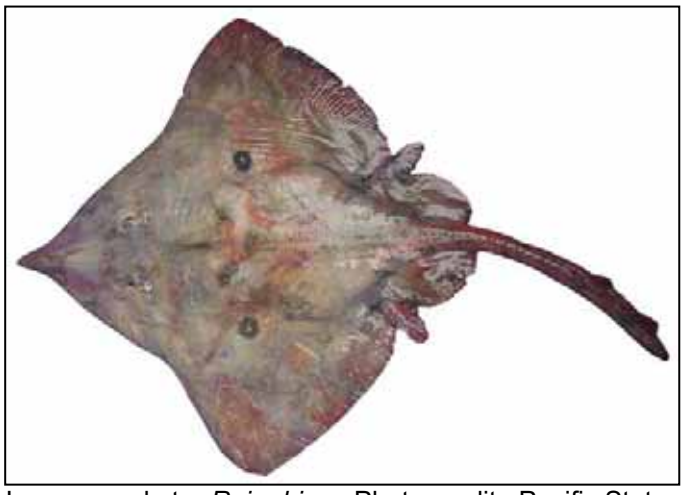
5 Skates and Rays



Longnose skate, *Raja rhina.* Photo credit: Pacific States Marine Fisheries Commission.

History of the Fishery

In California, the earliest fishers for cartilaginous fishes were indigenous people living along the coast. Chinese immigrants fished for assorted coastal rays and sharks in the mid 1800s, mostly in and around San Francisco Bay. Until the mid 1930s, most skates and rays were discarded except in Asian communities where they were consumed.

Skates and rays have not historically been targeted in commercial fisheries, but have primarily been taken incidentally by trawlers in northern and central California. Of the species identified in commercial landings, the most common species are the big skate, *Raja binoculata*, California skate, *Raja inornata*, shovelnose guitarfish, *Rhinobatos productus*, and bat ray, *Myliobatis californica*. This does not reflect actual species composition, however, because the majority of landings are reported as "unspecified skate" or "stingray".

In the past, the primary market has been for just the pectoral fins or "wings" of skates, with only a small portion of skate and ray landings marketed whole. Currently, skates are marketed both whole and as wings. Wings are sold largely in Asian markets as fresh or fresh-frozen, dried, or dehydrated and salted. The carcasses are usually discarded at sea or sometimes sold as bait for trap fisheries. Skates also have been processed for fishmeal, but these ventures failed for economic reasons. Reportedly, rounds punched from skinned wings have been used as an inexpensive substitute for scallops in seafood restaurants and markets.

In the early years of the fishery the majority of skate landings came through central California (Monterey and San Francisco) which accounted for 41 to 100 percent of the annual landings from 1948 through 1989 (72 percent average). Since 1975, the northern California ports (Eureka, Crescent City and Fort Bragg) have become progressively more important for skate landings. In 1995 northern California landings

increased dramatically, and has since accounted for 72 to 93 percent of the total landings. Total landings from ports south of Monterey have continued to be relatively insignificant.

Skate landings from 1916 to 1990, which ranged from 50,419 pounds (23 metric tons) in 1944 to 631,420 pounds (286 metric tons) in 1981, comprised 2 to 90 percent of the total elasmobranch landings with an average of 11.8 percent. Rays, which were not identified separately until 1978, were likely included with skate landings prior to 1978. Similar to the shark fishery, skate landings have fluctuated widely throughout the history of the fishery. While a shift to the shark fishery in 1938 resulted in a decrease in skate landings, the variations in catch roughly followed general economic conditions, though oceanographic conditions may also have had a role. Skate landings increased significantly in the mid 1990s. During this period, skate and ray landings increased over ten-fold in California from about 106,163 pounds (48 metric tons) in 1994 to 1,433,211 pounds (650 metric tons) in 1999, with a peak of 3,003,177 pounds (1362 metric tons) in 1997 (Figures 5-1 and 5-2). Landings fell sharply in 2002, corresponding with reduced demand in Asian markets. Over the past seven years, skate and ray landings have averaged about 284,000 pounds (129 metric tons).

The statewide economic value of skate and ray fisheries has been historically small compared to other fisheries. The average annual ex-vessel price for skates and rays ranged from $0.01 to $0.02 per pound ($0.02 to $0.04 per kilogram) from 1958 to 1969. Skate average prices rose from $0.09 per pound in the 1970s to $0.27 per pound in the 1990s ($0.20 to $0.60 per kilogram). From 2000 to 2008, prices averaged $0.33 per pound and reached as high as $10 per pound ($0.73 to $22 per kilogram). The price of rays has fluctuated considerably compared to skates. From the 1970s to 1980s, the average price per pound rose from $0.07 to $1.82 ($0.15 to $4.00 per kilogram), and then dropped to $0.74 in the 1990s ($1.63 per kilogram). Between 2000 and 2008, the average price was $0.68 per pound ($1.50 per kilogram) with a maximum of $50 per pound ($110 per kilogram). The ex-vessel value of skates and rays peaked in 1997 at approximately $525,000, and decreased to $112,000 in 2008. It should be noted that the high price per pound (over $3.00 per pound; $6.61 per kilogram) is for rays sold for research, usually electric rays, and represents less than 0.23 percent of the total landings. The ex-vessel price of skates and rays sold for food is much lower. The apparent increase in skate landings in the 1990s may be attributed to increased landings of previously discarded catch. When the commercial groundfish fishery was divided into limited entry and open access components in 1994, new quotas and regulations were required. The significant reduction of groundfish quotas for both components created more space in boat's holds to retain non-quota species. Trawl vessels were able to supplement groundfish landings with skate and ray bycatch. It is uncertain whether the effort to utilize the skate and ray resource has increased or if previously discarded catch is simply being retained and landed.

In 2009 new regulations require that longnose skate be sorted from other species upon landing (Title 14, CCR, §189). Previously, skate market categories were limited to only big skate and California skate, though these and other skate and ray species were mostly lumped into the "unspecified skate" market category in the absence of sorting

requirements. Under federal regulations, skates had been part of the “other fish” species complex because they had not been thoroughly studied nor received a stock assessment. Longnose skate has been removed from the “other species” complex and assigned species-specific allowable biological catch values for the 2009 and 2010 management cycle. State commercial fishery samplers began sampling the species composition of commercial skate landings in 2009. Current regulations also require all skates be landed whole (FGC §5508, 8042). The possession of skate wings aboard a vessel is prohibited as there are no equivalents or conversion factors established.

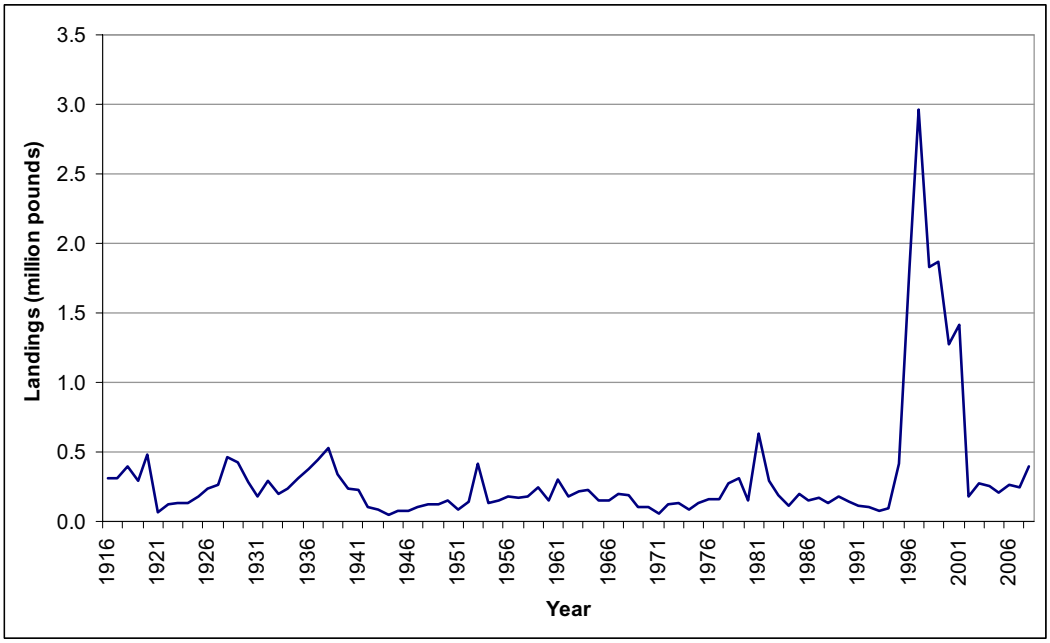


Figure 5-1. Skate commercial landings (all species combined), 1916-2008. Data source: Department catch bulletins (1916-1986) and CFIS data (1987-2008), all gear types combined.

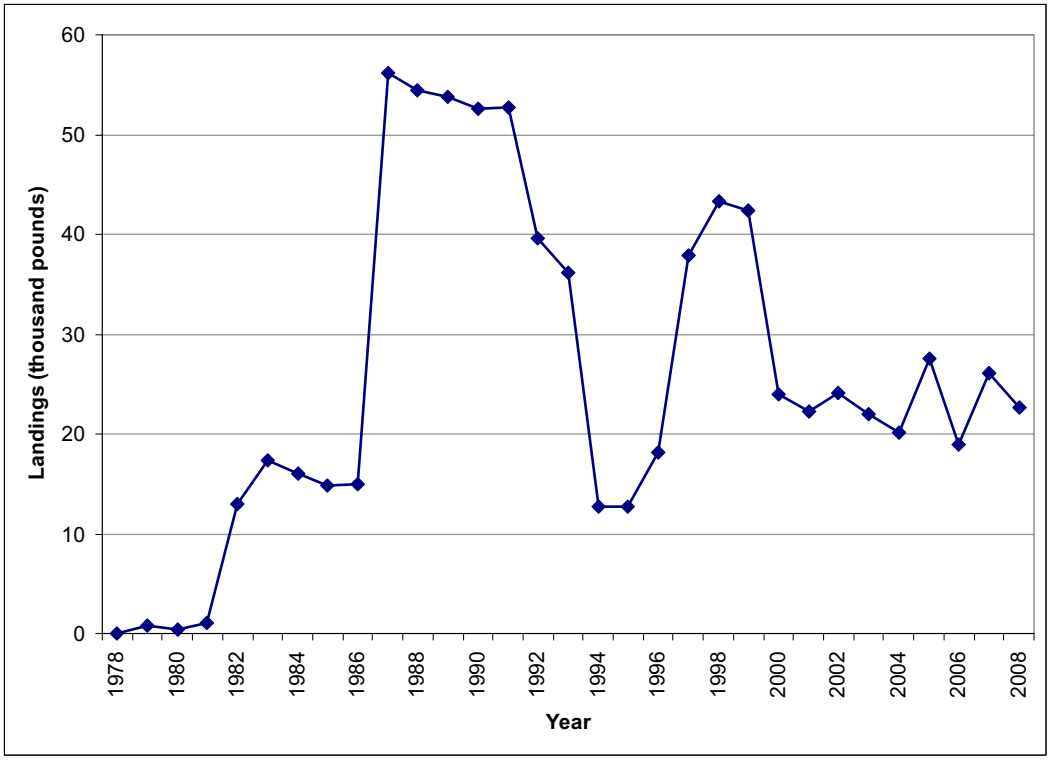


Figure 5-2. Ray commercial landings (all species combined), 1978-2008. Data source: CFIS data, all gear types combined. Data not available prior to 1978.

The recreational fishery for skate and rays is relatively meager. A few of the shallow nearshore species are targeted by small recreational fisheries. Rays dominate the catch (Figures 5-3 and 5-4); the most common species are bat rays, shovelnose guitarfish and thornbacks, *Platyrhinoidis triseriata*.

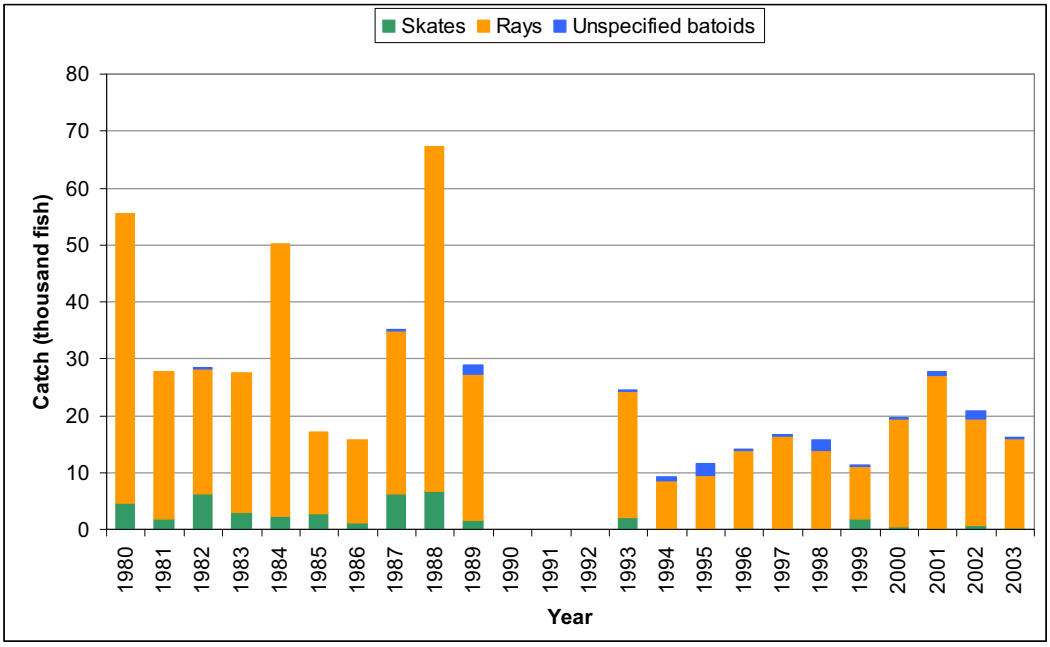


Figure 5-3. Skate and ray recreational catch (all species combined), 1980-2003. Source: MRFSS data, all fishing modes and gear types combined. Data not available from 1990-1992. CPFV data not available for central and northern California for 1993-1995.

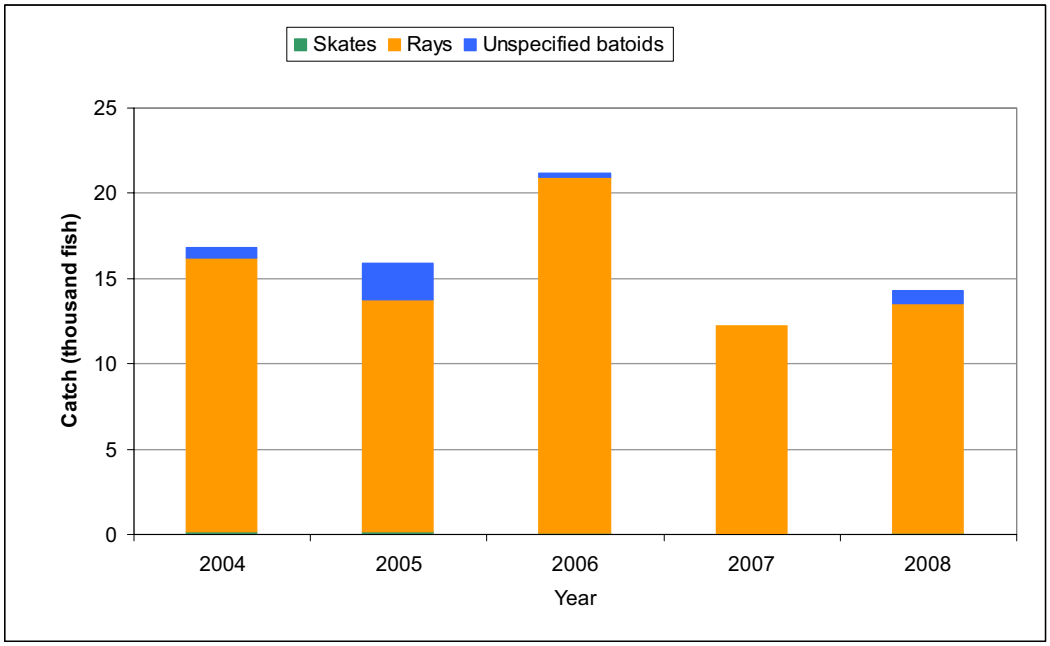


Figure 5-4. Skate and ray recreational catch (all species combined), 2004-2008. Source: CRFS data, all fishing modes and gear types combined.

Status of Biological Knowledge

The skates and rays, also known as batoids, are the largest group of elasmobranchs, comprising about 55 percent of the living cartilaginous fishes. They are often considered flattened sharks, adapted to a benthic lifestyle. Their pectoral fins expand forward and are fused to the head, forming a wide flat disc with five pairs of gill openings completely on the underside. The eyes and spiracles are positioned on the top of the head allowing them to see and respire while partially buried. The mouth is located on the ventral side, an adaptation for feeding on benthic prey. Their dorsal coloration is usually a shade of gray, brown or olive, which may camouflage them with sandy or muddy bottoms.

Batoids are found from the tropics to polar regions in all marine habitats, in shallow bays and estuaries to the open ocean to the deep continental slope in depths over 9500 feet (2895 meters) as well as in some freshwater habitats. Some species are fairly common in California waters; others are known only from a few specimens or are seasonal visitors that appear only during warm summer months or El Niño events. Like most elasmobranchs, the batoids typically have a life history strategy described by a slow growth rate, late onset of sexual maturity and few offspring. Populations with these characteristics are more vulnerable to overfishing.

Like sharks, all batoids have internal fertilization, which occurs in one of two reproductive modes. The skates are oviparous (egg layers), with fertilized eggs protected inside leathery rectangular egg cases that are deposited on the sea floor. Developing embryos are nourished through the attached egg yolk and hatch when it is depleted. Empty egg cases, often called “mermaid’s purses”, sometimes wash ashore and are found by beachgoers. The remaining batoids are all ovoviviparous. Embryos develop within the female, initially relying on an egg yolk for nutrients. After the nutrients have been consumed, embryos ingest or absorb an energy rich histotroph or “uterine milk” produced by the mother. In stingrays, this milk is secreted through hair like filaments called trophonemata. The gestation period for batoids varies widely among species, ranging from 2 months up to 3.5 years. Upon hatching, newborn batoids look like miniature adults.

Most batoids are generalized benthic predators, feeding on a wide variety of worms, mollusks, crustaceans, other invertebrates and fishes. They also employ a broad range of feeding strategies. Electric rays can shock large fishes and swallow them whole. Eagle rays can excavate hard shelled bivalves and use their plate-like teeth to crush them, whereas mantas, the largest of the batoids, filter tiny plankton. In turn, predators of batoids include marine mammals, sharks and other large fishes. For defense, some species have a sharp stinging spine in the tail whereas others have sandpapery denticles or enlarged thorns on the back and tail for protection. Currently, 22 species of skates and rays are known from California waters.

The Skates
Families Rajidae and Arhynchobatidae

Figure 7-4. Longnose skate, *Raja rhina*. Photo credit: Diane Haas.

The skates are the largest and most diverse group of the batoids, representing more than one-fourth of all living cartilaginous fishes worldwide. Eleven species in three genera are currently known from California waters. The three commercially important skates in California are the big skate, California skate and longnose skate.

Skates are characterized by a greatly flattened rhomboid-shaped disc. They often have rows of thorns or denticles on the back and tail, but they do not have stinging spines. There are two small dorsal fins near the end of the slender tail, and the caudal fin is generally weak or absent. They have paired electric organs on either side of the tail that emit weak electric signals. The exact role of these organs is unknown, but they may function in communicating with conspecifics, perhaps for recognizing mates or demonstrating aggression. Adult skates display sexual dimorphism, with males developing bell-shaped discs and rows of hooked thorns along the front and lateral edges (malar and alar thorns) of the disc for copulation. Skates occur worldwide from depths close inshore to nearly 9850 feet (3000 meters).

Big skate

The big skate has a stout, stiff elongated snout, typical of other hardnose skates (Rajidae). It has a diamond shaped disc, weakly notched pelvic fins, and a pair of prominent eyespots on the dorsal surface. Found from the eastern Bering Sea to southern Baja California, it inhabits shallow bays to 2624 feet (800 meters) deep, though it is more common at moderate depths. Big skates have the largest egg cases of any California's skate species, and are the only species to routinely have more than 1 embryo (up to 7) per egg case. They are also the largest skate found in California, growing up to 8 feet (2.4 meters) in length, though they are uncommon over 6 feet (1.8 meters). Maturity in females occurs at a length of 4.3 feet (1.3 meters) and 12 years; males mature at 3.6 feet (1.1 meters) around 10 to 11 years. They feed on polychaete worms, mollusks, crustaceans and benthic fishes. Predators include sevengill sharks and northern elephant seals.

California skate

The California skate has a moderately long, acutely pointed snout and an olive-brown dorsal surface covered with small scattered prickles. It occurs from Washington to southern Baja California. It is a common nearshore species that usually occurs on soft bottoms at depths less than 60 feet (18 meters), but has been reported from 5248 feet (1600 meters) deep. Females grow to about 30 inches (76 centimeters) in length

and mature at about 20 inches (52 centimeters); males are slightly smaller. California skates feed on small benthic invertebrates.

Longnose skate

The longnose skate is recognized by its extremely long pointy snout. It ranges from the eastern Bering Sea to southern Baja California. It is found from nearshore to depths over 3500 feet (1069 meters), usually over mud-cobble bottoms near areas with vertical relief. Females reach a length of about 71 inches (180 centimeters), while males reach about 41 inches (105 centimeters). Maturity occurs at 28 to 39 inches (70 to 100 centimeters) and 10 to 12 years in females; males mature around 24 to 29 inches (62 to 74 centimeters) and 10 to 11 years. Longnose skates over 24 inches (60 centimeters) in length feed mostly on bony fishes while smaller skates feed more on crustaceans.

Other hardnose skate species include the Pacific starry skate, *Raja stellulata*, a common nearshore skate covered with small star-shaped prickles, and the broad skate, *Amblyraja badia*, a rare deepwater species found from 2775 to 7616 feet (846 to 2322 meters). The remaining species found in California are the softnose skates (Arhynchobatidae), which are distinguished by a short flexible snout and usually live in deeper waters. These include the Aleutian skate, *Bathyraja aleutica*, fine-spined skate, *B. microtrachys*, and roughtail skate, *B. trachura*. The sandpaper skate, *B. interrupta*, named for its prickly, sandpaper-like dorsal surface, is sometimes known as *B. kincaidii* as it may be a distinct species from the northern Pacific form, but this needs further study. The rare Pacific white skate, *B. spinosissima*, and deepsea skate, *B. abyssicola*, are some of the deepest living of all skate species, found to 9695 feet (2938 meters) and 9528 feet (2904 meters), respectively.

The Guitarfishes and Thornbacks Families Rhinobatidae and Platyrhinidae

Guitarfishes, named for their similarity in shape to the musical instrument, are easily distinguished from other rays by a flattened, wedge-shaped disc, thick tail, and prominent dorsal fins. Thornbacks share this general shape, but have a more rounded snout (Figure 5-5). Guitarfishes and thornbacks are usually found inshore on or near the bottom in warm-temperate to tropical regions. They are bottom feeders and have rows of small, pebble-like teeth used to prey mainly on invertebrates and small fishes. Three species are found in California waters.

Figure 5-5. Thornback, *Platyrhinoidis triseriata*. Photo credit: Edgar Roberts.

Shovelnose guitarfish

The shovelnose guitarfish has a long pointed snout and a spade-shaped disc that is longer than wide. The dorsal surface is smooth except for a row of thorns extending along the back and tail, and coloration is olive to sandy brown. It ranges from San Francisco south to the Gulf of California, but is rare north of Monterey. This ray is generally a shallow water species found to 43 feet (13 meters) but occurs to depths of 298 feet (91 meters). It is found in shallow coastal waters, bays, sloughs and estuaries; these areas are important for mating and serve as nursery grounds. Shovelnose guitarfish are nomadic, gregarious and often abundant. During the summer pupping season prior to mating, females may outnumber males by as much as 53 to 1. After about a one year gestation, pups 6 to 9 inches (15 to 23 centimeters) long are born, with up to 28 pups per litter. Adult females reach about 5 feet (1.5 meters) in length and weigh around 40 pounds (18 kilograms) while males are smaller. Both sexes mature at around 3 feet (1 meter) in length in southern California, although females mature at 7 years and live to at least 16 years while males mature at 8 years and live to at least 11 years. Shovelnose guitarfish will partially bury themselves in sand or mud but have been observed in sea grass beds. They feed on a variety of crabs, worms, clams and fishes.

Banded guitarfish

The banded guitarfish, *Zapterx exasperata*, has a more rounded disc that is about equal in length and width. Its prickled dorsal surface has a single row of thorns along the back, and its coloration is sandy brown to dark gray with black bars. It reaches about 3 feet (1 meter) in length. Though found to depths of 656 feet (200 meters), it usually inhabits tidepools to 70 feet (21 meters) in rocky reef areas. It ranges from central California to the Gulf of California, but occurs rarely in California.

Thornback

The thornback has a heart-shaped disc and three parallel rows of large hooked thorns that extend along the back and down the narrow tail. The dorsal surface is olive to gray brown in color. Adults reach 36 inches (91 centimeters) in length. They are found from Tomales Bay to the Gulf of California, but are uncommon north of Monterey Bay. These rays are usually common inshore in waters shallower than 20 feet (6 meters) but have been found to 449 feet (137 meters). They inhabit mud and sand bottoms in bays, sloughs, coastal beaches and around kelp forests. Females mature at 19 inches (48 centimeters); males mature at 15 inches (37 centimeters). Newborn thornbacks are just over 4 inches (11 centimeters) long, born in litters of up to 15 pups. Thornbacks feed on benthic invertebrates and small fishes, and they are eaten by white sharks and Northern elephant seals.

The Electric Rays
Family Torpedinidae

Figure 5-6. Pacific electric ray, *Torpedo californica.* Photo credit: Daniel W. Gotshall.

Electric rays, also called torpedo rays, are characterized by their smooth flabby appearance with an enlarged sub-circular disc, short stout tail and large caudal fin (Figure 5-6). Their most noteworthy characteristic is the pair of specialized kidney-shaped electric organs in the disc, composed of modified muscle cells that are capable of producing a powerful electric shock. Electric rays are found worldwide in temperate to tropical regions, usually in shallow waters but recorded to over 3500 feet (1071 meters). Prey items include crustaceans, cephalopods, worms and fishes. Solitary and nomadic, electric rays are sometimes seen floating effortlessly in the water column. Only one species is known from California waters.

Pacific electric ray

The Pacific electric ray, *Torpedo californica*, is bluish gray in color dorsally, often with irregular black spots, and whitish below. It ranges from northern British Columbia, Canada to central Baja California, Mexico. It occurs on sandy bottoms, rocky reefs and near kelp beds usually at 10 to 100 feet (3 to 30 meters), although one has been observed swimming in the water column at 33 feet (10 meters) over waters 9840 feet (3000 meters) deep. Females reach a length of over 60 inches (137 centimeters), while males reach 36 inches (92 centimeters). Maturity in females occurs at a length of 29 inches (73 centimeters) and 9 years; males mature at 26 inches (65 centimeters) two years earlier. Maximum age is at least 16 years but possibly 24 years. Reproduction may occur biennially in females, with pups 7-9 inches (18-23 centimeters) long born in litters of 17 to 20 pups. Pacific electric rays employ two feeding strategies to capture mainly fish but also invertebrate prey. During the day they are ambush predators, lying partially buried in the sand until immobilizing prey with electric discharges. At night or in low visibility they actively forage in the water column. They can envelope and manipulate prey items towards their mouths with their highly dexterous pectoral fins.

Pacific electric rays can discharge an electric shock of 45 volts or more, so care should be taken when encountering them. The shock is unlikely fatal to humans, however it is strong enough to knock down an adult. Extremely active at night, they will sometimes act aggressively if approached by divers and swim directly at them.

The Stingrays
Families Urolophidae, Myliobatidae, Dasyatidae, Gymnuridae, and Mobulidae

Stingrays, named for the stinging spine in the tail, are most frequently found in warm temperate and tropical waters. In California, some species are relatively common while others only occasionally appear during periods of unusually warm water. They exhibit a remarkable size range from a maximum disc width (wingtip to wingtip) of about

8 inches (20 centimeters) in some stingrays to over 20 feet (6 meters) in the manta ray. They feed on a variety of invertebrates and fishes.

Bat ray

The bat ray, *Myliobatis californica*, is a heavy bodied eagle ray with a distinct thick head and long whip-like tail (Figure 5-7). It ranges from northern Oregon to the Gulf of California usually in waters less than 164 feet (50 meters) deep. Seasonally abundant from spring to fall, bat rays are commonly found over mud and sand in bays and sloughs, which are important feeding and nursery grounds. They are also common around rocky reefs and kelp forests. Gestation lasts 9 to 12 months, and pups are 8-12 inches (20-31 centimeters) in disc width at birth. Litter size increases from 2 pups in smaller females up to 12 in larger individuals. Maturity in males occurs at a disc width around 24-26 inches (62-66 centimeters) and 2 to 3 years; females reach maturity at about 35-39 inches (88-100 centimeters) and 5 years. Females grow to larger sizes than males, reaching a maximum disc width of 6 feet (1.8 meters). Females also live much longer, to at least 24 years, while maximum age in males is estimated to be 6 years.

Figure 5-7. Bat ray, *Myliobatis californica.* Photo credit: Daniel W. Gotshall.

Bat rays feed on a wide variety of benthic invertebrates including abalone, clams, snails, shrimps, crabs, worms, sea cucumbers and brittle stars. They occasionally eat small bony fishes. Divers can often see large pits in the sand left by excavating bat rays. Preventive measures like fencing and trapping have been used to keep bat rays from preying on oyster beds; however, studies have shown that crabs and not bat rays are the culprits. In fact, keeping bat rays away from these areas may do more harm as they are prevented from feeding on these detrimental crabs.

Round stingray

California's most common stingray, the round stingray, *Urobatis halleri*, is small with a nearly round disc. Its short stout tail has a well developed caudal fin and robust serrated spine. Round stingrays are found from Humboldt Bay, California to Panama, and are most abundant south of Point Conception. A benthic species, round stingrays usually occur in shallow nearshore waters less than 50 feet (15 meters) deep, including bays and sloughs, but have been reported to at least 298 feet (91 meters). They occur on soft mud or sand bottom and are often found camouflaged in areas of abundant eelgrass. Round stingrays segregate by age and sex as males and juveniles tend to live in shallow habitats while adult females live in offshore waters deeper than 46 feet (14 meters). During the spring and summer, adult females will move inshore to mate and pup. Most females give birth each year to a litter of 1 to 6 pups after a short 3

month gestation period. Both males and females reach maturity at a disc width of 6 inches (15 centimeters) and 6 years. Males reach a maximum disc width of 10 inches (25 centimeters) and females about 12 inches (31 centimeters). Their diet changes as they mature, with shifting preferences for polychaetes, crabs and bivalves.

Round stingrays are notorious for causing injuries to many beachgoers each year. They congregate in large numbers just off beaches and will sting bathers if stepped on. Although wounds are not fatal, they can be very painful; bathers can usually avoid this danger by shuffling their feet. Attempts have been made to reduce the number of injuries by removing the spines from captured round stingrays. This has been met with limited success as round stingrays can replace their spines every year.

Diamond stingray

The diamond stingray, *Dasyatis dipterura*, and the pelagic stingray, *Pteroplatytrygon violacea*, are members of the largest stingray family, the whiptail rays. The diamond stingray is found in shallow waters to a depth of 230 feet (17 meters) over mud and sand near rocky reefs and kelp forests. It ranges from southern California to northern Chile and the Galapagos. Rare in California waters, it appears more frequently and in greater numbers during periods of warm water. Its maximum reported size is 47 inches (120 centimeters) disc width.

Pelagic stingray

The pelagic stingray is an oceanic species, found from the upper surface to at least 780 feet (238 meters) in depth over very deep water. This migratory stingray is found worldwide in warm temperate and tropical regions, and has been recorded year round in California waters though it is rare north of Monterey Bay. It reaches a maximum disc width of 32 inches (80 centimeters), though stingrays in captivity may grow to 38 inches (96 centimeters). Both the pelagic stingray and diamond stingray have very long stinging spines that are potentially hazardous to humans.

California butterfly ray

The California butterfly ray, *Gymnura marmorata*, is found in warm temperate and tropical waters along sandy beaches and in shallow lagoons. It ranges from southern California to the Gulf of California and Peru. It is identified as the only California ray with a very broad disc that is nearly twice as wide as long, reaching 48 inches (122 centimeters) in females.

Manta

The manta, *Manta birostris*, and the spinetail mobula*, Mobula japanica*, are both found worldwide in warm temperate and tropical regions. These two members of the devil ray family, distinguished by their broad pectoral wings and hornlike cephalic fins, are occasionally found in southern California waters. They are usually seen at the

surface swimming individually or in large groups. The manta is the largest known ray, attaining a wing span of at least 22 feet (6.7 meters). The spinetail mobula is smaller, reaching a maximum width of 10.1 feet (3.1 meters). Mantas and mobulas are the only filter feeding batoids. They channel great quantities of water through specialized gill plates and strain out planktonic crustaceans and small fishes.

Status of the Population

There is considerable uncertainty regarding current or past population levels of California's skates and rays. It is unknown how the dramatic increase in landings in the mid 1990s affected the resource. Fishes that were previously discarded, both dead and alive, are now retained and landed. Given the past and potential increase in landings, skates and rays should be closely monitored. The life history of skates and rays is usually described by slow growth, late onset of maturity and low fecundity when compared to bony fishes. These characteristics leave most species vulnerable to overfishing. Decreases in skate and ray landings have already been observed in other regions. In the north Atlantic, fishing pressure has altered the abundance, distribution, and population structure of several skate species and overfishing has apparently occurred.

The first assessment for longnose skate populations off the U.S. west coast was completed in 2008, and represents the only stock assessment for any batoid occurring in California waters. Results of the assessment indicated that the biomass of the longnose skate population has been gradually decreasing from its unfished level in 1915. The estimated 2007 spawning stock biomass was at about 66 percent of the unfished stock level and was above the 25 percent overfishing threshold. The population model suggested a generally low harvest rate for longnose skates. This is expected given that longnose skates, along with other skate species, have not historically supported a directed fishery along the U.S. west coast.

The effect of recreational fisheries on the skate and ray resource is relatively unknown. Surveys of 55 shark derbies between 1951 and 1995 in Elkhorn Slough show that shovelnose guitarfish, which were the second most caught elasmobranch in the 1950s and 1960s, nearly disappeared from the catch by the 1970s. Shovelnose guitarfish declined to only about three percent of the catch by the 1990s, but coincided with an increase in the occurrence and relative abundance of thornbacks. The relative abundance of bat rays steadily increased over the years though the average number caught per derby declined during the last two decades. It is likely that a combination of fishing pressure, habitat alteration and oceanographic conditions influenced elasmobranch abundance and distribution. However, recreational fisheries sampling data show continued catches of bat rays, shovelnose guitarfish and thornbacks. It is difficult to determine the total numbers of skates and rays caught as sampled catch numbers vary considerably from year to year.

Management Considerations

Three species of skate, big skate, California skate and longnose skate, became federally designated groundfish in 1982 when the PFMC adopted the Pacific Coast Groundfish Fishery Management Plan. Prior to 1982, this species was managed by the California Department of Fish and Game (Department) through regulations adopted by the state legislature and the California Fish and Game Commission. All other skate and ray species are managed by the state. The recent longnose skate stock assessment provides a basic foundation for the management of longnose skates; however, the assessment relied on some critical assumptions based on limited supporting data. More research is needed to improve the longnose skate population model and to produce effective management plans for other skate and ray species in California. The information needed includes:

1. Landing data on size, sex and species composition of the recreational and commercial catch.
2. Survival rates for released catch.
3. Life history parameters for many of the species involved, including age determination and age validation studies.
4. Population dynamics including movement. This information will help determine if increased landings of previously discarded catch are altering the impact to the species involved.
5. Genetic studies to determine stock structure.

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Further Reading

Bizzarro JJ, Robinson HJ, Rinewalt CS and Ebert DA. 2007. Comparative feeding ecology of four sympatric skate species off central California, USA. Environ. Biol. Fishes. 80:197-220.

Carlisle A, King A, Cailliet GM and Brennan JS. 2007. Long-term trends in catch composition from elasmobranch derbies in Elkhorn Slough, California. Mar. Fish. Rev. 69(1-4):25-45.

Ebert DA. 2003. Sharks, rays, and chimaeras of California. Berkeley (CA): University of California Press. 284 p.

Ebert DA and Compagno LVJ. 2007. Biodiversity and systematics of skates (Chondrichthyes: Rajiformes: Rajoidei). Environ. Biol. Fishes. 80:111-124.

Gertseva VV. 2009. The population dynamics of the longnose skate, *Raja rhina*, in the northeast Pacific Ocean. Fish. Res. 95:146-153.

Gertseva VV and Schirripa MJ. 2008. Status of the Longnose Skate (*Raja rhina*) off the continental US Pacific Coast in 2007. In Pacific Coast groundfish fishery stock assessment and fishery evaluation, Volume 1. Available from: Pacific Fishery Management Council, Portland, OR. 131 p.

Martin L and Zorzi GD. 1993. Status and review of the California skate fishery. In: Branstetter S (editor). Conservation Biology of Elasmobranchs. NOAA Technical Report, NMFS 115:39-52. Available from: NTIS, Springfield, VA.

Skate commercial landings (all species combined), 1916-2008.

Year	Pounds	Year	Pounds	Year	Pounds
1916	307,716	**1947**	103,696	**1978**	275,057
1917	314,837	**1948**	119,101	**1979**	309,521
1918	398,031	**1949**	123,464	**1980**	155,216
1919	295,800	**1950**	153,758	**1981**	631,420
1920	479,812	**1951**	84,634	**1982**	287,808
1921	69,932	**1952**	138,716	**1983**	185,690
1922	121,210	**1953**	415,669	**1984**	116,293
1923	134,353	**1954**	136,221	**1985**	195,837
1924	131,137	**1955**	152,622	**1986**	150,125
1925	183,484	**1956**	175,751	**1987**	169,691
1926	232,993	**1957**	171,678	**1988**	127,852
1927	263,715	**1958**	176,896	**1989**	174,838
1928	458,926	**1959**	240,801	**1990**	143,732
1929	427,986	**1960**	146,934	**1991**	113,144
1930	286,390	**1961**	299,317	**1992**	103,469
1931	174,785	**1962**	182,178	**1993**	78,070
1932	292,412	**1963**	216,825	**1994**	93,391
1933	193,711	**1964**	222,705	**1995**	413,278
1934	232,175	**1965**	153,475	**1996**	1,830,076
1935	307,122	**1966**	154,014	**1997**	2,965,274
1936	381,944	**1967**	196,751	**1998**	1,834,740
1937	447,392	**1968**	186,350	**1999**	1,869,295

Skate commercial landings (all species combined), 1916-2008.					
Year	**Pounds**	**Year**	**Pounds**	**Year**	**Pounds**
1938	528,273	**1969**	106,068	**2000**	1,273,491
1939	336,854	**1970**	102,982	**2001**	1,410,925
1940	238,287	**1971**	61,223	**2002**	180,794
1941	224,698	**1972**	118,386	**2003**	275,452
1942	105,691	**1973**	133,433	**2004**	251,939
1943	81,109	**1974**	86,158	**2005**	210,418
1944	50,419	**1975**	135,291	**2006**	268,286
1945	74,009	**1976**	161,137	**2007**	247,495
1946	78,038	**1977**	161,426	**2008**	392,313

Data source: Department catch bulletins (1916-1986) and CFIS data (1987-2008), all gear types combined.

Ray commercial landings (all species combined), 1978-2008.					
Year	**Pounds**	**Year**	**Pounds**	**Year**	**Pounds**
1978	57	**1989**	53,728	**1999**	42,432
1979	839	**1990**	52,633	**2000**	24,018
1980	447	**1991**	52,704	**2001**	22,286
1981	1,100	**1992**	39,663	**2002**	24,163
1982	12,967	**1993**	36,163	**2003**	21,976
1983	17,306	**1994**	12,773	**2004**	20,110
1984	15,969	**1995**	12,740	**2005**	27,590
1985	14,771	**1996**	18,089	**2006**	18,924
1986	14,993	**1997**	37,903	**2007**	26,027
1987	56,143	**1998**	43,288	**2008**	22,672
1988	54,461				

Data source: CFIS data, all gear types combined. Data not available prior to 1978.

Skate and ray recreational catch (all species combined), 1980-2003.			
Year	Number of fish	Year	Number of fish
1980	55,607	**1992**	---
1981	27,700	**1993**	24,558
1982	28,362	**1994**	9,142
1983	27,541	**1995**	11,498
1984	50,077	**1996**	14,125
1985	17,208	**1997**	16,657
1986	15,795	**1998**	15,621
1987	35,115	**1999**	11,375
1988	67,281	**2000**	19,625
1989	28,823	**2001**	27,820
1990	---	**2002**	20,920
1991	---	**2003**	16,162

Data source: MRFSS data, all fishing modes and gear types combined. Data not available from 1990-1992. CPFV data not available for central and northern California for 1993-1995.

Skate and ray recreational catch (all species combined), 2004-2008.	
Year	Number of fish
2004	16,852
2005	15,878
2006	21,154
2007	12,211
2008	14,300

Data source: CRFS data, all fishing modes and gear types combined.