Handling of Fresh Crabs and Crabmeat

SEAgram

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Introduction

The king, Tanner, and Dungeness crab fisheries are important parts of the Alaska seafood industry, and the snow crab fishery is increasing in importance. Crab is marketed fresh in several forms—live, whole cooked, cooked sections, and cooked picked meat (Fig. 1).

Crabs deteriorate very rapidly after death, as a consequence of the growth and multiplication of microorganisms and the action of enzymes. Deterioration is much more rapid than for most species of fish. Therefore crabs must be kept alive until they are processed.

Because live crabs are delicate animals, they need to be handled with great care at all times. If weakened to the point that they are barely alive before processing, the meat may be discolored and chalky in texture, and have poor keeping qualities.

Cooked crabmeat is an excellent growth medium for bacteria and is easily spoiled. For this reason, it must not be exposed to bacterial contamination and should be kept cold and handled as rapidly as possible during all steps of processing, shipping, and marketing.

On-vessel holding

Crabs are often subjected to a relatively quick environmental change during the catching process, when they are brought from the seafloor to the surface. Many will be in a weakened condition and any further abrupt changes in temperature, salinity, and oxygen content of the water in which they are held must be avoided, to prevent a high mortality. Winter crab fisheries pose particular risk for injury and death due to freezing and wind chill. Tanner and snow crabs at sea lose limbs and die in direct proportion to increases in cold exposure (Stoner 2008). Proper catching equipment and good handling methods should be used to protect the crabs from physical damage.

On-deck handling and storage techniques dramatically affect the grade of fresh crabs. Crabs should be handled as little as possible, as some species shed their claws or legs resulting in mutilated specimens. The usual method of holding crabs on the fishing vessel is to place them in a flooded hold or in large tanks through which seawater is continuously pumped. The pumping rate depends on the size of the hold or tanks but must be sufficient to maintain dissolved oxygen at a level that will ensure the crabs remain alive and healthy. Bottom-to-top circulation is the preferred method of circulation, and the rate should give a complete water change about every 15 minutes. Water temperature should be kept as close as possible to the natural environment. All surfaces that have contact with the crabs, particularly the inside of holding tanks, should be smooth, resistant to corrosion, and cleaned easily and often.

Water circulated over crabs must be protected from contamination by fuel, oil, grease, bilgewater, and sewage through proper location of the seawater intake and proper design of the pump and plumbing. In some inlets, river mouths, and harbors, the water may be of such poor quality that a closed circulation system must be used.

Experiments using chilled circulating seawater with continuous aeration have shown that Dungeness crabs can be held for 5 days at 38°F and for 12 days at 35°F. At low temperatures, crabs are less active and the oxygen requirement will be lower. When cannibalism is a problem, it can be reduced at lower temperatures. It must be noted, however, that crabs held at these temperatures will not fully recover when placed in warmer water.

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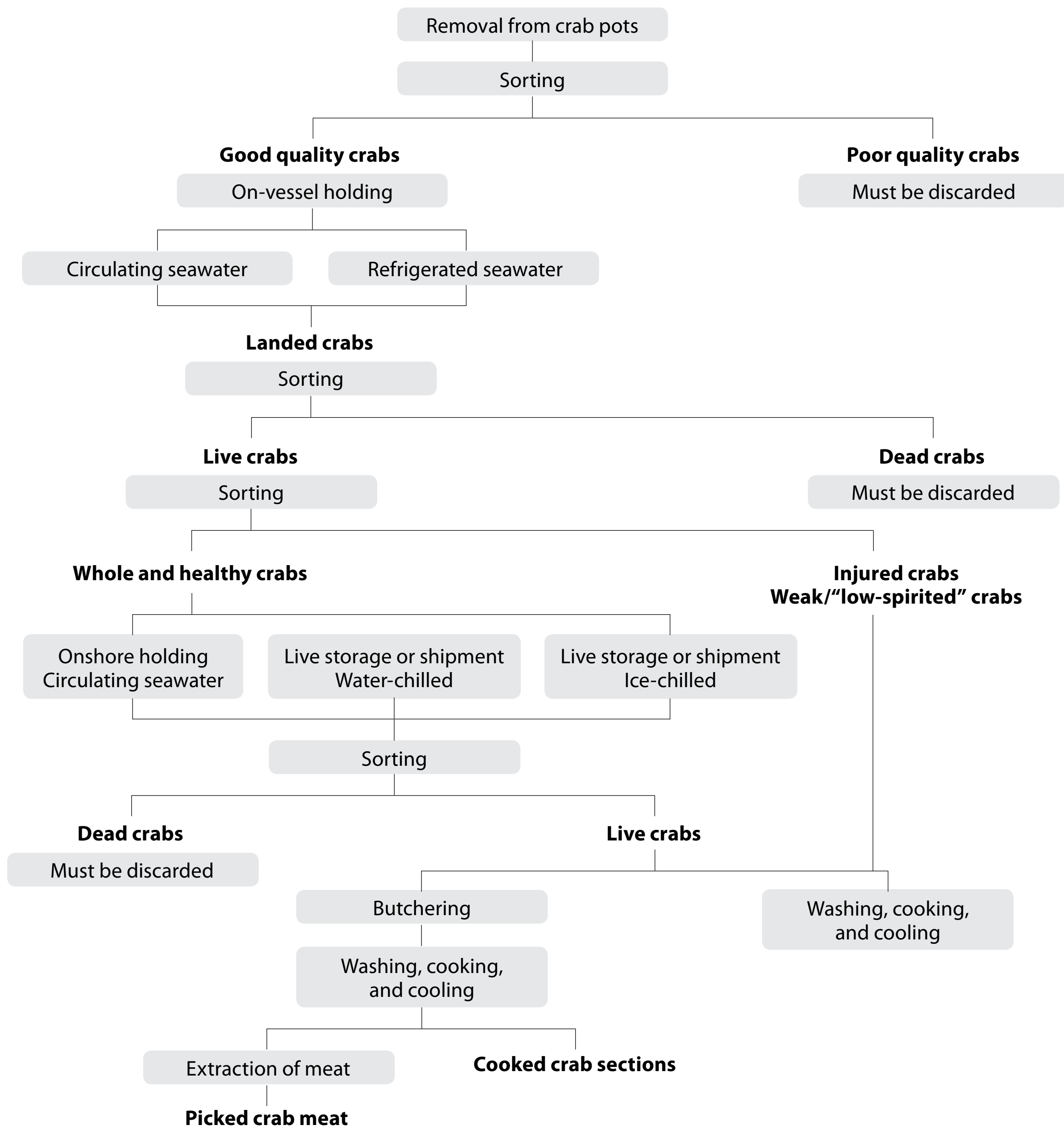

Figure 1. Flow sheet for handling fresh crabs and crabmeat.

When a boat is not equipped with a large hold suitable for crabs, they are kept in totes on deck so they stay cool and moist (Ke et al. 1981). Crabs can be held on deck for 24 hours and under very good holding conditions for as long as 48 hours. Increased shipboard time increases mortality in both king (Stevens 1990) and snow crabs (Botta et al. 1989). Shipboard times longer than 24 hours are not recommended, because discoloration of the meat and loss of flavor will be more pronounced. If the boat is making daily deliveries and the crabs are held on deck, they should be protected from sun, wind, and rain by a cover, and kept wet with sacks soaked in seawater to keep them alive. If the gills become dry, the crabs cannot breathe and will die.

Crabs kept in totes must be iced to keep them cool, and drain holes or a false bottom should be in place to prevent the crab from sitting in fresh water as the ice melts. Ice should be added at multiple levels within the tote to promote equal temperatures throughout (Botta et al. 1989). It is most important that ice be added on top of the crabs, because cool air near the ice will sink and circulate. If ice is only provided at the bottom, lack of circulation will cause the heavier cool air to stay low and only maintain crabs near the bottom of the tote (Botta et al. 1989). The practice of storing live crabs in the back-down position to keep them from moving around should be discouraged; crabs will die much more quickly if placed on their backs.

Maintaining high quality meat during processing

Crab meat rapidly deteriorates after death, so crabs must be alive when processed to ensure a high quality meat product. Snow crab sections are more prone to discoloration than whole crab or body meat (Ke et al. 1990), and crab should not be sectioned until shortly before the cooking operation to avoid discoloration. If the pre-processing condition of snow crab meat is somewhat deteriorated, the frozen meat tends to have a less pleasant taste and texture after about 6 months, and may be dark or have black streaks and specks (Botta et al. 1993). Since the production of consistently high quality crab meat products requires a uniform supply of high quality raw material, reference standards for overall quality of pre-processed crab meat may be helpful (Table 1, Ke et al. 1990).

Table 1. Simplified guidelines for sensory evaluation of snow crab meat.

Overall quality	Standards
Excellent	Pleasant characteristic crab flavor, pink-red leg pigment, creamy white meat, bright sheen, firm elastic moist texture.
Good	Slight characteristic crab flavor, slight dull leg pigment, creamy white meat, no sheen.
Fair and acceptable	Slight turnipy, vegetable-like flavor, dull leg pigment, slight graying and yellow color, no elasticity.
Unacceptable	Slightly sour, turnipy ammonia, no leg pigment, gray/yellow discoloration, lumpy, chalky, shredded appearance.
Spoiled	Sour, putrid odor, mushy and slimy texture, yellow or green discoloration, very unpleasant aftertaste.

Ke et al. 1990.

Colder temperatures do help to ensure the quality of crab meat postmortem, and it may be helpful to prechill the round crabs before processing to keep the microbial load low (Ke et al. 1981, 1990). Snow crab meat can be kept at an acceptable level for about 30 hours at 3°C but only 10 hours at 13°C. Any additional time puts the meat at risk for deteriorated taste, texture, and overall quality, even without microbial spoilage. Cooling by forced air, rather than static air, cools crabmeat more quickly and has been shown to reduce microbial spoilage in non-Alaska crab species more effectively than static-air cooling (Douglas et al. 1992).

Beyond the importance of cool temperature, the shelf life of crabmeat during processing may be somewhat extended through low-dose radiation treatment. The shelf life of fresh crabmeat post-processing of non-Alaska crab species has been extended 3 days exposing the meat to 1 kGy gamma radiation (Chen et al. 1996). This low dose irradiation treatment reduces pathogenic and spoilage microorganisms without negative effects on the taste and texture of the meat.

Predicting mortality in crabs for the live market

Fishing introduces many sources of injury for crabs, including physical damages to the carapace and limbs by fishing gear and physiological damages by exposure to wind, snow, and weather on deck (Shirley and McNutt 1998, Warrenchuk et al. 2002, Stoner 2008) and extremes or changes in temperature (Carls and O'Clair 1989), salinity, or available oxygen. The ability to objectively assess whether a crab will live or die is highly valuable during processing in sorting crabs for live versus precooked and processed markets.

External injuries are less useful in predicting mortality than one might think. Tanner crabs with delayed mortality generally had external injuries, but it is difficult to predict whether a crab will recover or die based on an injury (Stevens 1990). The problem with this method is that it does not account for internal or physiological injuries, which are difficult to detect and often fatal. The results of this method also vary widely among crabs by sex, size, and/or shell conditions (stage of molt), with small and recently molted crab being most susceptible to physical injuries (Kruse et al. 1994). Similarly, successful righting is not a good predictor of survival, and inability to right themselves is not a good predictor of mortality (Stoner 2008). Reflex testing proves to be a better method of assessing both internal and external injuries and yields the same results across demographic categories.

Reflexes are a measure of nervous system reactivity, and so incorporate and represent damages done by both physical injury and environmental stress. In a recent study of Bering Sea snow and Tanner crabs, a suite of six simple reflexes, including movements of the mouth, eyestalks, claws, and legs, is accurately and dependably used to predict future mortality (Stoner 2008, Stoner et al. 2008). After exposure to freezing temperatures, reflex impairment correctly predicted mortality and survival in 80.0% of Tanner crabs and 79.4% of snow crabs (Stoner 2008). These reflex tests are nontechnical and may easily be applied in-hand (out of the water) during processing to differentiate between the crabs that are likely to survive shipment to a live market, and weak crabs that should be cooked and processed.

To test a crab's reflexes, hold the crab in-hand and work through the suite of simple tests provided in Table 2. Test results should be scored based on presence/absence, meaning that a reflex should be considered "present" even if it is weak. Once all reflexes have been tested, simply count the number of these reflex tests not passed, with test

Table 2. Reflexes testing is useful in assessing vitality and stress in Tanner and snow crabs. The more failed reflex tests, the more likely it is that a crab will soon die. Reflexes should be tested using a blunt probe. Even a weak reflex is characterized as a "positive response." "Lost reflex" describes reflexes that are entirely lost.

Reflex	Test	Positive response	Lost reflex
Leg flare	Lift the crab upward by the carapace.	The crab spreads its legs outward into a wide, nearly horizontal stance.	The crab's legs droop below the horizontal with no attempt to raise them.
Leg retraction	While holding the crab by its carapace, attempt to draw the front legs forward.	The crab resists the motion or retracts its legs back.	The crab only resists the motion weakly.
Claw close	Observe the crab's claw for strong opening and closing motions or probe the claw.	The crab strongly opens and close its claws and attempts to grasp the probe.	The crab's claws do not move.
Eye retraction	Probe the crab's eyestalk or attempt to lift the eyestalk from its retracted position.	The crab's eyestalk retracts strongly below the carapace or resists lifting.	The crab's eyestalk will not retract or will only weakly resist lifting.
Mouth close	Probe the crab's mouthparts in attempt to open the mouth if it is closed, or draw the mouthparts downward if it is open.	The crab quickly attempts to close the mouth and/or cover the smaller mouthparts, or mouthparts move in an agitated manner.	The crab's mouthparts droop open or do not close tightly.
Kick	Attempt to pry the "tail flap" away from the crab's abdomen with a probe.	The crab immediately responds by kicking its legs and claws to protect itself. Males respond more strongly than females.	The crab's legs and claws do not move.

Adapted from Stoner et al. 2008.

results ranging from 0 (perfect reflexes) to 6 (no reflexes). After some practice, crab handlers are generally able to test the entire suite of reflexes in 4-10 crabs per minute.

The best predictor of mortality is simply the sum of lost reflexes—regardless of which reflexes. The proportion of crabs that die during holding clearly increases with the number of missing reflex responses (Stoner et al. 2008; Fig. 2) and the number of failed reflex tests will provide an estimated length of time until death (Stoner et al. 2008; Fig. 3). In studies of delayed mortality in crabs after capture in a trawl, 80% of mortality occurred within 2 days for snow crabs and 3 days for Tanner crabs (Stoner et al. 2008; Fig. 4). Within 7 days, 95% of mortality had occurred for both species (Stoner et al. 2008). Mortality due to stress from freezing takes slightly more time (Stoner 2008). Reflex impairment scores greater than "3" indicate poor health and a low likelihood that the crab will survive beyond 1-2 days after capture (Carls and O'Clair 1995, Stoner 2008, Stoner et al. 2008). Reflexes tend not to improve during holding, or usually don't improve by more than one point. Crabs earning the score "6" typically die within about an hour of testing. Crabs that fail only a few reflex tests but die anyway tend to have substantial external injuries (Stoner et al. 2008; Fig. 5).

In summary, the composite reflex score reflects both physical and physiological injuries and may therefore be used to predict future mortality in Tanner and snow crabs. Further research is planned to assess the relationship between reflex impairment and survival for Alaska red king crabs.

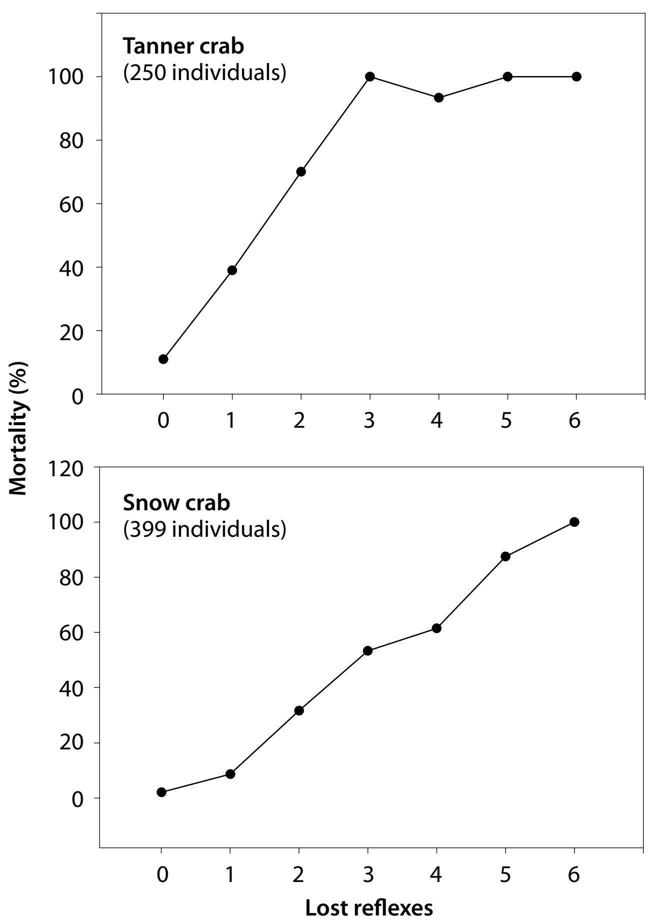

Figure 2. Percent mortality of Tanner crab and snow crab shown as the result of lost reflexes. Adapted from Stoner et al. 2008.

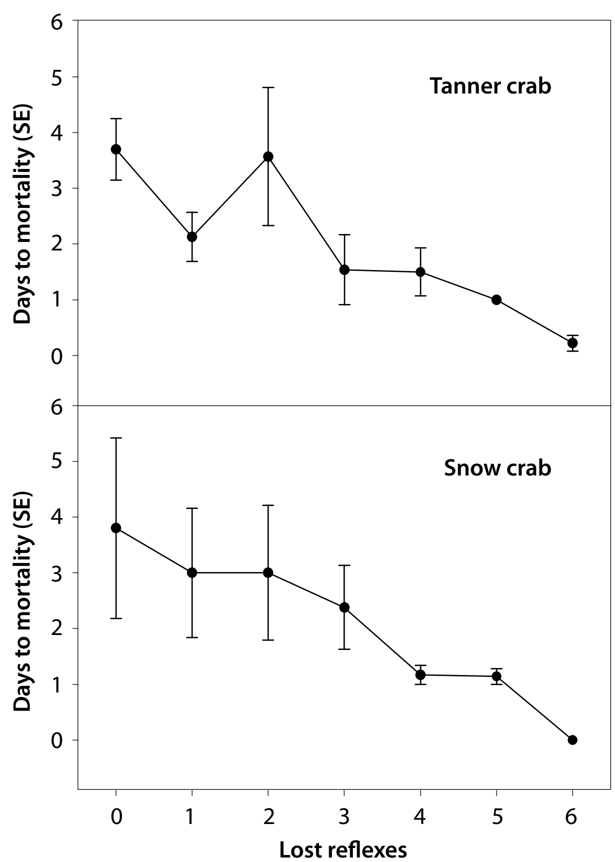

Figure 3. Time to mortality in days observed for Tanner and snow crab shown as a result of lost reflexes. Mean number of days with standard error. Adapted from Stoner et al. 2008.

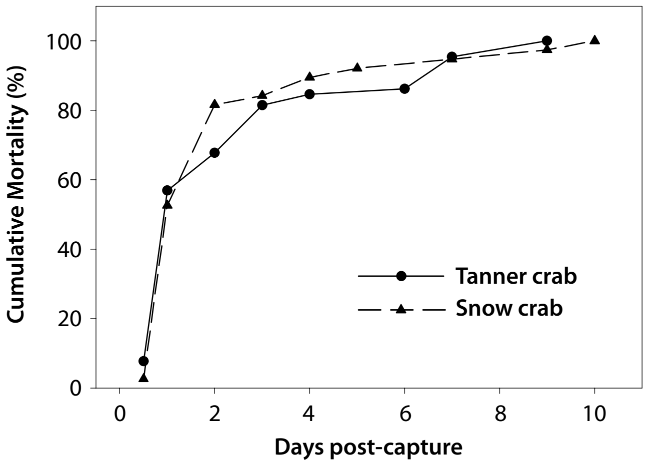

Figure 4. Percent cumulative mortality of Tanner crab and snow crab over time during holding at sea. The total numbers of Tanner and snow crab that died over the course of the experiment were 73 and 96, respectively. Adapted from Stoner et al. 2008.

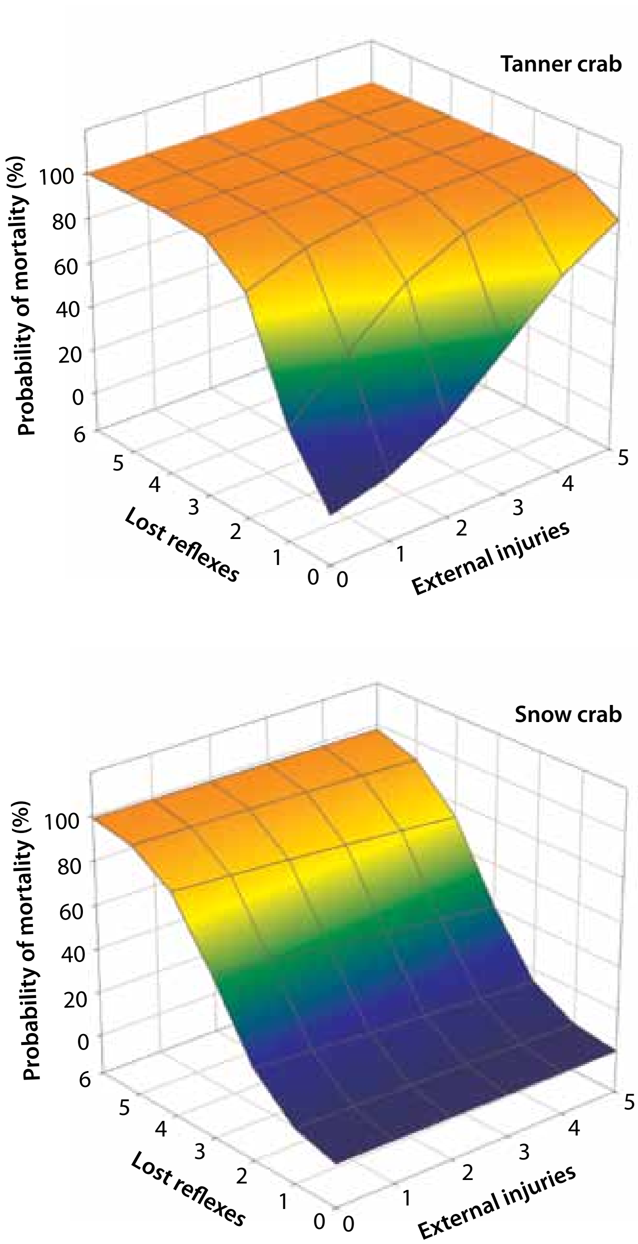

Figure 5. Probability of mortality for Tanner crab and snow crab with varied numbers of lost reflexes and injuries.

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