1 Coonstripe Shrimp, *Pandalus danae*

A coonstripe shrimp, *Pandalus danae,* caught near Crescent City, California. Photo credit: J. Bieraugel.

History of the Fishery

The California commercial fishery for the coonstripe shrimp, *Pandalus danae*, is a relatively new fishery. The first landing record for this species was in 1995; however, they were likely landed in small amounts prior to 1995 and recorded only in a general shrimp market category. Commercial coonstripe shrimp regulations adopted by the California Fish and Game Commission in 2002 (Title 14, CCR, §180.15) were devised cooperatively by the California Department of Fish and Game (Department) and fishers. Prior to 2002, the fishery was essentially unregulated. Current regulations cover general trap and vessel permit requirements, prohibit trawling, specify a closed season from November 1 through April 30, and provide a control date for a possible limited entry fishery. Logbooks are not required.

California has the largest directed coonstripe shrimp trap fishery on the west coast of North America. Most of the fishing activity takes place within a few miles of Crescent City Harbor. A formerly active trap fishery in southern Oregon has dwindled, culminating in landings of less than 10 pounds per season (4.5 kilograms per season) for the past three years. In the San Juan Islands of Washington state, there is small trap and trawl fishery for coonstripe shrimp. In southern British Columbia, there is short season trap fishery, a small directed trawl fishery and some coonstripe shrimp are caught incidentally in pink and sidestripe shrimp trawls. Total trap and trawl landings in both Washington and British Columbia are similar in size to California's trap fishery. In Alaska, coonstripe shrimp are not targeted, but are landed incidental to other fisheries.

The California commercial fishery for coonstripe shrimp had its first significant landings in 1996 and remained relatively stable from 1997 through 2002, averaging 78,200 pounds (36 metric tons) per year. After declining to a low of 22,200 pounds (10 metric tons) in 2007, the 2008 season yielded 85,200 pounds (39 metric tons), the second largest annual landings. Average landings for the fishery, since 1996, are almost 62,800 pounds (28 metric tons) (Figure 1-1).

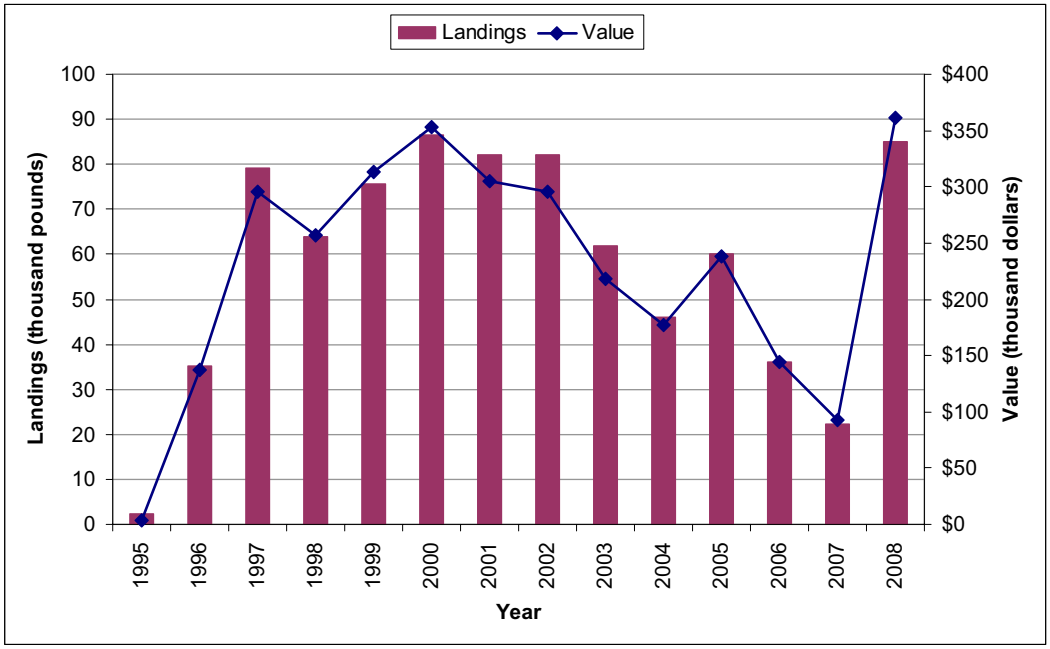

Figure 1-1. Coonstripe shrimp commercial landings and value, 1995-2008. Data source: CFIS data, all gear types combined.

Although catch-per-unit-effort is reportedly low, a high price per pound keeps diligent fishers interested. Fishers often soak gear for several days and can store several trips worth of Coonstripe shrimp alive before selling to the fish buyer. Count per pound ranges from 23 to 40 shrimp, but buyers prefer lower counts of larger shrimp. The live product is shipped to markets in the San Francisco and Los Angeles areas where consumers pay $5.99 to $6.99 per pound ($13.20 to $15.40 per kilogram), depending on quality. Since 1996, the average price paid to fishers has ranged from $3.52 to $4.25 per pound ($7.77 to $9.36 per kilogram). Paid the latter in 2008, total ex-vessel value was $361,800 (Figure 1-1). Average annual ex-vessel value from 1996 to 2008 was $245,400.

As an open access fishery, the size and composition of the fleet varies each year. Since 1995, there has been between 1 and 20 vessels making landings – mostly directed and some incidental. Only a few fishers consistently make substantial landings, others come and go. Seven vessels made landings in 2008, with four vessels catching the majority of the shrimp. All seven are also commercial Dungeness crab vessels. The coonstripe shrimp season, May 1 through October 31, complements the Dungeness crab season, December 1 through July 15. Since the enactment of the coonstripe shrimp vessel trap permit requirement in 2002, there are typically three times the number of permits sold as are used each year.

In the Crescent City area, fishers set traps on the muddy bottom near rocky reefs. The latest trap style is a tapered, circular design from Canada (Figure 1-2). Each trap weighs less than10 pounds (4.5 kilograms) and is constructed of mesh over a stainless steel frame. The traps are typically 39 inches (1 meter) diameter, 16 inches (41 centimeters) tall and have entry funnels 3 inches (8 centimeters) in diameter. Traps are fished in sets of 10 to 15 connected together on a long line string. Each end of the set is held down by a weight and marked with a buoy on the surface. Fresh fish, usually sardines, mackerel, herring or albacore, is used as bait. Some fishers position their traps at a rather specific depth, about 25 fathoms (46 meters), while others vary the depth and prospect as shallow as 12 fathoms (22 meters). The predominant fishers have about 500 traps, and may fish fewer. Gear is rarely lost, but does wear out.

Figure 1-2. A Crescent City commercial fisher empties a typical coonstripe shrimp trap onto a sorting table. Photo credit: J. Bieraugel.

Habitat damage and bycatch from this fishery is considered minimal. Since traps are set on muddy bottoms, they generally do not disturb coral, sponges and other fragile species often growing on rocks. Small shrimp and bycatch can escape the trap through the mesh, typically 0.5 inch square openings. Once onboard, the catch is carefully sorted and discards are thrown over, live if possible. Onboard fisheries observers have reported bycatch including hermit crabs; snails; juvenile Dungeness and rock crabs; decorator, umbrella and butterfly crabs; sunflower stars; hagfish; juvenile lingcod, cabezon and rockfish; sculpin; octopus; and other small shrimp.

Interest in recreational fishing also rose in the 1990s, presumably because the growing commercial fishery showed that the shrimp could be fished close to shore with lightweight traps. The recreational limit was increased from the general invertebrate species limit of 35 shrimp per day to 20 pounds (9 kilograms) per day in 1998 (Title 14, CCR, §29.88). There is no closed season or size limit for the recreational fishery. Effort and catch are believed to be minimal, although fishery surveys have not been conducted. This species is not targeted by commercial passenger fishing vessels.

Status of the Biological Knowledge

Coonstripe shrimp are crustaceans in the order Decopoda containing lobsters, crayfish, crabs and other shrimp. These caridean shrimp are members of the Pandalidae family, a family of cold water shrimp containing 24 genera and 162 species. Pandalid shrimp are medium to large size, have a laterally compressed body, a blade-like rostrum (spine-like extension of the anterior median carapace), well developed

antennal scales and a muscular abdomen. The muscular abdomen, used for swimming propulsion, has little room for organs—making it desirable as food. Antennal scales act as rudders and brakes and make possible elaborate escape maneuvers. Pereopods, the longest limbs, are relatively small and more suited to perching than walking. Pincers (claws called chelae), usually on the first two pereopods, are small or lacking in pandalids. The coonstripe shrimp has unevenly sized chelipeds (pereopods with chelae), favoring one side for feeding and other for grooming. They are known to spend a considerable amount of time keeping body surfaces and chemoreceptors clean. Their limbs are equipped with tiny brush and comb-like groups of setae especially for this purpose. The rostrum terminates in three points and has 7 to 16 dorsal spines and 5 to 10 ventral teeth. Body color is generally a milky-translucent background with prominent red to brown stripes and dots, sometimes with white markings and blue dots. There are broken, diagonal stripes on the abdomen and strong banding on the legs and antennae. The name coonstripe is sometimes attributed to other pandalid shrimp species which also bear striped markings.

Coonstripe shrimp is also referred to as dock shrimp for its habit of sometimes living around pilings. Normally, juveniles live in shallower water while adults live in the sublittoral zone at depths up to 606 feet (185 meters). This epibenthic shrimp inhabits a variety of bottom substrates, from mud to gravel, usually in areas with strong currents and shelter to hide in by day. Wide ranging, they are found from Sitka, Alaska to at least Point Loma, California (San Diego County). The southern end of their range has been incorrectly stated as far north as San Francisco, but with confirmation that *Pandalus gurneyi* is a synonym of *P. danae*, it is likely that the coonstripe shrimp range extends into Baja California, Mexico. Sporadically caught in many fisheries and surveys, they have only been found in densities high enough to support a fishery in a few select locations. Prey items include polychete worms and small invertebrates such as copepods and amphipods. Predators are likely octopus, crabs and various groundfish. Biological information on coonstripe shrimp is somewhat limited.

Coonstripe shrimp were the first of the pandalid shrimp to be described as protandrous hermaphrodites, beginning as males and transforming into females during the course of their lives. Most of the shrimp hatch as males in the spring, usually April, and spend about 3 months nearby as larvae. Larvae are complete with two pairs of antennae, mandibles, eyes and thoracic appendages used for swimming. Once the juvenile form is attained, usually by June, they undergo rapid molting and growth. Four months later, usually October, they are sexually mature and begin breeding. In their second year of breeding most are still males. Subsequently, the shrimp begin transforming into females. In their third year, they breed as females and probably do not survive another year. A small percentage of coonstripe shrimp are primary females, hatching and living their entire lives as females, thus adding resiliency to the species. This anomaly is assumed to increase in response to environmental pressures, such as fishing selectively for large females, which may unbalance the sex ratio. However, laboratory experiments indicate that for coonstripe shrimp, genetics is a stronger influence on sex determination. Sex change triggers are still poorly understood.

Coonstripe shrimp are unusual shrimp in that ovigerous (egg bearing) females can be found throughout the year (Figure 1-3). In studies from southern British Columbia, egg bearing females were mainly encountered from November to April. Recent anecdotal information from the California fishery indicates egg bearing females are encountered throughout the fishing season, especially near the beginning. Dockside sampling conducted by the Department in 1997, prior to the seasonal closure regulation, found the number of ovigerous females caught in the Crescent City fishery declined from 100 percent at the end of March to less than five percent at the end of June. During May 1997, corresponding to the first month of the current season, at least 50 percent of females caught were ovigerous. Larval recruitment in the closely related pink shrimp, *Pandalus jordani*, has been linked to ocean conditions and the strength and timing of the spring transition. Each year, along the Pacific Coast of North American between San Francisco, California (38° North Latitude) and the Queen Charlotte Islands, British Columbia, Canada (52° North Latitude), the coastal winds switch from the southerly winds of winter to the northerly winds of summer producing the spring transition. Some years, the impact of taking egg bearing females in late spring can have a large effect on recruitment because those may be the very eggs with the best chance of survival. Further investigation is necessary to understand how this concept relates to coonstripe shrimp recruitment.

Figure 1-3. A female coonstripe shrimp bearing eggs (green) along the underside of her abdomen. Photo credit: Scott Groth, ODFW.

The habit of continual breeding also complicates determining size at age for coonstripe shrimp. Research, again from British Columbia, found that males maturing in October of their first year averaged about 2.5 inches (6-7 cm) total length (TL), averaged 3.4 inches TL (8.5 centimeters) the following October and after becoming female by the third October, averaged 3.9 inches TL (10 centimeters). Large specimens can reach 5.5 inches TL (14 centimeters).

Coonstripe shrimp find their mates using a strategy called pure searching. Males do not guard the female or a territory. This avoidance of conflict allows them to be smaller without the necessary fighting chelipeds. The two sexes have chance encounters and may not even acknowledge each other until after the female molts and is therefore ready to mate. This strategy is found in populations of mobile species occurring in sufficient density that meetings are frequent. Mating is brief and females have the option to physically reject copulation and the depositing of the spermatophores. Soon after successful mating, the female extrudes, fertilizes and attaches the eggs to her swimming appendages where they are carried until hatching. Incubation of the eggs by the female produces lower fecundity but also lowers mortality before hatching. Cold water shrimp carry only a few hundred to a few thousand eggs each year and coonstripe shrimp averages 1140 eggs per year. This is a relatively small amount compared to warm water shrimp who release tens of thousands of eggs

annually. Like most cold water shrimp, the life history of coonstripe shrimp makes them unsuitable for aquaculture and susceptible to overfishing, especially in combination with habitat damage or climate change. There is currently no aquaculture of this species.

Status of the Population

Based on the short history of the fishery, the effort, landings and value appear relatively stable. However, to date there have been no estimates of abundance or other population parameters, such as recruitment and mortality rates, with which to assess the stock for sustainability. The relatively limited distribution of the fishable stock of coonstripe shrimp would seem to increase its vulnerability to overfishing.

Management Considerations

Although there are currently few active participants, coonstripe shrimp is an open access commercial fishery with no trap limits, and each year about three times as many permits are sold as vessels make landings. There is little to no interest within the industry in pursuing a permit or trap restriction program at this time. However, a control date of November 1, 2001 has been set in case a restricted access program is considered in the future (Title 14, CCR, §180.15); trap limits should be considered simultaneously. Gear cost and low catch-per-unit-effort will likely keep both the commercial and recreational fisheries from expanding rapidly, but effort should be monitored.

The current seasonal closure of the fishery is based on biological information from Canadian stocks, a short dockside sampling program in Crescent City and recommendations from local fishers. Although the season is designed to avoid the most common period of egg bearing females—sampling catch composition over a longer time period would check the effectiveness of this strategy. There is no closed season for the recreational fishery; egg bearing females can be legally harvested year round. Conservative management of this fishery is necessary because of the lack of data on this species. Further investigation of life cycle timing, the relationship of larval recruitment to ocean conditions and what portion of the stock is taken each year would help determine the impact of harvesting ovigerous females.

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Further Reading

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Coonstripe shrimp commercial landings and value, 1995-2008.

Year	Pounds	Value
1995	2,486	$3,729
1996	35,136	$137,734
1997	79,173	$295,017
1998	63,809	$256,431
1999	75,540	$312,906
2000	86,369	$353,627
2001	82,149	$305,265
2002	82,239	$295,505
2003	62,003	$218,533
2004	45,989	$177,448
2005	60,184	$238,551
2006	35,937	$144,664
2007	22,142	$92,706
2008	85,176	$361,801

Data Source: CFIS data, all gear types combined.