairdi* Tanner crabs likely migrate inshore, and mating occurs from February through June. Mature female *C. bairdi* Tanner crabs can form high density mating aggregations, or pods, consisting of hundreds of crabs per mound. These mounds may provide protection from predators and also attract males for mating. Mating need not occur every year, as female *C. bairdi* Tanner crabs can retain viable sperm in spermathecae for at least 2 years. Females carry clutches of 24,000 to 400,000 eggs and brood the embryos for 1 year after fertilization (Hilsinger 1976). Primiparous females may carry the fertilized eggs for as long as 1.5 years. Brooding occurs in 100 to 150 m depths.

SPECIES: Tanner crab, *Chionoecetes bairdi*

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	1 year	NA	Feb-March	NA	NA	NA	F	
Larvae	3 to 5 mo.	Diatoms Algae Zooplankton	Summer	MCS, ICS	P	NA	F	
Juveniles	1 to 6 years	Crustaceans polychaetes mollusks diatoms algae hydroids	All year	MCS, ICS, BAY, BCH	D	M	F	
Adults	6+ years	Polychaetes crustaceans mollusks hydroids algae fish	Spawning Jan. to June (peak April-May)	MCS, ICS	D	M	F	

Habitat Description for Snow Crab (*Chionoecetes opilio*)

Life History and General Distribution

Snow crabs (*Chionoecetes opilio*) are distributed on the continental shelf of the BS, Chukchi Sea, and in the western Atlantic Ocean as far south as Maine. Snow crab are not present in the GOA. In the BS, snow crabs are common at depths less than 200 m. The EBS population within U.S. waters is managed as a single stock; however, the distribution of the population extends into Russian waters to an unknown degree. While 50 percent of the females are mature at 5-cm CW, the mean size of mature females varies from year to year over a range of 6.3- to 7.2-cm CW. Females cease growing with a terminal molt to maturity and rarely exceed 8 cm CW. The median size of maturity for males is about 8.5-cm CW (approximately 6 to 8 years old). Males larger than 6 cm grow at about 2 cm per molt, up to an estimated maximum size of 14.5-cm CW, but individual growth rates vary widely. Natural mortality of adult snow crab is assumed to be about 25 percent per year (M=0.3).

Fishery

The snow crab fishery is prosecuted using mesh covered pots (generally 7 or 8 feet square) set on single lines. Male only crab greater than 7.8-cm CW may be harvested; however, a market minimum size of about 10.2 cm CW is generally observed. Most male snow crab probably enter the fishery at around age 6 to 8 years. Snow crab are probably one stock in the BS. The season in the BS opens on October 15 and closes May 31 of the following year. A 3-inch maximum tunnel height opening for snow crab pots is required to prevent bycatch of red king crab. A minimum of eight 4-inch escape rings are required on snow crab pots to reduce capture and handling mortality of non-target crab. Bycatch in the snow crab fishery consists primarily of *C. bairdi* and non-legal *C. opilio*.

Bottom trawls and dredges could disrupt nursery and adult feeding areas.

Relevant Trophic Information

Pacific cod, sculpins, skates, and halibut are the main predators on snow crabs in terms of biomass. Snow crabs less than 7-cm CW are most commonly consumed. Other predators include yellowfin sole, flathead sole, Alaska plaice, walleye pollock, rock sole, bearded seals, and walrus. Snow crabs are also cannibalistic.

Approximate Upper Size Limit of Juvenile Crab (in cm): The size at 50 percent maturity is 5- and 8.5-cm CW for female and male crabs, respectively.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Larvae of *C. opilio* snow crab are found in early summer primarily in the upper mixed layer (> 20 depth) and do not exhibit diel migration. The last of three larval stages settles onto bottom in nursery areas.

Early Juvenile: Shallow water areas of the EBS with muddy substrate are considered nursery areas for *C. opilio* snow crabs and are confined to the mid-shelf area due to the thermal limits of early and late juvenile life stages.

Late Juvenile: A geographic cline in size of *C. opilio* snow crabs indicates that a large number of morphometrically immature crabs occur in shallow waters less than 80 m.

Mature: Female *C. opilio* snow crabs have a terminal molt to maturity. Primiparous female snow crabs mate January through June and may exhibit longer egg development period and lower fecundity than multiparous female crabs. Multiparous female snow crabs can store spermatophores in seminal vesicles and fertilize subsequent egg clutches without mating. At least two clutches can be fertilized from stored spermatophores, but the frequency of this occurring in nature is not known. Females carry clutches of 10,000-70,000 eggs depending on size and brood the embryos for either 1 or 2 years after fertilization depending on the water temperature. However, fecundity may decrease up to 50 percent between the time of egg extrusion and hatching, presumably due to predation, parasitism, abrasion, or decay of unfertilized eggs. Brooding probably occurs in depths greater than 50 m.

SPECIES: Snow crab, *Chionoecetes opilio*

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	1-2 year	NA		NA	NA	NA	F	
Larvae	3 to 5 mo.	Diatoms algae zooplankton	Spring, summer	ICS, MCS	P	NA	F	
Juveniles	1 to 4 years	Crustaceans polychaetes mollusks diatoms algae hydroids	All year	ICS, MCS, OCS	D	M	F	
Adults	4+ years	Ploychaetes brittle stars mollusks crustaceans hydroids algae diatoms	Spawning Jan. to June (peak April-May)	ICS, MCS, OCS	D	M	F	

Habitat Description for Grooved Tanner Crab *(Chionoecetes tanneri)*

Life History and General Distribution

In the eastern North Pacific Ocean, the grooved Tanner crab (*Chionoecetes tanneri*) ranges from northern Mexico to Kamchatka. Little information is available on the biology of the grooved Tanner crab. This species occurs in deep water on the continental slope and is not common at depths above 300 m. Male and female crabs are found at similar depths. Male and female grooved Tanner crab generally reach maturity at 11.9- and 7.9-cm CW, respectively.

Fishery

Directed harvest of grooved Tanner crab has been sporadic since the first reported landings in 1988. Crabs are taken in mesh covered pots deployed on a longline. Harvest can occur only under conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game.

Relevant Trophic Information

Unavailable

Approximate Upper Size Limit of Juvenile Crab (in cm): Size at 50 percent maturity is 11.9-cm CW for males and 7.9-cm CW for females.

Habitat and Biological Associations

Egg: Information is not available.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Juveniles are found in deeper waters than adults and are most common from about 720-1100 m.

Mature: In the EBS, mature male grooved Tanner crabs may be found somewhat more shallow than mature females, but male and female crabs do not show clear segregation by depth. Females migrate to shallower depths to release eggs.

Habitat Description for Triangle Tanner Crab (*Chionoecetes angulatus*)

Life History and General Distribution

In the eastern North Pacific Ocean, the distribution of triangle Tanner crab (*Chionoecetes angulatus*) ranges from Oregon to the Sea of Okhotsk. This species occurs on the continental slope in waters deeper than 300 m and has been reported as deep as 2,974 m in the EBS. A survey limited to a particular depth range found that mature male crabs inhabit depths around 647 m shallower than the mean depth of 748 m for female crabs. Size at 50 percent maturity for male triangle Tanner crabs is 9.1-cm CW and 5.8-cm CW for females.

Fishery

A directed fishery for triangle Tanner crab occured for the first time in 1995. Prior to 1995, these crab had been harvested as bycatch in the *C. tanneri* fishery. Directed harvest is allowed only under the conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game. Crab are taken in mesh covered pots deployed on a longline.

Relevant Trophic Information

Unknown

Approximate Upper Size Limit of Juvenile Crab (in cm): In the EBS, male triangle Tanner crabs reach size at 50 percent maturity at 9.1-cm CW and females at 5.8-cm CW.

Habitat and Biological Associations

Egg: Information is not available.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Information is not available.

Mature: The mean depth of mature male triangle Tanner crabs (647 m) is significantly less than for mature females (748 m), indicating some pattern of sexual segregation by depth.