Fishery-at-a-Glance: Brown Smoothhound

Scientific Name: *Mustelus henlei*

Range: Brown Smoothhound are found from Coos Bay, Oregon south to the Gulf of California, Mexico and Costa Rica. In South America they have been observed from Ecuador to Peru.

Habitat: Brown Smoothhound are most common in sandy or muddy bottoms of bays, especially in cool temperate waters, but they are also found in deeper water on the continental shelf.

Size (length and weight): The maximum size recorded is 153.0 centimeters (60.2 inches) Total Length.

Life span: Brown Smoothhound have low longevity and an early age at first maturity for a shark species. The oldest fish recorded was 13 years old**.**

Reproduction: Brown Smoothhound develop inside eggs within the mother's body and are born live. They produce one to 20 pups per litter, depending on geographic location. Reproduction is annual with a gestation period of 10 to 12 months. In California the age at maturity for Brown Smoothhound ranges between 1 and 4 years old, when males are 570.0 to 650.0 millimeters (22.4 to 25.6 inches) total length and females are 700.0 millimeters (27.6 inches) Total Length.

Prey: Brown Smoothhound consume crabs, shrimp and small fishes.

Predators: Other sharks and piscivorous (fish-eating) birds consume small Brown Smoothhound.

Fishery: Brown Smoothhound are primarily caught as incidental catch by the gill net fishery for White Seabass in southern California and recreational anglers within inshore waters.

Area fished: Brown Smoothhound are caught throughout California, especially in muddy inshore estuaries and bays.

Fishing season: Brown Smoothhound are caught year-round.

Fishing gear: Brown Smoothhound are mainly retained commercially by set gill nets and by private anglers using hook and line gear, but incidental catch and bycatch of this species may occur in multiple fishing modes including bottom trawls, longlines and fish or lobster traps.

Market(s): There is no major market for Brown Smoothhound in California. Incidental commercial take of this species is sold at a low price.

Current stock status: The current stock status of Brown Smoothhound is unknown; however, they are not heavily targeted by any fishery and they have a resilient life history strategy. There are currently no concerns about this stock.

Management: Recreational management occurs in the form of daily bag and possession limits that apply to all species. There is a minimum size limit of 18.0 inches (457.2 millimeters) for the commercial take of Brown Smoothhound. Based on the available data it appears the current management is effective. Although if landings increase significantly or if it appears anglers begin targeting Brown Smoothhound, this may indicate the fishery needs management change**.**

1 The Species

1.1 Natural History

1.1.1 Species Description

The Brown Smoothhound (*Mustelus henlei*) is a houndshark of the family Triakidae. It is a relatively small shark with sharp teeth, a small head, long snout and slender body, tapering from the dorsal fin to the tail (Figure 1-1). Brown Smoothhound have large eyes, broad pectoral fins, two broadly triangular dorsal fins and two pelvic fins. Their tail has an elongate longer upper lobe. Brown Smoothhound appear very similar to the Gray Smoothhound (*Mustelus californicus*), but they can be differentiated by their sharp versus blunt teeth and a frayed edge on their dorsal fin, which lacks scales on the back one-fifth. Their coloration is typically red-brown to bronze above and silvery or white below (Miller and Lea 1972).

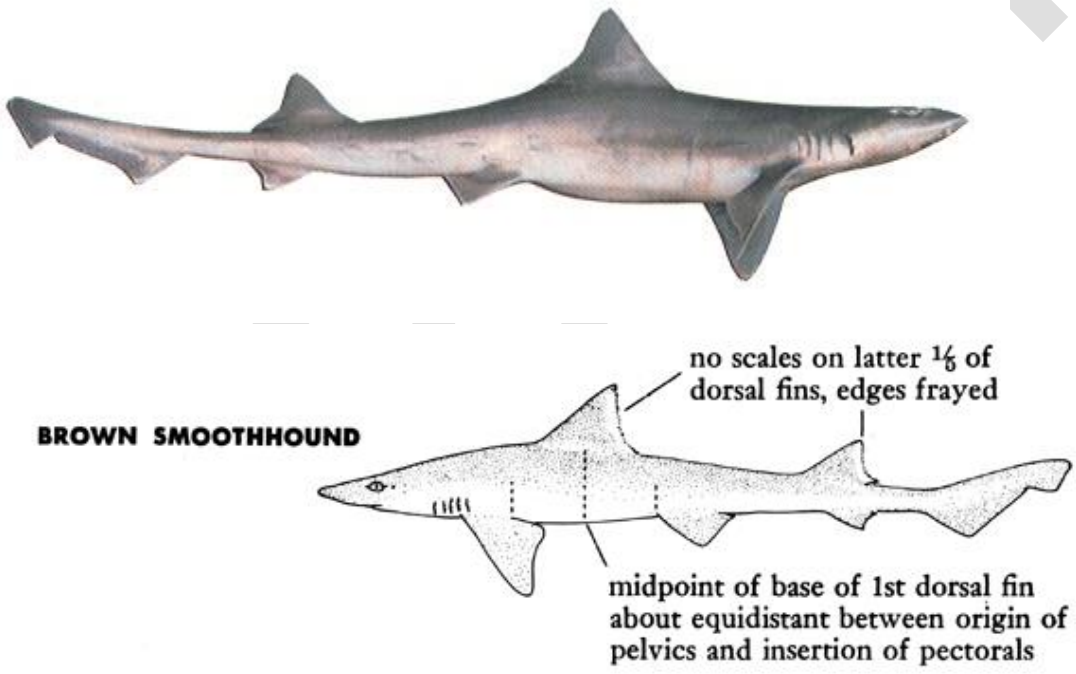

Figure 1-1. Photograph and illustration of the Brown Smoothhound (Photo Credit: CDFW) (Illustration: Reproduced from Miller and Lea 1972).

1.1.2 Range, Distribution, and Movement

Brown Smoothhound are found from the Gulf of California to Coos Bay, Oregon in the northern hemisphere and from Ecuador to Peru in the southern hemisphere (Figure 1-2) (Ebert 2003). They are very common throughout California in many habitats along the continental slope, but they are most often found within inshore bays and estuaries (Ebert 2003). Genetics analysis suggests that three distinct subpopulations exist; (1) Northern California, (2) Central-Southern California and Mexico, and (3) Costa Rica (Chabot et al. 2015). In San Francisco Bay, Brown Smoothhound use inshore

estuarine waters during spring and fall and are thought to move offshore during the winter to avoid reduced salinity from high rainfall and low water temperatures (Hopkins and Cech 2003). The direction and extent of their offshore migration is unknown. A tracking study in Tomales Bay, California from 2004 found that Brown Smoothhound are more active at night and that they typically swim in the direction of tidal flow (Campos et al. 2009). Their mean rate of movement was 0.09 meters (m) per second (0.30 feet (ft) per second)).

Figure 1-2. Range of Brown Smoothhound.

1.1.3 Reproduction, Fecundity, and Spawning Season

Like other sharks, Brown Smoothhound reproduce via internal fertilization. The male shark uses extensions of the pelvic fins called “claspers” to transfer sperm to the female and fertilize her eggs (Soto-Lopez et al. 2018). Brown Smoothhound bear live young that develop inside eggs within the mother’s body (ovoviviparity) (Ebert 2003). They give birth to one to ten pups annually in the spring and summer, and the number of young increases with the size of the female (Yudin 1987). Brown Smoothhound in the Gulf of California, Mexico and central California both have a 10 month gestation period (approximately between June and April), but larger litter sizes of up to 20 young are observed in sharks from Mexican waters, which may be attributed to the warmer water temperatures in this region (Perez-Jimeñez and Sosa-Nishizaki 2008; Soto-Lopez et al. 2018).

1.1.4 Natural Mortality

Determining the natural mortality (M) of marine species is important for understanding the health and productivity of their stocks. Natural mortality results from all causes of death not attributable to fishing such as old age, disease, predation or environmental stress. Natural mortality is generally expressed as a rate that indicates the percentage of the population dying in a year. Fish with high natural mortality rates must replace themselves more often and thus tend to be more productive. Natural mortality along with fishing mortality result in the total mortality operating on the fish stock.

The annual rate of natural mortality for Brown Smoothhound is estimated to be M = 0.295 using Hoenig's (1983) formula based on maximum reproductive age as estimated from the von Bertalanffy growth equation in Yudin and Cailliet (1990) (Smith et al. 1998). This rate is moderate compared to estimates of M for other shark species (Smith et al. 1998). The oldest Brown Smoothhound recorded was 13 years (yr) old (Yudin and Cailliet 1990).

1.1.5 Individual Growth

Individual growth of fishes is quite variable, not only among different groups of species, but also within the same species. Growth is often very rapid in young fish, but slows as adults approach their maximum size. The von Bertalanffy Growth Model is most often used in fisheries management, but other growth functions are also appropriate. The von Bertalanffy growth function is:

$$L_t = L_\infty(1 - e^{-k(t-t_0)})$$

where L_t is the length at age t, L_∞ is the maximum average length, k is the relative growth rate, t is the age of the fish, and t_0 is the theoretical age when the length of the fish is zero. The values of those estimated parameters for Brown Smoothhound are: L_∞ = 977, k = -0.224, t_0 = -1.296 (Yudin and Cailliet 1990). Both males and females grow most rapidly between 1 and 2 yr of age, with no significant difference in the time it takes to reach their maximum length, though females typically attain a greater maximum length than males (Yudin and Cailliet 1990). The largest Brown Smoothhound ever recorded was a 1,530.0 millimeters (mm) (60.3 inches (in)) female (Soto-Lopez et al. 2018).

The relationship between weight and length for Brown Smoothhound (both sexes combined) has also been modeled using the exponential equation:

$$W = aL^b$$

where W is the weight in grams, L is the total length in millimeters, a is a constant indicating the intercept and b is a constant indicating the slope of the regression line (a=8.07E-07 and b=3.21 for Brown Smoothhound) (Williams et al. 2013).

1.1.6 Size and Age at Maturity

Brown Smoothhound are relatively fast growing and reach maturity early for a shark species. At birth, the pups are between 200.0 and 300.0 mm (7.9 to 11.8 in) Total Length (TL) (Yudin 1987). In California the age at maturity for Brown Smoothhound ranges between 1 and 4 yr-old, when males are 570.0 to 650.0 mm (22.4 to 25.6 in) TL and females are 700.0 mm (27.6 in) TL (Yudin and Cailliet 1990). Based on fish sampled from northern Baja California del Sur, Mexico, the length at which 50% of Brown Smoothhound are mature is 635 mm (25 in) for males and 670 mm (26 in) for females (Soto-Lopez et al. 2018).

1.2 Population Status and Dynamics

The population status of Brown Smoothhound is unknown. Many are landed as bycatch throughout California and their post-release mortality rate is unknown, so this could pose a potential risk to the population. However, given that they are common throughout state waters, not targeted by any major commercial fishery, have a moderate rate of natural mortality and relatively short generation time for a shark there are no concerns about the status of the stock at this time.

1.2.1 Abundance Estimates

There are no known estimates of the absolute abundance of Brown Smoothhound in California. There is no stock assessment available as of 2017. An estimate of annual relative abundance in San Francisco Bay is available from fishery-independent otter trawl surveys done annually by the Department's San Francisco Bay Study since 1980 (Figure 1-3). The San Francisco Bay Study calculates monthly abundance indices for each species based on the mean catch per unit effort of young of the year fish (i.e. newly recruited juveniles) at all stations in a geographical region. These counts are multiplied by a weighting factor for the sampling area and summed for all five regions. The index of annual abundance presented here (Figure 1-3) is calculated as the average of monthly abundance over the period when new Brown Smoothhound recruits were most abundant (April to October). The abundance of Brown Smoothhound recruits appears quite variable within San Francisco Bay (Figure 1-3). A peak of 3,819 individuals were observed in 1989, but abundances declined until 1999, rebounding briefly in 2002 before hitting a record low of 134 recruits in 2006. As of 2016 the population is showing a slow increase with a relative abundance of 1,574 young of the year Brown Smoothhound.

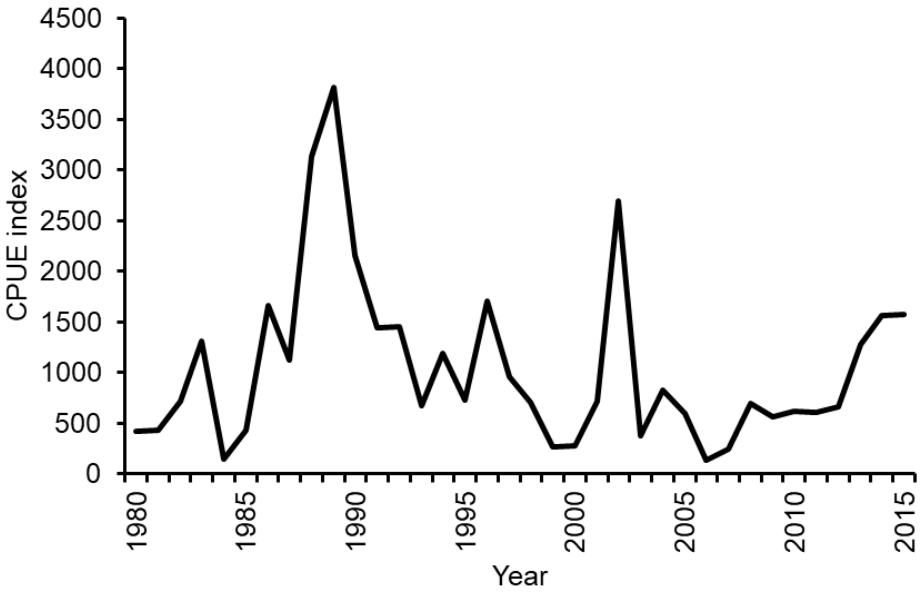

Figure 1-3. Abundance of young of the year Brown Smoothhound collected by otter trawl in San Francisco Bay from 1980 to 2015 by the Department's San Francisco Bay Study and the Interagency Ecological Program for the San Francisco Estuary (CDFW unpublished data 2018).

Since no commercial gill net fishing is allowed in the Brown Smoothhound's primary inshore sandy and muddy-bottom habitat, and few are retained by recreational anglers, Brown Smoothhound are thought to be largely protected from fishing pressure. Therefore, it is presumed that the population remains relatively stable in California

1.2.2 Age Structure of the Population

There is no stock assessment for Brown Smoothhound in California and too few are sampled for weight and length on an annual basis from fishery surveys or fishery-independent surveys to sufficiently characterize age structure for the whole population. Fishery-independent data on the length of Brown Smoothhound caught in otter trawls from the Department's San Francisco Bay Study were converted to ages using a length-age key, and the age structure for the population in San Francisco Bay is presented here (Figure 1-4) (CDFW unpublished data). Age structure of Brown Smoothhound appears relatively stable with good numbers of recruits in each sample year and a relatively even distribution of older age classes from 1980 to 2016 (Figure 1-4). The age structure should be interpreted with the caveat that less than 50 fish were sampled in many years. Age structure for 2017 was not included because only 12 Brown Smoothhound were sampled (CDFW unpublished data).

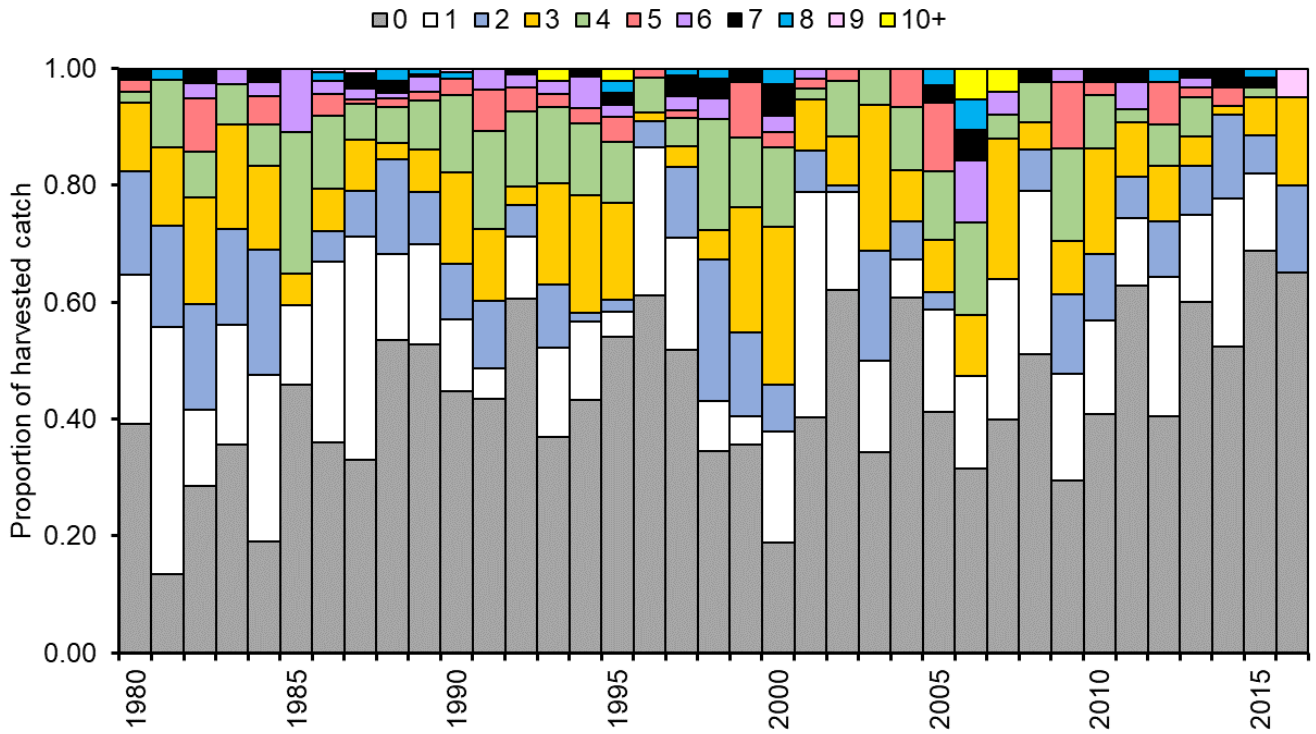

Figure 1-4. Fishery-independent index of age structure for Brown Smoothhound sampled in otter trawls by the Department's San Francisco Bay Study from 1980 to 2016. Length data of all sharks landed were converted to age classes. Fish older than 10 yr are presented in a summed category (CDFW unpublished data 2018).

1.3 Habitat

Brown Smoothhound are epibenthic, dwelling on or just above the seafloor where they spend most of their time foraging for prey (Campos et al. 2009). They are observed across a multitude of habitats in depths up to 200 m (656 ft) on the continental shelf (Love 1996), but they are most often found over soft-bottom sandy or muddy inshore estuaries and bays like Tomales Bay and Elkhorn Slough in northern California (Talent 1982; Yudin and Cailliet 1990; Haeseker and Cech Jr 1993). Both juveniles and adults are found in inshore habitats, where Brown Smoothhound are known to grow, forage (Razum 1952) and reproduce (Yudin 1987). Juveniles are typically found in eelgrass beds (Russo 2015), while adults are found over shallow muddy habitats (Campos et al. 2009). In northern California, Brown Smoothhound reside in bays most of the year and appear to move offshore during the winter months, potentially to avoid the colder, low salinity water (Hopkins and Cech 2003). Additional research is required to understand where Brown Smoothhound move in the winter and the potential importance of offshore habitats to the species.

1.4 Ecosystem Role

The Department is not aware of any directed research on the ecosystem role of Brown Smoothhound. As apex predators, sharks play an important role in regulating trophic interactions by controlling the abundance of secondary carnivores. Since Brown Smoothhound mainly feed on bottom dwelling prey, they probably impact lower trophic level organisms that reside in this area such as shrimp, crabs and small fish (Talent 1982).

1.4.1 Associated Species

Brown Smoothhound do not school or aggregate with other species, but they share habitat with other soft bottom habitat fishes in California such as Leopard Shark (*Triakis semifasciata*), flatfish, skates and rays, croaker and sea perch.

1.4.2 Predator-prey Interactions

Brown Smoothhound feed on bottom dwelling prey such as crabs, shrimp and small fishes (Razum 1952). Gill net studies from Tomales Bay (Haeseker and Cech Jr 1993) and Elkhorn Slough (Talent 1982) showed that Brown Smoothhound consumed mainly shrimp (e.g. Smooth Bay Shrimp (*Crangon stylirostris*), crabs (e.g. Yellow Shore Crab (*Hemigrapsus oregonensis)* and Graceful Rock Crab (*Cancer gracilis)*), small fish (e.g. California Anchovy (*Engraulis mordax)*, Pacific Staghorn Sculpin (*Leptocottus armatus)* and Bay Pipefish (*Syngnathus leptorhynchus)*), and polychaete worms. The diet of Brown Smoothhound appeared to vary across locations with different habitats or salinities. Although Razum (1952) did not observe any shift in diet with increases in length, Talent (1982) observed fishes were only consumed by larger Brown Smoothhound (80 to 100 centimeters (cm) (31 to 39 in) TL), suggesting some shift in diet may occur in larger individuals. Juvenile Brown Smoothhound (less than 55.0 cm (21.7 in)) are also prey for other sharks and piscivorous seabirds, specifically Sevengill Sharks (*Notorynchus cepedianus*) and Caspian Terns (*Hydroprogne caspia*) (Russo 2015).

1.5 Effects of Changing Oceanic Conditions

Oceanic changes due to climatic events impacting water temperature and nutrient availability such as El Niño Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO) and the North Pacific Gyre Oscillation (NPGO) can have profound effects on fishes and fisheries. The Brown Smoothhound is a generalist carnivore with a very broad distribution in the eastern Pacific from Peru north to Oregon, which suggests their population may be quite adaptable to changes in water temperature or ecosystem dynamics caused by climate change. As sea surface temperatures warm, Brown Smoothhound might become more common in areas north of California such as the coast of Oregon, Washington and Canada. Their primary prey, crustaceans, may decline in abundance, however, as ocean acidification could affect shell development for multiple bottom-dwelling invertebrates (Fabry et al. 2008). Additionally, warming temperatures could shift parameters of age, growth and reproduction for sharks in

California to match those observed in Mexico (e.g. larger litter sizes and a larger size at reproductive maturity) (Soto-Lopez et al. 2018).

2 The Fishery

2.1 Location of the Fishery

Brown Smoothhound are fished throughout the coast of California. They were commonly landed by set gill net in Santa Barbara and Ventura counties in the 1980s and early 2000s, but their landings declined and never rebounded following the ban on inshore gill netting in 1994 (FGC §8610 et seq.). In the recreational fishery, most Brown Smoothhound are landed by private/rental boaters, with an estimated 77% of the catch between 2004 and 2017 taken in Los Angeles, Orange and San Diego counties (Recreational Fisheries Information Network (RecFIN)). In 2017, RecFIN estimates show a total of 183 Brown Smoothhound were caught in the Southern district and 11 were caught in the Redwood district (Humboldt and Del Norte counties). See section 4.2.1 for information on fishery-dependent data collection.

2.2 Fishing Effort

2.2.1 Number of Vessels and Participants Over Time

The fishery was largest during the 1980s and early 1990s, prior to the voter initiative to ban gill and trammel nets within state waters in 1994 (FGC §8610 et seq.). The inshore gill net ban protected a large portion of their primary habitat (i.e. inshore/estuarine soft-bottom habitat) and many gill netters switched fisheries or retired, resulting in a substantial decline in landings (Figure 2-1). The number of vessels in the fishery peaked at 103 boats in 1987, but participation dropped by 96% with only five boats landing Brown Smoothhound in 1996 (CDFW Marine Landings Data System (MLDS)).

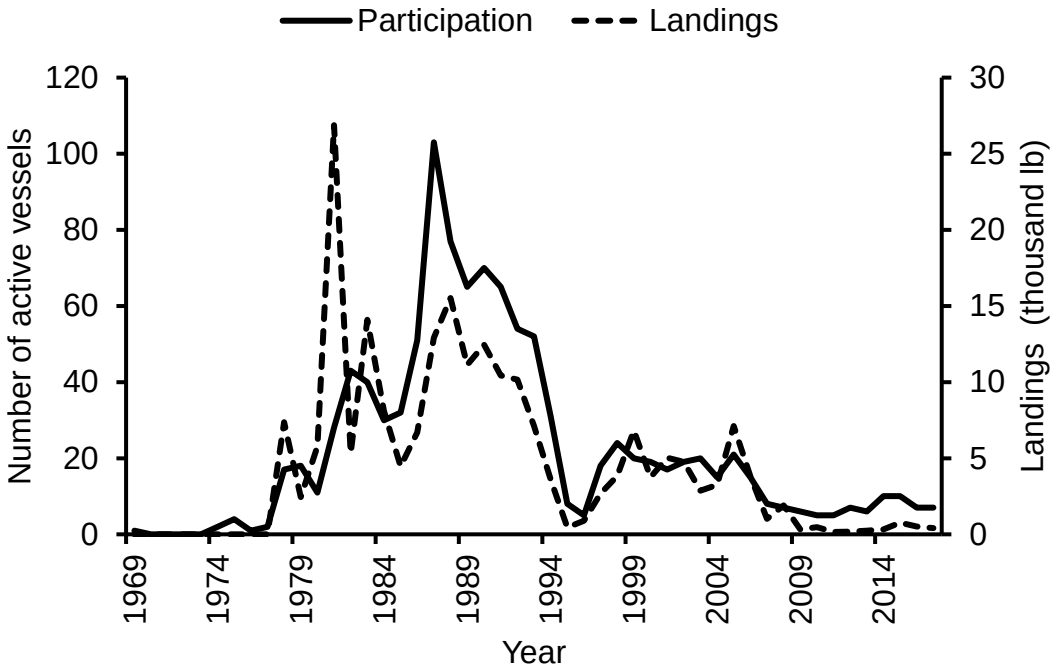

Figure 2-1. Brown Smoothhound commercial fishery participation (number of vessels) and landings (lb), 1969 to 2017. Data includes all ports and gear types (CDFW California Fisheries Information System Database (CFIS) 2018).

The commercial boats that most commonly land Brown Smoothhound are primarily targeting White Seabass (*Atractoscion nobilis*) with set gill nets (Figure 2-2). The size of gill net vessels has not changed significantly over time. Most boats range from 29 to 40 ft (9 to 12 m) in length and are crewed by a skipper working alone or with at least one deckhand. There was a modest increase in the fishery between 1997 and 2005 with around 20 vessels participating each year, but fewer than 11 boats per year have landed Brown Smoothhound since 2007, with only one or two vessels landing the majority of the catch (CDFW MLDS). The average soak time of each gill net set is 24 to 48 hours (CDFW MLDS). The fishery for Brown Smoothhound has no restrictions and is open all year. The heaviest months fished using gill nets during the height of the fishery in the 1980s were April and September, however, the months of June and July yielded the largest proportion of landings between 2013 and 2017 (CDFW MLDS).

Figure 2-2. Photograph of a boat equipped for set gill netting, the primary method for landing Brown Smoothhound throughout the history of the commercial fishery (Photo credit: C Watts, Flickr).

2.2.2 Type, Amount, and Selectivity of Gear

Brown Smoothhound are caught in California as bycatch and incidental catch by recreational anglers using hook and line gear. Between 2004 and 2017, hook and line anglers caught Brown Smoothhound as large as 112.2 cm (44.0 in) and as small as 19.5 cm (7.7 in) (RecFIN). The average size of Brown Smoothhound retained by recreational anglers between 2004 and 2017 was 65.9 cm (25.9 in) and 1.8 kilograms (kg) (4.0 pounds (lb)) while the average size discarded by anglers was 59.7 cm (23.5 in) and 0.9 kg (2.0 lb).

Brown Smoothhound are caught incidentally by multiple commercial fishing modes including gill nets, longlines, trawls and lobster and crab traps. Between 1969 and 2017, commercial landings of Brown Smoothhound were taken primarily by set gill nets (CDFW MLDS). Set gill nets are weighted and anchored to the seafloor in sandy or muddy habitats (Figure 2-3). They are constructed of one wall of webbing made of monofilament line and the bottom of the net is held down by lead lines that are composed of approximately 100 lb (45.4 kg) of weight per 100.0 fathoms (fm) (182.9 m) of line. They have poor species-selectivity, catching any species of fish small enough to get caught in the mesh openings (Shester and Micheli 2011). Brown Smoothhound are caught in set gill nets by fishermen targeting White Seabass and California Halibut (*Paralichthyes californicus*), with mesh sizes no less than 6.0 in (15.2 cm) (FGC §8623) and 8.5 in (21.6 cm) (FGC §8625), respectively. Most are caught in the White Seabass fishery as their slender body shape and small size is probably more susceptible to the smaller mesh size (Charles Villafana personal communication). Between 2007 and 2017, 36% of commercially landed Brown Smoothhound were caught by set gill nets, followed by crab or lobster traps (25%), single rigged trawls (16%), set longline (12%) and hook and line (7%) with the remaining landings (4%) split among various types of nets and traps. The selectivity of the listed gear types other than hook and line is

unknown, since length data are not formally collected on commercial landing receipts or log book records.

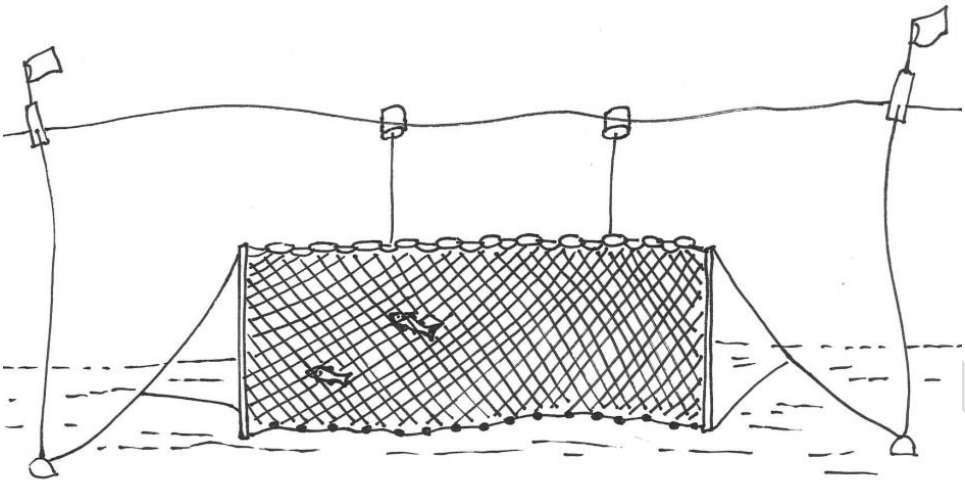

Figure 2-3. Illustration of a bottom set gill net anchored to the ocean floor (Image credit: J. Davis, CDFW).

2.3 Landings in the Recreational and Commercial Sectors

2.3.1 Recreational

Brown Smoothhound are edible, but few are retained by anglers, with an average of 74% released annually by private/rental boaters between 2004 and 2017 (RecFIN), displaying their undesirability for consumption. California Recreational Fisheries Survey (CRFS) data show landings of Brown Smoothhound by private/rental boaters were variable between 2005 and 2017, with the estimated number retained between 300 and 600 in 2005, 2009 and 2015, but that landings were much lower in other years, with a very small estimated take of only seven sharks in 2017 (Figure 2-4). Trends in landings somewhat follow trends in participation (angler trips for all species) as fewer fishing trips overall were completed in 2017 than in previous years. Commercial Passenger Fishing Vessel (CPFV) logbook data show that landings of Brown Smoothhound were highest in the late 1980s and early 1990s, with a peak of 361 sharks landed and 773 angler participants in 1989 (Figure 2-5). Since 1996 both landings and participation (number of anglers on trips where Brown Smoothhound were caught) declined rapidly with less than 50 sharks retained in most years (CDFW Marine Log System (MLS)). In 2017, 278 Brown Smoothhound were caught, but only three were retained by anglers aboard CPFVs with 289 anglers participating on the trips that caught them (CDFW MLS). The majority of these sharks were caught in Northern California (CDFW MLS). Sharks may have been discarded due to undesirability and/or because consumption of sharks is not advisable in some inshore areas due to high mercury levels in their fillets (California Ocean Sportfishing Regulations 2019).

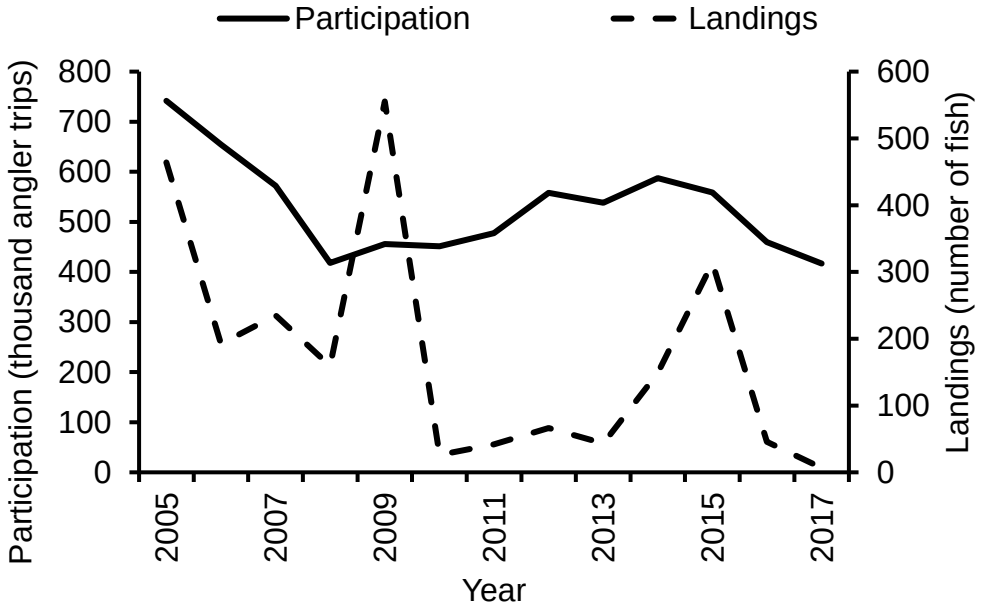

Figure 2-4. Participation (number of thousand angler trips) of private/rental boats and landings (total number of fish) of Brown Smoothhound from California, 2005 to 2017 (RecFIN 2018).

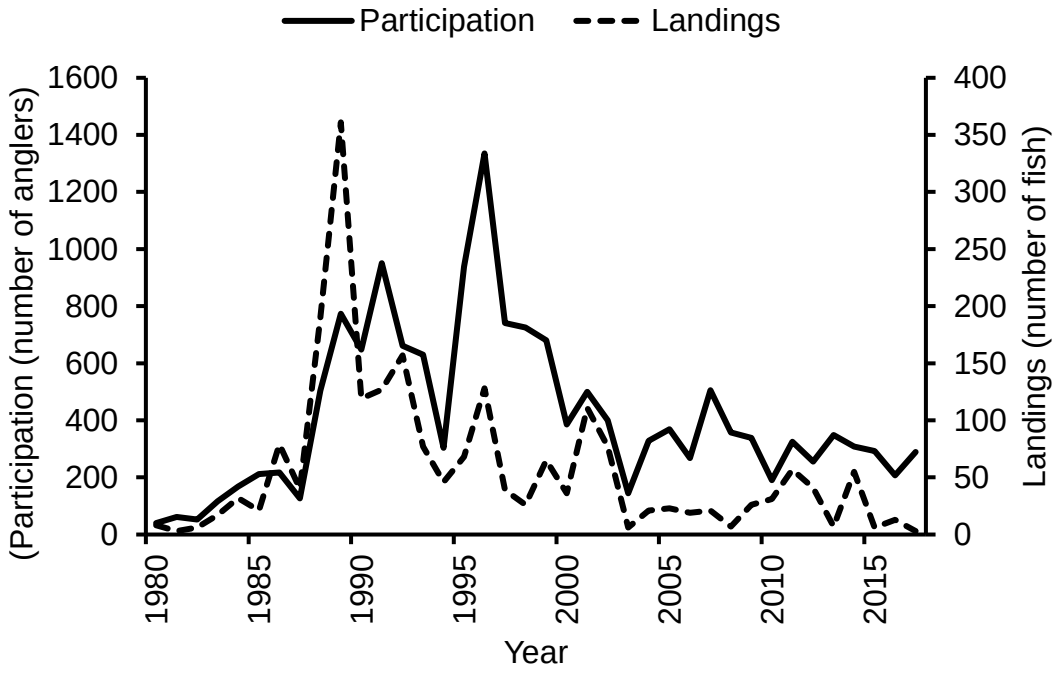

Figure 2-5. Participation (number of anglers) aboard CPFV trips where at least one Brown Smoothhound was caught and landings from all ports in number of fish kept from 1980 to 2017 (CDFW MLS 2018).

2.3.2 Commercial

Commercial landings of Brown Smoothhound were negligible prior to 1978, but rose quickly in the 1980s as the set gill net fishery expanded and became the primary gear type responsible for take (Figure 2-6) (CDFW CFIS). In 1981 fishery landings peaked at 26,876.0 lb (12,191 kg) with a value of $6,231. The fishery value peaked in 1988 at a value of $9,646 with 15,515.0 lb (7,037 kg) of Brown Smoothhound landed. Following the inshore ban of gill nets in 1994, landings dropped precipitously to 454.0 lb (206 kg) with a value of $587 in 1995 and set longline gear delivered the majority of the catch that year. Landings by set gill net rebounded in late 1990s and early 2000s with more than 2,800.0 lb (1,270 kg) landed annually between 1998 and 2006 at an annual value of approximately $2,000 to $4,000. A second drop in landings occurred in 2009 and in 2017 when only 419.0 lb (190 kg) were landed at a value of $409, with more than half the landings still retained by set gill net (Figure 2-6) (CDFW CFIS).

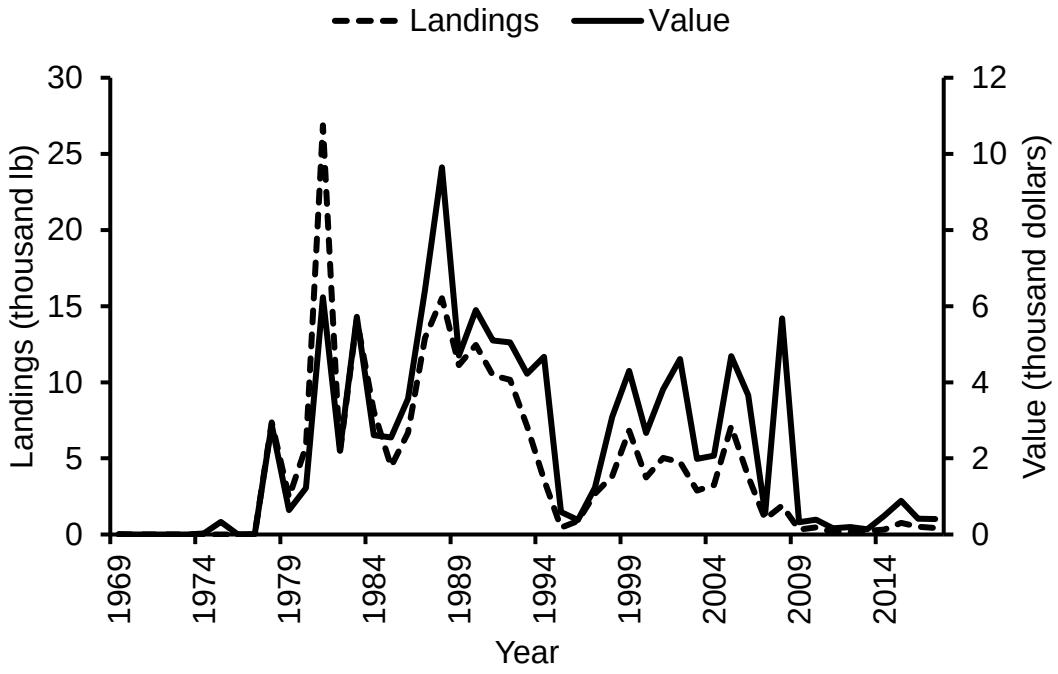

Figure 2-6. Brown Smoothhound commercial fishery landings (thousand lb) and value (thousand dollars), 1969 to 2017 (CDFW CFIS 2018).

2.4 Social and Economic Factors Related to the Fishery

The commercial fishery for Brown Smoothhound in California is of low economic value, as they are only retained as incidental catch in fisheries for other target species such as California Halibut and White Seabass (Charles Villafana pers. comm.). Although Brown Smoothhound are extremely common throughout California, they are often discarded due to their low market value. Historically, the most substantial commercial take of Brown Smoothhound occurred in the inshore set gill net fishery off

Santa Barbara County in the 1980s and early 1990s (CDFW CFIS). Following the ban on inshore gill netting in 1994, much of their primary habitat was protected from commercial fishing, and therefore landings never rebounded to the same level. In 1978 the average ex-vessel unit price for Brown Smoothhound was $0.38, rising to $0.95 in 1986 as demand increased (CDFW CFIS). However, the price dropped back down to $0.42 in 1987, and only incremental increases occurred in the 1990s. The average ex-vessel price for Brown Smoothhound hit $1.01 in 2006 and $2.55 in 2011, but there has been no substantial increase since then (CDFW CFIS) (Table 2-1). As of 2017, the ex-vessel price was $1.14 and 41% of landings were harvested by the set gill net fishery off Ventura County (CDFW CFIS) (Figure 2-7). Brown Smoothhound are known to be good for eating, but few are retained by recreational anglers because they are not interested in cleaning them given they, like other sharks, have large oily livers and very tough sand-paper like skin that is difficult to cut through.

Table 2-1. Poundage, ex-vessel value, and price per pound for Brown Smoothhound, 2000 to 2017 (CDFW CFIS 2018).

Year	Landings (pound)	Ex-vessel Value	Price per pound
2000	3,753	$2,665	$0.69
2001	5,029	$3,813	$0.72
2002	4,754	$4,610	$0.88
2003	2,877	$1,991	$0.71
2004	3,252	$2,074	$0.73
2005	7,113	$4,687	$0.79
2006	3,812	$3,658	$1.01
2007	1,008	$548	$0.61
2008	1,895	$5,681	$0.94
2009	332	$321	$0.87
2010	468	$387	$0.85
2011	162	$164	$2.55
2012	181	$194	$1.19
2013	247	$140	$0.56
2014	315	$493	$1.77
2015	762	$888	$0.94
2016	520	$418	$0.71
2017	419	$409	$1.14

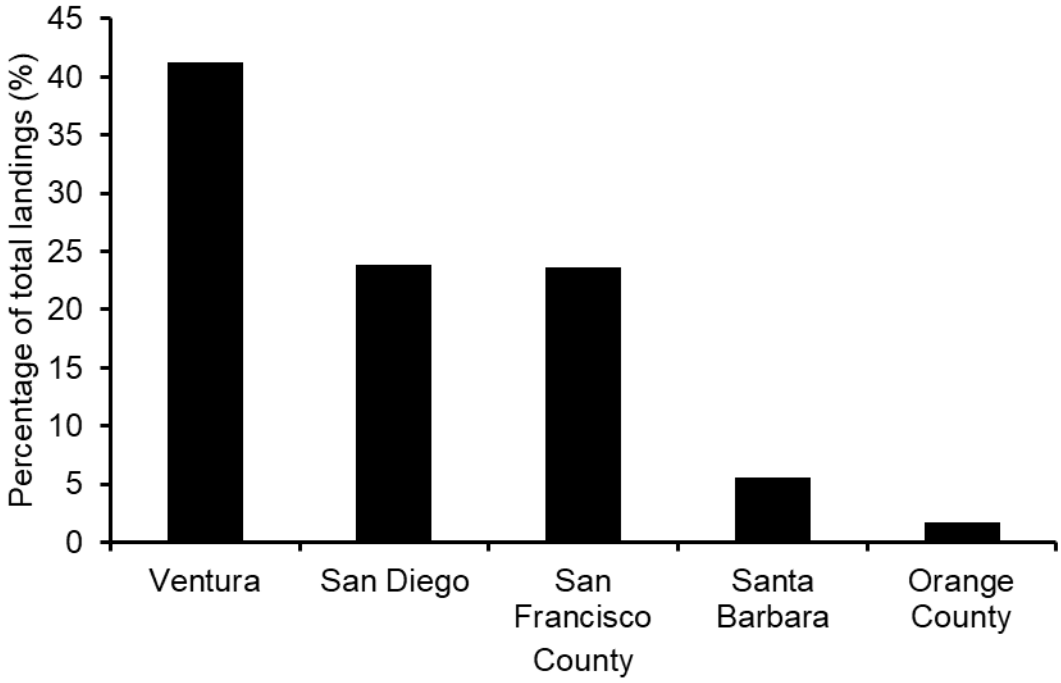

Figure 2-7. Percentage of total commercial landings of Brown Smoothhound from 2013 to 2017 by county for the top five counties (CDFW CFIS 2018).

3 Management

3.1 Past and Current Management Measures

Recreational management occurs in the form of daily bag and possession limits that apply to all species. There is a minimum size limit of 18.0 in (457.2 mm) for the commercial take of Brown Smoothhound which was adopted by the Department in 1992. Brown Smoothhound less than 18.0 in (457.2 mm) may be taken under a marine aquaria collector's permit.

3.1.1 Overview and Rationale for the Current Management Framework

Since Brown Smoothhound are very common throughout coastal California, are not frequently targeted or retained in the recreational fishery, and commercial take was greatly reduced with the banning of nearshore gill nets in 1994, no fishery management plan or harvest control rules are currently in place for this species. Commercial landings of Brown Smoothhound are monitored using data from the Department's MLDS, which are reported through landing receipts. Landings in the recreational fishery are recorded on CPFV logbooks and by CRFS samplers. Stock health is monitored based on fluctuations in reported landings and discards from these data sources.

3.1.1.1 Criteria to Identify When Fisheries Are Overfished or Subject to Overfishing, and Measures to Rebuild

Currently, no formal overfishing threshold criteria exist for Brown Smoothhound. However, landings are tracked in both the commercial and recreational sectors, and given the decrease in landings since the ban on nearshore gill net and trammel nets in 1994, there are currently no concerns about overfishing occurring in this stock. Based on the available data it appears the current management is effective. Although if landings increase significantly or if it appears anglers begin targeting Brown Smoothhound, this may indicate the fishery needs management changes to ensure sustainability.

3.1.1.2 Past and Current Stakeholder Involvement

Stakeholder involvement occurred when the size limit was developed since regulation changes are open to public comment. There have been no recent opportunities for stakeholder involvement.

3.1.2 Target Species

3.1.2.1 Limitations on Fishing for Target Species

3.1.2.1.1 Catch

The default catch limit for recreational anglers is no more than ten fish of a single species. No catch limit exists for the commercial fishery of Brown Smoothhound. The public is advised not to eat Brown Smoothhound caught in Tomales Bay and to limit

their consumption to three servings per week for those taken from Mission Bay due to high levels of mercury (California Ocean Sportfish Regulations 2019).

3.1.2.1.2 Effort

There are no regulatory limitations on fishing effort for Brown Smoothhound at this time.

3.1.2.1.3 Gear

There are no restrictions on the gear that may be used to take Brown Smoothhound.

3.1.2.1.4 Time

The Brown Smoothhound fishery is open year-round.

3.1.2.1.5 Sex

Brown Smoothhound may be retained regardless of their sex.

3.1.2.1.6 Size

There is a minimum size limit of 18.0 inches (457.2 millimeters) for the commercial take of Brown Smoothhound. From FGC §8598: “Notwithstanding §8140 or subdivision (b) of §8597, specimens of the following groups or species shall not be taken, possessed aboard a boat, or landed for commercial purposes. Taking, possessing, or landing of any of the following species in a commercial operation is prima facie evidence that it was taken, possessed, or landed for commercial purposes: (2)(B) Brown Smoothhound sharks *Mustelus henlei* that are less than 18 inches in a whole condition or dressed with head and tail removed.” Take of Brown Smoothhound under a marine aquaria collector’s permit is restricted to fish less than 18 inches total length (FGC §8597 (3)(B)).

3.1.2.1.7 Area

There are no restrictions on where Brown Smoothhound may be fished other than within no-take Marine Protected Areas (MPAs).

3.1.2.1.8 Marine Protected Areas

Pursuant to the mandates of the Marine Life Protection Act (FGC §2850), the Department redesigned and expanded a network of regional MPAs in state waters from 2004 to 2012. The resulting network increased total MPA coverage from 2.7% to 16.1% of state waters. Along with the MPAs created in 2002 for waters surrounding the Santa Barbara Channel Islands, California now has a scientifically-based ecologically connected network of 124 MPAs. The MPAs contain a wide variety of habitats and depth ranges.

Although MPAs were not designed to expressly benefit the habitat of the Brown Smoothhound, which is primarily soft-bottom sand or muddy habitat in shallow estuarine areas, many MPAs do include this habitat. Within state waters, excluding the San Francisco Bay Estuarine complex, there are 70 MPAs (either State Marine Reserves or State Marine Conservation Areas) each with at least 1.0 square nautical miles (nm^2) (3.4 square kilometers (km^2)) of soft bottom habitat in waters less than 300.0 ft (91.4 km). Thirteen of these have greater than 10.0 nm^2 (34.3 km^2) of soft bottom habitat, and they are distributed throughout the state. These 70 MPAs contain approximately 465 nm^2 (1,595 km^2) of soft bottom habitat, including 6.0 nm^2 (20.6 km^2) of estuarine habitat across four different estuaries (Kristine Lesyna and Paulo Serpa personal communication).

3.1.2.2 Description of and Rationale for Any Restricted Access Approach

There is no restricted access approach for the Brown Smoothhound fishery.

3.1.3 Bycatch

3.1.3.1 Amount and Type of Bycatch (Including Discards)

FGC §90.5 defines bycatch as “fish or other marine life that are taken in a fishery but which are not the target of the fishery.” Bycatch includes “discards,” which are defined as “fish that are taken in a fishery but are not retained because they are of an undesirable species, size, sex, or quality, or because they are required by law not to be retained” (FGC §91).

Commercial Bycatch (Set Gill Net)

Some Brown Smoothhound are caught as bycatch in the set gill net fishery for California Halibut; it is the 14th most common species observed in the catch. However, they are more common as bycatch in the set gill net fishery for White Seabass, as they are more likely to be caught in mesh sizes less than 7.5 in (19.1 cm). Data for the White Seabass gill net fishery collected between 2007 and 2017 by the West Coast Groundfish Observer Program (WCGOP), operated by the National Marine Fisheries Service (NMFS), showed that Brown Smoothhound were the fourth most common fish in the catch and 58% of those caught were discarded (Table 3-1).

Table 3-1. Most frequently observed finfish and invertebrate species associated with the White Seabass gill net fishery as retained catch and discards. Counts based on observations of 691 gill net sets, 2007 to 2017 (WCGOP; Charles Villafana pers. comm).

Common name (finfish)	**Scientific name**	**Count**	**Percent of catch**	**Total percent discarded**
White Seabass	*Atractoscion nobilis*	2,227	34.3	2
Swell Shark	*Cephaloscyllium ventriosum*	1,050	8.0	86
Spiny Dogfish	*Squalus acanthias*	631	4.4	68
Brown Smoothhound Shark	***Mustelus henlei***	**487**	**4.2**	**58**
Common Thresher Shark	*Alopias vulpinus*	428	2.4	4
Leopard Shark	*Triakis semifasciata*	341	2.4	31
Yellowtail	*Seriola lalandi*	168	2.2	1
Pacific Mackerel	*Scomber japonicus*	156	1.4	86
California Halibut	*Paralichthyes californicus*	149	1.0	55
California Scorpionfish	*Scorpaena guttata*	103	0.8	37
Common name (invertebrates)	**Scientific name**	**Count**	**Percent of catch**	**Total percent discarded**
Jumbo Squid	*Dosidicus gigas*	822	9.5	90
Rock Crab	*Cancer atennarius*	514	5.9	98
Spider Crab	*Majidae* spp.	383	4.4	78
Box Crab	*Lopholithodes foraminatus*	219	2.5	83
Whelk	*Kelletia kelletii*	172	2.0	55
Unidentified Sea Star		148	1.7	99
Yellow Rock Crab	*Cancer anthonyi*	58	0.7	100
Unidentified Crab		48	0.6	100

Commercial Bycatch (Trawl)

As part of a “rapid assessment” of California’s Halibut fishery, the California Ocean Science Trust (OST 2013) summarized trawl bycatch data collected in 2010 and 2011 from the WCGOP. Brown Smoothhound were the sixth most common species in the catch (Table 3-2).

Table 3-2. Observer data on bycatch fish species from trawl vessels targeting California Halibut in 2010 and 2011 listed in decreasing frequency of occurrence (OST 2013).

Common name	Species
Bat Ray	Myliobatis californicus
Big Skate	Beringraja binoculata
California Skate	Raja inornata
Leopard Shark	Triakis semifasciata
Skate, unidentified	
Brown Smoothhound	Mustelus henlei
Hornyhead Turbot	Pleuronichthys verticalis
Shovelnose Guitarfish	Rhinobatus productus
White Croaker	Genyonemous lineatus
Soupfin Shark	Galeorhinus galeus
English Sole	Pleuronectes vetulus
Pacific Sanddab	Citharichthys sordidus

Recreational Bycatch

Recreational anglers do not often target Brown Smoothhound, but due to their abundance and broad distribution, many are caught and released as bycatch. CRFS data estimate a peak of 1,972 Brown Smoothound were discarded by private/rental boaters in 2005 and several hundred were discarded annually until 2015 when the number of discards dropped considerably (RecFIN) (Figure 3-1). Estimates suggest only 36 Brown Smoothhound were discarded in 2016 and 67 were discarded in 2017. Fewer Brown Smoothhound are discarded from CPFVs (RecFIN). RecFIN estimates show a peak of 277 were discarded from CPFVs in 2005, while an average of 148 were discarded annually since 2004 (Figure 3-1). Similar numbers of Brown Smoothhound are also discarded from man-made/jetty and beach/bank fishing modes, however, the number of anglers sampled from these modes is too low to generate accurate estimates (RecFIN). No estimate of post-release discard mortality from hook and line fishing is available for this species, so it is unknown what proportion of discards survive. Given their relatively fast growth, early maturity and large litter size for a shark, discard mortality is unlikely to have a substantial impact on the population.

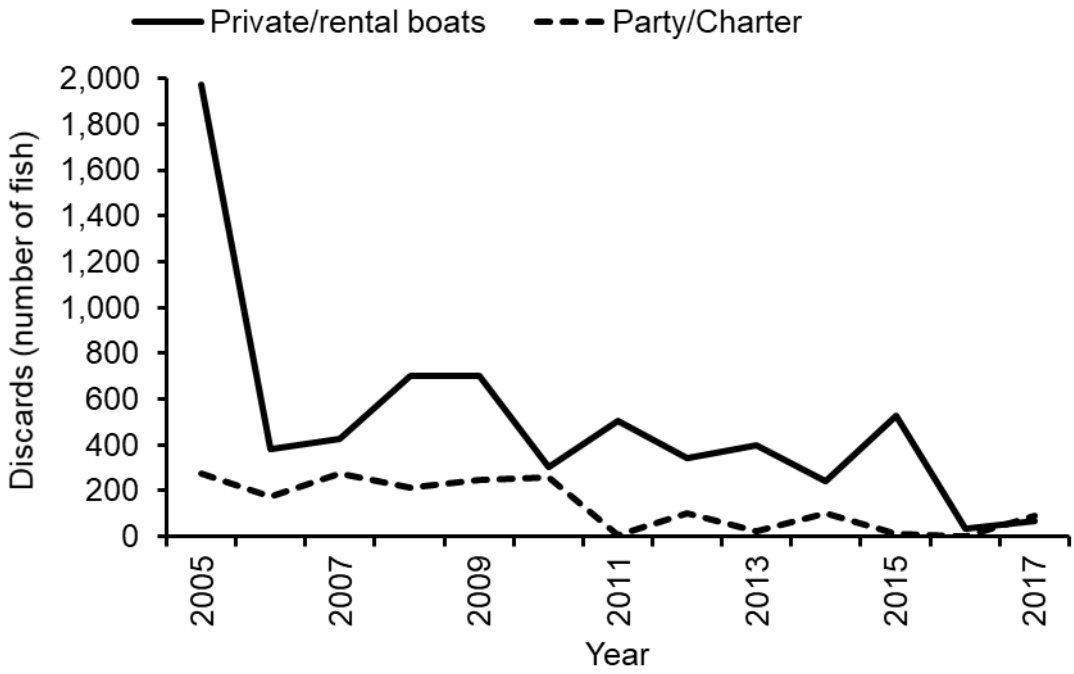

Figure 3-1. Estimated discards (number of fish) for Brown Smoothhound from private/rental and party/charter modes, 2005 to 2017 (RecFIN 2018).

To assess the most commonly caught species with Brown Smoothhound while recreational fishing, all trips where at least one Brown Smoothhound was caught were analyzed. This eliminates offshore fishing trips that solely target pelagic species; however, it is not possible to avoid trips where effort is split between multiple habitats, and both nearshore and offshore species are landed on the same trip. The most common species caught in 2017 on all trips where Brown Smoothhound were caught included California Halibut, Northern Anchovy, Leopard Shark, Bat Ray and Sevengill Shark (Table 3-3). Although Brown Smoothhound were caught on 100% of these trips, they are often not the most abundant species. As recreational anglers do not often target Brown Smoothhound, these other species may be the primary or secondary targets of the trip. Note that most of these species are also associated with Brown Smoothhound habitat (see section 1.4.1). All species listed in Table 3-3 have state or federal management measures in place.

Table 3-3. Number caught and percent of trips (frequency of occurrence) for the top ten most abundant species caught on sampled CPFV and private/rental boat trips (n=140) where at least one Brown Smoothhound was also caught in 2017 (RecFIN 2018).

Species	Number caught	Percent of trips	Number of Brown Smoothhound caught on associated trips
California Halibut	789	49	166
Brown Smoothhound Shark	359	100	359
Northern Anchovy	170	5	10
Leopard Shark	136	24	122
Bat Ray	135	23	161
Seven Gill Shark	93	12	75
Striped Bass	81	21	81
Blue Rockfish	44	3	5
Ocean Whitefish	42	1	2
Spiny Dogfish	40	4	22
Jacksmelt	35	6	11

3.1.3.2 Assessment of Sustainability and Measures to Reduce Unacceptable Levels of Bycatch

To minimize unacceptable levels of bycatch, the MLMA requires that the Department manage every recreational and commercial marine fishery in a way that limits bycatch to acceptable types and amounts (FGC §7056(d)). Once the magnitude and disposition of bycatch have been identified, the next step is to determine if that bycatch is acceptable. Brown Smoothhound are not a target species for commercial fisheries and are rarely targeted by recreational anglers, thus the bycatch of Brown Smoothhound by other fisheries is the most important issue to consider. The mortality of Brown Smoothhound is relatively high based on the number discarded dead from the commercial fishery for White Seabass. Of the Brown Smoothhound discarded, 49% were returned dead (WCGOP 2007 to 2017). However, their broad distribution, coupled with the fact that their primary inshore habitat is protected from gill netting and their life history strategy (young age at maturity, large litter sizes), suggests they are resilient to high levels of incidental harvest. Smith et al. (1998) used density dependence, female age at maturity, maximum reproductive age and average fecundity to estimate intrinsic rates of population increase to estimate the ability of different shark species to recover from fishing pressure. Vulnerability was tied most heavily to age at maturity, with Brown Smoothhound scoring highest in their ability to rebound compared to other sharks that matured later. It is unlikely the bycatch of Brown Smoothhound will hinder its ability to serve its ecosystem role, but a more formal assessment would be required to determine what constitutes an unacceptable level of bycatch for this species.

While it is illegal to retain a Great White Shark (*Carcharodon carcharias*) in California state and federal waters, they are occasionally caught incidentally in the set gill net fishery for White Seabass (where Brown Smoothhound are caught). Most Great White Sharks caught in gill net gear are young of the year and juveniles (Lowe et al.

2012). A NMFS status review of the local White Shark population estimated the average annual bycatch from 2001 to 2011 as 28 individuals with 16 mortalities per year (NMFS 2013).

3.1.4 Habitat

3.1.4.1 Description of Threats

There are no major known threats from fishing activities to the sand and mud soft-bottom habitat where Brown Smoothhound live. If organisms are present on the seafloor then weights on the bottom of set nets can snag the structure of the habitat and pull up or break fragile species (Auster 1998). There are no major known effects of set gill nets on sandy bottom habitat given there is no complex habitat, either reef or algal, that may be damaged by this gear type. There is no information at this time on lost gear and its associated habitat impacts. Potential threats to inshore habitats may include habitat loss due to coastal development and the runoff off pollutants and fertilizers from wastewater treatment plants and storm drains (especially for seagrass beds).

3.1.4.2 Measures to Minimize Any Adverse Effects on Habitat Caused by Fishing

Brown Smoothhound are not targeted by any major fisheries, and the adverse effects of gill nets and hook and line fishing on soft-bottom habitat are negligible. The area restriction on set gill nets protect a substantial amount of soft-bottom habitat from any adverse effects of fishing within 3 nautical miles of the mainland and 1 nautical mile of the islands. There are no gear restrictions on set gill nets in California to mitigate habitat interactions.

3.2 Requirements for Person or Vessel Permits and Reasonable Fees

Commercial Fishery

Any vessel commercially fishing must obtain a commercial fishing license to be permitted to fish in California waters. In 2019, the cost of this license is $379. Fishers using gill nets to land Brown Smoothhound are additionally required to obtain an annual limited entry and restricted access gill net permit, as well as submit a complete and accurate record of fishing activities on forms provided by the Department. The most current license options and fees for the commercial fishery (Table 3-4) may be accessed at https://www.wildlife.ca.gov/Licensing/Commercial/Descriptions.

Table 3-4. Annual commercial fishing license fees from January 1 to December 31, 2019. Accessed June 21, 2019 at https://www.wildlife.ca.gov/Licensing/Commercial/Descriptions.

License	Cost	Requirement
Resident Commercial Fishing License	$145.75	Required for any resident 16 yr of age or older who uses or operates or assists in using or operating any boat, aircraft, net, trap, line, or other appliance to take fish for commercial purposes, or who contributes materially to the activities on board a commercial fishing vessel.
Commercial Ocean Enhancement Stamp	$54.08	Required for commercial passenger fishing vessels operating south of Point Arguello (Santa Barbara County). Any commercial fisherman who takes, possesses aboard a commercial fishing vessel, or lands any White Seabass south of Point Arguello.
Commercial Boat Registration (Resident)	$379.00	Required for any resident owner or operator for any vessel operated in public waters in connection with fishing operations for profit in this state; or which, for profit, permits persons to sport fish.
Commercial Boat Registration (Nonresident)	$1,122.00	Required for any nonresident owner or operator for any vessel operated in public waters in connection with fishing operations for profit in this state; or which, for profit, permits persons to sport fish.
Gill/Trammel Net Permit	$498.25	Required for the owner or operator of a registered commercial fishing vessel to use a gill or trammel net. At least one person aboard each commercial fishing vessel must have a valid general gill net permit when engages in operations authorized by the permit.

Recreational fishery

Unless recreationally fishing off a public pier, all anglers 16 yr-old or older are required to purchase a fishing license to fish for Brown Smoothhound. Anglers fishing south of Point Arguello must also have an ocean enhancement validation. Captains operating their vessels as CPFVs or private charters must purchase a permit. In 2019, the cost of an annual resident sport fishing license is $49.94 and an ocean enhancement validation is $5.66 (Table 3-5). The most current license options and fees for the recreational fishery may be accessed at https://www.wildlife.ca.gov/Licensing/Fishing and https://www.wildlife.ca.gov/Licensing/Commercial/Descriptions.

Table 3-5. Annual sport fishing license fees from January 1 to December 31, 2019. Accessed June 21, 2019 at https://www.wildlife.ca.gov/Licensing/Fishing and https://www.wildlife.ca.gov/Licensing/Commercial/Descriptions.

License	Fee	Description
Commercial Passenger Fishing Vessel License	$379.00	Required for any boat from which persons are allowed to sport fish for a fee.
Resident Sport Fishing	$49.94	Required for any resident 16 yr of age or older to fish.
Nonresident Sport Fishing	$134.74	Required for any non-resident 16 yr of age or older to fish.
Ocean Enhancement Validation	$5.66	Required to fish in ocean waters south of Point Arguello (Santa Barbara County). An Ocean Enhancement Validation is not required when fishing under the authority of a One or Two-Day Sport Fishing License.
Reduced-Fee Sport Fishing License – Disabled Veteran	$7.47 at Department offices. $7.82 from license agents	Available for any resident or non-resident honorably discharged disabled veteran with a 50 percent or greater service-connected disability. After you prequalify for your first Disabled Veteran Reduced-Fee Sport Fishing License, you can purchase disabled veteran licenses anywhere licenses are sold.
Reduced-Fee Sport Fishing License – Recovering Service Member	$7.47	Available for any recovering service member of the US military. The Recovering Service Member Reduced-Fee Sport Fishing License is only available at Department License Sales Offices.
Reduced-Fee Sport Fishing License – Low Income Senior	$7.47	Available for low income California residents, 65 yr of age and older, who meet the specified annual income requirements. The Reduced-Fee Sport Fishing License for Low Income Seniors is only available at Department License Sales Offices.

4 Monitoring and Essential Fishery Information

4.1 Description of Relevant Essential Fishery Information

FCG §93 defines Essential Fishery Information (EFI) as “information about fish life history and habitat requirements; the status and trends of fish populations, fishing effort, and catch levels; fishery effects on age structure and on other marine living resources and users, and any other information related to the biology of a fish species or to taking in the fishery that is necessary to permit fisheries to be managed according to the requirements of this code.” This section summarizes the EFI that is routinely collected and used to monitor the health of the Brown Smoothhound stock.

Fishery-dependent data on commercial landings of Brown Smoothhound are collected by the Department via landing receipts and logbook data. FGC §8043 requires that every commercial fisherman that lands fish, and every person that is licensed as a fish receiver, submit a landing receipt. Additional data on the commercial catch of Brown Smoothhound is obtained by federal observers under the WCGOP who conduct onboard sampling of catch and discards on gill net boats.

Fishery-dependent data on the recreational fishery for Brown Smoothhound are recorded on CPFV logbooks and collected for all fishing modes by the CRFS staff.

4.2 Past and Ongoing Monitoring of the Fishery

4.2.1 Fishery-dependent Data Collection

Commercial Fishery

California gill net logbooks are a mandated system for commercial fishers to record fishing locations, time, depth, net length, mesh size, buoy line depth, soak time, total catch by species, market category, gear used, and information about the vessel and crew. These data are used by fishery managers to track the amount of fish landed and where the fishery is focused. California gill net logbooks are collected by the Department, edited and entered by federal and state staff into a database. However, the data collected from these logbooks are often inaccurate due to self-reporting, and frequently do not contain information on incidentally caught species such as Brown Smoothhound. For this reason this data stream is not very informative, and is not currently used in the management of this fishery.

Fishery managers and enforcement officers use state-issued sales receipts, referred to as fish tickets or landing receipts, to monitor fishery landings. Landing receipt data are transferred to the Pacific Coast Fisheries Information Network regional database system by state fishery agencies in Washington, Oregon, and California. Beginning in July 2019, landing receipt data must be submitted electronically. In California, this information is housed in the MLDS. Landing receipts record the weight of the fishes landed, price paid to the fishermen, date the fish were landed, type of gear used, port of landing and the fishing block location where the fish were harvested.

Federal fishery observers (via the WCGOP) monitor effort and landings, including the species makeup of both retained and discarded species, allowing for close

monitoring of bycatch levels to ensure that they remain within acceptable levels (Somers et. al 2018). Observers record the start time, end time, starting location, ending location, and depth of tows, as well as the gear type and fish ticket number corresponding with each trip. For each net deployment, observers record total catch weight, weight of discards by category, size composition of discards, reason for discards, species composition of discards, and the weight of the retained catch. They also note the catch of prohibited or protected species. Biological data are also collected, including the length frequency distribution. In 2017, 53 sets were observed in the White Seabass gill net fishery (Charles Villafana pers. comm.).

Recreational Fishery

Catch data for the recreational fishery are provided by two sources: (1) CPFV logbooks within the Department's MLS database and, (2) CRFS estimates on all fishing modes available from the RecFIN website.

CPFV logbook data are important for monitoring long-term trends in the catch and effort of party boats. Beginning in 1935, CPFV operators were required to keep daily catch logs and submit them to the Department on a monthly basis. These data have been collected continuously as of 2018, except for the years during World War II (1941 to 1946) when most CPFVs were not fishing (Hill and Schneider 1999). Logbook data have always included the date of fishing, port code, boat name, Department fishing block, angler effort and the number of fish kept per species, and after 1994 they included discarded fish, bait type and sea surface temperature (CDFW MLS). These data are accessible to Department scientists as part of the MLS.

CRFS data provide essential, standardized data for the recreational fishery. Current CRFS estimates (2004 to 2018) use catch and effort data collected by samplers from all fishing modes (beach/bank, man-made structures, private/rental boats, and CPFVs). In addition to the data listed above, CRFS also collects size (length and weight) information on kept fish. Numbers of discards are also recorded for all modes and discard lengths are obtained opportunistically on CPFVs. From 1980 to 2003, catch and effort data on all fishing modes were collected by the federal Marine Recreational Fisheries Statistical Survey (MRFSS) conducted by the National Oceanic and Atmospheric Administration. Estimates from CRFS and MRFSS are not directly comparable due to differences in methodology.

4.2.2 Fishery-independent Data Collection

No known targeted fishery-independent studies routinely monitor the abundance of Brown Smoothhound in southern California. In northern California, the Department's San Francisco Bay Study has done annual otter trawl surveys at several locations throughout the Bay since 1980 that provide a fishery-independent index of relative abundance of young of the year Brown Smoothhound (as discussed in section 1.2.1).

5 Future Management Needs and Directions

5.1 Identification of Information Gaps

Information gaps have been identified that could assist in the overall management of the fishery. More information on discard mortality, temporal migrations, gear selectivity, field sampling and life history strategy would be valuable contributions to management for Brown Smoothhound.

Table 5-1. Informational needs for Brown Smoothhound and their priority for management.

Type of information	Priority for management	How Essential Fishery information would support future management
Discard mortality – hook and line post release	High	Used to determine whether high rates of discarded fish pose a threat to the population.
Tracking temporal migrations	Medium	Used to understand what habitats (other than inshore estuarine) are important to the life strategy of the Brown Smoothhound and where they could potentially be exploited.
Selectivity of commercial fishing gear	Medium	Used to assess whether the size and age of sharks collected by set gill nets and other gear is detrimental to the population (e.g. removing fish before they have a chance to reproduce).
Quantify accuracy of shark identification in recreational catch	Medium	Use to determine whether the amount of bycatch is an accurate index, or whether Brown and Gray Smoothhound and other similar shark species are being recorded interchangeably.
Life history parameters in northern California versus southern California	Low	Used to determine whether populations should be managed as two separate entities (e.g. whether one population is more sensitive to fishing pressure).

5.2 Research and Monitoring

5.2.1 Potential Strategies to Fill Information Gaps

An estimate of discard mortality could be obtained by catching Brown Smoothhound on hook and line and/or in a gill net and monitoring their reaction in a controlled setting, or via tagging captured fish and recapturing them, either physically or visually over a measured time period to record post-release mortality. Temporal migrations could be tracked using external satellite tags. Assessment of the accuracy of fishery data would require observers on fishing vessels to quantify shark discards by species, and then compare the proportion of Brown Smoothhound to Gray Smoothhound and other species based on CRFS interviews. Comparison of life history strategies in northern versus southern populations would require an updated estimate of age and growth, age at maturity and litter size for sharks sampled in both areas.

5.2.2 Opportunities for Collaborative Fisheries Research

The Department has collaborated in the past and will continue to work with outside entities such as academic organizations, non-government organizations, citizen scientists, and both commercial and recreational fishery participants to help fill information gaps related to the management of state fisheries. The Department will also reach out to outside persons and agencies when appropriate while conducting or seeking out new fisheries research required for the management of Brown Smoothhound. Several of the information gaps identified above (section 5.1) are potential areas for collaboration. Estimating post-release mortality of discards and tracking temporal migrations are good subjects for collaborative studies on Brown Smoothhound that could involve academic institutions and anglers.

5.3 Opportunities for Future Management Changes

This section is intended to provide information on changes to the management of the fishery that may be appropriate, but does not represent a formal commitment by the Department to address those recommendations. ESRs are one of several tools designed to assist the Department in prioritizing efforts and the need for management changes in each fishery will be assessed in light of the current management system, risk posed to the stock and ecosystem, needs of other fisheries, existing and emerging priorities, as well as the availability of capacity and resources.

This section is intended to provide information on changes to the management of the fishery that may be appropriate but, does not represent a formal commitment by the Department to address those recommendations. ESRs are one of several tools designed to assist the Department in prioritizing efforts and the need for management changes in each fishery will be assessed in light of the current management system, risk posed to the stock and ecosystem, needs of other fisheries, existing and emerging priorities, as well as the availability of capacity and resources.

No management changes are suggested at this time for Brown Smoothhound. The inshore gill net ban in 1994 permanently protected their primary habitat from commercial harvest and they are rarely targeted inshore by recreational anglers. A Productivity Susceptibility Analysis ranked Brown Smoothhound Shark the second most vulnerable state-managed finfish behind Pacific Angel Shark (Swasey et al. 2016). However, the fact that Brown Smoothhound are mainly caught as bycatch and that they have early maturation and a high reproductive rate relative to other sharks makes Brown Smoothhound less vulnerable to overfishing and no further action is recommended in 2019.

5.4 Climate Readiness

Little is known about how climate change may affect Brown Smoothhound populations and habitats. To incorporate climate readiness into Brown Smoothhound management it is important to increase our understanding of the possible impacts of climate variability. California's coastal waters are already subject to high variability due

to episodic events such as ENSO, PDO, and NPGO. Climate change will bring even further uncertainty to these trends, with potentially extreme implications for ecosystem function and fishery sustainability in coastal areas. As noted in section 1.5, Brown Smoothhound are broadly distributed with a generalist diet and thus their population may be robust to the effects of climate change. To manage Brown Smoothhound populations effectively under climate change, it will be important to take a proactive approach to management. This may entail increased or targeted monitoring of populations and/or placing a higher priority on collecting data to fill in information gaps on the life strategy of this species.

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