Rearing habitat of larval Pacific Herring (*Clupea pallasii*) in shallow open water and tidal marsh habitats of San Pablo Bay and the western Delta.
Outline

Objectives

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Spatial Distribution

Environmental Relationships

Conclusions & Discussions
Outline

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Objectives

Describe the distribution of larval herring throughout the San Francisco Bay

and

Examine herring responses to environmental conditions.
Objectives

Describe the distribution of larval herring throughout the San Francisco Bay

and

Examine herring responses to environmental conditions.
Clupea pallasii

Anadromous

Spawn around Pacific Ocean

San Francisco Bay: March to November
Clupea pallasii

Anadromous

Spawn around Pacific Ocean

San Francisco Bay: November to March
Clupea pallasii

Anadromous

Spawn around Pacific Ocean

San Francisco Bay: March to November
Pacific Herring Spawn

Intertidal and subtidal demersal spawning

Image Source: Mike Bukey
Pacific Herring Spawn

Intertidal and subtidal demersal spawning

Hard substrate or vegetation

Image Source: CDFW
Pacific Herring Spawn

Intertidal and subtidal demersal spawning

Hard substrate or vegetation

Wide range of environmental conditions

NOAA Salinity Nowcast, 11/13/2016
Spawning in the Bay
Spawning in the Bay

Central Estuary
Spawning in the Bay

Central Estuary

South Bay
Spawning in the Bay

Central Estuary

South Bay
Spawn in the Bay

Central Estuary

South Bay
Data Sources

ICF International survey

CDFW 20mm survey

CDFW San Francisco Bay Study (SFBS) larval sampling
Data Sources

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CDFW San Francisco Bay Study (SFBS) larval sampling
ICF Survey Herring Larvae

2013 - Dry

Larvae • m$^{-3}$

- 25
- 50
- 75
- 100
ICF Survey Herring Larvae

2013 - Dry

2014 - Critical

Larvae • m⁻³

25

50

75

100
ICF Survey Herring Larvae

2013 - Dry

2014 - Critical

2016

Larvae • m⁻³

- 25
- 50
- 75
- 100
ICF Survey Herring Larvae

2013 - Dry

2014 - Critical

2016

Larvae • m⁻³

- 25
- 50
- 75
- 100
20mm Survey Herring Larvae

Wet

Above Normal

Below Normal

Dry

Critical

Larvae • m$^{-3}$

3

6

9
20mm Survey Herring Larvae

Latitude

Wet

Above Normal

Below Normal

Larvae $\cdot m^{-3}$

3

6

9

Longitude

Dry

Critical

Longitude

Longitude
20mm Survey Herring Larvae

![Maps showing larval densities in different conditions]

- **Wet**: High larval densities in certain areas.
- **Above Normal**: Moderate larval densities across various regions.
- **Below Normal**: Lower larval densities compared to normal conditions.
- **Dry**: Similar to above normal, but with slightly lower densities.
- **Critical**: Highest larval densities, indicating potential environmental stress.

Larvae • m⁻³

- 3
- 6
- 9
SF Bay Study 1980 – 1989
Herring Larvae

Wet

Above Normal

Dry

Critical

Herring Larvae • m⁻³

- 25
- 50
- 75
- 100
SF Bay Study 1980 – 1989
Herring Larvae

Herring Larvae • m$^{-3}$

- Wet
- Above Normal
- Dry
- Critical

ICF
SF Bay Study 1980 – 1989
Herring Larvae

Herring Larvae • m$^{-3}$

<table>
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Effect of freshwater flow

20mm survey larval counts by freshwater flow

\[ R^2 = 0.16 \]
\[ P < 0.05 \]
Effect of freshwater flow

20mm survey larval counts by freshwater flow

R² = 0.16
P < 0.05
Environmental Effects: Salinity

ICF Marsh Survey

20mm Survey

SFBS Larval Sampling
Environmental Effects: Salinity

ICF Marsh Survey

20mm Survey

SFBS Larval Sampling
Environmental Effects: Salinity

ICF Marsh Survey

20mm Survey

SFBS Larval Sampling
Environmental Effects: Salinity

Peak positive response 2-5
Negative Response Below 2
Environmental Effects: Salinity

Peak positive response 2-5
Negative Response Below 2
Environmental Effects: Salinity

Peak positive response 2-5
Negative Response Below 2
Environmental Effects: Temperature

Positive response above 15-20 degrees
Environmental Effects: Temperature

Positive response below 15-20 °C
Environmental Effects: Depth

ICF Marsh Surveys

20mm Survey

SFBS Larval Sampling
Environmental Effects: Depth

Negative response beyond 20m depth
Environmental Effects: Depth

Negative response beyond 20m depth
Environmental Effects: Turbidity

ICF Marsh Surveys

20mm Survey

SFBS Larval Sampling
Environmental Effects: Turbidity

Varying response by survey
Discussion

Herring respond to temperature, salinity, and depth
Discussion

Herring respond to temperature, salinity, and depth

Temperature:
Seasonal differences
Discussion

Herring respond to temperature, salinity, and depth

Temperature:
Seasonal differences

Salinity and Depth:
Spawning or habitat selection
Discussion

Herring larvae occur farther upstream in drier years
Discussion

Herring larvae occur farther upstream in drier years

(1) Herring spawns occur farther upstream during low flow years
Discussion

Herring larvae occur farther upstream in drier years

(1) Herring spawns occur farther upstream during low flow years

(2) Larvae migrate through the bay soon after hatching
Herring larvae occur farther upstream in drier years

(1) Herring spawns occur farther upstream during low flow years

(2) Larvae migrate through the bay soon after hatching
Potential impacts

Ecology
Potential impacts

- Ecology
- Fishery
Potential impacts

Ecology

Fishery

Industry
Moving onward

Where should we go from here?
Moving onward

Where should we go from here?

Larval surveys around the bay
Moving onward

Where should we go from here?

Larval surveys around the bay

Focused on potential spawning habitats
Moving onward

Where should we go from here?

Larval surveys around the bay

Focused on potential spawning habitats

Throughout the herring spawn season
Acknowledgments

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