# Chapter 2. Description of Stocks

## 2.1 Species Description

The croakers (Family Sciaenidae) are among the most important fishes caught by marine recreational anglers in California. Most croakers emit sounds, which have been variously described as 'drumming', 'croaking', 'grunting', 'snoring', 'bellowing', purring', 'buzzing', and 'whistling' (Welsh and Breder 1923). These sounds are produced by vibrations of the air bladder.

The white seabass, *Atractoscion nobilis*, is the largest croaker species in California waters (Thomas 1968). Adults are bluish to gray dorsally with dark speckling, and silver to white colored ventrally. Juveniles have several dark vertical bars. White seabass are relatively large fish which have been recorded to 5 ft (1.5 m) and 90 lbs (41 kg) (Miller and Lea 1972); however, individuals larger than 60 lbs (27 kg) are rarely observed (Thomas 1968).

Fossil records of white seabass have been found in several southern California Pleistocene deposits and in a Pliocene site at San Diego. Some deposits are probably 10 to 12 million years old (Fitch and Lavenberg 1971).

## 2.2 Distribution, Genetic Stock Structure, and Migration

White seabass range over the continental shelf of the Eastern North Pacific ocean from Juneau, Alaska, to Magdalena Bay, Baja California, Mexico. This species also inhabits the upper Gulf of California, Mexico; a subpopulation that appears to be isolated from the coastal mainland megapopulation (or stock) (Thomas 1968).

California Cooperative Oceanic Fisheries Investigations (CalCOFI) data collected between 1950 and 1978 indicate that white seabass larvae appear to settle out into coastal areas extending from Santa Rosa Island, California to Bahia Santa Maria, half way down the Baja California, Mexico peninsula (Moser et al. 1983). Fifteen percent of these occurrences were in California waters. Most of the larvae occurred from May to August and peaked in July. White seabass larvae were collected within San Francisco Bay (Richardson Bay) during a 1972 to 1973 study (Eldridge 1977). However, to date, no adults have been found within the bay. That event was correlated with upwelling, implying that the larvae were transported into the bay with warm water currents.

In the past, it was assumed that white seabass off California consisted of non-resident fish that migrated into the Southern California Bight from Baja California, Mexico. However, white seabass off the coasts of California and Baja California, Mexico are currently considered to be part of the same breeding population, and the center of this population appears to be off central Baja California, Mexico (Moser et al. 1983; Vojkovich and Reed 1983; Franklin 1997). Franklin (1997) examined white seabass

DNA from fish collected between 1990 and 1995 in Californian and Mexican waters, and he found that there are local spawning groups within the Southern California Bight that contribute to the genetic make-up of the population. Based on this research, Franklin (1997) concluded that the white seabass stock in the Eastern Pacific is composed of three components: northern, southern and Sea of Cortez. The northern component of the white seabass stock ranges from Point Conception, California to Magdalena Bay, Baja California, Mexico (Franklin 1997).

Recruitment of young white seabass to coastal habitats in southern California is probably related to the strength and persistence of northward flowing warm water currents (Allen and Franklin 1988). However, the exact relationship is still unknown. Although previous white seabass tagging studies for migration have been unsuccessful (Maxwell 1977b), hatchery-produced white seabass have been recaptured as far as 85 nautical miles from the point of release (CDFG 1999). Catch data indicate that white seabass move northward with seasonally warming ocean temperatures (Skogsberg 1939; Radovich 1961; Karpov et al. 1995). For example, there were substantial commercial catches of white seabass near San Francisco Bay, Tomales Bay, and Monterey Bay during the early 1900s when ocean waters were warmer, followed by a long period in which landings from the central California coast were rare. Since 1999, commercial and recreational catches of white seabass have increased north of Point Conception; possibly indicating a recent northward shift in the stock due to warmer waters brought up during the El-Niño/Southern Oscillation (ENSO) of 1997-1998.

### 2.3 Age and Growth

The age and growth of white seabass has been determined by reading scales and otoliths. Thomas (1968) used scales, but found them difficult to read for individuals older than 13 years. A 711 mm (28 in.) white seabass (the minimum legal size) was determined to be five years old and weigh about 3 kg (7 lb).

The white seabass length-weight relationship can be described by the equation:

$$W = 0.000015491^{*L2.9216},$$

where length is in millimeters and weight is in grams (Thomas 1968). However, this may not be an accurate estimator of over all lengths since only mature fish of both sexes were used in Thomas' calculations.

Data from otoliths indicate that white seabass can grow very quickly, especially during the first four years (Table 2-1). A recent study using sectioned otoliths found that white seabass grow much faster than previously thought, indicating that larger individuals are considerably younger than previous estimates (CDFG unpubl. data). The von Bertalanffy growth equation for juvenile and adult fishes of both sexes was calculated to be:

$$L_t = 1391\ [1-e^{-0.0156(t+1.297)}]$$

Growth rates for males and females were not evaluated separately. The oldest fish aged was 27 years and measured 1365 mm total length (TL). These otolith data indicate that a 711 mm (28 in.) white seabass is approximately three years old. In contrast, the same fish would be five years old according to Thomas's (1968) scale data.

The age estimates based on otolith data were closer to those proposed by Clark (1930), who investigated white seabass gross gonadal development. She estimated fish less than 35 cm (13.7 in.) were one year old; fish between 35 to 65 cm (13.7 to 25.6 in.) were two years old; and, fish larger than 75 cm (29.5 in.) were three years old or older.

The discrepancies between Thomas's (1968) study and the more recent Department study may be partly due to the following reasons: First, different ageing structures were used in each study; and second, the Department's study was conducted during a period of oceanic warming which may have influenced (increased) white seabass growth rates.

Table 2-1. Mean total length and weight at age for white seabass

| Age class (years) | Mean length in mm (inches) using scales | Mean length in mm (inches) using otoliths | Weight in kg (pounds) |
|---|---|---|---|
| 0 | - | 274 (10.8) | 0.2 (0.5) |
| 1 | 231 (9.1) | 411 (16.2) | 0.7 (1.5) |
| 2 | 336 (13.2) | 542 (21.3) | 1.5 (3.3) |
| 3 | 467 (18.4) | 685 (27.0) | 3.0 (6.6) |
| 4 | 571 (22.5) | 808 (31.8) | 4.8 (10.7) |
| 5 | 723 (28.5) | 867 (34.1) | 5.9 (13.1) |
| 6 | 866 (34.1) | 985 (38.8) | 8.6 (19.0) |
| 7 | 929 (36.6) | 1004 (39.5) | 9.1 (20.1) |
| 8 | 981 (38.6) | 1063 (41.8) | 10.8 (23.8) |
| 9 | 1033(40.7) | 1130 (44.5) | 12.9 (28.4) |
| 10 | 1072(42.2) | 1072 (42.2) | 11.0 (24.4) |
| 11 | 1144(45.0) | 1269 (50.0) | 18.1 (39.9) |
| 12 | 1194(47.0) | 1183 (46.6) | 14.7 (32.5) |
| 13 | 1217(47.9) | 1131 (44.5) | 12.9 (28.5) |
| 14 | - | 1229 (48.4) | 16.5 (36.3) |
| 17 | - | 1245 (49.0) | 17.1 (37.7) |
| 27 | - | 1365 (53.7) | 22.4 (49.3) |

Note:Data using scales from Thomas (1968)
Data using otoliths from CDFG unpubl. data (2000); small sample size for age classes seven and older.

### 2.4 Reproduction, Fecundity and Seasonality

Precise spawning areas have not been determined, but data indicate that peak spawning occurs in southern California from April through August (Skogsberg 1925). During this period, mature fish appear to congregate near shore, over rocky habitat, and near kelp beds (Thomas 1968).

A study of white seabass maturity in the late 1920s indicated that females begin maturing when they are near 24 inches (607 mm) in length or three years old and males may reach sexual maturity at about 20 inches (508 mm) or two years old (ages based on otolith data above). All white seabass have probably spawned at least once by the time they reach 31.5 inches (800 mm) total length (Clark 1930) or four years old.

White seabass have the largest eggs of the West Coast sciaenids. These eggs are buoyant and drift with the ocean currents. The dark colored larvae appear to settle out in coastal areas (Moser et al. 1983). Fecundity has been determined from artificial propagation attempts (CDFG 1994). Batch fecundity, the number of eggs released by one female at a single time, has ranged from 0.76 million to 1.5 million eggs, and has varied as a function of mean female body weight.

Although it has been reported that white seabass spawn more than once per season, spawning intervals for individual females are unknown. However, it has been estimated that females spawn about four to five times during each season.

### 2.5 Natural Mortality

Thomas (1968) calculated a natural mortality rate of 0.303 for fish caught in commercial gill nets. These fish represented the majority of commercially-caught white seabass and tend to be larger than recreationally-caught fish. Recently, natural mortality rates were determined for juvenile white seabass based on OREHP data. Kent and Ford (1990) found that natural mortality rates ranged from 0.258 (one and two year old fish) to 0.117 (three and four year old fish). Likewise, MacCall et al. (1976) and Dayton and MacCall (1992) calculated natural mortality rates for white seabass from the recreational and commercial fisheries, which were significantly less than Thomas' (1968) estimate (Table 2-2) . In light of these values, it would seem that Thomas' estimate was high since natural mortality rates usually decline and level off as fish age.

Table 2-2. Estimates of white seabass natural mortality (M)

| Source | M |
|---|---|
| Thomas 1968 | 0.303 |

| | |
|---|---|
| MacCall et al. 1976 | 0.13 |
| Kent and Ford 1990 | 0.258 (1 to 2 yr old); 0.117 (3 to 4 yr old) |
| Dayton and MacCall 1992 | 0.08 |

In comparison, natural mortality rates for another sciaenid, the red drum (*Sciaenops ocellatus*), were similar. Red drum are found in the Gulf of Mexico and the Atlantic ocean, and have a life history similar to white seabass. The natural mortality rates for them are 0.20 to 0.23 for subadults (1 to 5 yr old) and 0.12 to 0.13 for adults (6+ yr old) (SAFMC 2000). These rates are consistent with those calculated for white seabass by Kent and Ford (1990).

## 2.6 Parasites and Disease

Love and Moser (1976) provided a review of parasites commonly associated with marine fishes, including those common to white seabass taken from Mexican and Californian waters. External parasites consisted of three species of copepod (*Lepeophtheirus abdominis*, *L. thompsoni*, and *Neobrachiella gracilis*) and an unidentified monogenetic trematode, which were found attached to the body, fins, and mouth. Internally, three species of cestode worms (*Callitetrarhynchus gracilis*, *Grillotia smarisgora*, and *Lacistorhyncus tenuis*) have been found in the viscera and mesentery of white seabass. In addition, two species of digenera trematodes (*Pleorchis magniporus*, *P. californiensis*) have been found in the intestines, along with one species of nematode worm (*Anisakis* sp.). Two protozoans (*Ceratomyxa venusta* and *Kudoa clupeidae*) have been discovered in the gallbladder and muscle tissue of white seabass.

Little is known about disease in wild white seabass stocks. Chen et al. (1995) identified the marine gliding bacteria, *Flexibacter maritimus*, as the cause of lesions on white seabass, Northern anchovy (*Engralis mordax*) and Pacific sardine (*Sardinops sagax*) being held in close proximity. They also identified the presence of a second pathogenic bacteria, *Vibrio* species on white seabass. The cause of the infections was attributed to physical trauma such as net abrasions from capture and transfer, aggressive feeding behavior of captive white seabass, and wounds resulting from fish-eating birds (Chen et al. 1995). A third bacteria found to affect hatchery-reared white seabass is a Rickettsiales-like bacteria (CDFG 1998), which appeared to be similar to Rickettsia bacteria found on net pen-reared salmon in Chile. Whether these and other bacteria are present on wild fish is currently unknown.

Worldover, scientific information on the diseases of marine fishes is poorly developed compared to information on the diseases of livestock and avian species. Investigation of disease in aquatic animals is more difficult due to the extensive and variable nature of the marine environment and the large number of species involved. Disease events are more likely to be recognized in aquaculture facilities than in wild stocks. Thus, information on the health status of commonly cultured species, such as salmonids, tends to be more comprehensive (AQIS 1999).

The effect of external and internal parasites and pathogens on healthy fish are often minor, being manifested as inflamation, lesions or increased mucus secretions (Smith 1975). However, conditions which stress fish can induce pathogenogenic infections that may result in death.

## 2.7 Predator/Prey Relationships

Knowledge of the food preferences and habits of white seabass are primarily anecdotal. However, mysid shrimp (Mysidae) made up a major portion of the diet of juvenile white seabass taken in and just outside of San Diego Bay (Crooke 1989a). Adults are known to feed on northern anchovy (*Engraulis mordax*); market squid (*Loligo opalescens*); Pacific sardine (*Sardinops sagax*); blacksmith (*Chromis punctipinnis*); silversides (Atherinopsidae species); and pelagic red crab (*Pleuroncodes planipes*) (Thomas 1968). Large white seabass have been found to have eaten only Pacific mackerel (*Scomber japonicus*) (Fitch 1958).

Commercial fishermen have recorded numerous instances of sea lion and shark predation on adult white seabass caught in nets (Fitch and Lavenberg 1971). Studies to identify the predators of white seabass eggs, larvae, and juveniles have not been done. Hypothetically, predators would include all piscivorous fishes such as kelp and sand bass (*Paralabrax clathratus* and *P. nebulifer*). In laboratory tanks, white seabass larvae are cannibalistic and must be graded by size (Crooke 1989a). This behavior probably takes place in the wild.

## 2.8 Competition

White seabass are often taken in conjunction with other migratory or seasonally available species such as bonito (*Sarda chiliensis*), California barracuda (*Sphyraena argentea*), and yellowtail (*Seriola lalandi*). Juveniles have been found mixed with bait fish caught by round haul nets. However, no specific data exist concerning white seabass competition with other species.

## 2.9 Critical Habitat

Young-of-the-year (age 0) white seabass ranging in length from 6 to 57 mm (0.25 to 2.25 in.) inhabit the open coast at depths of from 4 to 9 m (12 to 30 ft). These young fish are closely associated with small drifting debris and algae in shallow areas just outside the surf zone (Allen and Franklin 1988; 1992). Anecdotal information indicate that they are occasionally caught mixed with bait fish (anchovy) schools. By the time white seabass are two years old, some have moved into protected bays and are found in association with eelgrass beds (Crooke 1989b). Larger juveniles (three and four years old) are caught off piers and jetties and in kelp beds. Large white seabass school over rocky substrate in or near the large kelp beds that fringe the beaches and offshore islands. They are also found several miles offshore in schools swimming at or near the surface (Skogsberg 1939; Squire 1972).

## 2.10 Status of the Stocks

Historically, the white seabass resource extended as far north as San Francisco Bay, but as oceanographic conditions changed and the various segments of the fishery grew, there was a steady decline in availability and subsequently catch. In essence, the resource contracted geographically, so that the bulk of the resource was situated off of southern California and northern Baja California, Mexico. Only during ENSOs were white seabass caught in quantity north of Point Conception. However, recent increase of catches by recreational and commercial fishermen in the Monterey Bay area during the past two years may indicate expansion of the stock (Department unpubl. data). There are few data available concerning the status of white seabass populations in Mexican waters, so it is difficult to determine if this is a geographic expansion of the stock due to increasing numbers or a shifting of the stock northward.

Although a current stock assessment has not been done for white seabass there are indications that the white seabass population in California is recovering from low levels seen in the 1970s, 1980s, and most of the 1990s. It appears that white seabass may be entering a pattern similar to the 1940s, where abundance increased following a shift from a period of warmer to colder ocean waters. Warmer waters have occurred in the Southern California Bight from the late 1970s to mid 1990s, but have become colder the last few years. During this time, there has also been a steady increase in white seabass take in California waters, approaching catch levels of the late 1940s and early 1950s. A similar pattern also occurred in the late 1890s and early 1900s when white seabass catches were high following a much warmer period that ended in the 1880s (MacCall pers. comm.).

In addition to increased catches of white seabass, there has been a steady increase in the size of fish taken. For example, the weight of white seabass caught by the recreational fishery averaged about 2.4 kilograms (5 lbs) in the 1980s but increased to 6.2 kilograms (14 lbs) in the 1990s (RecFIN 2001). It is difficult to determine if a similar change has occurred in the commercial fishery since most white seabass taken are well above the legal size limit of 28 inches (711 mm). However, anecdotal information from the commercial fishery suggests that a similar trend is occurring.

White seabass recruitment in the Southern California Bight has also increased steadily since 1982, with large increases occurring in recent years (Crooke pers. comm.; Allen et al. 2001). Fishery-independent data from gill net surveys indicate a significant increase in 0 to 4 year old white seabass from 1995-2001 (Allen et al. 2001). The largest recruitment during this period occurred in 1999 when a large number of one and two year old fish were caught. This was probably a result of a strong year class associated with the ENSO of 1997-1998.