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About the Authors

Susie Byersdorfer has been a shellfish research biologist with the Alaska Department of Fish and Game in Kodiak, Alaska, since 1989. She has worked on the basic life history of a number of commercially important shellfish species including king crabs. Her current interests include specimen collection and preservation, and developing survey field guides for biologists.

William Donaldson conducted shellfish research for the Alaska Department of Fish and Game from 1973 through 1997. His career work focused on developing life history information for Tanner crabs.

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Preface

This field guide primarily concerns four commercially fished species of king crabs in the North Pacific Ocean and Bering Sea, namely \textit{Paralithodes camtschaticus}, \textit{P. platypus}, \textit{Lithodes aequispinus}, and \textit{L. couesi}. The information also may be applicable to other related species. This publication is complementary to \textit{Biological Field Techniques for Chionoecetes Crabs} (Jadamec et al. 1999) and is designed to mirror that publication where appropriate.

State, federal, and university scientists have used different criteria when collecting data on king crabs. This leads to problems in data compatibility and interpretation. The intent here is to allow for standardization of data collection by fisheries observers, shoreside samplers, shellfish scientists, and fishermen. Such standardization would improve data accuracy, and thus promote better management of these commercially important crabs. When data are collected citing this publication, there should be little or no ambiguity as to measurements taken and definitions used. This guide is not all inclusive, but is intended to identify structures and organs, measurements and descriptions, and techniques that are commonly used in lab and field studies on king crabs.

About Nomenclature

The family Lithodidae (stone or king crabs) has 16 genera and 95 known species. King crabs are among the largest arthropods. The term \textit{Lithodes} is derived from the Greek lithos, meaning stone, and eidos, meaning form. Therefore, the genus name \textit{Lithodes} can be taken to mean “resembling a stone” or to “have a stony nature or structure.”

Several common names have been used interchangeably with this group of crabs. Most confusion has been with the common name of \textit{L. aequispinus}. The accepted common name is “golden king crab” (Williams et al. 1989); however, the term “brown king crab” is commonly and incorrectly used in Alaska (see State of Alaska 2003). “Brown king crab” correctly refers to \textit{Paralithodes brevipes} (Dawson 1989). There also remains confusion concerning the correct spelling of the specific names for red and golden king crabs. These issues have been clarified for \textit{P. camtschaticus} (Shirley 1990) and for \textit{L. aequispinus} (Shirley 2002).

King crabs belong to the infraorder Anomura. The term anomura refers to those crabs or stalk-eyed crustaceans with “unsymmetrical tails.” This is somewhat of a misnomer as there are many anomurans that have perfectly symmetrical tails. The meaning of anomura may have been in the Greek sense of “anomalos,” uneven, irregular, inconsistent, abnormal, unusual, and deviating from the regular rule. This meaning would have been applied to differentiate these crabs from the “true” crabs or Brachyura to which \textit{Chionoecetes} crabs belong (Rafael Lemaitre, National Museum of Natural History, Washington D.C., Oct. 2003, pers. comm.). For reviews of nomenclature, see Dawson 1989 and Zaklan 2002.
1. Taxonomy

The king crabs were originally described by Tilesius (1815) as a member of the genus *Maja*, family Majidae. Latreille (1829) recognized that king crabs were not brachyurans but rather anomurans, and consequently transferred king crabs to the genus *Lithodes*. Bouvier (1896) split the genus *Lithodes* primarily on the basis of the different pattern of calcification of the plates of the second abdominal segment of the abdomen, and erected the genus *Paralithodes* for those forms with five distinct plates separated by well defined sutures (Bright 1967).

**Classification of the genera Lithodes Latreille 1806 and Paralithodes Brandt 1850**

<table>
<thead>
<tr>
<th>Phylum:</th>
<th>Arthropoda</th>
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<tr>
<td>Subphylum:</td>
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<td>Lithodidae</td>
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<td>Genus:</td>
<td>Lithodes, Paralithodes</td>
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**Species:**

- *P. camtschaticus* (Tilesius 1815), red king crab
- *P. platypus* Brandt 1850, blue king crab
- *L. aequispinus* Benedict 1895, golden king crab
- *L. couesi* Benedict 1895, scarlet king crab

A taxonomic key to the four species of king crabs commercially fished in Alaska waters is presented on pages 2–5. Photos and life history information for other species of related lithodid crabs that occur in the North Pacific Ocean and Bering Sea are presented in Appendix 1.
Key to Species of King Crabs
(*Paralithodes* and *Lithodes*)

1a. Rostrum spine 1 ends in a single sharp-tipped projection. Second abdominal segment is covered by five distinct plates (Fig. 1) ........................................2a *Paralithodes* spp.

![Posterior view showing second abdominal segment](image1)

**Figure 1.** Posterior view of the second abdominal segment, and side and dorsal views of the rostrum showing the key characteristics of *Paralithodes* crabs. (S. Byersdorfer)

1b. Rostrum spine 1 is divided into a paired tip and rostrum has a large, down-curved spine in side profile. Second abdominal segment plates are completely or partly fused; there are fewer than five in number (Fig. 2) ........................................3a *Lithodes* spp.

![Posterior view showing second abdominal segment](image2)

**Figure 2.** Posterior view of the second abdominal segment, and side and dorsal views of the rostrum showing the key characteristics of *Lithodes* crabs. (S. Byersdorfer)
2a. Mid-dorsal plate of carapace usually has three pairs of prominent spines. Antennal scaphocerite in form of a sharp spine. Carapace surface more spinous in young specimens than in adults. Live specimens are red to reddish-purple dorsally (Fig. 3a).

**Red King Crab, *Paralithodes camtschaticus***

![Dorsal View of Carapace](image)

*Figure 3a. Dorsal carapace view of mature male red king crab showing mid-dorsal plate spination and antennal scaphocerite. (S. Byersdorfer)*

2b. Mid-dorsal plate of carapace bearing two pairs of large spines. Antennal scaphocerite in form of a long biramous spine. Live specimens are dark blue or yellow/blue dorsally (Fig. 3b).

**Blue King Crab, *Paralithodes platypus***

![Dorsal View of Carapace](image)

*Figure 3b. Dorsal carapace view of mature male blue king crab showing mid-dorsal plate spination and antennal scaphocerite. (S. Byersdorfer)*
3a. Carapace covered in spines approximately equal in length. Spines of the lateral margins are equal in length or slightly larger than those on dorsal surface. Rostrum has fairly broad base and is armed with 9 to 10 spines. Mid-dorsal plate of carapace has 5 to 9 spines. Live specimens are golden (Fig. 4a).

**Golden King Crab, *Lithodes aequispinus***

3b. Carapace covered in spines of different lengths; at least 2 of the spines on the lateral margins are distinctly longer than the spines of the dorsal surface of the carapace. Rostrum is long and slender, and armed with 7 spines. Mid-dorsal plate is narrow relative to *L. aequispinus* and has 4 to 6 spines. Live specimens are brick red to pinkish (Fig. 4b).

**Scarlet King Crab, *Lithodes couesi***
1. Taxonomy

*Paralithodes camtschaticus*, red king crab, has 6 prominent spines on mid-dorsal plate.

*Paralithodes platypus*, blue king crab, has 4 prominent spines on mid-dorsal plate.

*Lithodes aequispinus*, golden king crab, has 5–9 spines on mid-dorsal plate.

*Lithodes couesi*, scarlet king crab, has 4–6 prominent spines on mid-dorsal plate.

Figure 5. Comparison of color and mid-dorsal spine patterns for four species of king crabs. (S. Byersdorfer)
2. Life History

King crabs are anomuran decapods belonging to the family Lithodidae. Red king crabs and blue king crabs are considered shallow water species while golden and scarlet king crabs are deepwater species.

King crabs are not considered “true” crabs, as are the brachyurans. Distinguishing king crab characteristics include asymmetrical abdomen, asymmetrical 1st pair of walking legs, and modified 5th pair of walking legs, which are hidden inside the branchial chambers.

The available information on these four species of king crabs is incomplete. Red king crab life history is best understood. Much of what is known about the life history of these four species has been summarized in Appendices 2–4. The appendix tables are from NPFMC (1998) and Zaklan (2002), and have been modified and reproduced here.

The following text presents a brief and general life history based on available literature. Where not specific, the text is based on literature for red king crabs. For more specific information by species, refer to the appendix tables.

Prior to mating, female king crabs must shed their old shells and produce a new one in a process called molting. Immature females with ripe ovaries that are ready to mate for the first time are referred to as pubescent or adolescent. As they prepare to undergo the molting process, it is thought that they release pheromones into the water that are detectable by male crabs for up to several weeks before the molt.

When a male locates a female, he grasps her first anterior pair of legs in his claws called chelae and holds her facing himself for up to several days. This behavior is called “hand-holding or grasping.” Soon the female begins to molt, her old shell separates, and within a 15 minute period she wriggles out of her old shell and is covered in a new, softer shell. At the same time she absorbs water and swells up, thus growing in size. After the female has molted, the male releases the old shell and delicately regrasps the softshell female. The male then places her upside-down and beneath him, and inserts his ventral surface between her abdominal flap and body. Males extrude strings of sperm packets (spermatophores), from the opening at the base of their 5th pair of legs. Using the brushy tip of these legs, he spreads the spermatophores onto the carapace area around the gonopores of the female. This process may require several attempts over a period of hours. After copulation, the male releases the female and shows no further interest.

Females extrude their ova from paired openings (gonopores) on the underside of the second walking legs. Upon exposure to seawater, a sac forms around each ovum, which attaches itself to the small hairs of the pleopods. During this process sperm from the spermatophores fertilize the ova. Female king crabs cannot store sperm.
2. Life History

Therefore, they must mate when ready to extrude ova. If a male does not fertilize a female with ripe ovaries, she may resorb ova inside of her body and not extrude them (Paul and Paul 1997). Alternately, she may extrude the unfertilized eggs, which will later be lost. The success rate of fertilization depends on male size and mating history. The proportion of eggs fertilized by small red king crab males less than 90 mm carapace length (CL) declines from 68% on their first mating to 12% on their third, whereas males > 135 mm CL can fertilize up to four females with 100% success (Paul and Paul 1990, Paul and Paul 1997).

Females producing their first clutch of eggs immediately after reaching sexual maturity are called primiparous. Those producing their second and additional clutches are called multiparous. The number of eggs produced by each female (fecundity), increases linearly with female body size in weight.

Embryos are incubated on the abdomen of females for 11–12 months. After hatching, larvae pass through four zoeal and one glaucothoe stage (Fig. 6). Hatching (eclosion) of red king crabs usually occurs concurrent with the spring phytoplankton bloom; early stage zoeae are primarily herbivorous, but later zoeal stages become increasingly zooplanktivorous (Shirley and Shirley 1989). Primiparous females hatch their eggs earlier than multiparous females, having been able to mate, extrude eggs, and begin brooding earlier the prior year (Shirley et al. 1990).

Each zoeal instar lasts approximately two weeks, but this varies with water temperature. Settlement of glaucothoe usually occurs in early July, but this varies with hatching date and water temperature (Shirley and Shirley 1989). The glaucothoe metamorphoses into the first instar, which takes up a benthic existence. Soon after settlement and metamorphosis to the first crab stage, juvenile red king crabs are considered to be in their “early benthic phase” (Loher 2001). Crabs in this stage are highly susceptible to predation. This period of their benthic life is probably the most dangerous, and has the highest mortality because they are too small to escape large predators. In the Bering Sea, major predators of small crab include Pacific cod *Gadus macrocephalus*, Pacific halibut *Hippoglossus stenolepis*, Alaska plaice *Pleuronectes quadrituberculatus*, yellowfin sole *Limanda aspera*, flathead sole *Hippoglossoides elassodon*, arrowtooth flounder *Atheresthes stomias*, walleye pollock *Theragra chalcogramma*, Pacific herring *Clupea pallasi*, and sockeye salmon *Oncorhynchus nerka* (Livingston and Ward 1993, Loher 2001). Predation by these commercially important fish is well documented; however, major predation also occurs by noncommercial species though it is less well documented. Those species include sculpins *Myoxocephalus* spp., Irish lords *Hemilepidotus* spp., snailfish *Liparis* spp., and skates *Raja* spp.
Figure 6. Generalized red king crab life cycle showing grasping adults through the first benthic instar. (a. J. Haaga. b-e. S. Byersdorfer)
Another major predator, and perhaps one of the most significant, is the larger king crab. Up to age 1, juvenile red king crabs are found on the same type of structurally complex habitat that is preferred by the settling stages. The presence of larger king crabs in such habitats could be a major limitation to successful recruitment (Loher 2001).

At about 1–2 years of age, red king crabs begin to move to deeper water and gather into vertical piles. These piles are referred to as pods (Fig. 7a). Aggregations and pods have been defined for adult crab by Stone et al. (1993). They are referred to as pods if the majority of individuals are in physical contact with each other and stacked atop each other (Fig. 7b). Structurally dense and socially organized groups of adults are termed aggregations (Fig. 7c). Podding is thought to be an adaptation for predator defense (Powell and Nickerson 1965a, Dew 1990). Podding has not been observed in other lithodid species, but juvenile golden king and scarlet king crabs form dense aggregations (T. Shirley, University of Alaska Fairbanks, Juneau, unpublished observations).

Somerton (1981) noted five adaptations to a deepwater existence for scarlet king crabs: elongated legs, inflated branchial chambers, large exhalent openings, large scaphognathites, and bright red coloration. He noted that the bright red coloration is cryptic at depths inhabited by scarlet king crabs. Inflated branchial chambers, large exhalent openings, and large scaphognathites (appendages in the exhalent openings that pump water) are related to lower oxygen levels at increased sea depth. He stated that enlargement of these features, compared with related shallow-water lithodid crabs, implies that a relatively greater volume of water is pumped over the gills. The reduced musculature in elongated legs is most likely an energy conservation adaptation to great depth where food is scarce. Also, long slender legs may allow more rapid movement by taking fewer but larger steps over the seafloor.

King crabs are opportunistic feeders. In a study of red king crabs at Norton Sound, Alaska, the dominant crab prey items were unidentified fishes, sea urchins, hydroids, polychaete worms, bivalves, gastropod mollusks, crabs, sand dollars, brittle stars, and sea stars (Jewett et al. 1990).
Figure 7. Red king crab pods. a. Pod of age-1 crab resting off-bottom. b. An 8 ft (2.7 m) high resting pod of 9,000 adult and sub-adult male and female red king crabs. c. The same pod as in (b), but now in its foraging mode. (B. Dew, 7c © Ecological Society of America)
3. Distribution

Red King Crabs

Red king crabs occur in the North Pacific: Bering Sea, Bristol Bay, Alaska, U.S.A. (Benedict 1895). Bering Sea to Sea of Japan (Marukawa 1930). Hokkaido, Japan; Cape Gamova, Sea of Okhotsk, eastern Kamchatka to Cape Olyutorsk, Russia; Aleutian Islands and Norton Sound, U.S.A. to Queen Charlotte Islands, B.C., Canada (Makarov 1962). Korea (Kim 1970). *P. camtschaticus* has been successfully introduced into the Barents Sea in the North Atlantic (Jørstad et al. 2002). Distribution in Gulf of Alaska, Bering Sea, and Aleutian Islands waters is depicted in Fig. 8.

Blue King Crabs

Blue king crabs occur in the North Pacific: Sea of Japan, south to Cape Gamova, Vladivostok; Sakhalin, Kurile Island, Kitami, Japan; Korea (Sakai 1976). Sea of Okhotsk, east Kamchatka, Russia; and Bering Strait (Makarov 1962). In Alaska, discrete populations exist around the Pribilof Islands, St. Matthew Island, and St. Lawrence Island. Smaller populations have been found at King Island, Nunivak Island, and Herendeen Bay. In the Gulf of Alaska populations exist at Olga Bay–Kodiak Island and at Port Wells–Prince William Sound, Russel Fiord, Glacier Bay, Lynn Canal, and Endicott Arm–Southeast Alaska (Somerton 1985). Somerton (1985) noted that both *P. camtschaticus* and *P. platypus* occupy the same latitudinal range in the North Pacific but that each species is absent or rare where the other exists. He speculated that the populations of blue king crabs that are present today might be relics of a former, broader distribution. Somerton (1985) attributed the isolated distribution of *P. platypus* to three mechanisms either singly or in combination: reproductive interference, competitive displacement, and predatory exclusion. Distribution in Gulf of Alaska, Bering Sea, and Aleutian Islands waters is depicted in Fig. 9.
Figure 8. Distribution map of the red king crab Paralithodes camtschaticus in Gulf of Alaska, Bering Sea, and Aleutian Islands waters. (C. Armistead)

Figure 9. Distribution map of the blue king crab Paralithodes platypus in Gulf of Alaska, Bering Sea, and Aleutian Islands waters. (C. Armistead)
Golden King Crabs

Golden king crabs occur in the North Pacific: Bering Sea, Pribilof Islands; Sea of Okhotsk, Japan (Benedict 1895); east of Siwoya Cape (Makarov 1962) to south B.C., Canada, in the upper continental slope (Butler and Hart 1962); west Sagami Bay (Hiramoto and Sato 1970); Shioya-zaki, and Matsushima, Enoshima (Sakai 1976); and Suruga Bay, Japan (Suzuki and Sawada 1978). Golden king crabs also inhabit the Patton Seamount in the Gulf of Alaska (Hughes 1981). Distribution in Gulf of Alaska, Bering Sea, and Aleutian Islands waters is depicted in Fig. 10.

Scarlet King Crabs

Scarlet king crabs occur in the North Pacific: Bering Sea, north of Unalaska, near the Shumagin Islands, Alaska (Benedict 1895) to San Diego, California (Makarov 1962); N.W. far off Midway Island (32°03.8′N 172°50.2′E); Kushiro, Shioya-zaki (Takeda 1974); Hokkaido and off Onahama, Japan (Sakai 1976). Scarlet king crabs are common on the seamounts in the Gulf of Alaska (Somerton 1981). Distribution in Gulf of Alaska, Bering Sea, and Aleutian Islands waters is depicted in Fig. 11.

Vertical distribution profiles for adult, juvenile, and reproductive components are depicted for red king crab in Fig. 12a and for blue and golden king crabs in Fig. 12b (NOAA 1990). See also Appendix 3, page 66, and Appendix 4, page 67. Sufficient data are not available to construct profiles for scarlet king crabs.
Figure 10. Distribution map of the golden king crab Lithodes aequispinus in Gulf of Alaska, Bering Sea, and Aleutian Islands waters. (C. Armistead)

Figure 11. Distribution map of the scarlet king crab Lithodes couesi in Gulf of Alaska, Bering Sea, and Aleutian Islands waters. (C. Armistead)
Figure 12a. Adult, juvenile, and reproductive distributions for red king crabs, in meters. (NOAA 1990)
Biological Field Techniques for Lithodid Crabs

Figure 12b. Adult, juvenile, and reproductive distributions for blue and golden king crabs, in meters. (NOAA 1990)