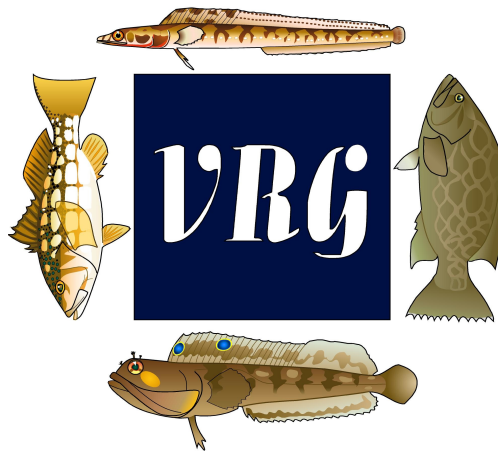


FISHERIES INVENTORY AND UTILIZATION
OF SAN DIEGO BAY, SAN DIEGO, CALIFORNIA
FOR SURVEYS CONDUCTED IN APRIL AND JULY 2015



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Executive Summary

The Vantuna Research Group at Occidental College surveyed the estuarine fishes of San Diego Bay in April and July 2015 for the Port of San Diego. The survey followed the protocols established from July 1994 to April 1999 (Allen 1999, Allen et al. 2002, Pondella et al. 2006, Pondella and Williams 2009a, Williams and Pondella 2012). The goals of the current study were to update the previous studies and address the following objectives:

- Identify, determine and quantify the utilization of the fishery populations in San Diego Bay
- Identify habitats that support juvenile fish species and describe nursery utilization
- Determine geographic and/or habitat areas of San Diego Bay that support significant populations of fish species utilized as forage by endangered avian species

In order to accomplish the objectives for these two sampling periods, we have documented the following parameters:

- ✓ Fish species composition and abundance
 - Species diversity
 - Abundance by bay Ecoregion
- ✓ Ecological importance of species
- ✓ Nursery area function
- ✓ Fish assemblage structure
- ✓ Water quality parameters
- ✓ Fish density and biomass estimates
 - Numerical and biomass density
 - Density and standing stock of avian forage species
 - Density and standing stock of fishery species
 - Panamic species unique to San Diego Bay



Sunrise in the South-Central Ecoregion. (Photo: JW)

Composition and Abundance

During this study, 23,483 (50 species) fishes weighing a total of 377 kg were collected during April and July 2015. The most numerous species comprising 33.9% of the catch was Slough Anchovy (*Anchoa delicatissima*), followed by Northern Anchovy (*Engraulis mordax*; 28.4%), Topsmelt (*Atherinops affinis*; 8.5%), and California Grunion (*Leuresthes tenuis*; 6.9%). In terms of biomass, Round Stingrays (*Urobatis halleri*) dominated the catch comprising 34.4% of the biomass, followed by California Butterfly Ray (*Gymnura marmorata*; 13.6%), Northern Anchovy (13.5%), and Spotted Sand Bass (*Paralabrax maculatofasciatus*; 13.5%). Northern Anchovy was a numerically and biomass dominant species for the first time since 2005 and California Grunion was a numerically dominant species for the first time since 1997. All other dominant species in terms of abundance and biomass are typically dominant.

Ecological Importance of Species

The principle fishes surveyed during these sampling periods as determined by the Ecological Index were the following species: Slough Anchovy, Round Stingray, Spotted Sand Bass, and Northern Anchovy. Slough Anchovy ranked first (E.I. 3,778), Round Stingray ranked second (E.I. 3,737), and spotted sand bass ranked third (E.I. 1,495). All three species were found ubiquitously throughout the bay; Round Stingray and Spotted Sand Bass were dominant in terms of biomass and Slough Anchovy in terms of numerical abundance. These species were followed by Northern Anchovy (E.I. 1,047), which were mostly captured in the North Ecoregion in July where it dominated the nearshore catch.

Best Estimates of Density and Standing Stock

The stock size estimate in 2015 was the highest of any other survey since 2005, and the biomass standing stock was the highest of all surveys. The best total estimate for the total stock size was 35,117,726 fishes. With an estimated surface area of 4,858 ha this gives an overall fish density 0.72 individuals/m². The highest estimate was of Slough Anchovy (13.9 million), followed by Northern Anchovy (13.0 million), Kelp Pipefish (1.74 million), Giant Kelpfish (*Heterostichus rostratus*; 1.6 million), and Topsmelt (1.1 million). As is typical, schooling and forage fishes dominated the stock estimate for the bay. The total best estimate of biomass standing stock was 518,177 kg, or approximately 10.67 g/m².

Avian Forage and Fisheries Species

Forage species are primarily surface dwelling schooling fish that are accessible to diving avian predators, especially terns. Generally, forage fishes are small silvery-sided fishes that are found in large schools. These schooling fishes are not habitat specific and move throughout the bay's ecosystem. Thirteen species of important forage fishes were captured during this study. The most abundant forage fishes were Slough Anchovy, Northern Anchovy, California Grunion, and Topsmelt. These species were primarily found at small (juvenile) size classes (<50 mm SL) appropriate for nesting birds to feed

their young in the area. The typical timing for the recruitment of fishes to San Diego Bay begins in the spring and continues through the summer, which is what was observed in 2015. The biomass standing stock estimate for forage fish was 146.1 MT. During this study, 15 important California recreational or commercial species were captured. The standing stock estimate of fisheries species totaled 122.0 MT.

San Diego Bay as a Unique Fish Habitat and Nursery Area

San Diego Bay is known for being the northern edge of the range for a number of southern fishes that are not normally distributed in the Southern California Bight. As an example, at least nineteen northern range extensions have been reported from the bay. During the study, five species [California Butterfly Ray, Shortfin Corvina (*Cynoscion parvipinnis*), Pacific Seahorse (*Hippocampus ingens*), California Halfbeak (*Hyporhamphus rosae*) and California Needlefish (*Strongylura exilis*)] with primarily southern distributions were taken in spite of the exceptionally warm water in the bay due to the presence of a strong El Niño. These fishes were mostly found in the southern half of the bay, though at least one was found in each ecoregion.

As the largest estuary in Southern California, San Diego Bay provides critical habitat for bay and estuary fishes and continues to be a nursery area for the majority (56%) of the fishes found there. The high productivity rate coupled with the abundance of juvenile fishes in the bay highlights the importance of the bay as a nursery habitat. The bay contains extensive shallow water eelgrass habitat that supports a unique assemblage of juvenile and adult fishes. San Diego Bay serves as critical habitat for many fishes that, in turn support surrounding nearshore ecosystems. Juvenile fishes emigrate from the bay to offshore habitats, and important or endangered avian species utilize forage fishes in the bay. Southern California indigenous bay and estuary fishes represented 41.6% of the total catch in this survey.

Trends and Comparisons

Overall, 2015 Shannon-Wiener Diversity estimates in each ecoregion were very even and somewhat similar to the historical values, though diversity in the North-Central Ecoregion was the highest of any sampling period, and diversity in the North and South-Central Ecoregions were slightly depressed by the large proportion of anchovies. Species richness for 2015 was average among the range of values for the North, North-Central, and South-Central Ecoregions for any survey period, but among the lowest for the South Ecoregion.

Field Surveys

To adequately assess the status of all components of the ichthyofauna of the San Diego Bay, four Ecoregions of San Diego Bay including North, North-Central, South-Central, and South were sampled and inventoried (Figure 1, Table 1).

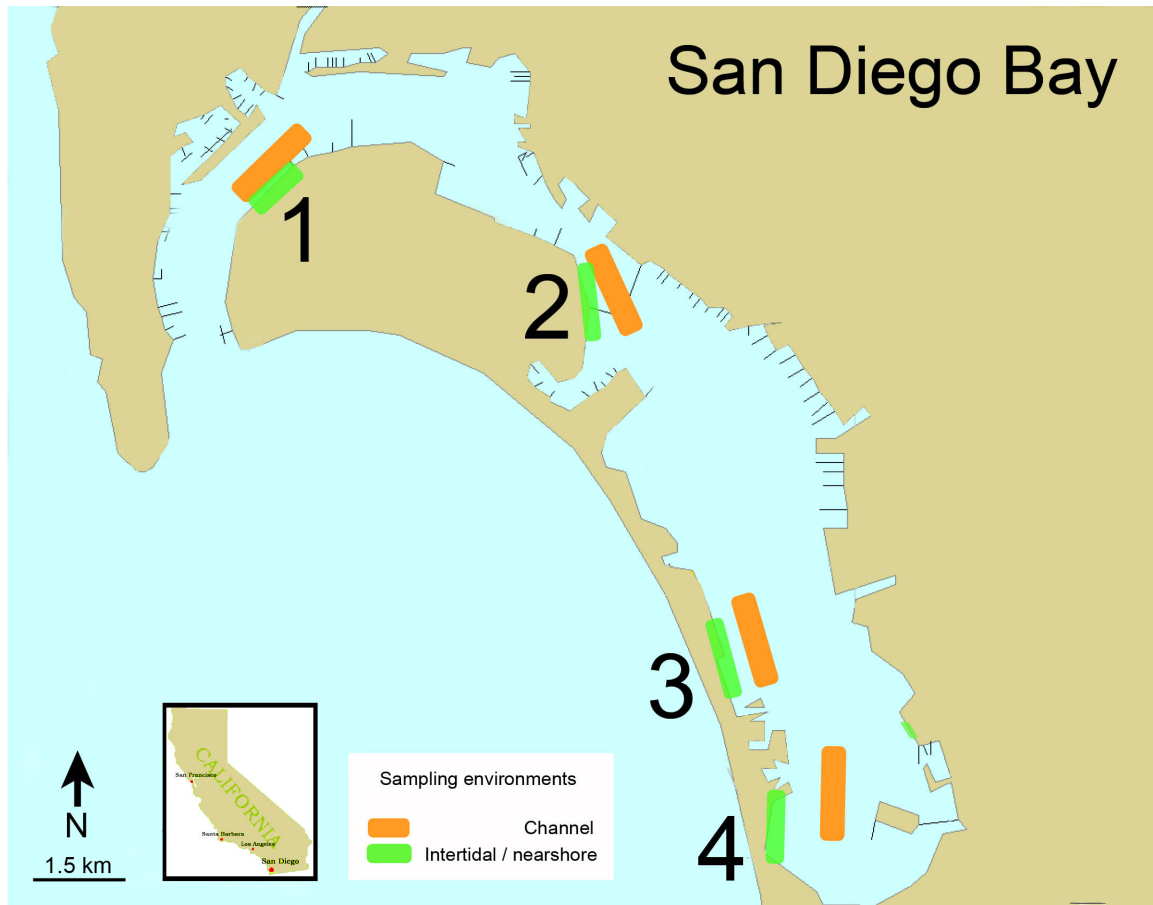


Figure 1. Sampling locations of the North (1), North-Central (2), South-Central (3) and South (4) Ecoregions in San Diego Bay.

Table 1. Lambert Coordinates (LAT, LONG) for San Diego Bay Fisheries Inventory and Utilization study, 2015.

| Ecoregion | Site | Latitude | Longitude |
|---------------|---------------|-------------|--------------|
| North | Vegetated | 32° 41' 50" | 117° 13' 40" |
| | Non-Vegetated | 32° 42' 45" | 117° 12' 30" |
| North-Central | Vegetated | 32° 41' 25" | 117° 09' 50" |
| | Non-Vegetated | 32° 41' 12" | 117° 09' 45" |
| South-Central | Vegetated | 32° 39' 05" | 117° 08' 30" |
| | Non-Vegetated | 32° 38' 48" | 117° 08' 25" |
| South-Central | Vegetated | 32° 37' 00" | 117° 07' 45" |
| | Non-Vegetated | 32° 36' 50" | 117° 06' 45" |

Sampling Procedures

Sampling occurred during the spring and summer quarters of 2015 (April 11-12, April 18-19 and July 21-24, 2015). One ecoregion was sampled per day. Collections were made off the 5-m *R/V Blennius* and the 6.5-m *R/V Neoclinus*. At each ecoregion, the following five subhabitats were sampled: deep channel, nearshore non-vegetated, nearshore vegetated, intertidal non-vegetated, and intertidal vegetated.

Fish were sampled at each ecoregion using the following gear:

- 1) A 15.2 X 1.8 m large seine equipped with a 1.8 X 1.8 X 1.8 m bag (1.2 cm mesh wings and 0.6 cm mesh in bag) was used to sample fishes in the intertidal subhabitat of each ecoregion at a depth of 0-2 meters. The sampling area was randomly selected within ecoregions. The net was set parallel to the shoreline and pulled in shore by 15 m rope lines, covering an area of about 220 m² per haul. Three replicates per subhabitat were conducted for a total of six per ecoregion.
- 2) A 4.6 m X 1.2 small seine with 3 mm mesh was utilized to collect fish in the shallow intertidal habitat of 0-0.5m depths. The small seine was pulled 10 m along shore and pivoted towards the shore, covering an area of approximately 62 m². Three replicates per subhabitat were conducted for a total of six per ecoregion.



- 3) A 1 m² square enclosure constructed of 2.5 cm metal pipe and canvas was used to survey small, burrow-inhabiting fish in shallow intertidal areas of the bay. The enclosure was randomly set within each subhabitat in a depth of 0.25-0.75 m. One liter of 9:1 isopropanol-2-quinoline solution was added to the enclosed water and then searched for 10 minutes using a 1 mm mesh dipnet. Three replicates per subhabitat were conducted for a total of six per ecoregion.

- 4) A 1.6 m beam trawl (4 mm mesh wings and 2 mm knotless mesh in the codend) was used to sample nearshore fish species. Standardized 10 minute tows were conducted behind the 5-m research vessel, covering an area of approximately 290 m² per replicate. Three replicates per subhabitat were conducted for a total of six per ecoregion.



- 5) A 66 X 6 m purse seine (1.2 cm mesh wings and 0.6 cm mesh bag) was used to sample fish species in the nearshore and channel subhabitats. The purse seine was randomly set within each subhabitat and sampled a total area of approximately 296 m² per replicate. Three replicates per subhabitat were conducted for a total of nine in each ecoregion.
- 6) An 8 m semi-balloon otter trawl (2 cm mesh wings and 0.8 cm mesh codend) towed behind the 5-m research vessel was used to survey fishes from the deepest portions of the channel subhabitat. The otter trawl was towed for 10 minutes and sampled a total area of approximately 2,417 m² per each replicate. Three replicates were conducted per ecoregion.

All fishes were identified and measured to the nearest centimeter and gram using hanging scales or a digital balance. Most individuals were measured aboard the research vessels and returned to the water, though large catches of small individuals were returned to the laboratory for identification and measurement. Coordinates of each sampling effort were recorded for all sampling events. For otter and beam trawls the start and finish of each tow were recorded. The sampling events are plotted in Figures 2-5.



Downtown San Diego from Shelter Island. (photo: RA)

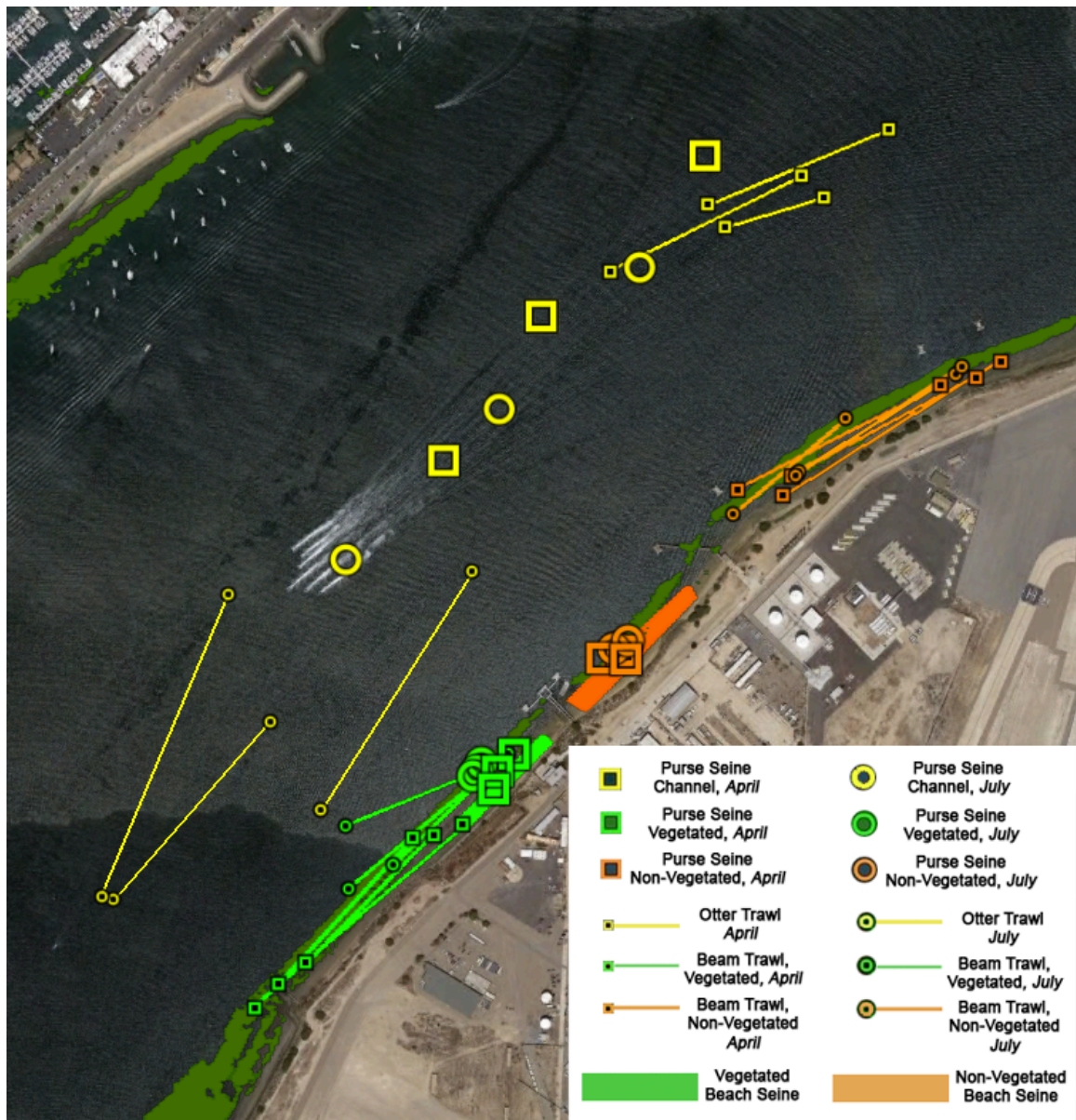


Figure 2. Sampling events for the North Ecoregion, 2015.

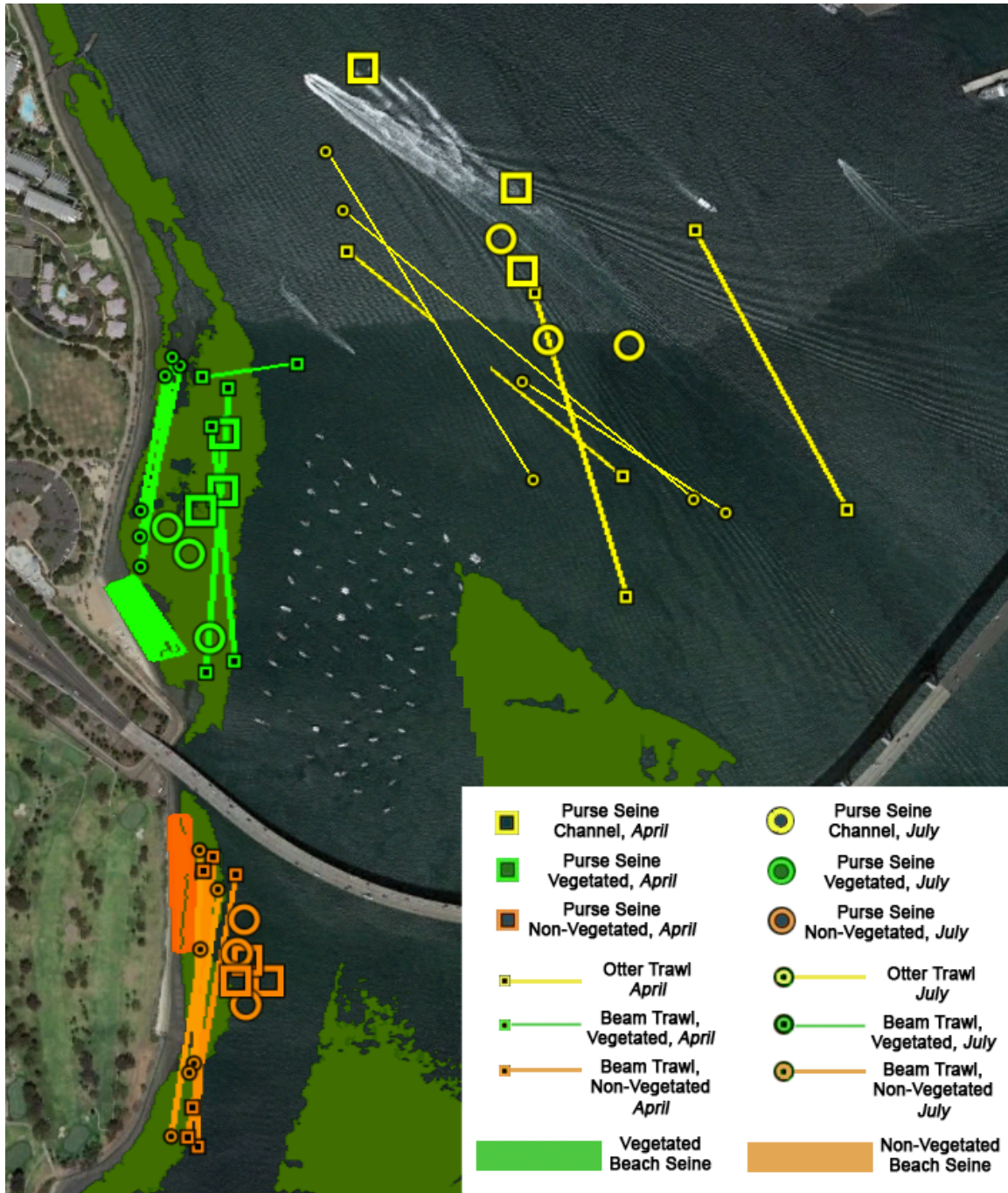


Figure 3. Sampling events for the North-Central Ecoregion, 2015.

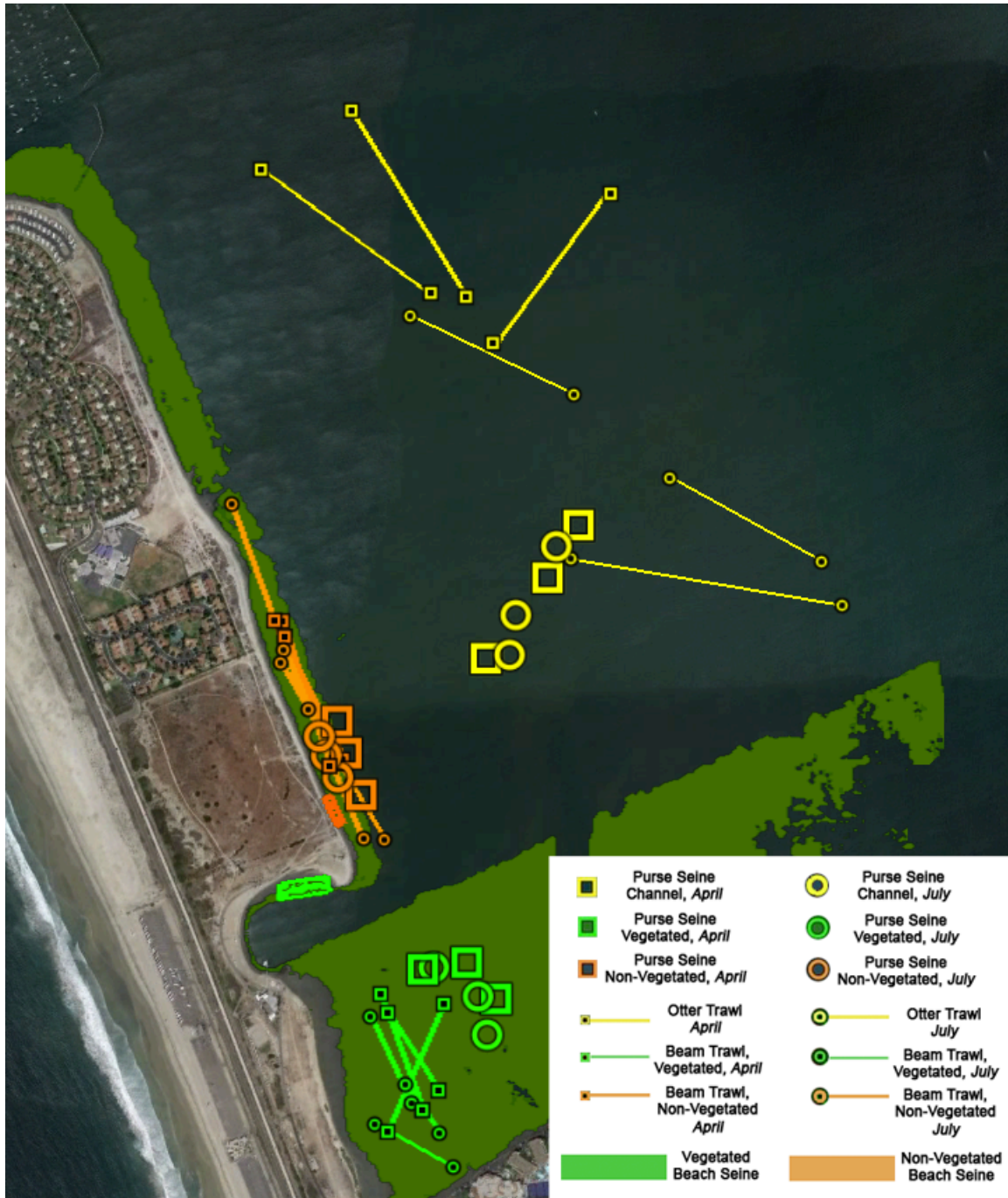


Figure 4. Sampling events for the South-Central Ecoregion, 2015.

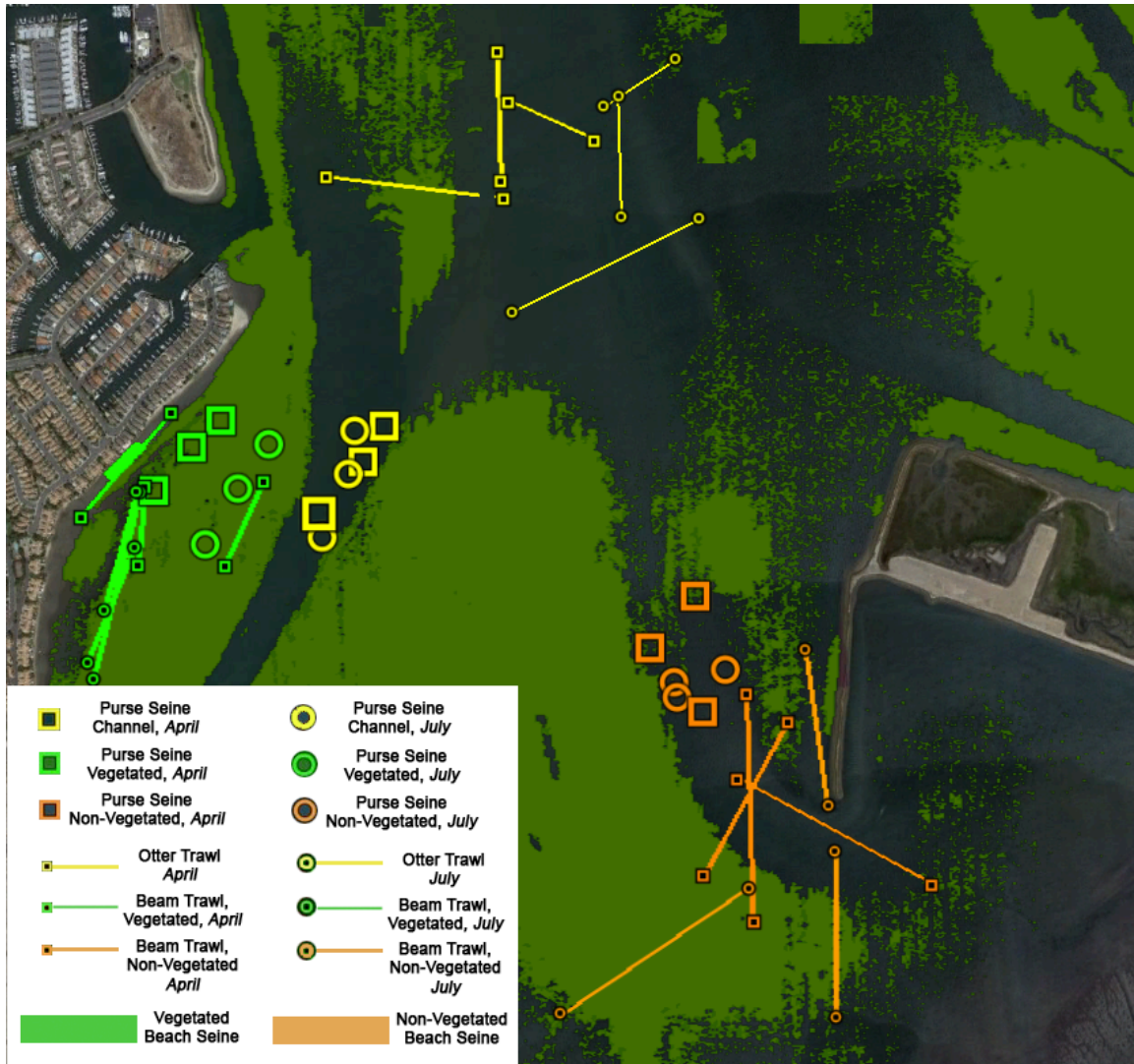


Figure 5. Sampling events for the South Ecoregion, 2015.

Water Quality Parameters

Water temperature ($^{\circ}\text{C}$), salinity (ppt), dissolved oxygen ($\text{mg O}_2/\text{l}$), and pH were measured at each ecoregion. Temperature increased from north to south in the bay during both sampling periods, though the temperature was about $4\text{--}6\text{ }^{\circ}\text{C}$ warmer at each ecoregion during the July sampling period. Salinity increased slightly from north to south during the July sampling period, but declined sharply in the South Ecoregion during the April sampling period. This can likely be attributed to significant rainfall around the Otay Watershed during early March, which then flowed from Otay Reservoir via the Otay River into the South Ecoregion through the San Diego National Wildlife Refuge. Dissolved oxygen generally decreased from north to south and declined sharply in the South Ecoregion during the April sampling period just as salinity did and likely for the same reason. Values for pH were relatively stable throughout the bay, but had highest values in the ocean-adjacent North Ecoregion (Figure 6).

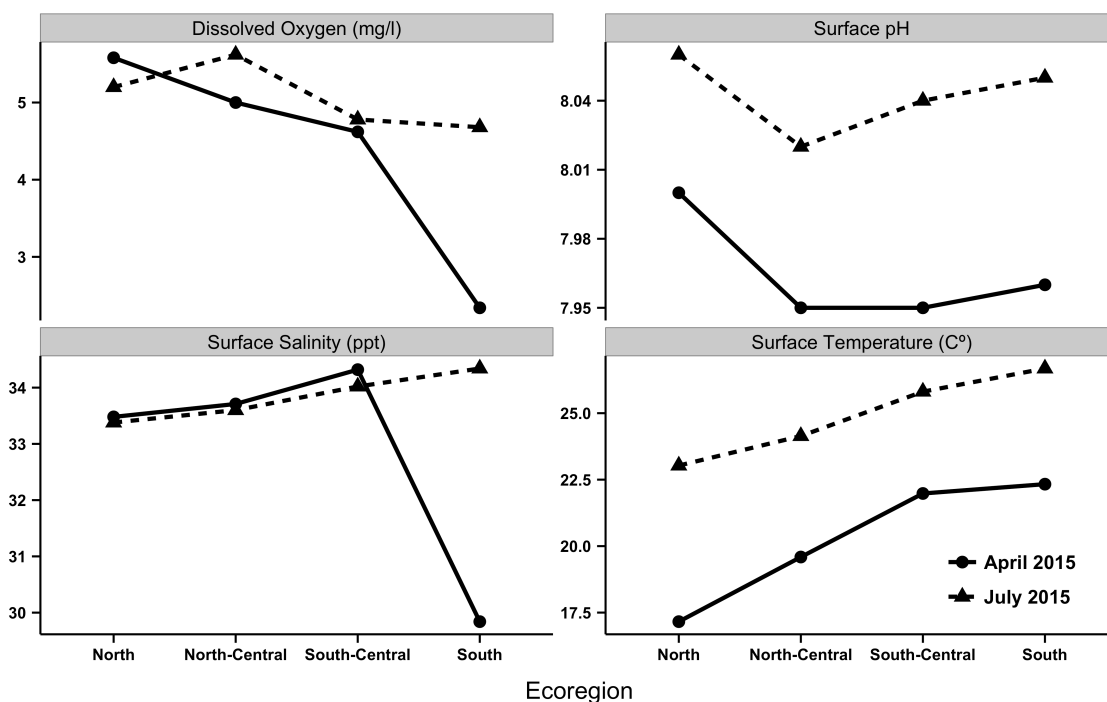


Figure 6. Summary of mean physical-chemical measurements by ecoregion in April and July, 2015.

Numerical Catch and Biomass

During this study, 23,483 (50 species) fishes weighing 377 kg were collected during April and July 2015 (Tables 2 and 3). The most numerous species comprising 33.9% of the catch was Slough Anchovy (*Anchoa delicatissima*), followed by Northern Anchovy (*Engraulis mordax*; 28.4%), Topsmelt (*Atherinops affinis*; 8.5%), and California Grunion (*Leuresthes tenuis*; 6.9%). In terms of biomass, Round Stingrays (*Urobatis halleri*) dominated the catch comprising 34.4% of the biomass, followed by California Butterfly Ray (*Gymnura marmorata*; 13.6%), Northern Anchovy (13.5%), and Spotted Sand Bass (*Paralabrax maculatofasciatus*; 13.5%). Northern Anchovy was a numerically and biomass dominant species for the first time since 2005 and California Grunion was a numerically dominant species for the first time since 1997. All other dominant species in terms of abundance and biomass are typically dominant.

Total catch varied greatly by ecoregion (Figure 7) largely as a product of the dominance of three species of forage fishes. Abundance was greatest at the North Ecoregion (10,209; Table 4), followed by the North-Central Ecoregion (5,868; Table 5), South-Central Ecoregion (4,620; Table 6), and South Ecoregion (2,786; Table 7). The North Ecoregion was dominated by Northern Anchovy (6,472) and California Grunion (1,528). Slough Anchovy completely dominated catches in the North-Central (2,918), South-Central (3,136), and South (1,409) Ecoregions.

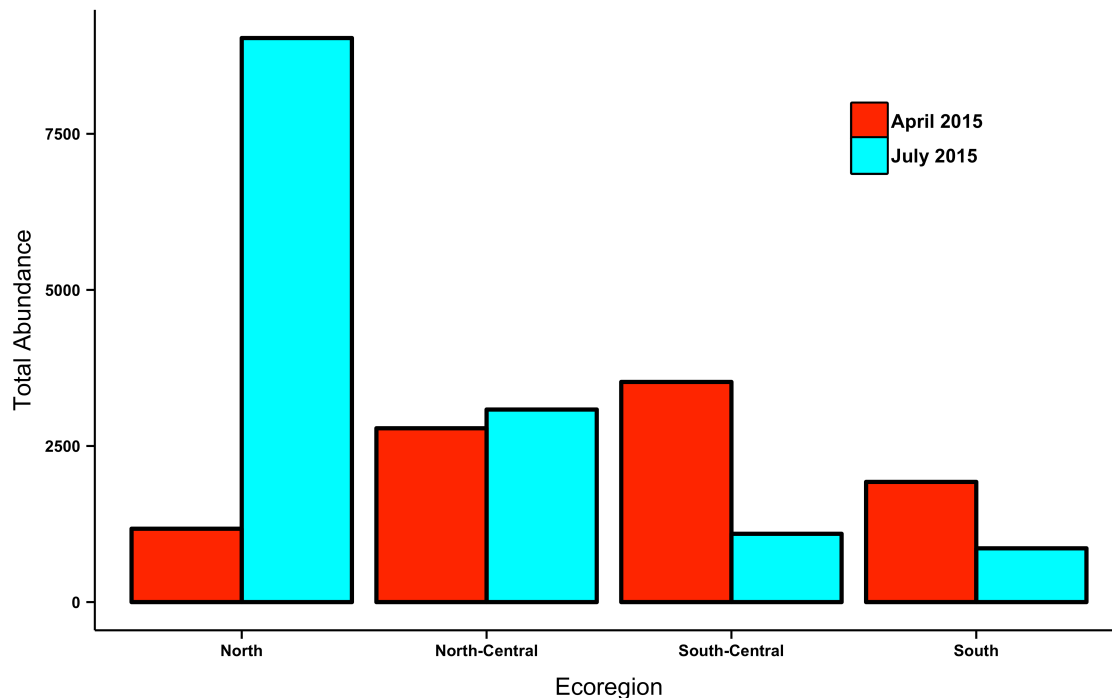


Figure 7. Catch of San Diego Bay fishes by ecoregion, April and July 2015.

Overall, the catch of the five numerically dominant fishes had mixed patterns over the four ecoregions (Figure 8). Northern Anchovy and California Grunion were limited to the North and North-Central Ecoregions and were the numerically dominant species in the North Ecoregion. Slough Anchovy were ubiquitous throughout the bay, but were dominant in the North-Central, South-Central, and South Ecoregions. Topsmelt and Kelp Pipefish (*Syngnathus californiensis*; considered synonymous with *Syngnathus leptorhynchus* in this document; Garcia and Rouse, in prep).

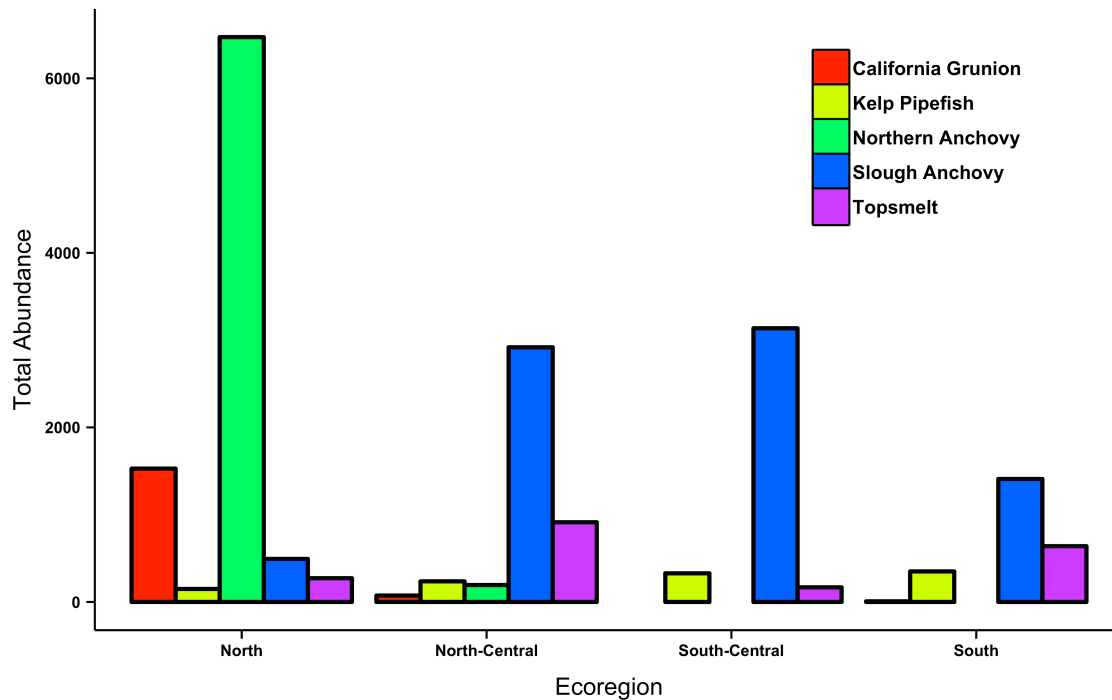


Figure 8. Total catch of the five numerically dominant species by ecoregion, 2015.

Round Stingray had the highest catch in terms of biomass at two ecoregions (North-Central, 41.4 kg; South-Central, 38.0 kg). Round Stingray was second in biomass (36.4 kg) to Northern Anchovy (49.1 kg) in the North Ecoregion. In the South Ecoregion, Round Stingrays were second (14.2 kg) to California Butterfly Ray (44.7 kg). It should be noted that the high biomass of California Butterfly Ray in the South Ecoregion is almost entirely due to a single, very large (1.57 m disc width; 44.5 kg) individual. Other dominant species in the North-Central Ecoregion in terms of biomass include the Bat Ray (25.0 kg), Spotted Sand Bass (20.9 kg), and Pacific Angel Shark (*Squatina californica*; a single 12.0 kg individual). Additional dominant species in the South-Central Ecoregion also include the Spotted Sand Bass (12.1 kg) and California Butterfly Ray (6.5 kg).

Table 2. Total abundance of fishes collected in San Diego Bay during 2015 by ecoregion.

| Scientific Name | Common Name | Ecoregions | | | | Total | % |
|-------------------------------------|--------------------------|------------|---------------|---------------|-------|--------|--------|
| | | North | North-Central | South-Central | South | | |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 493 | 2,918 | 3,136 | 1,409 | 7,956 | 33.88 |
| <i>Engraulis mordax</i> | Northern Anchovy | 6,472 | 194 | | | 6,666 | 28.39 |
| <i>Atherinops affinis</i> | Topsmelt | 272 | 913 | 167 | 639 | 1,991 | 8.48 |
| <i>Leuresthes tenuis</i> | California Grunion | 1,528 | 73 | | 7 | 1,608 | 6.85 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 149 | 236 | 328 | 350 | 1,063 | 4.53 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 251 | 305 | 306 | 51 | 913 | 3.89 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 310 | 516 | 75 | | 901 | 3.84 |
| <i>Urobatis halleri</i> | Round Stingray | 143 | 212 | 244 | 86 | 685 | 2.92 |
| <i>Clevelandia ios</i> | Arrow Goby | 160 | 36 | 93 | 64 | 353 | 1.50 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 34 | 194 | 79 | 39 | 346 | 1.47 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 9 | 112 | 81 | 22 | 224 | 0.95 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 215 | 6 | | | 221 | 0.94 |
| <i>Paralichthys californicus</i> | California Halibut | 39 | 15 | 28 | 12 | 94 | 0.40 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 7 | 7 | 44 | 22 | 80 | 0.34 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 1 | | 1 | 71 | 73 | 0.31 |
| <i>Seriphus politus</i> | Queenfish | 6 | 37 | 2 | | 45 | 0.19 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 17 | 13 | 4 | | 34 | 0.14 |
| <i>Embiotoca jacksoni</i> | Black Perch | 27 | | | | 27 | 0.11 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 6 | 17 | 3 | 1 | 27 | 0.11 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 8 | 15 | 1 | 1 | 25 | 0.11 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 16 | 4 | | | 20 | 0.09 |
| <i>Sardinops sagax</i> | Pacific Sardine | 15 | | | 1 | 16 | 0.07 |
| <i>Cheilotrema saturnum</i> | Black Croaker | | 13 | 1 | | 14 | 0.06 |
| <i>Fundulus parvipinnis</i> | California Killifish | | | 13 | | 13 | 0.06 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 13 | | | | 13 | 0.06 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | | 9 | 2 | | 11 | 0.05 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 4 | 3 | | | 7 | 0.03 |
| <i>Myliobatis californica</i> | Bat Ray | | 5 | 1 | 1 | 7 | 0.03 |
| <i>Umbrina roncador</i> | Yellowfin Croaker | | 5 | | 1 | 6 | 0.03 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 1 | | 2 | 2 | 5 | 0.02 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | | 1 | 3 | 1 | 5 | 0.02 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | | | 2 | 2 | 4 | 0.02 |
| <i>Albula gilberti</i> | Cortez Bonefish | | 1 | | 2 | 3 | 0.01 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | 3 | | | | 3 | 0.01 |
| <i>Xystreureys liolepis</i> | Fantail Sole | 2 | 1 | | | 3 | 0.01 |
| <i>Atractoscion nobilis</i> | White Seabass | 1 | | 1 | | 2 | 0.01 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 2 | | | | 2 | 0.01 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | | 2 | | | 2 | 0.01 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | | 1 | 1 | | 2 | 0.01 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | | | 1 | 2 | 0.01 |
| <i>Strongylura exilis</i> | California Needlefish | 2 | | | | 2 | 0.01 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | | | 1 | 1 | < 0.01 |
| <i>Girella nigricans</i> | Opaleye | 1 | | | | 1 | < 0.01 |
| <i>Haemulon californiensis</i> | Salema | | 1 | | | 1 | < 0.01 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | 1 | | | | 1 | < 0.01 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | | 1 | | | 1 | < 0.01 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | | 1 | | | 1 | < 0.01 |
| <i>Roncador stearnsii</i> | Spotfin Croaker | | | 1 | | 1 | < 0.01 |
| <i>Scorpaena guttata</i> | California Scorpionfish | | | 1 | | 1 | < 0.01 |
| <i>Squatina californica</i> | Pacific Angel Shark | | 1 | | | 1 | < 0.01 |
| # of Species: 50 | | 10,209 | 5,868 | 4,620 | 2,786 | 23,483 | |

Table 3. Total biomass (g) of fishes collected in San Diego Bay during 2015 by ecoregion.

| Scientific Name | Common Name | Ecoregions | | | | Total (g) | % |
|-------------------------------------|--------------------------|------------|---------------|---------------|--------|-----------|--------|
| | | North | North-Central | South-Central | South | | |
| <i>Urobatis halleri</i> | Round Stingray | 36,357 | 41,432 | 37,953 | 14,198 | 129,940 | 34.45 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | | | 6,500 | 44,710 | 51,210 | 13.58 |
| <i>Engraulis mordax</i> | Northern Anchovy | 49,092 | 1,855 | | | 50,947 | 13.51 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 9,360 | 20,891 | 12,065 | 8,510 | 50,826 | 13.48 |
| <i>Myliobatis californica</i> | Bat Ray | | 25,000 | 900 | 300 | 26,200 | 6.95 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 1,220 | 7,124 | 4,334 | 2,020 | 14,698 | 3.90 |
| <i>Squatina californica</i> | Pacific Angel Shark | | 12,000 | | | 12,000 | 3.18 |
| <i>Paralichthys californicus</i> | California Halibut | 4,946 | 525 | 721 | 1,255 | 7,447 | 1.97 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 432 | 2,377 | 1,618 | 874 | 5,301 | 1.41 |
| <i>Atherinops affinis</i> | Topsmelt | 1,154 | 1,633 | 350 | 1,382 | 4,519 | 1.20 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 991 | 889 | 1,347 | 176 | 3,403 | 0.90 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 1,109 | 1,116 | 229 | | 2,454 | 0.65 |
| <i>Leuresthes tenuis</i> | California Grunion | 1,555 | 640 | | 1 | 2,196 | 0.58 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | | 1,700 | | 400 | 2,100 | 0.56 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 1,543 | 49 | | | 1,591 | 0.42 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 139 | 135 | 709 | 331 | 1,313 | 0.35 |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | | | 1,300 | | 1,300 | 0.34 |
| <i>Seriphus politus</i> | Queenfish | 13 | 1,175 | 11 | | 1,199 | 0.32 |
| <i>Albula gilberti</i> | Cortez Bonefish | | 490 | | 600 | 1,090 | 0.29 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | 1,000 | | | | 1,000 | 0.27 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 722 | 80 | | | 802 | 0.21 |
| <i>Xystreurus liolepis</i> | Fantail Sole | 500 | 250 | | | 750 | 0.20 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 193 | 158 | 139 | 157 | 647 | 0.17 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 333 | 126 | 125 | | 584 | 0.15 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 392 | 66 | 3 | 42 | 503 | 0.13 |
| <i>Embiotoca jacksoni</i> | Black Perch | 500 | | | | 500 | 0.13 |
| <i>Cheilotrema saturnum</i> | Black Croaker | | 318 | 156 | | 474 | 0.13 |
| <i>Hypsoblenius gentilis</i> | Bay Blenny | 77 | 257 | 36 | 29 | 399 | 0.11 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | | 190 | 146 | 38 | 374 | 0.10 |
| <i>Girella nigricans</i> | Opaleye | 250 | | | | 250 | 0.07 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | 250 | | | | 250 | 0.07 |
| <i>Sardinops sagax</i> | Pacific Sardine | 117 | | | 35 | 152 | 0.04 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 110 | | 16 | 11 | 137 | 0.04 |
| <i>Scorpaena guttata</i> | California Scorpionfish | | | 95 | | 95 | 0.03 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 88 | | | | 88 | 0.02 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | | 42 | 41 | | 83 | 0.02 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 49 | 32 | | | 81 | 0.02 |
| <i>Clevelandia ios</i> | Arrow Goby | 29 | 25 | 13 | 7 | 74 | 0.02 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | | 45 | | | 45 | 0.01 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | | 27 | 11 | | 38 | 0.01 |
| <i>Fundulus parvipinnis</i> | California Killifish | | | 35 | | 35 | 0.01 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | | 34 | | | 34 | 0.01 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 18 | | | | 18 | < 0.01 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | | | 15 | 15 | < 0.01 |
| <i>Haemulon californiensis</i> | Salema | | 12 | | | 12 | < 0.01 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | < 1 | | 3 | 2 | 5 | < 0.01 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | | 2 | | | 2 | < 0.01 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | | | 1 | 2 | < 0.01 |
| <i>Atractoscion nobilis</i> | White Seabass | 1 | | 1 | | 2 | < 0.01 |
| <i>Strongylura exilis</i> | California Needlefish | 1 | | | | 1 | < 0.01 |
| # of Species: 50 | | 112,541 | 120,695 | 68,857 | 75,094 | 377,186 | |

Table 4. Total number of individuals and biomass (g) of fish species captured in the North Ecoregion, 2015.

| Scientific Name | Common Name | Abundance | | Biomass | |
|-------------------------------------|-----------------------|---------------|-------|----------------|--------|
| | | # | % | grams | % |
| <i>Engraulis mordax</i> | Northern Anchovy | 6,472 | 63.40 | 49,092 | 43.62 |
| <i>Leuresthes tenuis</i> | California Grunion | 1,528 | 14.97 | 1,555 | 1.38 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 493 | 4.83 | 1,220 | 1.08 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 310 | 3.04 | 1,109 | 0.99 |
| <i>Atherinops affinis</i> | Topsmelt | 272 | 2.66 | 1,154 | 1.03 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 251 | 2.46 | 991 | 0.88 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 215 | 2.11 | 1,543 | 1.37 |
| <i>Clevelandia ios</i> | Arrow Goby | 160 | 1.57 | 29 | 0.03 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 149 | 1.46 | 193 | 0.17 |
| <i>Urobatis halleri</i> | Round Stingray | 143 | 1.40 | 36,357 | 32.31 |
| <i>Paralichthys californicus</i> | California Halibut | 39 | 0.38 | 4,946 | 4.39 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 34 | 0.33 | 9,360 | 8.32 |
| <i>Embiotoca jacksoni</i> | Black Perch | 27 | 0.26 | 500 | 0.44 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 17 | 0.17 | 333 | 0.30 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 16 | 0.16 | 722 | 0.64 |
| <i>Sardinops sagax</i> | Pacific Sardine | 15 | 0.15 | 117 | 0.10 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 13 | 0.13 | 88 | 0.08 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 9 | 0.09 | 432 | 0.38 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 8 | 0.08 | 77 | 0.07 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 7 | 0.07 | 139 | 0.12 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 6 | 0.06 | 392 | 0.35 |
| <i>Seriphus politus</i> | Queenfish | 6 | 0.06 | 13 | 0.01 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 4 | 0.04 | 49 | 0.04 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | 3 | 0.03 | 250 | 0.22 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 2 | 0.02 | 18 | 0.02 |
| <i>Strongylura exilis</i> | California Needlefish | 2 | 0.02 | 1 | < 0.01 |
| <i>Xystreurus liolepis</i> | Fantail Sole | 2 | 0.02 | 500 | 0.44 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 1 | 0.01 | 110 | 0.10 |
| <i>Atractoscion nobilis</i> | White Seabass | 1 | 0.01 | 1 | < 0.01 |
| <i>Girella nigricans</i> | Opaleye | 1 | 0.01 | 250 | 0.22 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | 0.01 | 1 | < 0.01 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 1 | 0.01 | < 1 | < 0.01 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | 1 | 0.01 | 1,000 | 0.89 |
| # of Species: 33 | | 10,209 | | 112,541 | |

Table 5. Total number of individuals and biomass (g) of fish species captured in the North-Central Ecoregion, 2015.

| Scientific Name | Common Name | Abundance | | Biomass | |
|-------------------------------------|--------------------------|--------------|-------|----------------|--------|
| | | # | % | grams | % |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 2,918 | 49.73 | 7,124 | 5.90 |
| <i>Atherinops affinis</i> | Topsmelt | 913 | 15.56 | 1,633 | 1.35 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 516 | 8.79 | 1,116 | 0.92 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 305 | 5.20 | 889 | 0.74 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 236 | 4.02 | 158 | 0.13 |
| <i>Urobatis halleri</i> | Round Stingray | 212 | 3.61 | 41,432 | 34.33 |
| <i>Engraulis mordax</i> | Northern Anchovy | 194 | 3.31 | 1,855 | 1.54 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 194 | 3.31 | 20,891 | 17.31 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 112 | 1.91 | 2,377 | 1.97 |
| <i>Leuresthes tenuis</i> | California Grunion | 73 | 1.24 | 640 | 0.53 |
| <i>Seriphus politus</i> | Queenfish | 37 | 0.63 | 1,175 | 0.97 |
| <i>Clevelandia ios</i> | Arrow Goby | 36 | 0.61 | 25 | 0.02 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 17 | 0.29 | 66 | 0.05 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 15 | 0.26 | 257 | 0.21 |
| <i>Paralichthys californicus</i> | California Halibut | 15 | 0.26 | 525 | 0.44 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 13 | 0.22 | 318 | 0.26 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 13 | 0.22 | 126 | 0.10 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | 9 | 0.15 | 27 | 0.02 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 7 | 0.12 | 135 | 0.11 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 6 | 0.10 | 49 | 0.04 |
| <i>Myliobatis californica</i> | Bat Ray | 5 | 0.09 | 25,000 | 20.71 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | 5 | 0.09 | 1,700 | 1.41 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 4 | 0.07 | 80 | 0.07 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 3 | 0.05 | 32 | 0.03 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | 2 | 0.03 | 2 | < 0.01 |
| <i>Albula gilberti</i> | Cortez Bonefish | 1 | 0.02 | 490 | 0.41 |
| <i>Haemulon californiensis</i> | Salema | 1 | 0.02 | 12 | 0.01 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | 1 | 0.02 | 42 | 0.03 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 1 | 0.02 | 190 | 0.16 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | 1 | 0.02 | 34 | 0.03 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | 1 | 0.02 | 45 | 0.04 |
| <i>Squatina californica</i> | Pacific Angel Shark | 1 | 0.02 | 12,000 | 9.94 |
| <i>Xystreurys liolepis</i> | Fantail Sole | 1 | 0.02 | 250 | 0.21 |
| # of Species: 33 | | 5,868 | | 120,695 | |

Table 6. Total number of individuals and biomass (g) of fish species captured in the South-Central Ecoregion, 2015.

| Scientific Name | Common Name | Abundance | | Biomass | |
|-------------------------------------|--------------------------|--------------|-------|---------------|--------|
| | | # | % | grams | % |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 3,136 | 67.88 | 4,334 | 6.29 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 328 | 7.10 | 139 | 0.20 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 306 | 6.62 | 1,347 | 1.96 |
| <i>Urobatis halleri</i> | Round Stingray | 244 | 5.28 | 37,953 | 55.12 |
| <i>Atherinops affinis</i> | Topsmelt | 167 | 3.61 | 350 | 0.51 |
| <i>Clevelandia ios</i> | Arrow Goby | 93 | 2.01 | 13 | 0.02 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 81 | 1.75 | 1,618 | 2.35 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 79 | 1.71 | 12,065 | 17.52 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 75 | 1.62 | 229 | 0.33 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 44 | 0.95 | 709 | 1.03 |
| <i>Paralichthys californicus</i> | California Halibut | 28 | 0.61 | 721 | 1.05 |
| <i>Fundulus parvipinnis</i> | California Killifish | 13 | 0.28 | 35 | 0.05 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 4 | 0.09 | 125 | 0.18 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 3 | 0.06 | 146 | 0.21 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 3 | 0.06 | 3 | 0.00 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 2 | 0.04 | 6,500 | 9.44 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 2 | 0.04 | 3 | 0.00 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | 2 | 0.04 | 11 | 0.02 |
| <i>Seriphus politus</i> | Queenfish | 2 | 0.04 | 11 | 0.02 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 1 | 0.02 | 16 | 0.02 |
| <i>Atractoscion nobilis</i> | White Seabass | 1 | 0.02 | 1 | < 0.01 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 1 | 0.02 | 156 | 0.23 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | 1 | 0.02 | 41 | 0.06 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 1 | 0.02 | 36 | 0.05 |
| <i>Myliobatis californica</i> | Bat Ray | 1 | 0.02 | 900 | 1.31 |
| <i>Roncador stearnsii</i> | Spotfin Croaker | 1 | 0.02 | 1,300 | 1.89 |
| <i>Scorpaena guttata</i> | California Scorpionfish | 1 | 0.02 | 95 | 0.14 |
| # of Species: 27 | | 4,620 | | 68,857 | |

Table 7. Total number of individuals and biomass (g) of fish species captured in the South Ecoregion, 2015.

| Scientific Name | Common Name | Abundance | | Biomass | |
|-------------------------------------|--------------------------|--------------|-------|---------------|--------|
| | | # | % | grams | % |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 1,409 | 50.57 | 2,020 | 2.69 |
| <i>Atherinops affinis</i> | Topsmelt | 639 | 22.94 | 1,382 | 1.84 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 350 | 12.56 | 157 | 0.21 |
| <i>Urobatis halleri</i> | Round Stingray | 86 | 3.09 | 14,198 | 18.91 |
| <i>Atherinopsis californiensis</i> | Jacksnelt | 71 | 2.55 | 11 | 0.01 |
| <i>Clevelandia ios</i> | Arrow Goby | 64 | 2.30 | 7 | 0.01 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 51 | 1.83 | 176 | 0.23 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 39 | 1.40 | 8,510 | 11.33 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 22 | 0.79 | 331 | 0.44 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 22 | 0.79 | 874 | 1.16 |
| <i>Paralichthys californicus</i> | California Halibut | 12 | 0.43 | 1,255 | 1.67 |
| <i>Leuresthes tenuis</i> | California Grunion | 7 | 0.25 | 1 | < 0.01 |
| <i>Albula gilberti</i> | Cortez Bonefish | 2 | 0.07 | 600 | 0.80 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 2 | 0.07 | 44,710 | 59.54 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 2 | 0.07 | 2 | < 0.01 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | 1 | 0.04 | 15 | 0.02 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | 0.04 | 1 | 0.00 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 1 | 0.04 | 29 | 0.04 |
| <i>Myliobatis californica</i> | Bat Ray | 1 | 0.04 | 300 | 0.40 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 1 | 0.04 | 38 | 0.05 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 1 | 0.04 | 42 | 0.06 |
| <i>Sardinops sagax</i> | Pacific Sardine | 1 | 0.04 | 35 | 0.05 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | 1 | 0.04 | 400 | 0.53 |
| # of Species: 23 | | 2,786 | | 75,094 | |

Shannon-Wiener Diversity and Species Richness

The Shannon-Wiener Diversity index was used to estimate diversity in San Diego Bay and provide a basis for comparison among ecoregions within the bay. The Shannon-Wiener Diversity index, (H'): $H' = -\sum p_i (\ln p_i)$ where p_i = proportion of species i , was calculated for total catches by ecoregion and by sampling month. Despite the variation in species composition and catch, diversity was fairly uniform among the four ecoregions, though richness declined slightly in the South-Central and South Ecoregions (Figure 9). Species richness remained the same, but diversity declined slightly from April to July 2015 as a result of the large proportion of anchovies caught that month (Figure 10).

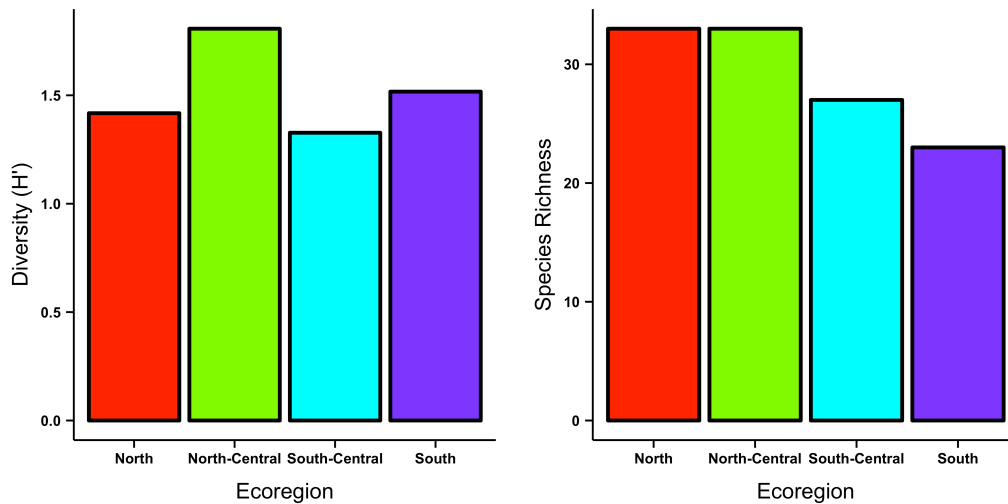


Figure 9. Shannon-Wiener Diversity (H') and number of species (richness) in each San Diego Bay ecoregion, 2015.

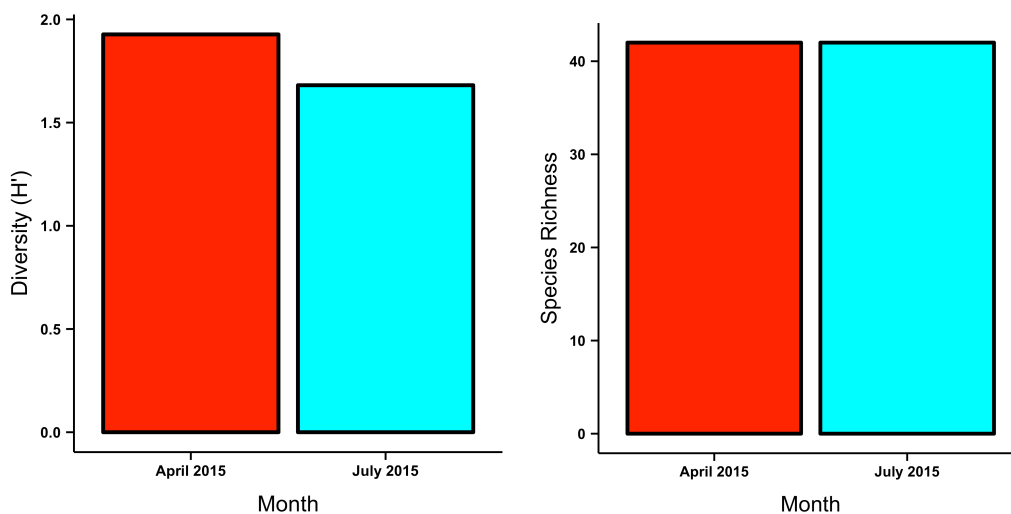


Figure 10. Shannon-Wiener Diversity (H') and number of species (richness) of fishes in San Diego Bay by sampling month, 2015.

Catch by Sampling Ecoregion and Period

North Ecoregion – A total of 10,209 fishes belonging to 33 species, weighing 112.5 kg were collected in the North Ecoregion over two sampling periods in 2015 (Table 4). Northern Anchovy was the most frequently caught species (63.4%), followed by California Grunion (15.0%), Slough Anchovy (4.8%), Giant Kelpfish (*Heterostichus rostratus*; 3.0%), and Topsmelt (2.7 %). Northern Anchovy also led in total biomass (43.6%), followed by Round Stingray (32.3%), Spotted Sand Bass (8.3%), California Halibut (*Paralichthys californicus*; 4.4%) and California Grunion (1.4%).

North-Central Ecoregion - A total of 5,868 fishes belonging to 33 species, weighing 120.7 kg were collected in the North-Central Ecoregion in April and July, 2015 (Table 5). Slough Anchovy was the most abundant species (49.7%), followed by Topsmelt (15.6%), Giant Kelpfish (8.8%), Shiner Perch (*Cymatogaster aggregata*; 5.2%), and Kelp Pipefish (4.0%). Round stingray led in total biomass (34.3%), followed by Bat Ray (20.71%), Spotted Sand Bass (17.3%), Pacific Angel Shark (one individual accounting for 9.9%), and Slough Anchovy (5.9%).

South-Central Ecoregion - A total of 4,620 fishes belonging to 27 species, weighing 68.9 kg were collected in the South-Central Ecoregion over the two sampling periods in 2015 (Table 6). Slough Anchovy was by far the most abundant species (67.9%), followed by Kelp Pipefish (7.1%), Shiner Perch (6.6%), Round Stingray (5.3%), and Topsmelt (3.6%). Round Stingray led in total biomass (55.1%), followed by Spotted Sand Bass (17.5%), California Butterfly Ray (9.4%), Slough Anchovy (6.3%) and Barred Sand Bass (*Paralabrax nebulifer*; 2.3%).

South Ecoregion - A total of 2,786 fishes belonging to 23 species, weighing 75.1 kg were collected in the South Ecoregion in April and July, 2015 (Table 7). Slough Anchovy was the most abundant species (50.6%), followed Topsmelt (22.9%), Kelp Pipefish (12.6%), Round Stingray (3.1%), and Jacksmelt (*Atherinopsis californiensis*; 2.5%). California Butterfly Ray led in total biomass (two individuals, one of which accounted for 59.3% of the 59.5%), followed by Round Stingray (18.9%), Spotted Sand Bass (11.3%), Slough Anchovy (2.7%) and Topsmelt (1.8%).

In April 2015, 9,410 individuals comprising 42 species of fishes were captured (Figure 11, Table 8). In July, the catch increased to 14,073 fish, and species richness remained the same. Total biomass was greater in July (211 kg) than April (166 kg) (Figure 12, Table 9). Biomass increased substantially in July in the North and South Ecoregions, driven entirely by large amounts of Northern Anchovy in the North Ecoregion, and a single large California Butterfly Ray in the South Ecoregion. Biomass was higher in the North-Central and South-Central Ecoregions during the April sampling period mostly as a product of lower catches of Round Stingray and Slough Anchovy in July (Figure 12).

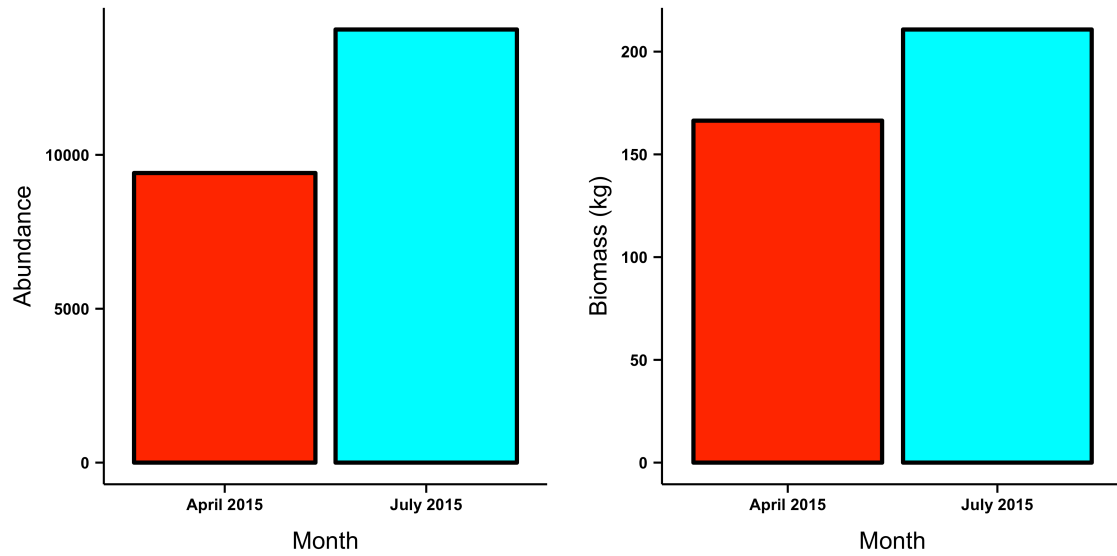


Figure 11. Total catch of fishes and biomass (kg) in San Diego Bay by sampling period, 2015.

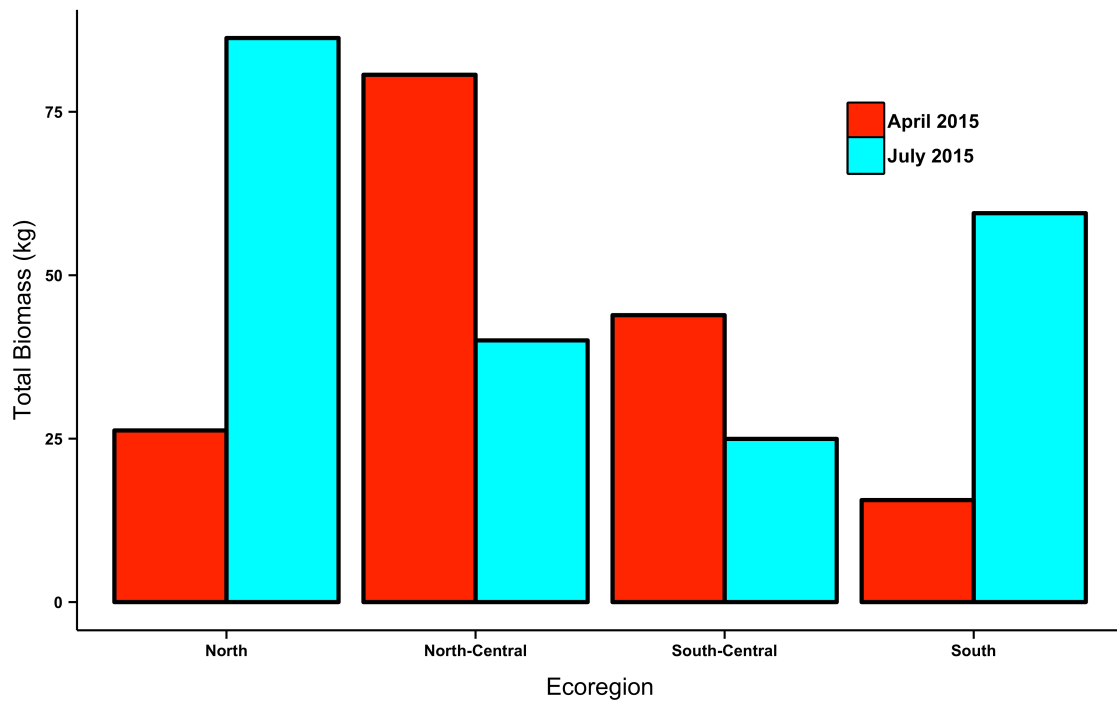


Figure 12. Biomass (kg) of San Diego Bay fishes by ecoregion, April and July 2015.

Table 8. Total abundance of fish species taken in San Diego Bay by sampling period, 2015.

| Scientific Name | Common Name | 2015 | | Total | % |
|-------------------------------------|--------------------------|--------------|---------------|---------------|--------|
| | | April | July | | |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 4,577 | 3,379 | 7,956 | 33.88 |
| <i>Engraulis mordax</i> | Northern Anchovy | 194 | 6,472 | 6,666 | 28.39 |
| <i>Atherinops affinis</i> | Topsmelt | 1,083 | 908 | 1,991 | 8.48 |
| <i>Leuresthes tenuis</i> | California Grunion | 116 | 1,492 | 1,608 | 6.85 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 486 | 577 | 1,063 | 4.53 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 778 | 135 | 913 | 3.89 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 701 | 200 | 901 | 3.84 |
| <i>Urobatis halleri</i> | Round Stingray | 404 | 281 | 685 | 2.92 |
| <i>Clevelandia ios</i> | Arrow Goby | 242 | 111 | 353 | 1.50 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 237 | 109 | 346 | 1.47 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 102 | 122 | 224 | 0.95 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 169 | 52 | 221 | 0.94 |
| <i>Paralichthys californicus</i> | California Halibut | 49 | 45 | 94 | 0.40 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 60 | 20 | 80 | 0.34 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 73 | | 73 | 0.31 |
| <i>Seriphus politus</i> | Queenfish | 37 | 8 | 45 | 0.19 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 11 | 23 | 34 | 0.14 |
| <i>Embiotoca jacksoni</i> | Black Perch | 20 | 7 | 27 | 0.11 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 1 | 26 | 27 | 0.11 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 13 | 12 | 25 | 0.11 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 4 | 16 | 20 | 0.09 |
| <i>Sardinops sagax</i> | Pacific Sardine | 1 | 15 | 16 | 0.07 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 3 | 11 | 14 | 0.06 |
| <i>Fundulus parvipinnis</i> | California Killifish | 11 | 2 | 13 | 0.06 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 1 | 12 | 13 | 0.06 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | 3 | 8 | 11 | 0.05 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 2 | 5 | 7 | 0.03 |
| <i>Myliobatis californica</i> | Bat Ray | 6 | 1 | 7 | 0.03 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | 6 | | 6 | 0.03 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 3 | 2 | 5 | 0.02 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | | 5 | 5 | 0.02 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 2 | 2 | 4 | 0.02 |
| <i>Albula gilberti</i> | Cortez Bonefish | 3 | | 3 | 0.01 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | 1 | 2 | 3 | 0.01 |
| <i>Xystreureys liolepis</i> | Fantail Sole | 1 | 2 | 3 | 0.01 |
| <i>Atractoscion nobilis</i> | White Seabass | 1 | 1 | 2 | 0.01 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | | 2 | 2 | 0.01 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | 2 | | 2 | 0.01 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | 1 | 1 | 2 | 0.01 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | 1 | 2 | 0.01 |
| <i>Strongylura exilis</i> | California Needlefish | 2 | | 2 | 0.01 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | 1 | 1 | < 0.01 |
| <i>Girella nigricans</i> | Opaleye | | 1 | 1 | < 0.01 |
| <i>Haemulon californiensis</i> | Salema | 1 | | 1 | < 0.01 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | | 1 | 1 | < 0.01 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | | 1 | 1 | < 0.01 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | | 1 | 1 | < 0.01 |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | 1 | | 1 | < 0.01 |
| <i>Scorpaena guttata</i> | California Scorpionfish | | 1 | 1 | < 0.01 |
| <i>Squatina californica</i> | Pacific Angel Shark | 1 | | 1 | < 0.01 |
| Total: | | 9,410 | 14,073 | 23,483 | |
| # of Species: | | 42 | 42 | | |

Table 9. Total biomass (g) of fish species taken in San Diego Bay by sampling period, 2015.

| Scientific Name | Common Name | 2015 | | Total | % |
|-------------------------------------|--------------------------|----------------|----------------|----------------|--------|
| | | April | July | | |
| <i>Urobatis halleri</i> | Round Stingray | 68,276 | 61,664 | 129,940 | 34.45 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 2,010 | 49,200 | 51,210 | 13.58 |
| <i>Engraulis mordax</i> | Northern Anchovy | 1,855 | 49,092 | 50,947 | 13.51 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 27,006 | 23,820 | 50,826 | 13.48 |
| <i>Myliobatis californica</i> | Bat Ray | 25,900 | 300 | 26,200 | 6.95 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 8,849 | 5,849 | 14,698 | 3.90 |
| <i>Squatina californica</i> | Pacific Angel Shark | 12,000 | | 12,000 | 3.18 |
| <i>Paralichthys californicus</i> | California Halibut | 2,605 | 4,842 | 7,447 | 1.97 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 1,352 | 3,949 | 5,301 | 1.41 |
| <i>Atherinops affinis</i> | Topsmelt | 1,631 | 2,888 | 4,519 | 1.20 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 2,630 | 773 | 3,403 | 0.90 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 1,254 | 1,200 | 2,454 | 0.65 |
| <i>Leuresthes tenuis</i> | California Grunion | 1,237 | 959 | 2,196 | 0.58 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | 2,100 | | 2,100 | 0.56 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 1,229 | 362 | 1,591 | 0.42 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 944 | 369 | 1,313 | 0.35 |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | 1,300 | | 1,300 | 0.34 |
| <i>Seriphus politus</i> | Queenfish | 1,177 | 22 | 1,199 | 0.32 |
| <i>Albula gilberti</i> | Cortez Bonefish | 1,090 | | 1,090 | 0.29 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | | 1,000 | 1,000 | 0.27 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 80 | 722 | 802 | 0.21 |
| <i>Xystreurus liolepis</i> | Fantail Sole | 250 | 500 | 750 | 0.20 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 357 | 290 | 647 | 0.17 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 145 | 439 | 584 | 0.15 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 42 | 461 | 503 | 0.13 |
| <i>Embiotoca jacksoni</i> | Black Perch | 331 | 169 | 500 | 0.13 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 292 | 182 | 474 | 0.13 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 90 | 309 | 399 | 0.11 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | | 374 | 374 | 0.10 |
| <i>Girella nigricans</i> | Opaleye | | 250 | 250 | 0.07 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | 10 | 240 | 250 | 0.07 |
| <i>Sardinops sagax</i> | Pacific Sardine | 35 | 117 | 152 | 0.04 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 137 | | 137 | 0.04 |
| <i>Scorpaena guttata</i> | California Scorpionfish | | 95 | 95 | 0.03 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 5 | 83 | 88 | 0.02 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | 41 | 42 | 83 | 0.02 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 17 | 64 | 81 | 0.02 |
| <i>Clevelandia ios</i> | Arrow Goby | 59 | 15 | 74 | 0.02 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | | 45 | 45 | 0.01 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | 23 | 15 | 38 | 0.01 |
| <i>Fundulus parvipinnis</i> | California Killifish | 35 | < 1 | 35 | 0.01 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | | 34 | 34 | 0.01 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | | 18 | 18 | < 0.01 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | 15 | 15 | < 0.01 |
| <i>Haemulon californiensis</i> | Salema | 12 | | 12 | < 0.01 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 4 | 1 | 5 | < 0.01 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | 2 | | 2 | < 0.01 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | 1 | 2 | < 0.01 |
| <i>Atractoscion nobilis</i> | White Seabass | 1 | 1 | 2 | < 0.01 |
| <i>Strongylura exilis</i> | California Needlefish | 1 | | 1 | < 0.01 |
| Total: | | 166,415 | 210,770 | 377,186 | |
| # of Species: | | 42 | 42 | | |

Catch in Bay Depth Strata and Subhabitats

Of the three bay depth strata (intertidal, nearshore and channel) the greatest catch of fishes was in the nearshore strata (16,396 individuals from 39 species; Table 10). 4,427 fishes from 22 species were captured in the intertidal, and 2,660 fishes from 24 species were captured in the channel. A total of 11,621 fishes were taken in non-vegetated areas of the nearshore and intertidal (Table 11) comprised of 37 of the 50 species captured during the 2015 surveys. 9,202 fishes, also from 37 species, were caught in the nearshore and intertidal vegetated areas.



Purse seine being retrieved from the nearshore in the North Ecoregion. (photo: RA)

Table 10. Total abundance of fish species taken from San Diego Bay by depth strata, 2015.

| Scientific Name | Common Name | Depth Strata | | | Total | % |
|-------------------------------------|--------------------------|--------------|--------------|---------------|---------------|--------|
| | | Channel | Intertidal | Nearshore | | |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 2,040 | 20 | 5,896 | 7,956 | 33.88 |
| <i>Engraulis mordax</i> | Northern Anchovy | | | 6,666 | 6,666 | 28.39 |
| <i>Atherinops affinis</i> | Topsmelt | 2 | 1,654 | 335 | 1,991 | 8.48 |
| <i>Leuresthes tenuis</i> | California Grunion | | 1,539 | 69 | 1,608 | 6.85 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 2 | 255 | 806 | 1,063 | 4.53 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 4 | 278 | 631 | 913 | 3.89 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 1 | 90 | 810 | 901 | 3.84 |
| <i>Urobatis halleri</i> | Round Stingray | 340 | 35 | 310 | 685 | 2.92 |
| <i>Clevelandia ios</i> | Arrow Goby | | 280 | 73 | 353 | 1.50 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 32 | 116 | 198 | 346 | 1.47 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 32 | 36 | 156 | 224 | 0.95 |
| <i>Micrometrus minimus</i> | Dwarf Perch | | | 221 | 221 | 0.94 |
| <i>Paralichthys californicus</i> | California Halibut | 72 | 9 | 13 | 94 | 0.40 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 46 | 2 | 32 | 80 | 0.34 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | | 72 | 1 | 73 | 0.31 |
| <i>Seriphus politus</i> | Queenfish | 3 | | 42 | 45 | 0.19 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 4 | | 30 | 34 | 0.14 |
| <i>Embiotoca jacksoni</i> | Black Perch | | | 27 | 27 | 0.11 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 26 | | 1 | 27 | 0.11 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | | 5 | 20 | 25 | 0.11 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 20 | | | 20 | 0.09 |
| <i>Sardinops sagax</i> | Pacific Sardine | | | 16 | 16 | 0.07 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 9 | | 5 | 14 | 0.06 |
| <i>Fundulus parvipinnis</i> | California Killifish | | 13 | | 13 | 0.06 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 11 | | 2 | 13 | 0.06 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | | 11 | | 11 | 0.05 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | | 2 | 5 | 7 | 0.03 |
| <i>Myliobatis californica</i> | Bat Ray | 1 | | 6 | 7 | 0.03 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | | | 6 | 6 | 0.03 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | | 3 | 2 | 5 | 0.02 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 4 | | 1 | 5 | 0.02 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 3 | | 1 | 4 | 0.02 |
| <i>Albula gilberti</i> | Cortez Bonefish | | | 3 | 3 | 0.01 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | | | 3 | 3 | 0.01 |
| <i>Xystreurys liolepis</i> | Fantail Sole | 3 | | | 3 | 0.01 |
| <i>Atractoscion nobilis</i> | White Seabass | | 2 | | 2 | 0.01 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 2 | | | 2 | 0.01 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | | 1 | 1 | 2 | 0.01 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | | | 2 | 2 | 0.01 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | | 2 | | 2 | 0.01 |
| <i>Strongylura exilis</i> | California Needlefish | | 2 | | 2 | 0.01 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | | 1 | 1 | < 0.01 |
| <i>Girella nigricans</i> | Opaleye | | | 1 | 1 | < 0.01 |
| <i>Haemulon californiensis</i> | Salema | | | 1 | 1 | < 0.01 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | 1 | | | 1 | < 0.01 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | 1 | | | 1 | < 0.01 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | | | 1 | 1 | < 0.01 |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | | | 1 | 1 | < 0.01 |
| <i>Scorpaena guttata</i> | California Scorpionfish | | | 1 | 1 | < 0.01 |
| <i>Squatina californica</i> | Pacific Angel Shark | 1 | | | 1 | < 0.01 |
| Total: | | 2,660 | 4,427 | 16,396 | 23,483 | |
| # of Species: | | 24 | 22 | 39 | | |

Table 11. Total catch of fish species taken from San Diego Bay by subhabitat, 2015.

| Scientific Name | Common Name | Subhabitat | | | Total | % |
|-------------------------------------|--------------------------|------------|---------------|-----------|--------|--------|
| | | Channel | Non-Vegetated | Vegetated | | |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 2,040 | 3,158 | 2,758 | 7,956 | 33.88 |
| <i>Engraulis mordax</i> | Northern Anchovy | | 5,151 | 1,515 | 6,666 | 28.39 |
| <i>Atherinops affinis</i> | Topsmelt | 2 | 643 | 1,346 | 1,991 | 8.48 |
| <i>Leuresthes tenuis</i> | California Grunion | | 625 | 983 | 1,608 | 6.85 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 2 | 544 | 517 | 1,063 | 4.53 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 4 | 335 | 574 | 913 | 3.89 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 1 | 598 | 302 | 901 | 3.84 |
| <i>Urobatis halleri</i> | Round Stingray | 340 | 121 | 224 | 685 | 2.92 |
| <i>Clevelandia ios</i> | Arrow Goby | | 25 | 328 | 353 | 1.50 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 32 | 93 | 221 | 346 | 1.47 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 32 | 106 | 86 | 224 | 0.95 |
| <i>Micrometrus minimus</i> | Dwarf Perch | | 51 | 170 | 221 | 0.94 |
| <i>Paralichthys californicus</i> | California Halibut | 72 | 9 | 13 | 94 | 0.40 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 46 | 31 | 3 | 80 | 0.34 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | | 72 | 1 | 73 | 0.31 |
| <i>Seriphus politus</i> | Queenfish | 3 | | 42 | 45 | 0.19 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 4 | 4 | 26 | 34 | 0.14 |
| <i>Embiotoca jacksoni</i> | Black Perch | | 7 | 20 | 27 | 0.11 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 26 | 1 | | 27 | 0.11 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | | 16 | 9 | 25 | 0.11 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 20 | | | 20 | 0.09 |
| <i>Sardinops sagax</i> | Pacific Sardine | | 9 | 7 | 16 | 0.07 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 9 | 1 | 4 | 14 | 0.06 |
| <i>Fundulus parvipinnis</i> | California Killifish | | | 13 | 13 | 0.06 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 11 | 1 | 1 | 13 | 0.06 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | | 1 | 10 | 11 | 0.05 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | | 3 | 4 | 7 | 0.03 |
| <i>Myliobatis californica</i> | Bat Ray | 1 | 2 | 4 | 7 | 0.03 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | | 1 | 5 | 6 | 0.03 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | | 2 | 3 | 5 | 0.02 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 4 | 1 | | 5 | 0.02 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 3 | 1 | | 4 | 0.02 |
| <i>Albula gilberti</i> | Cortez Bonefish | | | 3 | 3 | 0.01 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | | 1 | 2 | 3 | 0.01 |
| <i>Xystreurus liolepis</i> | Fantail Sole | 3 | | | 3 | 0.01 |
| <i>Atractoscion nobilis</i> | White Seabass | | 1 | 1 | 2 | 0.01 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 2 | | | 2 | 0.01 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | | 2 | | 2 | 0.01 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | | 1 | 1 | 2 | 0.01 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | | 1 | 1 | 2 | 0.01 |
| <i>Strongylura exilis</i> | California Needlefish | | | 2 | 2 | 0.01 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | | 1 | 1 | < 0.01 |
| <i>Girella nigricans</i> | Opaleye | | 1 | | 1 | < 0.01 |
| <i>Haemulon californiensis</i> | Salema | | | 1 | 1 | < 0.01 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | 1 | | | 1 | < 0.01 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | 1 | | | 1 | < 0.01 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | | 1 | | 1 | < 0.01 |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | | | 1 | 1 | < 0.01 |
| <i>Scorpaena guttata</i> | California Scorpionfish | | 1 | | 1 | < 0.01 |
| <i>Squatina californica</i> | Pacific Angel Shark | 1 | | | 1 | < 0.01 |
| Total: | | 2,660 | 11,621 | 9,202 | 23,483 | |
| # of Species: | | 24 | 37 | 37 | | |

Nursery Area Function

San Diego Bay continues to be a nursery area for a majority of the fishes found there. Approximately 56% of all fishes sampled in San Diego Bay were juveniles (Table 12). In terms of percent juveniles captured, four of the top five species (Jacksmelt, Northern Anchovy, Topsmelt and California Grunion) are all critical commercial and/or forage fish species. The high catch of juvenile fishes in the bay highlights the continued importance of San Diego Bay as a nursery area for bay, estuarine, and nearshore species.

Table 12. Percent of juveniles taken of the top 20 species of fish from San Diego Bay, 2015.

| Scientific Name | Common Name | Total Abundance | Juveniles | % Juvenile |
|-------------------------------------|-----------------------|-----------------|---------------|--------------|
| <i>Atherinopsis californiensis</i> | Jacksmelt | 212 | 211 | 99.53 |
| <i>Clevelandia ios</i> | Arrow Goby | 629 | 625 | 99.36 |
| <i>Engraulis mordax</i> | Northern Anchovy | 6,666 | 6,479 | 97.19 |
| <i>Atherinops affinis</i> | Topsmelt | 2,017 | 1,896 | 94.00 |
| <i>Leuresthes tenuis</i> | California Grunion | 1,608 | 1,509 | 93.84 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 901 | 806 | 89.46 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 27 | 22 | 81.48 |
| <i>Embiotoca jacksoni</i> | Black Perch | 27 | 21 | 77.78 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 913 | 704 | 77.11 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 25 | 19 | 76.00 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 34 | 22 | 64.71 |
| <i>Seriphus politus</i> | Queenfish | 45 | 28 | 62.22 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 221 | 132 | 59.73 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 226 | 129 | 57.08 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 1,065 | 598 | 56.15 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 346 | 123 | 35.55 |
| <i>Paralichthys californicus</i> | California Halibut | 94 | 33 | 35.11 |
| <i>Urobatis halleri</i> | Round Stingray | 685 | 49 | 7.15 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 7,957 | 9 | 0.11 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 80 | 0 | 0.00 |
| | | 23,778 | 13,415 | 56.42 |

Ecological Importance of Species

An index of ecological importance was also calculated to estimate the relative importance of each species within the bay assemblage. An Ecological Index (E.I.) was determined using the total catch for each species during this study and incorporated three significant ecological variables: % Number, % Weight, and % Frequency of Occurrence, by Ecoregion and month ($E.I. = (\%N + \%Wt) * \%F.O$; Table 13; Figure 13). This index is indicative of the importance of each species to the energy flow within the San Diego Bay ecosystem. Slough Anchovy ranked first with an E.I. of 3,778, Round Stingray ranked a very close second (E.I. 3,737), and Spotted Sand Bass ranked third (E.I. 1,495). All three species were found ubiquitously throughout the bay during both sampling periods; Round Stingray was dominant in terms of biomass and Slough Anchovy was dominant in terms of numerical abundance. These species were followed by Northern Anchovy (E.I. 1,047), which was only found in the North Ecoregion in July and North-Central Ecoregion in April, but in very high abundance, and Topsmelt (E.I. 968), which were also ubiquitous throughout the bay as mostly juveniles during both sampling periods.

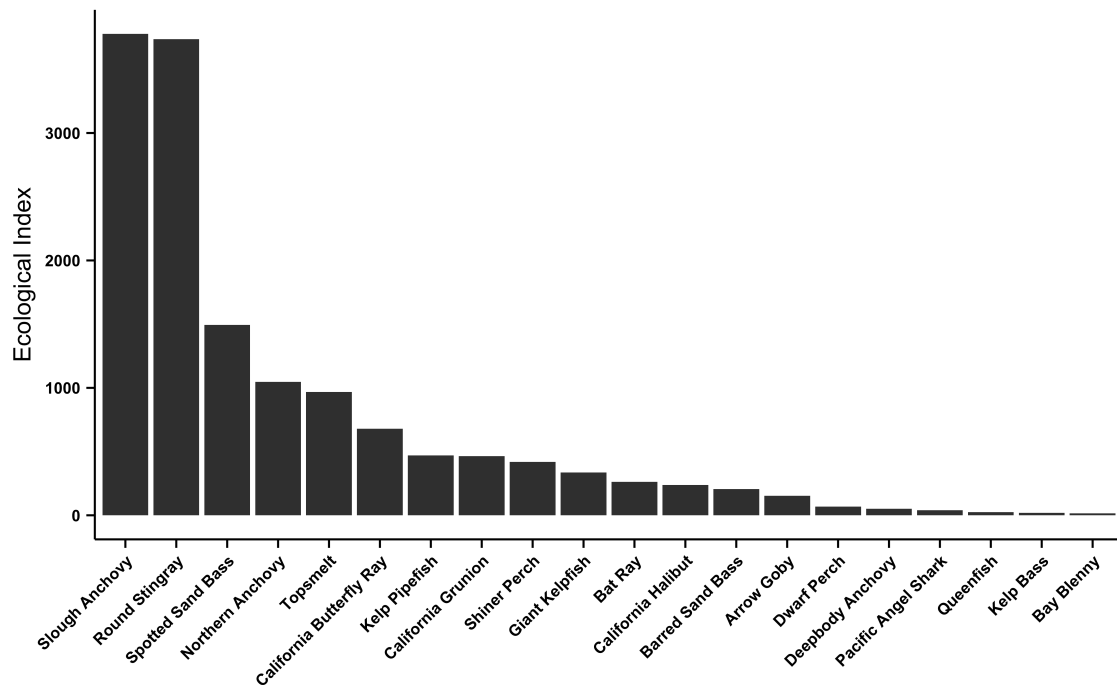


Figure 13. Top 20 species of San Diego Bay fishes ranked by Ecological Index, 2015.

Table 13. Relative abundance, relative biomass, frequency of occurrence, and Ecological Index (E.I.) of San Diego Bay fishes, 2015.

| Scientific Name | Common Name | Abundance % | Biomass % | Frequency of Occurrence | Ecological Index |
|-------------------------------------|--------------------------|----------------|--------------|-------------------------------|---------------------|
| <i>Anchoa delicatissima</i> | Slough Anchovy | 33.88 | 3.90 | 100.0 | 3777.65 |
| <i>Urobatis halleri</i> | Round Stingray | 2.92 | 34.45 | 100.0 | 3736.70 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 1.47 | 13.48 | 100.0 | 1494.85 |
| <i>Engraulis mordax</i> | Northern Anchovy | 28.39 | 13.51 | 25.0 | 1047.34 |
| <i>Atherinops affinis</i> | Topsmelt | 8.48 | 1.20 | 100.0 | 967.65 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 0.02 | 13.58 | 50.0 | 679.69 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 4.53 | 0.17 | 100.0 | 469.81 |
| <i>Leuresthes tenuis</i> | California Grunion | 6.85 | 0.58 | 62.5 | 464.36 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 3.89 | 0.90 | 87.5 | 419.13 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 3.84 | 0.65 | 75.0 | 336.55 |
| <i>Myliobatis californica</i> | Bat Ray | 0.03 | 6.95 | 37.5 | 261.60 |
| <i>Paralichthys californicus</i> | California Halibut | 0.40 | 1.97 | 100.0 | 237.48 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 0.95 | 1.41 | 87.5 | 206.44 |
| <i>Clevelandia ios</i> | Arrow Goby | 1.50 | 0.02 | 100.0 | 152.29 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 0.94 | 0.42 | 50.0 | 68.15 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 0.34 | 0.35 | 75.0 | 51.66 |
| <i>Squatina californica</i> | Pacific Angel Shark | 0.00 | 3.18 | 12.5 | 39.82 |
| <i>Seriphus politus</i> | Queenfish | 0.19 | 0.32 | 50.0 | 25.48 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 0.14 | 0.15 | 62.5 | 18.73 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 0.11 | 0.11 | 75.0 | 15.92 |
| <i>Umbrina roncadior</i> | Yellowfin Croaker | 0.03 | 0.56 | 25.0 | 14.56 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 0.31 | 0.04 | 37.5 | 13.02 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 0.11 | 0.13 | 50.0 | 12.42 |
| <i>Albula gilberti</i> | Cortez Bonefish | 0.01 | 0.29 | 25.0 | 7.54 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 0.09 | 0.21 | 25.0 | 7.44 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 0.06 | 0.13 | 37.5 | 6.94 |
| <i>Embiotoca jacksoni</i> | Black Perch | 0.11 | 0.13 | 25.0 | 6.19 |
| <i>Xystreurus liolepis</i> | Fantail Sole | 0.01 | 0.20 | 25.0 | 5.29 |
| <i>Pleuronichthys gutturalis</i> | Diamond Turbot | 0.02 | 0.10 | 37.5 | 4.52 |
| <i>Roncadior stearnsii</i> | Spotfin Croaker | 0.00 | 0.34 | 12.5 | 4.36 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | 0.00 | 0.27 | 12.5 | 3.37 |
| <i>Sardinops sagax</i> | Pacific Sardine | 0.07 | 0.04 | 25.0 | 2.71 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 0.03 | 0.02 | 50.0 | 2.56 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | 0.05 | 0.01 | 37.5 | 2.13 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | 0.01 | 0.07 | 25.0 | 1.98 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 0.06 | 0.02 | 25.0 | 1.97 |
| <i>Fundulus parvipinnis</i> | California Killifish | 0.06 | 0.01 | 25.0 | 1.62 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 0.02 | 0.00 | 50.0 | 1.13 |
| <i>Girella nigricans</i> | Opaleye | 0.00 | 0.07 | 12.5 | 0.88 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | 0.01 | 0.02 | 25.0 | 0.76 |
| <i>Scorpaena guttata</i> | California Scorpionfish | 0.00 | 0.03 | 12.5 | 0.37 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 0.01 | 0.00 | 25.0 | 0.23 |
| <i>Atractoscion nobilis</i> | White Seabass | 0.01 | 0.00 | 25.0 | 0.22 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | 0.00 | 0.01 | 12.5 | 0.20 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 0.01 | 0.00 | 12.5 | 0.17 |
| <i>Pleuronichthys ritleri</i> | Spotted Turbot | 0.00 | 0.01 | 12.5 | 0.17 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | 0.01 | 0.00 | 12.5 | 0.11 |
| <i>Strongylura exilis</i> | California Needlefish | 0.01 | 0.00 | 12.5 | 0.11 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | 0.00 | 0.00 | 12.5 | 0.10 |
| <i>Haemulon californiensis</i> | Salema | 0.00 | 0.00 | 12.5 | 0.09 |

Principle species

Slough Anchovy (*Anchoa delicatissima*)

Slough Anchovy was ranked as the most ecologically important in San Diego Bay. This species was ubiquitous throughout the bay during these surveys, and were



found in all sampling periods, ecoregions, depth strata and subhabitats. Despite only having the sixth highest biomass of all fishes captured in 2015, they accounted for 33.9% of the total abundance captured during the surveys. Nearly every individual captured was considered to be an adult, with very few qualifying as juveniles (Figure 14). The bay is a well known nursery area for this critical species and there are no doubt a significant number of juveniles of this species utilizing the bay, however juvenile Slough Anchovy are exceptionally narrow species that are unlikely to be captured through most sampling methods employed.

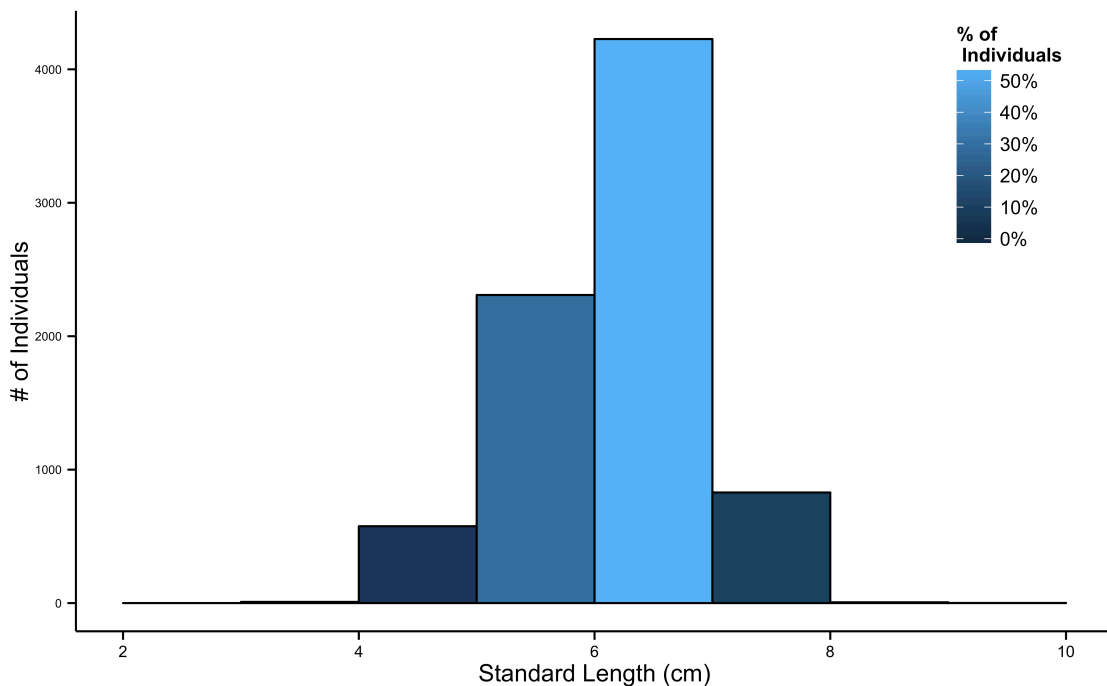


Figure 14. Total number of Slough Anchovy individuals by standard length (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

Round Stingray (*Urobatis halleri*)

The second highest ranked species in terms of ecological importance in 2015 was the Round Stingray. Like the Slough Anchovy, this species was ubiquitous throughout the bay during these surveys, and were found in all sampling periods, ecoregions, depth strata and subhabitats. While only consisting of 2.9% of the total individuals captured in the 2015 surveys, those individuals accounted for 34.5% of the biomass. The sizes of captured Round Stingrays were widely stratified and representative of its entire size range (Figure 15). Round Stingrays were caught primarily in the channel and nearshore depth strata, with just a few individuals captured in the intertidal. While they were observed in all four ecoregions, the highest catches were in the North-Central and South-Central Ecoregions.

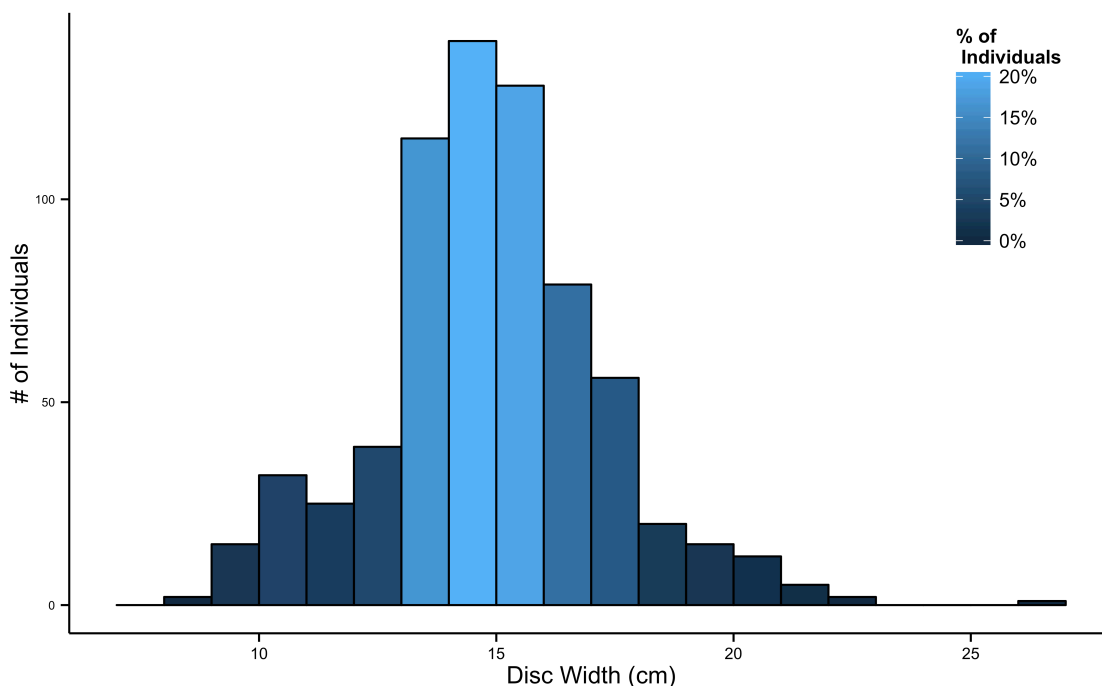


Figure 15. Total number of Round Stingray individuals by disc width (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

Spotted Sand Bass (*Paralabrax maculatofasciatus*)



Spotted sand bass are the ubiquitous mesocarnivore in San Diego Bay. In 2015, they ranked third in Ecological Index – a product of having the fourth highest biomass despite only having the tenth highest numerical abundance. Like the Slough Anchovy and Round Stingray that rank higher,

this species was ubiquitous throughout the bay during these surveys, and were found in all sampling periods, ecoregions, depth strata and subhabitats. This important recreational fish species primarily utilizes bays and estuaries along the Southern California coastline. There was a bimodal distribution in size classes of spotted sand bass (Figure 16) indicating the presence of both juveniles and adults of this fast-growing species.

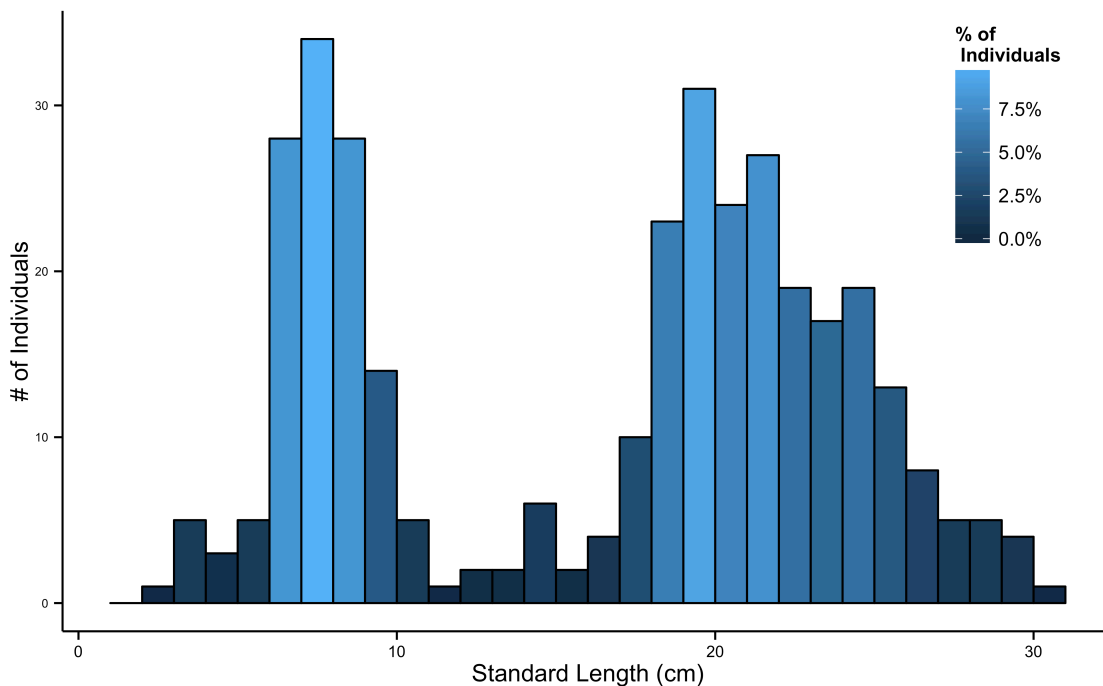


Figure 16. Total number of Spotted Sand Bass individuals by standard length (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

Northern Anchovy (*Engraulis mordax*)

Northern Anchovy ranked fourth in Ecological Index. They were only found in the North Ecoregion in July and North-Central Ecoregion in April, and only in the



vegetated and non-vegetated nearshore subhabitats, but ranked second highest in overall abundance (28.4%) and third highest in biomass (13.5%). In those areas and times large schools of primarily juveniles were captured by purse seine (Figure 17). Although adult Northern Anchovy typically live outside of bays and harbors, young-of-the-year utilize the calm, warm water and vegetation in the bay for shelter.

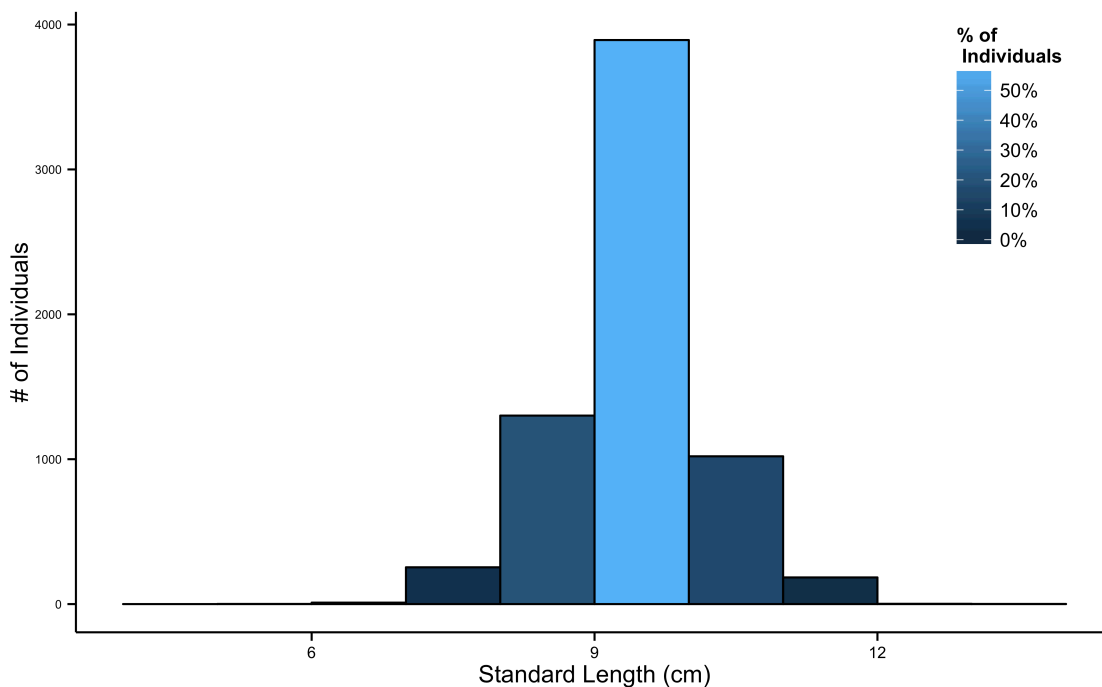


Figure 17. Total number of Northern Anchovy individuals by standard length (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

Topsmelt (*Atherinops affinis*)

As with the top three species as ranked by the Ecological Index were found during both sampling periods and at all ecoregions, depth



strata and subhabitats, though very few (2) were found in the channel subhabitat. These mostly juvenile fish were more than twice as abundant in the vegetated (1,346) versus non-vegetated (643) subhabitats. They were the third most abundant fish in the survey comprising 8.5% of the catch, but due to their small size only 1.2% of the biomass. There is a slight bimodal distribution to their size frequency (Figure 18) indicating that while the vast majority of individuals were young-of-the-year fishes, some adults were present in the bay at the time of sampling.

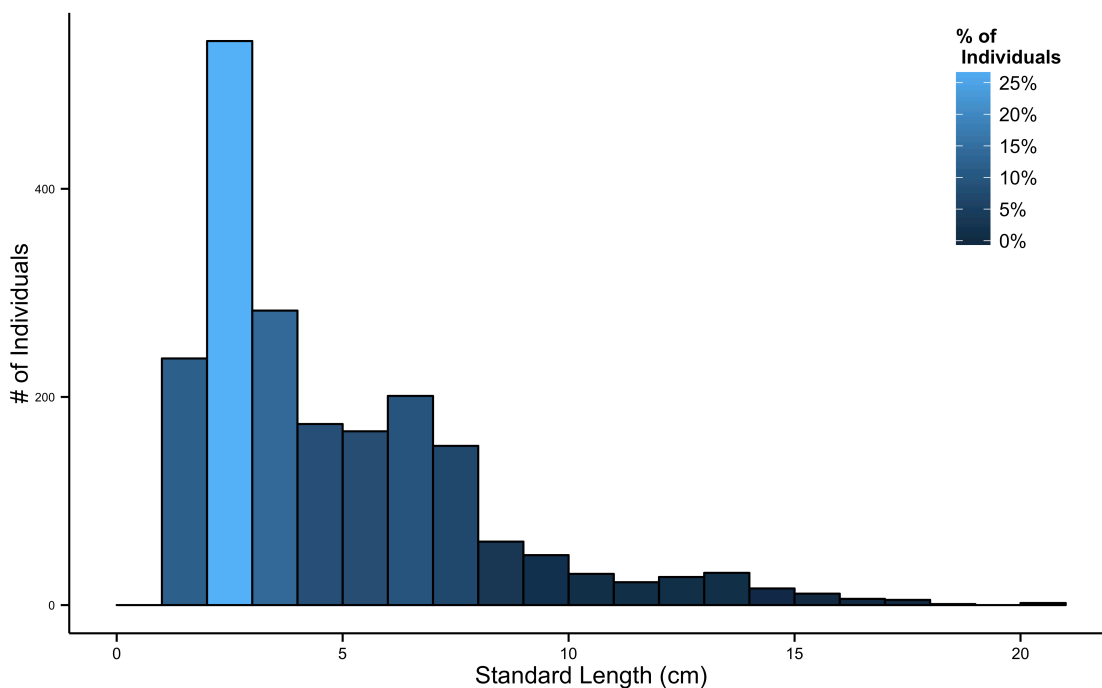


Figure 18. Total number of Topsmelt individuals by standard length (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

California Butterfly Ray (*Gymnura marmorata*)

Only four individual California Butterfly Ray individuals were caught in 2015 – one each survey period in both the South-Central and South Ecoregions – comprising just 0.02% of the total catch, however this species ranked sixth in Ecological Index as a result of one of those individuals being a 1.57 m wide, 44.5 kg adult (Figure 19). While that individual certainly skews the results of the ecological importance metric, it is likely that there are a significant number of individuals utilizing the large, flat, shallow, muddy substrate and elevated temperatures in the southern half of the bay.

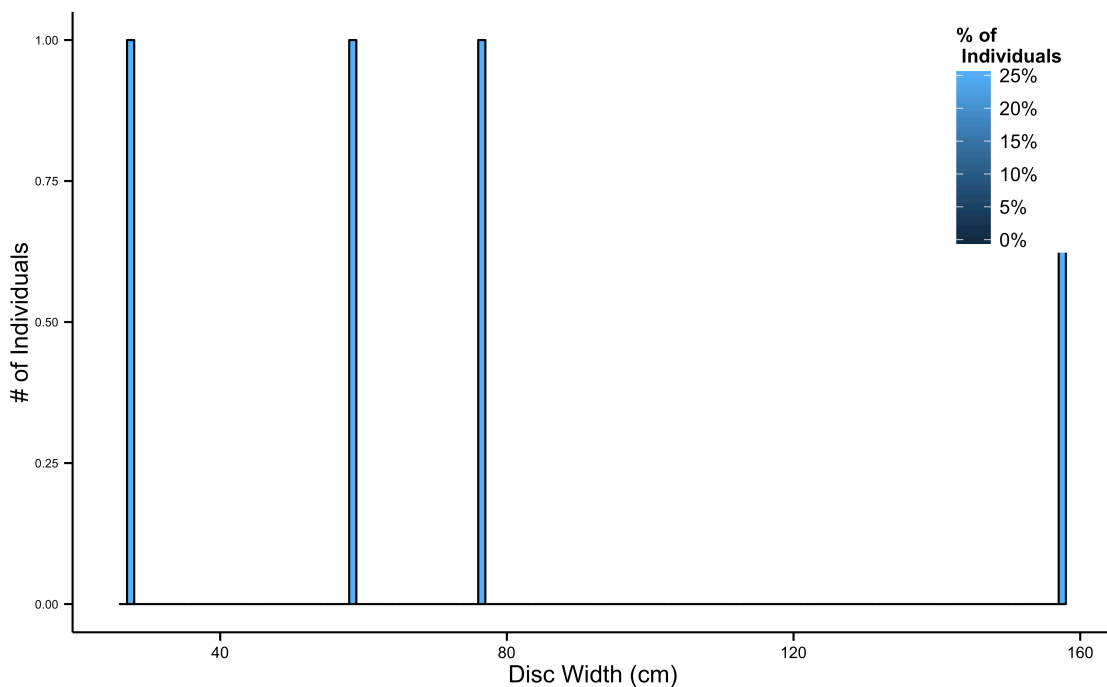
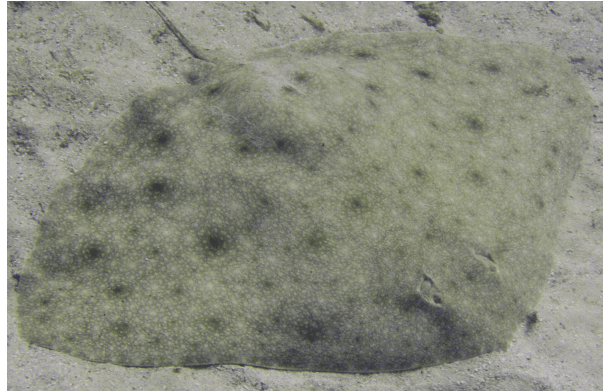


Figure 19. Total number of California Butterfly Ray individuals by disc width (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

Kelp Pipefish (*Syngnathus californiensis*)

Though these long, narrow fishes only account for 0.2% of the biomass captured in 2015, Kelp Pipefish ranked seventh in Ecological Index by



accounting for 4.5% of the total abundance and being caught in the all ecoregions during both survey periods. They were caught in all depth strata and habitats, though like Topsmelt, only two were captured in the channel subhabitat. Nearly three quarters of the individuals were captured in the nearshore subhabitat showing no apparent preference for vegetated versus non-vegetated habitat, but increasing in abundance from north to south. A uniform size distribution belies the fact that more than half (56%) of the individuals captured are juveniles (Figure 20) but supports the idea that this species grows quickly and may reproduce year-round.

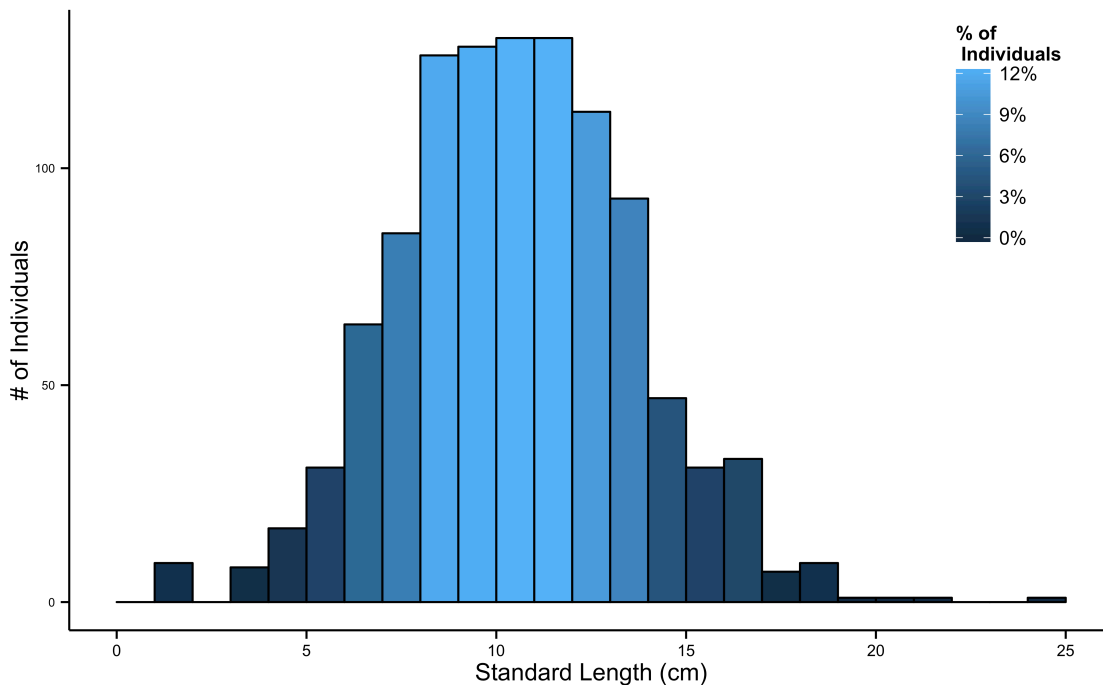


Figure 20. Total number of Kelp Pipefish individuals by standard length (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

California Grunion (*Leuresthes tenuis*)

This species was ranked eighth in terms of Ecological Index, because it was the fourth highest catch (6.9%) during the 2015 surveys. This species has been observed in San Diego Bay in past surveys, but only in small numbers since 1998. This resurgence is consistent with surveys in other bays and harbors in the Southern California Bight over the last two years (VRG, unpublished data). They were present mostly in the intertidal in the North Ecoregion in July, but were also present in small numbers during April and in the North-Central Ecoregion. Though a small number of



California Grunion adults were captured during the surveys, nearly all of them were between 2-5 cm SL (Figure 21) suggesting that either these young-of-the-year drifted into the areas of the bay closest to open ocean after hatching at coastal beaches or the beaches in the North Ecoregion are begin utilized as spawning grounds for this unique species.

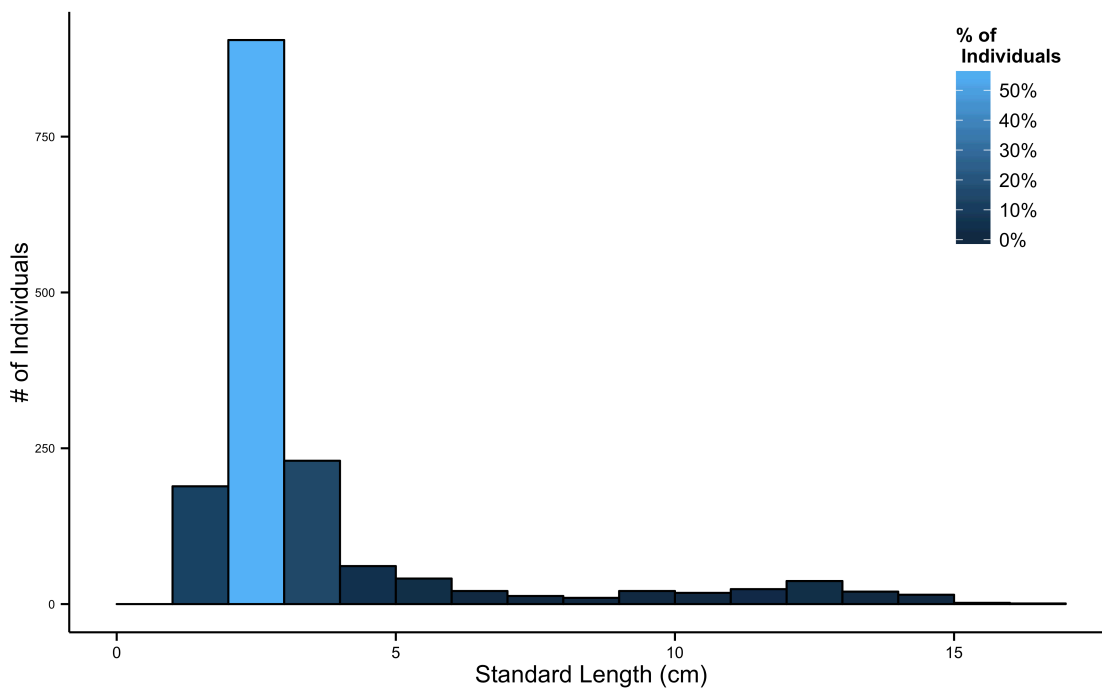


Figure 21. Total number of California Grunion individuals by standard length (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

Shiner Perch (*Cymatogaster aggregata*)



Shiner Perch ranked ninth in ecological index largely as a result of being the sixth most abundant species captured (3.9%). Adult shiner perch, which live offshore, are known to utilize the bay for reproduction. Thus the bimodal distribution (Figure 22) and

large amount of young-of-the-year captured in April is an indication of this life history pattern. A few larger individuals were present, but the bulk of the stock was young fishes that were typically associated with eelgrass beds in the North, North-Central, and South-Central Ecoregions, representing a slight northward shift from 2012 (Williams and Pondella 2012).

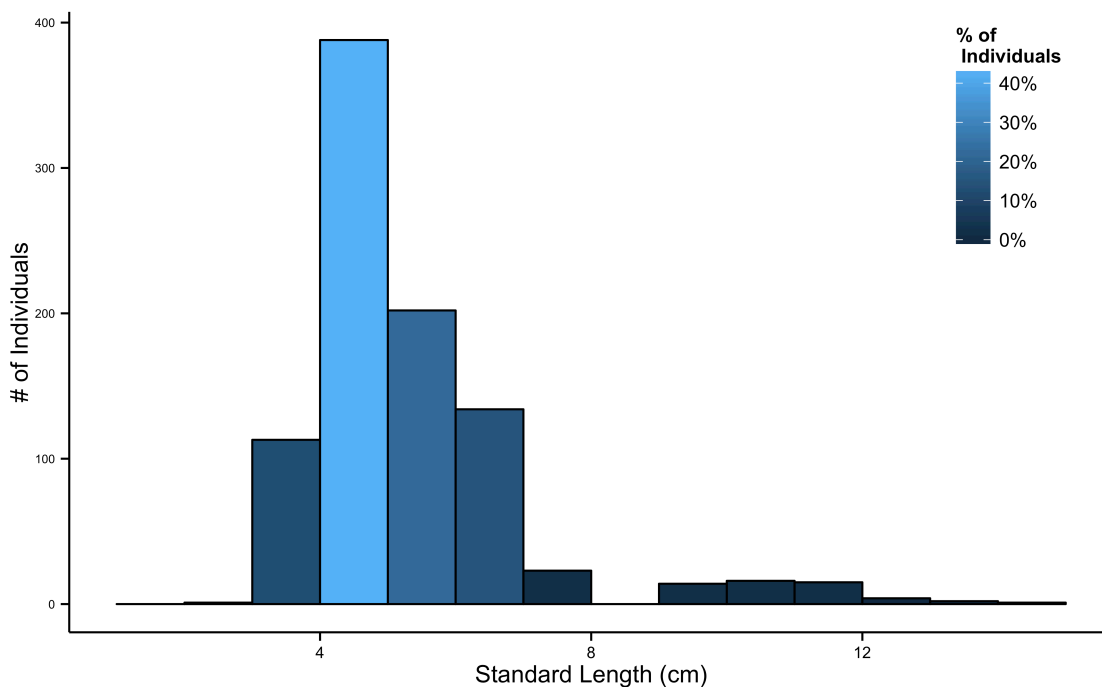


Figure 22. Total number of Shiner Perch individuals by standard length (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

Giant Kelpfish (*Heterostichus rostratus*)

Giant Kelpfish ranked tenth in the Ecological Index and were present during each sampling period and in all ecoregions



except for the South Ecoregion. They were found in both vegetated and non-vegetated habitats in the nearshore and intertidal depth strata (a single individual was also caught in the channel subhabitat), however, nine times the number of individuals were taken in the nearshore strata (810) than the intertidal (90). 89.5% of the Giant Kelpfish captured were juveniles, and all individuals were less than 20 cm SL. The generally bimodal distribution of size classes (Figure 23) indicates that there are likely only two to three age classes present during this sampling period.

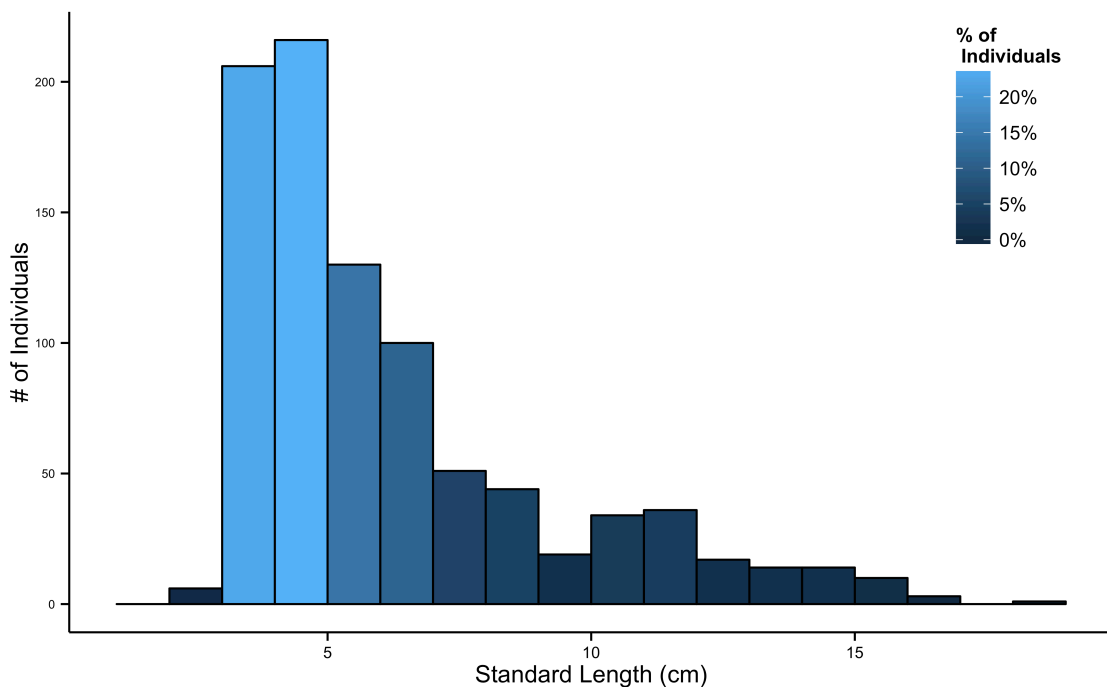


Figure 23. Total number of Giant Kelpfish individuals by standard length (cm) from San Diego Bay, 2015. Bar color indicates relative percentage of individuals at each size class.

Catch by Sampling Method

The greatest number of species were collected in the purse seines (32 species), followed by beam trawl (24), large seine and otter trawl (21 each), small seine (17) and square enclosure (3) (Tables 14 and 15). The purse seine captured the greatest number of fish, catching a total of 14,854, a number greatly influenced by large schools of anchovies. There were moderate catches in the beam trawl (2,554), small seine (2,439), large seine (1,981), and otter trawl (1,648). Catches in the square enclosure were negligible (7; Table 14). The greatest amount of biomass was also captured in the purse seine (234.4 kg), with high biomass also captured in the otter trawl (91.7 kg) and beam trawl (35.8 kg). The large seine (13.8 kg) and small seine (1.3 kg) captured lower amounts of biomass, and the square enclosure captured less than 1 g of fishes (Table 15).

The purse seine was most effective sampling the schooling fishes (Slough Anchovy, Northern Anchovy). The beam trawl was most effective for catching benthic nearshore and eelgrass fishes (Kelp Pipefish, Giant Kelpfish, Shiner Perch, Dwarf Perch). The square enclosure was largely ineffective in 2015. The large and small beach seines were particularly effective at catching juvenile Topsmelt and California Grunion. The top species caught in the otter trawls was Round Stingray. The highest density of fishes was captured in the small seine (0.820 individuals/m²) followed by the purse seine (0.697 individuals/m²; Table 16). The purse seines and beam trawls produced the highest biomass values (11.00 g/m² and 2.57 g/m², respectively). The square enclosures captured the smallest amount of biomass (0.01 g/m²).



Ben Grime throwing the grappling hook to retrieve the purse end of the purse seine. (photo: RA)

Table 14. Total catch (# of individuals) of fish species taken in San Diego Bay in 2015 by sampling method.

| PURSE SEINE | | | | BEAM TRAWL | | | |
|-------------------------------------|--------------------------|--------|-------|-------------------------------------|-------------------------|-------|-------|
| Scientific Name | Common Name | # | % | Scientific Name | Common Name | # | % |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 6,782 | 45.66 | <i>Syngnathus californiensis</i> | Kelp Pipefish | 790 | 30.93 |
| <i>Engraulis mordax</i> | Northern Anchovy | 6,666 | 44.88 | <i>Heterostichus rostratus</i> | Giant Kelpfish | 789 | 30.89 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 342 | 2.30 | <i>Cymatogaster aggregata</i> | Shiner Perch | 292 | 11.43 |
| <i>Atherinops affinis</i> | Topsmelt | 292 | 1.97 | <i>Micrometrus minimus</i> | Dwarf Perch | 168 | 6.58 |
| <i>Urobatis halleri</i> | Round Stingray | 195 | 1.31 | <i>Urobatis halleri</i> | Round Stingray | 132 | 5.17 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 171 | 1.15 | <i>Paralabrax nebulifer</i> | Barred Sand Bass | 119 | 4.66 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 78 | 0.53 | <i>Clevelandia ios</i> | Arrow Goby | 73 | 2.86 |
| <i>Leuresthes tenuis</i> | California Grunion | 69 | 0.46 | <i>Anchoa delicatissima</i> | Slough Anchovy | 44 | 1.72 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 53 | 0.36 | <i>Atherinops affinis</i> | Topsmelt | 44 | 1.72 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 39 | 0.26 | <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 32 | 1.25 |
| <i>Seriphus politus</i> | Queenfish | 39 | 0.26 | <i>Paralabrax clathratus</i> | Kelp Bass | 20 | 0.78 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 22 | 0.15 | <i>Hypsoblennius gentilis</i> | Bay Blenny | 18 | 0.70 |
| <i>Embiotoca jacksoni</i> | Black Perch | 17 | 0.11 | <i>Embiotoca jacksoni</i> | Black Perch | 10 | 0.39 |
| <i>Sardinops sagax</i> | Pacific Sardine | 16 | 0.11 | <i>Cheilotrema saturnum</i> | Black Croaker | 4 | 0.16 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 16 | 0.11 | <i>Gibbonsia elegans</i> | Spotted Kelpfish | 4 | 0.16 |
| <i>Paralichthys californicus</i> | California Halibut | 15 | 0.10 | <i>Seriphus politus</i> | Queenfish | 4 | 0.16 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 10 | 0.07 | <i>Hippocampus ingens</i> | Pacific Seahorse | 2 | 0.08 |
| <i>Myliobatis californica</i> | Bat Ray | 7 | 0.05 | <i>Ilypnus gilberti</i> | Cheekspot Goby | 2 | 0.08 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | 6 | 0.04 | <i>Paralichthys californicus</i> | California Halibut | 2 | 0.08 |
| <i>Albula gilberti</i> | Cortez Bonefish | 3 | 0.02 | <i>Cosmocampus arctus</i> | Snubnose Pipefish | 1 | 0.04 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 2 | 0.01 | <i>Halichoeres semicinctus</i> | Rock Wrasse | 1 | 0.04 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | 2 | 0.01 | <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 1 | 0.04 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 2 | 0.01 | <i>Porichthys myriaster</i> | Specklefin Midshipman | 1 | 0.04 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 2 | 0.01 | <i>Scorpaena guttata</i> | California Scorpionfish | 1 | 0.04 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 1 | 0.01 | # of Species: 24 | | 2,554 | |
| <i>Cheilotrema saturnum</i> | Black Croaker | 1 | 0.01 | | | | |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | 1 | 0.01 | | | | |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 1 | 0.01 | | | | |
| <i>Girella nigricans</i> | Opaleye | 1 | 0.01 | | | | |
| <i>Haemulon californiensis</i> | Salema | 1 | 0.01 | | | | |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | 1 | 0.01 | | | | |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | 1 | 0.01 | | | | |
| # of Species: 32 | | 14,854 | | | | | |

Table 14 (continued).

| LARGE SEINE | | | |
|-------------------------------------|--------------------------|-------|-------|
| Scientific Name | Common Name | # | % |
| <i>Atherinops affinis</i> | Topsmelt | 837 | 42.25 |
| <i>Leuresthes tenuis</i> | California Grunion | 452 | 22.82 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 236 | 11.91 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 90 | 4.54 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 72 | 3.63 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 63 | 3.18 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 60 | 3.03 |
| <i>Clevelandia ios</i> | Arrow Goby | 48 | 2.42 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 34 | 1.72 |
| <i>Urobatis halleri</i> | Round Stingray | 31 | 1.56 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 18 | 0.91 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | 11 | 0.56 |
| <i>Fundulus parvipinnis</i> | California Killifish | 10 | 0.50 |
| <i>Paralichthys californicus</i> | California Halibut | 7 | 0.35 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 3 | 0.15 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 2 | 0.10 |
| <i>Atractoscion nobilis</i> | White Seabass | 2 | 0.10 |
| <i>Strongylura exilis</i> | California Needlefish | 2 | 0.10 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 1 | 0.05 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | 0.05 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 1 | 0.05 |
| # of Species: 21 | | 1,981 | |

| SMALL SEINE | | | |
|-------------------------------------|----------------------|-------|-------|
| Scientific Name | Common Name | # | % |
| <i>Leuresthes tenuis</i> | California Grunion | 1,086 | 44.53 |
| <i>Atherinops affinis</i> | Topsmelt | 817 | 33.50 |
| <i>Clevelandia ios</i> | Arrow Goby | 228 | 9.35 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 193 | 7.91 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 42 | 1.72 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 27 | 1.11 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 26 | 1.07 |
| <i>Urobatis halleri</i> | Round Stingray | 4 | 0.16 |
| <i>Fundulus parvipinnis</i> | California Killifish | 3 | 0.12 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 2 | 0.08 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 2 | 0.08 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 2 | 0.08 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 2 | 0.08 |
| <i>Paralichthys californicus</i> | California Halibut | 2 | 0.08 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | 1 | 0.04 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 1 | 0.04 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | 0.04 |
| # of Species: 17 | | 2,439 | |

Table 14 (continued).

| OTTER TRAWL | | | |
|-------------------------------------|--------------------------|-------|-------|
| Scientific Name | Common Name | # | % |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 1,110 | 67.35 |
| <i>Urobatis halleri</i> | Round Stingray | 323 | 19.60 |
| <i>Paralichthys californicus</i> | California Halibut | 68 | 4.13 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 30 | 1.82 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 27 | 1.64 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 26 | 1.58 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 20 | 1.21 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 11 | 0.67 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 9 | 0.55 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 4 | 0.24 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 4 | 0.24 |
| <i>Xystreureys liolepis</i> | Fantail Sole | 3 | 0.18 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 2 | 0.12 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 2 | 0.12 |
| <i>Seriphus politus</i> | Queenfish | 2 | 0.12 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 2 | 0.12 |
| <i>Atherinops affinis</i> | Topsmelt | 1 | 0.06 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 1 | 0.06 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | 1 | 0.06 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | 1 | 0.06 |
| <i>Squatina californica</i> | Pacific Angel Shark | 1 | 0.06 |
| # of Species: 21 | | 1,648 | |

| SQUARE ENCLOSURE | | | |
|----------------------------------|--------------------|---|-------|
| Scientific Name | Common Name | # | % |
| <i>Clevelandia ios</i> | Arrow Goby | 4 | 57.14 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 2 | 28.57 |
| <i>Leuresthes tenuis</i> | California Grunion | 1 | 14.29 |
| # of Species: 3 | | 7 | |

Table 15. Total biomass (g) of fish species taken from San Diego Bay in 2015 by sampling method.

| PURSE SEINE | | | | BEAM TRAWL | | | |
|-------------------------------------|--------------------------|---------|-------|-------------------------------------|-------------------------|--------|--------|
| Scientific Name | Common Name | grams | % | Scientific Name | Common Name | grams | % |
| <i>Engraulis mordax</i> | Northern Anchovy | 50,947 | 21.73 | <i>Urobatis halleri</i> | Round Stingray | 21,108 | 58.93 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 46,300 | 19.75 | <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 7,475 | 20.87 |
| <i>Urobatis halleri</i> | Round Stingray | 45,545 | 19.43 | <i>Heterostichus rostratus</i> | Giant Kelpfish | 1,977 | 5.52 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 34,513 | 14.72 | <i>Paralabrax nebulifer</i> | Barred Sand Bass | 1,864 | 5.20 |
| <i>Myliobatis californica</i> | Bat Ray | 26,200 | 11.18 | <i>Cymatogaster aggregata</i> | Shiner Perch | 888 | 2.48 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 13,315 | 5.68 | <i>Micrometrus minimus</i> | Dwarf Perch | 844 | 2.35 |
| <i>Atherinops affinis</i> | Topsmelt | 2,329 | 0.99 | <i>Syngnathus californiensis</i> | Kelp Pipefish | 448 | 1.25 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | 2,100 | 0.90 | <i>Hypsoblennius gentilis</i> | Bay Blenny | 332 | 0.93 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 1,739 | 0.74 | <i>Paralabrax clathratus</i> | Kelp Bass | 177 | 0.49 |
| <i>Paralichthys californicus</i> | California Halibut | 1,686 | 0.72 | <i>Porichthys myriaster</i> | Specklefin Midshipman | 145 | 0.40 |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | 1,300 | 0.55 | <i>Anchoa delicatissima</i> | Slough Anchovy | 96 | 0.27 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 1,278 | 0.54 | <i>Scorpaena guttata</i> | California Scorpionfish | 95 | 0.27 |
| <i>Seriphus politus</i> | Queenfish | 1,188 | 0.51 | <i>Hippocampus ingens</i> | Pacific Seahorse | 83 | 0.23 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 1,172 | 0.50 | <i>Paralichthys californicus</i> | California Halibut | 75 | 0.21 |
| <i>Albula gilberti</i> | Cortez Bonefish | 1,090 | 0.46 | <i>Gibbonsia elegans</i> | Spotted Kelpfish | 50 | 0.14 |
| <i>Leuresthes tenuis</i> | California Grunion | 965 | 0.41 | <i>Embiotoca jacksoni</i> | Black Perch | 48 | 0.13 |
| <i>Micrometrus minimus</i> | Dwarf Perch | 748 | 0.32 | <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 38 | 0.11 |
| <i>Embiotoca jacksoni</i> | Black Perch | 452 | 0.19 | <i>Cheilotrema saturnum</i> | Black Croaker | 24 | 0.07 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 290 | 0.12 | <i>Clevelandia ios</i> | Arrow Goby | 22 | 0.06 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 265 | 0.11 | <i>Atherinops affinis</i> | Topsmelt | 15 | 0.04 |
| <i>Girella nigricans</i> | Opaleye | 250 | 0.11 | <i>Halichoeres semicinctus</i> | Rock Wrasse | 10 | 0.03 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | 240 | 0.10 | <i>Seriphus politus</i> | Queenfish | 2 | 0.01 |
| <i>Sardinops sagax</i> | Pacific Sardine | 152 | 0.06 | <i>Ilypnus gilberti</i> | Cheekspot Goby | 1 | < 0.01 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 110 | 0.05 | <i>Cosmocampus arctus</i> | Snubnose Pipefish | 1 | < 0.01 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 99 | 0.04 | # of Species: 24 | | 35,818 | |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | 45 | 0.02 | | | | |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 27 | 0.01 | | | | |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 26 | 0.01 | | | | |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 17 | 0.01 | | | | |
| <i>Symphurus atricaudus</i> | California Tonguefish | 17 | 0.01 | | | | |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | 15 | 0.01 | | | | |
| <i>Haemulon californiensis</i> | Salema | 12 | 0.01 | | | | |
| # of Species: 32 | | 234,430 | | | | | |

Table 15 (continued).

| LARGE SEINE | | | | SMALL SEINE | | | |
|-------------------------------------|--------------------------|--------|--------|-------------------------------------|----------------------|-------|-------|
| Scientific Name | Common Name | grams | % | Scientific Name | Common Name | grams | % |
| <i>Urobatis halleri</i> | Round Stingray | 7,042 | 50.87 | <i>Urobatis halleri</i> | Round Stingray | 615 | 45.63 |
| <i>Atherinops affinis</i> | Topsmelt | 2,068 | 14.94 | <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 140 | 10.39 |
| <i>Leuresthes tenuis</i> | California Grunion | 1,115 | 8.05 | <i>Leuresthes tenuis</i> | California Grunion | 116 | 8.63 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 1,028 | 7.43 | <i>Syngnathus californiensis</i> | Kelp Pipefish | 112 | 8.34 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 888 | 6.41 | <i>Atherinops affinis</i> | Topsmelt | 104 | 7.72 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 713 | 5.15 | <i>Cymatogaster aggregata</i> | Shiner Perch | 61 | 4.53 |
| <i>Paralichthys californicus</i> | California Halibut | 357 | 2.58 | <i>Paralabrax nebulifer</i> | Barred Sand Bass | 50 | 3.71 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 337 | 2.43 | <i>Clevelandia ios</i> | Arrow Goby | 45 | 3.33 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 58 | 0.42 | <i>Heterostichus rostratus</i> | Giant Kelpfish | 41 | 3.04 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 49 | 0.36 | <i>Paralichthys californicus</i> | California Halibut | 40 | 2.97 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | 38 | 0.27 | <i>Hypsoblennius gentilis</i> | Bay Blenny | 10 | 0.74 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 36 | 0.26 | <i>Anchoa delicatissima</i> | Slough Anchovy | 4 | 0.30 |
| <i>Fundulus parvipinnis</i> | California Killifish | 32 | 0.23 | <i>Fundulus parvipinnis</i> | California Killifish | 3 | 0.24 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 30 | 0.22 | <i>Ilypnus gilberti</i> | Cheekspot Goby | 3 | 0.22 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | 27 | 0.20 | <i>Cosmocampus arctus</i> | Snubnose Pipefish | 1 | 0.07 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | 13 | 0.09 | <i>Gibbonsia elegans</i> | Spotted Kelpfish | 1 | 0.07 |
| <i>Clevelandia ios</i> | Arrow Goby | 7 | 0.05 | <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | 0.07 |
| <i>Atractoscion nobilis</i> | White Seabass | 2 | 0.01 | | | | |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | 0.01 | | | | |
| <i>Strongylura exilis</i> | California Needlefish | 1 | 0.01 | | | | |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 1 | < 0.01 | | | | |
| # of Species: 21 | | 13,843 | | # of Species: 17 | | 1,348 | |

Table 15 (continued).

| OTTER TRAWL | | | |
|-------------------------------------|--------------------------|--------|--------|
| Scientific Name | Common Name | grams | % |
| <i>Urobatis halleri</i> | Round Stingray | 55,630 | 60.63 |
| <i>Squatina californica</i> | Pacific Angel Shark | 12,000 | 13.08 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 7,670 | 8.36 |
| <i>Paralichthys californicus</i> | California Halibut | 5,289 | 5.76 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 4,910 | 5.35 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 1,327 | 1.45 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 1,234 | 1.35 |
| <i>Platyrhinoidis triseriata</i> | Thornback | 1,000 | 1.09 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 802 | 0.87 |
| <i>Xystreureys liolepis</i> | Fantail Sole | 750 | 0.82 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 358 | 0.39 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 336 | 0.37 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 160 | 0.17 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 142 | 0.15 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 71 | 0.08 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | 34 | 0.04 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 18 | 0.02 |
| <i>Seriphus politus</i> | Queenfish | 9 | 0.01 |
| <i>Atherinops affinis</i> | Topsmelt | 3 | < 0.01 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 2 | < 0.01 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 2 | < 0.01 |
| # of Species: 21 | | 91,746 | |

| SQUARE ENCLOSURE | | | |
|----------------------------------|--------------------|-------|-------|
| Scientific Name | Common Name | grams | % |
| <i>Clevelandia ios</i> | Arrow Goby | 0.2 | 40.00 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 0.2 | 40.00 |
| <i>Leuresthes tenuis</i> | California Grunion | 0.1 | 20.00 |
| # of Species: 3 | | 0.5 | |

Table 16. Comparison of mean densities and biomass densities by gear type for San Diego Bay 1994-1999 and April and July 2005, April and July 2008, June 2009 (from Pondella and Williams 2009b), April and July 2012, and April and July 2015.

| 1994-1999 | | April/July 2005 | | April/July 2008 | | June 2009 | | April/July 2012 | | April/July 2015 | |
|-----------|------------------|-----------------|------------------|-----------------|------------------|-----------|------------------|-----------------|------------------|-----------------|------------------|
| Gear | #/m ² | Gear | #/m ² | Gear | #/m ² | Gear | #/m ² | Gear | #/m ² | Gear | #/m ² |
| BT | 0.080 | BT | 1.164 | BT | 0.223 | BT | - | BT | 0.386 | BT | 0.183 |
| OT | 0.009 | OT | 0.032 | OT | 0.004 | OT | - | OT | 0.005 | OT | 0.028 |
| PS | 1.770 | PS | 0.569 | PS | 0.390 | PS | 0.485 | PS | 0.122 | PS | 0.697 |
| LS | 0.369 | LS | 0.676 | LS | 0.171 | LS | - | LS | 0.366 | LS | 0.188 |
| SS | 2.338 | SS | 0.440 | SS | 0.702 | SS | - | SS | 1.659 | SS | 0.820 |
| SE | 3.583 | SE | 1.042 | SE | 0.542 | SE | 1.542 | SE | 0.708 | SE | 0.146 |
| Gear | g/m ² | Gear | g/m ² | Gear | g/m ² | Gear | g/m ² | Gear | g/m ² | Gear | g/m ² |
| BT | 2.232 | BT | 5.137 | BT | 3.496 | BT | - | BT | 7.199 | BT | 2.573 |
| OT | 1.678 | OT | 1.425 | OT | 0.416 | OT | - | OT | 0.684 | OT | 1.582 |
| PS | 6.306 | PS | 5.579 | PS | 3.910 | PS | 5.355 | PS | 7.949 | PS | 11.000 |
| LS | 1.051 | LS | 1.684 | LS | 1.114 | LS | - | LS | 1.502 | LS | 1.311 |
| SS | 0.272 | SS | 0.216 | SS | 0.256 | SS | - | SS | 1.044 | SS | 0.453 |
| SE | 0.636 | SE | 0.176 | SE | 12.313 | SE | 0.542 | SE | 2.063 | SE | 0.010 |

Table 17. Estimates of area coverage of depth strata within each Ecoregion of San Diego Bay. Proportions and areas were used to weigh density and estimate standing stocks of fisheries.

| % Area | | | |
|---------------|------------|-----------|---------|
| Ecoregion | Intertidal | Nearshore | Channel |
| North | 6 | 33 | 60 |
| North-Central | 5 | 38 | 57 |
| South-Central | 3 | 61 | 36 |
| South | 4 | 84 | 13 |

| Hectares/Habitat | | | | | |
|----------------------------|------------|-----------|---------|-------|----------|
| Ecoregion | Intertidal | Nearshore | Channel | TOTAL | % of Bay |
| North | 61 | 327 | 593 | 982 | 20 |
| North-Central | 41 | 307 | 460 | 808 | 17 |
| South-Central | 51 | 1227 | 726 | 2005 | 41 |
| South | 40 | 890 | 133 | 1064 | 22 |
| # Hectares | 194 | 2751 | 1913 | 4858 | |
| % Bay Area (Allen 2002) | 4 | 57 | 39 | | |

Best Estimates of Density and Standing Stock

Density estimates used for the standing stock assessment were determined using the *Best Estimate of Density* within each Ecoregion. The best density estimate was determined in the following manner:

- 1) Sample densities estimated by gear type for each species were averaged over all samples within the three depth strata (Intertidal, Nearshore, and Channel).
- 2) The maximum density for each species by gear type within each depth stratum was determined to be the *Best Estimate of Density* for that species within that depth stratum.
- 3) The proportional aerial coverage of the three depth strata within the Ecoregion was determined previously by Allen et al. (2002) were used for the current study. These aerial proportions were then used to weight the *Best Estimate of Density* within the depth strata by species. A weighted average was then taken among these best estimates over the three depth strata for each species.
- 4) The sum of the weighted densities of all species represented *Best Estimate of Density* (numerical and biomass) for each depth stratum and Ecoregion was calculated.

Standing stock estimates were calculated by multiplying the best estimates by the total area of the individual Ecoregions and San Diego Bay, as a whole (Table 17). The best estimate for the total stock size was 35,117,726 fishes (Table 18). With an estimated surface area of 4858 ha (Table 17) this gives an overall fish density 0.72 individuals/m² (Table 18). The highest estimate was of Slough Anchovy (13.9 million), followed by Northern Anchovy (13.0 million), Kelp Pipefish (1.7 million), Giant Kelpfish (1.6 million), and Topsmelt (1.1 million). As is typical, schooling and avian forage fishes dominated the stock estimate for the bay.

The total best estimate of biomass standing stock was 518.177 kg (Table 19). This gives an overall estimate of 10.67 g/m². The stock size estimate in 2015 was higher than in any survey since 2005, and the biomass standing stock was the highest of any survey (Table 20). This is undoubtedly due to the comparatively large number of small schooling fishes and the influence of the occasional catch of high biomass elasmobranchs such as the 45.5 kg California Butterfly Ray.



A 1.57 m wide, 45.5 kg California Butterfly Ray laying upside down in the purse seine. (photo: JW)

Table 18. Best estimate of densities and stock estimates, April and July 2015.

| Scientific Name | Common Name | Depth Strata | | | Weighted Mean | Stock Estimate |
|-------------------------------------|--------------------------|----------------|----------------|----------------|----------------|-------------------|
| | | Channel | Intertidal | Nearshore | | |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 0.13091 | 0.00170 | 0.41188 | 0.28590 | 13,888,822 |
| <i>Engraulis mordax</i> | Northern Anchovy | | | 0.46917 | 0.26743 | 12,991,662 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 0.00003 | 0.06485 | 0.05675 | 0.03496 | 1,698,195 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 0.00014 | 0.00907 | 0.05668 | 0.03273 | 1,589,829 |
| <i>Atherinops affinis</i> | Topsmelt | 0.00014 | 0.27453 | 0.02048 | 0.02271 | 1,103,276 |
| <i>Leuresthes tenuis</i> | California Grunion | | 0.36492 | 0.00486 | 0.01736 | 843,588 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 0.00042 | 0.02235 | 0.02386 | 0.01466 | 712,121 |
| <i>Urobatis halleri</i> | Round Stingray | 0.00557 | 0.00294 | 0.01253 | 0.00943 | 458,113 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 0.00070 | 0.00874 | 0.01168 | 0.00728 | 353,837 |
| <i>Micrometrus minimus</i> | Dwarf Perch | | | 0.01207 | 0.00688 | 334,197 |
| <i>Clevelandia ios</i> | Arrow Goby | | 0.08333 | 0.00524 | 0.00632 | 307,150 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 0.00052 | 0.00322 | 0.00855 | 0.00520 | 252,778 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 0.00648 | 0.00019 | 0.00225 | 0.00382 | 185,415 |
| <i>Serphus politus</i> | Queenfish | 0.00014 | | 0.00267 | 0.00158 | 76,727 |
| <i>Paralichthys californicus</i> | California Halibut | 0.00117 | 0.00067 | 0.00077 | 0.00093 | 44,954 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 0.00007 | | 0.00144 | 0.00085 | 41,092 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | | 0.00067 | 0.00129 | 0.00076 | 37,113 |
| <i>Embiotoca jacksoni</i> | Black Perch | | | 0.00120 | 0.00068 | 33,132 |
| <i>Sardinops sagax</i> | Pacific Sardine | | | 0.00113 | 0.00064 | 31,183 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | | 0.00682 | 0.00007 | 0.00031 | 15,198 |
| <i>Myliobatis californica</i> | Bat Ray | 0.00014 | | 0.00042 | 0.00030 | 14,361 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | | | 0.00042 | 0.00024 | 11,694 |
| <i>Cheilotrema saturnum</i> | Black Croaker | 0.00016 | | 0.00029 | 0.00022 | 10,897 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 0.00045 | | 0.00007 | 0.00022 | 10,481 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | | 0.00034 | 0.00029 | 0.00018 | 8,610 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 0.00019 | | 0.00014 | 0.00015 | 7,491 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 0.00034 | | | 0.00013 | 6,532 |
| <i>Albula gilberti</i> | Cortez Bonefish | | | 0.00021 | 0.00012 | 5,847 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | | 0.00067 | 0.00014 | 0.00011 | 5,284 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 0.00014 | | 0.00007 | 0.00010 | 4,616 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | | | 0.00014 | 0.00008 | 3,979 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | | | 0.00014 | 0.00008 | 3,898 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 0.00007 | | 0.00007 | 0.00007 | 3,296 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | | 0.00034 | 0.00007 | 0.00005 | 2,642 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | | 0.00104 | | 0.00004 | 2,024 |
| <i>Scorpaena guttata</i> | California Scorpionfish | | | 0.00007 | 0.00004 | 1,989 |
| <i>Fundulus parvipinnis</i> | California Killifish | | 0.00101 | | 0.00004 | 1,959 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | | 0.00007 | 0.00004 | 1,949 |
| <i>Girella nigricans</i> | Opaleye | | | 0.00007 | 0.00004 | 1,949 |
| <i>Haemulon californiensis</i> | Salema | | | 0.00007 | 0.00004 | 1,949 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | | | 0.00007 | 0.00004 | 1,949 |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | | | 0.00007 | 0.00004 | 1,949 |
| <i>Xystreurys liolepis</i> | Fantail Sole | 0.00005 | | | 0.00002 | 980 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 0.00003 | | | 0.00001 | 653 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | | 0.00034 | | 0.00001 | 653 |
| <i>Atractoscion nobilis</i> | White Seabass | | 0.00019 | | 0.00001 | 368 |
| <i>Strongylura exilis</i> | California Needlefish | | 0.00019 | | 0.00001 | 368 |
| <i>Platyrrhinoidis triseriata</i> | Thornback | 0.00002 | | | 0.00001 | 327 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | 0.00002 | | | 0.00001 | 327 |
| <i>Squatina californica</i> | Pacific Angel Shark | 0.00002 | | | 0.00001 | 327 |
| Grand Totals: | | 0.14792 | 0.84811 | 1.10749 | 0.72288 | 35,117,726 |

Table 19. Best estimate of biomass densities and standing stock, April and July 2015.

| | | Depth Strata | | | Weighted Mean | Stock Estimate (kg) | Stock Estimate (MT) |
|-------------------------------------|--------------------------|----------------|----------------|-----------------|-----------------|---------------------|---------------------|
| Scientific Name | Common Name | Channel | Intertidal | Nearshore | | | |
| <i>Gymnura marmorata</i> | California Butterfly Ray | 6.26408 | | 0.12669 | 2.51520 | 122,189 | 122.2 |
| <i>Urobatis halleri</i> | Round Stingray | 0.95901 | 0.66686 | 2.88760 | 2.04662 | 99,425 | 99.4 |
| <i>Engraulis mordax</i> | Northern Anchovy | | | 3.58577 | 2.04389 | 99,292 | 99.3 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 0.16399 | 0.09735 | 2.34713 | 1.40571 | 68,290 | 68.3 |
| <i>Myliobatis californica</i> | Bat Ray | 0.04223 | | 1.82292 | 1.05553 | 51,278 | 51.3 |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 0.20045 | 0.00466 | 0.83689 | 0.55539 | 26,981 | 27.0 |
| <i>Atherinops affinis</i> | Topsmelt | 0.00169 | 0.19584 | 0.16308 | 0.10145 | 4,928 | 4.93 |
| <i>Paralichthys californicus</i> | California Halibut | 0.09118 | 0.03384 | 0.11057 | 0.09994 | 4,855 | 4.86 |
| <i>Paralabrax nebulifer</i> | Barred Sand Bass | 0.02288 | 0.08409 | 0.13391 | 0.08861 | 4,305 | 4.30 |
| <i>Umbrina roncadore</i> | Yellowfin Croaker | | | 0.14780 | 0.08425 | 4,093 | 4.09 |
| <i>Heterostichus rostratus</i> | Giant Kelpfish | 0.00028 | 0.03191 | 0.14203 | 0.08234 | 4,000 | 4.00 |
| <i>Squatina californica</i> | Pacific Angel Shark | 0.20687 | | | 0.08068 | 3,919 | 3.92 |
| <i>Cymatogaster aggregata</i> | Shiner Perch | 0.00099 | 0.06752 | 0.12188 | 0.07255 | 3,525 | 3.52 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 0.09910 | 0.00339 | 0.04036 | 0.06179 | 3,002 | 3.00 |
| <i>Roncadore stearnsii</i> | Spotfin Croaker | | | 0.09150 | 0.05215 | 2,534 | 2.53 |
| <i>Seriophis politus</i> | Queenfish | 0.00141 | | 0.08291 | 0.04781 | 2,323 | 2.32 |
| <i>Albula gilberti</i> | Cortez Bonefish | | | 0.07672 | 0.04373 | 2,124 | 2.12 |
| <i>Leuresthes tenuis</i> | California Grunion | | 0.10559 | 0.06792 | 0.04294 | 2,086 | 2.09 |
| <i>Micrometrus minimus</i> | Dwarf Perch | | | 0.06060 | 0.03454 | 1,678 | 1.68 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 0.00003 | 0.03777 | 0.03216 | 0.01986 | 965 | 0.96 |
| <i>Embiotoca jacksoni</i> | Black Perch | | | 0.03183 | 0.01814 | 881 | 0.88 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | | 0.00336 | 0.02385 | 0.01373 | 667 | 0.67 |
| <i>Cheilodroma saturnum</i> | Black Croaker | 0.00275 | | 0.02041 | 0.01271 | 617 | 0.62 |
| <i>Paralabrax clathratus</i> | Kelp Bass | 0.00245 | | 0.01865 | 0.01159 | 563 | 0.56 |
| <i>Girella nigricans</i> | Opaleye | | | 0.01760 | 0.01003 | 487 | 0.49 |
| <i>Halichoeres semicinctus</i> | Rock Wrasse | | | 0.01689 | 0.00963 | 468 | 0.47 |
| <i>Porichthys myriaster</i> | Specklefin Midshipman | 0.00617 | | 0.01042 | 0.00834 | 405 | 0.41 |
| <i>Platyrrhinoides triseriata</i> | Thornback | 0.01724 | | | 0.00672 | 327 | 0.33 |
| <i>Sardinops sagax</i> | Pacific Sardine | | | 0.01071 | 0.00611 | 297 | 0.30 |
| <i>Pleuronichthys decurrens</i> | Curlfin Sole | 0.01383 | | | 0.00539 | 262 | 0.26 |
| <i>Xystreurys liolepis</i> | Fantail Sole | 0.01293 | | | 0.00504 | 245 | 0.24 |
| <i>Atherinopsis californiensis</i> | Jacksmelt | | 0.00256 | 0.00774 | 0.00452 | 219 | 0.22 |
| <i>Scorpaena guttata</i> | California Scorpionfish | | | 0.00682 | 0.00389 | 189 | 0.19 |
| <i>Pleuronichthys guttulatus</i> | Diamond Turbot | 0.00579 | | 0.00273 | 0.00382 | 185 | 0.19 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | | | 0.00596 | 0.00340 | 165 | 0.17 |
| <i>Gibbonsia elegans</i> | Spotted Kelpfish | | 0.00123 | 0.00359 | 0.00210 | 102 | 0.10 |
| <i>Pleuronichthys verticalis</i> | Hornyhead Turbot | | | 0.00317 | 0.00181 | 88 | 0.09 |
| <i>Clevelandia ios</i> | Arrow Goby | | 0.01509 | 0.00159 | 0.00151 | 73 | 0.07 |
| <i>Symphurus atricaudus</i> | California Tonguefish | 0.00122 | | 0.00120 | 0.00116 | 56 | 0.06 |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | | 0.00106 | 0.00060 | 29 | 0.03 |
| <i>Haemulon californiensis</i> | Salema | | | 0.00084 | 0.00048 | 23 | 0.02 |
| <i>Pleuronichthys ritteri</i> | Spotted Turbot | 0.00059 | | | 0.00023 | 11 | 0.01 |
| <i>Leptocottus armatus</i> | Pacific Staghorn Sculpin | | 0.00360 | | 0.00014 | 7.0 | 0.01 |
| <i>Fundulus parvipinnis</i> | California Killifish | | 0.00303 | | 0.00012 | 5.9 | 0.01 |
| <i>Citharichthys stigmaeus</i> | Speckled Sanddab | 0.00031 | | | 0.00012 | 5.9 | 0.01 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | | 0.00101 | 0.00009 | 0.00009 | 4.5 | < 0.01 |
| <i>Cosmocampus arctus</i> | Snubnose Pipefish | | 0.00034 | 0.00007 | 0.00005 | 2.6 | < 0.01 |
| <i>Hyporhamphus rosae</i> | California Halfbeak | | 0.00034 | | 0.00001 | 0.7 | < 0.01 |
| <i>Atractoscion nobilis</i> | White Seabass | | 0.00017 | | 0.00001 | 0.3 | < 0.01 |
| <i>Strongylura exilis</i> | California Needlefish | | 0.00009 | | < 0.00001 | 0.2 | < 0.01 |
| Grand Totals: | | 8.11745 | 1.35963 | 13.06366 | 10.66647 | 518,177 | 518.2 |

Table 20. Stock estimates and biomass standing stock; 1994-1999, April and July 2005, April and July 2008, April and July 2012, and April and July 2015.

| | 1994-1999 | April/July 2005 | April/July 2008 | April/July 2012 | April/July 2015 |
|----------------------------|------------|-----------------|-----------------|-----------------|-----------------|
| Stock Estimate (#) | 84,776,769 | 56,320,404 | 24,776,133 | 14,249,941 | 35,117,726 |
| Standing Stock (kg) | 342,427 | 339,268 | 246,492 | 459,754 | 518,177 |

Avian Forage Species

Forage species are primarily surface dwelling schooling fish that are accessible to diving avian predators, especially terns. Generally, forage fishes are small silvery-sided fishes that are found in large schools. These schooling fishes are generally not habitat specific and move throughout the bay's ecosystem. Thirteen species of important forage fishes (Pondella and Williams 2011) were captured during this study. The most abundant forage fishes were Slough Anchovy, Northern Anchovy, California Grunion, and Topsmelt. These species were primarily found at small (juvenile) size classes (<50 mm SL) appropriate for nesting birds to feed their young in the area. The typical timing for the recruitment of fishes to San Diego Bay begins in the spring and continues through the summer and this is what was observed in 2015. The biomass standing stock estimate for forage fish was 146.1 MT. When estimating by ecoregion, values were highest at the North Ecoregion (432.2 MT) which was driven almost entirely by Northern Anchovy, and decreased to the south (82.0 MT, 48.5 MT, and 25.1 MT for the North-Central, South-Central, and South Ecoregions, respectively; Table 21).



A long-billed dowitcher (*Limnodromus scolopaceus*) foraging in the North Ecoregion. (photo: RA)

Table 21. Best estimate of biomass standing stock for forage fish species by ecoregion, 2015.

| Ecoregion | Scientific Name | Common Name | Depth Strata | | | Weighted Mean | Stock Estimate (kg) | Stock Estimate (MT) |
|---------------|------------------------------------|----------------------|----------------|----------------|-----------------|----------------|---------------------|---------------------|
| | | | Channel | Intertidal | Nearshore | | | |
| North | <i>Engraulis mordax</i> | Northern Anchovy | | | 13.82083 | 7.87788 | 382,707 | 382.7 |
| | <i>Anchoa delicatissima</i> | Slough Anchovy | | 0.00403 | 0.34119 | 0.19464 | 9,456 | 9.46 |
| | <i>Atherinops affinis</i> | Topsmelt | | 0.02554 | 0.30574 | 0.17530 | 8,516 | 8.52 |
| | <i>Heterostichus rostratus</i> | Giant Kelpfish | | 0.00455 | 0.29023 | 0.16561 | 8,045 | 8.05 |
| | <i>Leuresthes tenuis</i> | California Grunion | | 0.19508 | 0.27168 | 0.16266 | 7,902 | 7.90 |
| | <i>Micrometrus minimus</i> | Dwarf Perch | | | 0.22845 | 0.13022 | 6,326 | 6.33 |
| | <i>Cymatogaster aggregata</i> | Shiner Perch | | 0.04432 | 0.22511 | 0.13009 | 6,320 | 6.32 |
| | <i>Anchoa compressa</i> | Deepbody Anchovy | | | 0.03899 | 0.02223 | 1,080 | 1.08 |
| | <i>Sardinops sagax</i> | Pacific Sardine | | | 0.03300 | 0.01881 | 914 | 0.91 |
| | <i>Atherinopsis californiensis</i> | Jacksmelt | | | 0.03097 | 0.01765 | 858 | 0.86 |
| | <i>Clevelandia ios</i> | Arrow Goby | | 0.03495 | 0.00086 | 0.00189 | 92 | 0.09 |
| | <i>Hyporhamphus rosae</i> | California Halfbeak | | 0.00134 | | 0.00005 | 3 | < 0.01 |
| | Grand Total: | | | 0.30980 | 15.58705 | 8.89701 | 432,217 | 432.2 |
| North-Central | <i>Anchoa delicatissima</i> | Slough Anchovy | 0.05775 | 0.01174 | 1.74457 | 1.01740 | 49,425 | 49.43 |
| | <i>Engraulis mordax</i> | Northern Anchovy | | | 0.52224 | 0.29768 | 14,461 | 14.46 |
| | <i>Heterostichus rostratus</i> | Giant Kelpfish | | 0.08750 | 0.24626 | 0.14387 | 6,989 | 6.99 |
| | <i>Atherinops affinis</i> | Topsmelt | | 0.32235 | 0.20076 | 0.12733 | 6,186 | 6.19 |
| | <i>Cymatogaster aggregata</i> | Shiner Perch | | 0.18485 | 0.09310 | 0.06046 | 2,937 | 2.94 |
| | <i>Anchoa compressa</i> | Deepbody Anchovy | | | 0.03801 | 0.02166 | 1,052 | 1.05 |
| | <i>Leuresthes tenuis</i> | California Grunion | | 0.22727 | | 0.00909 | 442 | 0.44 |
| | <i>Micrometrus minimus</i> | Dwarf Perch | | | 0.01394 | 0.00794 | 386 | 0.39 |
| | <i>Clevelandia ios</i> | Arrow Goby | | 0.01075 | 0.00491 | 0.00323 | 157 | 0.16 |
| | Grand Total: | | 0.05775 | 0.84446 | 2.86379 | 1.68866 | 82,035 | 82.0 |
| South-Central | <i>Anchoa delicatissima</i> | Slough Anchovy | 0.39189 | 0.00114 | 0.91582 | 0.67490 | 32,787 | 32.79 |
| | <i>Anchoa compressa</i> | Deepbody Anchovy | 0.33671 | 0.00795 | 0.02534 | 0.14608 | 7,096 | 7.10 |
| | <i>Cymatogaster aggregata</i> | Shiner Perch | 0.00014 | 0.04091 | 0.21396 | 0.12365 | 6,007 | 6.01 |
| | <i>Atherinops affinis</i> | Topsmelt | 0.00017 | 0.05455 | 0.05434 | 0.03322 | 1,614 | 1.61 |
| | <i>Heterostichus rostratus</i> | Giant Kelpfish | 0.00113 | 0.03561 | 0.03161 | 0.01988 | 966 | 0.97 |
| | <i>Clevelandia ios</i> | Arrow Goby | | 0.01371 | | 0.00055 | 27 | 0.03 |
| | <i>Fundulus parvipinnis</i> | California Killifish | | 0.01212 | | 0.00048 | 24 | 0.02 |
| | <i>Atherinopsis californiensis</i> | Jacksmelt | | 0.00606 | | 0.00024 | 12 | 0.01 |
| | Grand Total: | | 0.73004 | 0.17204 | 1.24107 | 0.99901 | 48,532 | 48.5 |
| South | <i>Anchoa delicatissima</i> | Slough Anchovy | 0.40991 | 0.00386 | 0.34600 | 0.35724 | 17,355 | 17.35 |
| | <i>Atherinops affinis</i> | Topsmelt | 0.00676 | 0.38788 | 0.09150 | 0.07030 | 3,415 | 3.42 |
| | <i>Anchoa compressa</i> | Deepbody Anchovy | 0.05968 | 0.00561 | 0.05912 | 0.05720 | 2,779 | 2.78 |
| | <i>Cymatogaster aggregata</i> | Shiner Perch | 0.00394 | | 0.03998 | 0.02432 | 1,182 | 1.18 |
| | <i>Sardinops sagax</i> | Pacific Sardine | | | 0.00985 | 0.00562 | 273 | 0.27 |
| | <i>Clevelandia ios</i> | Arrow Goby | | 0.01667 | 0.00057 | 0.00099 | 48 | 0.05 |
| | <i>Atherinopsis californiensis</i> | Jacksmelt | | 0.00417 | | 0.00017 | 8 | 0.01 |
| | <i>Leuresthes tenuis</i> | California Grunion | | 0.00134 | | 0.00005 | 3 | < 0.01 |
| | <i>Hyporhamphus rosae</i> | California Halfbeak | | 0.00038 | | 0.00002 | 1 | < 0.01 |
| | Grand Total: | | 0.48029 | 0.41990 | 0.54703 | 0.51592 | 25,063 | 25.1 |

Fisheries Species

During this study, 15 species were captured which have importance in either the recreational or commercial fisheries in California. The most abundant fisheries species were the Northern Anchovy, Spotted Sand Bass, and California Halibut. Including all Ecoregions, standing stock estimates of fisheries species totaled 122.0 MT. Like the forage fishes, when estimating by ecoregion values were greatest at the North Ecoregion (461.7 MT) which was again driven almost entirely by Northern Anchovy, and declined to the south (152.2 MT, 89.7 MT, and 69.3 MT for North-Central, South-Central, and South Ecoregions, respectively; Table 22).

Table 22. Best estimate of biomass standing stock for recreational/commercial fishery species by ecoregion, 2015.

| Ecoregion | Scientific Name | Common Name | Depth Strata | | | Weighted Mean | Stock Estimate (kg) | Stock Estimate (MT) |
|---------------|-------------------------------------|--------------------|----------------|----------------|-----------------|----------------|---------------------|---------------------|
| | | | Channel | Intertidal | Nearshore | | | |
| North | <i>Engraulis mordax</i> | Northern Anchovy | | | 13.82083 | 7.87788 | 382,707 | 382.7 |
| | <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 0.04827 | | 2.28322 | 1.32026 | 64,138 | 64.1 |
| | <i>Paralichthys californicus</i> | California Halibut | 0.31030 | 0.11212 | 0.02155 | 0.13779 | 6,694 | 6.7 |
| | <i>Embiotoca jacksoni</i> | Black Perch | | | 0.12731 | 0.07257 | 3,525 | 3.5 |
| | <i>Paralabrax clathratus</i> | Kelp Bass | | | 0.07461 | 0.04253 | 2,066 | 2.1 |
| | <i>Paralabrax nebulifer</i> | Barred Sand Bass | 0.01910 | | 0.04364 | 0.03232 | 1,570 | 1.6 |
| | <i>Sardinops sagax</i> | Pacific Sardine | | | 0.03300 | 0.01881 | 914 | 0.91 |
| | <i>Seriphus politus</i> | Queenfish | | | 0.00366 | 0.00209 | 101 | 0.10 |
| | <i>Atractoscion nobilis</i> | White Seabass | | 0.00030 | | 0.00001 | 1 | < 0.01 |
| | Grand Total: | | 0.37767 | 0.11242 | 16.40781 | 9.50424 | 461,716 | 461.7 |
| North-Central | <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 0.41718 | 0.35985 | 3.25394 | 2.03184 | 98,707 | 98.71 |
| | <i>Engraulis mordax</i> | Northern Anchovy | | | 0.52224 | 0.29768 | 14,461 | 14.46 |
| | <i>Umbrina roncadore</i> | Yellowfin Croaker | | | 0.47860 | 0.27280 | 13,253 | 13.25 |
| | <i>Seriphus politus</i> | Queenfish | 0.00055 | | 0.32798 | 0.18717 | 9,093 | 9.09 |
| | <i>Paralabrax nebulifer</i> | Barred Sand Bass | 0.00896 | 0.27576 | 0.22011 | 0.13999 | 6,801 | 6.80 |
| | <i>Albula gilberti</i> | Cortez Bonefish | | | 0.13795 | 0.07863 | 3,820 | 3.82 |
| | <i>Paralichthys californicus</i> | California Halibut | 0.00745 | 0.01606 | 0.10557 | 0.06372 | 3,096 | 3.10 |
| | <i>Cheilotrema satrumum</i> | Black Croaker | 0.00024 | | 0.08164 | 0.04663 | 2,265 | 2.27 |
| | <i>Paralabrax clathratus</i> | Kelp Bass | 0.00290 | | 0.02414 | 0.01489 | 723 | 0.72 |
| | Grand Total: | | 0.43728 | 0.65167 | 5.15219 | 3.13336 | 152,218 | 152.2 |
| South-Central | <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 0.38851 | 0.02957 | 2.24240 | 1.43087 | 69,512 | 69.51 |
| | <i>Roncadore stearnsii</i> | Spotfin Croaker | | | 0.36599 | 0.20861 | 10,135 | 10.13 |
| | <i>Paralabrax nebulifer</i> | Barred Sand Bass | 0.03979 | 0.02917 | 0.24770 | 0.15787 | 7,669 | 7.67 |
| | <i>Paralichthys californicus</i> | California Halibut | 0.04505 | 0.05376 | 0.00028 | 0.01988 | 966 | 0.97 |
| | <i>Scorpaena guttata</i> | Scorpionfish | | | 0.02730 | 0.01556 | 756 | 0.76 |
| | <i>Paralabrax clathratus</i> | Kelp Bass | 0.00690 | | 0.00718 | 0.00678 | 330 | 0.33 |
| | <i>Cheilotrema satrumum</i> | Black Croaker | 0.01076 | | | 0.00420 | 204 | 0.20 |
| | <i>Seriphus politus</i> | Queenfish | 0.00563 | | | 0.00220 | 107 | 0.11 |
| | <i>Atractoscion nobilis</i> | White Seabass | | 0.00038 | | 0.00002 | 1 | < 0.01 |
| | Grand Total: | | 0.49663 | 0.11288 | 2.89086 | 1.84599 | 89,678 | 89.7 |
| South | <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 0.26745 | | 1.60895 | 1.02141 | 49,620 | 49.62 |
| | <i>Paralichthys californicus</i> | California Halibut | 0.01971 | | 0.31532 | 0.18742 | 9,105 | 9.10 |
| | <i>Albula gilberti</i> | Cortez Bonefish | | | 0.16892 | 0.09628 | 4,677 | 4.68 |
| | <i>Umbrina roncadore</i> | Yellowfin Croaker | | | 0.11261 | 0.06419 | 3,118 | 3.12 |
| | <i>Paralabrax nebulifer</i> | Barred Sand Bass | 0.02365 | 0.03144 | 0.06782 | 0.04914 | 2,387 | 2.39 |
| | <i>Sardinops sagax</i> | Pacific Sardine | | | 0.00985 | 0.00562 | 273 | 0.27 |
| | <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | | 0.00422 | 0.00241 | 117 | 0.12 |
| | Grand Total: | | 0.31081 | 0.03144 | 2.28769 | 1.42646 | 69,297 | 69.3 |

Southern (Panamic) Species Found in San Diego Bay

San Diego Bay is known for being the northern edge of the range for a number of southern fishes that are not typically distributed throughout the Southern California Bight (Table 23). During the study, just five species with primarily southern distributions were taken (Table 24) despite the exceptionally warm water and strong El Niño conditions. These fishes were mostly found in the southern half of the bay, though at least one was found in each ecoregion.

Table 23. Panamic species previously recorded in San Diego Bay.

| Scientific Name | Common Name | First Recorded SDB | |
|-----------------------------------|--------------------------|--------------------|----------------------------|
| | | Collection Date | Citation |
| <i>Albula vulpes</i> | bonefish | prior to 1918 | Starks (1918) |
| <i>Caranx caballus</i> | green jack | 1857 | Girard (1858) |
| <i>Caranx caninus</i> | Pacific crevalle jack | 16 Mar 1972 | Miller and Lea (1972) |
| <i>Caranx sexfasciatus</i> | bigeye trevally | Nov 1990 | Lea and Walker (1995) |
| <i>Cetengraulis mysticetus</i> | anchoveta | 1980-1986 | Duffy (1987) |
| <i>Chanos chanos</i> | milkfish | 22 Mar 1982 | Duffy and Bernard (1985) |
| <i>Cynoscion parvipinnis</i> | shortfin corvina | common | Jordan and Gilbert (1880) |
| <i>Dasyatis dipterura</i> | diamond stingray | 1880 (type locale) | Jordan and Gilbert (1880) |
| <i>Gymnura marmorata</i> | California butterfly ray | 1864 (type locale) | Cooper (1864) |
| <i>Haemulon flaviguttatum</i> | Cortez grunt | May 1991 | Lea and Rosenblatt (1992) |
| <i>Hippocampus ingens</i> | Pacific seahorse | 1855 (type locale) | Girard (1858) |
| <i>Hyporhamphus rosae</i> | California halfbeak | 1880 (type locale) | Jordan and Gilbert (1880) |
| <i>Mugil curema</i> | white mullet | 25 May 1985 | Lea et al. (1988) |
| <i>Pseudupeneus grandisquamis</i> | red goatfish | 1998 | Allen et al. (2002) |
| <i>Scomberomorus sierra</i> | Pacific sierra | Dec 1995 | Williams et al. (2011) |
| <i>Selene brevoortii</i> | Mexican lookdown | Nov 1990 | Lea and Walker (1995) |
| <i>Strongylura exilis</i> | California needlefish | common | Fitch and Lavenberg (1975) |
| <i>Zapteryx exasperata</i> | banded guitarfish | 1880 (type locale) | Jordan and Gilbert (1880) |



Shortfin Corvina (*Cynoscion parvipinnis*) captured in the South Ecoregion. (photo: JW)

Table 24. Abundance of Panamic species collected in San Diego Bay by ecoregion, April and July 2015.

| | | Ecoregions | | | | | | | |
|------------------------------|--------------------------|------------|------|---------------|------|---------------|------|-------|------|
| Scientific Name | Common Name | North | | North-Central | | South-Central | | South | |
| | | April | July | April | July | April | July | April | July |
| <i>Cynoscion parvipinnis</i> | Shortfin Corvina | | | | | | | | 1 |
| <i>Gymnura marmorata</i> | California Butterfly Ray | | | | | 1 | 1 | 1 | 1 |
| <i>Hippocampus ingens</i> | Pacific Seahorse | | | 1 | | 1 | | | |
| <i>Hyporhamphus rosae</i> | California Halfbeak | 1 | | | | | | | 1 |
| <i>Strongylura exilis</i> | California Needlefish | 2 | | | | | | | |

Indigenous Bay and Estuary Fishes

As the largest estuary in Southern California, San Diego Bay provides critical habitat for bay and estuary fishes. The high productivity rate coupled with the abundance of juvenile fishes in the bay highlights the importance of the bay as a nursery habitat. The bay contains extensive shallow water eelgrass habitat that supports a unique assemblage of juvenile and adult fishes. San Diego Bay serves as critical habitat for many fishes that, in turn support surrounding nearshore ecosystems. Juvenile fishes migrate out of the bay to surrounding habitats. And, these fishes provide a critical forage base for important and endangered avian species. Southern California indigenous bay and estuary fishes represented 41.6% of the total catch in this survey (Table 25).

Table 25. Indigenous bay/estuarine species taken in San Diego Bay by ecoregion in 2015.

| | | Ecoregions | | | | | |
|-------------------------------------|----------------------|------------|---------------|---------------|-------|-------|-------|
| Scientific Name | Common Name | North | North-Central | South-Central | South | Total | % |
| | | | | | | | |
| <i>Anchoa delicatissima</i> | Slough Anchovy | 493 | 2,918 | 3,136 | 1,409 | 7,956 | 33.88 |
| <i>Syngnathus californiensis</i> | Kelp Pipefish | 149 | 236 | 328 | 350 | 1,063 | 4.53 |
| <i>Clevelandia ios</i> | Arrow Goby | 160 | 36 | 93 | 64 | 353 | 1.50 |
| <i>Paralabrax maculatofasciatus</i> | Spotted Sand Bass | 34 | 194 | 79 | 39 | 346 | 1.47 |
| <i>Anchoa compressa</i> | Deepbody Anchovy | 7 | 7 | 44 | 22 | 80 | 0.34 |
| <i>Hypsoblennius gentilis</i> | Bay Blenny | 8 | 15 | 1 | 1 | 25 | 0.11 |
| <i>Fundulus parvipinnis</i> | California Killifish | | | 13 | | 13 | 0.06 |
| <i>Ilypnus gilberti</i> | Cheekspot Goby | 1 | | 2 | 2 | 5 | 0.02 |
| Total % of catch: | | 8.3% | 58.0% | 77.3% | 67.7% | | 41.6% |

Invasive Species

In addition to being a warm-water refuge for southern species, San Diego Bay is also a major port-of-entry and commercial shipping hub. Releases of ballast water and historically disturbed habitat provide ideal opportunities for invasive species, such as Yellowfin Goby (*Acanthogobius flavimanus*) and Chameleon Goby (*Tridentiger trigonocephalus*) to establish themselves in the bay. The Yellowfin Goby was first described inside tidal marshes of the South Ecoregion by Williams et al. (1998) and has been reported in many brackish and freshwater areas in California where they pose a threat to native fish species as predators. Although low-salinity requirements of this species appear to limit its expansion potential, no eradication or control efforts for this invasive have been successful (Molnar et al. 2008). Williams et al. (1998) recommended management actions that reduce off-season freshwater inflows and return tidal action to impounded saltmarsh areas in order to favor native species and prevent further spread of exotics.

The Chameleon Goby was first captured in San Diego Bay in January 1995 during the Allen et al. (2002) survey, and subsequently described with additional records by Pondella and Chinn (2005). Despite the possibility of competing with native species for habitat, this invader has not become sufficient enough of a problem to require management action, and there are no known natural controls in California's marine environment (Molnar et al. 2008). Ironically, the Chameleon Goby may actually be controlled by Yellowfin Goby predation (Meng et al. 1994).

During the previous survey in 2012, sampling yielded both of those species: a total of three Yellowfin Goby and 18 Chameleon Goby. Given the widespread nature of Chameleon Goby throughout the bay (captured in the channel, nearshore vegetated, and nearshore non-vegetated areas, in all ecoregions but the North), we reported that there may be a sustained invasion and self-recruiting population of Chameleon Goby within the bay (Williams and Pondella 2012). However, no Chameleon Goby were caught in 2015, and the only Yellowfin Goby encountered was a single partially digested individual that was regurgitated by a Spotted Sand Bass in the South Ecoregion.

Comparison of the Current and Historical April and July Surveys

Diversity and richness were determined for April and July from the previous surveys (Allen 1999, Pondella et al. 2006, Pondella and Williams 2009a, Williams and Pondella 2012) to allow direct comparisons of the data sets. The 1995-1998 survey years were used for the comparison because these were the only years from the Allen et al. (2002) where both April and July were sampled. Overall, 2015 Shannon-Wiener Diversity estimates in each ecoregion were comparatively moderate to strong. Diversity in most ecoregions was slightly below the 2008 and 2012 values, likely depressed by high anchovy catches in the North and South-Central Ecoregions, but was the highest for any sampling period in the North-Central Ecoregion (Table 26, Figure 24). Species richness for 2015 was average among the range of values for the North, North-Central, and South-Central Ecoregions for any survey period, but among the lowest for the South Ecoregion (Table 27; Figure 25).

Total catch and biomass from the April and July sampling periods were also compared from 1995-1998, 2005, 2008, 2012, and 2015. Overall, catch in 2015 at the North Ecoregion was higher than in recent sampling years, below average but similar to 2012 in the North-Central Ecoregion, about average in the South-Central Ecoregion, and slightly below average in the South Ecoregion (Table 28; Figure 26). Total abundance in the North Ecoregion was heavily influenced by large schools of Northern Anchovy, just as they were during the 1995-1998 sampling periods, but not to the same extent. Estimates of total biomass were among the highest of all surveys in every ecoregion (Table 29; Figure 27) undoubtedly due to catches of larger elasmobranchs (e.g. California Butterfly Ray; Pacific Angel Shark) and large schools of forage fishes (e.g. Northern Anchovy, Slough Anchovy). Overall, the current community statistics were comparable to the previous surveys, with an evident overall upward trend in abundance and biomass since 2008.

A pregnant male Pacific Seahorse (*Hippocampus ingens*) from the North-Central Ecoregion. (photo: CW)



Table 26. Shannon-Wiener diversity (H') values for April and July surveys by ecoregion and year.

| Ecoregion | Sampling Years | | | | | | | |
|---------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 1995 | 1996 | 1997 | 1998 | 2005 | 2008 | 2012 | 2015 |
| North | 0.74 | 0.90 | 1.34 | 1.42 | 1.77 | 1.72 | 1.56 | 1.42 |
| North-Central | 1.75 | 0.93 | 1.50 | 1.25 | 1.47 | 1.62 | 1.63 | 1.81 |
| South-Central | 1.32 | 1.72 | 1.12 | 0.37 | 2.01 | 1.88 | 1.92 | 1.33 |
| South | 1.93 | 1.84 | 1.35 | 0.59 | 1.06 | 2.03 | 1.84 | 1.52 |
| Total: | 1.46 | 1.04 | 1.65 | 1.31 | 1.97 | 2.05 | 2.02 | 1.98 |

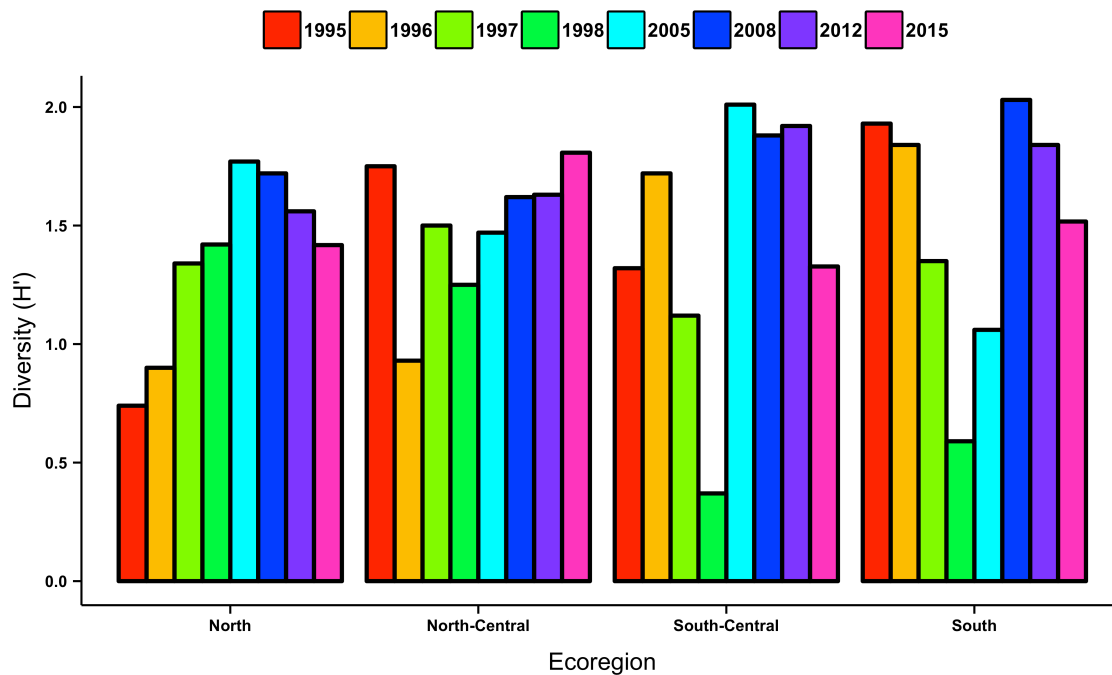


Figure 24. Shannon-Wiener diversity (H') values for April and July surveys by ecoregion and year.

Table 27. Species richness values for April and July surveys by ecoregion and year.

| Ecoregion | Sampling Years | | | | | | | |
|---------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 1995 | 1996 | 1997 | 1998 | 2005 | 2008 | 2012 | 2015 |
| North | 37 | 42 | 29 | 34 | 38 | 33 | 30 | 33 |
| North-Central | 34 | 34 | 31 | 26 | 38 | 27 | 37 | 33 |
| South-Central | 33 | 23 | 27 | 22 | 25 | 23 | 32 | 27 |
| South | 36 | 24 | 26 | 30 | 23 | 25 | 29 | 23 |
| Total: | 55 | 55 | 42 | 51 | 57 | 48 | 52 | 50 |

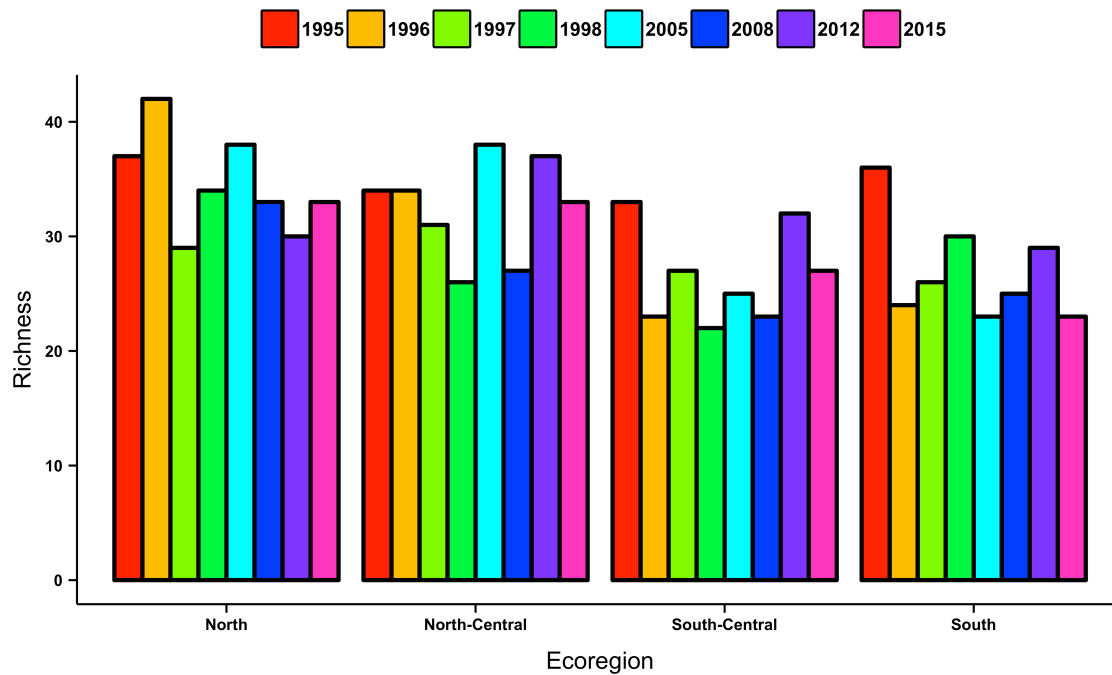


Figure 25. Species richness values for April and July surveys by ecoregion and year.

Table 28. Total catch for April and July surveys by ecoregion.

| Ecoregion | Sampling Years | | | | | | | |
|---------------|----------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| | 1995 | 1996 | 1997 | 1998 | 2005 | 2008 | 2012 | 2015 |
| North | 59,178 | 91,175 | 8,978 | 14,484 | 4,237 | 7,233 | 4,244 | 10,209 |
| North-Central | 19,523 | 112,964 | 8,718 | 11,603 | 12,537 | 3,355 | 5,645 | 5,868 |
| South-Central | 22,403 | 3,623 | 10,659 | 8,267 | 2,346 | 2,666 | 3,422 | 4,620 |
| South | 5,063 | 3,153 | 4,735 | 14,738 | 5,336 | 2,438 | 3,952 | 2,786 |
| Total: | 106,167 | 210,916 | 33,090 | 49,094 | 24,458 | 15,691 | 17,264 | 23,483 |

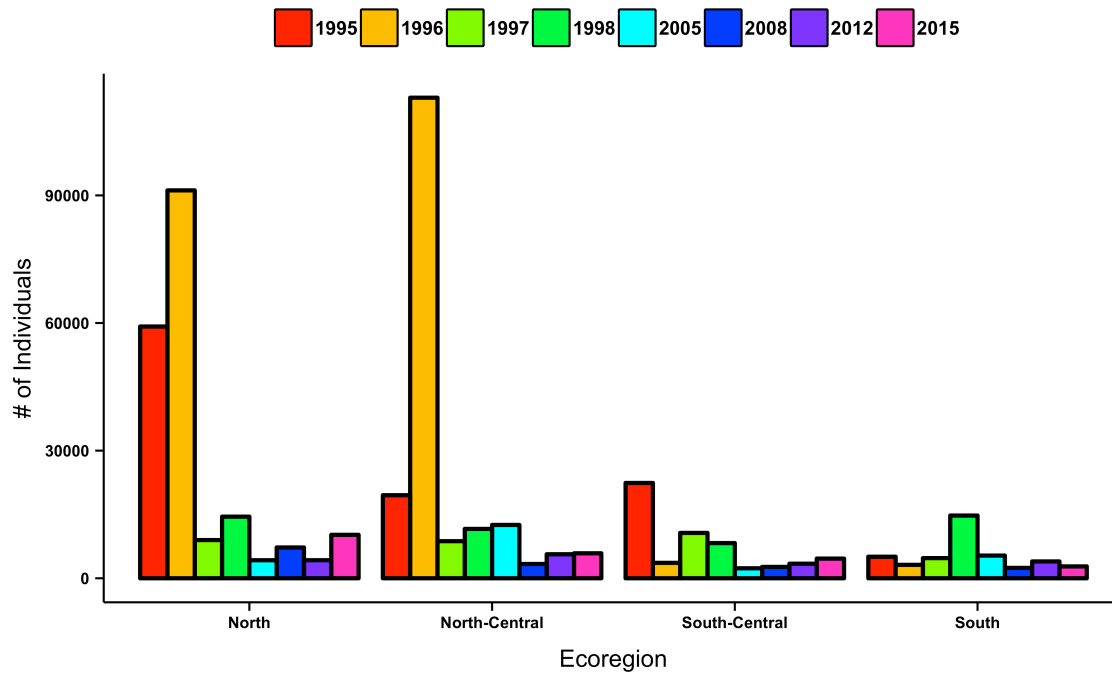


Figure 26. Total catch for April and July surveys by ecoregion.

Table 29. Total biomass (kg) of fishes captured during April and July surveys by ecoregion.

| Ecoregion | Sampling Years | | | | | | | |
|---------------|----------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | 1995 | 1996 | 1997 | 1998 | 2005 | 2008 | 2012 | 2015 |
| North | 111.9 | 195.4 | 70.1 | 58.7 | 58.9 | 36.5 | 119.7 | 112.5 |
| North-Central | 97.2 | 192.3 | 88.4 | 74.4 | 121.0 | 55.3 | 83.0 | 120.7 |
| South-Central | 111.8 | 46.6 | 65.4 | 33.2 | 34.2 | 43.7 | 70.7 | 68.9 |
| South | 89.2 | 75.8 | 48.2 | 52.3 | 77.8 | 49.0 | 74.8 | 75.1 |
| Total: | 410.0 | 510.1 | 272.1 | 218.6 | 291.9 | 184.5 | 348.2 | 377.2 |

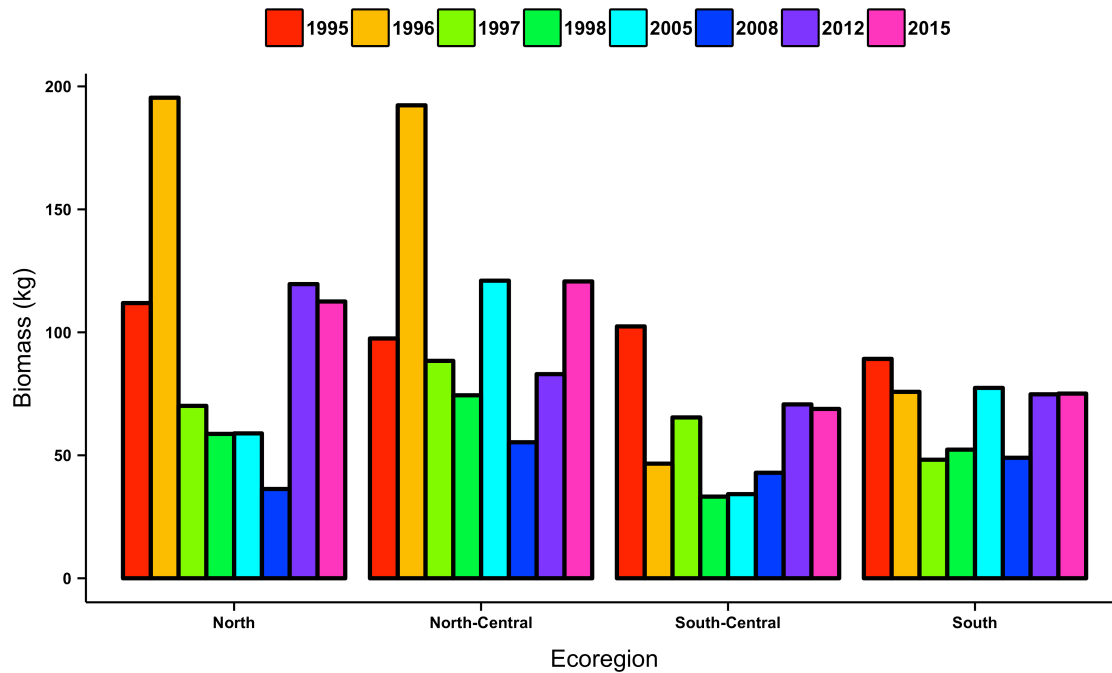


Figure 27. Total biomass (kg) of fishes captured during April and July surveys by ecoregion.

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View from the North Ecoregion to downtown San Diego. (photo: JW)