# Salton Sea Fisheries Long-term Monitoring

## Sampling Report: Summer 2017

Jointly conducted by:
California Department of Fish and Wildlife
United States Fish and Wildlife Service

**Background:**

In early 2016, historic indices of tilapia abundance at the Salton Sea appeared to have reversed: tilapia fry were no longer observed in places where fish were regularly visible in the past, piscivorous bird numbers at the lake were severely reduced, anglers were only catching a small fraction of past numbers of fish, and only a few small fish kills were observed. As observations of these conditions continued in early 2017, the question of whether the tilapia population was still viable was the impetus for the California Department of Fish and Wildlife (CDFW) to re-initiate gillnetting efforts.

USFWS personnel joined with CDFW to deploy and set nets, and combined their vessels, vehicles and facilities to complete this exercise. All members of the interagency team participated in all aspects of the sampling activity to gain a greater awareness of the operation. Participating staff were Tom Anderson, Ryan Woody, Sara Miller and Matt Salkiewicz from the USFWS and Samantha Haynes, Jose Figueroa and Jack Crayon from CDFW. CDFW had sampled the Salton Sea fish population regularly 2003-2008 and for this effort we selected a subset of the original sites to sample (Fig. 1).

In the past sampling effort CDFW monitored the status and trends of the Salton Sea fisheries for six years, from the spring of 2003 through the fall of 2008. CDFW personnel started quarterly sampling at fourteen stations around the sea, as the basis of a long-term monitoring program.

**Figure 1**


Salton Sea Gill Netting Points
North Shore
Varner Harbor
Whitewater River
North Basin
North Desert Shores
Bat Caves
The Cliffs
The Dome
Inter-basin
North Wister
South Salton City
South Basin
Alamo River
Launch Points
2017 Sites
Test Base
Obsidian Butte
New River
0 2 4 8 12 16 20
Kilometers

Each quarter, conditions allowing, this protocol produced about 528 net-hours of sampling. After each quarter's sampling was completed, a report was prepared and distributed, summarizing the numbers and species of fish netted, and calculating the overall and species-based catch-per-unit-effort (CPUE). The reports also offered insights on the condition and population structure of each species.

Since sampling was discontinued in 2008, largely due to a lack of useable boat launching sites, all indices of tilapia population size had remained robust. There were annual signs of reproduction, piscivorous birds continued to forage in large numbers at the Salton Sea, anglers continued to have remarkable success at harvesting tilapia, and fish kills still produced numbers in the thousands to tens of thousands. Although anecdotal in nature, the strength of these indices were similar to those occurring during CDFW's active fish-sampling years, and the Department considers them to be correlated to high tilapia numbers.

**Methods**:
Methods used in the 2017 sampling of Salton Sea fish follows the protocols established by CDFW for the 2003-2008 monitoring effort.

*2003-2008 Methods*:
Sampling sites initially comprised three broad habitat types: pelagic (3 sites), near-shore (8 sites), and estuarine (3 sites). Pelagic sites were in the approximate middles of the north basin, south basin and inter-basin areas of the Salton Sea. Near-shore sites were spaced widely apart, four each, near the west and east shores, to capture as much breadth of habitat as possible. Estuarine sites were in the body of the Salton Sea, yet close enough to the mouths of the New, Alamo, and Whitewater Rivers, to be under the influence of their outflows. See Appendix 1 for the UTM coordinates of all sites.

Sampling took place during each of the putative seasons, as follows: spring- April and May; summer- July and August; fall- October and November; winter- January and February. We attempted to compress the total sampling period into as few days as possible, to the extent that the weather, equipment maintenance, and personnel scheduling constraints allowed it. Nets were typically set at one or two sites in the morning, and hauled in after approximately 24 hours. The exact number of hours set was recorded for each net, to the nearest quarter-hour.

Fish were sampled by deploying multi-panel monofilament gill nets with 6 X 30 foot panels of 0.5, 1, 2, 3, and 4 inch mesh. Two nets were set at all sites at the water's surface. The nets were set far enough apart to allow room for maneuvering a boat during setting and retrieval, usually 100-200 meters. The nets at near-shore and estuarine sites were set in 2.5 to 4.5 meters of water, typically 200-300 meters from the shore.

Two additional nets were set at the bottom of water column at the three pelagic sites. The conditions fish experience at the bottom in deep water is different enough from the surface water, in dissolved oxygen, light, food availability and temperature, that this could be considered a discrete habitat, and thus we sampled it as though it were a separate site.
At the time of each set and retrieval, water depth, water temperature, conductivity, salinity, and dissolved oxygen are measured and recorded. When nets were pulled in the following

day, all fish were removed and immediately stored on ice. Data were collected from these fish as soon as possible, on the same day they were hauled in. All fish were identified to species level and counted. For the four sport fish in the Salton Sea, (tilapia, Gulf croaker, orangemouth corvina, and sargo), lengths (fork length), sex, physical condition, and reproductive status were recorded. Lengths of fish under 50 centimeters were recorded to the nearest millimeter. Lengths of fish over 50 centimeters were recorded to the nearest centimeter.

*Changes to Protocol after 2003*:
Our protocol was designed to elucidate long-term trends in the fisheries. Previous to our efforts, deep water habitats provided some low level of productivity for the fisheries, and were important habitat components to sample. However, our three deep-water sites were completely unproductive, a costly element of our efforts, and the least probable site for fish use, given the severe reduction in population size which we discovered.

We therefore eliminated sampling at the three deep-water sites after 2003, which reduced our efforts by 288 net-hours, to a quarterly total effort of 528 net-hours. All future comparisons of CPUE that we made were among quarterly data sets that exclude previously sampled deep-water sites from the calculations.

*Changes to Protocol for 2017 Sampling:*
To allow comparison of current and future monitoring efforts by CDFW to past results, our protocol for fish monitoring beginning in 2017 was adapted from those previously used. Because of limited staff and resources, we scaled back the sampling effort to six sites (yellow points Figure 1). Estuarine sites were selected with the goal of evaluating the influence of freshwater inflows. Near-shore sites were subjectively selected because these sites were highly productive in the past monitoring effort. Sites were also selected to provide three sites in both the north and south basins of the Salton Sea. Net setting protocols remained the same, however, during summer 2017, all previous sampling sites were no longer in water deep enough to fully deploy nets. For the current sampling effort, our team moved into deeper water from the previous sites, at a right angle to the shore, until we were able to set nets in water approximately 8-9 feet deep.)

**2017 Sampling Results**:
Our summer 2017 sampling session was conducted from July 13 through August 10, at six of our previously sampled sites. Table 1 shows the numbers of fish sampled at each site. Total number of tilapia sampled at these sites was 327 fish with 294.5 net-hours of effort, for a CPUE of 1.11. Three size classes of fish were found to be present in the Salton Sea (Table 2).

**Table 1 Sampling Results**

| Date | Site | Net-hours | Tilapia | Croaker | Corvina | Sargo | Other | Total Fish | CPUE |
|---|---|---|---|---|---|---|---|---|---|
| 7/14/2017 | Alamo River | 48.0 | 67 | 0 | 0 | 0 | 0 | 67 | 1.40 |
| 7/20/2017 | New River | 48.0 | 48 | 0 | 0 | 0 | 0 | 48 | 1.00 |
| 7/26/2017 | Test Base* | 48.0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.02 |
| 7/27/2017 | North Shore | 55.0 | 39 | 0 | 0 | 0 | 0 | 39 | 0.71 |
| 8/3/2017 | Bat Caves** | 47.5 | 4 | 0 | 0 | 0 | 0 | 4 | 0.08 |
| 8/8/2017 | Whitewater | 48.0 | 168 | 0 | 0 | 0 | 0 | 168 | 3.50 |
| | The Dome | | | | | | | | |
| | The Cliffs | | | | | | | | |
| | Desert Shores | | | | | | | | |
| | So. Salton City | | | | | | | | |
| | No.Wister | | | | | | | | |
| **Totals** | | **294.5** | **327** | **0** | **0** | **0** | **2** | **327** | **1.11** |
| | | | | | | | | | |
| * Nets were coated on top 1/3 by colonizing barnacles, and coated with algae. Mesh was visible to fish. | | | | | | | | | |
| ** Nets were heavily coated with algae, and mesh was highly visible | | | | | | | | | |

**Table 2 Sampling Results by Size Class**

| | Size Class 1 | | | Size Class 2 | | | Size Class 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Range (mm)** | **n** | **%** | **Range (mm)** | **n** | **%** | **Range (mm)** | **n** | **%** |
| Summer '17 | 64-76 | 28 | 9 | 80-200 | 128 | 39 | 279-394 | 171 | 52 |

**Discussion**:

Tilapia numbers were highly variable, by location. This is consistent with past results, wherein numbers of fish varied among sites, but were not consistently the highest or lowest at any particular site. Chart 1 shows a comparison of all results for the previous years of sampling tilapia, by season. (Note that the scale is logarithmic, for ease of viewing.) For six years of sampling, tilapia numbers consistently increased annually, and summer sampling numbers were usually the largest during the year. The 2003-2008 monitoring occurred following a crash of all fish populations in the Salton Sea, and the data document the recovery of the tilapia population.

A comparison of 2017 sampling results by site, with the prior six years of summer season sampling, highlights several phenomena (see Tables 3 and 4): 1) The numbers of fish sampled at the river sites were very low, but within the sites' historical ranges. 2) The numbers of fish collected at the three nearshore sites were the lowest we have ever sampled. 3) Three size classes were present in the lake; thus, there is population structure, and breeding took place late this spring. These size classes presented in Table 2 are consistent with our previous summer season observations of age structure in the population.

**Chart 1**

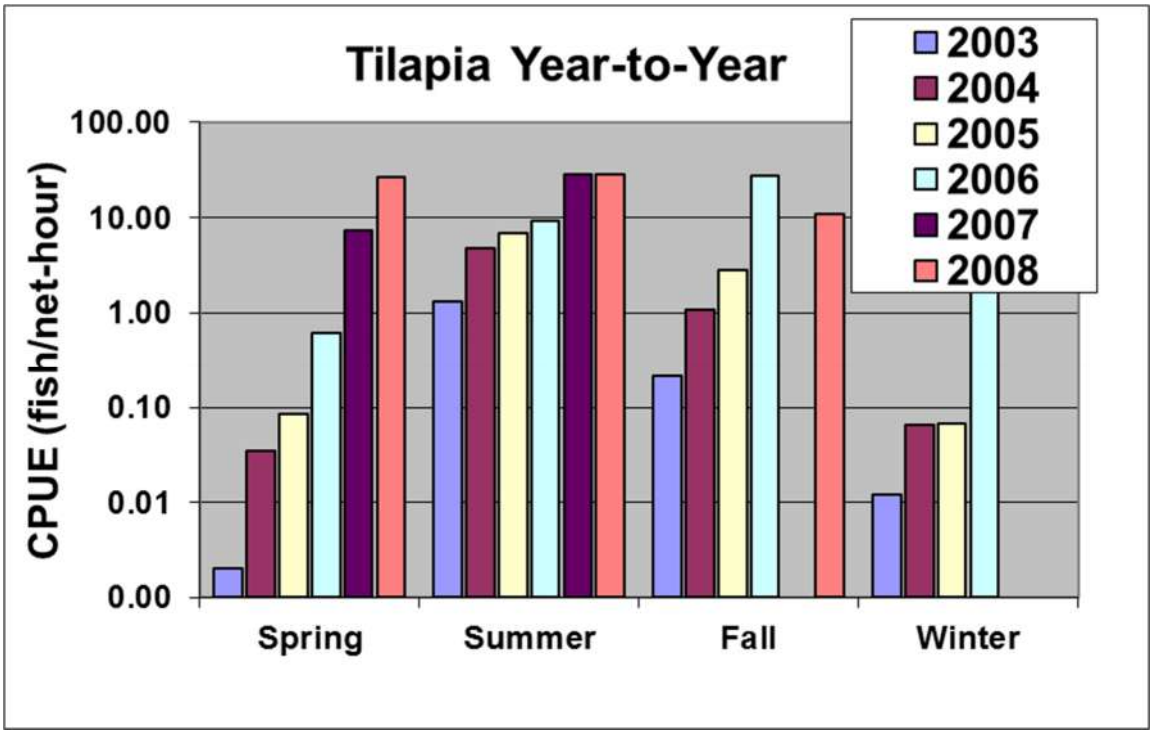


**Table 3 Comparison of Summer Quarter Results**

| Alamo River | | New River | | Whitewater River | |
|---|---|---|---|---|---|
| Quarter | CPUE | Quarter | CPUE | Quarter | CPUE |
| Su 04 | 0.28 | Su 03 | 0.18 | Su 05 | 0.00 |
| Su 03 | 0.34 | Su 04 | 0.30 | Su 03 | 0.04 |
| Su 17 | 1.40 | Su 07 | 0.55 | Su 17 | 3.50 |
| Su 05 | 1.71 | Su 17 | 1.00 | Su 04 | 6.85 |
| Su 06 | 1.94 | Su 06 | 8.40 | Su 06 | 12.00 |
| Su 07 | 3.26 | Su 05 | 11.05 | Su 07 | 23.25 |
| Su 08 | 23.51 | Su 08 | 15.46 | Su 08 | 23.79 |

**Table 4 Comparison of Summer Quarter Results**

| Bat Caves | | North Shore | | Test Base | |
|---|---|---|---|---|---|
| Quarter | CPUE | Quarter | CPUE | Quarter | CPUE |
| Su 17 | 0.08 | Su 17 | 0.71 | Su 17 | 0.02 |
| Su 03 | 2.43 | Su 03 | 2.12 | Su 03 | 1.73 |
| Su 04 | 4.02 | Su 04 | 8.83 | Su 06 | 5.29 |
| Su 06 | 10.09 | Su 05 | 8.99 | Su 07 | 12.46 |
| Su 05 | 18.36 | Su 06 | 22.61 | Su 04 | 23.07 |
| Su 07 | 23.88 | Su 07 | 24.38 | Su 05 | 25.02 |
| Su 08 | 36.12 | Su 08 | 30.63 | Su 08 | 32.54 |

The Salton Sea tilapia population found in 2017 is much smaller than previously documented. Although the fish were not aged, the presence of three size classes indicates some level of recruitment took place this year. We cannot say if the level of recruitment is enough to sustain the population.

It has often been speculated that fish would persist at the river mouths when water quality degraded to the point of eliminating them from the rest of the lake. All past water quality data that CDFW collected showed no substantial difference in either salinity or oxygen levels between the river sites and other sampling sites. The waters of the rivers mix rapidly with the higher salinity lake waters, and whatever strata develop are spatially small and short-lived. More fish were collected at the river mouths this season; this may be due to lower salinity, or other factors such as hydrogen sulfide eruptions at the other sites. All three river mouths harbored greater densities of tilapia than the nearshore sites which suggests that the influence of freshwater inflows seems to provide a refugia from some population limiting phenomena. Although fish numbers were greater at the river mouths, reproduction does not appear to occur there. The flow of water and rate of sediment deposition from the rivers would preclude the conditions needed for tilapia nesting.

**Additional Observations**:

There were no tilapia of any size observed in Varner Harbor this year. There were no nests, and no fry where they had been visible in past years. The water in Varner Harbor is shallow and clear to the bottom at the site of past tilapia nesting. Our sampling did produce young hatched this year, so breeding presumably now takes place at different locations. There were notable fish kills immediately prior to this year's sampling, observed at various places around the lake. No fish from either of the two smaller size classes have been observed in summer fish kills this year. The sites of observed fish kills were well attended by gulls, herons and egrets. It is possible that the smaller classes were scavenged by these birds, since our surveys found smaller live fish present in the lake.

In addition to tilapia, we observed robust indications of barnacle reproduction while gillnetting. After leaving nets overnight at the Test Base sampling site, the entire upper 18 inches of netting were coated with barnacle cyprids that had attached overnight. Photograph 1 shows barnacle colonization that occurred overnight on a float.

We observed low numbers of piscivorous birds at the Salton Sea in 2016 and 2017. Numbers of Brown Pelicans, American White Pelicans, Double-crested Cormorants, Caspian Terns, and Western Grebes were all greatly reduced.[1,2,3] There have been public assertions that this lack of birds was due to a lack of fish to eat. We have now seen that fish were produced this year and were available as forage during mid-summer. We made numerous observations of pelicans and cormorants feeding while sampling for fish, especially at the north end of the sea. Even though bird numbers at the Salton Sea are lower than in previous years, the same species of birds are utilizing the resource in a manner similar to past patterns of usage. Nevertheless, there are fewer fish available as forage in

[1] Data collected from CDFW aerial surveys monitoring piscivorous birds from 2009 through 2017
[2] Data collected from CDFW surveys of local nesting colonies.
[3] Personal observations by S Haynes, J Crayon, T Anderson

the Salton Sea and we expect that may have an impact on avian use and the current numbers of piscivorous birds. We surmise that birds would go elsewhere if they arrive and do not find sufficient foraging opportunities.

Most of the bird species at the Salton Sea are migratory and travel between Canada and South America, utilizing the Salton Sea as a stopping point, wintering area, or breeding site. Migratory birds may move more or less in a given year depending on the local conditions. If conditions are favorable, they may remain in an area longer than usual, or they can be driven to move by the lack of food resources. Reduced numbers at the Salton Sea may also be a function of exogenous factors such as weather patterns, or reduced breeding success throughout the species' range. We offer the following observations for four high-visibility species:

1) The rainy weather in northern California this past winter created habitat for American White Pelicans; the majority of them remained north of Sacramento during the winter instead of traveling south to the Salton Sea.[4] This may account for lower than usual numbers of birds observed during aerial surveys in fall and winter, 2016. American White Pelicans started to arrive at the Salton Sea during the summer, as expected.

2) Eared Grebes congregate at Mono Lake in large numbers to feed on brine shrimp, before migrating to the Salton Sea in the late fall. The number of Eared Grebes at Mono Lake have historically predicted the numbers that arrive at the Salton Sea.[5] In 2015, surveys of Eared Grebes at Mono Lake produced a population estimate near 800,000. In 2016, the population estimate was half that number.[6] Therefore, fewer birds were expected to arrive at the Salton Sea in the late fall and early spring.

3) Double-crested Cormorants numbers were also lower during the winter 2016 surveys. A small resident population remained throughout the spring and summer but did not initiate large nesting colonies, and had limited breeding success.[7] During our tilapia sampling, we saw cormorant numbers increase at the Salton Sea.[8,9] They may have nested or foraged elsewhere during the spring but are now arriving at the Salton Sea to forage and roost for the fall and winter. This would be normal behavior given the species' plasticity in choosing breeding and wintering foraging habitats.

4) Brown Pelicans arrived at the Salton Sea as expected during June and July. During this time, we observed about two thousand Brown Pelicans, including juveniles.[10] The numbers of Brown Pelicans that arrive at the Salton Sea in the summer is dependent on the species' breeding success in Baja California, which may be influenced by the

[4] Personal communications, Dan Skalos, CDFW ES performing breeding waterfowl survey, May 2017
[5] Jehl, J.R. & McKernan, R.L. Hydrobiologia (2002) 473: 245. https://doi.org/10.1023/A:1016514725025
[6] Personal communications, Dave Marquart, Mono Lake Tufa State Natural Reserve, May 2017
[7] Data collected from CDFW surveys of local nesting colonies.
[8] Data collected from CDFW surveys of local nesting colonies.
[9] Personal observations; S Haynes, J Crayon, T Anderson
[10] CDFW Airboat surveys

available forage in the gulf near their breeding sites.[11] However, no noticeable differences in populations of Brown Pelicans (or Double-crested Cormorants) were observed near the Gulf of California during this spring and summer.[12] Numbers of visiting Brown Pelicans in the fall and winter were within the lower range of previous years' surveys.[13]

**Looking Forward:**

One goal of this sampling effort was the creation of a dual-agency group of staff familiar with and experienced at sampling fish at the Salton Sea. The vessels and staff currently available could undertake another year of sampling in summer 2018, should questions about the status of the fisheries require it.

[11] Anderson, D. W., & Anderson, I. T. (1976). Distribution and status of brown pelicans in the California current. *American Birds, 30*(1), 3-12. Retrieved from https://sora.unm.edu/sites/default/files/journals/nab/v030n01/p00003-p00012.pdf.

[12] Personal Communications, Eduardo Soto of Alto Golfo de California y Delta del Rio Colorado and Alex Calvo of the Pronatura Noroeste, May 2017

[13] Data collected from CDFW aerial surveys monitoring piscivorous birds from 2009 through 2017

**Appendix 1 Location of Sampling Sites**

| SITE NAME | HABITAT TYPE | UTM COORDINATES |
|---|---|---|
| Whitewater River | Estuarine | 11S 0587948 3707343 |
| New River | Estuarine | 11S 0621567 3666958 |
| Alamo River | Estuarine | 11S 0628480 3675635 |
| North Shore | Near-shore | 11S 0598465 3709237 |
| North Wister | Near-shore | 11S 0628368 3685497 |
| Bat Caves | Near-shore | 11S 0607427 3699864 |
| South Salton City | Near-shore | 11S 0604971 3682198 |
| North Desert Shores | Near-shore | 11S 0589366 3699424 |
| The Dome | Near-shore | 11S 0596997 3690022 |
| The Cliffs | Near-shore | 11S 0615062 3691509 |
| Test Base | Near-shore | 11S 0608813 3672196 |
| North Basin | Pelagic | 11S 0596156 3701218 |
| Inter-basin | Pelagic | 11S 0606837 3689452 |
| South Basin | Pelagic | 11S 0618275 3678697 |

**Photograph 1 Barnacle colonization on float**