

Disclaimer



This is an edited and annotated copy of slides presented at the [16 May 2023 White Sturgeon Fishery Virtual Public Meeting](#). The original slides shown at the meeting were designed to support and illustrate the oral presentation given by CDFW experts. To improve clarity to readers in the absence of the presentation, some slides here have been edited and some explanatory comments have been added in the notes section.

Email Sturgeon@wildlife.ca.gov to clarify any questions about these slides.



WHITE STURGEON RECREATIONAL FISHERY: VIRTUAL PUBLIC MEETING

Originally presented: 16 May 2023

JONATHAN NELSON, DR. JOHN KELLY, COLBY HAUSE, DR. DYLAN STOMPE

California Department of Fish and Wildlife

Agenda

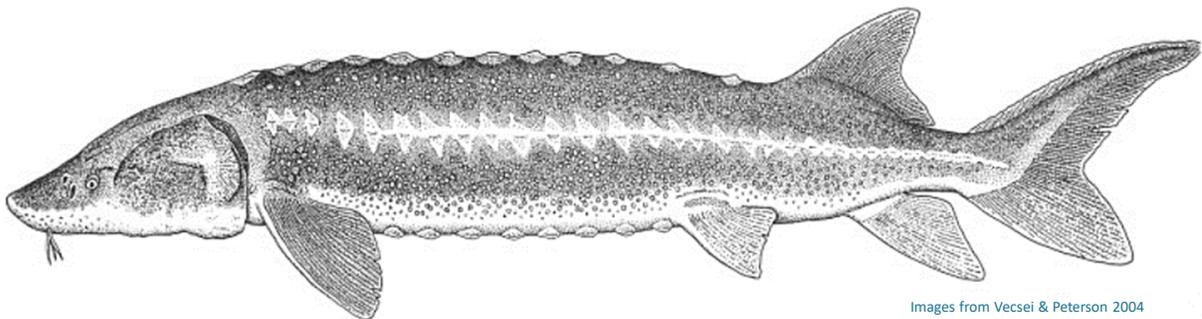
- I. Biology of White Sturgeon
- II. History of the Fishery
- III. Monitoring Programs
- IV. Population status
- V. 2022 Harmful Algal Bloom
- VI. The Future of the Fishery
- VII. Angler Survey
- VIII. Questions and comments



I. Biology of White Sturgeon

- Sturgeon (Family Acipenseridae)

- Ancient bony fishes
- 25 species worldwide
- 8 species in North America
 - White, Green, Lake, Shortnose, Shovelnose, Pallid, Alabama, Atlantic (and Gulf subspecies)



Images from Vecsei & Peterson 2004

- Sturgeon are very different from other species targeted in California (e.g. salmon, striped bass, halibut, rock fish). It is important to keep these difference in mind when considering management and conservation goals.
- Have been around 200+ million years
- All species worldwide are considered at risk or endangered (IUCN)

I. Biology of White Sturgeon

- Sturgeon (Family Acipenseridae)

- Ancient bony fishes
- 25 species worldwide
- 8 species in North America
- 2 species in California, both anadromous
 - **Green Sturgeon**
 - Ventral (bottom) stripe
 - **Less** than 33 lateral (side) scutes
 - **White Sturgeon**
 - No stripes
 - **More** than 36 lateral scutes



Photo: NOAA Fisheries

- Color can be used to ID the two California species, but it's not 100% reliable.

I. Biology of White Sturgeon

- Sturgeon (Family Acipenseridae)

- Ancient bony fishes
- 25 species worldwide
- 8 species in North America
- 2 species in California, both anadromous
 - Green Sturgeon
 - Marine oriented
 - Historically lower abundance
 - Protected as "threatened", U.S. Endangered Species Act



- Green sturgeon spend most of adult life in coastal oceans.
- Enter bays/estuaries to feed in summer, and move up-river to freshwater to spawn every 2-6 years.

I. Biology of White Sturgeon

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 - Marine oriented
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 - White Sturgeon
 - Estuary and freshwater oriented



- White Sturgeon are capable of ocean (saltwater) movement but do not do it frequently.
- Typically associated with large west coast rivers and estuaries (Fraser, Columbia, Kootenai, Snake, Sacramento, San Joaquin).

I. Biology of White Sturgeon

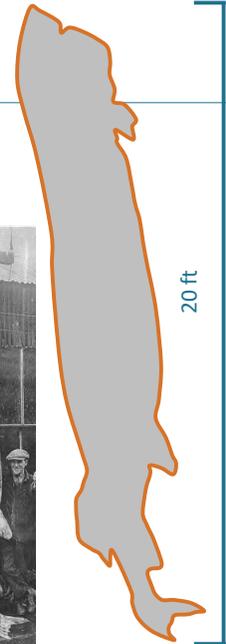
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 - **Green Sturgeon**
 - Marine oriented
 - Historically lower abundance
 - Protected as "threatened", U.S. Endangered Species Act
 - **White Sturgeon**
 - Estuary and freshwater oriented
 - 1 California population
 - Spawns in Central Valley
 - CA Species of Special Concern
 - Recreational fishery



- California population is genetically distinct from other west coast populations.
- It is not listed under ESA or CESA, but is a species of special concern.

I. Biology of White Sturgeon

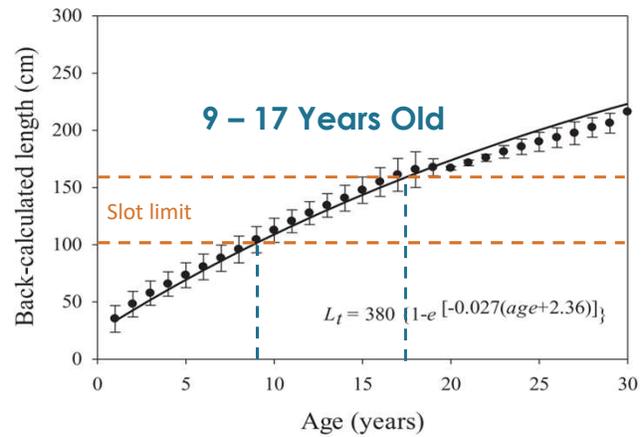
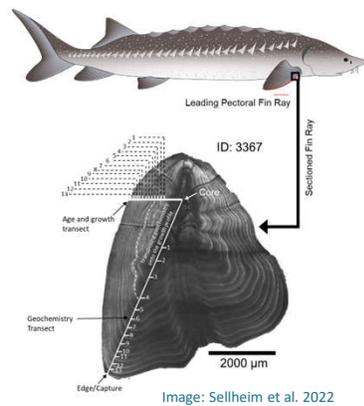
- Maximum size: 20+ feet
- Maximum weight: 1800 lbs (0.9 tons)
- Maximum age: >100 years



- Historically, White Sturgeon grew to 20 ft long or more. Fish of that size probably do not exist, but very large fish are still caught in some populations.

I. Biology of White Sturgeon

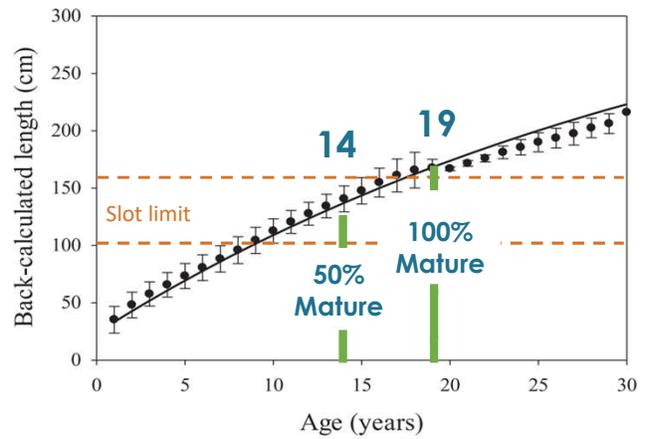
- Slow growth



- The following slides highlight some of the differences in sturgeon vs. more familiar targeted species.
- White Sturgeon can grow very large, but do not grow quickly.
- Age is determined by taking a section of the first pectoral fin ray and counting annual growth rings.
- In CA, fish inside the legal slot limit are approximately 9-17 years old.

I. Biology of White Sturgeon

- Slow growth
- Late age at maturity



- Sturgeon also reach first maturity at a late age.

I. Biology of White Sturgeon

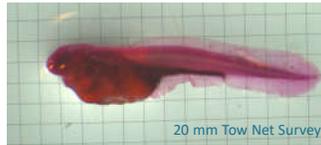
- Slow growth
- Late age at maturity
- Spawning Frequency
 - Males 1-2 years
 - Females 2-5 years
- Migration from December–May
- Spawning



- Sturgeon do not die after spawning like Pacific salmon and can spawn many times during their lives.
- There is a recovery interval between spawning events for individuals. Females take longer between spawning attempts.
- No redds or nests, sturgeon are broadcast spawners
- Majority of spawning in CA population occurs on Sacramento River between Verona and Colusa.

I. Biology of White Sturgeon

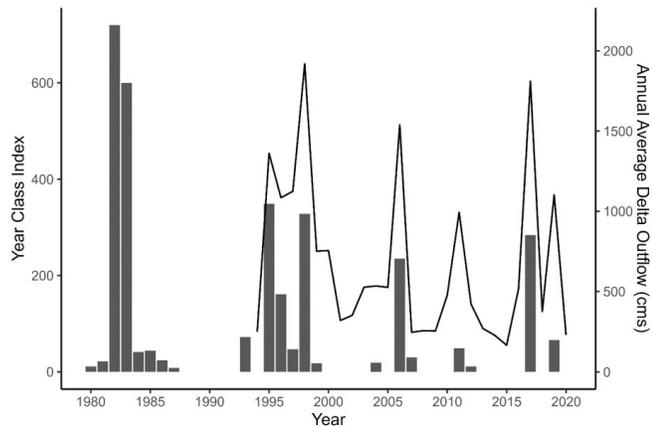
- Slow growth
- Late age at maturity
- Spawning Frequency
 - Males 1-2 years
 - Females 2-5 years
- Migration from December–May
- Spawning
- Development



- Development is rapid. A week or two to hatch (temperature dependent)
- Larvae and juveniles move rapidly down in the Delta to rear.

I. Biology of White Sturgeon

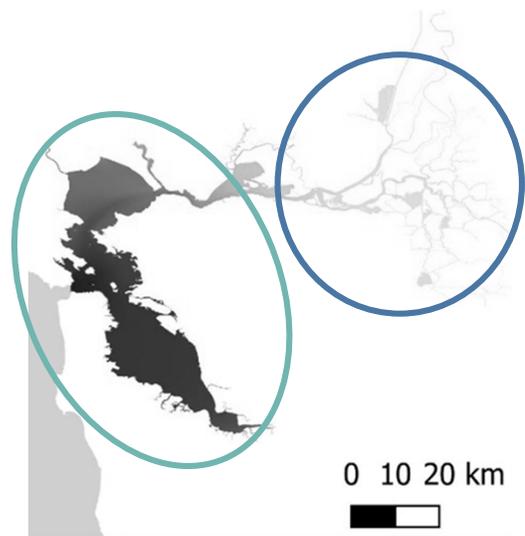
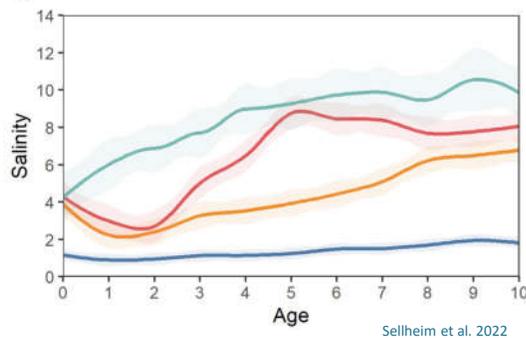
- Slow growth
- Late age at maturity
- Spawning Frequency
 - Males 1-2 years
 - Females 2-5 years
- Migration from December–May
- Spawning
- Development
- Infrequent recruitment



- Sturgeon appear to spawn every year, but successful recruitment is closely associated with wet years, as measured by high average Delta outflow.

I. Biology of White Sturgeon

- Post-spawning behavior
- Subgroups using different habitat
- Diet



- Adults return to Bay/Delta after spawning.
- Recent evidence (Sellheim et al. 2022) using microchemical analysis of fin rays shows that there are likely 4 subgroups of White Sturgeon. One group appears to spend all its time in freshwater (freshwater Delta), while another moves into saltier water quickly and remains there (SF Bay region). Two other groups show intermediate behaviors. Need to consider this for management and exposure to risks.
- Diet of White Sturgeon is broad. Crustaceans (shrimp, amphipods, crabs, etc.), mollusks (clams, gastropods), fish eggs (e.g. herring spawn), and benthic fishes (esp. when sturgeon are big).

II. History of the Fishery

Commercial and Recreational Fishery

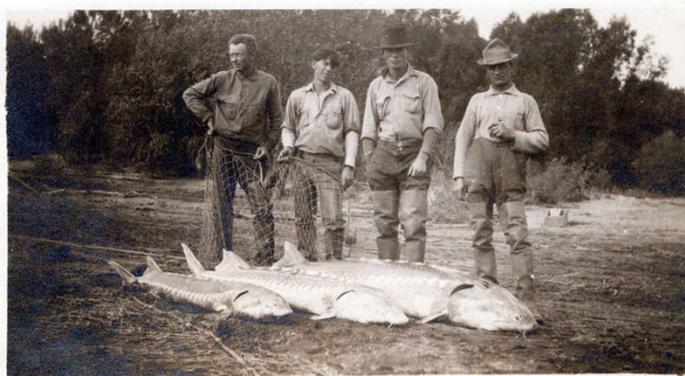


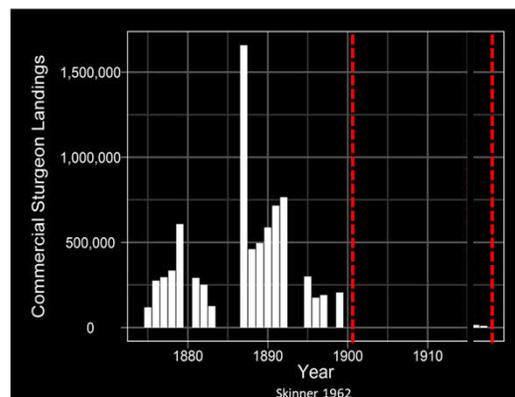
Photo: CDFW
"...Sturgeon taken on Williams Bar 3 ½ miles above Colusa... April 16-17-18 1916"

II. History of the Fishery

Commercial and Recreational Fishery

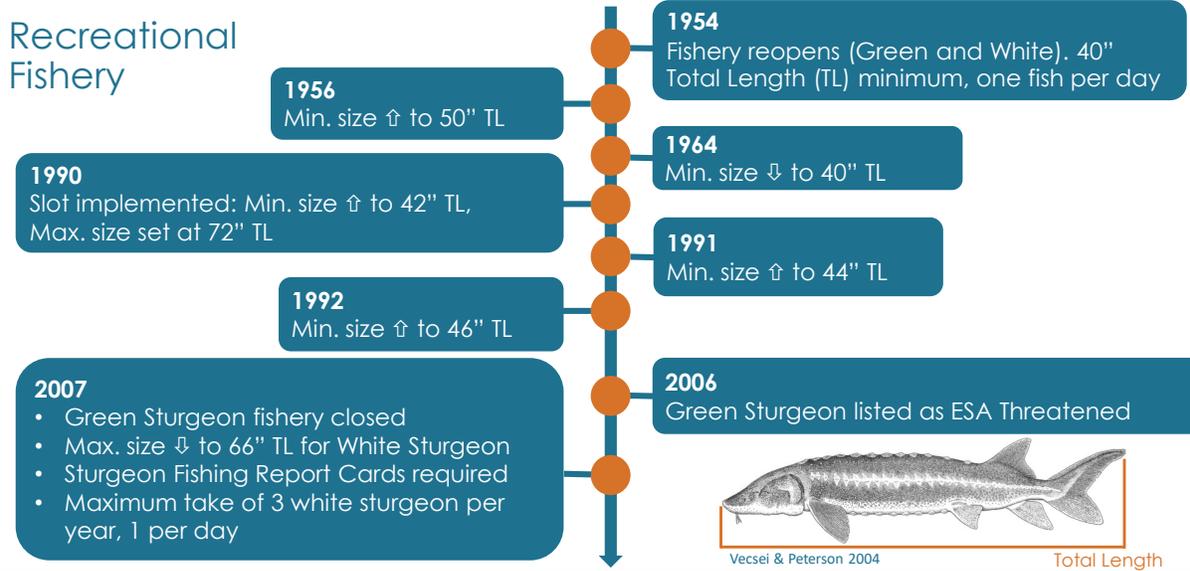
- 1860's: Sturgeon fishery first monitored
- 1901: Closed
- 1909: Reopened
- 1917: Closed long term.

Commercial fishery remains closed.



II. History of the Fishery

Recreational Fishery



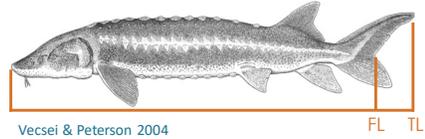
Vecsei & Peterson 2004

Total Length

II. History of the Fishery

California: 2013 – present

- Size limit changed to 40-60" Fork Length (FL)
- Fish >68" FL may not be removed from water
- Single barbless hook
- No use of snares or gaffs to help land fish
- Fishing closed for sturgeon from Keswick Dam – Hwy 162 bridge on Sacramento River, and 1 January – 15 March in central SF Bay



Washington and Oregon (co-managed)

- Catch and release in most waters
- Harvest permitted in specific reaches and on specific days (e.g. 3 days in September, 12 days May/June), from dawn until 2 pm.
- 44-50" FL slot limit
- Harvest days, locations, and slot limit vary annually based on monitoring

Idaho

- Catch and release only

III. Monitoring

- Mark-recapture (tagging) Program

- August – October
- All sturgeon: pit tags
- Slot-sized sturgeon: reward disk tags



- Mark-capture (ie. Tagging) program informs population monitoring
- Sampling started in the 1980's but has only occurred annually since 2005
- Nets are deployed each year from August-October to catch a wide size range of White Sturgeon
- White Sturgeon within the legal harvest size range (40-60 inches) are tagged with an external reward disk tag (ranging from \$50-\$150) and released to be recaptured by anglers in the recreational fishery
- Goal is for anglers to return disk tag in exchange for reward, and department receives important data to inform population abundance models

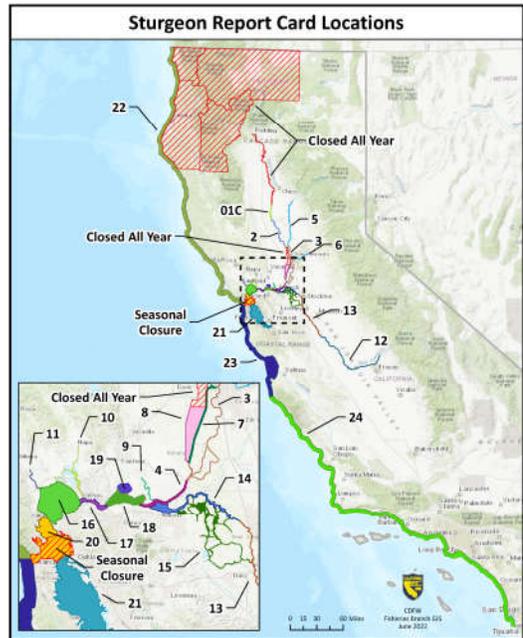
III. Monitoring

• Sturgeon Report Card Program

- Card must be in angler's possession
- Anglers must record:
 - Date
 - length (FL)
 - species
 - location code
 - If the fish was kept or released
 - Disc tag number, if present



- Cards due by January 30th of the following year



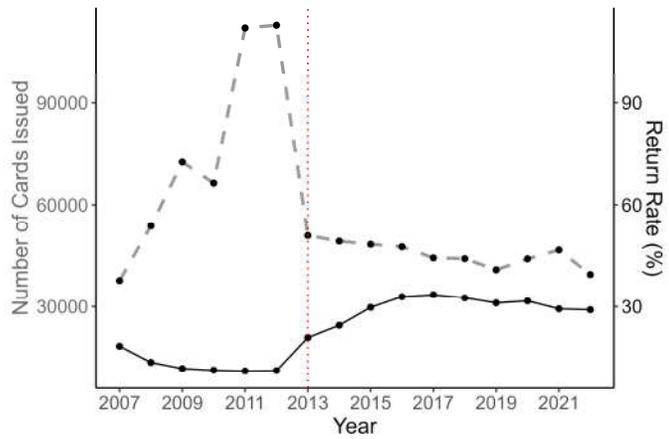
- Sturgeon report card informs population monitoring and provides data on the fishery
- All anglers are required to purchase a report card before fishing for White Sturgeon

III. Monitoring

- Average number cards purchased: 45,000
- Average reporting rate: 31%



Scan QR code to see the CDFW Sturgeon Report Card web page



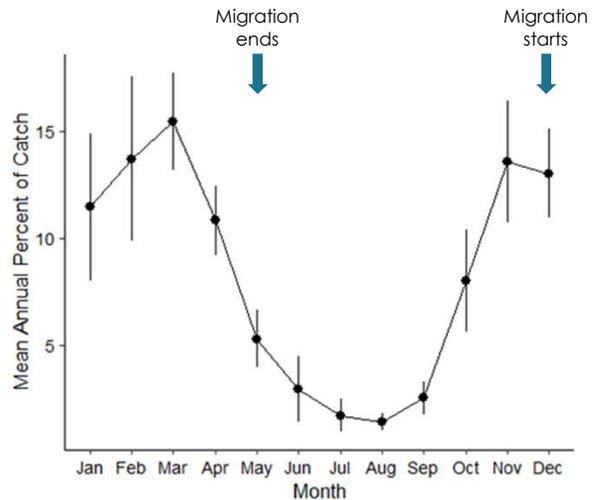
Report Cards were first issued in 2007. Cards were free for the first 5 years while anglers got used to using them. Starting in 2013, a small fee has been charged to cover the costs of the program.

III. Monitoring

Highest catch: fall – spring

Coincides with the timing of upstream spawning migration into Sacramento-San Joaquin Delta and lower rivers

Lowest catch: summer



- Data from returned report cards indicate that most fish are reported as caught between October and May. This period roughly coincides with the spawning migration. The lowest reported catch occurs over the summer months.

III. Monitoring

Total caught:

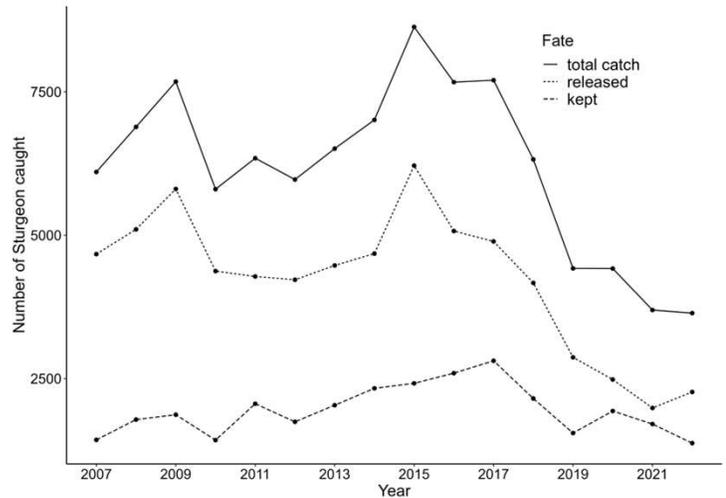
- Max: ~ 8,600 in 2015
- Min: ~ 3,600 in 2022*

Released Fish:

- Max: ~ 6,200 in 2015
- Min: ~ 2,000 in 2021

Kept Fish:

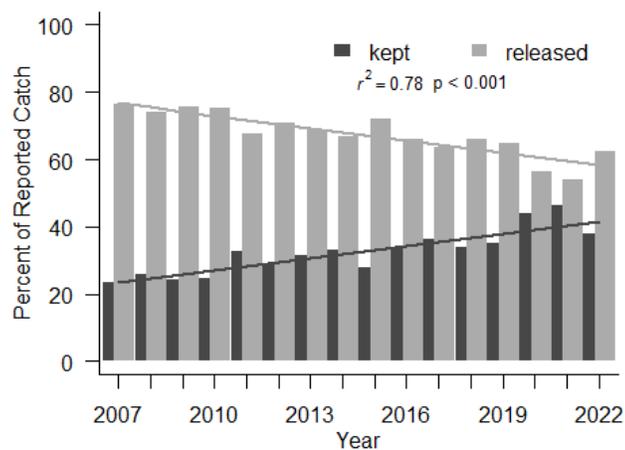
- Max: ~ 2,800 in 2017
- Min: ~ 1,300 in 2022*



- Data from the Report Card program reporting the number of fish caught, kept, and released.
- There has been a declining trend in all metrics since 2015.

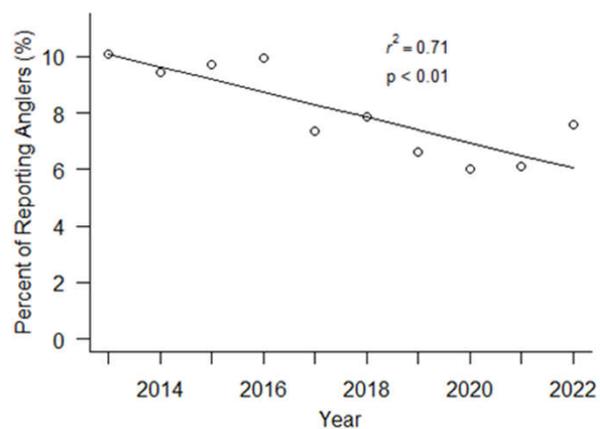
III. Monitoring

- Proportion of total catch that is harvested has increased over time



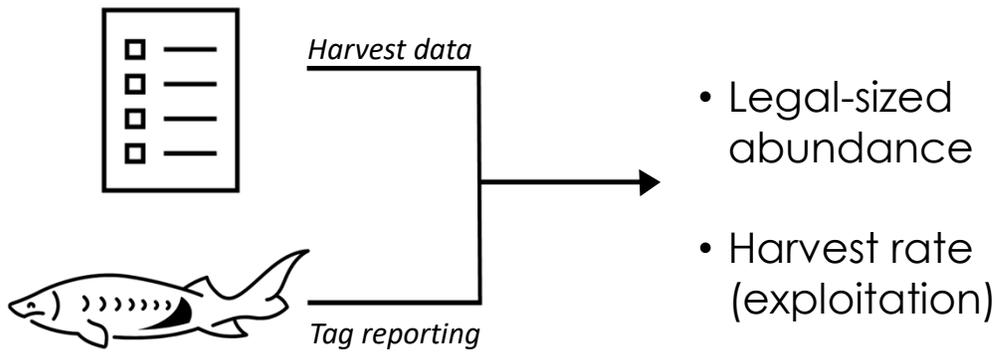
III. Monitoring

- The fraction of anglers that report releasing sturgeon without retaining any caught has significantly decreased over time



- Report Card data in the past have not let anglers identify themselves as catch and release only. Instead, we can track the fraction of anglers that report releasing fish without keeping any they caught.

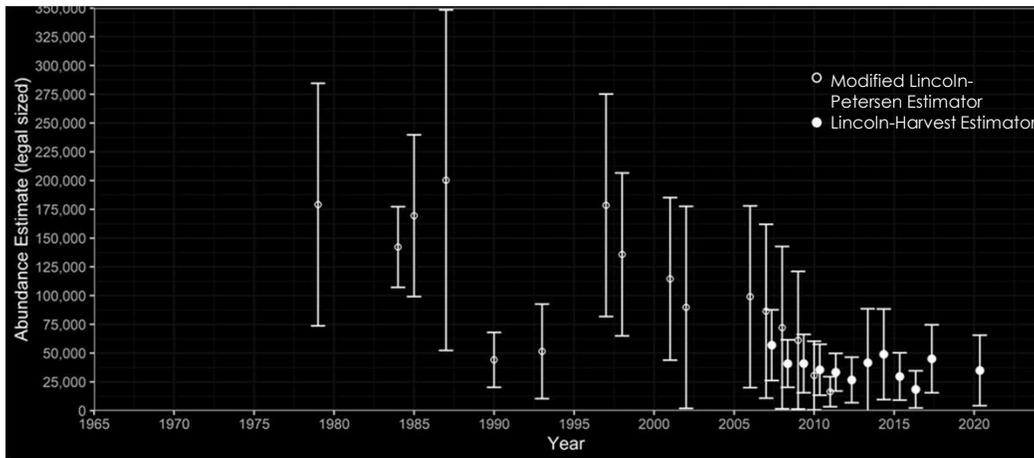
IV. Population Status



IV. Population Status

Abundance

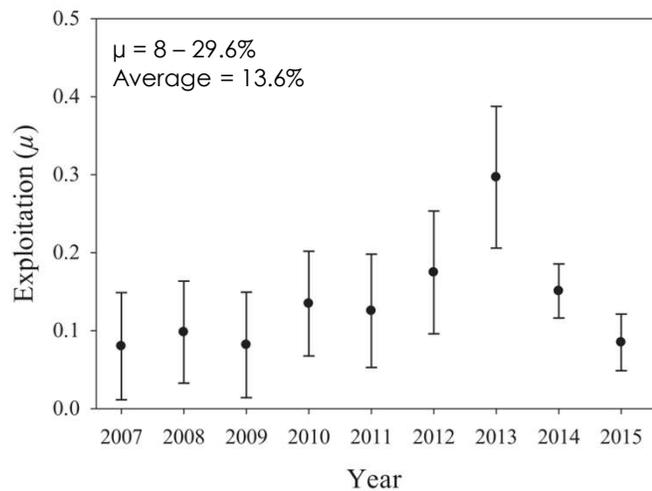
Recent estimate ~33,000 "slot-sized" White Sturgeon



IV. Population Status

Harvest

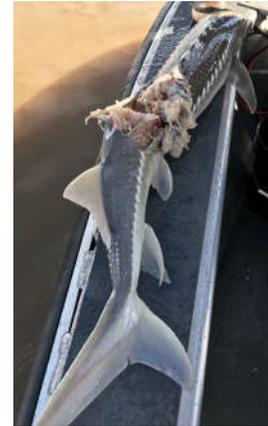
- Current 5-year average: 8%
- Washington and Oregon: 4% target
- Idaho: no harvest



Blackburn et al. 2019

IV. Population Status

- Additional sources of mortality:
 - Ship strikes



Photos (clockwise from top: N. Demetras; C. Parker; Z. Medinas; CDFW)

- Large vessels (commercial transport, tugs, etc., not small recreational boats) are a documented source of mortality for sturgeon species, including White Sturgeon.

IV. Population Status

- Additional sources of mortality:
 - Ship strikes
 - Poaching



- White Sturgeon are highly prized for caviar. There is an active black market for it in California.

IV. Population Status

- Additional sources of mortality:
 - Ship strikes
 - Poaching
 - Predation



- Sea lions have been documented eating sturgeon.
- Sea lions are solely managed by NOAA Fisheries under the authority of the Marine Mammal Protection Act.

IV. Population Status

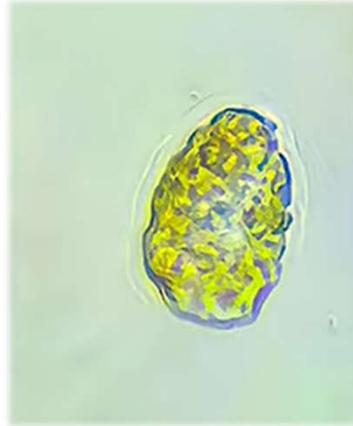
- Additional sources of mortality:
 - Ship strikes
 - Poaching
 - Predation
 - Pumps and diversions



- California's water system is highly modified and sturgeon can become trapped at water operation facilities and diversions. Younger life stages are likely most vulnerable.

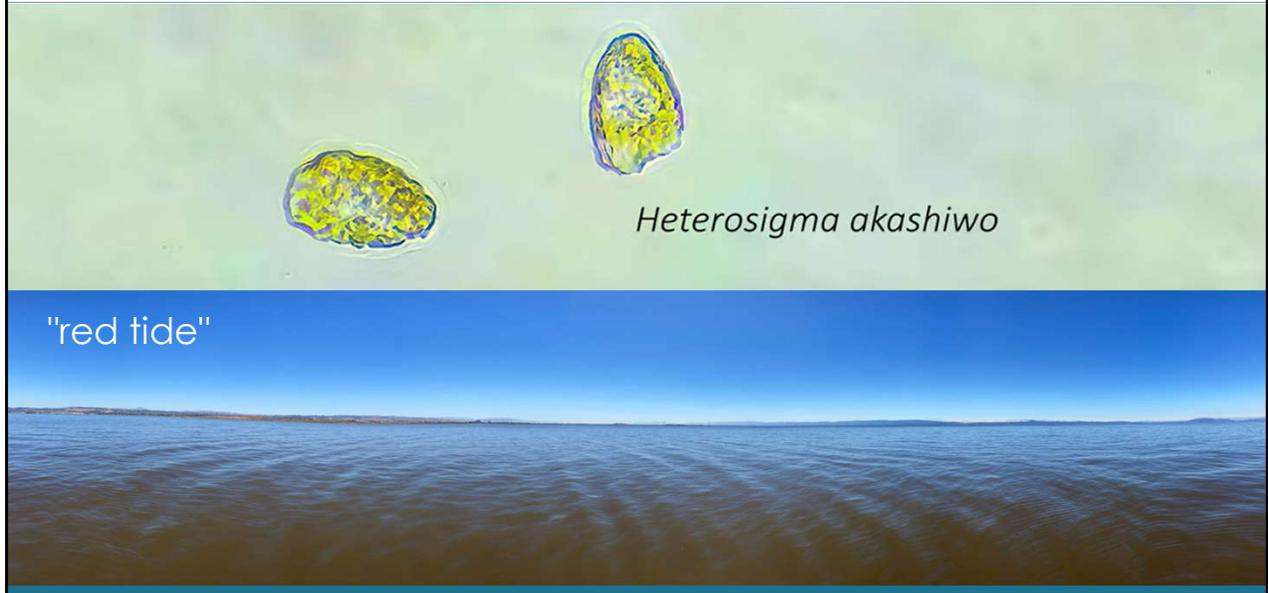
IV. Population Status

- Additional sources of mortality:
 - Ship strikes
 - Poaching
 - Predation
 - Pumps and diversions
 - Harmful Algal Blooms (HABs)



- HAB are a newer issue, haven't had to deal with this (at this magnitude) before

V. 2022 Harmful Algal Bloom

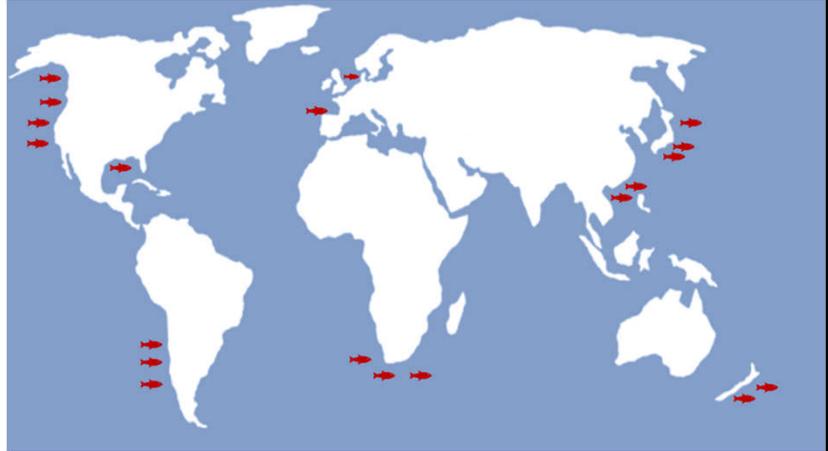


Picture from San Pablo Bay in late August, during the peak of the HAB

V. 2022 Harmful Algal Bloom

H. akashiwo

- Globally Distributed
- Wide temperature and salinity range



- World map: Red fish indicate locations of recorded *H. akashiwo* blooms with associated fish kills in Japan, China, New Zealand, South Africa, Chile, Europe, and the Pacific and Gulf Coasts of North America
- Marine Phytoflagellate
- Tolerates 11-24C, 5-35ppt

V. 2022 Harmful Algal Bloom

H. akashiwo

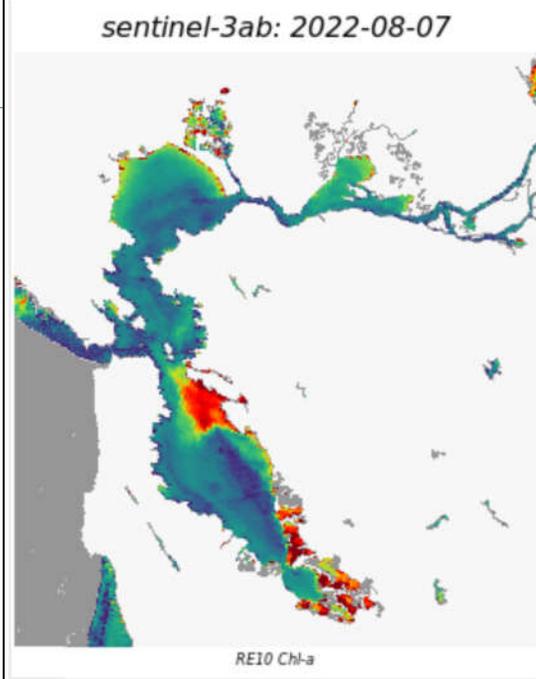
- Globally Distributed
- Wide temperature and salinity range
- Dormant in sediment until ideal conditions
 - High nutrient loads (ammonium, nitrate, urea)
 - Ideal temperature and salinity conditions
- Produce toxins



- Resting cysts during adverse conditions, can persist throughout seasons
- Brevetoxins have neurotoxic effects on fish, causing paralysis and death at high concentrations
- Haemolytic compounds, reactive oxygen species, and polyunsaturated acids may directly or through tissue injury cause excessive mucus secretion
- Coats gills, cause asphyxiation
- Combination with low DO from algal bloom could compound to cause mortality

V. 2022 HAB Timeline

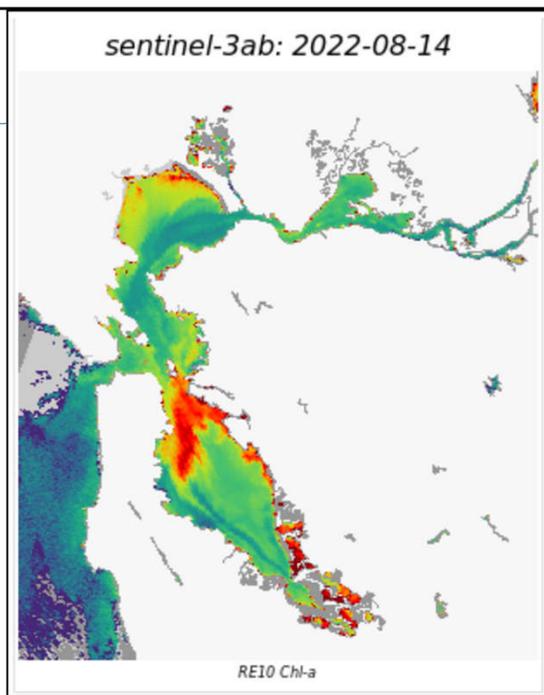
- August 7, 2022



- Imagery from the Sentinel-3AB satellites showing chlorophyll-a concentrations in surface waters of the San Francisco Bay Estuary and delta. More chlorophyll-a (oranges and reds) indicates higher concentrations of photosynthetic algae.
- HAB first detected off of Alameda harbor.

V. 2022 HAB Timeline

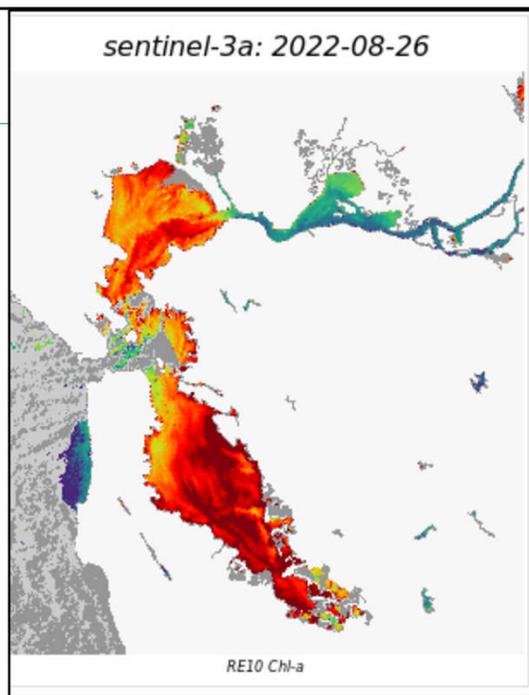
- August 7, 2022
- August 20, 2022



- Imagery from the Sentinel-3AB satellites showing chlorophyll-a concentrations in surface waters of the San Francisco Bay Estuary and delta. More chlorophyll-a (oranges and reds) indicates higher concentrations of photosynthetic algae.
- Bloom intensifies in central/south Bay, spreads throughout system including San Pablo Bay.

V. 2022 HAB Timeline

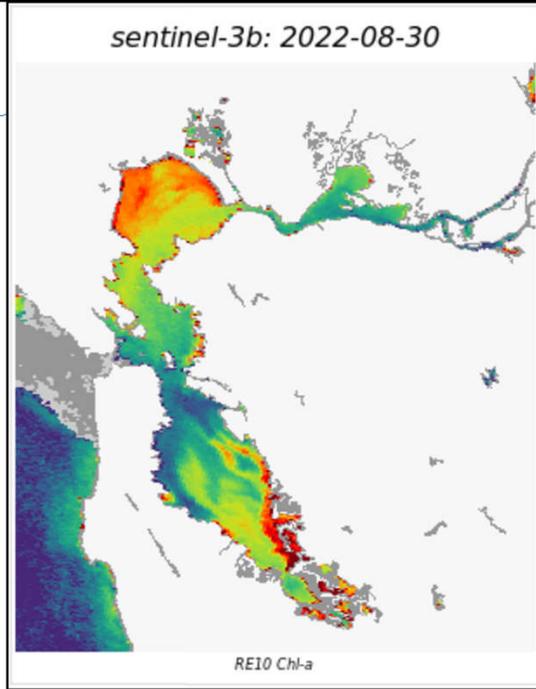
- August 7, 2022
- August 20, 2022
- August 26, 2022



- Imagery from the Sentinel-3AB satellites showing chlorophyll-a concentrations in surface waters of the San Francisco Bay Estuary and delta. More chlorophyll-a (oranges and reds) indicates higher concentrations of photosynthetic algae.
- Severe conditions throughout the region.
- Many dead fish were being reported at this time.

V. 2022 HAB Timeline

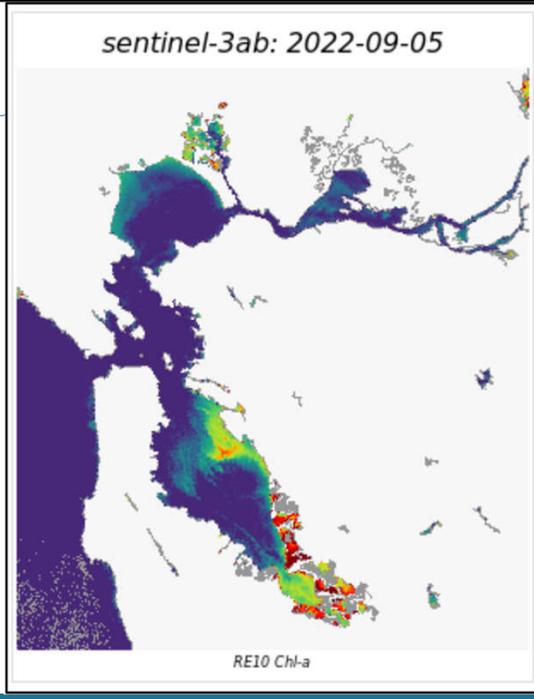
- August 7, 2022
- August 20, 2022
- August 26, 2022
- August 30, 2022



- Imagery from the Sentinel-3AB satellites showing chlorophyll-a concentrations in surface waters of the San Francisco Bay Estuary and delta. More chlorophyll-a (oranges and reds) indicates higher concentrations of photosynthetic algae.
- Algae concentrations decrease but still system-wide and strong in San Pablo Bay.
- Dissolved oxygen dropped system wide, including very low levels in South Bay.

V. 2022 HAB Timeline

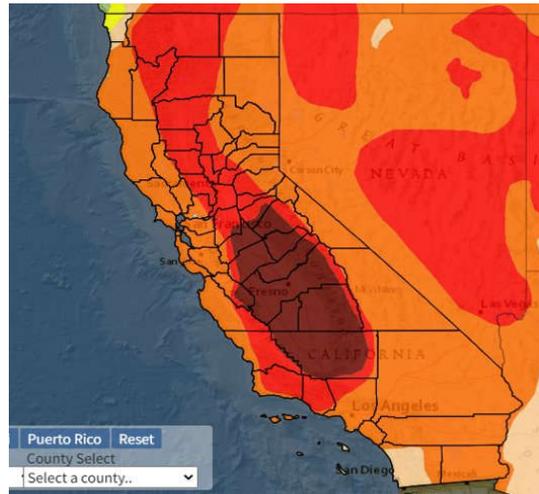
- August 7, 2022
- August 20, 2022
- August 26, 2022
- August 30, 2022
- September 5, 2022



- Imagery from the Sentinel-3AB satellites showing chlorophyll-a concentrations in surface waters of the San Francisco Bay Estuary and delta. More chlorophyll-a (oranges and reds) indicates higher concentrations of photosynthetic algae.
- Bloom subsided, DO returned to normal.

V. 2022 Harmful Algal Bloom

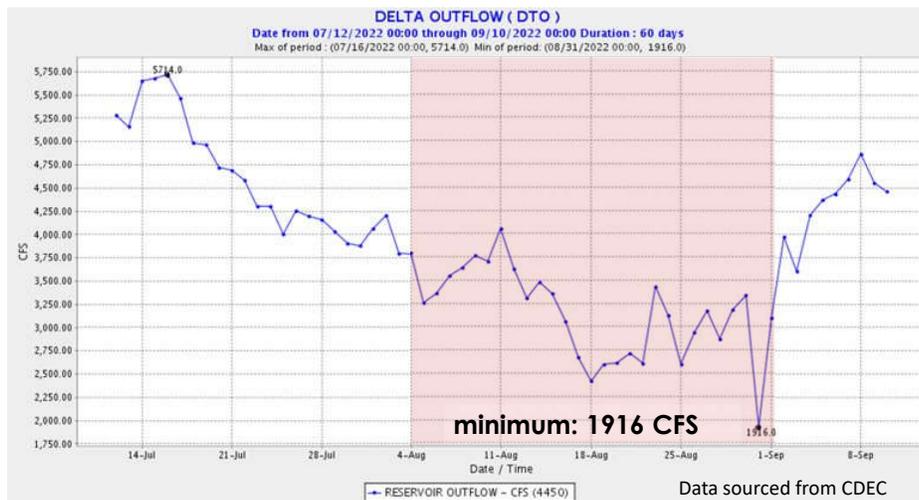
Ambient Conditions: severe drought



- State had experienced several years of severe drought leading to low flows throughout the system.

V. 2022 Harmful Algal Bloom

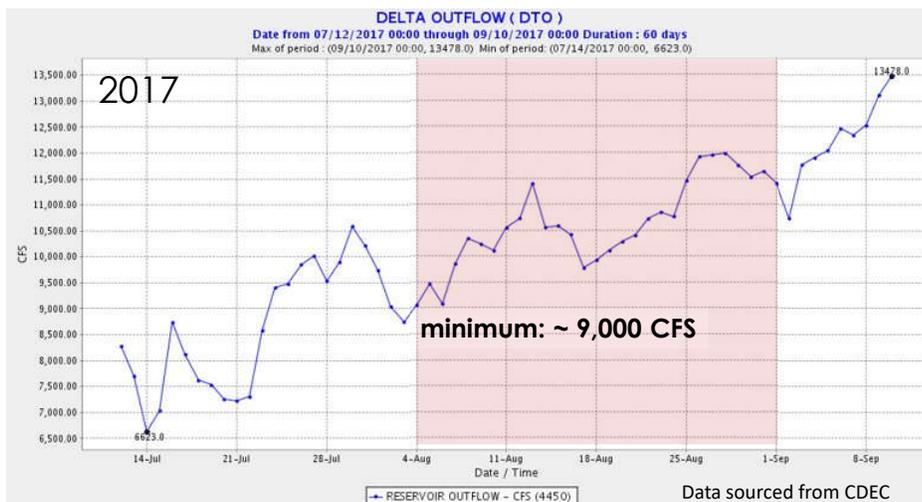
Ambient Conditions: low flows



- Flows were very low, leading to warm, saline conditions in the region.

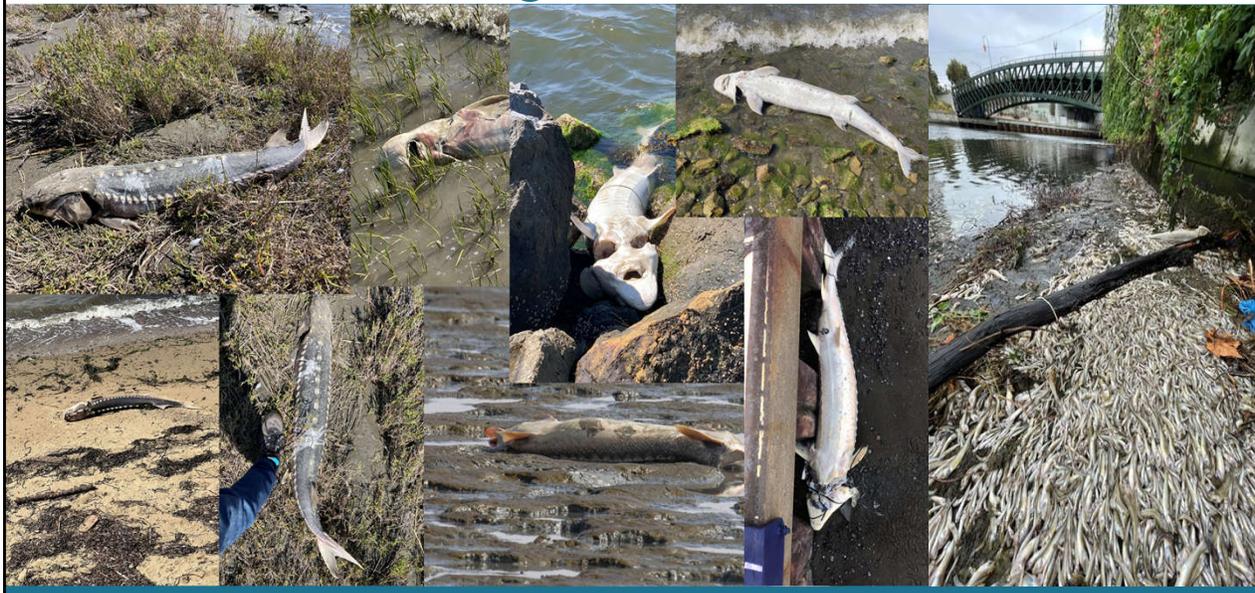
V. 2022 Harmful Algal Bloom

Ambient Conditions: low flows



- Comparison to flows in a wet year during the same time period.

V. 2022 Harmful Algal Bloom



- Largest recorded fish kill in SF Bay
- Many species impacted... including yellowfin goby, striped bass, bat rays, and many sturgeon.

V. 2022 Harmful Algal Bloom

Carcass sampling data sources:

- iNaturalist



Sources of white sturgeon carcass data from the 2022 harmful algal bloom

V. 2022 Harmful Algal Bloom

Carcass sampling data sources:

- iNaturalist
- San Francisco Estuary Institute



Harmful Algal Bloom Fish Mortality

[Home](#)

August 26, 2022

San Francisco Bay is experiencing a harmful algal bloom (HAB) of *Heterosigma akashiwo*, an organism that has caused fish kills in other estuaries. While fish mortality events were not observed during this event's early stages, fish-kill reports began emerging around August 22, shared by researchers studying the bloom and Bay Area residents.

To assess the HAB event's impacts on Bay wildlife,

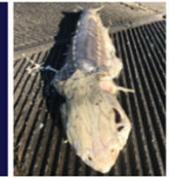
Sources of white sturgeon carcass data from the 2022 harmful algal bloom

V. 2022 Harmful Algal Bloom

Carcass sampling data sources:

- iNaturalist
- San Francisco Estuary Institute
- Sturgeon carcass "mortality study"

STURGEON CARCASS REPORTING: What's that smell?



White Sturgeon are popular recreational fish. Green Sturgeon are protected by the Endangered Species Act and cannot be fished. Sturgeon can live more than 100 years and evolved over 200 million years ago. Both species can be found in both the San Francisco Bay and the Sacramento-San Joaquin Delta year-round!

Threats to sturgeon in the SF Bay and Delta include:
Predation by California sea lions, habitat degradation, dredging, ship strikes and poaching.

HOW TO REPORT:

If You Smell Something, Say Something!

If you find a dead sturgeon, email photos to California Sturgeon Research at CaSturgeonResearch@gmail.com

Include the **date**, **location** (smartphone map coordinates preferred), and a **common object** for size reference.

Do not move or disturb the carcass.

RESOURCES:

For more information, please visit the following sites:

- wildlife.ca.gov/Conservation/Fishes/Sturgeon
- [facebook.com/casturgeonresearch](https://www.facebook.com/casturgeonresearch)
- [fisheries.noaa.gov/species/green-sturgeon](https://www.fisheries.noaa.gov/species/green-sturgeon)

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Sources of white sturgeon carcass data from the 2022 harmful algal bloom

V. 2022 Harmful Algal Bloom

Carcass sampling data sources:

- iNaturalist
- San Francisco Estuary Institute
- Sturgeon carcass "mortality study"
- CDFW Shore and Boat-Based Surveys



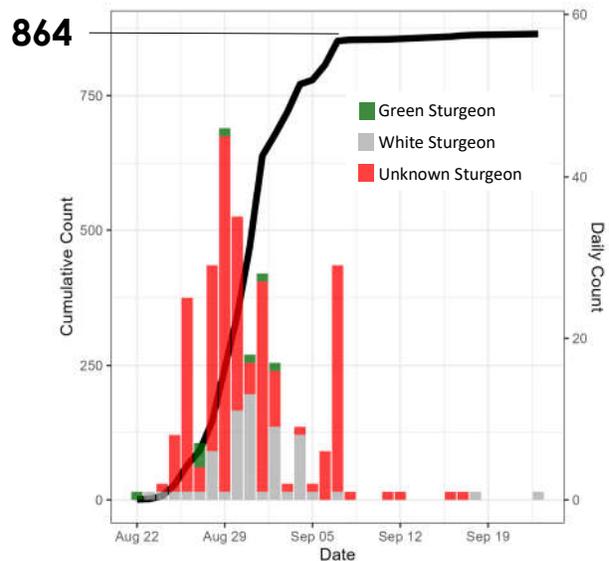
Sources of white sturgeon carcass data from the 2022 harmful algal bloom.

- After data collection, CDFW scientists spent a lot of effort cleaning the data to avoid counting carcasses multiple times if they were reported to multiple sites. Staff also viewed all submitted photos to confirm species identification when possible. Follow up calls were made when needed to clarify reported details.

V. 2022 Harmful Algal Bloom

HAB Related Mortality

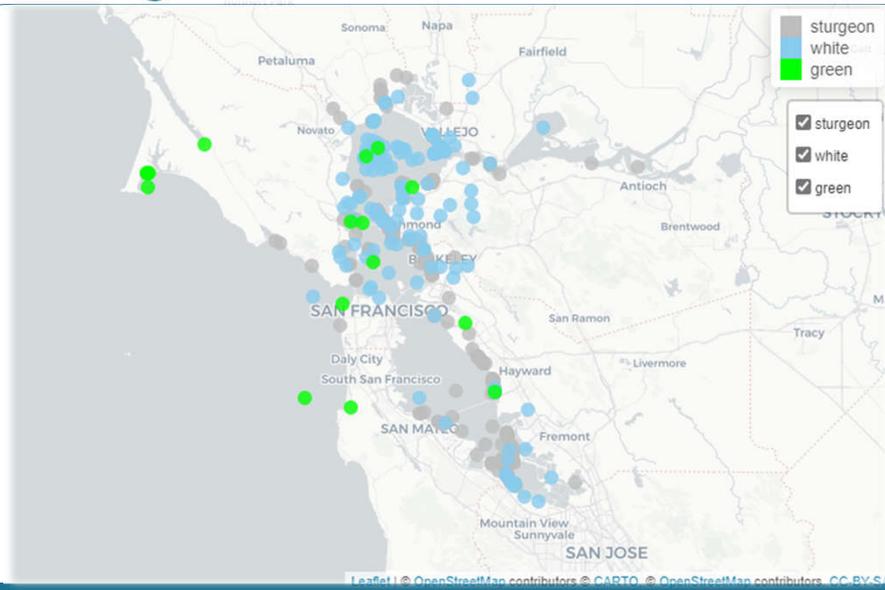
- 864 Sturgeon (total)
- 195 White Sturgeon
- 17 Green Sturgeon
- 652 unidentified Sturgeon



- Identification was confirmed by two CDFW sturgeon experts. Unidentified fish were either poorly photographed, incomplete carcasses, or too decayed to display identifiable features.

V. 2022 Harmful Algal Bloom

Spatial distribution of carcasses:

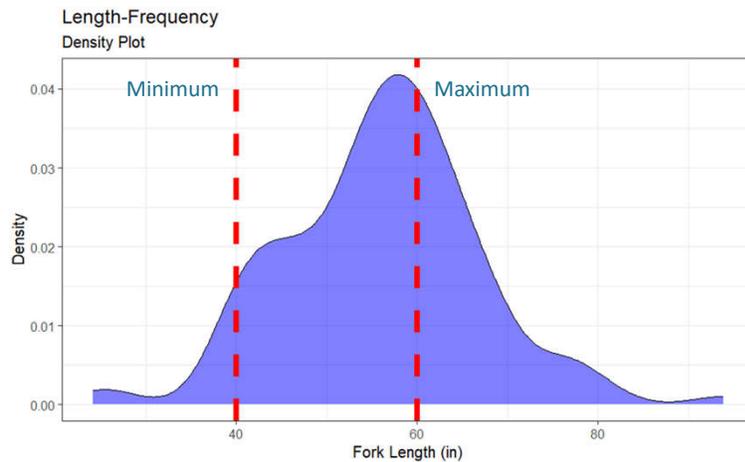


- Carcasses (mostly Green Sturgeon) observed in marine areas outside of the Bay likely indicate that mortality was caused by a toxic effect of the HAB, rather than simply depleted DO levels due to the algal bloom.
- Many points are on land due to how the data were reported. CDFW staff contacted reporters to clarify siting locations whenever possible.
- Carcass survey coverage was not complete due to the emergency nature of the response. Empty coastlines mostly reflect areas that were private or hard to reach by the public.

V. 2022 Harmful Algal Bloom

Length distribution of carcasses:

- White Sturgeon (n=115)
 - Max – 93in FL
 - Average – 56in FL
- 86% larger than the minimum size (greater than 40 inches)
- 30% larger than the maximum size (greater than 60 inches)

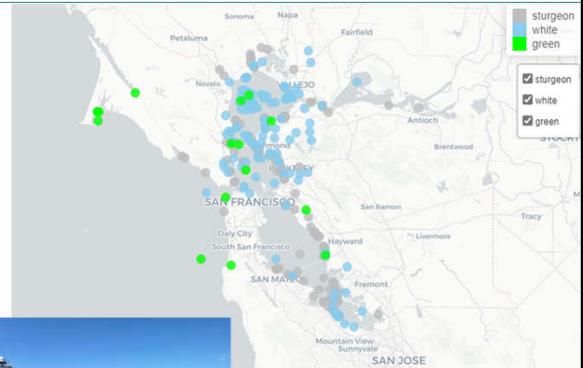


- All measurements by scientists, not public.
- Not all carcasses could be measured due to decomposition.

V. 2022 Harmful Algal Bloom

Implications:

- Large Scale Impact:
 - Sampling was spatially restricted
- Adult fish heavily impacted
- Increased Mortality Rate:
 - Carcasses sink, likely higher mortality than documented



- Evidence from scientific studies and other fish kills indicate that sturgeon do not float much or for long.
- Carcass counts are a minimum and it is likely that many more fish died than were counted.

VI. The Future of the Fishery

- The Department's goal is to maintain a fishery that can have sustainable harvest for future generations
- Population cannot continue to support current harvest rates
 - **Life history:** slow growth, late maturity, long lived, and infrequent successful recruitment
 - **Catastrophic mortality event:** warrants additional protective measures
 - Actual loss of adults is likely higher than observed
 - Risk that future generations could be greatly impacted
 - **Angler Success:** Technology and social media have greatly increased the ability of anglers to locate and catch sturgeon
- The fishery needs to be managed for an annual harvest target based on abundance estimates

VI. The Future of the Fishery

- **Monitoring and reporting:**
 - Need increased angler returns for report card and disk tags
 - Need fishery-independent surveys in combination with angler-provided data
- **Evaluation of future regulations will consider:**
 - Seasonal and geographic closures
 - Catch-and-release and harvest seasons
 - Bag limits
 - Slot limit range
 - Harvest quota system
- **Goal is to establish new regulations for 2025**
 - Public input through angler survey and Fish and Game Commission meetings
 - Interim Emergency Regulations for a Catch-and-Release only fishery may be needed until harvest rates can be effectively managed with new regulations

VII. Angler Preference Survey

We need your input! The survey will be available next week in 8 languages:

- English
 - Chinese (simplified)
 - Chinese (traditional)
 - Korean
 - Russian
 - Spanish
 - Tagalog
 - Vietnamese
- Emailed to fishing license holders, posted to social media, and on the CDFW Sturgeon webpage
 - Please take a few minutes to complete the survey. It will be open until August 15, 2023.
 - Questions? Email sturgeon@wildlife.ca.gov



VIII. Questions and Comments



Scan QR code to see the CDFW Sturgeon Report Card web page



"Clyde Strickland and Sturgeon taken on Williams Bar [above Colusa] April 16-17-18 1916." Photo: CDFW



Juvenile Green (top) and White (bottom) sturgeon captured during 2020 CDFW tagging. Photo: CDFW

Additional comments: Sturgeon@wildlife.ca.gov