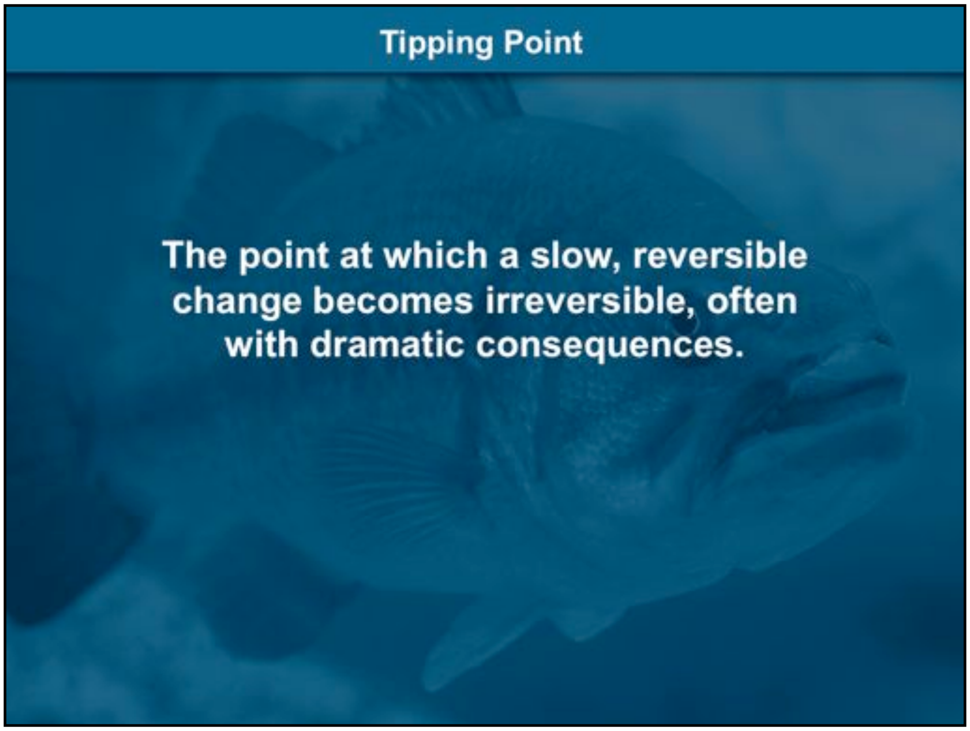
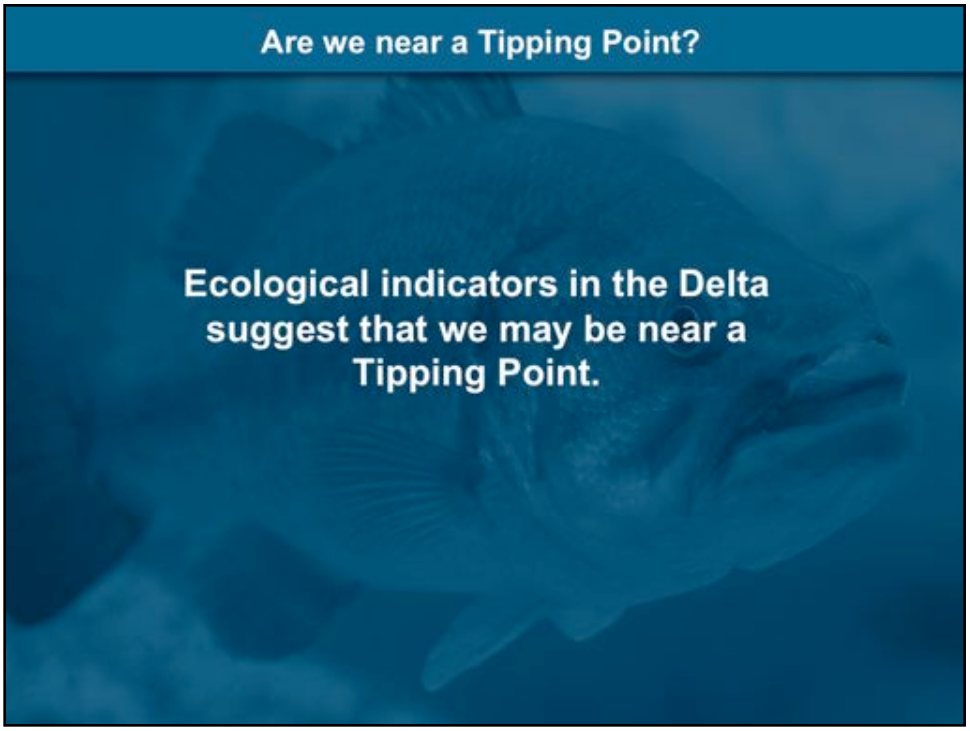
California's Delta covers almost 750,000 acres of land, consists of hundreds of miles of waterways, and is the largest estuary on the west coast of North and South America.

The State Water Project and federal Central Valley Project bring Delta water to 24 million Californians, nearly two-thirds of the state population, and irrigate 750,000 acres of cropland.



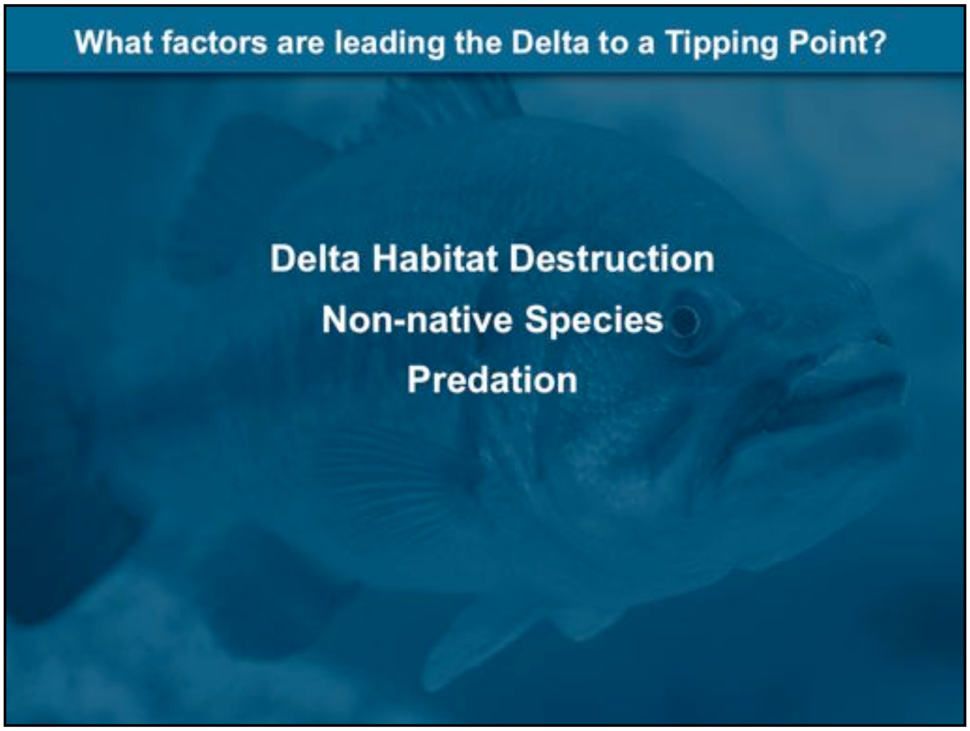
The dictionary defines Tipping Point as "the point at which a slow, reversible change becomes irreversible, often with dramatic consequences."



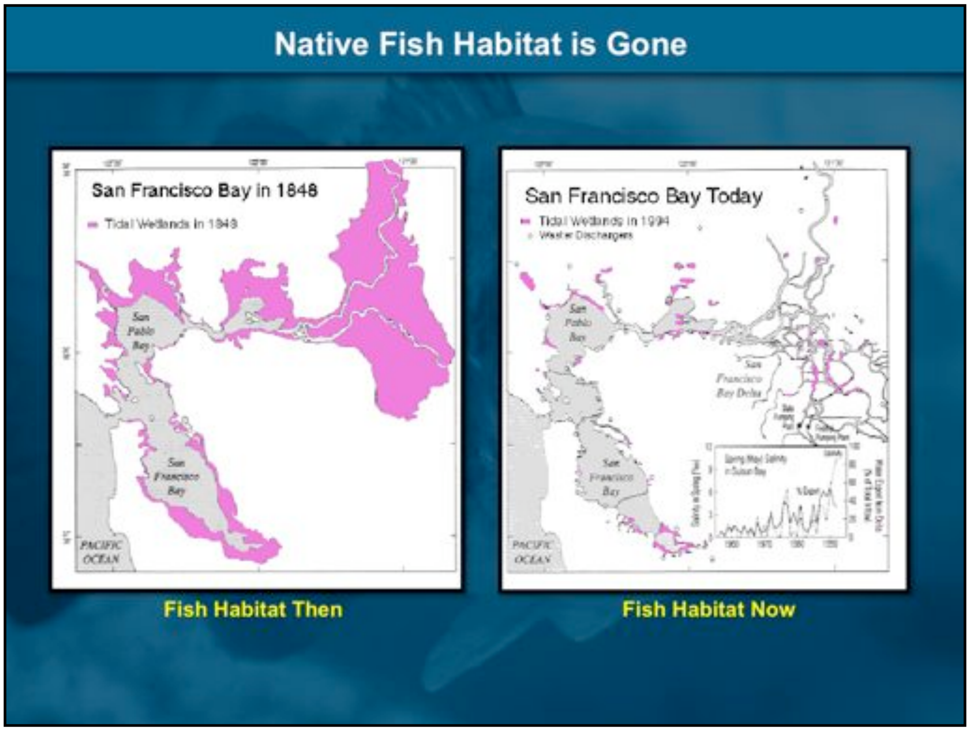
Are we at or near a Tipping Point for native species in the Delta?

Many ecological indicators in the Delta suggest that we may be near, or at least approaching a Tipping Point.

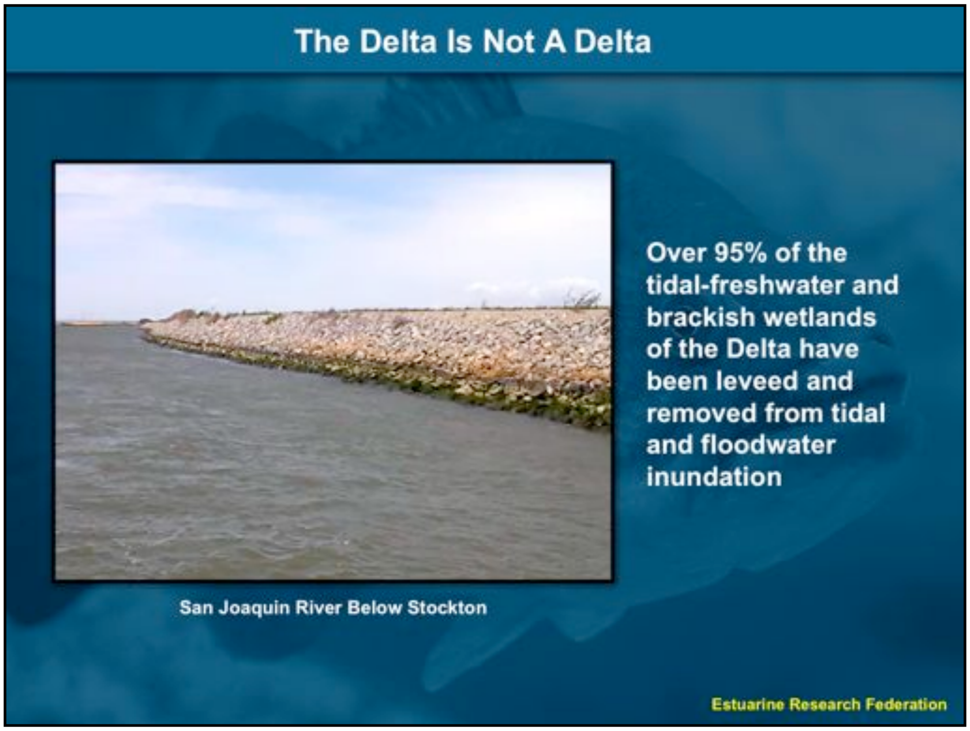
These indicators include a collapse of the aquatic food chain, replacement of native plant and animal communities with non-native species, and what's referred to by many as the "crash" of delta fish communities, such as Delta smelt populations and anadromous salmon and steelhead that pass through the Delta



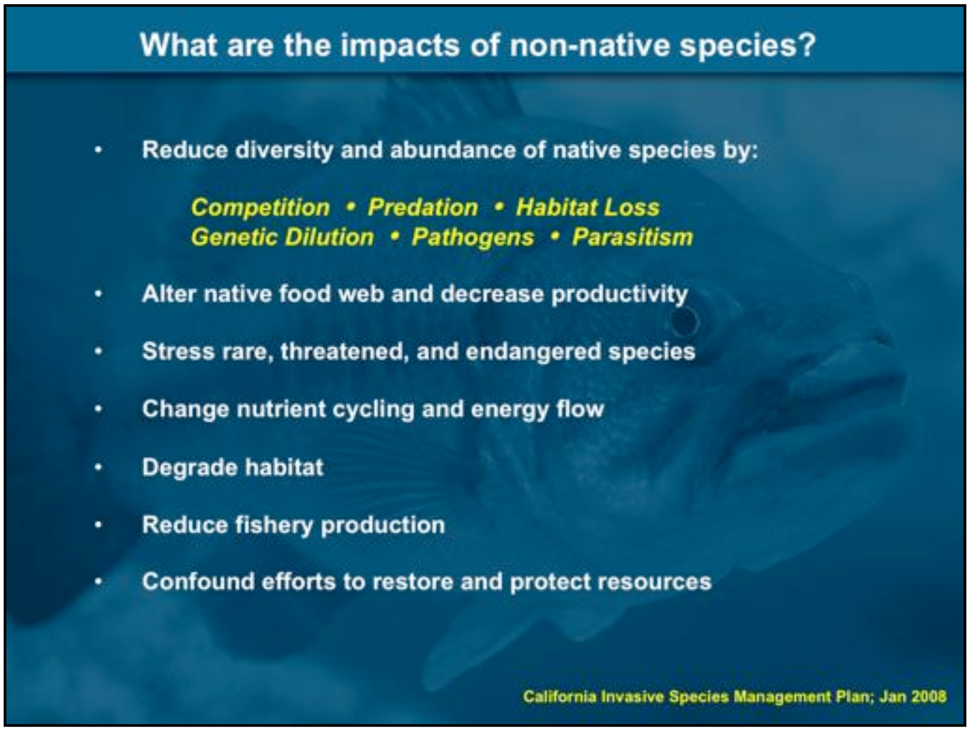
Experts are investigating the many potential causes for the decline of the Delta. There is no doubt that historical Delta habitat destruction, invasion of non-native species, and predation by non-native predator fish are major factors associated with the collapse of native Delta fish communities.



Perhaps the most obvious and dramatic change in the Delta is the widespread loss of shallow water habitat, vital nursery areas for juveniles of almost all fish species. Shallow water habitat is also important for primary and secondary producers, the organisms at the base of the food chain that ultimately provide food for native fish.



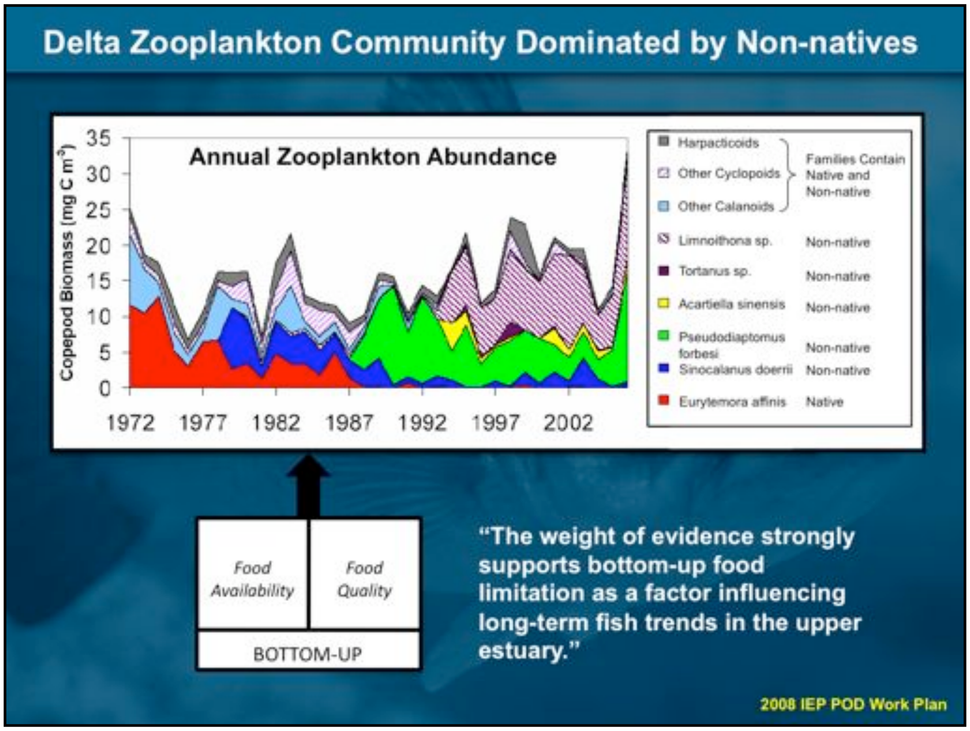
The modern Delta is a network of water conveyance canals protected by rip-rap levees, which not only eliminate native fish habitat but create habitat that favors non-native fish. Levees reduce native fish habitat complexity by decreasing gravel and woody debris recruitment, and decreasing food production. The Estuarine Research Federation estimates that over 95% of Delta wetlands have been destroyed due to levees.



The invasion of Delta waters by non-native plants and fish occurred simultaneous to the destruction of Delta habitat, and may be as ecologically disastrous.

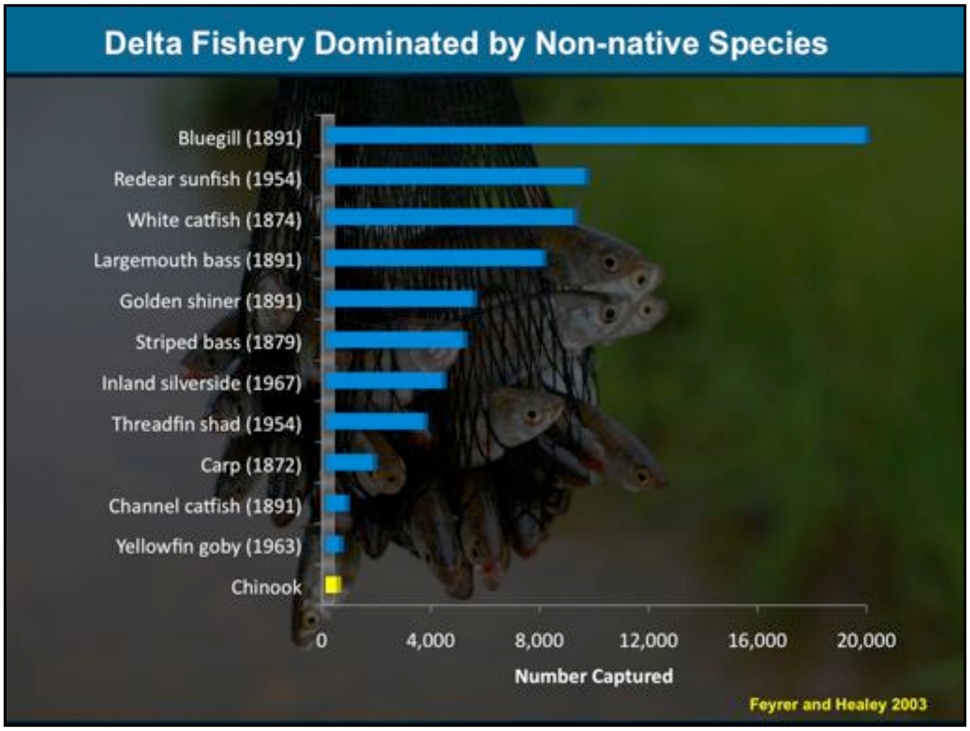
The detrimental impacts of non-native species are extensive and well known, including reduced diversity and abundance of native species through competition, predation and habitat loss.

Other impacts of non-native species include altering the Delta food web by decreasing primary and secondary productivity, stressing threatened and endangered species, degrading habitat, reducing fishery production, and perhaps most importantly, confounding all of our efforts to restore and protect native resources.



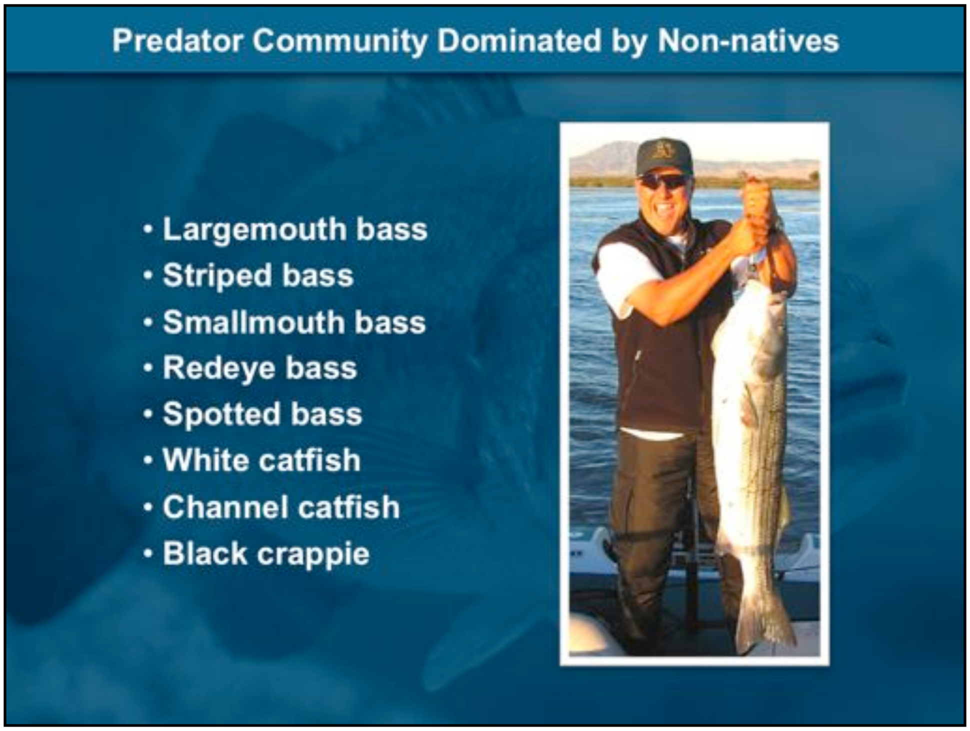
Non-native species have drastically altered the Delta food web, such that native zooplankton communities that once fed diverse native fisheries in the Delta, have been replaced by non-native zooplankton that are less available and of poorer nutritional value than native zooplankton.

Significant changes in food resources have the potential to limit native fish productions, and according to new research by the Interagency Ecological Program, "the weight of evidence strongly supports bottom-up food limitation as a factor influencing long-term fish trends in the upper estuary."



Zooplankton aren't the only communities that have been replaced by non-native species. In a decade of fish sampling by government agencies in the south Delta, the 11 most abundant fish captured were non-native species. In this study, which is consistent with other Delta studies, the overwhelming majority of the biomass consisted of non-native fish species.

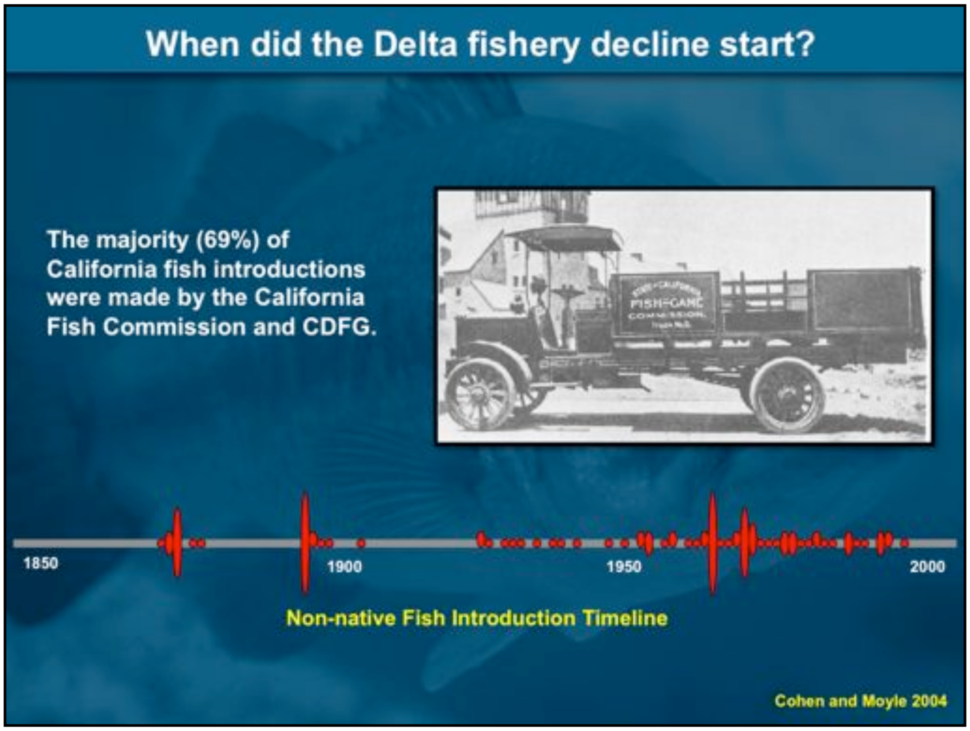
Many of these species compete with native fish, such as juvenile salmon, for limited food and space. Others, such as striped bass, largemouth bass, and white catfish are known to be significant predators that prey on salmon smolts as they move through the Delta. As Professor Mount stated, from a biomass perspective the Delta is doing very well, it just isn't producing what we want.



Historically, the Delta consisted of approximately 29 native fish species, none of which were significant predators of other fish. Presently, 12 of these original species are either eliminated from the Delta or threatened with extinction.

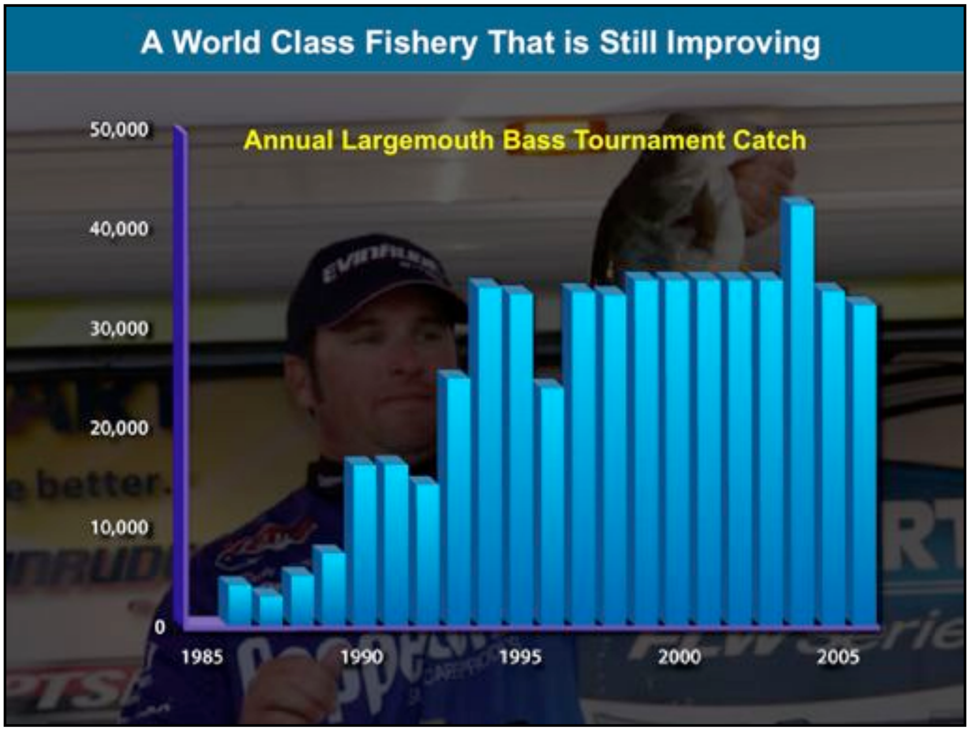
Although none of these original fish populations were significant predators, today the Delta and lower tributaries are full of large non-native predators that were deliberately introduced into the Delta by the California Department of Fish and Game, and it's predecessor, the California Fish and Game Commission.

All of the top predators responsible for preying on native fish are currently managed with angling gear, season, and size regulations to maintain or increase their abundance.



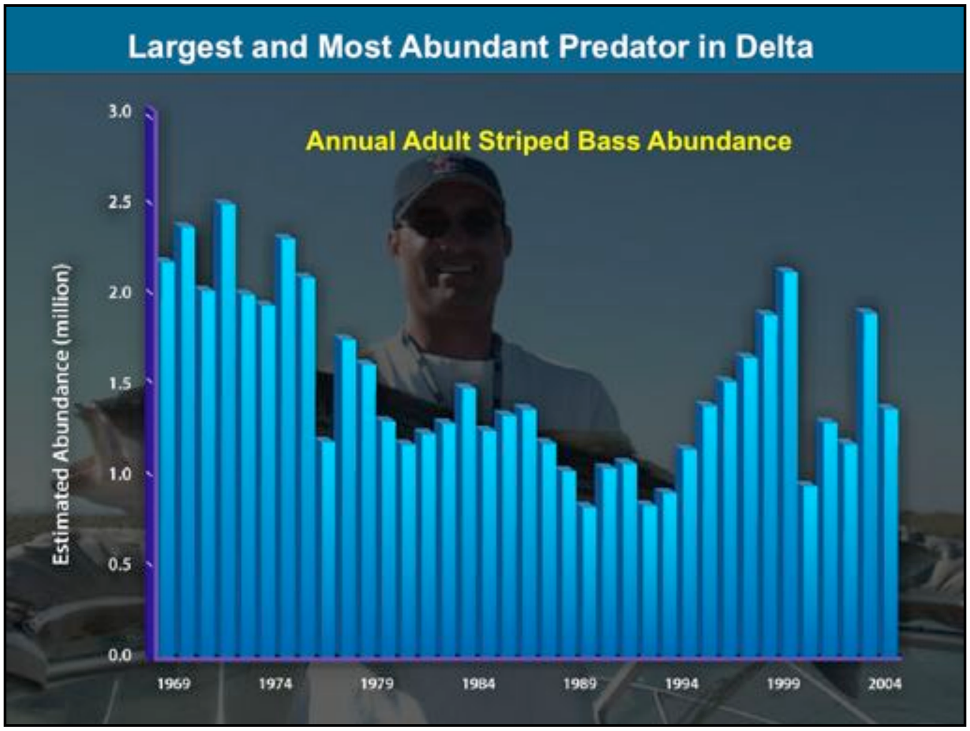
Although people generally think of non-native species as "hitchhikers" that arrive with ballast water or bait buckets, the majority of non-native fish introductions in California were deliberately planted by the California Fish Commission and California Department of Fish and Game.

Collectively, non-native fish have a detrimental impact on native fish through predation and competition for resources, such as food and space.



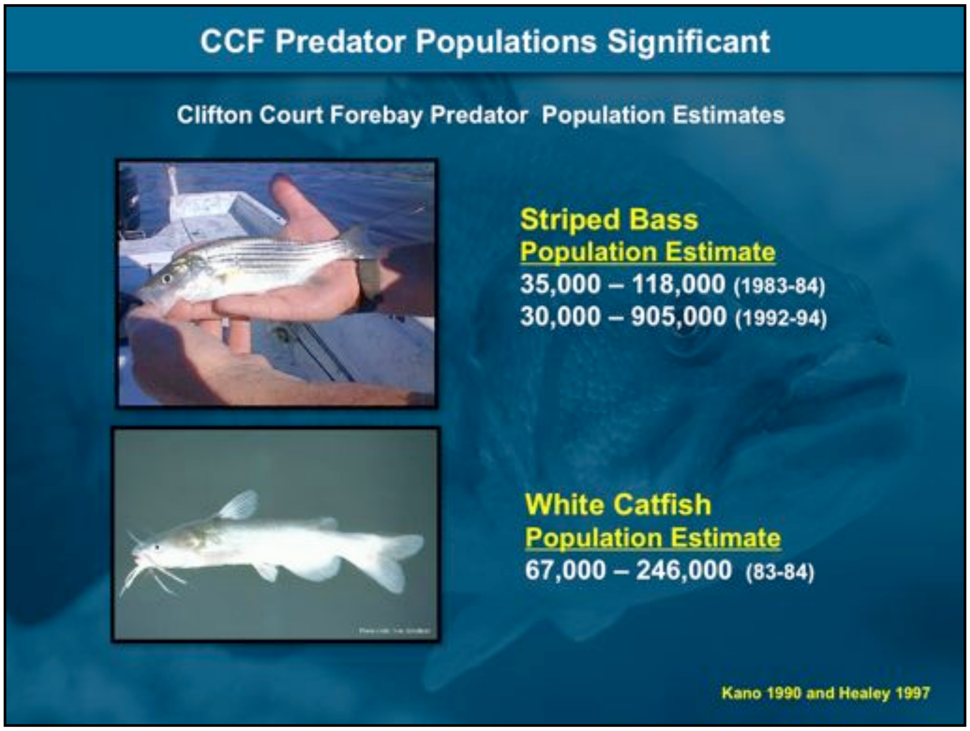
As a recent government study states, *"Although none of the IEP surveys adequately tracks largemouth bass population trends, the Delta has become the top sport fishing destination in North American for largemouth bass, which illustrates the recent success of this species. Each year, lucrative fishing tournaments are held in the Delta to take advantage of the large number of trophy-sized bass in the region. Largemouth bass have a much more limited distribution in the estuary than striped bass, but a higher per capita impact on small fishes (Nobriga and Feyrer 2007).*

One cause for the increase in bass abundance is believed to be the continued spread of the non-native plant *E. densa*, which increased by about 10% each year from 2004 to 2006.

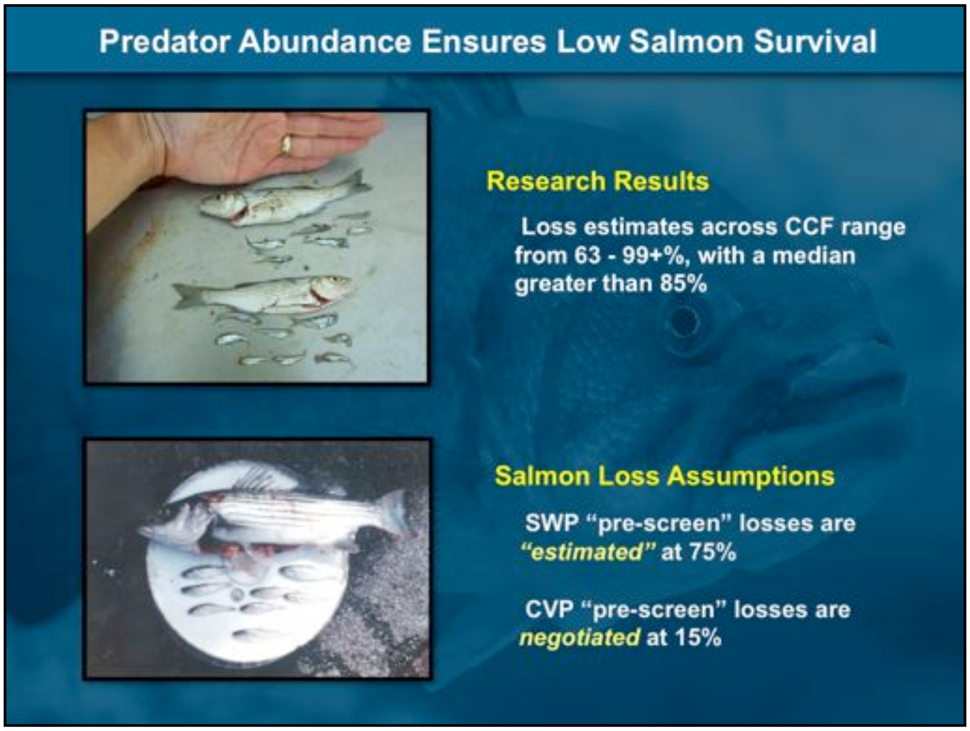


Striped bass were first introduced in the Delta in 1879, and were so successful that by 1890 there was a commercial fishery underway. As Professor McGinnis notes in his recent book on California freshwater fish, prior to the 1870's the Delta had no large, pelagic predator that fed voraciously during a long annual stay in freshwater.

Today, although the myth persists that the striped bass population is collapsing, the California Department of Fish and Game estimates that there are over 1 million stripers in the Delta. Their abundance remains high, even though in 1992 the stocking of striped bass in the Delta was curtailed due to concern over predation on the endangered winter-run Chinook salmon.

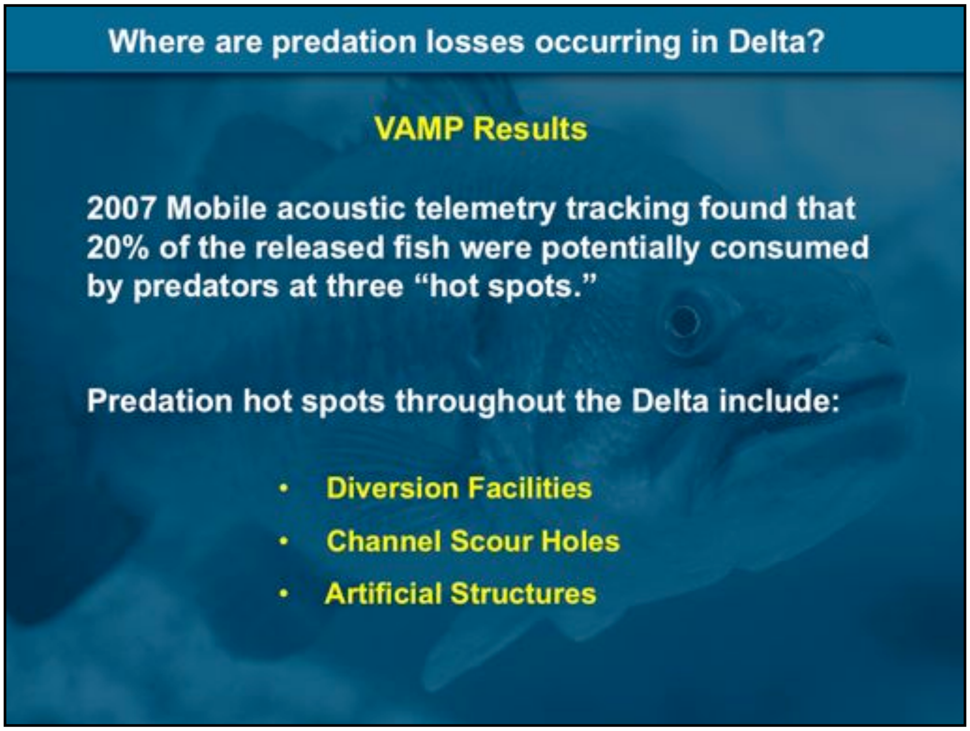


Although little research has been conducted to ascertain the abundance of various predators throughout the Delta, some studies have tried to estimate the abundance of striped bass and white catfish in Clifton Court Forebay. Estimates of striped bass in Clifton Court range from 35,000 to 118,000 in 1983 and 1984, to 30,000 to 905,000 in 1992 through 1994. There is no reason to suspect that striped bass populations have decreased in Clifton Court in recent years. If anything, recent observations suggest that striped bass are very abundant, especially in the spring when juvenile salmon are present.



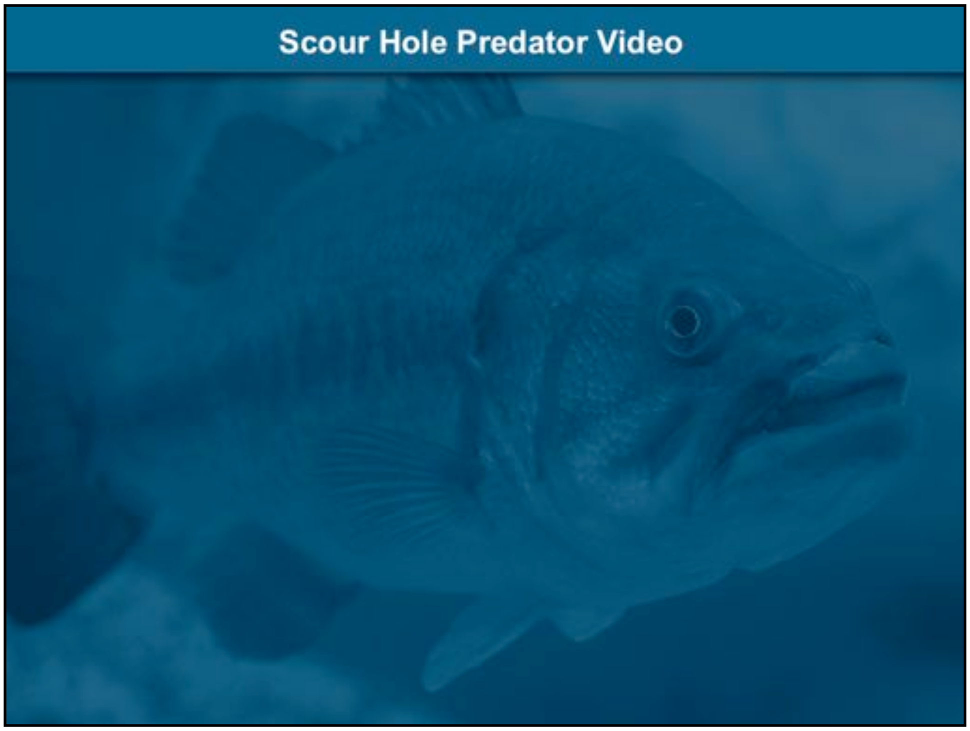
Although predation on juvenile Chinook Salmon in Clifton Court Forebay is difficult to accurately assess, all evidence suggests that predation losses are extremely high, with a mean predation rate of several studies over 85%.

Losses of juvenile Chinook are so high in Clifton Court that for ESA permitting purposes prescreen losses are estimated at 75%. That means the majority of Chinook that enter Clifton Court Forebay are eaten by non-native predators, who's abundance could be reduced by a variety of methods.



Recent acoustic telemetry research by government and private water interests suggests that predation may be high at hot spots such as diversion facilities, channel scour holes, and artificial structures.

Such findings are important since predation can be reduced through predator removal programs, changes in channel geomorphology, and reductions in the number of instream structures.

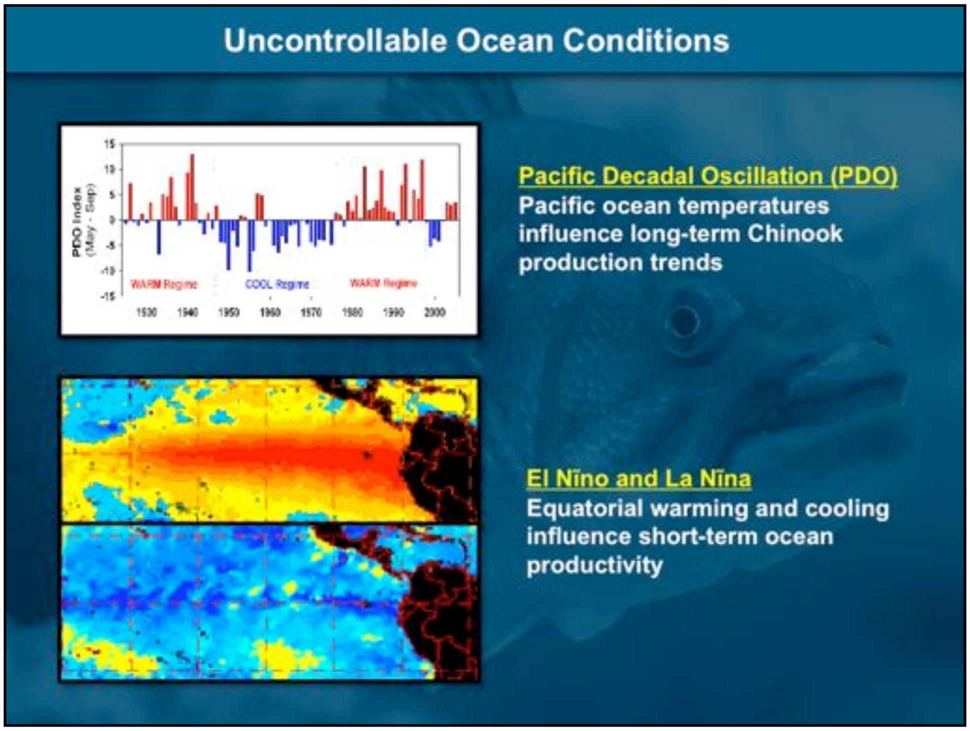


Because the Delta is too turbid to visually observe fish, a high-tech acoustic video camera was recently used to observe fish abundance and behavior at suspected predation hot spots. Divers recorded visual evidence that corroborates telemetry data, suggesting that that predators congregate in scour holes and around artificial structures.

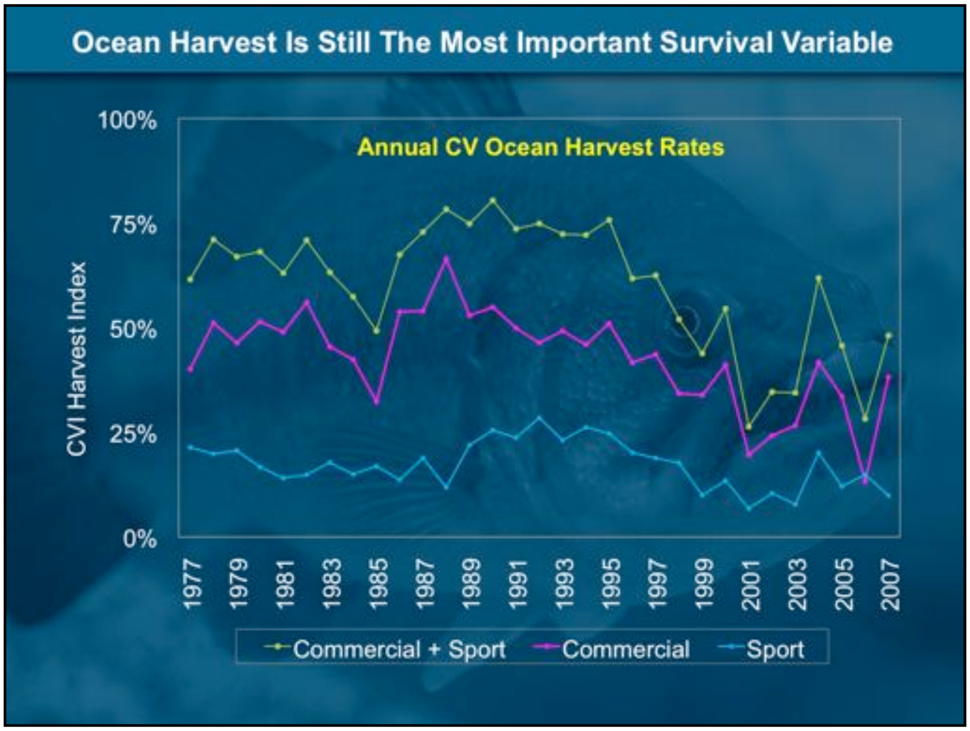
This underwater acoustic video image shows a large school of threadfin shad being herded by large predators, likely striped bass. It is believed that threadfin shad, similar to juvenile salmon, use low-velocity scour holes to escape high velocity main flow areas, only to be predated on and harassed by non-native predators such as striped bass.

Artificial structures such as agricultural diversions, agricultural returns, road bridges, and marina and boat docks, are very abundant throughout the Delta, and evidence suggests they increase habitat for large predators, and as a result may increase predation on juvenile salmon.

This underwater acoustic video on the San Joaquin River shows a large number of predators, probably striped bass, congregating behind the Mossdale Bridge pilings. Predators use velocity shadows created by structures to conserve energy and hide from downstream migrating fish.



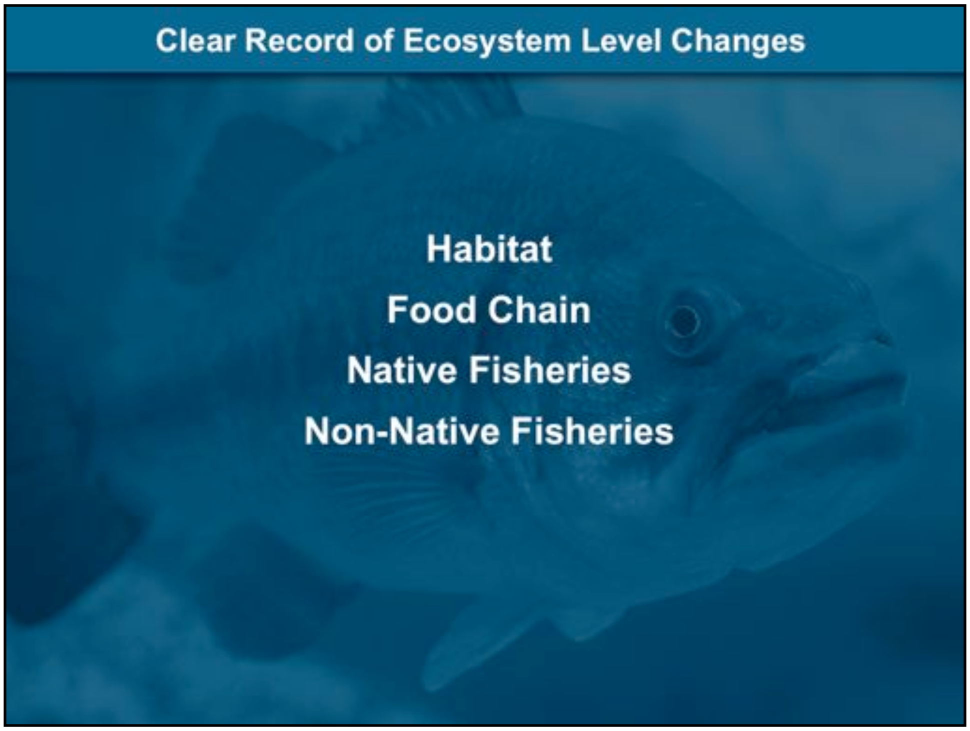
Although resource managers spend tens of millions of dollars a year on research and restoration efforts, it is important to remember that the most important factors influencing the number of adult Chinook returning to spawn each year occur in the ocean, and include ocean temperatures, food availability, and commercial and sport harvest.



Whereas ocean temperatures and food availability are out of our direct control, ocean harvest is not.

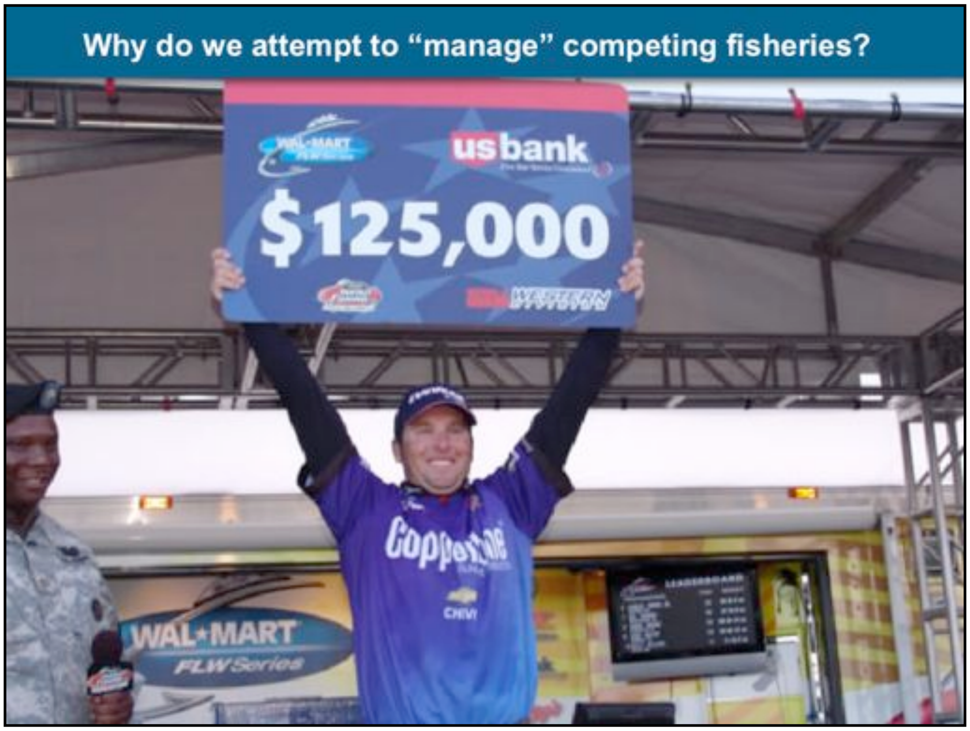
Although commercial ocean harvest was closed in 2008 in response to alarmingly low returns in 2007, ocean harvest is the single largest *controllable* factor that influences the number of adult that return to Central Valley rivers each year.

For example, commercial fisherman harvested on-average about 35% of the population of adult Central Valley Salmon each year, for the period between 2000 and 2007, and a higher percentage in previous years. Reducing or eliminating ocean harvest may be the quickest and most cost-effective way to increase the number of Chinook salmon that return to spawn in Central Valley tributaries each year.



Overall, there is a clear record of ecosystem-level changes in fish habitat, zooplankton and the aquatic food chain, and both native and non-native fish communities within the Delta.

It is clear that these changes are significant enough that they confound our ability to protect and restore native fisheries, represent immediate and irreversible threats to salmon populations, and are consistent with the theory that we may be reaching a Tipping Point in the Delta.

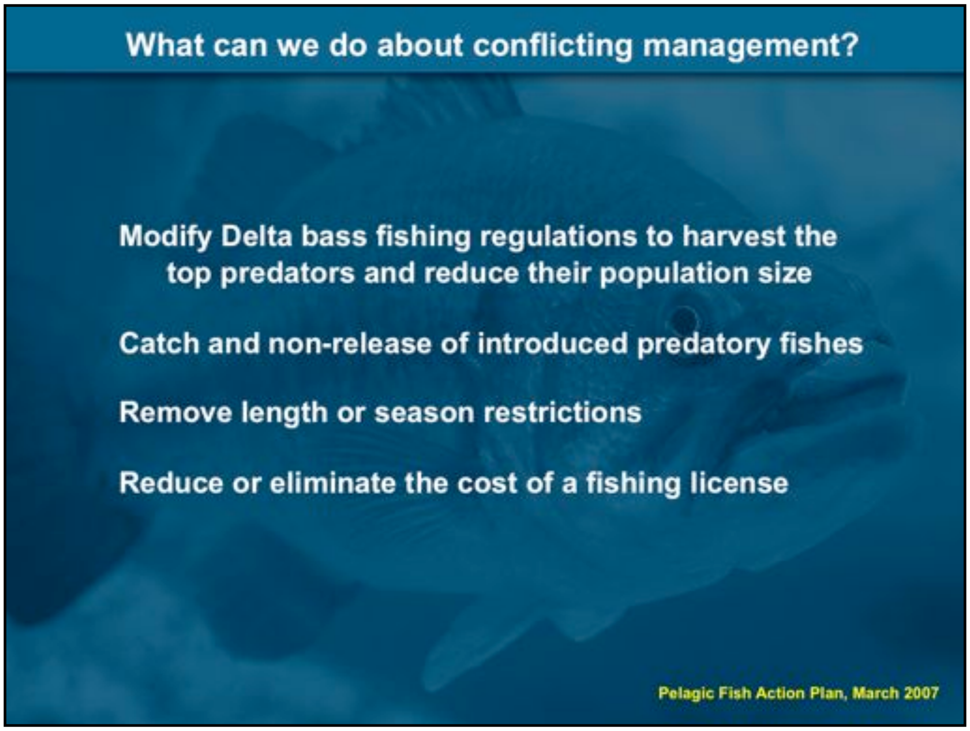


Why do we attempt to "manage" competing native and non-native fisheries?

Why do we impose ESA restrictions with hardships affecting all Californian's to protect native species such as Chinook salmon, steelhead trout, Delta smelt, and Sacramento splittail, and at the same time promote actions that increase the abundance of non-native fish species that either prey on, or compete for food and space resources with ESA protected native fish?

Why do our resource managers ignore sound biological principles in favor of attempting to manage competing resources?

How much longer will it be until this mismanagement ensures we are past the Tipping Point?

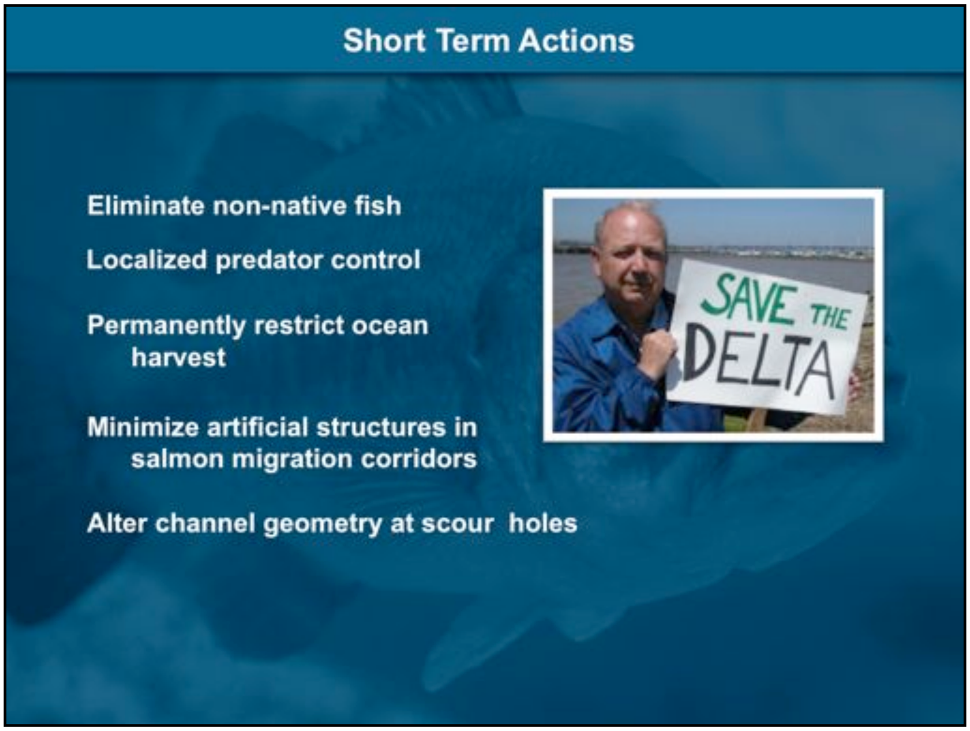


Perhaps better questions include:

How can we immediately reduce competition for limited resources, and reduce predation of native fish by non-native fish?

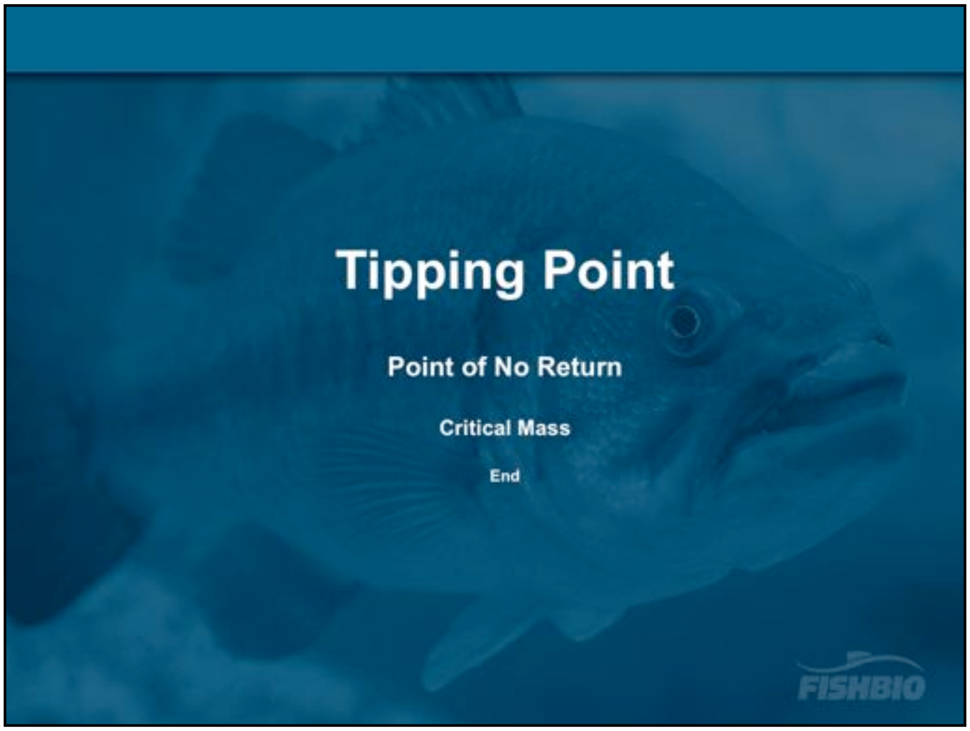
How can we improve conditions for native fish while reducing the abundance of non-native fish, at no cost?

In a joint action plan the California Department of Water Resources and California Department of Fish and Game identified 4 key steps to improving our native fisheries, including modifying Delta bass fishing regulations to reduce their abundance by increasing harvest, removing length and season restrictions, and eliminating or reducing the cost of a fishing license.



Several key actions must be implemented if we are going to keep our native fisheries from the Tipping Point, including eliminating non-native fish throughout the Delta by localized predator control, permanently restricting commercial ocean harvest, minimizing artificial structures in salmon migration corridors, and altering channel geometry at scour holes.

Long term action needed to restore our native fish populations, including salmon and steelhead, include restoring interconnected habitats within the Delta, establishing migratory corridors for fish and flood flows along selected Delta River channels, and reducing mortality around the South Delta Diversion Facilities by instituting diversion management, implementing conveyance improvements, and relocating diversions.



This presentation was developed by the San Joaquin River Group.

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