Albacore

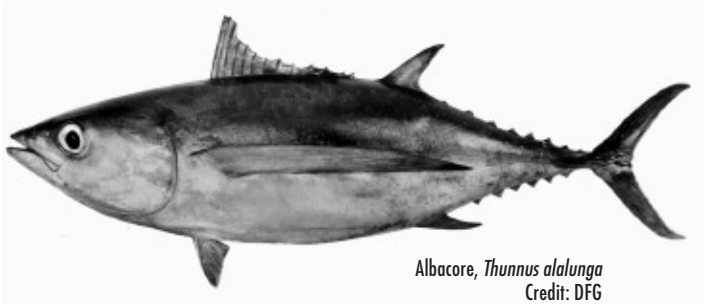
History of the Fishery

Albacore (*Thunnus alalunga*) is a highly migratory species that has been targeted by California's recreational anglers and commercial fishermen for more than 100 years. Currently, it ranks among the state's most important marine fish resources, in terms of both economic value and sport-related benefits. Commercial landings of albacore at California ports have increased from $4 million to $10 million (ex-vessel dollars) on an annual basis since 1996. In recent times, the recreational fishery for albacore has contributed at least $25 million per year to California's economy through angling-related expenditures.

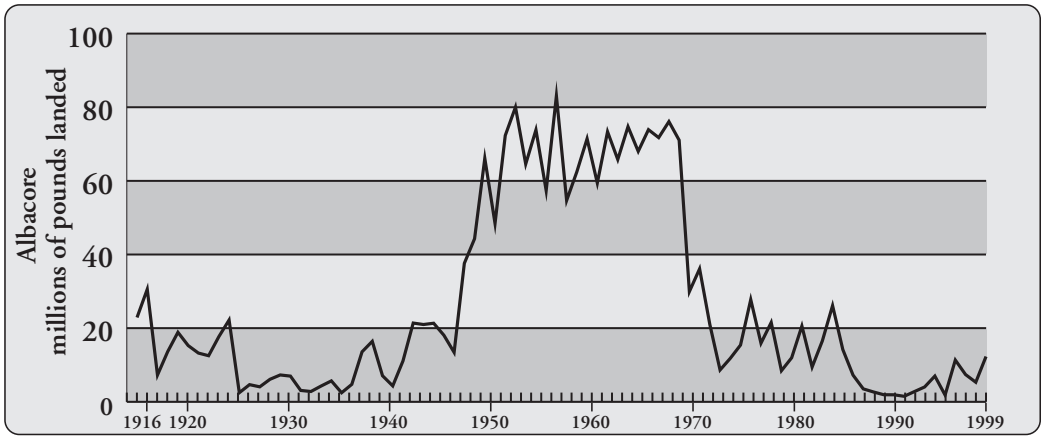
The commercial fisheries for albacore developed rapidly following the first canning operations of this species in 1903 in San Pedro Bay, California. The vast majority of albacore commercially harvested by California fishermen is processed as canned "white meat" tuna that generally commands premium prices in the marketplace. Through the first quarter of the 20th century, the tuna-canning industry and its related fisheries endeavored to meet increasing demands for seafood, particularly packed products that had a long shelf life. The commercial fisheries for albacore continued to expand through the mid-1940s, extending northward to coastal waters off northern California, Oregon, and Washington, and westward to the central Pacific Ocean, several hundred miles off the California coast. The geographic expansion of the fisheries slowed during the 1950s through the mid-1960s, but the flourishing market continued, with record landings during this period that averaged roughly 30 million pounds annually. During the mid-1970s, the commercial fishing fleet extended farther into the central Pacific Ocean, with some vessels fishing north and west of the Hawaiian Islands, as far as the International Date Line. Since the 1980s, the albacore fisheries of California have typically operated within roughly 900 miles of the U.S. Pacific coast; the distance largely dependent on the stock's migratory route in any given year. California's commercial fishery for albacore has generally concentrated on the North Pacific albacore stock during the summer and fall seasons as the fish move through waters of the northeastern Pacific Ocean during their annual migration. However, in recent years during the winter months, some vessels have also targeted the South Pacific albacore stock that inhabits waters off New Zealand's east coast between the International Date Line and 110°W longitude. Commercial landings of albacore in California have varied over the last decade, ranging from a high of 12.3 million pounds in 1999 to a low of 1.8 million pounds in 1995.

During the early years of California's commercial fisheries for albacore, pole-and-line (live bait fishing) and troll (artificial-jig fishing) gears were used extensively. Other gears, such as longlines, purse seines, and drift gillnets have also been used by California fishermen, but trolling operations have dominated since the early 1980s and now contribute over 90 percent of the annual catch of albacore. Generally speaking, troll, pole-and-line, purse seines, and drift gillnet vessels operate in surface fisheries that target two to five-year-old fish (juvenile albacore) in the upper portions of the water column, and longline vessels operate in subsurface fisheries that harvest five to ten year-old fish (adult albacore) from deeper waters. California-based troll vessels, or jig boats, can be broadly classified into two groups – relatively small boats (30-50 feet in length) that typically carry a crew of two or three fishermen, spend one to three weeks at sea, and target albacore in inshore waters; and larger boats (50-90 feet in length) that commonly operate with three to five fishermen, spend one to two months at sea, and fish both inshore and offshore waters. Historically, commercial fishing effort for albacore has fluctuated over the past 100 years, based primarily on market and oceanic conditions. For example, from 1916 to 1925, about 300 vessels equipped for one-day trips participated in the fishery, operating exclusively in coastal waters. The commercial fleet that fished the central Pacific Ocean, as well as inshore waters, grew steadily over the next 25 years, reaching 3,000 boats in 1950. The number of vessels declined during the 1950s, and by 1960, 1,000 boats were involved in the fishery. During the 1970s, the commercial fleet began to increase once again to over 2,000 vessels, but by the late 1980s and through the 1990s, fewer than 500 boats typically landed their commercial catches at California ports.

Albacore are harvested commercially by countries other than the United States, including Japan, Taiwan and South and North Korea in the western Pacific Ocean, and Canada and Mexico in the eastern Pacific Ocean. Currently, the California troll fishery accounts for roughly 10 percent of the total commercial landings of North Pacific albacore, with Japan (75 percent) contributing the largest amount, followed by Oregon/Washington, Taiwan, and Canada (about five percent each). In a typical year, during the late spring and summer, the Japanese pole-and-line fleet will target the juvenile albacore as they



Albacore, *Thunnus alalunga*
Credit: DFG



Commercial Landings 1916-1999, Albacore
Data Source: DFG Catch Bulletins and commercial landing receipts. Data includes shipments and landings from areas north and south of the state between 1916 and 1969.

form identifiable schools and begin their annual migration in waters off the east coast of Japan to the central Pacific Ocean (Emperor Seamount). In the summer and into the fall, the U.S. and Canada troll fleets will follow the albacore as they continue their migration to the eastern Pacific Ocean and coastal waters off the U.S. Pacific Coast.

Recreational fishing for albacore developed during the early 1900s, when vessel owners in southern California first realized that the angling community was very willing to charter their boats for fishing. As the popularity of albacore increased, as a food and sport fish, so did the partyboat (commercial passenger-carrying fishing vessels or CPFV) industry. In the very early years of the sport fishery, only a few CPFV trips were made, concentrating in waters around the Channel Islands; however, by the mid 1950s, more than 100 CPFVs carried anglers to other inshore waters in pursuit of the stock as it conducted its annual migration. The CPFV industry continued to grow during the 1960s, with increases in fishing capacity and range, which allowed boats to carry more anglers and venture further from port in years when the albacore remained farther offshore. Over the last 10 years, from 40 to 60 large CPFVs, that typically accommodate from 15 to 60 anglers for one-to three-day trips, have fished for albacore in California waters, mostly based in southern California, with several operations further north in Morro Bay and San Francisco. Additionally, from 60 to 90 smaller CPFVs have routinely operated in California since the early 1990s, with these vessels usually carrying six to 10 anglers on one-day fishing excursions. Catches of albacore on CPFV trips have been highly variable over the years, based largely on the migratory behavior of the stock in any given year. For example, in 1994, as the stock approached the coast of North America, the bulk of the population traveled north to waters off Oregon and Washington, resulting in a poor fishing season for recreational anglers in California, where less than 200 albacore were landed on CPFV-related trips. In 1999, the stock took a more southerly route as it neared the U.S. Pacific Coast and spent much of the summer and fall in inshore waters off southern California and northern Mexico, where anglers on CPFVs landed a total of 258,448 fish – the highest total on record. The long tradition of albacore sport fishing in California is not only due to the CPFV industry, but also an increasing number of anglers that fish from privately-owned boats. Both represent an enthusiastic sport fishery that anxiously awaits the arrival of the first pulse of albacore to California's inshore waters each summer. Sport fishing in California typically peaks during the mid-summer months (July and August) as the bulk of the stock travels to inshore waters off the U.S. Pacific Coast. However, arrival and departure times associated with the stock's migration through U.S. owned fishing grounds have varied substantially over the years, with spring arrivals and winter departures frequently observed.

The actual operations of most fisheries, including those associated with albacore, are essentially defined in accordance with the biological characteristics and ecological relations exhibited by the species. This is particularly true for albacore and its related fisheries, given that the migration and distribution patterns of this species are highly influenced by the prevailing oceanographic conditions.

Status of Biological Knowledge

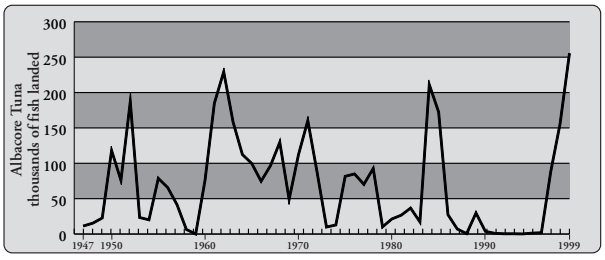
Albacore are members of the Scombridae family, which includes 40 to 50 species of tuna and mackerel, 23 of which are found, for at least a part of their life, in North American waters. Albacore, as well as other species of tuna, have unique biological characteristics that enable them to swim continuously at very high speeds and cover vast areas during annual migrations. Albacore are literally

built for speed, with torpedo-shaped (fusiform) bodies, smooth skin, and streamlined fins, and can reach speeds of more than 50 miles per hour for short periods of time. Albacore are metallic dark blue along the back, with dusky to silvery white coloration along the sides and on the belly. The pectoral fins are exceptionally long, extending to nearly half the length of the body, and albacore are commonly referred to as longfin tuna. In addition to these morphological adaptations, albacore possess highly specialized physiological functions that allow for rapid movement and sustained endurance. First and foremost, many tuna, including albacore, have a highly evolved circulatory system that includes countercurrent exchangers that act to reduce the loss of heat generated by increased muscular activity, allowing them to regulate their body temperature and ultimately, increase the efficiency of their muscles. Additionally, albacore have higher blood pressure and volume than most of the other species of fish.

Albacore are widely distributed throughout the world's oceans in tropical, sub-tropical, and temperate zones. The North Pacific albacore stock, the population targeted by both the commercial and recreational fisheries of California, is centered around 35° N latitude in the Pacific Ocean. This stock's distribution extends from the central (west) coast of Mexico to the Gulf of Alaska in the eastern Pacific Ocean, and from the equator to the north (east) coast of Japan in the western Pacific Ocean. The actual boundaries of the stock's range depend largely on the season of the year and oceanic conditions. Currently, fishery researchers are uncertain whether the population of albacore inhabiting the North Pacific Ocean is strictly a single stock or possibly, composed of two (or more) stocks. Results from some tagging experiments indicate that substocks of albacore may exist in the North Pacific Ocean, based on differences in migratory routes, growth and mortality rates, and size distributions of the commercial catches. However, more information concerning albacore biology and genetics is needed before definitive conclusions can be drawn regarding the stock structure of the North Pacific population of albacore.

As stated previously, the North Pacific albacore stock, particularly juveniles, typically complete an expansive annual migration that begins in the spring and early summer off Japan, continues throughout the late summer into inshore waters off the U.S. Pacific Coast, and ends late in the year in the western Pacific Ocean. It is generally believed that oceanic conditions strongly influence both the timing and geographical extent of the albacore's migration in any given year. Migrating albacore concentrate along thermal discontinuities (oceanic fronts) associated with waters of the Transition Zone in the North Pacific Ocean. The vast majority of albacore are caught in waters with sea-surface temperatures (SSTs) that range from 59˚-67˚F. The migrating fish are typically bounded by these thermal gradients as they conduct their round-trip travel across the Pacific Ocean. Although the bulk of the migrating stock is typically observed within this SST range, telemetry studies have shown that this species will spend brief periods of time in much colder water (49˚F). Upwelling, where nutrient-rich waters from the ocean depths rise to the surface, is another important phenomenon associated with oceanic fronts and ultimately, an event that highly influences the distribution of the migrating albacore. It is likely that the albacore are attracted to upwelling fronts, given these areas are very productive and contain much forage for predatory fish such as albacore. Although scientists are quite certain that oceanic fronts define albacore distribution and thus, vulnerability to fisheries, they feel other oceanographic parameters also influence the migratory behavior of the stock, including salinity, ocean color and clarity, and vertical thermal/density structure. In general, catches from the commercial fisheries indicate that albacore are most abundant along the warm side of upwelling fronts in clear blue oceanic waters that are associated with salinity gradients between 33 and 35 parts per thousand and well defined thermoclines. Recent research indicates that the fish adjust their behavior to very different oceanic conditions when passing through at least four distinct physical regimes (geographical strata) of the North Pacific Ocean. Thus, determining what are the most influential environmental parameters depends on where in the ocean and what time of year the assessment is conducted.

Albacore are top carnivores in the ocean ecosystem and opportunistically prey on schooling stocks, such as sardine, anchovy, and squid. Albacore are preyed upon by man, as well as the larger species of billfish, tuna, and sharks. Similar size albacore travel together in school groups that contain small aggregations of fish, which collectively, can be up to 19 miles wide. At the onset of the migration, during the spring and summer months in the western Pacific Ocean, the young albacore form relatively small, loose, and broadly scattered groups. As the seasons progress, the groups become more compact and contain greater numbers of schools. The more sedentary, older albacore typically form more compact schools. Generally



Recreational Catch 1947-1999 , Albacore Tuna

Data Source: DFG, commercial passenger fishing vessel logbooks.

speaking, albacore schools are not as large or as dense as those of some of the larger schooling tunas, such as yellowfin and skipjack. Bluefin, yellowfin, and skipjack tunas are occasionally caught along with albacore by the surface fisheries off the U.S. Pacific Coast. Although albacore spend much of their time in the surface waters of the ocean, they will also explore deeper waters of the thermocline in search of prey.

North Pacific albacore mature at roughly five to six years of age (approximately 33 inches in length). Peak spawning of albacore in the Pacific Ocean is generally believed to occur in subtropical waters centered around 20˚N and 20˚S latitude. It is assumed that the North Pacific albacore stock spawns from March through July on grounds located in the western and central Pacific Ocean. There is some information, albeit limited, that albacore may spawn multiple times in a year. Albacore are believed to be pelagic spawners that broadcast their gametes in open water, often near the surface, with fertilization being external. Estimates of female fecundity (number of eggs) range from 0.8 to 2.6 million eggs per spawning. The early life history of albacore is not clearly understood, but very young albacore (larvae and juveniles in their first year of life) are believed to remain relatively close to the spawning grounds and eventually, congregate in waters south and east of Japan prior to beginning their first migration.

Approximate growth rates for North Pacific albacore are as follows: age-one fish are 14.2 inches and 2.2 pounds; age-two fish are 20.5 inches and 6.5 pounds; age-three fish are 25.6 inches and 12.7 pounds; age-four fish are 30 inches and 20.3 pounds; age-five fish are 33.5 inches and 28.3 pounds, and age 10-12 fish can reach up to 55.0 inches and over 100 pounds. Albacore are believed to reach a maximum age of roughly 11-12 years, although interpretations of age for older fish are typically subject to increased uncertainty and thus, longevity cannot be strictly defined at this time. The sex ratio of juvenile albacore is approximately one to one, but males appear to outnumber females as the fish age, e.g., the sex ratio of the catches from the longline fisheries, which target adult fish, is generally skewed towards higher numbers of males than females.

Status of the Population

Fishery researchers generally agree that the North Pacific albacore population is currently a relatively healthy stock that has responded favorably to rates of exploitation over the last decade or so. Recent assessments of the entire stock indicated that sustainable yields, on a global basis, likely range between 176.4 and 220.5 million pounds, roughly the level of total annual catch observed during the latter part of the 1990s. For example, the combined commercial and recreational landings in 1999 (U.S. and foreign) was approximately 209.5 million pounds. Catches and fishing effort associated with U.S. fisheries for albacore, both commercial and recreational, were considerably higher in the latter part of the 1990s than during the early and mid 1990s, which is baseline information that generally indicates the population has responded relatively well to recent levels of exploitation. Catch-per-unit-effort (CPUE) data from the U.S. troll fishery, a fishing statistic often used as an index of population size, has been relatively constant over the last 10 years (30 to 60 fish per day), with the exception of 1996 and 1998, when fishing success peaked at roughly 100 fish per day. The CPUE statistics from the pole-and-line fishery of Japan, which harvests juvenile albacore similar to the U.S. troll fleet, have been generally consistent since the early 1990s as well, with the trend increasing noticeably during the late 1990s. The CPUE time series associated with the Japan longline fishery, which targets adult albacore and larger juveniles, indicates a productive stock that has been increasing in size since the early 1990s. It is more difficult to assess the status of the overall population using CPUE data from the recreational fisheries, given the influence of oceanic factors on albacore's migratory behavior. It is likely that catch and fishing effort associated with the North Pacific albacore stock will remain at or slightly above current levels into the near future, given favorable oceanographic and market conditions.

Although fishing pressure is likely an important factor that influences albacore abundance in the North Pacific Ocean, it must necessarily be interpreted in the context of the overall condition of the stock's environment. That is, albacore abundance in the North Pacific Ocean has fluctuated considerably over the last several decades, with strong and weak periods occurring intermittently, based largely on the ocean's carrying capacity in any given year.

Management Considerations

See the Management Considerations Appendix A for further information.

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