# The F Words

*a presentation to NBWA*

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The Bay Institute

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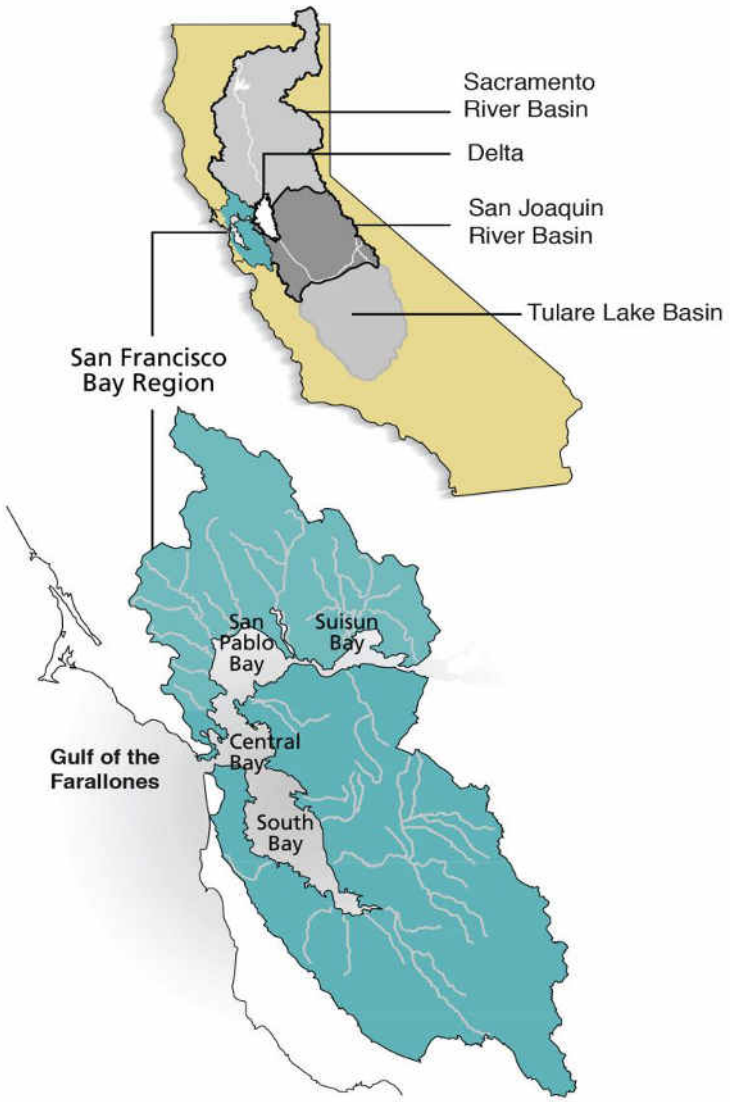
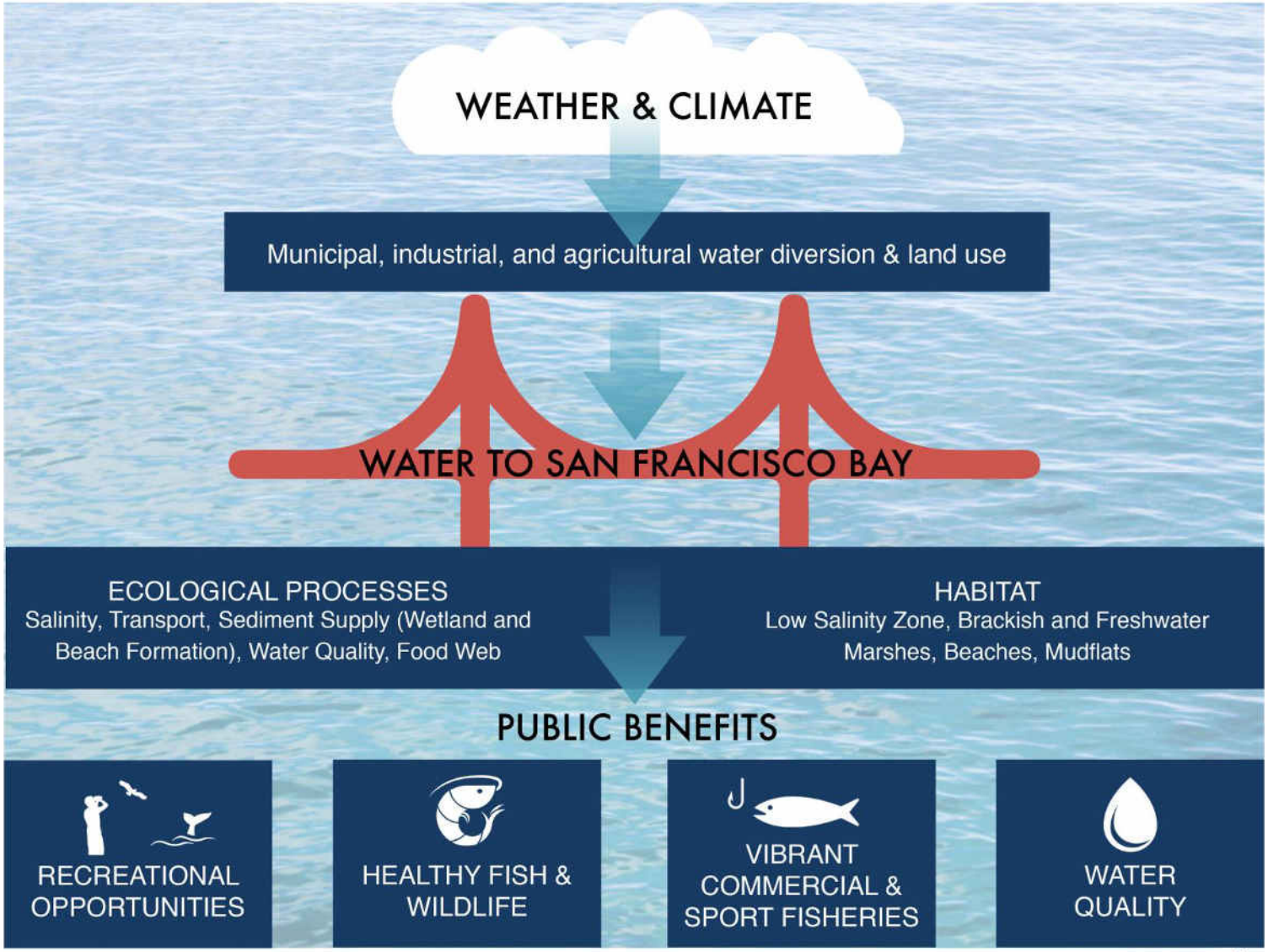
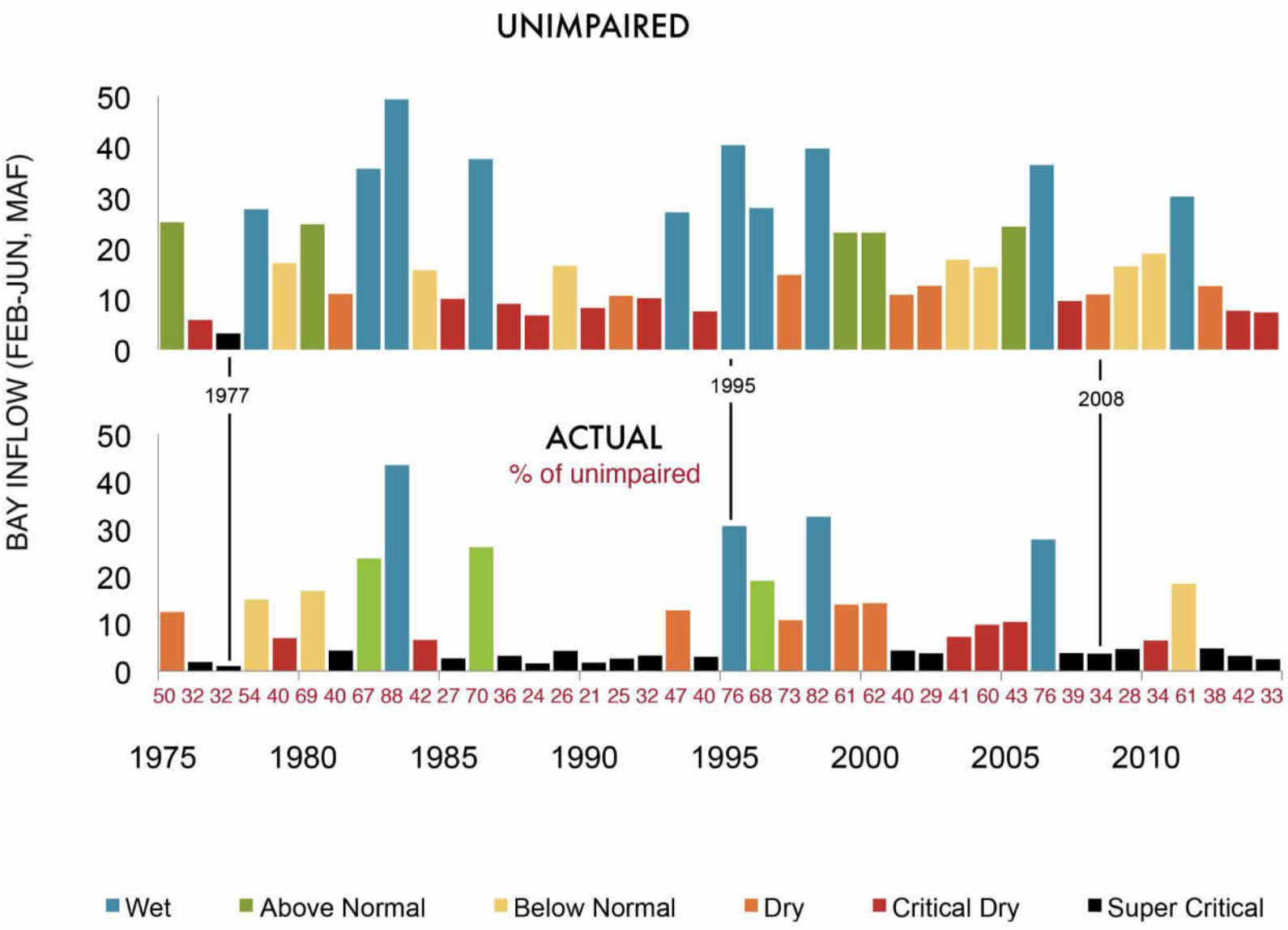
# Freshwater Flow

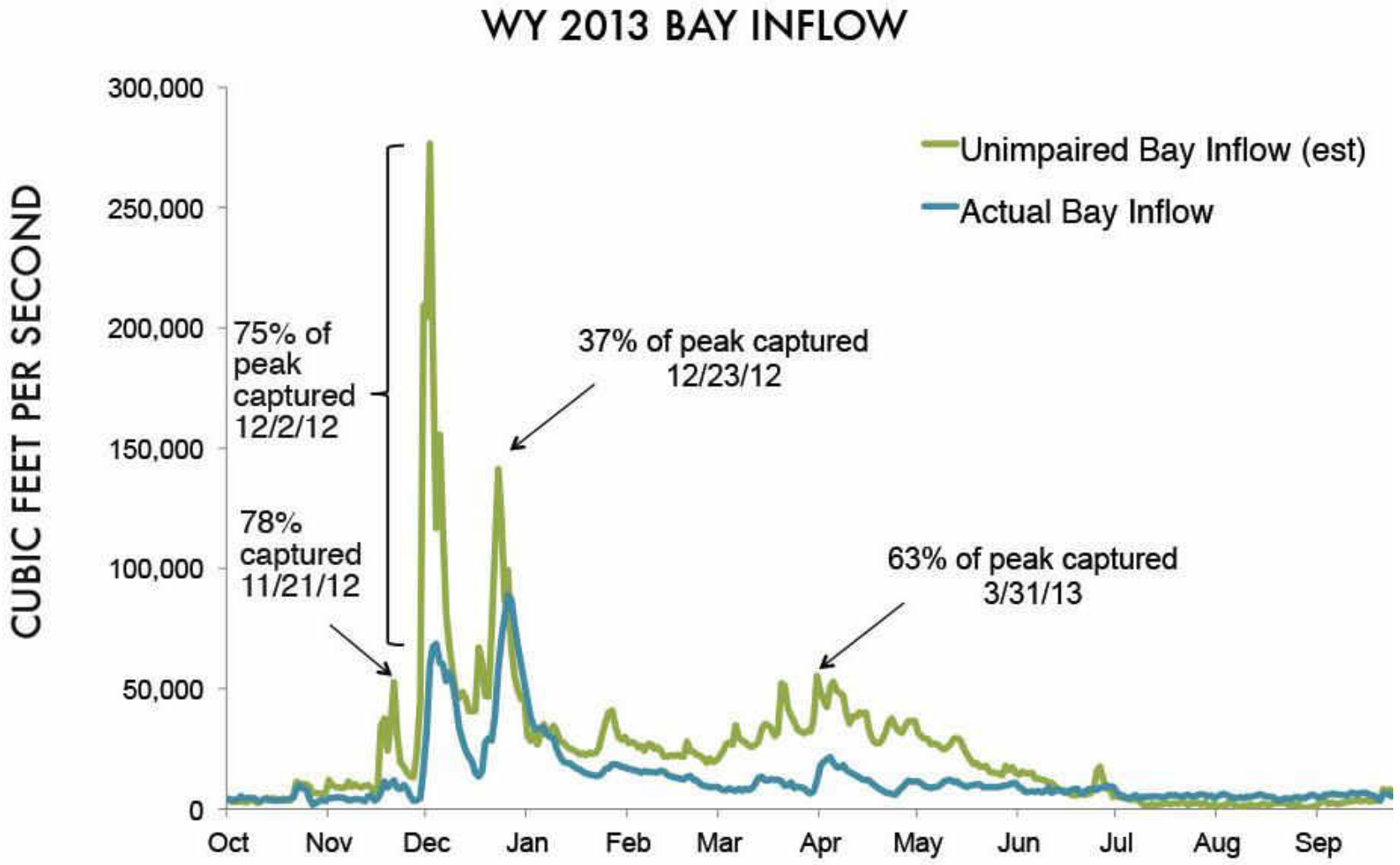

Sacramento
River Basin
Delta
San Joaquin
River Basin
Tulare Lake Basin
San Francisco
Bay Region
San
Pablo
Bay
Suisun
Bay
Central
Bay
South
Bay
Gulf of the
Farallones

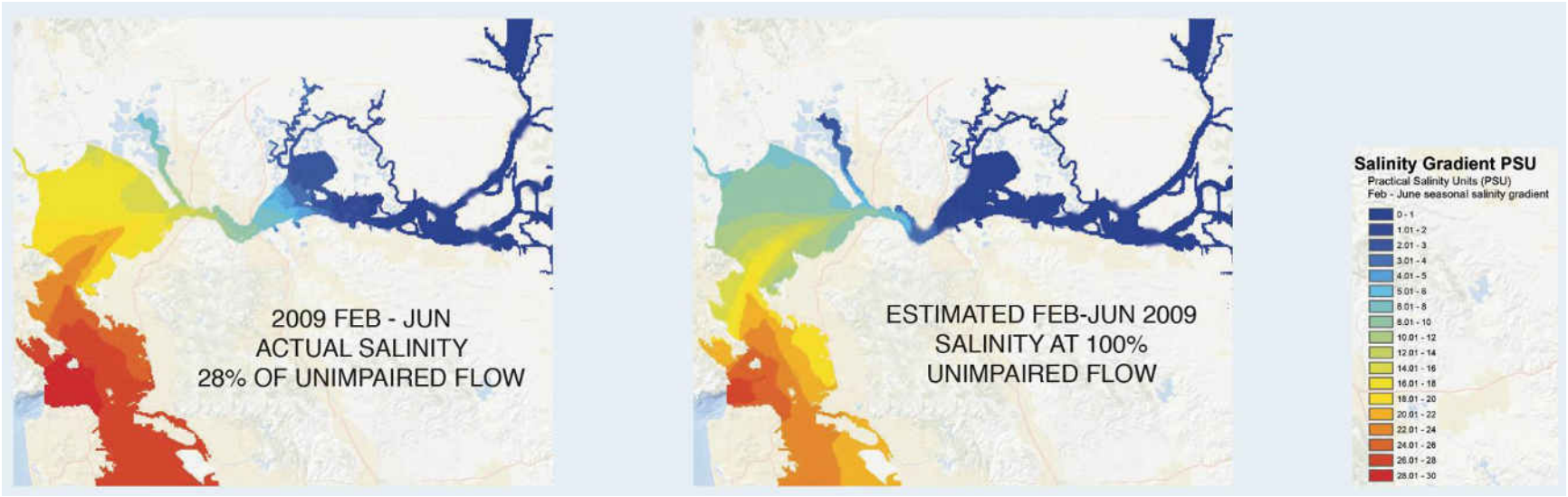

WEATHER & CLIMATE
Municipal, industrial, and agricultural water diversion & land use
WATER TO SAN FRANCISCO BAY
ECOLOGICAL PROCESSES
Salinity, Transport, Sediment Supply (Wetland and Beach Formation), Water Quality, Food Web
HABITAT
Low Salinity Zone, Brackish and Freshwater Marshes, Beaches, Mudflats
PUBLIC BENEFITS
RECREATIONAL OPPORTUNITIES
HEALTHY FISH & WILDLIFE
VIBRANT COMMERCIAL & SPORT FISHERIES
WATER QUALITY

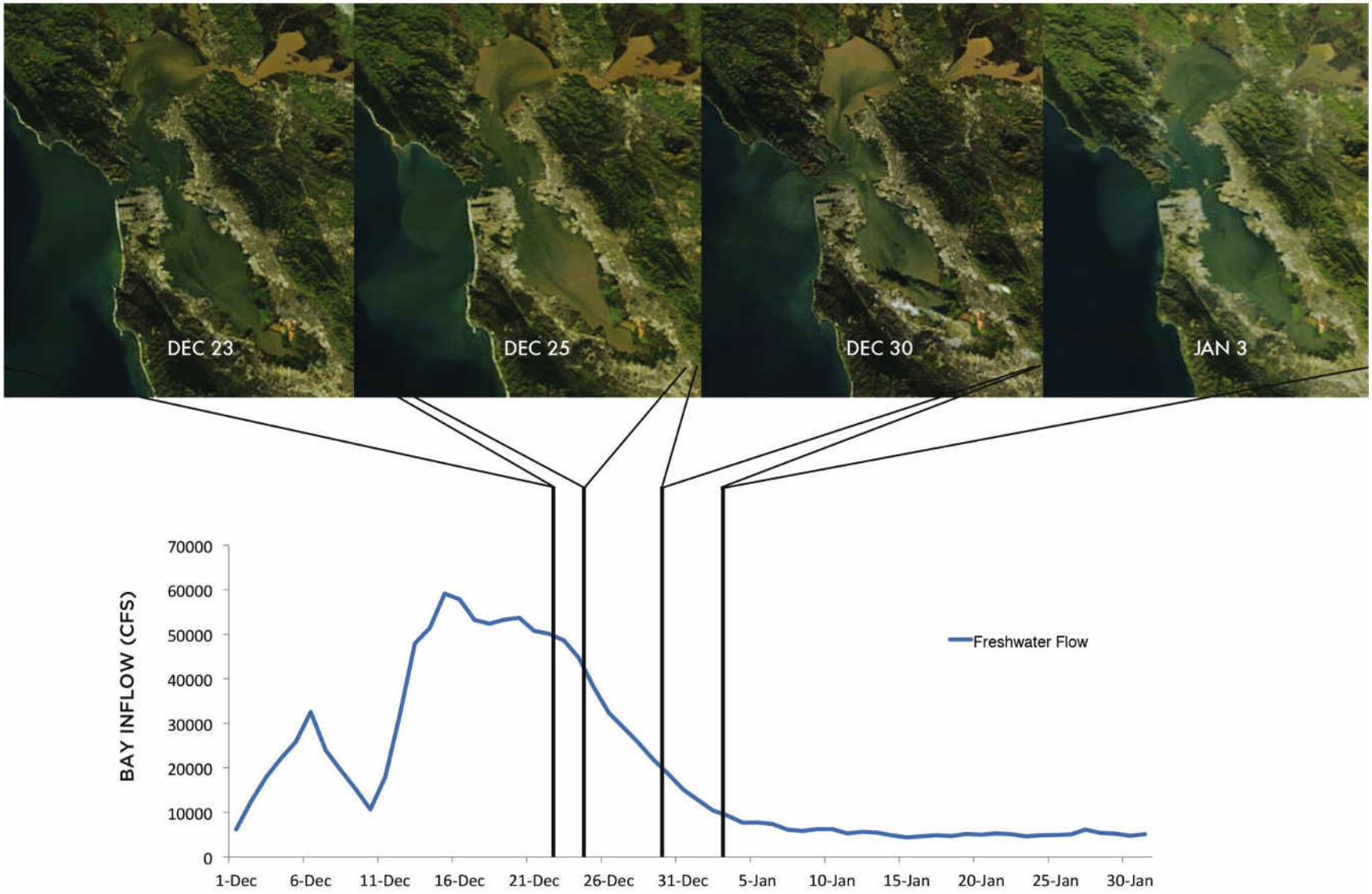
# WHAT DO THESE SPECIES HAVE IN COMMON?

| SPECIES | NATIVE? | LIFE SPAN (YEARS) | RESIDENT/ MIGRATORY/ NURSERY REARING | REPRODUCES WHERE? | ABUNDANCE CORRELATED WITH FLOW? |
|---|---|---|---|---|---|
| Chinook Salmon | Yes | 3-5 | Anadromous | River | **YES** |
| Striped Bass | No | 4-10 | Anadromous | River | **YES** |
| Green Sturgeon | Yes | Decades | Anadromous | River | **YES** |
| Delta Smelt | Yes | 1 | Resident | Delta | **YES** |
| Longfin Smelt | Yes | 1-3 | Resident/ Migratory | Delta/ Suisun | **YES** |
| Starry Flounder | Yes | 7-8 | Nursery Rearing | Ocean | **YES** |
| Sacramento Splittail | Yes | 5-7 | Resident | Shallow Freshwater | **YES** |
| American Shad | No | 5-7 | Migratory | River | **YES** |
| Staghorn Sculpin | Yes | 1-3 | Resident | Ocean/ Estuary | **YES** |
| Leopard Shark | Yes | Decades | Nursery Rearing | Ocean/ Bay/ Estuary | **YES** |
| Bay Shrimp | Yes | 1.5-2.5 | Nursery Rearing | Ocean | **YES** |


UNIMPAIRED
BAY INFLOW (FEB-JUN, MAF)
50
40
30
20
10
0
1977
1995
2008
ACTUAL
% of unimpaired
50 32 32 54 40 69 40 67 88 42 27 70 36 24 26 21 25 32 47 40 76 68 73 82 61 62 40 29 41 60 43 76 39 34 28 34 61 38 42 33
1975
1980
1985
1990
1995
2000
2005
2010
Wet
Above Normal
Below Normal
Dry
Critical Dry
Super Critical

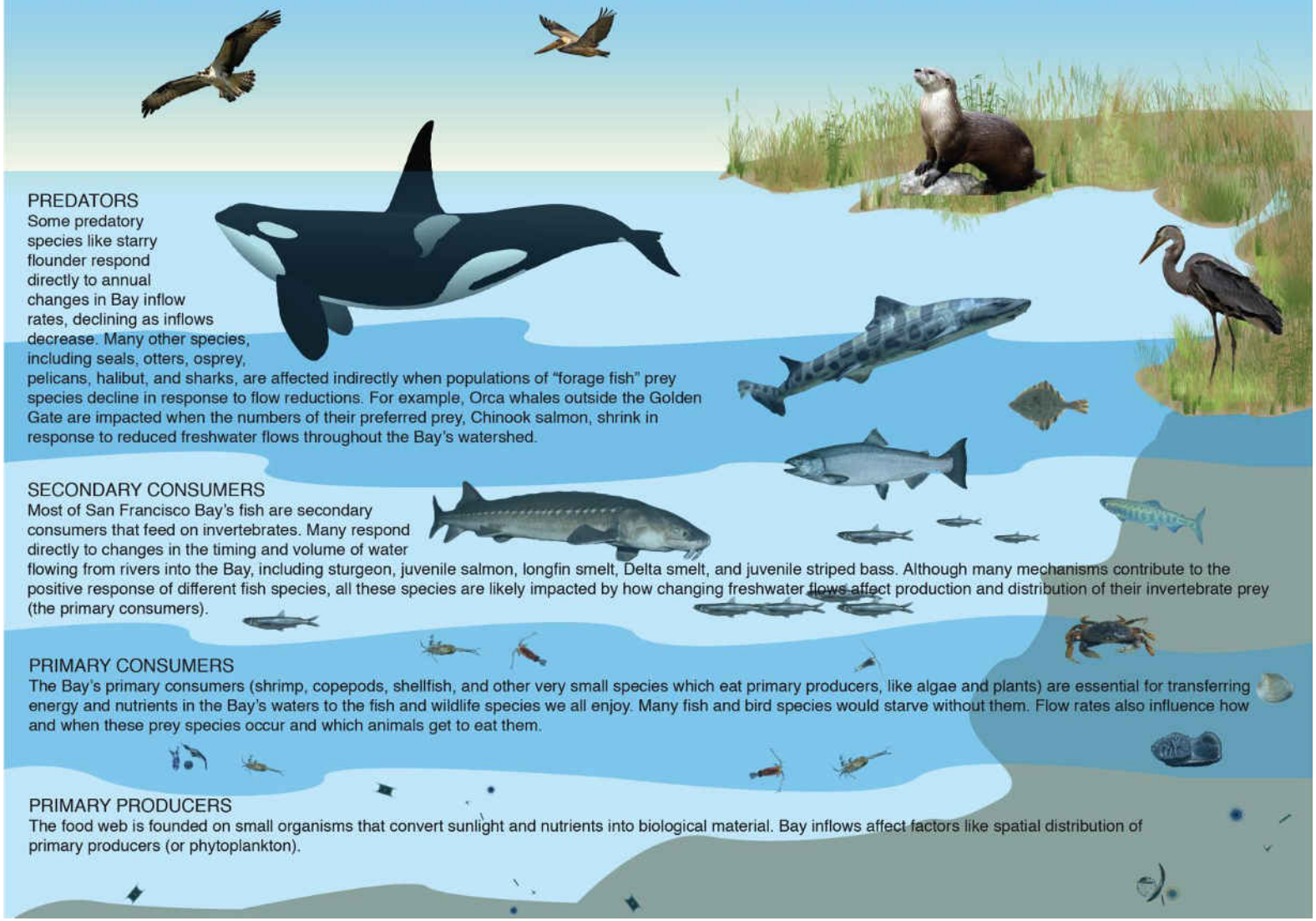

WY 2013 BAY INFLOW
CUBIC FEET PER SECOND
300,000
250,000
200,000
150,000
100,000
50,000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Unimpaired Bay Inflow (est)
Actual Bay Inflow
75% of peak captured 12/2/12
78% captured 11/21/12
37% of peak captured 12/23/12
63% of peak captured 3/31/13


2009 FEB - JUN
ACTUAL SALINITY
28% OF UNIMPAIRED FLOW
ESTIMATED FEB-JUN 2009
SALINITY AT 100%
UNIMPAIRED FLOW
Salinity Gradient PSU
Practical Salinity Units (PSU)
Feb - June seasonal salinity gradient
0 - 1
1.01 - 2
2.01 - 3
3.01 - 4
4.01 - 5
5.01 - 6
6.01 - 8
8.01 - 10
10.01 - 12
12.01 - 14
14.01 - 16
16.01 - 18
18.01 - 20
20.01 - 22
22.01 - 24
24.01 - 26
26.01 - 28
28.01 - 30




Images from NASA

# FRESHWATER FLOWS AFFECT FOOD WEBS IN THE BAY AND BEYOND



## PREDATORS

Some predatory species like starry flounder respond directly to annual changes in Bay inflow rates, declining as inflows decrease. Many other species, including seals, otters, osprey, pelicans, halibut, and sharks, are affected indirectly when populations of "forage fish" prey species decline in response to flow reductions. For example, Orca whales outside the Golden Gate are impacted when the numbers of their preferred prey, Chinook salmon, shrink in response to reduced freshwater flows throughout the Bay's watershed.

## SECONDARY CONSUMERS

Most of San Francisco Bay's fish are secondary consumers that feed on invertebrates. Many respond directly to changes in the timing and volume of water flowing from rivers into the Bay, including sturgeon, juvenile salmon, longfin smelt, Delta smelt, and juvenile striped bass. Although many mechanisms contribute to the positive response of different fish species, all these species are likely impacted by how changing freshwater flows affect production and distribution of their invertebrate prey (the primary consumers).

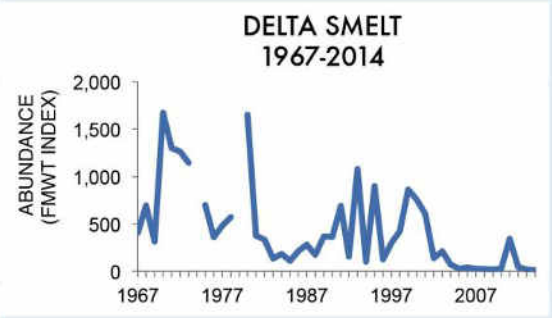
## PRIMARY CONSUMERS

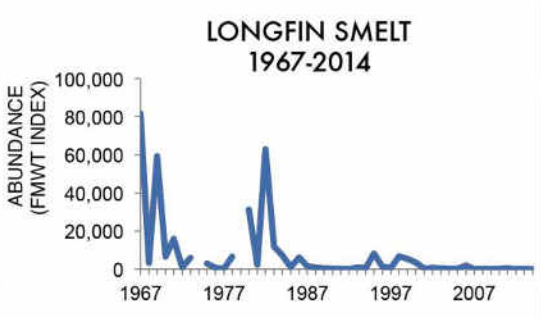
The Bay's primary consumers (shrimp, copepods, shellfish, and other very small species which eat primary producers, like algae and plants) are essential for transferring energy and nutrients in the Bay's waters to the fish and wildlife species we all enjoy. Many fish and bird species would starve without them. Flow rates also influence how and when these prey species occur and which animals get to eat them.

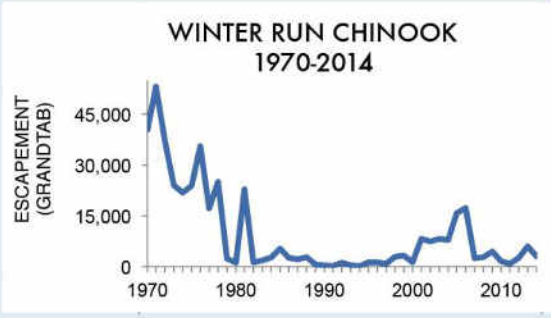
## PRIMARY PRODUCERS

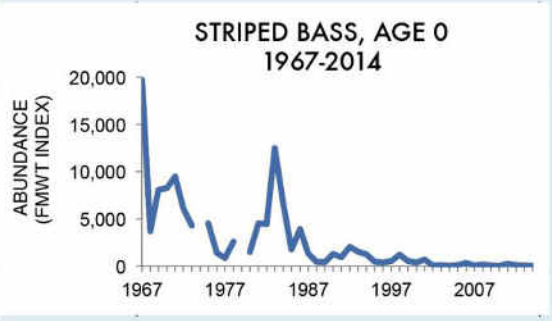
The food web is founded on small organisms that convert sunlight and nutrients into biological material. Bay inflows affect factors like spatial distribution of primary producers (or phytoplankton).

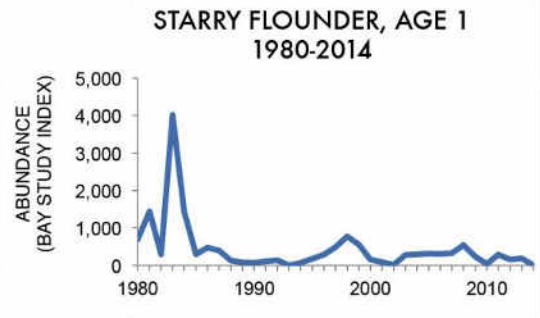
# COLLAPSE OF SPECIES ACROSS MULTIPLE TROPHIC LEVELS

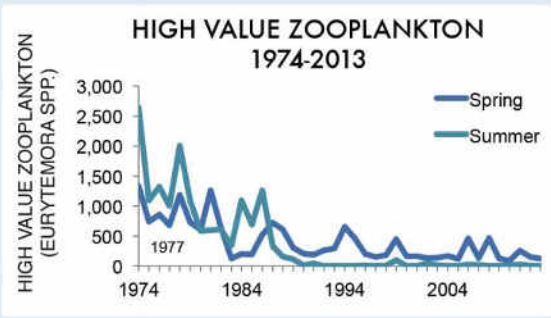


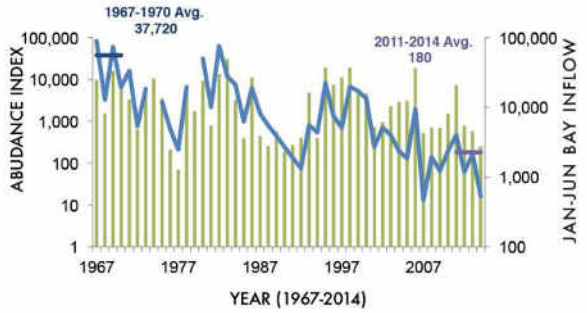



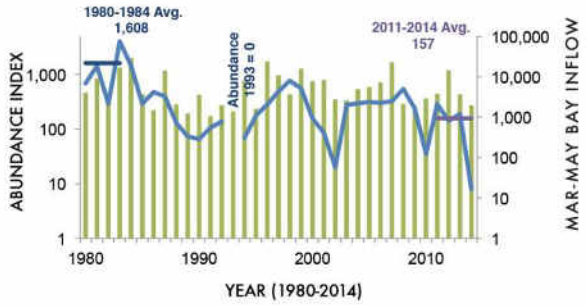



## LONGFIN SMELT



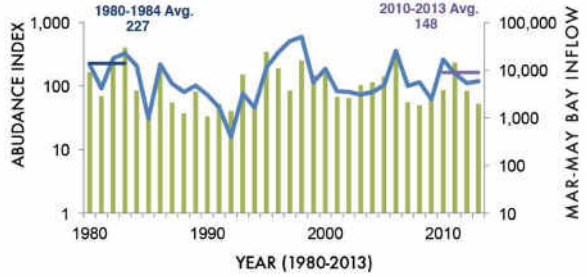

Longfin smelt - Recent average decline 99.5%

## STARRY FLOUNDER




Starry flounder – Recent average decline 90%

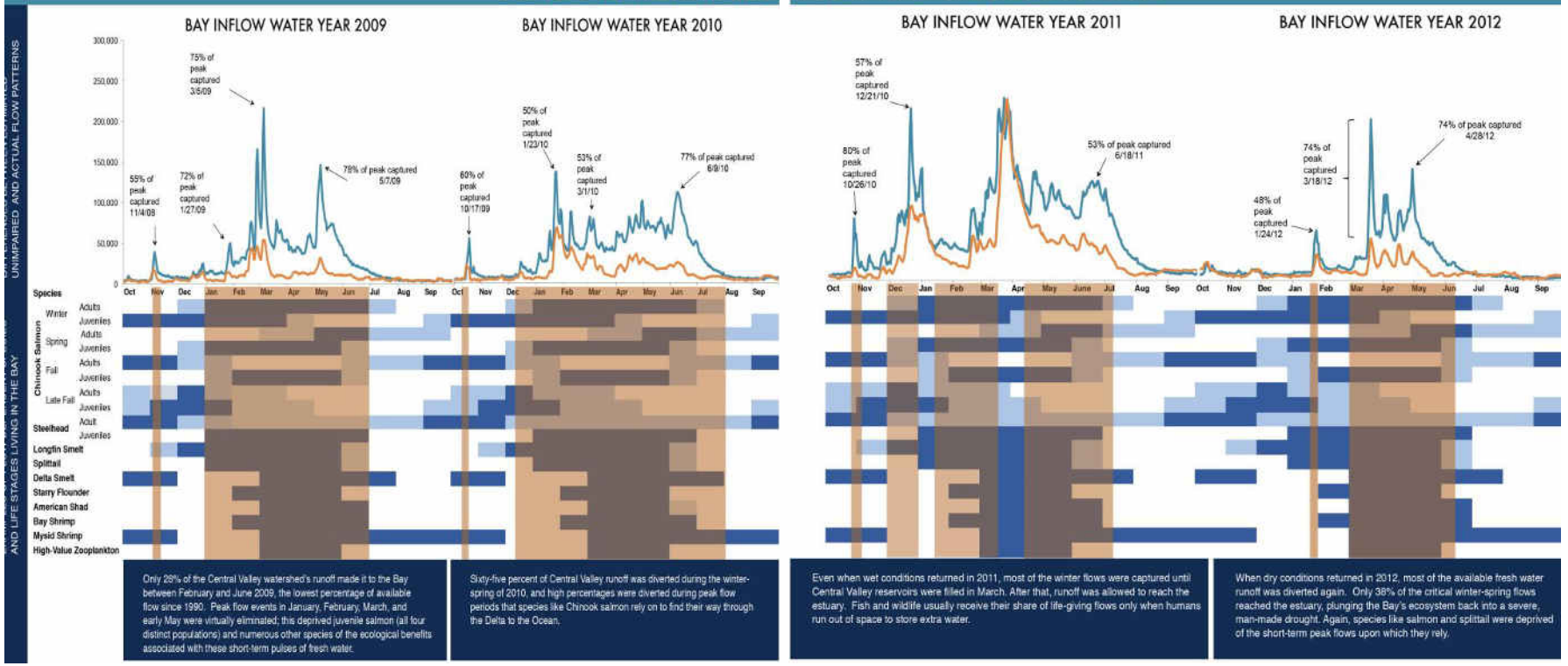
## BAY SHRIMP




Bay Shrimp - Recent average decline 35%

# IMPACTS TO FRESHWATER

# FLOW AND SPECIES 2009-2012



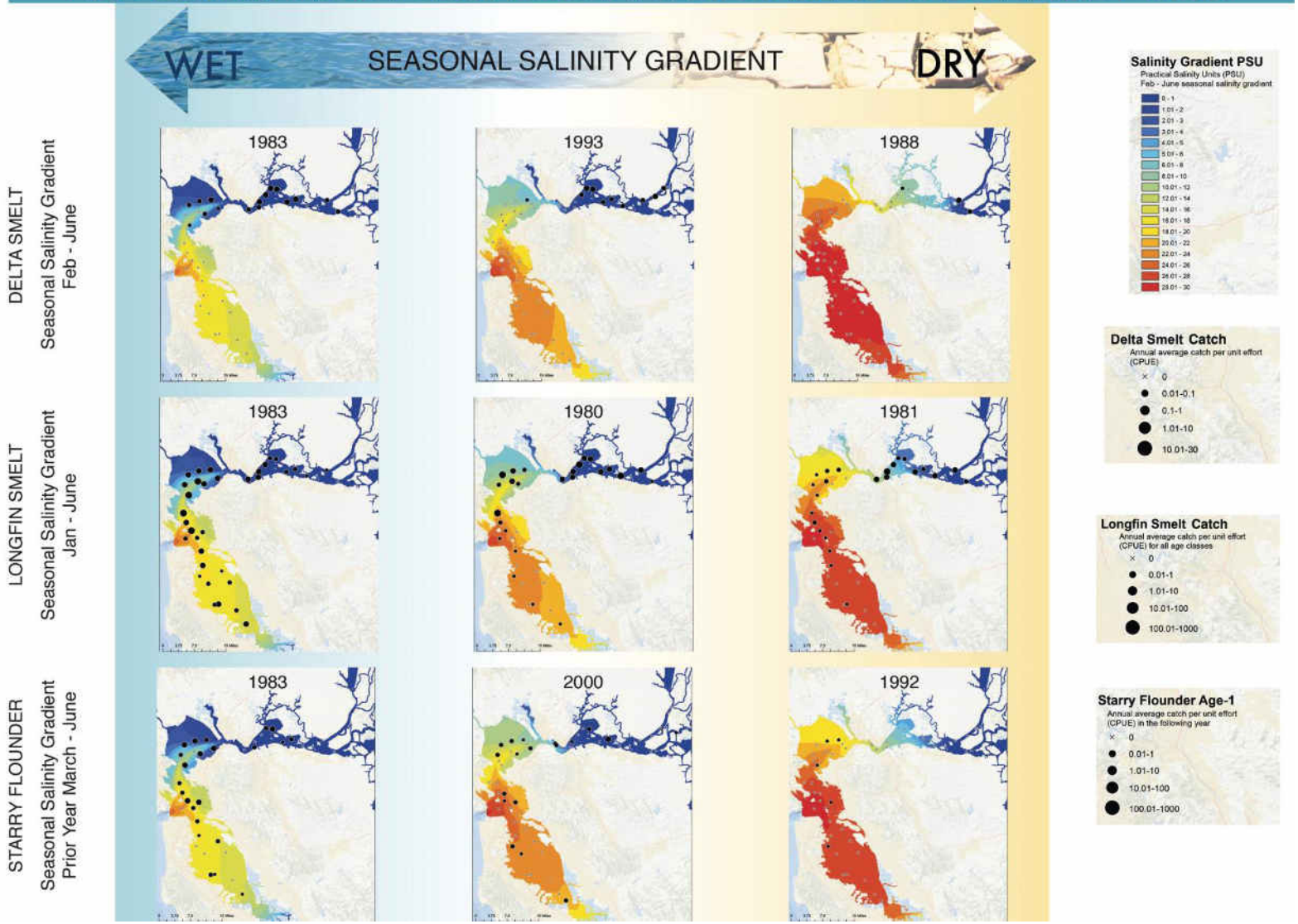

Only 28% of the Central Valley watershed's runoff made it to the Bay between February and June 2009, the lowest percentage of available flow since 1990. Peak flow events in January, February, March, and early May were virtually eliminated; this deprived juvenile salmon (all four distinct populations) and numerous other species of the ecological benefits associated with these short-term pulses of fresh water.

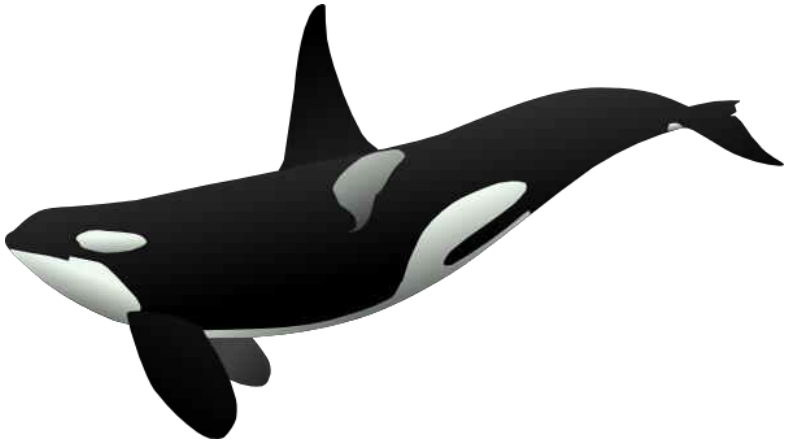
Sixty-five percent of Central Valley runoff was diverted during the winter-spring of 2010, and high percentages were diverted during peak flow periods that species like Chinook salmon rely on to find their way through the Delta to the Ocean.

Even when wet conditions returned in 2011, most of the winter flows were captured until Central Valley reservoirs were filled in March. After that, runoff was allowed to reach the estuary. Fish and wildlife usually receive their share of life-giving flows only when humans run out of space to store extra water.

When dry conditions returned in 2012, most of the available fresh water runoff was diverted again. Only 38% of the critical winter-spring flows reached the estuary, plunging the Bay's ecosystem back into a severe, man-made drought. Again, species like salmon and splittail were deprived of the short-term peak flows upon which they rely.

# FISH DISTRIBUTION CHANGES IN RESPONSE TO THE SALINITY FIELD





# What can be done about the F words?

- Adopt stronger water quality standards for the estuary now
- Require all water diverters to contribute their fair share
- Reduce reliance on the Delta as a water supply source for exported water
- Integrate flow management with wetland and beach restoration to battle climate change