

Double Brood Ovaries

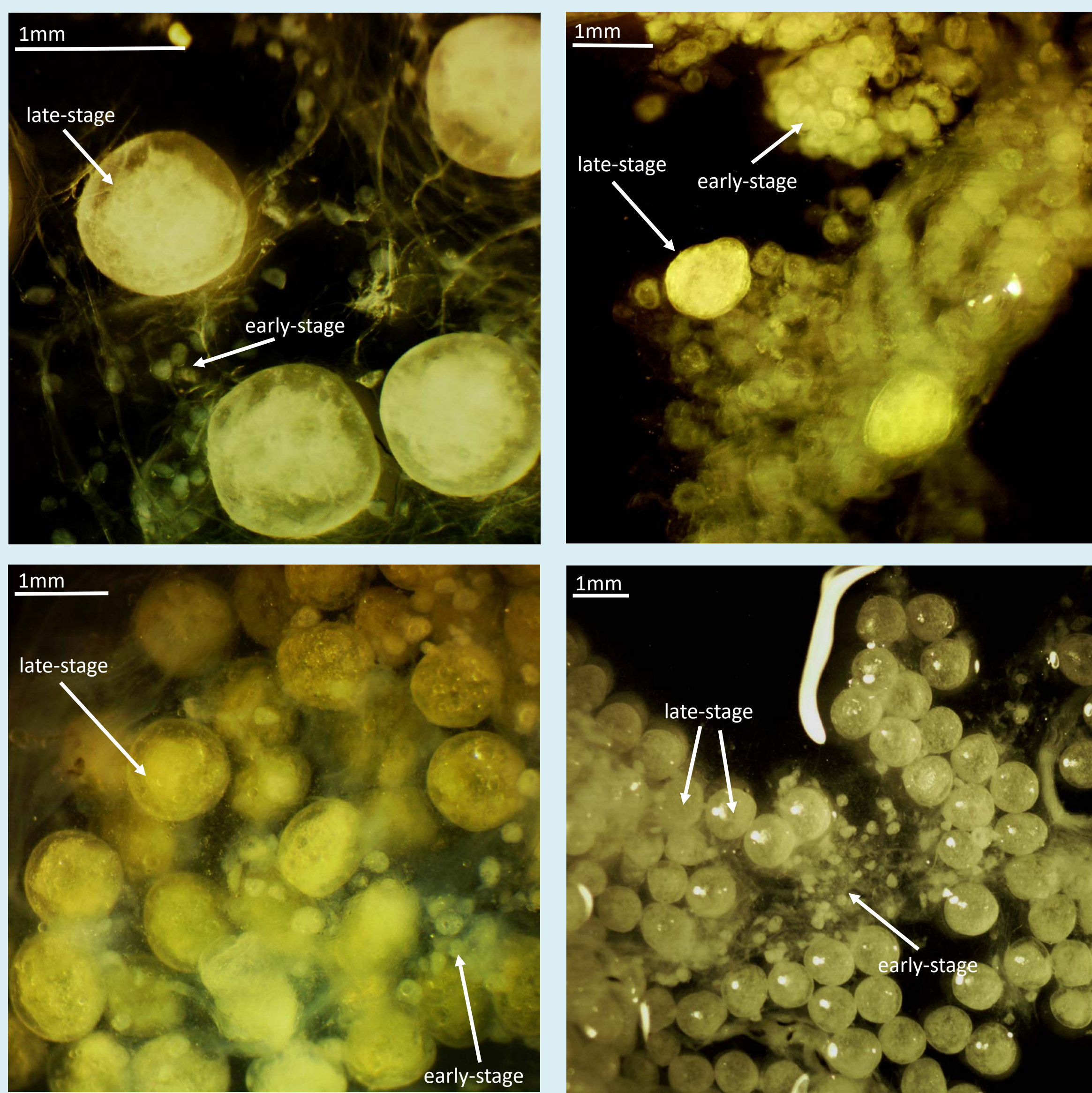


Fig 1. Dissecting scope photographs of mixed-stage (double brood) ovaries with early-stage and late-stage eggs present.

Proportion of Gonad Stages in Reproductively Mature Females

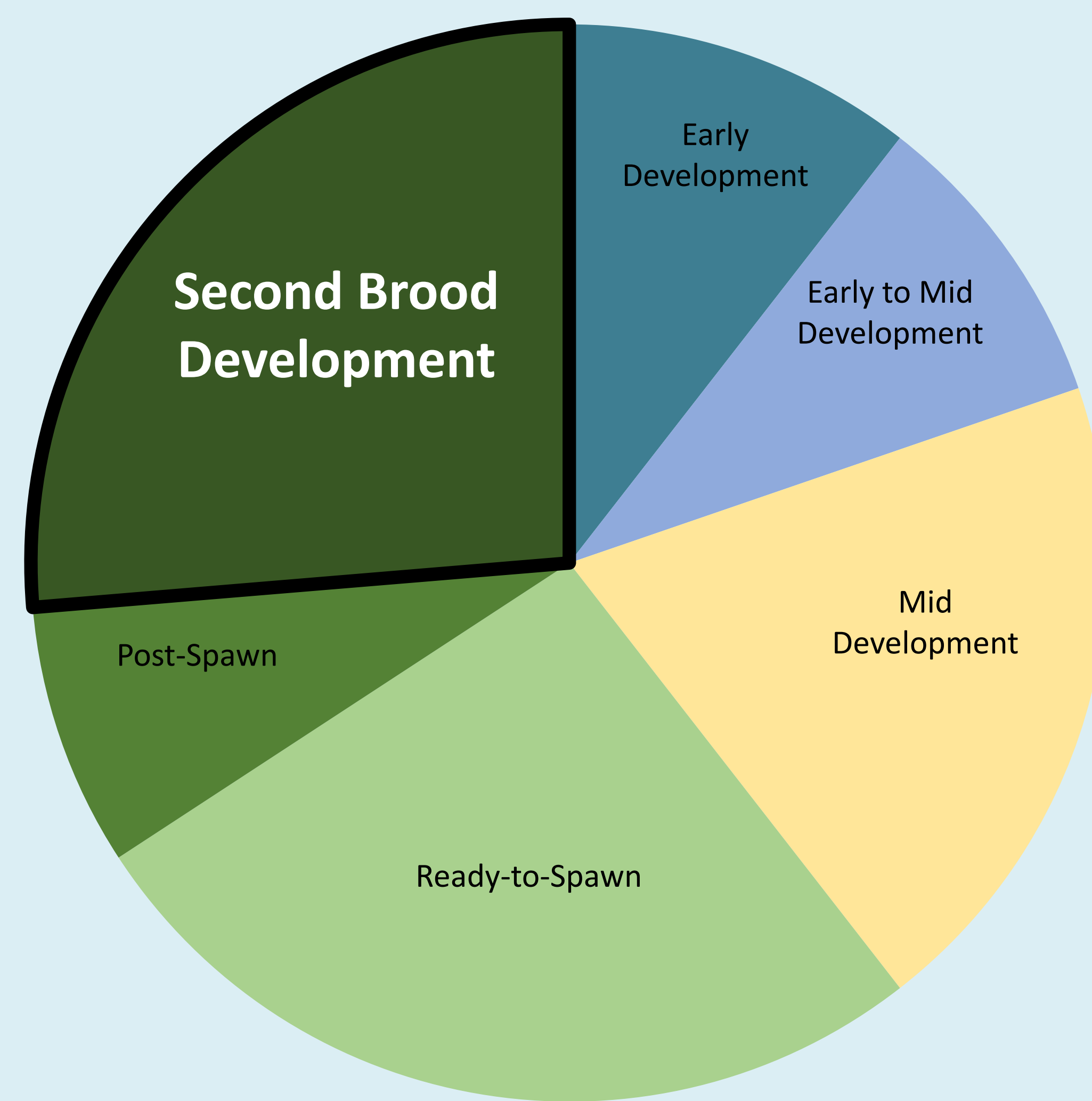


Fig 2. Female gonads with multiple stages of eggs (double broods) constitute more than 25% of all age-2 reproductively mature (≥ 80 mm SL) females. All females had eggs or evidence of spawning (i.e. there were no females that had a “no gonads” rating).

Evidence for multiple broods and early gametic production in the threatened Longfin Smelt

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Introduction

Despite extensive research into their life history, habitat use, and migration, the reproductive biology of Longfin Smelt (*Spirinchus thaleichthys*) of the San Francisco Estuary (SFE) remains understudied and relatively cryptic. This knowledge gap, along with potentially outdated length-maturity minimums, hinders our ability to accurately predict recruitment.

Methods

We investigated reproductive characteristics in Longfin Smelt captured by otter trawl in San Pablo Bay tributaries and southern San Francisco Bay creeks and marshes (November 2018 to April 2019). Specimens were frozen, and those 50mm SL and larger were dissected. Using the gonad staging rubric for Delta Smelt¹ as a model, we created a new rubric specific to Longfin Smelt gonad characteristics. We assigned the “double brood” stage to fish with gonads that had a large majority of early-stage eggs compared to the number of late-stage eggs. Gonads with few early-stage eggs and majority ready-to-spawn eggs were not considered “double brood”.

Results

Gonad analysis revealed 2 recurring themes: (1) occurrence of double broods (Figs 1, 2), and (2) gonads present in individuals that were smaller than the traditional size cutoff for age-2 reproductively mature fish (80mm SL minimum)² (Fig 3). Double brood gonads were present in over 25% of adult females, while a significant portion of sub-adult fish possessed gonads at some point of maturation. Females as small as 57mm SL and males as small as 59mm SL possessed early-developing gonads (males were not included in either graph due to divergence in the staging rubric). The smallest female to possess ready-to-spawn eggs was 75mm SL.

Discussion

Our preliminary study provides supporting evidence for Longfin Smelt maturation at age-1 and multiple spawning events over ontogeny³. Interestingly, the high proportion of adults with double broods indicates that multiple spawning events may be even more common than previously thought. Instead of a semelparous strategy, Longfin Smelt may exhibit a bet-hedging, income-breeding reproductive strategy, whereby energy is directly allocated to reproduction when feeding and environmental conditions are favorable. Further investigation into these behaviors and their fitness tradeoffs are needed to help understand spawning and recruitment success in the SFE.

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References

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Longfin Smelt may be able to mature early and generate multiple broods

Proportion of Gonad Stages by Length

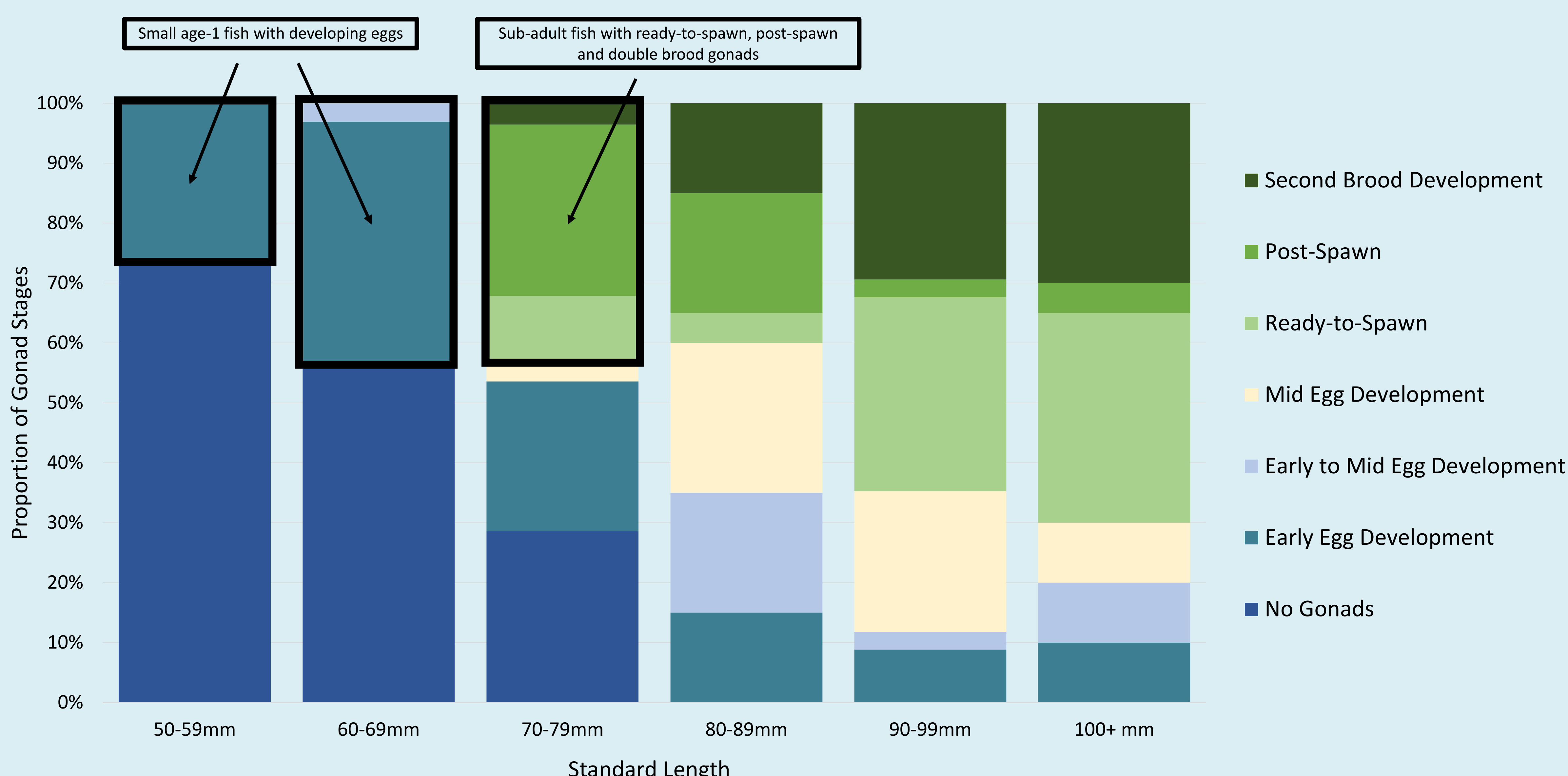


Fig 3. The proportion of gonad stages differs greatly for each length category. While the cutoff for age-2 reproductively mature fish is ~ 80 mm SL, more than 40% of fish in the 70-79mm category have at least fully developed (ready-to-spawn) eggs. Age-1 fish also have a significant amount of early-developing eggs. Omission of these two categories from models can lead to an underestimation of recruitment potential for subsequent years.