# EFH 5-year Review for 2010: Summary Report

## Appendix 3 BSAI Crab FMP species reviews

Red king crab .....1
Blue king crab.....10
Golden king crab .....20
Tanner crab .....32
Snow crab.....47

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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] **RED KING CRAB**

## 2.0 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; however, summary tables that denote habitat associations (Table 2), reproductive traits (Table 3), and predator and prey associations (Table 4) are also provided. In each section, a species-specific table summarizes habitat requirements.

**Table 1 Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.**

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

**Table 2 Summary of habitat associations for BSAI crab.**

| Scallop | | Nearshore | | | | Shelf | | | Slope | | | | | | Stratum Reference | | | | | | | Location | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Inner | Middle | Outer | Upper | | Inter-mediate | | Lower | Basin | | | | | | | | | | | | Pelagic | | |
| Species | Life Stage | 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 | Surafce | Near surface | Semi-demersal | Demersal | 1-200m (epi) | 201-1000m (meso) | >1000m (bathy) |
| **Red king crab** | M | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |
| | LJ | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |
| | EJ | | | | | x | x | | | | | | | | | | | | | | | | | | x | | | |
| | L | | | | | x | x | | | | | | | | | | | | | | | | | | | x | | |
| | E | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |

| Scallop | | Physical Oceanography | | | | | Substrate | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |
| Species | Life Stage | 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 |
| **Red king crab** | M | | | | | | x | x | x | x | x | x | x | x | x | x | x | | |
| | LJ | | | | | | x | x | x | x | x | x | x | x | x | x | x | | |
| | EJ | | | | | | | | | x | | | | | | | | x | x |
| | L | | | | | | | | | | | | | | | | | | |
| | E | | | | | | x | x | x | x | x | x | x | x | x | x | x | | |

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] **RED KING CRAB**

| Scallop | | Structure | | | | | | | | | Community Associations | | | | | | | | | | | | Oceanographic Properties | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | 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) |
| **Red king crab** | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| | LJ | | | | | | | | | | | | | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table 3 Summary of biological associations for BSAI crab.**

| Scallop | | Reproductive Traits | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Age at Maturity | | | | Fertilization/Egg Development | | | | | Spawning Behavior | | | | | | Spawning Season | | | | | | | | | | |
| | | Female | | Male | | | | | | | | | | | | | | | | | | | | | | | |
| **Species** | Life Stage | **50%** | **100%** | **50%** | **100%** | **External** | **Internal** | **Oviparous** | **Ovoviviparous** | **Viviparous** | **Batch Spawner** | **Broadcast Spawner** | **Egg Case Deposition** | **Nest Builder** | **Egg/Young Guarder** | **Egg/Young Bearer** | **January** | **February** | **March** | **April** | **May** | **June** | **July** | **August** | **September** | **October** | **November** | **December** |
| **Red king crab** | M | **7 to 8** | | **7 to 10** | | **x** | | **x** | | | | | | | | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | | | | | |
| | LJ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | |

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] RED KING CRAB

**Table 4 Summary of predator and prey associations for BSAI crab**

| Scallop | | Predator to | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | Algae | Plants | Plankton | Zooplankton | Diatoms | Sponges | Eusphausiid | Hydroids | Amphipoda | Copepods | Starfish | Polychaetes | Squid | Philodae (gunnels) | Bi-valves | Mollusks | Crustaceans | Ophiuroids (brittle stars) | Shrimps, mysidacae | Sand lance | Osmerid (eulachon) | Herring | Myctophid (lantern fishes) | Cottidae (sculpins) | Arrowtooth | Rockfish | Salmon | Pacific cod | Pollock | Halibut |
| Red king crab | M | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | LJ | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Scallop | | Prey of | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | | Jellyfish | Starfish | Chaetognaths (arrowworms) | Crab | Herring | Salmon | Pollock | Pacific cod | Ling cod | Rockfish | Rock Sole | Flathead Sole | Yellowfin sole | Arrowtooth flounder | Hailbut | Salmon Shark | Northern Fur Seal | Harbor Seal | Steller sea lion | Dalls Porpoise | Beluga whale | Killer Whale | Minke whale | Eagles | Murres | Puffin | Kittiwake | Gull | Terrestrial Mammals |
| Red king crab | M | | | | | | | x | x | | | | | | | x | | | | | | | | | | | | | | |
| | LJ | | | | | | | x | x | | | x | x | x | x | x | | | | | | | | | | | | | | |
| | EJ | | | | | | | x | x | | | x | x | x | x | x | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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

### Life History and General Distribution

Red king crab (*Paralithodes camtshaticus*) is widely distributed throughout the BS and AI, GOA, Sea of Okhotsk, and along the Kamchatka shelf. Red king crab are 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 slower and do not get as large as males. In Bristol Bay, 50 percent maturity is attained by males at 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 6.8 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 16.5 percent per year (M=0.18), due to old age, disease, and predation.

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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 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 Adak 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 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 area, St. Matthew, and St. Lawrence Island area, but are managed in conjunction with the predominant blue king crab fisheries. Red king crab stocks are managed separately to accommodate different life histories and fishery characteristics. Male only red king crab >16.5 cm CL are allowed to be taken from Bristol Bay and the Pribilof and AI. The minimum size limit for harvest of male only crab from the Norton Sound and the St. Matthew and St. Lawrence Island population is 12 cm. Since the IFQ fishery in 2005, the season in Bristol Bay begins on November 1 and can last for three months. Bycatch in red king crab fisheries consists primarily of Tanner crab and nonlegal red king crab. The commercial fishery for red king crab in Norton Sound occurs in the summer, opening in late June, and a winter through-the-ice fishery opens November 15 and closes May 15.

**Deleted:** T

**Deleted:** generally has lasted less than 10 days in recent years

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

### Relevant Trophic Information

Pacific cod is the main predator on red king 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 during molting.

**Approximate Upper Size Limit of Juvenile Crab (in cm):** The size at 50 percent maturity is 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 9 and 12 cm, respectively, for Bristol Bay and the Pribilof and Aleutian Islands.

### Habitat and Biological Associations

*Egg*: Egg hatch of larvae is synchronized with the spring phytoplankton bloom in southeast Alaska 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 crab larvae spend 2 to 3 months in pelagic larval stages before settling to the benthic life stage. Reverse diel migration and feeding patterns of larvae coincide with the distribution of food sources.

*Early Juvenile*: Early juvenile stage red king crabs are solitary and need high relief habitat or coarse substrate such as boulders, cobble, shell hash, and living substrates such as bryozoans and stalked ascidians. Young-of-the-year crabs occur at depths of 50 m or less.

*Late Juvenile*: Late juvenile stage red king crabs ages of 2 and 4 years exhibit decreasing reliance on habitat and a tendency for the crab to form pods consisting of 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), generally beginning in January and continuing through June. Males grasp females just prior to female molting, after which the eggs (43,000 to 500,000 eggs) are fertilized and extruded on the female's abdomen. The female red king crab carries the eggs for 11 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 | 11 mo | NA | May-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 | SAV (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 | |

### 3.1 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 "1" means information is available to determine EFH.

**Table 8.1 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 | x | 1 | 1 |

### 3.1.1 Red King Crab

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

**Larvae—No EFH Description Determined**
Insufficient information is available.

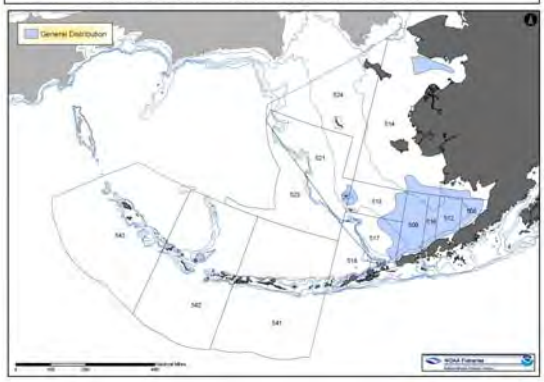
**Early Juveniles—No EFH Description Determined**
Insufficient information is available.

**Late Juveniles**
EFH for late juvenile 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, bryozoans, ascidians, and shell hash, as depicted in Figure 3.

**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, as depicted in Figure 3.

## 3.2 Maps of Essential Fish Habitat

Figure 3. EFH Distribution - BSAI Red King Crab (Late Juveniles/Adults)



### 4.4 Evaluation of Effects on EFH of BSAI Crab Species

This section evaluates whether the fisheries, as they are currently conducted off of Alaska, will affect habitat that is essential to the welfare of the managed fish populations in a way that is more than minimal and not temporary. The previous statement describes the standard set in the EFH regulations which, if met, requires Councils to act to minimize such effects. The above analysis has identified changes to habitat features that are not expected to be temporary. The habitat features were selected as those which a) can be affected by fishing and b) may be important to fish in spawning, breeding, feeding, and growth to maturity. This section evaluates the extent that these changes relate to the EFH of each managed species and whether they constitute an effect to EFH that is more than minimal.

Two conclusions are necessary for this evaluation: (1) the definition of EFH draws a distinction between the amount of habitat necessary for a species to "support a sustainable fishery and the managed species' contribution to a healthy ecosystem" (50 CFR 600.10) and all habitat features used by any individuals of a species; (2) this distinction applies to both the designation of EFH and the evaluation of fishing effects on EFH. If these conclusions are valid, the "more than minimal" standard relates to impacts that potentially affect the ability of the species to fulfill its fishery and ecosystem roles, not just impacts on a local scale. The forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that species (a term used to represent "the ability of a species to support a sustainable fishery and its role in a healthy ecosystem").

The evaluation method is detailed in Section B.3.1 of Appendix B of the EFH EIS (NMFS 2005).

The Effects of Fishing on EFH analysis in the EFH EIS was made to answer the question: "Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature?" The following text summarizes the results of the analysis for each managed species. The details of the analysis for each species, including the habitat connections and the evaluation of effects, are contained in Section B.3.3 of Appendix B of the EFH EIS (NMFS 2005) and are incorporated by reference.

#### 4.4.1 Red King Crab

| Issue | Evaluation |
|---|---|
| Spawning/breeding | S (Substantial effect) |
| Feeding | U (Unknown effect) |
| Growth to maturity | MT (Minimal, temporary, or no effect) |

Summary of Effects - There is an area of overlap between current female red king crab distribution and areas where trawling occurs in the southern Bristol Bay. Southern Bristol Bay is an important spawning ground for red king crab and heavy trawling there could greatly impact the crab spawning success. Trawling in deeper waters also somewhat overlaps the migration route to mating areas. There are essentially no fishing effects in areas important to juvenile red king crab. All known juvenile rearing areas are currently protected by trawl closure areas. Most of the distribution of red king crab was to the north and east of the high fishing effects areas during the past 15 years. However, a high density of mature female crab were found in the heavy trawling area during 2008-2009, and it appears that mature female crab moved back to the historical important spawning ground in the southern Bristol Bay. Given the current overlap, trawling intensity in the southern Bristol Bay, and the importance of the spawning ground there, professional judgement indicates that trawling fisheries have currently adversely affect the EFH of red king crab.

**Deleted:** MT
**Deleted:** Minimal, temporary, or no effect
**Deleted:**
**Deleted:** only a small
**Deleted:** Mating areas experience little impact; however,
**Deleted:** t
**Deleted:** is
**Deleted:** very small
**Deleted:** and
**Deleted:** fishing
**Deleted:** areas with red king crab of all life stages,
**Deleted:** do not

## 4.5 Conclusions

### Species Evaluations

Evaluations were completed for 26 managed species (or species groups) and 8 forage species, all managed under the 5 FMPs developed by the Council (Table B.4-1 of the EFH EIS). See Sections B.3.2 to B.3.4 of the EFH EIS for more detailed information. Based on the available information, the analysis found indication that continued fishing (trawling) at the current rate and intensity in the southern Bristol Bay would affect the capacity of EFH to support the life history processes of red king crab. In other words, the effects of fishing on EFH would be more than minimal. Reasons for substantial ratings were predominantly overlap of an important spawning ground of red king crab with bottom trawling in the southern Bristol Bay. This heavy trawling could impact the stock recovery and jeopardize the ability of the stock to produce MSY over the long term. Beyond trawling in the southern Bristol Bay, other fishings may have minimum impacts on red king crab EFH.

**Deleted:** no

**Deleted:** any species

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**Deleted:** minimal

**Deleted:** either lack of a connection to affected habitat features, or findings from stock analyses that current fishing practices (including effects on habitat) do not

**Deleted:** Other evaluations indicated that, even though a connection may exist between a habitat feature and a life-history process, the expected feature reductions were considered too small to make effects at the population level likely. There were also cases where the effects did not overlap significantly with the distribution of the species. ¶

Most of unknown ratings were for species that have received relatively little study; hence, their life history needs and population status are poorly known. Most species with unknown ratings support small or no fisheries. Conversely, species that support significant fisheries have been studied more. In some cases, associations between the habitat features and life history processes were indicated, but the evaluator did not have enough information to assess whether the linkage and the amount of feature reduction would affect species welfare.

Even for well studied species, the knowledge to trace use of habitat features confidently for spawning, breeding, feeding, and growth to maturity to population level effects is not yet available. Several evaluators specifically cited uncertainty regarding the effect of particular noted linkages, and some urged caution.

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2 BLUE KING CRAB

## 2.0 Life History Features and Habitat Requirements of FMP Species

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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; however, summary tables that denote habitat associations (Table 2), reproductive traits (Table 3), and predator and prey associations (Table 4) are also provided. In each section, a species-specific table summarizes habitat requirements.

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The following abbreviations are used in the habitat tables to specify location, position in the water column, bottom type, and other oceanographic features.

**Table 1. Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.**

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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

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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2 BLUE KING CRAB

**Table 2. Summary of habitat associations for BSAI crab.**

| BSAI Crab | | Nearshore | | | | Shelf | | | Slope | | | | | | Stratum Reference | | | | | | | Location | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Inner | Middle | Outer | Upper | | Inter-mediate | | Lower | Basin | | | | | | | | | | | Pelagic | | |
| Species | Life Stage | 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 | Surafce | Near surface | Semi-demersal | Demersal | 1-200m (epi) | 201-1000m (meso) | >1000m (bathy) |
| Blue king crab | M | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |
| | LJ | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |
| | EJ | | | | | x | x | | | | | | | | | | | | | | | | | | x | | | |
| | L | | | | | x | x | | | | | | | | | | | | | | | | | | | x | | |
| | E | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |

| BSAI Crab | | Physical Oceanography | | | | | Substrate | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | 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 |
| | LJ | | | | | | | | x | x | | | | | | | | x | x |
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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2 BLUE KING CRAB

| BSAI crab | Structure | | | | | | | | | | Community Associations | | | | | | | | | | | | Oceanographic Properties | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | 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) |
| Blue king crab | M | | | x | x | x | x | | x | x | | | | | | | | | | | | | | | |
| | LJ | | | x | x | x | x | | x | x | | | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | x | x | x | x | | x | x | | | | | | | | | | | | | | | |

**Table 3. Summary of biological associations for BSAI crab.**

| BSAI Crab | | Reproductive Traits | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Age at Maturity | | | | Fertilization/Egg Development | | | | | Spawning Behavior | | | | | | Spawning Season | | | | | | | | | | |
| | | Female | | Male | | | | | | | | | | | | | | | | | | | | | | | |
| Species | Life Stage | 50% | 100% | 50% | 100% | External | Internal | Oviparous | Ovoviparous | Viviparous | Batch Spawner | Broadcast Spawner | Egg Case Deposition | Nest Builder | Egg/Young Guarder | Egg/Young Bearer | 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 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2 BLUE KING CRAB

**Table 4 Summary of predator and prey associations for BSAI crab**

BSAI crab Predator to

| Species | Life Stage | Algae | Plants | Plankton | Zooplankton | Diatoms | Sponges | Euphausiid | Hydroids | Amphipoda | Copepods | Starfish | Polychaetes | Squid | Philodae (gunnels) | Bi-valves | Mollusks | Crustaceans | Ophiuroids (brittle stars) | Shrimps, mysidacae | Sand lance | Osmerid (eulachon) | Herring | Myctophid (lantern fishes) | Cottidae (sculpins) | Arrowtooth | Rockfish | Salmon | Pacific cod | Pollock | ulibut |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blue king crab | M | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | LJ | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Scallop Prey of

| Species | | Jellyfish | Starfish | Chaetognaths (arrowworms) | Crab | Herring | Salmon | Pollock | Pacific cod | Ling cod | Rockfish | Rock Sole | Flathead Sole | Yellowfin sole | Arrowtooth flounder | Hailbut | Salmon Shark | Northern Fur Seal | Harbor Seal | Steller sea lion | Dalls Porpoise | Beluga whale | Killer Whale | Minke whale | Eagles | Murres | Puffin | Kittiwake | Gull | nmals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Blue king crab | M | | | | | | | | x | | | | | | | x | | | | | | | | | | | | | | |
| | LJ | | | | | | | | x | | | | | | | x | | | | | | | | | | | | | | |
| | EJ | | | | | | | | x | | | | | | | x | | | | | | | | | | | | | | |
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## 2.4 Habitat Description for Blue King Crab *(Paralithodes platypus*

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### 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 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 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. Unlike red king crab, juvenile blue king crab do not form pods, instead they rely on cryptic coloration for protection from predators. Adult male blue king crab occur at an average depth of 70 m and an average temperature of 0.6°C.

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### 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 are fished: the Pribilof Islands and the St. Matthew Island stocks. These blue king crab fisheries occurred in September in past years. Bycatch in the blue king crab fisheries consists almost entirely of non-legal blue king crabs. Male only crabs >16.5 cm carapace width (CW) are harvested in the Pribilof Islands, while the St. Matthew Islands fishery is managed with a minimum size limit of 140 mm.

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Bottom trawls and dredges could disrupt nursery and adult feeding 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 9-cm and 12-cm CL for female and male crabs from the Pribilof Islands, and 8-cm 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.

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*Early Juvenile*: Early juvenile blue king crabs require substrate characterized by gravel and cobble overlaid with shell hash and sponge, hydroid, and barnacle assemblages. These habitat areas have been found at 40 to 60 m around the Pribilof Islands.

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*Late Juvenile*: Late juvenile blue king crabs 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. It has been suggested that 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.

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**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 | D | CB, G, R | F | |
| Adults | 5+ years | | Spawning Feb-Jun | MCS, ICS | D | S, M, CB, G, R | F | |

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### 3.1 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 "1" means information is available to determine EFH.

**Table 8.1 EFH information levels currently available for BSAI crab, by life history stage.**

| BSAI Crab Species | Egg | Larvae | Early Juvenile | Late Juvenile | Adult |
|---|---|---|---|---|---|
| Blue king crab | inferred | x | x | x | x |

### 3.1.2 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: No EFH Description Determined**
Insufficient information is available.

**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, as depicted in Figure 4.

**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, as depicted in Figure 4.

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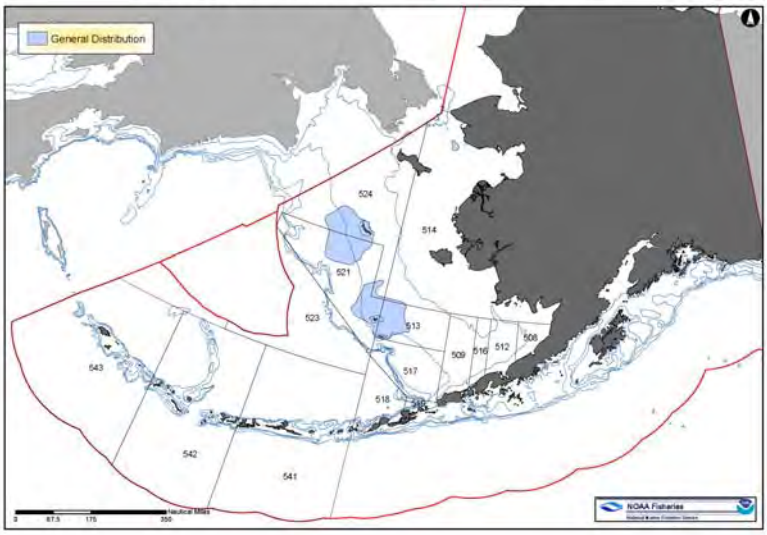
## 3.2 Maps of Essential Fish Habitat

Figure 4. EFH Distribution - BSAI Blue King Crab (Late Juveniles/Adults)



## 4.4 Evaluation of Effects on EFH of BSAI Crab Species

This section evaluates whether the fisheries, as they are currently conducted off of Alaska, will affect habitat that is essential to the welfare of the managed fish populations in a way that is more than minimal and not temporary. The previous statement describes the standard set in the EFH regulations which, if met, requires Councils to act to minimize such effects. The above analysis has identified changes to habitat features that are not expected to be temporary. The habitat features were selected as those which a) can be affected by fishing and b) may be important to fish in spawning, breeding, feeding, and growth to maturity. This section evaluates the extent that these changes relate to the EFH of each managed species and whether they constitute an effect to EFH that is more than minimal.

Two conclusions are necessary for this evaluation: (1) the definition of EFH draws a distinction between the amount of habitat necessary for a species to "support a sustainable fishery" and the managed species "contribution to a healthy ecosystem" (50 CFR 600.10) and all habitat features used by any individuals of a species; (2) this distinction applies to both the designation of EFH and the evaluation of fishing effects on EFH. If these conclusions are valid, the "more than minimal" standard relates to impacts that potentially affect the ability of the species to fulfill its fishery and ecosystem roles, not just impacts on a local scale. The forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that species (a term used to represent "the ability of a species to support a sustainable fishery and its role in a healthy ecosystem").

The evaluation method is detailed in Section B.3.1 of Appendix B of the EFH EIS (NMFS 2005).

The Effects of Fishing on EFH analysis in the EFH EIS was made to answer the question: "Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature?" The following text summarizes the results of the analysis for each managed species. The details of the analysis for each species, including the habitat connections and the evaluation of effects, are contained in Section B.3.3 of Appendix B of the EFH EIS (NMFS 2005) and are incorporated by reference.

### 4.4.2 Blue King Crab

| Issue | Evaluation |
|---|---|
| Spawning/breeding | MT (Minimal, temporary, or no effect) |
| Feeding | U (Unknown effect) |
| Growth to maturity | U (Unknown effect) |

Summary of Effects: Fishing activity effects are unknown or are considered to have overall minimal and temporary effects on the EFH for blue king crab, although the Pribilof Islands stock is below MSST and the St. Matthew stock of blue king crabs has just recovered to $B_{MSY}$. It is unknown if habitat loss or degradation by fishing activities had any role in the decline of these stocks. For the Pribilof Islands blue king crab, any fishing activities thought to have adverse consequences on habitat have previously been mitigated by establishment of the Pribilof Islands trawl closure area. For St. Matthew blue king crab, there has never been a groundfish bottom trawl fishery in the area. Given the current very small overlap and fishing intensity in areas with blue king crab of all life stages, professional judgement indicates that fisheries do not currently adversely affect the EFH of blue king crab.

## 4.5 Conclusions

**Species Evaluations**

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Evaluations were completed for 26 managed species (or species groups) and 8 forage species, all managed under the 5 FMPs developed by the Council (Table B.4-1 of the EFH EIS). See Sections B.3.2 to B.3.4 of the EFH EIS for more detailed information. Based on the available information, the analysis found no indication that continued fishing at the current rate and intensity would affect the capacity of EFH to support the life history processes of any species. In other words, the effects of fishing on EFH would not be more than minimal. Reasons for minimal ratings were predominantly either lack of a connection to affected habitat features, or findings from stock analyses that current fishing practices (including effects on habitat) do not jeopardize the ability of the stock to produce MSY over the long term. Other evaluations indicated that, even though a connection may exist between a habitat feature and a life-history process, the expected feature reductions were considered too small to make effects at the population level likely. There were also cases where the effects did not overlap significantly with the distribution of the species.

Most of unknown ratings were for species that have received relatively little study; hence, their life history needs and population status are poorly known. Most species with unknown ratings support small or no fisheries. Conversely, species that support significant fisheries have been studied more. In some cases, associations between the habitat features and life history processes were indicated, but the evaluator did not have enough information to assess whether the linkage and the amount of feature reduction would affect species welfare.

Even for well studied species, the knowledge to trace use of habitat features confidently for spawning, breeding, feeding, and growth to maturity to population level effects is not yet available. Several evaluators specifically cited uncertainty regarding the effect of particular noted linkages, and some urged caution.

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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] GOLDEN KING CRAB

## 2.0 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; however, summary tables that denote habitat associations (Table 2), reproductive traits (Table 3), and predator and prey associations (Table 4) are also provided. In each section, a species-specific table summarizes habitat requirements.

The following abbreviations are used in the habitat tables to specify location, position in the water column, bottom type, and other oceanographic features.

**Table 1 Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.**

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

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] GOLDEN KING CRAB

**Table 2 Summary of habitat associations for BSAI crab.**

| BSAI Crab | | Nearshore | | | | Shelf | | | Slope | | | | | | Stratum Reference | | | | | | | Location | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Inner | Middle | Outer | Upper | | Inter-mediate | | Lower | Basin | | | | | | | | | | | | Pelagic | | |
| Species | Life Stage | 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 | Surafce | Near surface | Semi-demersal | Demersal | 1-200m (epi) | 201-1000m (meso) | >1000m (bathy) |
| Golden king crab | M | | | | | | | x | x | x | x | x | | | | x | | x | | | | | | | x | | x | |
| | LJ | | | | | | | | | | | | x | x | | | | x | | | | | | | x | | x | |
| | EJ | | | | | | | | | | | | x | x | | | | | | | | | | | x | | x | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | x | x | x | x | | | | | | | x | | | | | | | x | | x | |

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| BSAI Crab | | Physical Oceanography | | | | | Substrate | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | 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 |
| Golden king crab | M | | | | | | | | x | x | | | | | | | | x | x |
| | LJ | | | | | | | | x | x | | | | | | | | x | x |
| | EJ | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | x | x | | | | | | | | x | x |

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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] GOLDEN KING CRAB

BSAI Crab

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| Species | Life Stage | Structure | | | | | | | | | Community Associations | | | | | | | | | | | | Oceanographic 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) |
| Golden king crab | M | | | x | x | x | x | x | x | x | | | | | | | | | | | | | | | |
| | LJ | | | x | x | x | x | | x | x | | | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | x | x | x | x | | x | x | | | | | | | | | | | | | | | |

**Table 3 Summary of biological associations for BSAI crab.**

BSAI Crab

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| Species | Life Stage | Reproductive Traits | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Age at Maturity | | | | Fertilization/Egg Development | | | | | Spawning Behavior | | | | | | Spawning Season | | | | | | | | | | |
| | | Female | | Male | | | | | | | | | | | | | | | | | | | | | | | |
| | | 50% | 100% | 50% | 100% | External | Internal | Oviparous | Ovoviviparous | Viviparous | Batch Spawner | Broadcast Spawner | Egg Case Deposition | Nest Builder | Egg/Young Guarder | Egg/Young Bearer | January | February | March | April | May | June | July | August | September | October | November | December |
| 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 | | | | | | | | | | | | | | | | | | | | | | | | | | | |

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] GOLDEN KING CRAB

**Table 4 Summary of predator and prey associations for BSAI crab**

BSAI Crab — Predator to

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| Species | Life Stage | Algae | Plants | Plankton | Zooplankton | Diatoms | Sponges | Eusphausiid | Hydroids | Amphipoda | Copepods | Starfish | Polychaetes | Squid | Philodae (gunnels) | Bi-valves | Mollusks | Crustaceans | Ophiuroids (brittle stars) | Shrimps, mysidacae | Sand lance | Osmerid (eulachon) | Herring | Myctophid (lantern fishes) | Cottidae (sculpins) | Arrowtooth | Rockfish | Salmon | Pacific cod | Pollock | Halibut |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Golden king crab | M | x | | | | x | | | x | | | x | x | | | x | x | x | x | | | | | | | | | | | | |
| | LJ | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

BSAI Crab — Prey of

Deleted: Scallop

| Species | | Jellyfish | Starfish | Chaetognaths (arrowworms) | Crab | Herring | Salmon | Pollock | Pacific cod | Ling cod | Rockfish | Rock Sole | Flathead Sole | Yellowfin sole | Arrowtooth flounder | Hailbut | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Golden king crab | M | | | | | | | | x | | | | | | | x | | | | | | | | | | | | | | |
| | LJ | | | | | | | | x | | | | | | | x | | | | | | | | | | | | | | |
| | EJ | | | | | | | | x | | | | | | | x | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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## 2.5 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 (NMFS 2004). In the BS and AI, golden king crab are found primarily at depths from 200 to 1,000 m (Somerton and Otto), generally in high relief habitat such as inter-island passes, and they are usually slope-dwelling (NMFS 2004). Size at sexual maturity of males has been estimated to be 13.0 cm CL in the eastern Bering Sea south of 54° 14' N latitude, 10.9 cm CL in the Bowers ridge area, and 12.1 cm Cl in the Seguam Pass area (Otto and Cummiskey 1985). Size at sexual maturity of females has been estimated to be 11.1 cm CL in the eastern Bering Sea south of 54° 14' N latitude, 10.6 cm CL in the Bowers ridge area, and 11.3 cm CL in the Seguam Pass area (Otto and Cummiskey 1985). Females carry an average of approximately 10,000 eggs (Shirley 2006), although they may carry up to 27,000 eggs (Jewett et al. 1985), depending on their size. Females carry and incubate eggs approximately 12 months prior to hatching, but time between production of successive clutches is approximately 590 days due to a prolonged period between hatching of the clutch and molting by the female (Shirley 2006). Reproduction is asynchronous and aseasonal (Adams and Paul 1999, Somerton and Otto 1985) as is the molting cycle (McBride et al. 1982, Otto and Cummiskey 1985, Sloan 1985, Blau and Pengilly 1994, Paul and Paul 2000).

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**Deleted:** Size at sexual maturity depends on latitude and ranges from 9.8 to 11 cm CL, with crabs in the northern areas maturing at smaller sizes.

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**Deleted:** The season of reproduction appears to be protracted and may be year-round

### 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. The golden king crabs in the AI in the areas east and west of 174° W longitude are managed as two separate stocks. T the commercial fishing season for golden king crabs in the Aleutian Islands Area is August 15 through May 15, and male crabs >15.2 cm CW are harvested. Golden king crabs are harvested in the BS under conditions of a permit issued by the Commissioner of the Alaska Department of Fish and Game. Bycatch in the commercial golden king crab fishery consists almost exclusively of non-legal golden king crab. Escape mechanisms were adopted into regulation 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 or at least one-third of one vertical pot surface composed of not less than nine-inch stretched webbing are required on pots used in golden king crab fisheries. Commercial fishing for golden king crabs in the Aleutian Islands Area typically occurs at depths of 183–549 m (Barnard and Burt 2007).

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**Deleted:** we

**Deleted:** : Adak and Dutch Harbor

**Deleted:** he fishing season opens September 1

**Deleted:** ring

**Relevant Trophic Information** Unknown

**Approximate Upper Size Limit of Juvenile Crab (in cm):** See size at maturity estimates for males and females under "Life History and General Distribution," above.

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

**Deleted:** Information is limited.

*Larvae*: Larvae are lecithotrophic and so do not require diel vertical migrations for feeding in shallow waters (Shirley and Zhou 1997). Depth distribution is unknown but is suspected to be deep and larvae are suspected to be more benthic than planktonic (Shirley and Zhou 1997). Larval period is relatively short (approximately 25 days), followed by a glaucothoe stage that lasts approximately 41 days before settlement (Shirley and Zhou 1997).

*Early Juvenile*: Information is not available, but apparently settle in deep water, given observations that juveniles become more abundant with increasing depth (Shirley 2006).

*Late Juvenile*: Late juvenile golden king crabs are found throughout the depth range of the species. Abundance of late juvenile crab increases with depth; in a 1991 pot survey in the AI juvenile crabs were most abundant at the deepest depths fished (548–913 m; Blau et al. 1996).

*Mature*: Large (legal) male crabs are at at highest densities between 274 and 639 m whereas adult females are at highest densities between 274 and 456 m; large males and adult females are absent or at low densities >730 m (Blau et al. 1996)..

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National Marine Fisheries Service (NMFS). 2004. Bering Sea Aleutian Islands Crab Fisheries Final Environmental Impact Statement. DOC, NOAA, National Marine Fisheries Service, AK Region, P.O. Box 21668, Juneau, AK 99802-1668, August 2004.

Otto, R. S., and P. A. Cummiskey. 1985. Observations on the reproductive biology of golden king crab

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**Deleted:** 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

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**Deleted:** Abundance of sub-legal males increases at depth >364 m. Female abundance is greatest at intermediate depths between 274 and 364 m.¶

**Comment [n1]:** Table is redundant (relative to the numerous Tables 1–4), unclear, and entries in it are more, often than not, wrong. Delete it.

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¶
¶
**Life Stage** ... [1]

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(*Lithodes aequispina*) in the Bering Sea and Aleutian Islands. Pages 123–136 *in* Proceedings of the International King Crab Symposium. University of Alaska Sea Grant Report No. 85-12, Fairbanks.

Paul, A. J., and J. M. Paul. 2000. Changes in chela heights and carapace lengths in male and female golden king crabs *Lithodes aequispinus* after molting in the laboratory. Alaska Fishery Research Bulletin 6(2): 70–77.

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### 3.1 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 "1" means information is available to determine EFH.

**Table 8.1 EFH information levels currently available for BSAI crab, by life history stage.**

| BSAI Crab Species | Egg | Larvae | Early Juvenile | Late Juvenile | Adult |
|---|---|---|---|---|---|
| Golden king crab | x | x | x | x | x |

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**Deleted:** X
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#### 3.1.3 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**
Insufficient information is available.
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, as depicted in Figure 5.

**Comment [n2]:** This is not a description opf habitat; it is essentially a description of stock distribution. In fact, it references a distributuion map!

**Adults**
Insufficient information is available.
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, as depicted in Figure 5.

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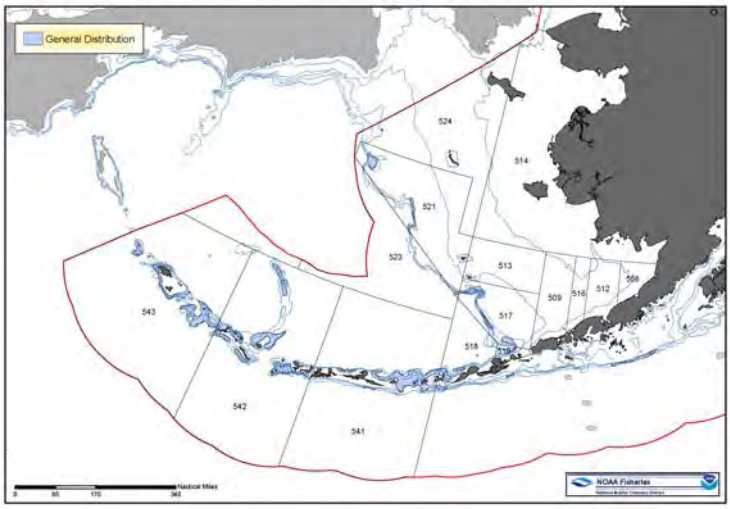
### 3.2 Maps of Essential Fish Habitat

Figure 5. EFH Distribution - BSAI Golden King Crab (Late Juveniles/Adults)



## 4.4 Evaluation of Effects on EFH of BSAI Crab Species

**Comment [n4]:** I'm not sure what this whole section is doing in here…

This section evaluates whether the fisheries, as they are currently conducted off of Alaska, will affect habitat that is essential to the welfare of the managed fish populations in a way that is more than minimal and not temporary. The previous statement describes the standard set in the EFH regulations which, if met, requires Councils to act to minimize such effects. The above analysis has identified changes to habitat features that are not expected to be temporary. The habitat features were selected as those which a) can be affected by fishing and b) may be important to fish in spawning, breeding, feeding, and growth to maturity. This section evaluates the extent that these changes relate to the EFH of each managed species and whether they constitute an effect to EFH that is more than minimal.

**Comment [n5]:** The "above analysis"? What is this and the sentences that follow in the paragraph talking about?

Two conclusions are necessary for this evaluation: (1) the definition of EFH draws a distinction between the amount of habitat necessary for a species to support a sustainable fishery and the managed species' contribution to a healthy ecosystem (50 CFR 600.10) and all habitat features used by any individuals of a species; (2) this distinction applies to both the designation of EFH and the evaluation of fishing effects on EFH. If these conclusions are valid, the more-than-minimal standard relates to impacts that potentially affect the ability of the species to fulfill its fishery and ecosystem roles, not just impacts on a local scale. The forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that species (a term used to represent "the ability of a species to support a sustainable fishery and its role in a healthy ecosystem).

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The evaluation method is detailed in Section B.3.1 of Appendix B of the EFH EIS (NMFS 2005).

The Effects of Fishing on EFH analysis in the EFH EIS was made to answer the question: Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature? The following text summarizes the results of the analysis for each managed species. The details of the analysis for each species, including the habitat connections and the evaluation of effects, are contained in Section B.3.3 of Appendix B of the EFH EIS (NMFS 2005) and are incorporated by reference.

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### 4.4.3 Golden King Crab

| Issue | Evaluation |
|---|---|
| Spawning/breeding | U (Unknown effect) |
| Feeding | U (Unknown effect) |
| Growth to maturity | U (Unknown effect) |

**Deleted:** MT (Minimal, temporary, or no effect)
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Summary of Effects—Fishing activities are unknown due to unknown nature of habitat requirements and EFH. Nonetheless there is no information suggesting that overall fishing effects on golden king crabs EFH are beyond minimal and temporary.

**Deleted:** considered to have overall minimal and temporary effects on the EFH for golden king crab. Groundfish trawl fishing in the EBS slope is of some concern; however, any effects are thought to be minimal. Professional judgment indicates that fisheries do not adversely affect the EFH of golden king crab

## 4.5 Conclusions

**Species Evaluations**

Evaluations were completed for 26 managed species (or species groups) and 8 forage species, all managed under the 5 FMPs developed by the Council (Table B.4-1 of the EFH EIS). See Sections B.3.2 to B.3.4 of the EFH EIS for more detailed information. Based on the available information, the analysis found no indication that continued fishing at the current rate and intensity would affect the capacity of EFH to support the life history processes of any species. In other words, the effects of fishing on EFH

would not be more than minimal. Reasons for minimal ratings were predominantly either lack of a connection to affected habitat features, or findings from stock analyses that current fishing practices (including effects on habitat) do not jeopardize the ability of the stock to produce MSY over the long term. Other evaluations indicated that, even though a connection may exist between a habitat feature and a life-history process, the expected feature reductions were considered too small to make effects at the population level likely. There were also cases where the effects did not overlap significantly with the distribution of the species.

Most of unknown ratings were for species that have received relatively little study; hence, their life history needs and population status are poorly known. Most species with unknown ratings support small or no fisheries. Conversely, species that support significant fisheries have been studied more. In some cases, associations between the habitat features and life history processes were indicated, but the evaluator did not have enough information to assess whether the linkage and the amount of feature reduction would affect species welfare.

Even for well studied species, the knowledge to trace use of habitat features confidently for spawning, breeding, feeding, and growth to maturity to population level effects is not yet available. Several evaluators specifically cited uncertainty regarding the effect of particular noted linkages, and some urged caution.

**Comment [n6]:** What is this whole section referring to?

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**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 | | n/a | all year | LSP | D | | | |
| Larvae | U | | all year | U | P | | | |
| Juveniles | | | all year | | D | | | |
| Adults | | Ophiuroids, sponges, plants | Spawning Feb.-Aug. | LSP BSN | D | | | |

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] **TANNER CRAB**

## 2.0 Life History Features and Habitat Requirements of FMP Species Error! Bookmark not defined.

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; however, summary tables that denote habitat associations (Table 2), reproductive traits (Table 3), and predator and prey associations (Table 4) are also provided. In each section, a species-specific table summarizes habitat requirements.

The following abbreviations are used in the habitat tables to specify location, position in the water column, bottom type, and other oceanographic features.

**Table 1 Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.**

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

**Table 2 Summary of habitat associations for BSAI crab.**

| BSAI Crab | | Nearshore | | | | Shelf | | | Slope | | | | | | Stratum Reference | | | | | | | Location | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Inner | Middle | Outer | Upper | | Inter-mediate | | Lower | Basin | | | | | | | | | | | | Pelagic | | |
| Species | Life Stage | 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 | Surafce | Near surface | Semi-demersal | Demersal | 1-200m (epi) | 201-1000m (meso) | >1000m (bathy) |
| Tanner crab | M | | | | | x | x | x | x | x | x | | | | | | x | x | | | | | | | x | | | |
| | LJ | | | x | x | x | x | x | x | x | | | | | | | | x | | | | | | | x | | | |
| | EJ | | | x | x | x | x | x | x | x | | | | | | | | x | | | | | | | x | | | |
| | L | | x | x | x | x | x | | | | | | | | | | | | | | | | | | | x | | |
| | E | | | | x | x | x | x | x | x | x | x | | | | | | | | | | | | | x | | | |

**Deleted:** Scallop

| BSAI Crab | | Physical Oceanography | | | | | Substrate | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | 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 |
| Tanner crab | M | | | | 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 | |
| | EJ | | | | | | x | x | x | x | x | x | x | x | x | x | x | x | |
| | L | | | | x | x | | | | | | | | | | | | | |
| | E | | | | x | | x | x | x | x | x | x | x | x | x | x | x | x | |

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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] **TANNER CRAB**

| BSAI Crab | | Structure | | | | | | | | | | Community Associations | | | | | | | | | | | | Oceanographic Properties | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | 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) |
| Tanner crab | M | x | x | x | x | | | x | | | x | | | | | | | | | | | | | | | |
| | LJ | x | x | x | x | | | | | | x | | | | | | | | | | | | | | | |
| | EJ | x | x | x | x | | | | | | x | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | x | x | x | x | | | | | | x | | | | | | | | | | | | | | | |

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**Table 3 Summary of biological associations for BSAI crab.**

| BSAI Crab | | Reproductive Traits | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Age at Maturity | | | | Fertilization/Egg Development | | | | | Spawning Behavior | | | | | | Spawning Season | | | | | | | | | | |
| | | Female | | Male | | | | | | | | | | | | | | | | | | | | | | | |
| Species | Life Stage | 50% | 100% | 50% | 100% | External | Internal | Oviparous | Ovoviviparous | Viviparous | Batch Spawner | Broadcast Spawner | Egg Case Deposition | Nest Builder | Egg/Young Guarder | Egg/Young Bearer | January | February | March | April | May | June | July | August | September | October | November | December |
| Tanner crab | M | 6 to 8 | | 6 to 8 | | x | x | x | | | | | | | | x | x | x | x | x | x | x | | | | | | |
| | LJ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] TANNER CRAB

**Table 4 Summary of predator and prey associations for BSAI crab**

BSAI Crab — Predator to

| Species | Life Stage | Algae | Plants | Plankton | Zooplankton | Diatoms | Sponges | Eusphausiid | Hydroids | Amphipoda | Copepods | Starfish | Polychaetes | Squid | Philodae (gunnels) | Bi-valves | Mollusks | Crustaceans | Ophiuroids (brittle stars) | Shrimps, mysidacae | Sand lance | Osmerid (eulachon) | Herring | Myctophid (lantern fishes) | Cottidae (sculpins) | Arrowtooth | Rockfish | Salmon | Pacific cod | Pollock | Halibut |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tanner crab | M | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | LJ | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | x | | | x | x | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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BSAI Crab — Prey of

| Species | | Jellyfish | Starfish | Chaetognaths (arrowworms) | Crab | Herring | Salmon | Pollock | Pacific cod | Ling cod | Rockfish | Rock Sole | Flathead Sole | Yellowfin sole | Arrowtooth flounder | Hailbut | Cottidae (sculpins) | Eel Pouts | Harbor Seal | Steller sea lion | Dalls Porpoise | Beluga whale | Killer Whale | Minke whale | Eagles | Murres | Puffin | Kittiwake | Gull | Mammals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tanner crab | M | | | | x | | | | x | | | | | | | | x | x | | | | | | | | | | | | |
| | LJ | | | | x | | | x | x | | x | x | x | x | x | x | x | x | | | | | | | | | | | | |
| | EJ | | | | x | | | x | x | | x | x | x | | x | x | x | x | | | | | | | | | | | | |
| | L | x | | x | | x | x | x | | | | | | x | | | | | | | | | | | | | | | | |
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## 2.7 Habitat Description for Tanner Crab (*Chionoecetes bairdi*

### Life History and General Distribution

Tanner crab (*Chionoecetes bairdi*), originally described by Rathbun (1924), is one of five species in the genus *Chionoecetes*. The common name for *C. bairdi* of "Tanner crab" (Williams et al. 1989), was recently modified to "southern Tanner crab" (McLaughlin et al. 2005). Previously, the term "Tanner crab" has also been variously used to refer to other members of the genus, or to the genus as a whole.

**Deleted:** 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 are found in lower abundance in the GOA. Size at 50 percent maturity, as measured by CW is 11 cm for males and 9 cm for females in the BS. The corresponding age of maturity for male Tanner crab is approximately 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). ¶

Tanner crab are distributed on the continental shelf of the North Pacific Ocean and Bering Sea from Kamchatka to Oregon. In the east, their range extends as far south as Oregon (Hosie and Gaumer 1974), and in the west as far south as Hokkaido, Japan (Kon 1996). The northern extent of their range is in the Bering Sea (Somerton 1981a) where they are found along the Kamchatka peninsula (Slizkin 1990) to the west and in Bristol Bay to the east. Off Alaska, Tanner crab are concentrated around the Pribilof Islands and immediately north of the Alaska Peninsula. They are found in lower abundance in the GOA. The corresponding age of maturity for male and female Tanner crab is approximately 6 to 8 years. Natural mortality of adult Tanner crab is assumed to be about 20 percent per year (M=0.23).

In the EBS, the Tanner crab distribution may be limited by water temperature (Somerton 1981a). *C. bairdi* is common in the southern half of Bristol Bay, around the Pribilof Islands, and along the shelf break where water temperatures are generally warmer. The southern range of the cold water congener the snow crab, *C. opilio*, in the EBS is near the Pribilof Islands (Turnock and Rugolo 2009). The distributions of snow and Tanner crab overlap on the shelf from approximately 56° to 58°N, and in this area, the two species hybridize (Karinen and Hoopes 1971).

Tanner crabs in the EBS are considered to be a separate stock distinct stock from Tanner crabs in the eastern and western Aleutian Islands (NPFMC 1998). The unit stock is that defined across the geographic range of the EBS continental shelf, and managed as a single unit. Clinal differences in some biological characteristics may exist across the range of the unit stock (Somerton 1981a).

*Reproduction*

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In most majid crabs, the molt to maturity is the final or terminal molt. For *C. bairdi*, it's now accepted that both males (Otto 1998, Tamone et al. 2007) and females (Donaldson and Adams 1989) undergo terminal molt at maturity. Females terminally molt from their last juvenile, or pubescent, instar usually while being grasped by a male (Donaldson and Adams 1989). Subsequent mating occurs annually in a hard shell state (Hilsinger 1976) and after extrusion of a clutch of eggs. Mating in old-shell adult females has been documented (Donaldson and Hicks 1977); fertile egg clutches can be produced in the absence of males by using stored sperm from the spermathacae (Adams and Paul 1983, Paul and Paul 1992). Two or more consecutive egg fertilization events can follow a single copulation using stored sperm to self-fertilize (Paul 1982, Adams and Paul 1983).

Maturity in males can be classified either physiologically or morphometrically. Physiological maturity is the presence of spermataphores in the male gonads whereas morphometric maturity is the presence of a large claw (Brown and Powell 1972). During the molt to morphometric maturity, there is a disproportionate increase in the size of the chelae in relation to the carapace (Somerton 1981a). Many earlier studies on Tanner crabs assumed that morphometrically mature male crabs continued to molt and grow throughout life, however, evidence is irrefutable supporting a terminal molt for males (Tamone et al. 2007). A consequence of the terminal molt in male Tanner crab is that a substantial portion of the population may never reach the legal harvest size of 138 mm carapace width.

While observations are lacking for the EBS, seasonal differences have been observed between mating

periods for pubescent and multiparous Tanner crab females in the GOA and Prince William Sound. Pubescent molting and mating takes place over a protracted period from winter through early summer, whereas multiparous mating occurs over a relatively short period during mid April to early June (Hilsinger 1976, Munk et al. 1996, and Stevens 2000). In the EBS egg condition for multiparous Tanner crabs assessed between April and July 1976 also suggested that hatching and extrusion of new clutches for this maturity status began in April and ended sometime in mid -une (Somerton 1981a).

*Fecundity*

A variety of factors affect female Tanner crab fecundity including female size, maturity status, age post terminal molt, and egg loss (NMFS 2004). Among these factors, female size is the most important, with estimates of 89 to 424 thousand eggs for EBS females 75 to 124 mm carapace width (cw) respectively (Haynes et al. 1976). Maturity status is another significant factor affecting fecundity with primiparous females being only ~70% as fecund as equal size multiparous females (Somerton and Meyers 1983). The number of years post maturity molt, and whether or not, a female has had to use stored sperm from that first mating can also affect egg counts (Paul 1984, Paul and Paul 1992). Additionally, older senescent females often carry small clutches or no eggs (i.e., barren) suggesting that female Tanner crab reproductive output is a declining function of age (NMFS 2004a).

*Size at Maturity*

Somerton (1981b) noted differences in the size of Tanner crab female maturity across its EBS range as seen in trawl survey data. Between 1975 to 1979 east of 167° 15' W longitude, the mean size of mature females in the stock ranged from 92.0 to 93.6 mm cw. West of that longitude, the size of 50% female maturity ranged from 78.0 to 82.0 mm cw. For ADF&G harvest strategy purposes, mature females are defined as females >=80 mm cw (Bowers et al. 2008). For male Tanner crab during the same survey years, the observed mean size at maturity was 117.0 mm cw and 108.9 mm cw east and west of 167° 15' W longitude, respectively (Somerton 1981b). Size at 50 percent maturity, is 93.3 mm cw for males and 69.3 mm cw for females in the EBS.

*Natural Mortality*

Due to a lack of age information, Somerton (1981a) estimated mortality separately for individual EBS cohorts of juveniles and adults. Somerton postulated that because of net selectivity of the survey sampling gear, age 5 Tanner crab (mean cw=95 mm) were the first cohort to be fully recruited to the gear; he estimated an instantaneous natural mortality rate of 0.35 for this size class using catch curve analysis. Using a catch curve analysis with two different data sets, Somerton then estimated natural mortality rates of adults (fished population) from data from the EBS population survey of 0.20 to 0.28. When using CPUE data from the Japanese fishery the estimated rates were 0.13 to 0.18. Somerton concluded that estimates (0.22 to 0.28) from models that used both the survey and fishery data were the best. The natural mortality rate (M) of EBS Tanner crab is set at 0.23 for the purpose of assessing stock status and OFL-setting based on the current expectation of longevity of at least 18-20 y.

**Fishery**

*Management Unit*

Fisheries have historically taken place for Tanner crab throughout their range in Alaska, but currently only the fishery in the EBS is managed under a federal fisheries management plan (NPFMC 1998). The plan defers certain management controls for Tanner crab to the state of Alaska with federal oversight (Bowers et al. 2008). The state manages Tanner crab based on registration areas, divided into districts. Under the plan, the state can adjust or further subdivide these districts as needed to avoid overharvest in a particular area, change size limits from other stocks in the registration area, change fishing seasons, or encourage exploration (NPFMC 1998).

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The Tanner crab fisheries are prosecuted using mesh covered pots (generally 7 or 8 feet square) set on single lines. Mean age at recruitment is 8 to 9 years. Male crab >14 cm CW may be harvested. Fisheries operate on three separate stocks: EBS, eastern AI, and western AI. The directed fishery was closed in 1996 due to low catch per unit effort (CPUE) relative to pre-season expectations. The Tanner crab stocks of the AI are very small, and populations are found in only a few large bays and inlets. As such, the fisheries are limited, occurring during the winter. No commercial fishery was allowed for Tanner crabs in either the east or west AI in 1995 and 1996. The directed fishery for BS Tanner crab opens 7 days after closure of the Bristol Bay red king crab fishery. However, retention of Tanner crab is allowed during the Bristol Bay red king crab fishery that opens November 1. Bycatch in the directed fishery consists of primarily of non-legal Tanner crab and red king crab. A 3-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.¶
¶
Bottom trawls and dredges could disrupt nursery and adult feeding areas.¶

The Bering Sea District of Tanner crab Registration Area J (Figure 3) includes all waters of the Bering Sea north of Cape Sarichef at 54° 36' N lat. and east of the U.S.-Russia Maritime Boundary Line of 1991. This district is divided into the Eastern and Western Subdistricts at 173° W long. The Eastern Subdistrict is further divided at the Norton Sound Section north of the latitude of Cape Romanzof and east of 168° W long. and the General Section to the south and west of the Norton Sound Section (Bowers et al. 2008).

The domestic Tanner crab (*C. bairdi*) pot fishery rapidly developed in the mid-1970s (Table 2, Figures 5). For stock biomass and fishery data tabled in this document, we adopted the convention that 'year' refers to the survey year, and fishery data are those subsequent to the survey, through prior to the survey in the following year. Other notation is explicit – e.g., 2008/09 is the 2008 summer survey and the winter 2009 fishery. United States landings were first reported for Tanner crab in 1968 at 1.01 million pounds taken incidentally to the EBS red king crab fishery (Table 2). Tanner crab was targeted thereafter by the domestic fleet and landings rose sharply in the early-1970s, reaching a high of 66.6 million pounds in 1977 (Table 2, Figure 5). Landings fell precipitously after the peak in 1977 through the early 1980s, and domestic fishing was closed in 1985 and 1986 as a result of depressed stock status. In 1987, the fishery reopened and landings rose again in the late-1980s to a second peak in 1990 at 40.1 million pounds, and then fell sharply through the mid-1990s (Figure 5). The domestic Tanner crab fishery closed between 1997 and 2004 as a result of severely depressed stock condition. The domestic Tanner crab fishery re-opened in 2005 and has averaged 1.7 million pounds retained catch between 2005-2007 (Table 2). Landings of Tanner crab in the foreign Japanese pot and tangle net fisheries were reported between 1965-1978, peaking at 44.0 million pounds in 1969 (Table 2, Figure 5). The Russian tangle net fishery was prosecuted between 1965-1971 with peak landings in 1969 at 15.6 million pounds. Both the Japanese and Russian Tanner crab fisheries were displaced by the domestic fishery by the late-1970s.

Discard and bycatch losses of Tanner crab originate from the directed pot fishery, non-directed pot fisheries (notably, for snow crab and red king crab), and the groundfish trawl fisheries (Table 3). Discard/bycatch mortalities were estimated using post-release handling mortality rates (HM) of 50% for pot fishery discards and 80% for trawl fishery bycatch (NPFMC 2008). Total Tanner crab discard and bycatch losses by sex are shown in Table 3 for 1965-2008. The pattern of total discard/bycatch losses is similar to that of the retained catch (Table 2). These losses were persistently high during the late-1960s through the late-1970s; male losses peaked in 1970 at 44.5 million pounds (Table 3). A subsequent peak mode of discard/bycatch losses occurred in the late-1980s through the early-1990s which, although briefer in duration, revealed higher losses for males than the earlier mode, peaking at 49.2 million pounds in 1990. From 1965-1975, the groundfish trawl fisheries contributed significantly to total bycatch losses, although the combined pot fisheries are the principal source of contemporaneous non-retained losses to the stock (Table 3). Total Tanner crab retained catch plus non-directed losses of males and females (Table 4, Figure 4a) reflect the performance patterns in the directed and non-directed fisheries. Total male catch rose sharply with fishery development in the early 1960s and reveals a bimodal distribution between 1965 and 1980 with peaks of 104.7 million pounds in 1969 and 115.5 million pounds in 1977 (Table 4, Figure 4a). Total male catch rose sharply after the directed domestic fishery reopened in 1987 and reached a peak of 89.3 million pounds in 1990. Total male and female catch fell sharply thereafter with the collapse of the stock and the fishery closure in 1997.

Since re-opening of the domestic fishery in 2005, the relationship of total male discard/bycatch losses by all pot and trawl fisheries combined to retained catch shifted significantly relative to that between 1980-1996 (Tables 2 and 3). For 2005-2008, the ratio of total male discard losses to retained catch was 4.3, 3.8, 4.6, and 2.4, respectively, and averaged 3.8 (se=0.5). The majority of these male losses are sub-legal sized crab, and a principal contributor to these non-retained losses is the directed Tanner crab fishery (Table 7a). This contrasts the pre-closure performance of the domestic fishery between 1980-1996 which averaged 1.1 (se=0.1) pounds of non-retained male losses to each pound of retained catch. These ratios in terms of numbers of non-retained male losses to retained legal crab are more striking due to the

contribution of sub-legal sized crab to total male discards. Discard and bycatch losses of male and female Tanner crab (Table 3) during the closures of the directed domestic fishery (1985-1986 and 1997-2004) reflect losses due to non-directed EBS pot fisheries and the domestic groundfish trawl fishery.

*Exploitation Rates*
The historical patterns of fishery exploitation on LMB and MMB were derived (Table 6, Figures 7a and 7b). The exploitation rate on LMB was estimated as the proportion of retained catch to LMB at the time of the fishery, while that on MMB as the proportion of total male catch to MMB at the time of the fishery. Estimates of LMB are currently available only for 1980-2008. When the re-analysis of the NMFS trawl survey database is completed, MMB estimates will be available for the time series record, 1968 to present. During 1980-2008, exploitation rate (μ) on LMB was highest in 1980 at 0.19 and fell with stock condition through the mid-1980s. LMB exploitation rate revealed a second prominent mode during 1989-1993, peaking at 0.18 in 1991 and averaging 0.17 (Table 6, Figure 7b). These rates of exploitation on LMB are less than the equivalent value of M=0.23 for this stock; the EBS Tanner crab stock did not persist at sustainable or healthy stock levels under these rates. The pattern of μ on MMB from 1969-2008 reveals two high periods: one associated with the high total catches between 1969-1980; the other coincident with the mode of high catches in the late-1980s through early-1990s. The variability in μ on MMB during the early period (1969-1980) is attributed to early biomass estimates which will be replaced by a new biomass time-series biomass in 2010. Exploitation rates on MMB during the 1990s peaked at 0.42 in 1990, averaged 0.21 between 1986-1997, and closely followed the build up in stock biomass during that period.

**Relevant Trophic Information**

Pacific cod is thought to be the main predator on Tanner crabs in terms of biomass (Livingston 1989, Livingston et al. 1993). Sculpins, while of lower stock biomass than the EBS Pacific cod, are also a sinigicant predator of Tanner crabs of all sizes, and particularly large, mature crabs of both sexes. Predators consume primarily age 0 and 1 juvenile Tanner crab with a less than 70 mm cw. However, flathead sole, rock sole, halibut, skates, yellowfin sole and eel pouts are important in terms of numbers of juvenile crab. Larval predators include salmon, herring, jellyfish, and chaetognaths. Cannibalism has been observed in laboratory environments among juvenile crabs during molting.

**Approximate Upper Size Limit of Juvenile Crab (in cm):** The size at 50 percent maturity is 6.9 and 9.3 cm cw for female and male crabs.

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**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. They are strong swimmers and perform diel migrations in the water column (down at night). They usually stay near the depth of the chlorophyll maximum during the day. The last larval stage settles onto the bottom mud.

*Early Juvenile*: Early juvenile *C. bairdi* Tanner crabs occur at depths of 10 to 20 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 migrate inshore, and mating is known to occur from February through June. Mature female *C. bairdi* Tanner crabs have been observed in high density mating aggregations, or pods, consisting of hundreds to thousands of crabs per mound. These mounds may provide protection from predators and also attract males for mating. Mating need not occur annually as female *C. bairdi* Tanner crabs can retain viable sperm in spermathecae and mobilize stored sperm in the absence of male for self-fertilization of a newly extgruded clutch of eggs. Females carry clutches of 50,000 to 400,000 eggs and nurture the embryos for 1 year after fertilization before hatching. While the congener, *C. opilio*, has been shown to exhibit biennial spawning in cold water realms ≤1.5 $^{o}$C (Rugolo et al., 2005), this behavior has not been observed in *C. bairdi* persumtively since Tanner crab inhabit warmer waters than the snow crab. Primiparous females may carry the fertilized eggs for as long as 1.5 years. Brooding occurs in 100 to 150 m depths.

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**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 | April-March | NA | NA | NA | F | |
| Larvae | 2 to 7 mo. | Diatoms<br>Algae<br>Zooplankton | Summer | MCS, ICS | P | NA | F | |
| Juveniles | 1 to 6 years | Crustaceans<br>polychaetes<br>mollusks<br>diatoms<br>algae<br>hydroids | All year | MCS, ICS, BAY, BCH | D | M | F | |
| Adults | 6+ years | Polychaetes<br>crustaceans<br>mollusks<br>hydroids<br>alsae<br>diatoms | Spawning Jan.<br>To June (peak April-May) | MCS, ICS | D | M | F | |

### 3.1 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 "1" means information is available to determine EFH.

**Table 8.1 EFH information levels currently available for BSAI crab, by life history stage.**

| BSAI Crab Species | Egg | Larvae | Early Juvenile | Late Juvenile | Adult |
|---|---|---|---|---|---|
| Tanner crab | x | x | x | 1 | 1 |

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#### 3.1.4 Tanner Crab

**Eggs**
Essential fish habitat of Tanner crab eggs can only be inferred form the general distribution of egg-bearing female crab. (See also Adults.)

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**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 can only be inferred from 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, as depicted in Figure 6.

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**Adults**
EFH for adult Tanner crab is inferred from 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, as depicted in Figure 6.

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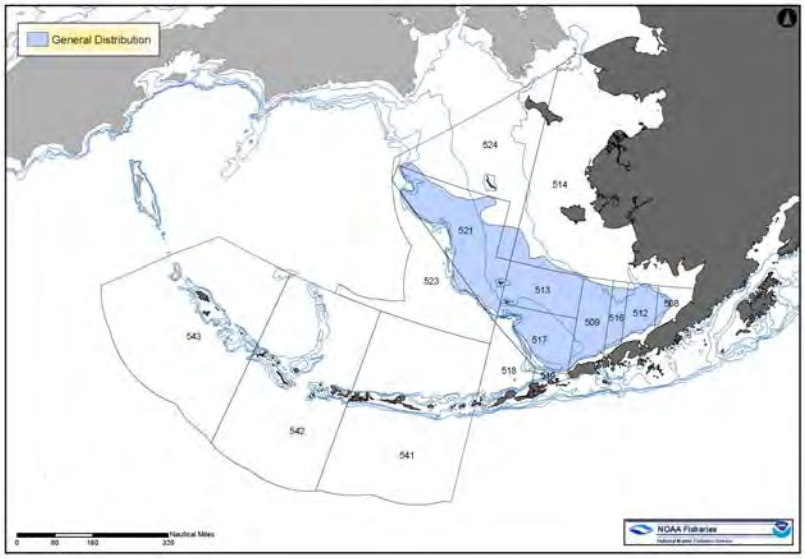
### 3.2 Maps of Essential Fish Habitat

Figure 6. EFH Distribution - BSAI Tanner Crab (Late Juveniles/Adults)



### 4.4 Evaluation of Effects on EFH of BSAI Crab Species

This section evaluates whether the fisheries, as they are currently conducted off of Alaska, will affect habitat that is essential to the welfare of the managed fish populations in a way that is more than minimal and not temporary. The previous statement describes the standard set in the EFH regulations which, if met, requires Councils to act to minimize such effects. The above analysis has identified changes to habitat features that are not expected to be temporary. The habitat features were selected as those which a) can be affected by fishing and b) may be important to fish in spawning, breeding, feeding, and growth to maturity. This section evaluates the extent that these changes relate to the EFH of each managed species and whether they constitute an effect to EFH that is more than minimal.

Two conclusions are necessary for this evaluation: (1) the definition of EFH draws a distinction between the amount of habitat necessary for a species to "support a sustainable fishery and the managed species' contribution to a healthy ecosystem" (50 CFR 600.10) and all habitat features used by any individuals of a species; (2) this distinction applies to both the designation of EFH and the evaluation of fishing effects on EFH. If these conclusions are valid, the "more than minimal" standard relates to impacts that potentially affect the ability of the species to fulfill its fishery and ecosystem roles, not just impacts on a local scale. The forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that species (a term used to represent "the ability of a species to support a sustainable fishery and its role in a healthy ecosystem").

The evaluation method is detailed in Section B.3.1 of Appendix B of the EFH EIS (NMFS 2005).

The Effects of Fishing on EFH analysis in the EFH EIS was made to answer the question: "Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature?" The following text summarizes the results of the analysis for each managed species. The details of the analysis for each species, including the habitat connections and the evaluation of effects, are contained in Section B.3.3 of Appendix B of the EFH EIS (NMFS 2005) and are incorporated by reference.

#### 4.4.5 Tanner Crab

| Issue | Evaluation |
|---|---|
| Spawning/breeding | MT (Minimal, temporary, or no effect) |
| Feeding | MT (Minimal, temporary, or no effect) |
| Growth to maturity | MT (Minimal, temporary, or no effect) |

Summary of Effects— Fishing activities are considered to have minimal and temporary effects on the EFH for Tanner crabs. Tanner crab settle and grow on mud habitat, which was the least affected habitat in the EBS. This analysis of the spatial distribution of Tanner crabs relative to expected habitat impacts indicates that Tanner crabs have not demonstrated shifts away from regions heavily impacted by fishing. The effects of fishing activities on Tanner crab feeding activities is minimal.

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### 4.5 Conclusions

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**Species Evaluations**

Evaluations were completed for 26 managed species (or species groups) and 8 forage species, all managed under the 5 FMPs developed by the Council (Table B.4-1 of the EFH EIS). See Sections B.3.2 to B.3.4 of the EFH EIS for more detailed information. Based on the available information, the analysis

found no indication that continued fishing at the current rate and intensity would affect the capacity of EFH to support the life history processes of any species. In other words, the effects of fishing on EFH would not be more than minimal. The reason for minimal ratings were predominantly either lack of a connection to affected habitat features. Other evaluations indicated that, even though a connection may exist between a habitat feature and a life-history process, the expected feature reductions were considered too small to make effects at the population level likely. There were also cases where the effects did not overlap significantly with the distribution of the species.

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Most of unknown ratings were for species that have received relatively little study; hence, their life history needs and population status are poorly known. Most species with unknown ratings support small or no fisheries. Conversely, species that support significant fisheries have been studied more. In some cases, associations between the habitat features and life history processes were indicated, but the evaluator did not have enough information to assess whether the linkage and the amount of feature reduction would affect species welfare.

Even for well studied species, the knowledge to trace use of habitat features confidently for spawning, breeding, feeding, and growth to maturity to population level effects is not yet available. Several evaluators specifically cited uncertainty regarding the effect of particular noted linkages, and some urged caution.

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[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] **SNOW CRAB**

## 2.0 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; however, summary tables that denote habitat associations (Table 2), reproductive traits (Table 3), and predator and prey associations (Table 4) are also provided. In each section, a species-specific table summarizes habitat requirements.

The following abbreviations are used in the habitat tables to specify location, position in the water column, bottom type, and other oceanographic features.

**Table 1 Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features.**

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

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] SNOW CRAB

**Table 2 Summary of habitat associations for BSAI crab.**

| Scallop | | Nearshore | | | | Shelf | | | Slope | | | | | | Stratum Reference | | | | | | | Location | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Inner | Middle | Outer | Upper | | Inter-mediate | | Lower | Basin | | | | | | | | | | | Pelagic | | |
| Species | Life Stage | 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 | Surafce | Near surface | Semi-demersal | Demersal | 1-200m (epi) | 201-1000m (meso) | >1000m (bathy) |
| Snow crab | M | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |
| | LJ | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |
| | EJ | | | | | x | x | | | | | | | | | | | | | | | | | | x | | | |
| | L | | | | | x | x | | | | | | | | | | | | | | | | | | | x | | |
| | E | | | | | x | x | x | | | | | | | | | | | | | | | | | x | | | |

Comment [RJF1]:

| Scallop | | Physical Oceanography | | | | | Substrate | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | 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 |
| Snow crab | M | | | | | | x | x | x | x | x | x | x | x | x | x | x | | |
| | LJ | | | | | | x | x | x | x | x | x | x | x | x | x | x | | |
| | EJ | | | | | | x | x | x | x | x | x | x | x | x | x | x | | |
| | L | | | | | | | | | | | | | | | | | | |
| | E | | | | | | x | x | x | x | x | x | x | x | x | x | x | | |

Comment [RJF2]:

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] **SNOW CRAB**

| Scallop | | Structure | | | | | | | | | Community Associations | | | | | | | | | | | | Oceanographic Properties | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Life Stage | 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) |
| Snow crab | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| | LJ | | | | | | | | | | | | | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | |

Comment [RJF3]:

**Table 3 Summary of biological associations for BSAI crab.**

| Scallop | | Reproductive Traits | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Age at Maturity | | | | Fertilization/Egg Development | | | | | Spawning Behavior | | | | | | Spawning Season | | | | | | | | | | |
| | | Female | | Male | | | | | | | | | | | | | | | | | | | | | | | |
| Species | Life Stage | 50% | 100% | 50% | 100% | External | Internal | Oviparous | Ovoviviparous | Viviparous | Batch Spawner | Broadcast Spawner | Egg Case Deposition | Nest Builder | Egg/Young Guarder | Egg/Young Bearer | January | February | March | April | May | June | July | August | September | October | November | December |
| Snow crab | M | 5 to 6 | | 6 to 8 | | x | x | x | | | | | | | | x | x | x | x | x | x | x | | | | | | |
| | LJ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | |

[Excerpted from Crab FMP, Appendix D.3: Section 2.0, 2.2] SNOW CRAB

**Table 4 Summary of predator and prey associations for BSAI crab**

Snow Crab — Predator to

| Species | Life Stage | Algae | Plants | Plankton | Zooplankton | Diatoms | Sponges | Eusphausiid | Hydroids | Amphipoda | Copepods | Starfish | Polychaetes | Squid | Philodae (gunnels) | Bi-valves | Mollusks | Crustaceans | Ophiuroids (brittle stars) | Shrimps, mysidacae | Sand lance | Osmerid (eulachon) | Herring | Myctophid (lantern fishes) | Cottidae (sculpins) | Arrowtooth | Rockfish | Salmon | Pacific cod | Pollock | Halibut |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Snow crab | M | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | LJ | x | | | | x | | | x | | | x | x | | | x | x | x | | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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BSAI Crab — Prey of

| Species | | Jellyfish | Starfish | Chaetognaths (arrowworms) | Crab | Herring | Salmon | Pollock | Pacific cod | Ling cod | Rockfish | Rock Sole | Flathead Sole | Yellowfin sole | Arrowtooth flounder | Hailbut | Cottidae (sculpins) | Eel Pouts | Harbor Seal | Steller sea lion | Dalls Porpoise | Beluga whale | Killer Whale | Minke whale | Eagles | Murres | Puffin | Kittiwake | Gull | Terrerstrial Mammals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tanner crab | M | | | | | | | | x | | | | | | | | x | | | | | | | | | | | | | |
| | LJ | | | | | | | | x | | | x | x | | x | x | x | x | | | | | | | | | | | | |
| | EJ | | | | | | | | | | | | | | | | x | x | | | | | | | | | | | | |
| | L | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## 2.8 Habitat Description for Snow Crab (*Chionoecetes opilio*

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### Life History and General Distribution

Snow crabs (*Chionoecetes opilio*) are distributed on the continental shelf of the BS, Chukchi Sea, and as far south as the Sea of Japan in the western Pacific Ocean. Snow crab occur in the western Atlantic Ocean as far south as Maine. Snow crab are not present in the GOA. In the BS, snow crab 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 upon reaching 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. Male snow crab have a terminal molt upon reaching maturity. Natural mortality of adult snow crab is estimated at 0.23 using maximum observed age from tagging of about 18 years.

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### 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 8 to 10 years. Snow crab are probably one stock in the BS. The season opening date since the 2008 season is October 15, however, fishing usually occurs after January 15, which was the fishery opening date pre-2008. A 3-inch maximum tunnel height opening for snow crab pots is required to inhibit the 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 smaller non-target crab. Bycatch in the snow crab fishery consists primarily of *C. bairdi* and *C. opilio* less than 10.2 cm CW.

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

### Relevant Trophic Information

Pacific cod, sculpins, skates, eel pouts 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. Juvenile snow crabs have been observed to be cannibalistic during molting in laboratory environments.

**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 and exhibit diel migration. The last of three larval stages settles onto bottom in nursery areas.

*Early Juvenile*: Shallow water areas of the EBS 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 and male *C. opilio* snow crabs are acknowledged to attain terminal molt status at maturity. Primiparous female snow crabs mate January through June and may exhibit longer egg development period and lower fecundity than multiparous female crabs. Multiparous females release eggs and mate mainly in March and April (Rugolo et al. 2005). 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 approximately 36,000 eggs and nurture the embryos for approximately 1 year after fertilization. However, fecundity may decrease 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.

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**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 year | NA | | NA | NA | NA | F | |
| Larvae | 2 to 7 mo. | Diatoms<br>algae<br>zooplankton | Spring, summer | ICS, MCS | P | NA | F | |
| Juveniles | 1 to 4 years | Crustaceans<br>polychaetes<br>mollusks<br>diatoms<br>algae<br>hydroids | All year | ICS, MCS, OCS | D | M | F | |
| Adults | 4+ years | Ploychaetes<br>brittle stars<br>mollusks<br>crustaceans<br>hydroids<br>algae<br>diatoms | Spawning Jan. To June (peak April-May) | ICS, MCS, OCS | D | M | F | |

### 3.1 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 “1" means information is available to determine EFH.

**Table 8.1 EFH information levels currently available for BSAI crab, by life history stage.**

| BSAI Crab Species | Egg | Larvae | Early Juvenile | Late Juvenile | Adult |
|---|---|---|---|---|---|
| Snow crab | inferred | x | x | 1 | 1 |

#### 3.1.5 Snow Crab

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

**Larvae—No EFH Description Determined**
Insufficient information is available.

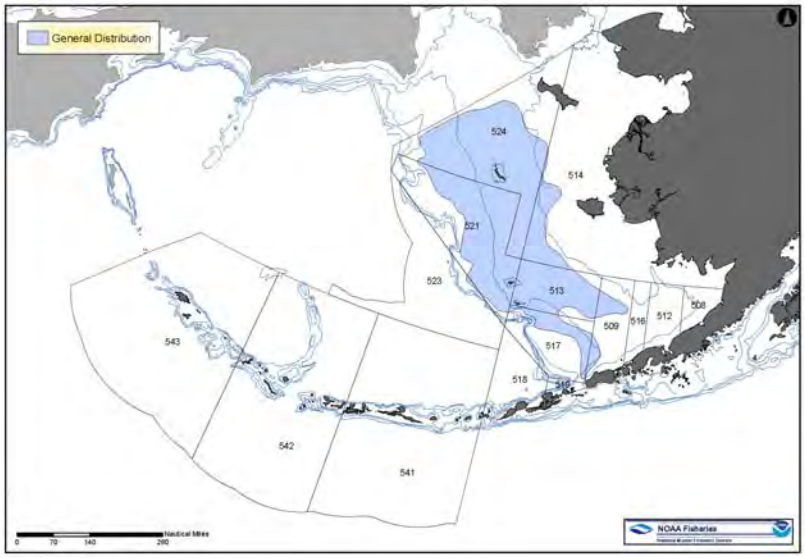
**Early Juveniles—No EFH Description Determined**
Insufficient information is available.

**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, as depicted in Figure 7.

**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, as depicted in Figure 7.

### 3.2 Maps of Essential Fish Habitat

Figure 7. EFH Distribution - BSAI Snow Crab (Late Juveniles/Adults)



### 4.4 Evaluation of Effects on EFH of BSAI Crab Species

This section evaluates whether the fisheries, as they are currently conducted off of Alaska, will affect habitat that is essential to the welfare of the managed fish populations in a way that is more than minimal and not temporary. The previous statement describes the standard set in the EFH regulations which, if met, requires Councils to act to minimize such effects. The above analysis has identified changes to habitat features that are not expected to be temporary. The habitat features were selected as those which a) can be affected by fishing and b) may be important to fish in spawning, breeding, feeding, and growth to maturity. This section evaluates the extent that these changes relate to the EFH of each managed species and whether they constitute an effect to EFH that is more than minimal.

Two conclusions are necessary for this evaluation: (1) the definition of EFH draws a distinction between the amount of habitat necessary for a species to support a sustainable fishery and the managed species contribution to a healthy ecosystem (50 CFR 600.10) and all habitat features used by any individuals of a species; (2) this distinction applies to both the designation of EFH and the evaluation of fishing effects on EFH. If these conclusions are valid, the more than minimal standard relates to impacts that potentially affect the ability of the species to fulfill its fishery and ecosystem roles, not just impacts on a local scale. The forgoing analysis has indicated substantial effects to some habitat features in some locations, many of which are within the spatial boundaries of the EFH of a species that may use them in a life-history function. These habitat changes may or may not affect the welfare of that species (a term used to represent the ability of a species to support a sustainable fishery and its role in a healthy ecosystem).

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The evaluation method is detailed in Section B.3.1 of Appendix B of the EFH EIS (NMFS 2005).

The Effects of Fishing on EFH analysis in the EFH EIS was made to answer the question: Is there evidence that fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature? The following text summarizes the results of the analysis for each managed species. The details of the analysis for each species, including the habitat connections and the evaluation of effects, are contained in Section B.3.3 of Appendix B of the EFH EIS (NMFS 2005) and are incorporated by reference.

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#### 4.4.6 Snow Crab

| Issue | Evaluation |
|---|---|
| Spawning/breeding | U (Unknown effect) |
| Feeding | MT (Minimal, temporary, or no effect) |
| Growth to maturity | MT (Minimal, temporary, or no effect) |

Summary of Effects - Fishing activities are considered to have overall minimal and temporary effects on the EFH for snow crabs. The current distribution of snow crab does not overlap the high trawl effects area to any extent. Juvenile snow crab distribution occurs on mud substrate and does not overlap areas of high trawling effects. Fishing effects on snow crab habitat and the subsequent impacts on snow crab feeding are expected to be minimal.

### 4.5 Conclusions

**Species Evaluations**

Evaluations were completed for 26 managed species (or species groups) and 8 forage species, all managed under the 5 FMPs developed by the Council (Table B.4-1 of the EFH EIS). See Sections B.3.2

to B.3.4 of the EFH EIS for more detailed information. Based on the available information, the analysis found no indication that continued fishing at the current rate and intensity would affect the capacity of EFH to support the life history processes of any species. In other words, the effects of fishing on EFH would not be more than minimal. Reasons for minimal ratings were predominantly either lack of a connection to affected habitat features, or findings from stock analyses that current fishing practices (including effects on habitat) do not jeopardize the ability of the stock to produce MSY over the long term. Other evaluations indicated that, even though a connection may exist between a habitat feature and a life-history process, the expected feature reductions were considered too small to make effects at the population level likely. There were also cases where the effects did not overlap significantly with the distribution of the species.

Most of unknown ratings were for species that have received relatively little study; hence, their life history needs and population status are poorly known. Most species with unknown ratings support small or no fisheries. Conversely, species that support significant fisheries have been studied more. In some cases, associations between the habitat features and life history processes were indicated, but the evaluator did not have enough information to assess whether the linkage and the amount of feature reduction would affect species welfare.

Even for well studied species, the knowledge to trace use of habitat features confidently for spawning, breeding, feeding, and growth to maturity to population level effects is not yet available. Several evaluators specifically cited uncertainty regarding the effect of particular noted linkages, and some urged caution.

**General Effects on Fish Habitat**

While this evaluation identified no specific instances of adverse effects on EFH that were more than minimal and not temporary, the large number of unknown ratings and expressions of concern make it prudent to look for more general patterns across all of the species and habitat features.

Specific areas with high fishing effort were identified in the effects-of-fishing analysis. These included two large areas of the EBS, one north of Unimak Island and Unimak Pass and the other between the Pribilof Islands and Bristol Bay. Both of these areas have continued to be highly productive fishing grounds through decades of intensive fishing. While that may initially seem at odds with the LEI results, it is consistent with the evaluation that the habitat features affected by fishing either are not those important to the species fished in those areas, or are not being affected in a way that limits species welfare.

Fishing concentrations in other areas were smaller, but made up higher proportions of the EBS slope. The largest effect rates were on living structure, including coral. The high reliance on limited areas for fishing production and their high estimated LEIs make it prudent to obtain better knowledge of what processes occur in those locations.

Table B.3-1 of the EFH EIS shows the habitat connections identified for each life stage of managed species and species groups. Each row represents a species life stage and each column one of the habitat types from the fishing-effects analysis. At their intersections, evaluators entered letters representing each of the habitat features (prey or structure classes) used by that life stage in that habitat. Most species of groundfish have pelagic larval and egg stages. Only one species, Atka mackerel, had a connection with a benthic habitat feature for its egg or larval stages. Crab species are attached to the female in the egg stage, pelagic in the larval stage and benthic in the juvenile and adult stages. A combined tally at the bottom of Table B.3-1 notes how many species/life-stages were identified for each habitat feature in each habitat. Prey features represented about twice as many connections as structure features. The habitat

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feature/type combinations that had LEIs above 5 percent, outlined in the table, tended to have few connections. The highest number of connections (six) were for living structures on the GOA deep shelf, which had the lowest LEI of the outlined habitat feature/type combinations (6.2 percent). Connections with the highlighted blocks mostly involved rockfish species, with a few connections from Atka mackerel and blue king crab.

Cropping and summing effects on habitat features by distributions of the adults of each species (Table B.3-3 in the EFH EIS) depicted how the fishing effects overlapped in the locations where each species is present. The general distribution values related to the broader areas occupied, while the concentration values related to areas of higher abundance. Concentration LEIs were generally higher than the estimates based on general distribution because adult species concentrations determine where fisheries operate. It is unfortunate that distributions were not available for juveniles because connections to the habitat feature with the highest LEIs (living structure) mostly involved the growth to maturity process. Characterizing juvenile distributions should be a high priority for future research.

Reductions across adult species distributions for the living structure were mostly between 10 and 17 percent. Higher values occurred for red king crab (29 percent for both coverages). NMFS noted that the distribution of juveniles was mostly outside of the affected areas. Prey class effects by species distributions were all at or below 5 percent.

While LEIs for hard corals are subject to the limitations mentioned in Section B.2.6 in the EFH EIS, they had the highest LEIs when considered by species distributions. Intersections where meaningful effects are most likely to occur are those between areas where hard corals are prevalent and species for which a significant portion of their distribution occurs in the same areas, including populations of golden king crab, Atka mackerel, sablefish, and the rockfish species. Coral LEIs at these points ranged from 23 to 59 percent. While few evaluators cited coral as specifically linked to life history functions, in some areas it may be an important component of the living structure that is potentially linked to growth to maturity for some of these species. Because of their very slow recovery, corals warrant particular consideration for protection and for the development of improved knowledge of their habitat functions and distribution.

Lit. Cited

Rugolo, L.J., D. Pengilly, R. MacIntosh and K. Gravel. 2005. Reproductive dynamics and life-history of snow crab (*Chionoecetes opilio*) in the eastern Bering Sea. Final Completion Report to the NOAA, Award NA17FW1274, Bering Sea Snow Crab Fishery Restoration Research.

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| **Species** | | **Jellyfish** | **Starfish** | **Chaetognaths (arrowworms)** | **Crab** | **Herring** | **Salmon** | **Pollock** | **Pacific cod** | **Ling cod** | **Rockfish** | **Rock Sole** | **Flathead Sole** | **Yellowfin sole** | **Arrowtooth flounder** | **Hailbutt** | **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** |
| **Snow crab** | M | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
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