# What to Expect When Expecting: Investigation of Mysid Fecundity in the Upper San Francisco Estuary

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## Introduction

The CDFW has conducted its Zooplankton Study since 1968, collecting mysid and zooplankton abundance data from the upper San Francisco Estuary. The study has recorded mysid fecundity data for several species since 1974, observing changes in embryo counts and stage over time. Here we analyze the fecundity of 3 species, *Hyperacanthomysis longirostris*, an introduced species, *Neomysis kadiakensis* and *Neomysis mercedis*, 2 native species.

## Methodology

Currently mysid samples are collected monthly throughout the year at 17 fixed stations and 2 to 4 non-fixed low-salinity zones from San Pablo Bay to the eastern delta. A 0.505mm mesh mysid net is used to collect the samples, which are preserved in 10% formalin with rose bengal dye to better discern between organisms and detritus.

Samples are brought back to the lab for processing, where target organisms are identified by species, measured (total length in mm), sexed and in the case of gravid mysids, embryos are staged (egg shaped, comma shaped, or eyed, Figure 1) and embryo counts are recorded.

Preliminary analysis was performed using R to create overall annual mean density of the 3 mysid species over the past 40 years, log transformed embryo counts in relation to month of the year, linear models of embryo counts versus length of mysid, and embryo stage.

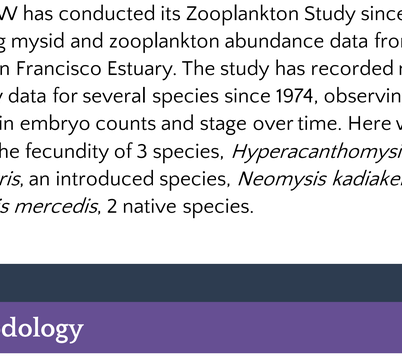


Figure 1. A) *H. longerostris* with egg-shaped eggs (stage 1) (photo by Tricia Bippus), B) with comma-shaped eggs (stage 2) (photo by Tricia Bippus), C) with eyed neonates (stage 3) (photo by Nene Ugbah), D) eyed neonate (photo by Nene Ugbah), E) *N. mercedis* gravids with 1-3 stage eggs (photo by Tricia Bippus), F) *N. kadiakensis* gravid with eyed neonates (photo by Tricia Bippus).

## Results

- Overall, the annual mean density of the 3 species have declined within the 40 years the study has been conducted (Figure 2), despite mysid reproducing throughout the year.
- There are higher averages of embryo counts for all 3 species during the first half of the year (month 1 to 6), however all mysid species are seen reproducing throughout the year (Figure 3).
- *H. longirostris* has been observed to have higher embryo counts at shorter body length compared to *N. kadiakensis* and *N. mercedis* (Figure 4). This is consistent with the observation that *H. longirostris* reaches maturity at shorter lengths compared to the 2 other species.
- There were significant differences in embryo counts between *H. longirostris* and *N. kadiakensis*; and *H. longirostris* and *N. mercedis* relative to length. However, there was not significant difference between *N. kadiakensis* and *N. mercedis* (Table 1).
- Declines in embryo counts across embryo stages with all 3 species was observed, with *H. longirostris* and *N. kadiakensis* having more pronounced decline compared to *N. mercedis* (Figure 5).


Figure 2. Catch-per-Unit-Effort of *H. longirostris*, *N. kaidiakensis*, *N. mercedis* from 1974-2020.

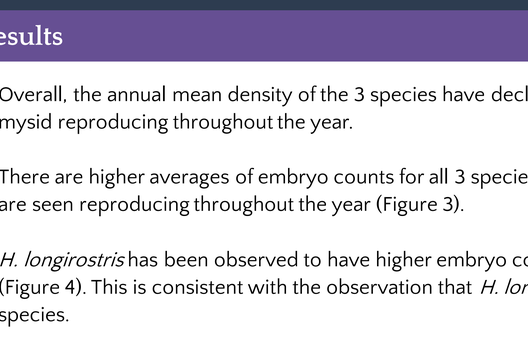


Figure 3. Relationship between embryo counts and month of the year when samples were collected from 1976 - 2020.

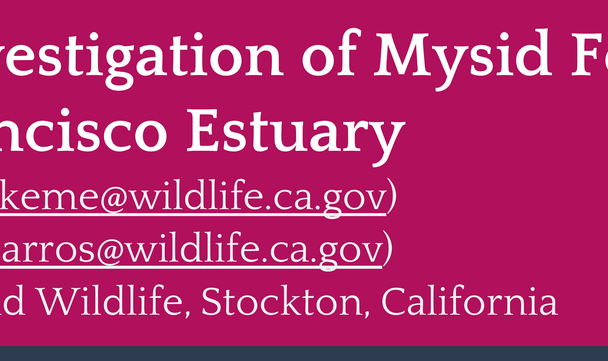


Figure 4. Relationship between embryo counts and body lengths (mm) for *H. longirostris*, *N. kadiakensis*, and *N. mercedis*.

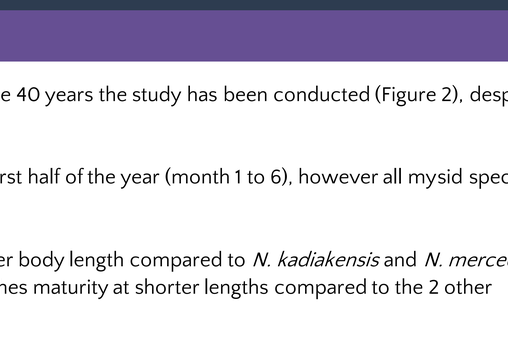


Figure 5. Relationship between embryo count and embryo stage (egg shaped, comma shaped, eyed neonate).

| Comparison | P value |
|---|---|
| Hyperacanthomysis longirostris - Neomysis kadiakensis | <.0001 |
| Hyperacanthomysis longirostris - Neomysis mercedis | <.0001 |
| Neomysis kadiakensis - Neomysis mercedis | 0.2272 |

Table 1. P-values comparing regression lines of the body lengths versus embryo count (Figure 1).

## Discussion

CDFW has conducted its Zooplankton Study for more than 40 years in the upper San Francisco Estuary. In that time, declines in overall abundance of mysids have been observed, with the steepest declines seen in the native species, *N. mercedis* compared to moderate declines in *H. longirostris*, an invasive species first observed in 1993.

*H. longirostris* can reach reproductive size at shorter lengths than *N. mercedis* or *N. kadiakensis* and is more fecund than the 2 native species at comparative lengths. These attributes provide further advantage to *H. longirostris,* helping it outcompete native mysid species, in addition to being able to tolerate higher temperatures, higher salinities and lower food availability (Avila and Hartman 2020).

The 3 mysid species have been shown to reproduce throughout the year, with higher embryo counts seen in the first six months. More investigations should be conducted to better understand why this occurs.

In addition, further investigations should explore possible differences of fecundity in relation to the locations of sample collection and varied environmental conditions for each of the mysid species.

## Acknowledgements

This investigation was made possible by the Interagency Ecological Program as part of EMP Zooplankton Study. Thanks to the CDFW lab and field staff who collected and processed samples all these decades and continue to do so.

## Works Cited

Avila M, Hartman R. 2020. San Francisco Estuary mysid abundance in the fall, and the potential for competitive advantage of *Hyperacanthomysis longirostris* over *Neomysis mercedis*. California Fish and Wildlife 106 (1): 19-38.