NZ National Institute for Water & Atmospheric Research

Reproduction of hāpuku, *Polyprion oxygeneios*, in New Zealand

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***Present Institute: The New Zealand Institute for Plant and Food Research**

New Zealand Aquaculture

The industry

- grown from small beginnings to a significant primary industry, sustainably producing three flagship products
- a target goal of $1 billion in sales by 2025
- a need for species diversification and high value products
  - Requires significant research & development

Greenshell Mussel
(Perna canaliculus)

Pacific Oysters
(Crassostrea gigas)

Chinook Salmon
(O. tshawytscha)

http://aquaculture.org.nz/

Hapuku

In 2007, NIWA established a broodstock selective breeding programme

- Southern hemisphere species

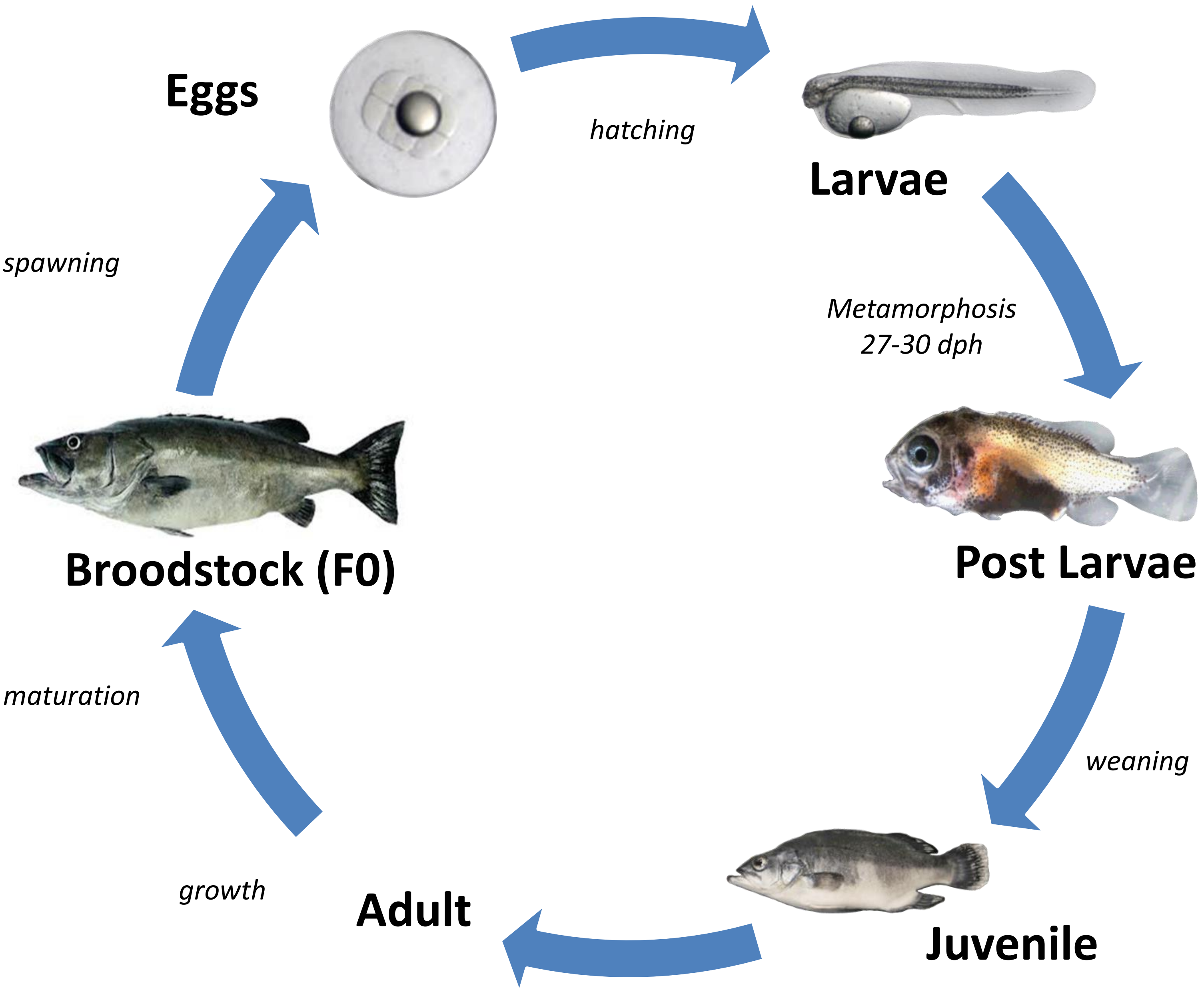
- Long-lived deep water species
- Sexually mature (10-13 years in wild)
- Grow large

- Growth - very rapid during juvenile stages and up to the first 3 years of their life (~ 4 kg at 2.5 years)

- Recently began to understand the reproductive physiology of this species – due to the availability of captive stocks

Hāpuku *(Polyprion oxygeneios)*

The hapuku production cycle



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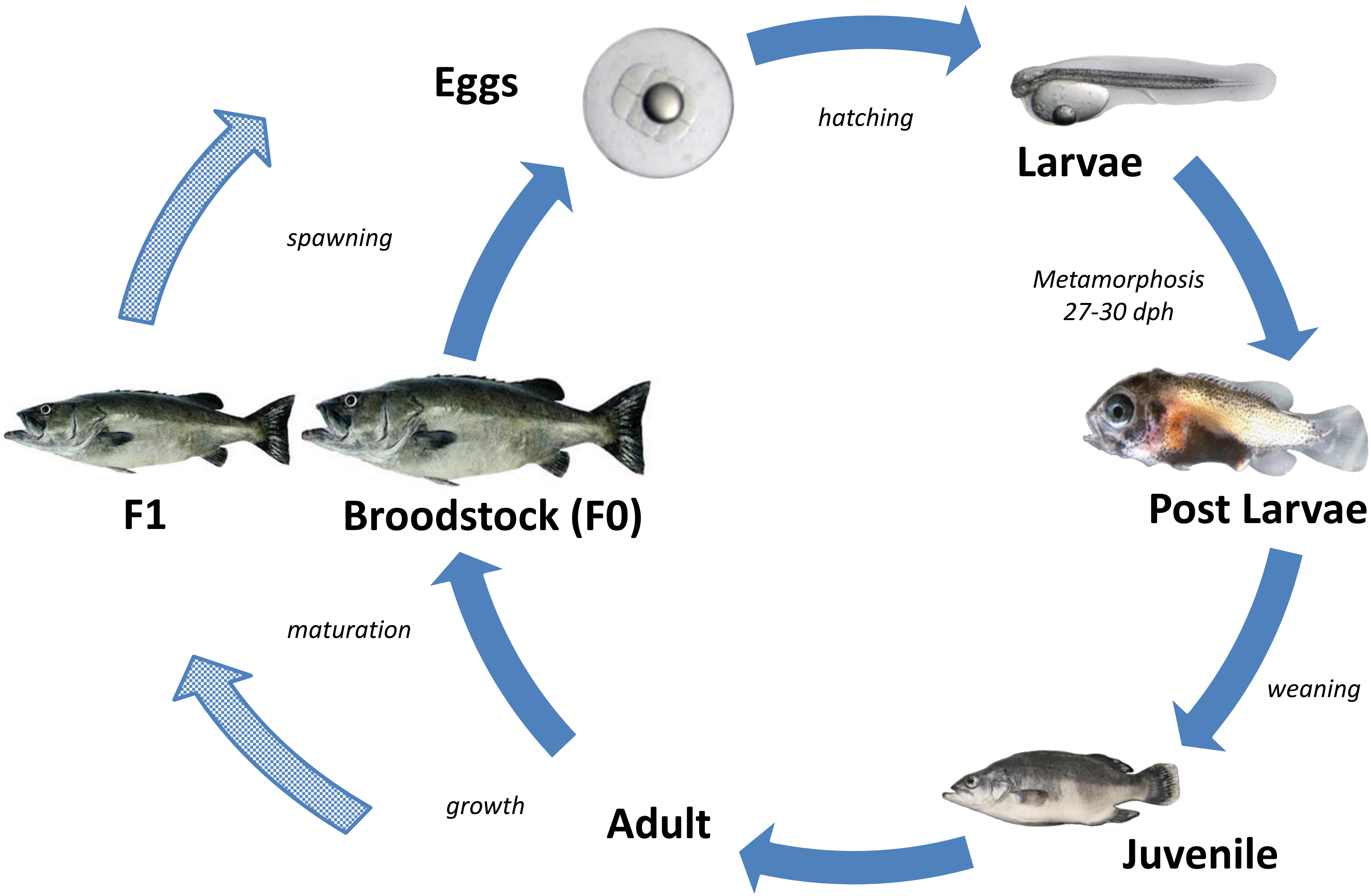

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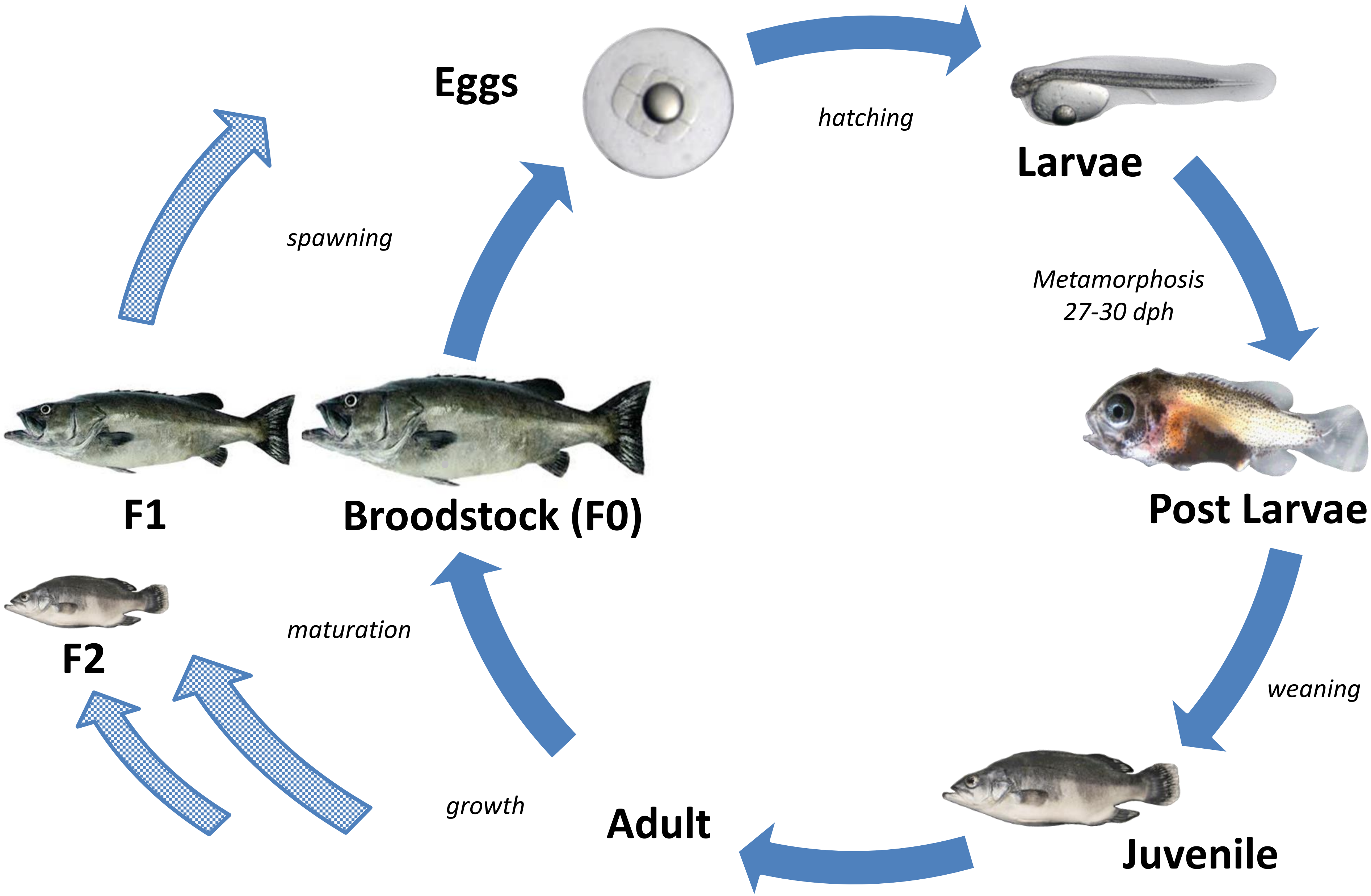

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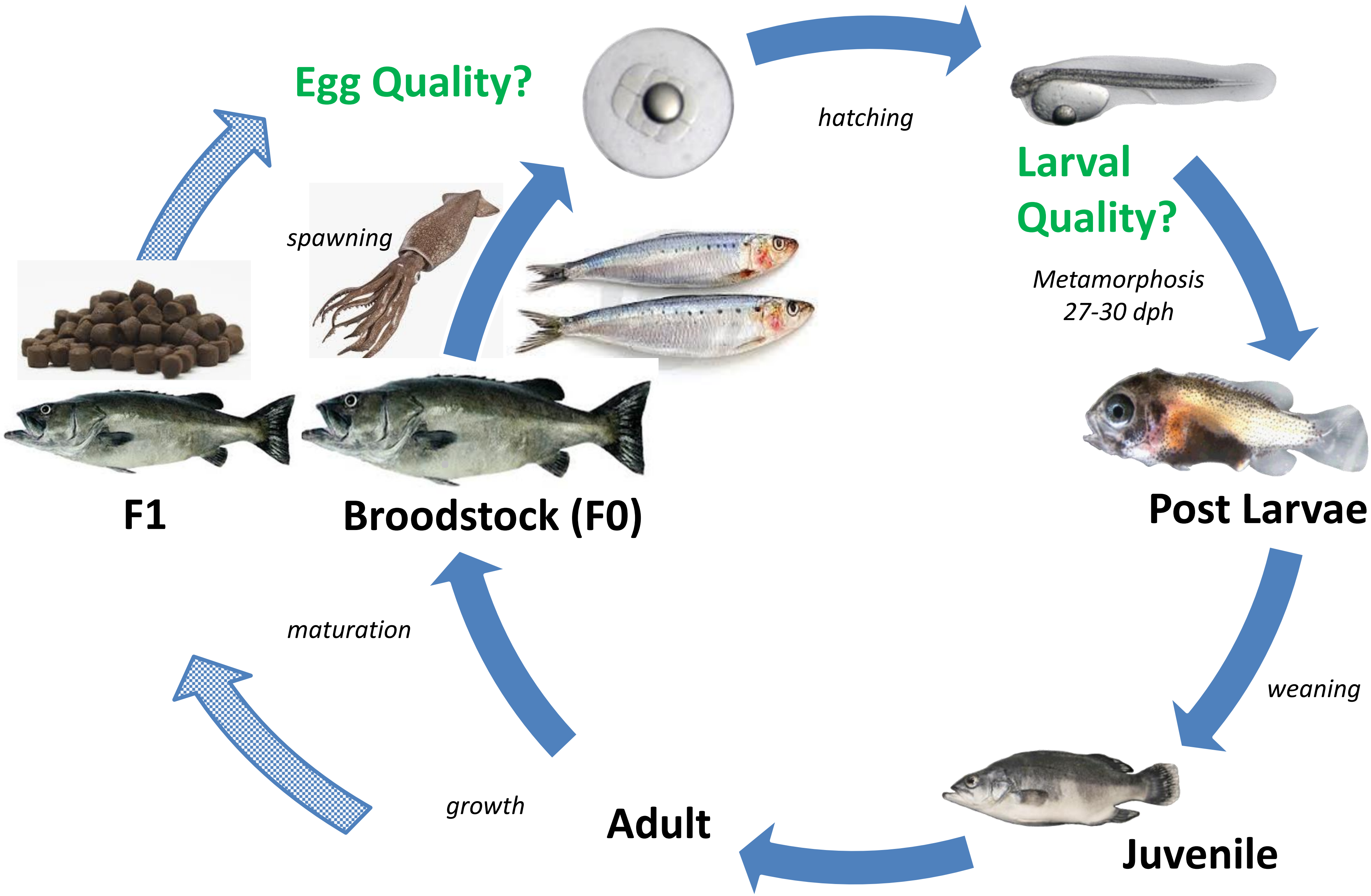

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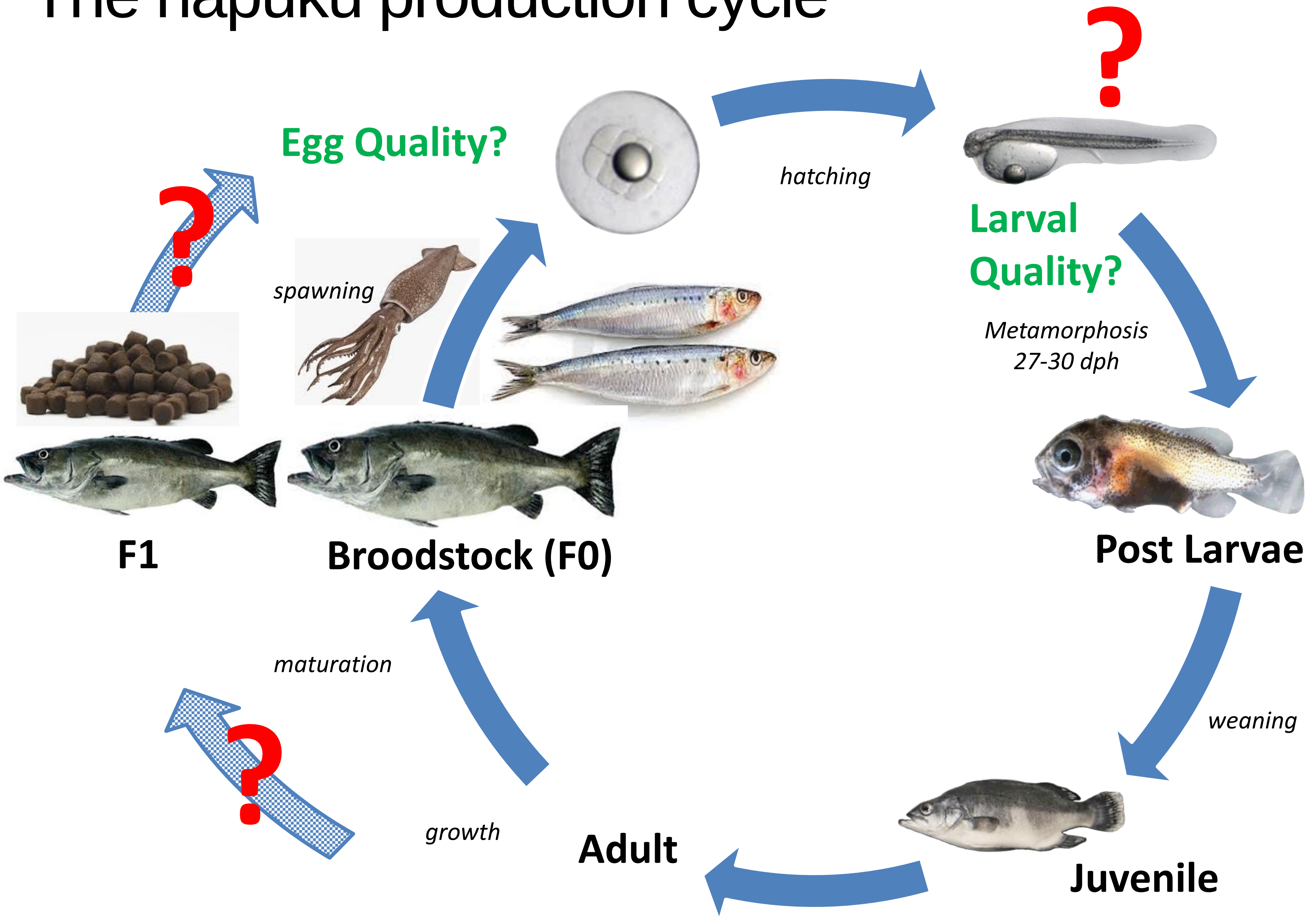
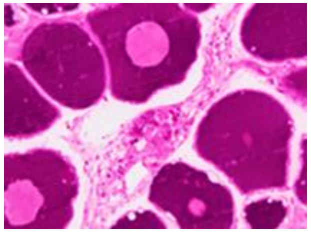
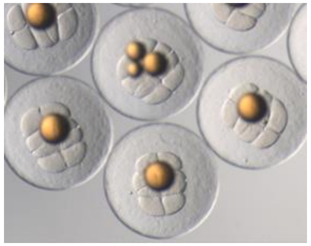


Core research objectives since 2012

- Examining early oogenesis using next generation sequencing **Wylie** et al. *in prep*
- Describing ovarian development of 'first-time spawning' hapuku **Wylie** et al. *2018*
- Improving spawning of F1 hapuku with hormonal manipulations **Wylie** et al. *in prep*
- Reducing generation intervals (puberty advancement) **Wylie** et al. *2018*
- Life-cycle closure **Wylie** et al. *in prep*
- Enhancing larval survival





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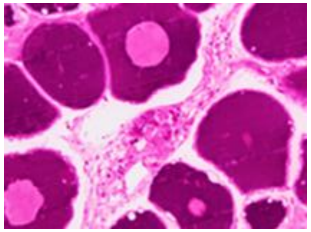

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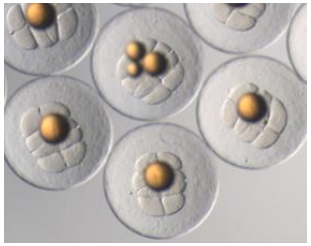

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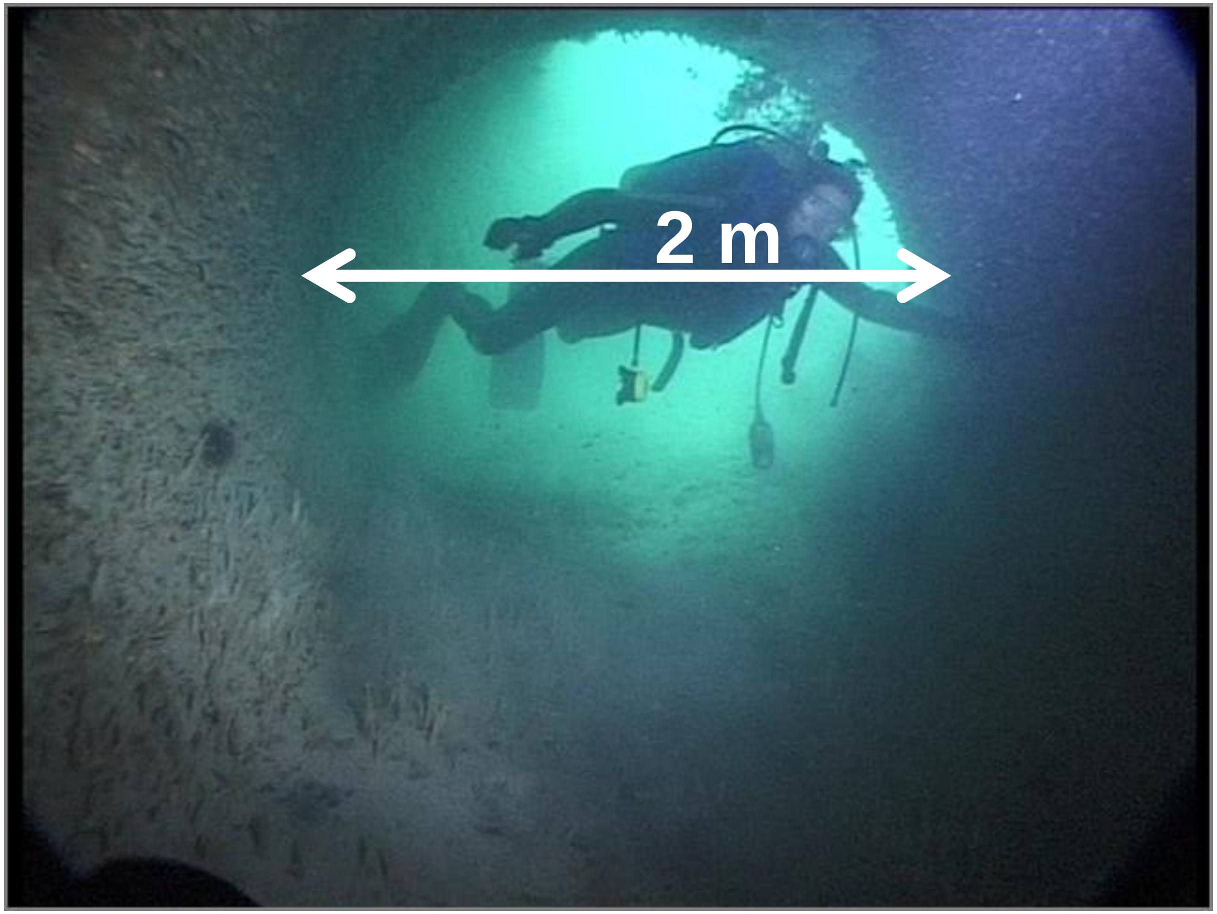
- ❑ Enhancing larval survival

Study sites

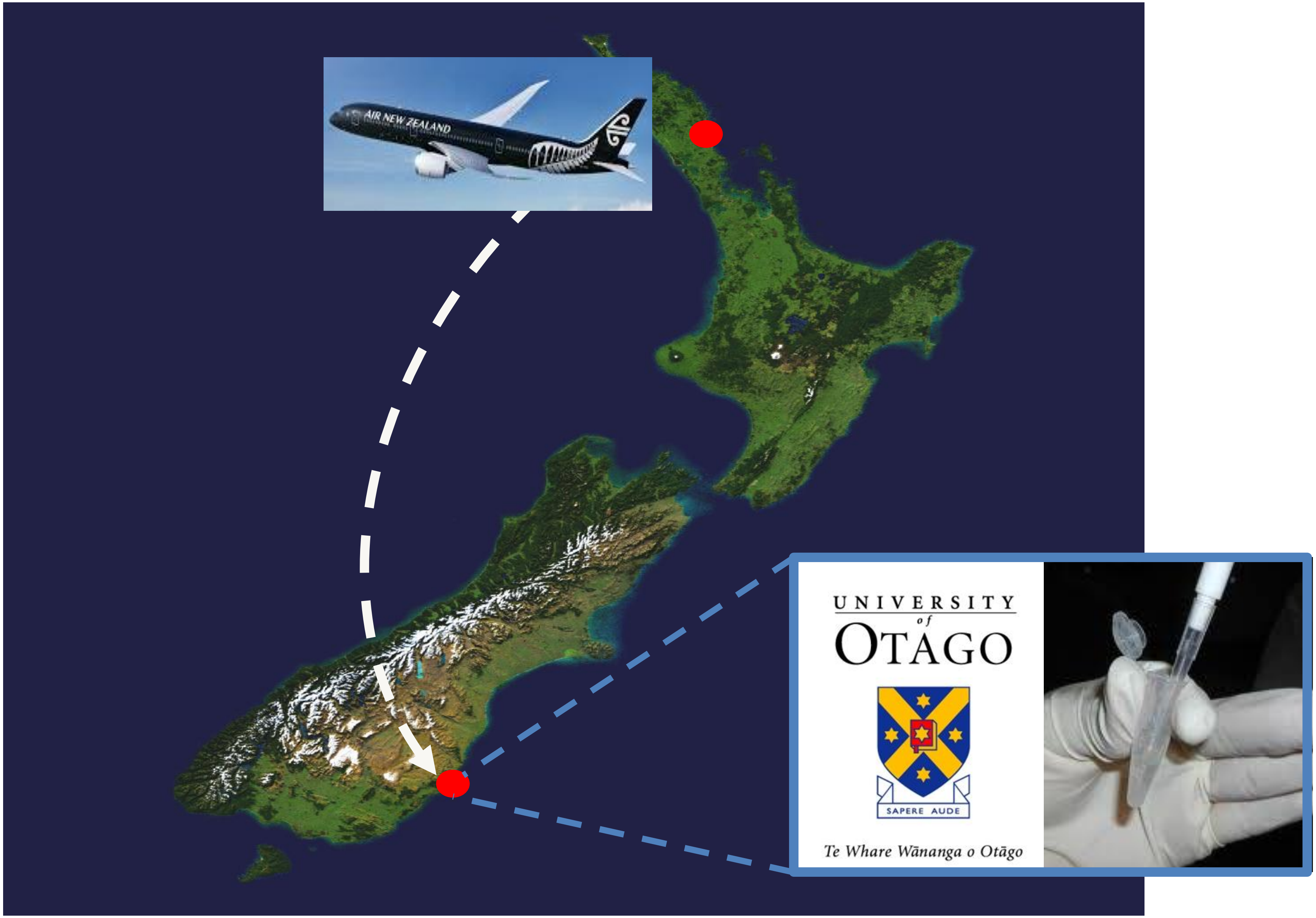
Live animal work conducted at NIWA's Northland Marine Science Centre

Northland Marine Research Centre

- Land based marine aquaculture facility bordering the Pacific Ocean
- Makes use of power station infrastructure



Water Source:
Existing power station intakes



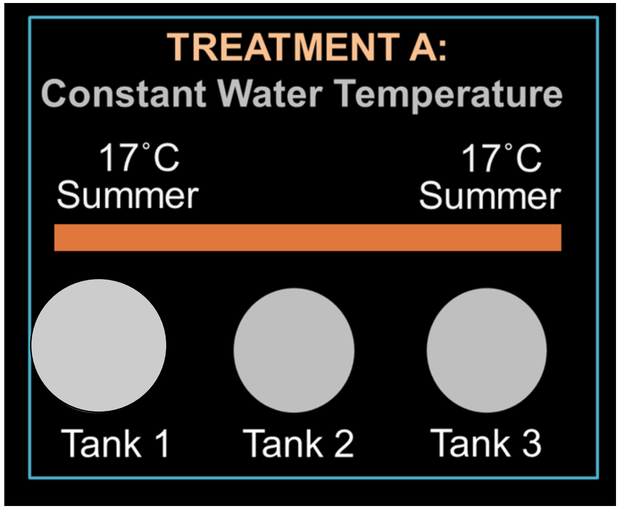
Sample analysis conducted at the Department of Zoology

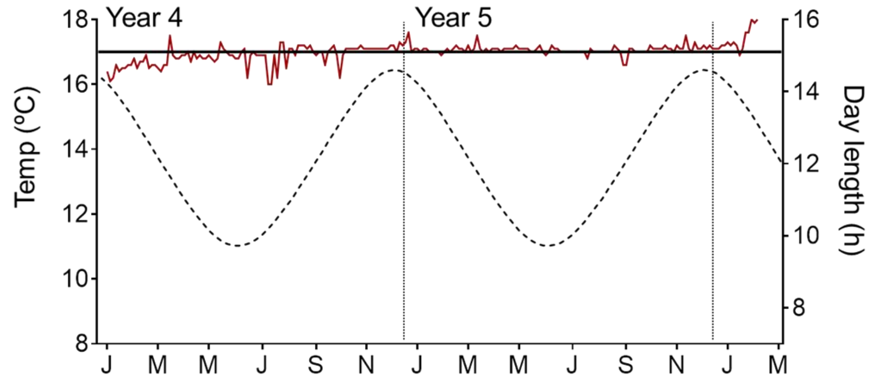
I. Oogenesis in hapuku:

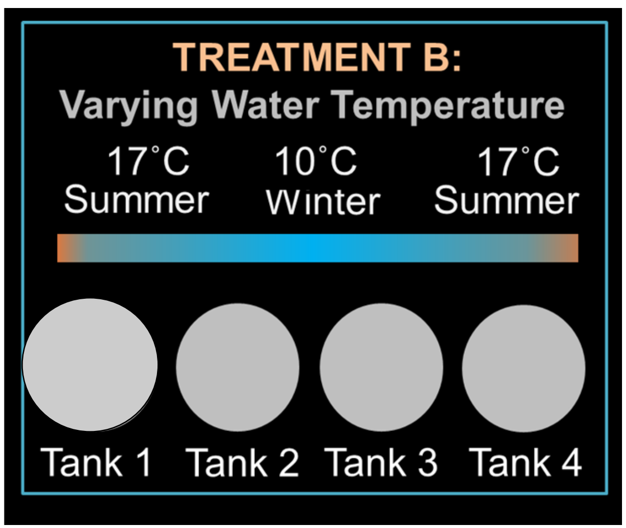
Aims:

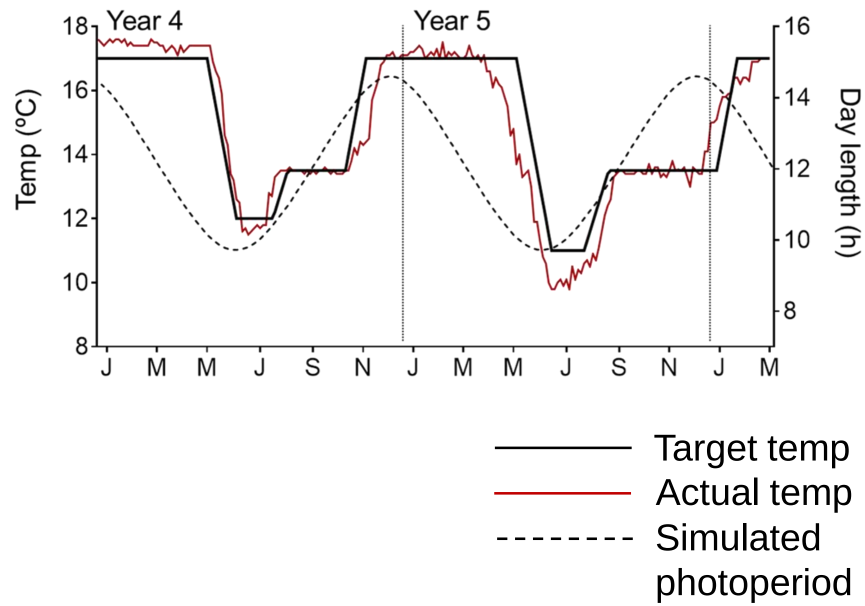
- Assess the effect of thermal regime on ovarian development of first-time spawning F1
    - Improve husbandry conditions
    - Provide a basis for photoperiod manipulations
    - Determine the age at maturity of F1

Oogenesis in first-time spawning hapuku:









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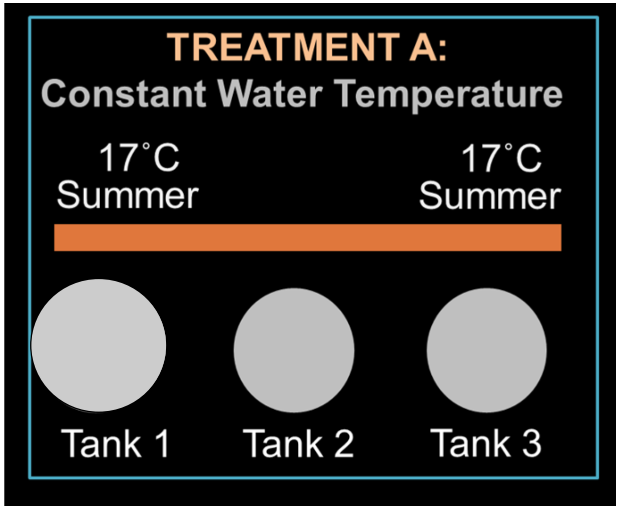

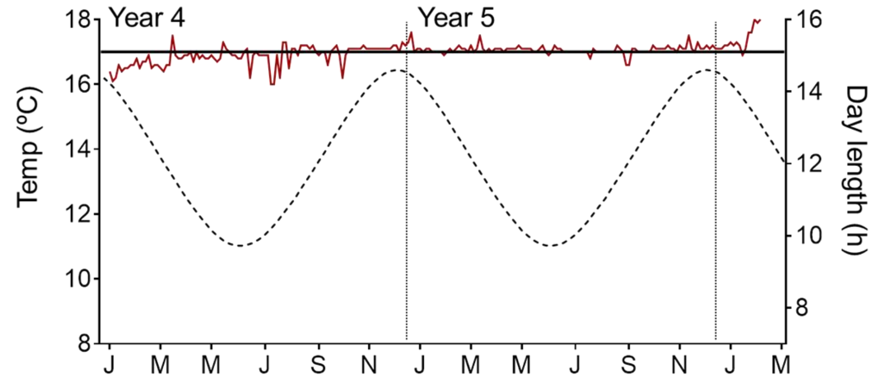

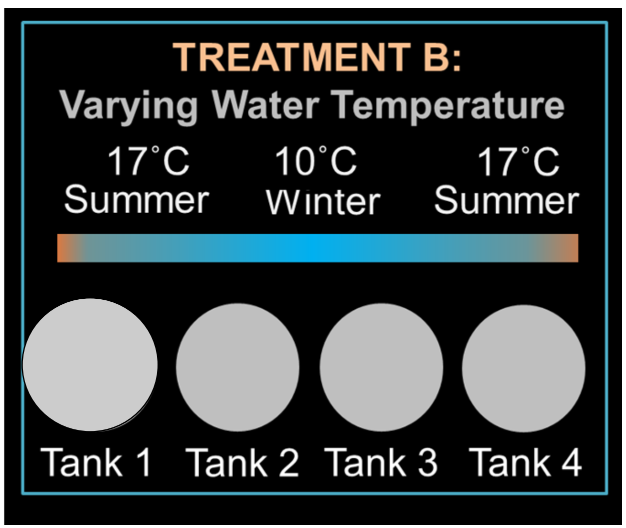

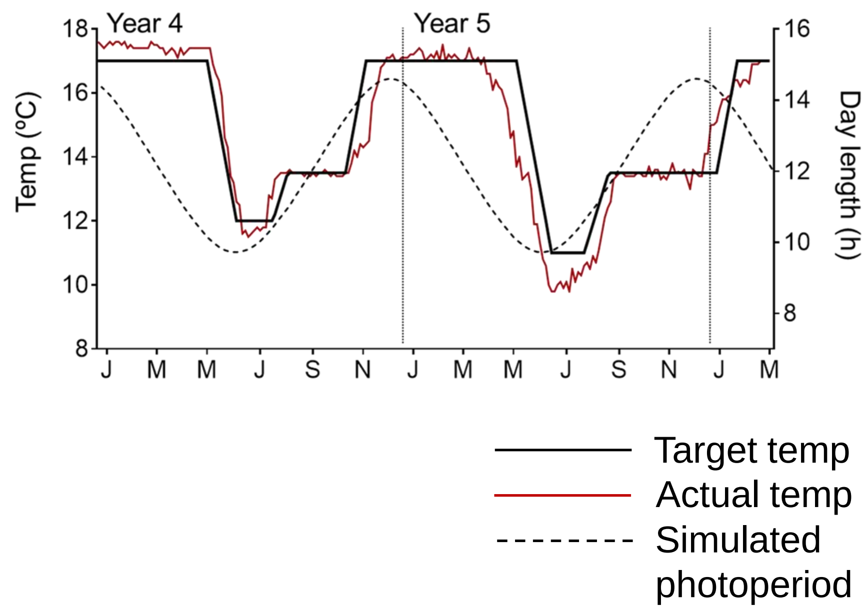

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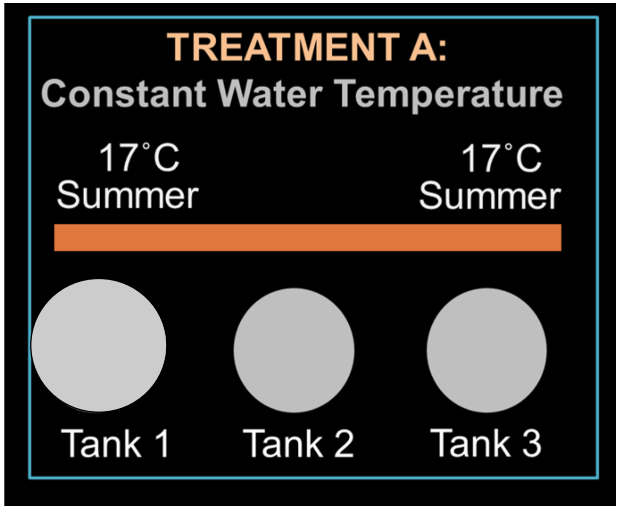

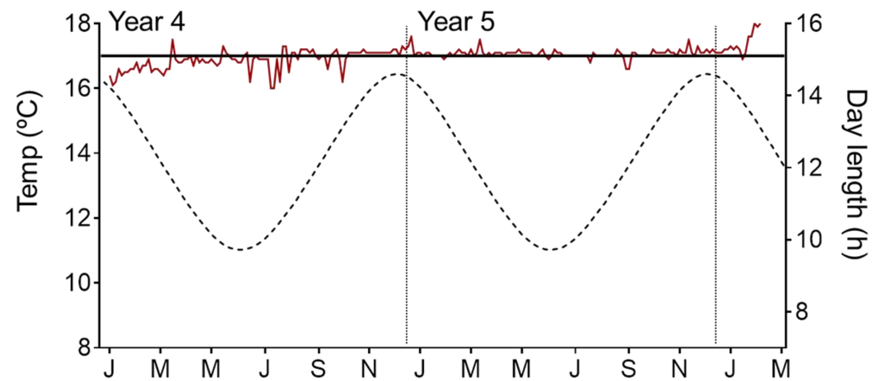

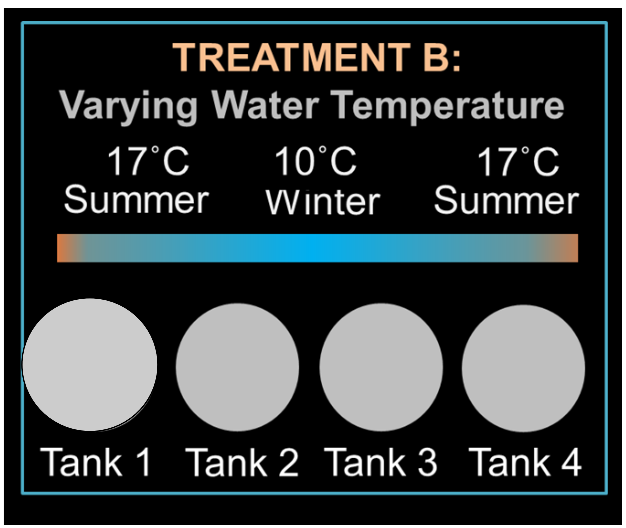

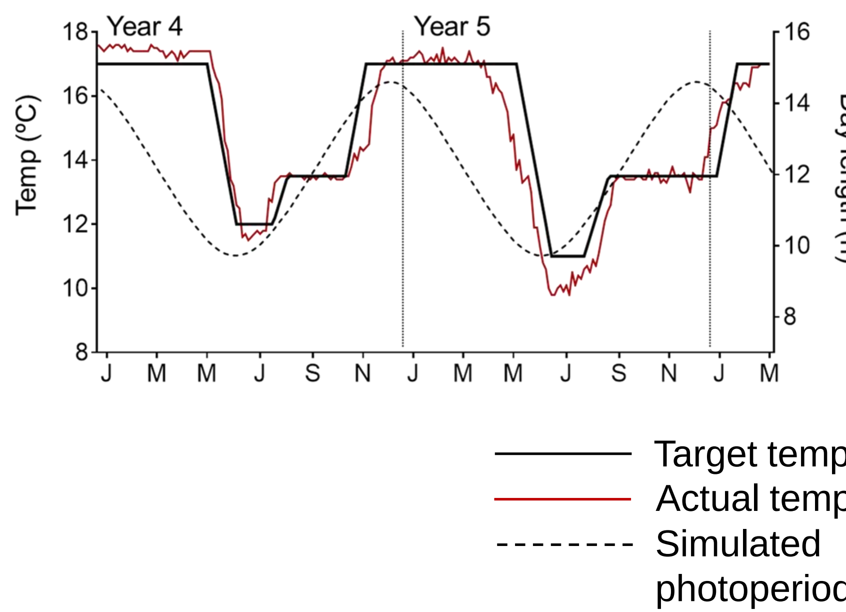

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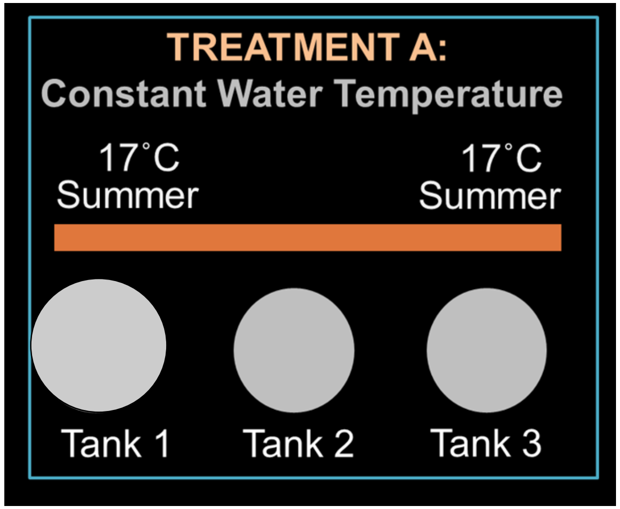
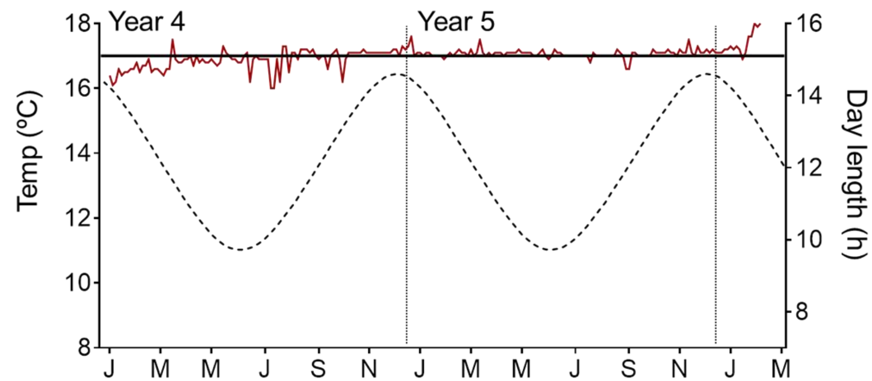
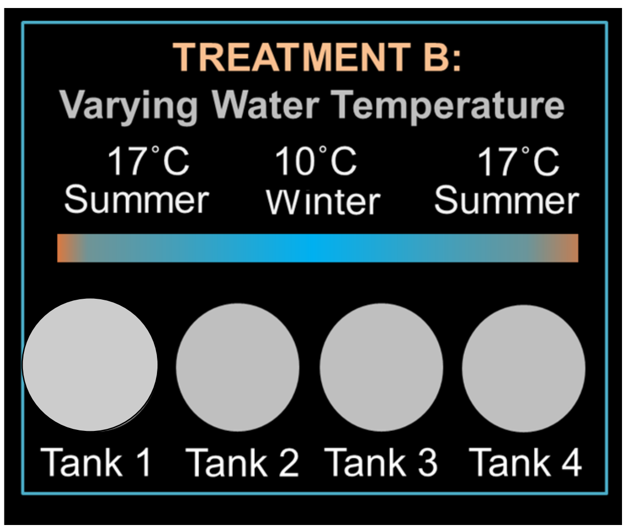
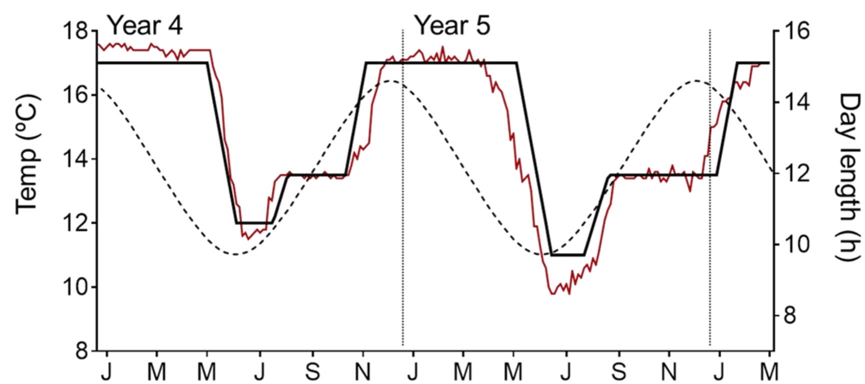
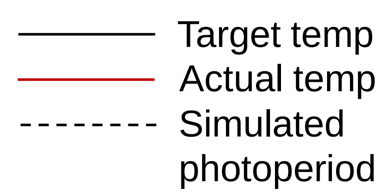


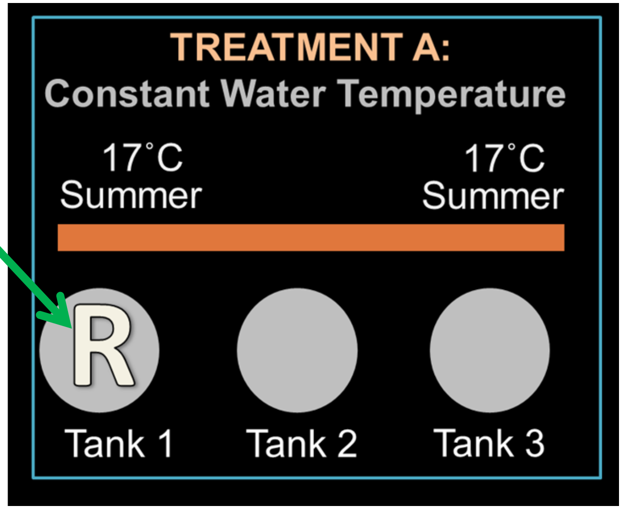


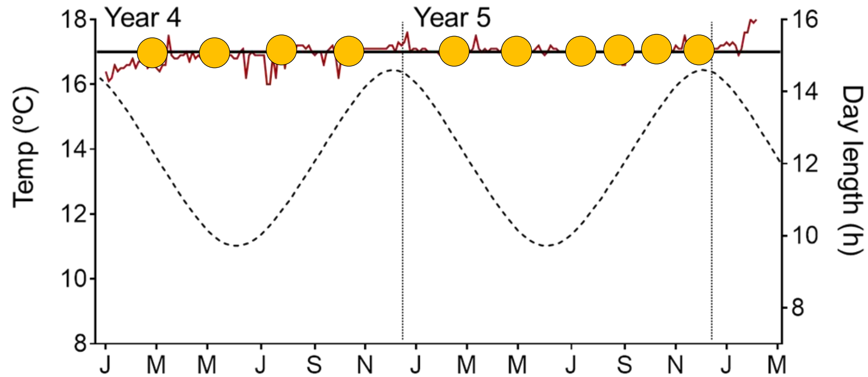


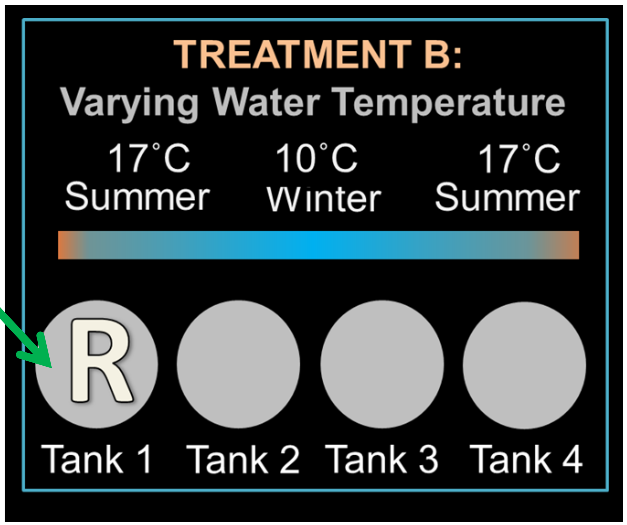


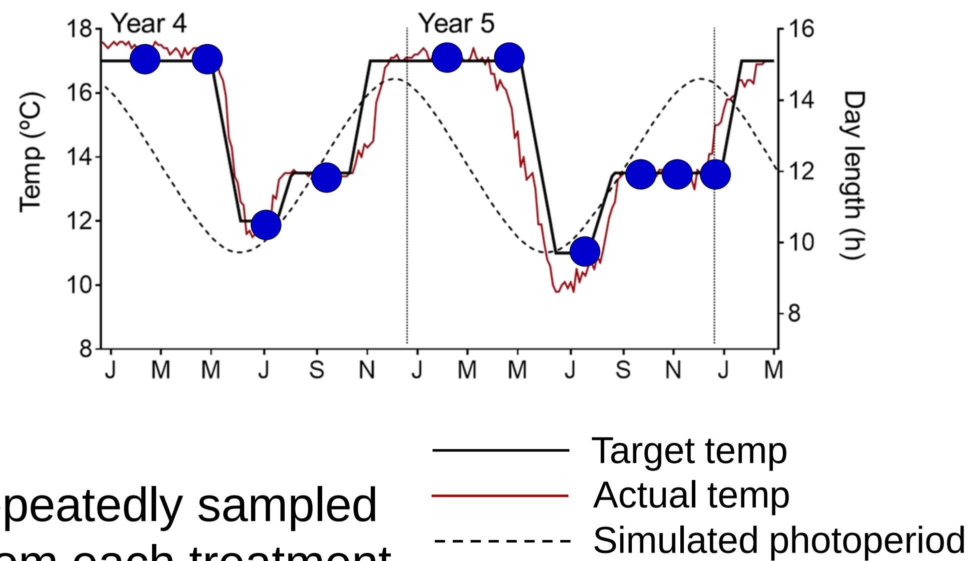


- Photoperiods kept consistent
- Approx. 20 fish per tank (male and female; 4 yr old at start)

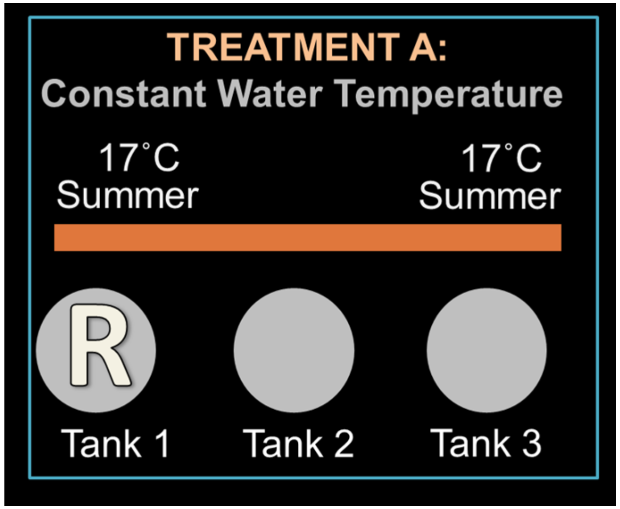


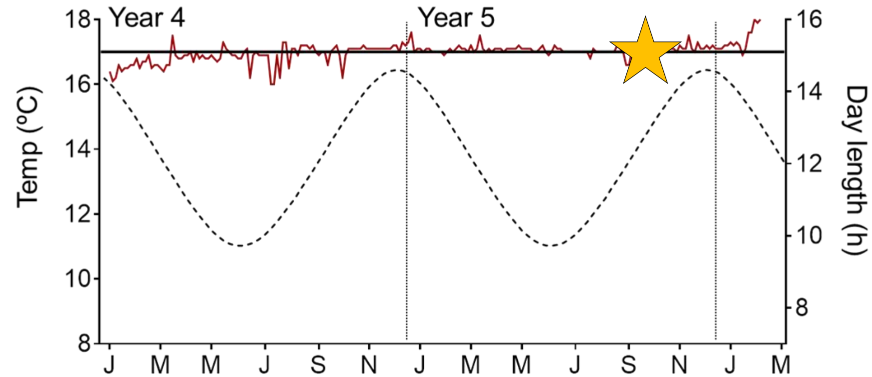


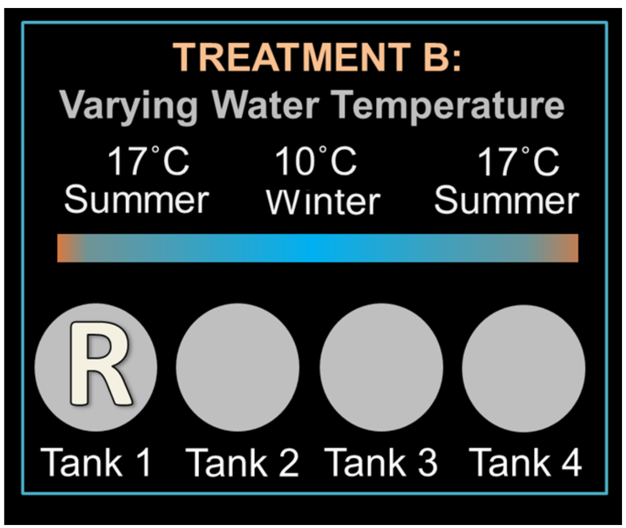


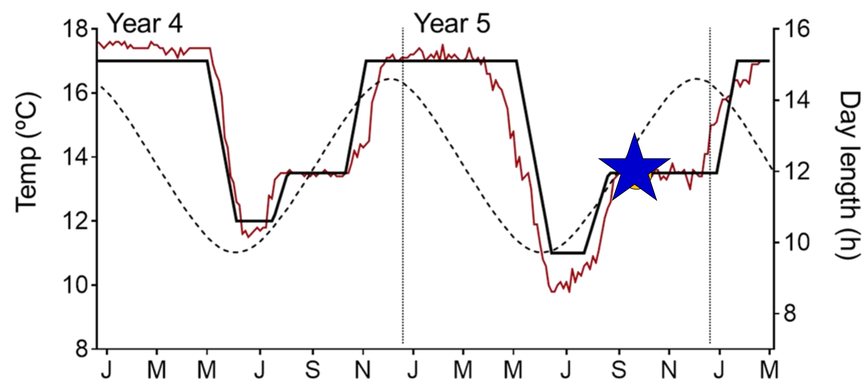


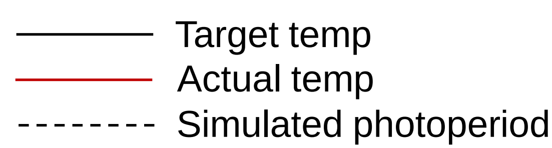
- A gonad biopsy and blood sample - repeatedly sampled every 8 weeks from fish in one tank from each treatment



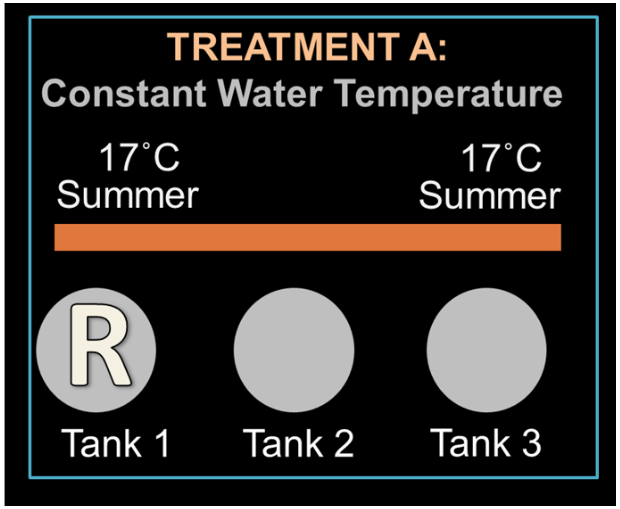


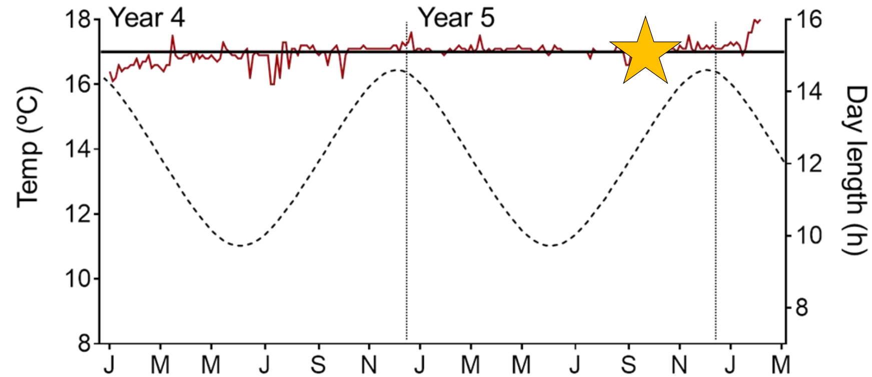


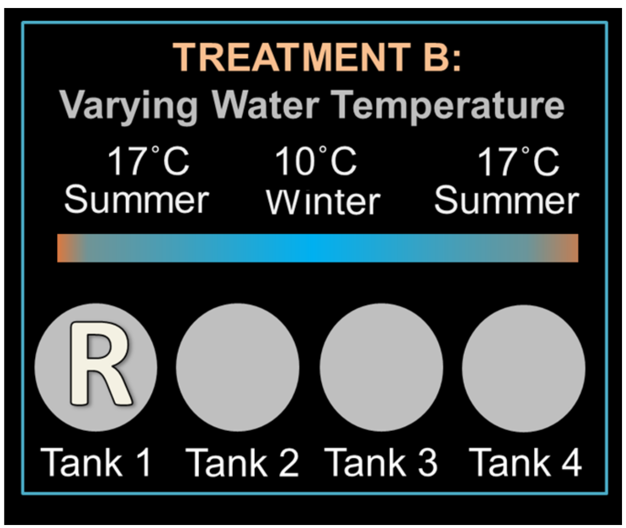


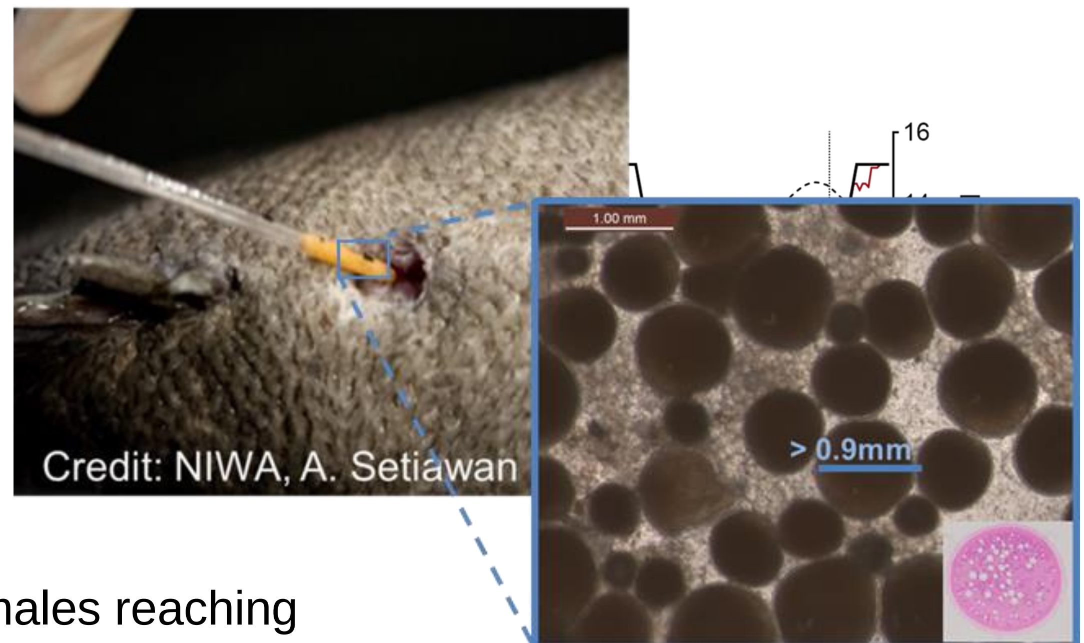


- Prior to the predicted spawning season all fish were biopsied in October



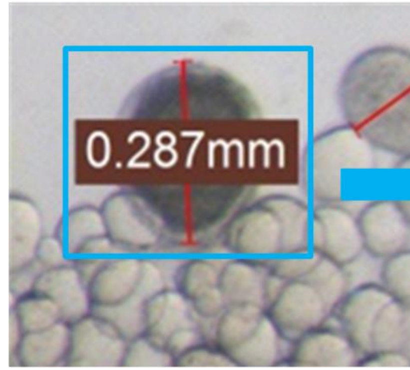


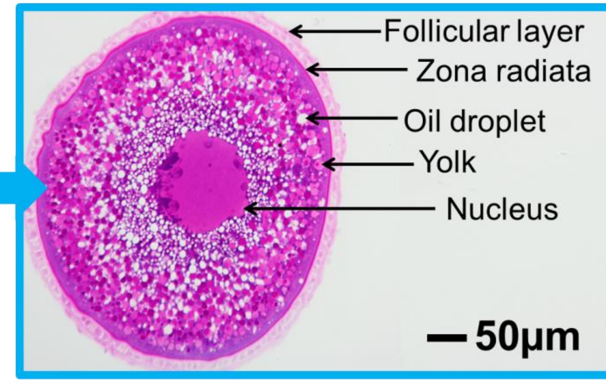




- Determine the percentage of females reaching spawning condition

Sample collection





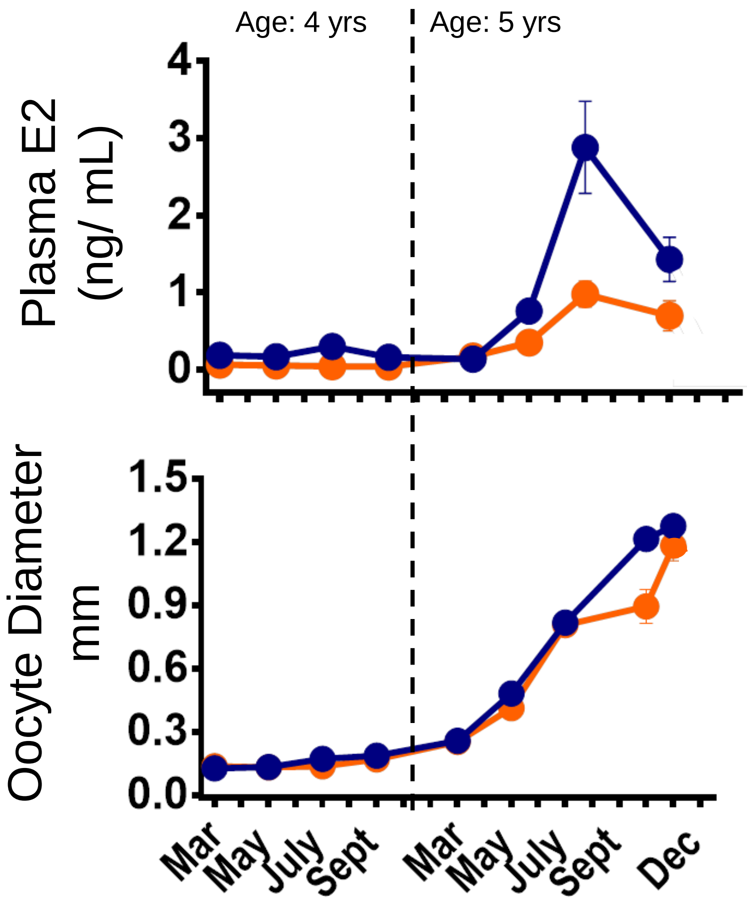
Ovarian biopsies collected ~ every 8 weeks for two years

Oocyte diameters measured by light microscopy. Samples processed for histological analysis

RT-PCR of genes linked to oogenesis (gonadotropin receptors: *fshr and lhr*)

Oogenesis and the reproductive cycle

Constant Temperature
Varying Temperature



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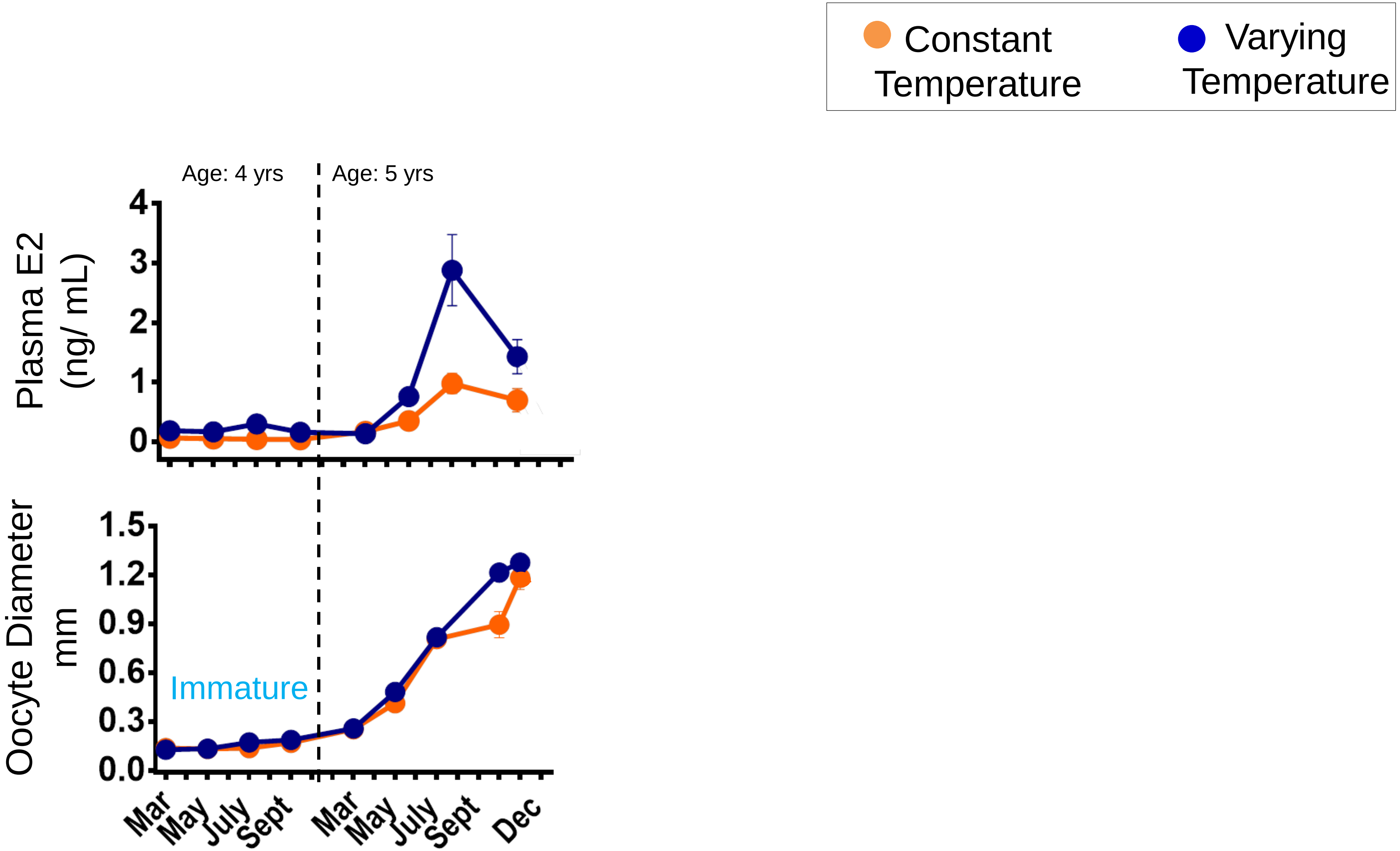

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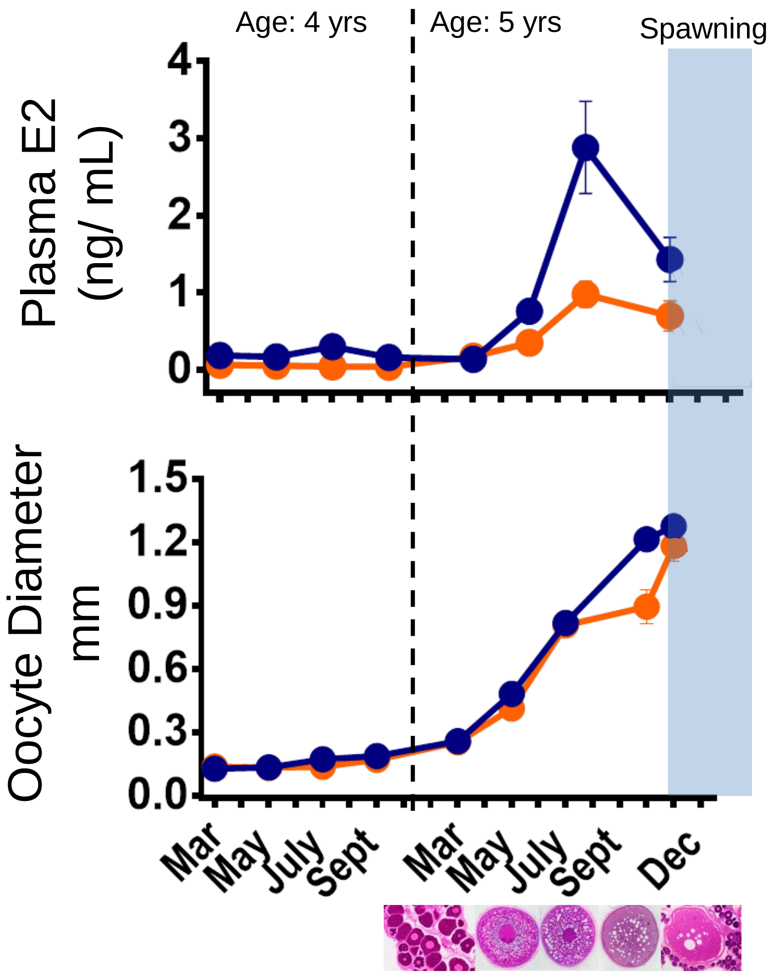

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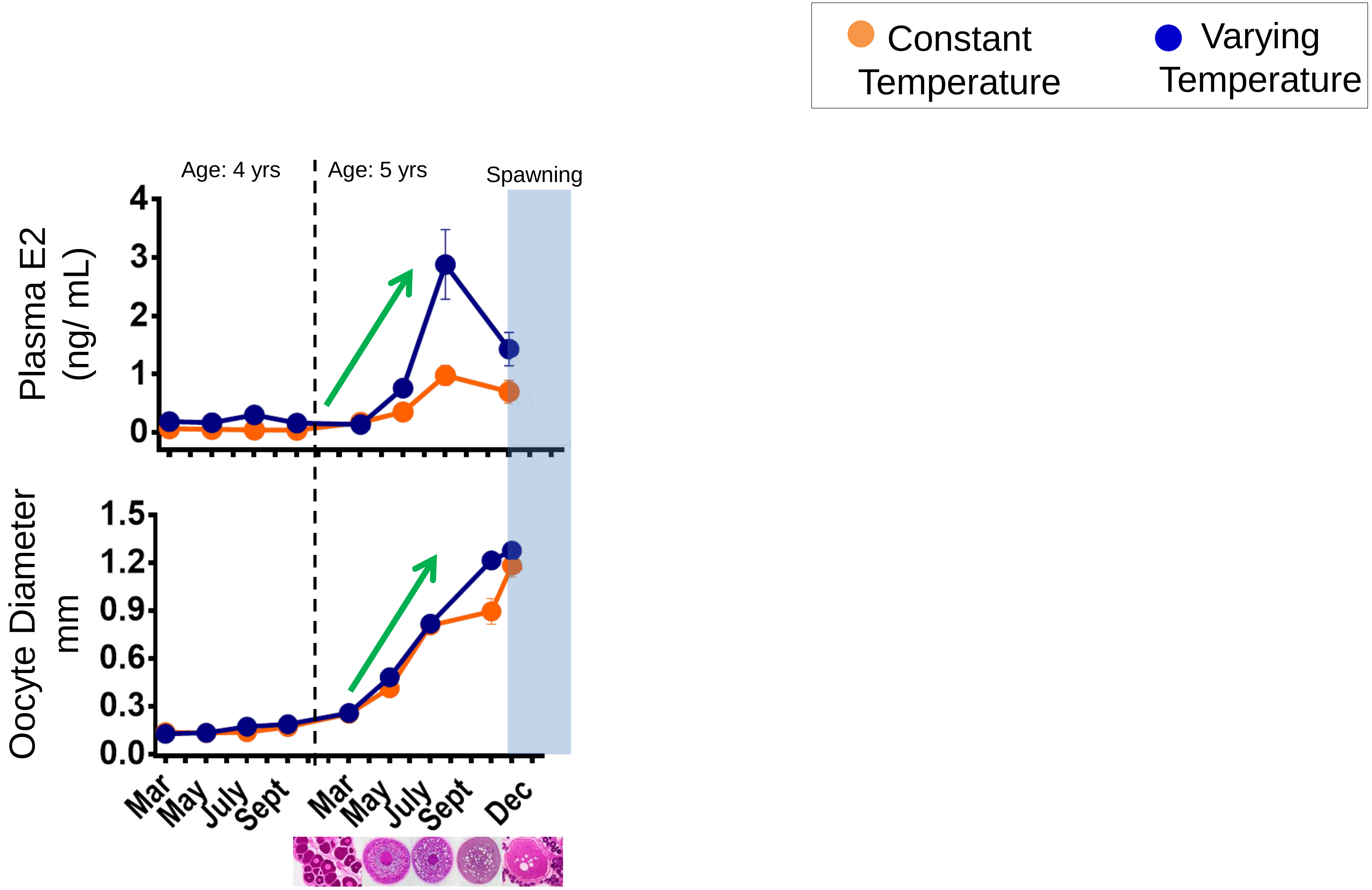

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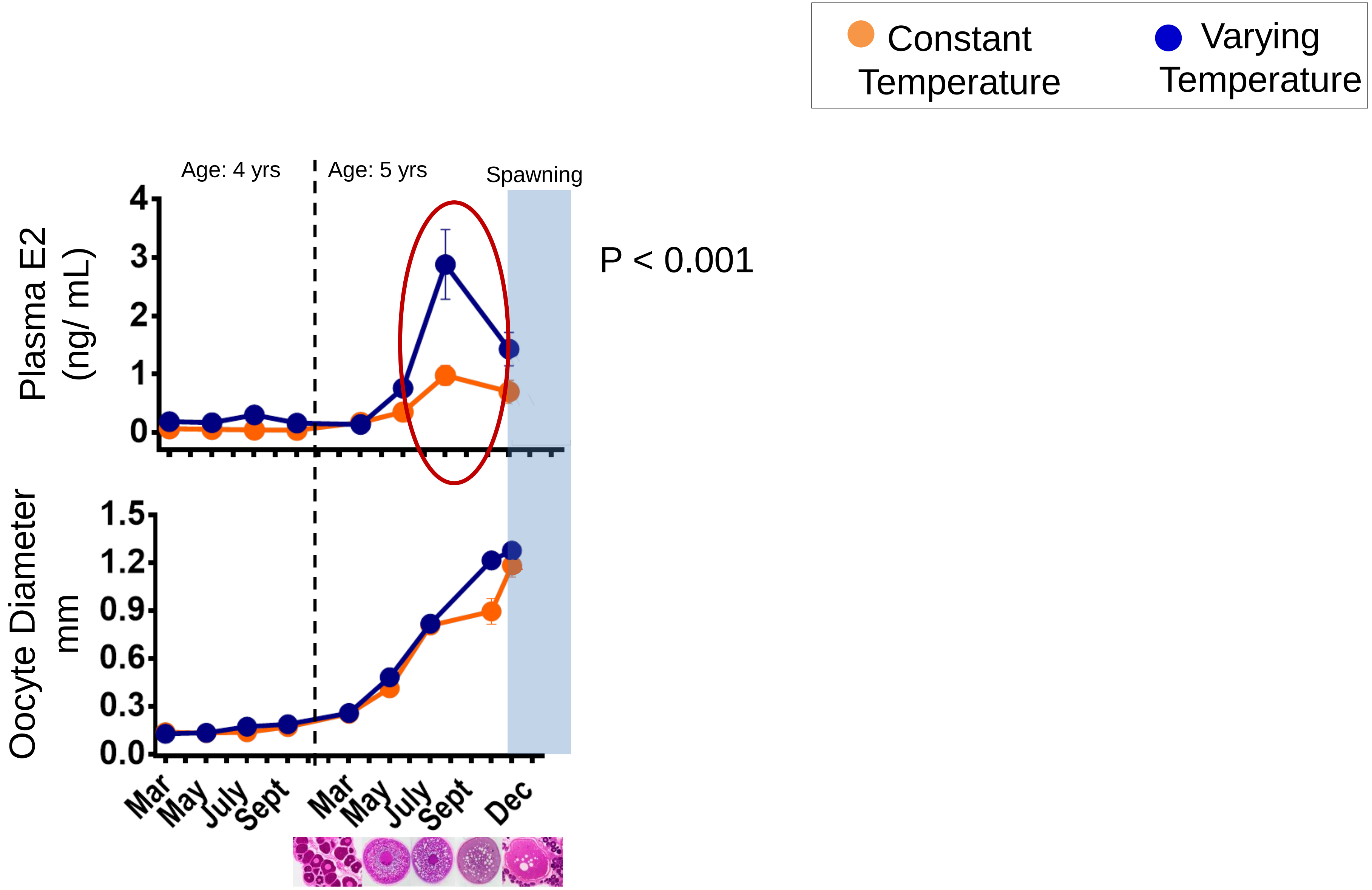

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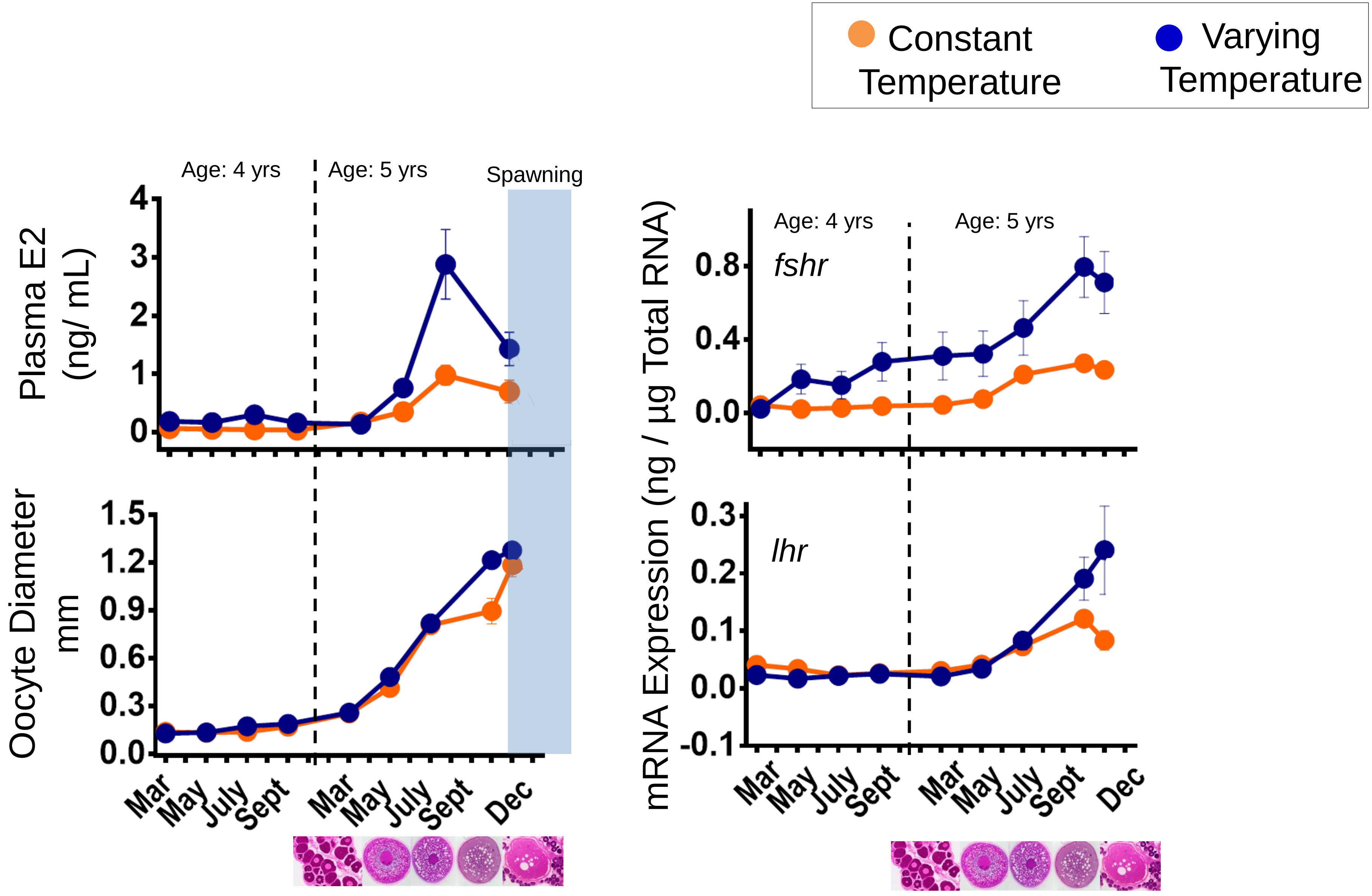

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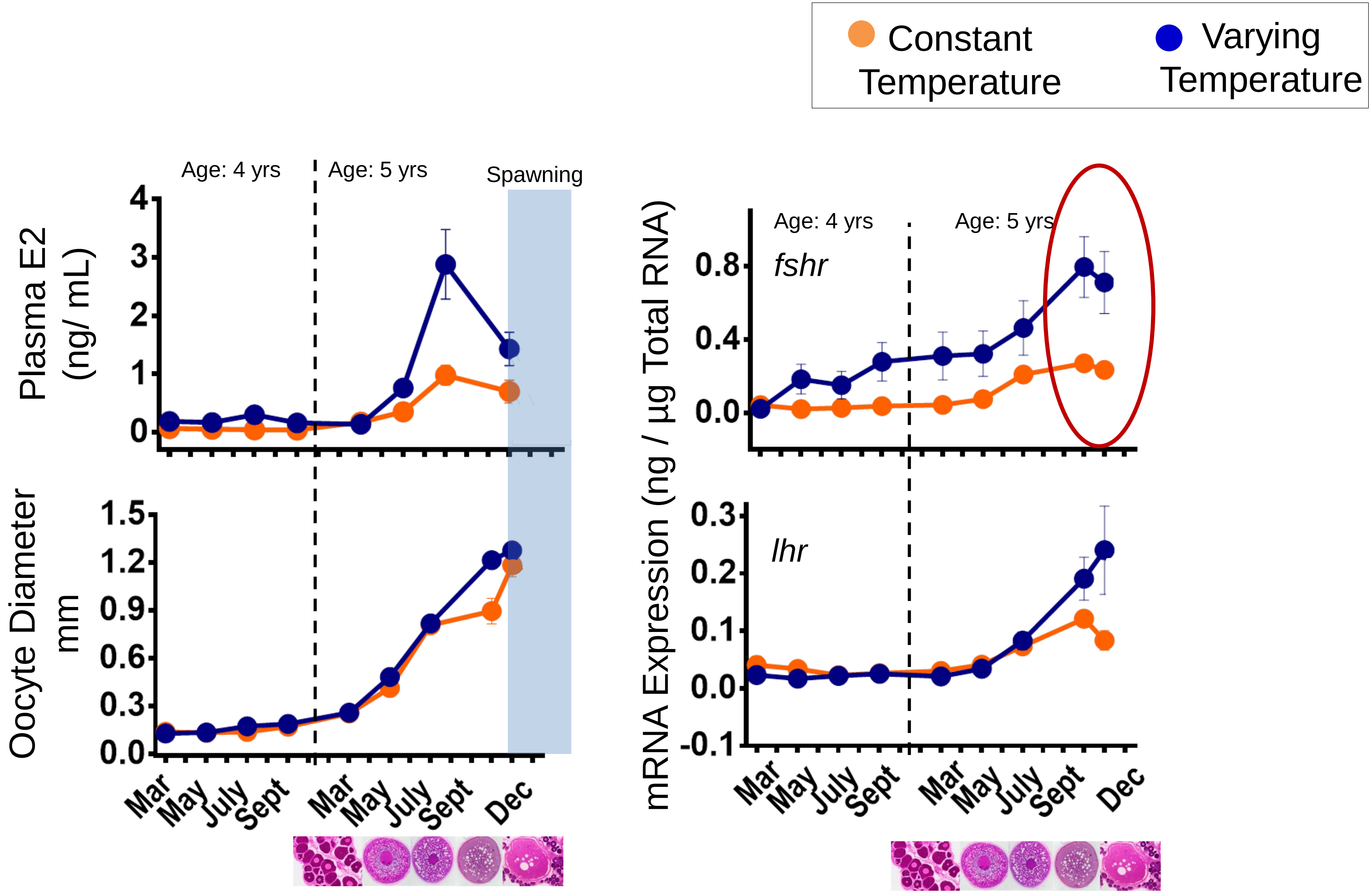
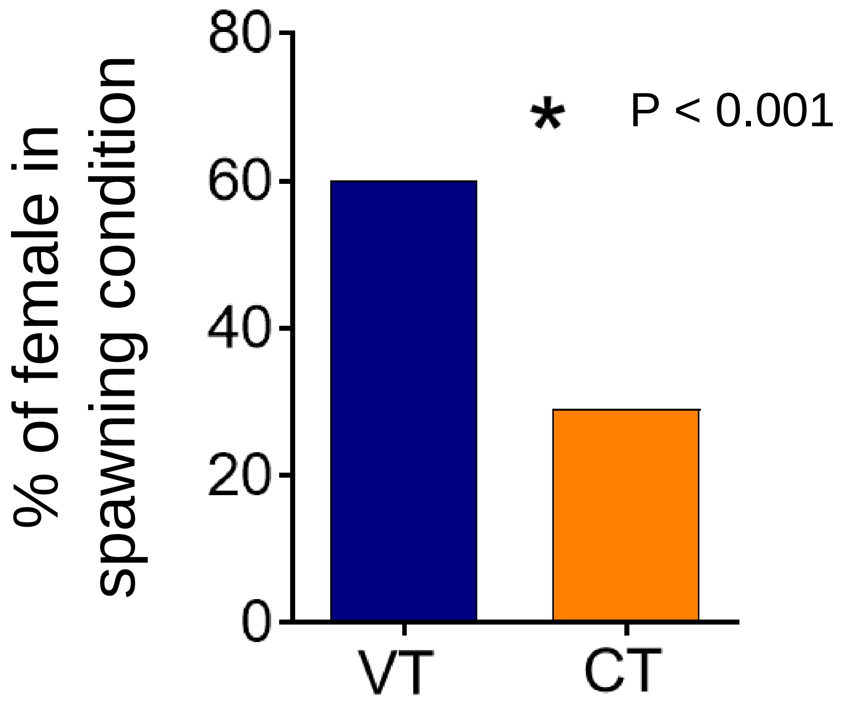
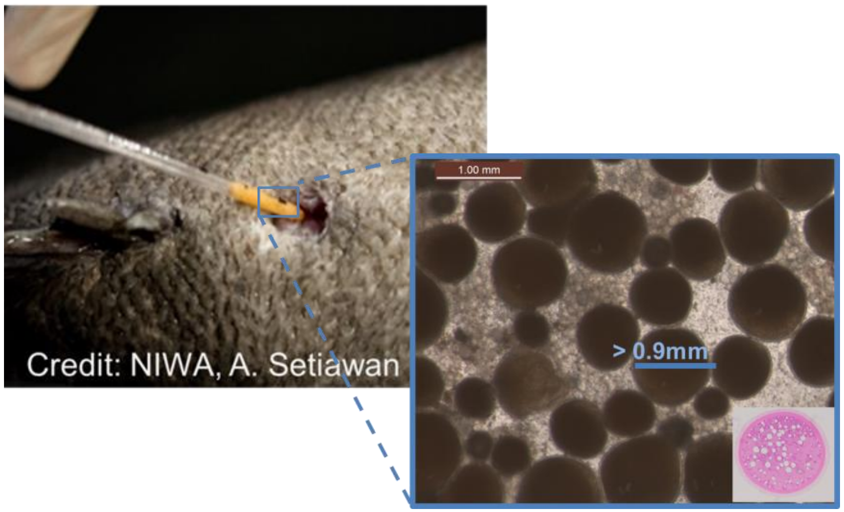


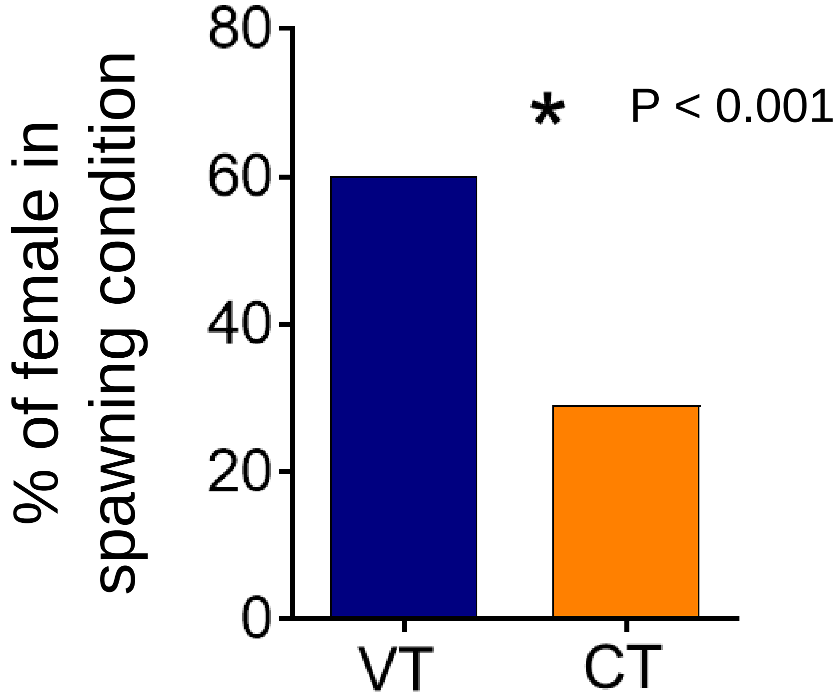
Percentage reaching spawning condition

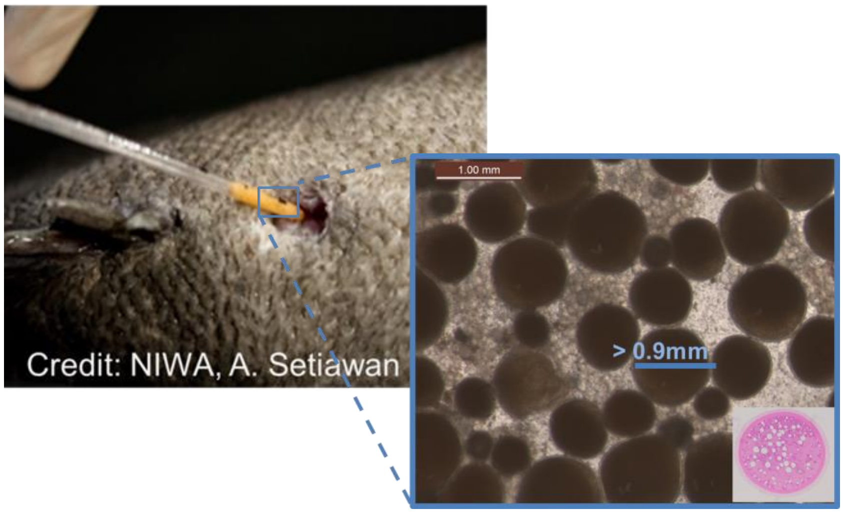




- Fewer (~50 % less) females reached pre-spawning condition in tanks maintained at a constant 17 degrees

Percentage reaching spawning condition





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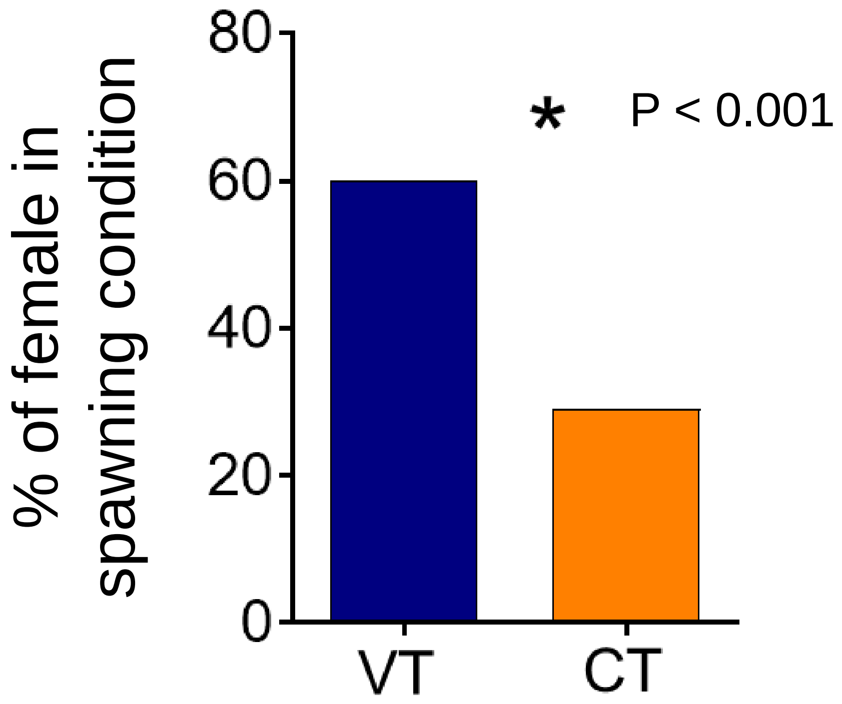
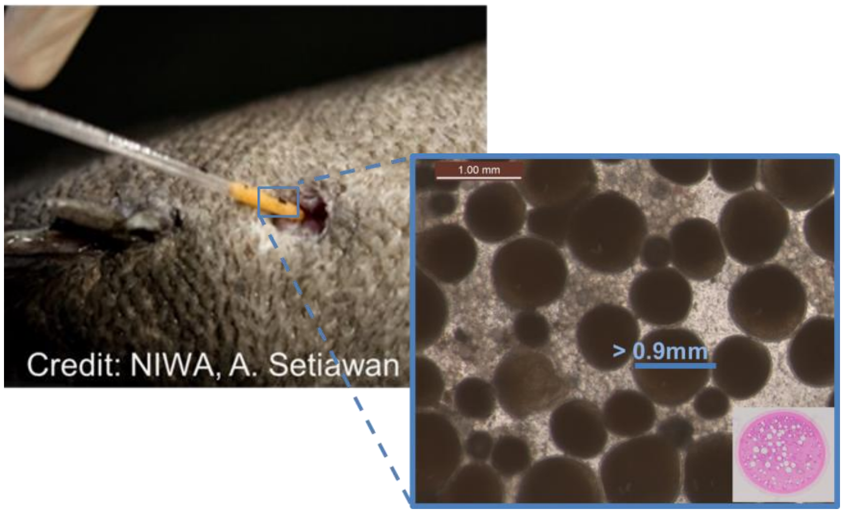
Exposure to a decreased temperature is important for appropriate progression of oogenesis

Percentage reaching spawning condition





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F1 broodstock also failed to spawn naturally

Progress to date:

- Ovarian development of ‘first-time spawning’ hapuku has been described
  - Cool water temperatures are important for the appropriate progression of oogenesis
  - Sexual maturity occurs at 5 years in captivity
  - Life cycle completed in 2013

- Hormonal manipulations induced spawning
  - Some F1 broodstock now spawn naturally at 7 years old (handling-dependent)

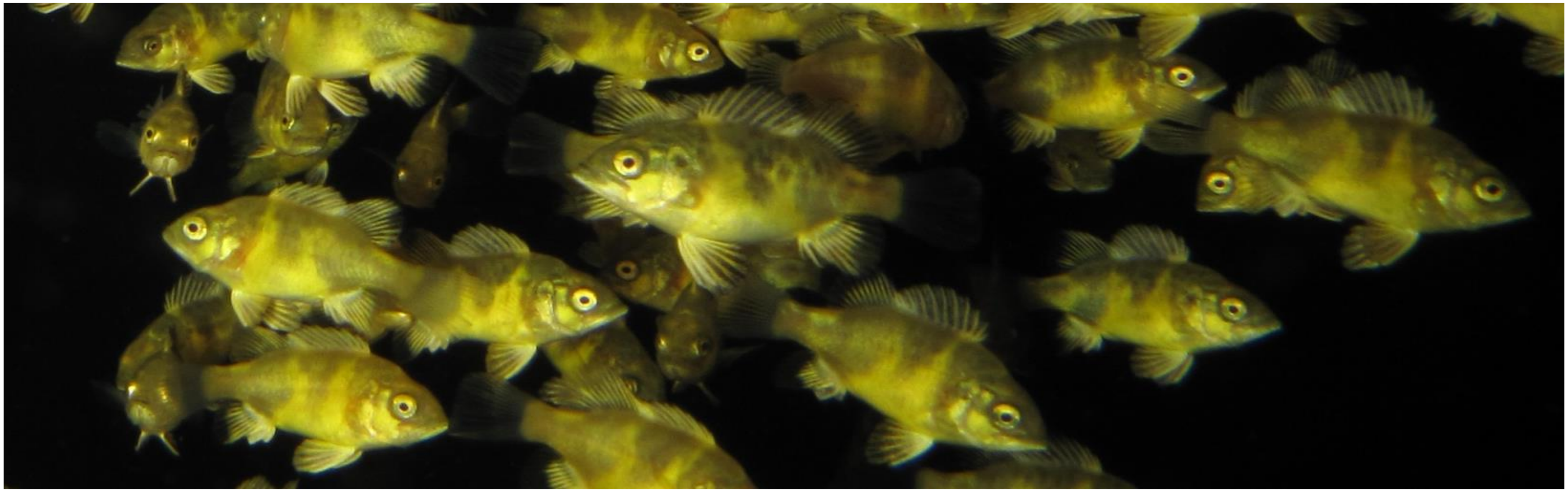
- Larval survival (F2) improved to 7.2 % at 28 dph
  - Continued F2 survival through to fingerling at 5.5%
  - Improvements based on a many factors
    - Changes to broodstock rearing (i.e density, reduced handling)
    - Improved larval rearing conditions (i.e hygiene)

Concluding remarks:

- Captive-bred hāpuku are a viable and sustainable source of high quality gametes with fingerling survival exceeding that of wild-caught broodstock

- Reliable production levels are not achieved until 7 years of age

- Minimal handling and focus on early growth may hasten reproductive competence

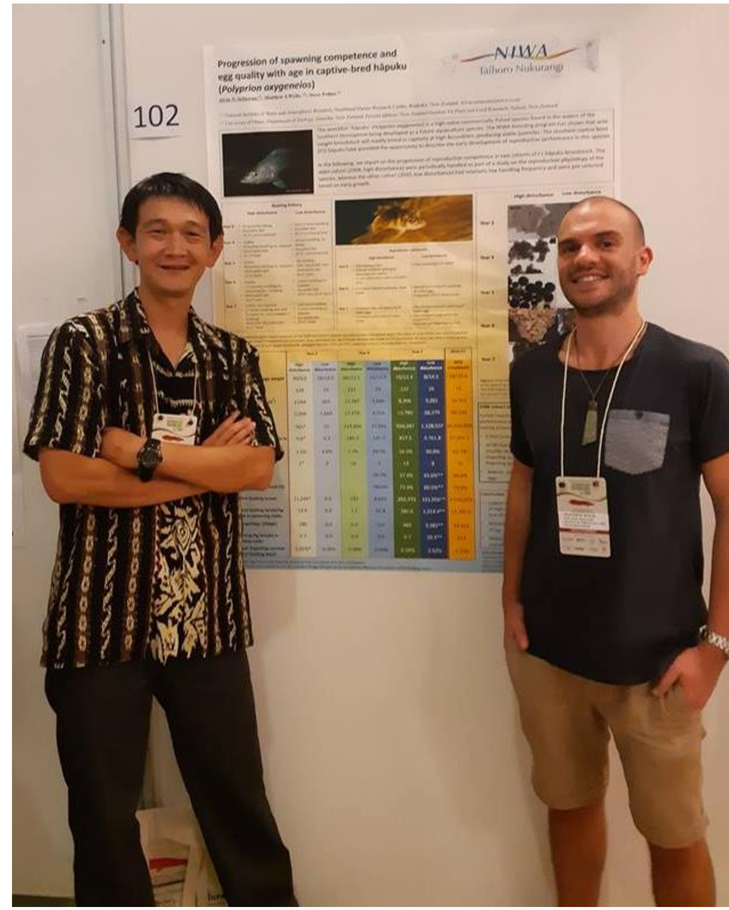


Acknowledgements

Assoc. Prof.
Mark Lokman

Dr. Jane
Symonds

Prof. Abigail
Elizur



Dr. Alvin
Setiawan

NIWA
Taihoro Nukurangi

Technical and Management Staff at NIWA
Northland Marine Research Centre

www.niwa.co.nz

Questions?