Roe enhancement aquaculture: a solution to controlling overabundant sea urchin populations in southern Victoria

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POSTERA CRESCAM LAUDE
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Port Phillip Bay

(Southern Victoria)

- Population overabundance of sea urchins (*Heliocidaris erythrogramma*)
- Resulted in > 50% of rocky reef being urchin barrens instead of kelp beds

See **Professor Steve Swearers** talk on **Thursday** at **13:00** in the **Social Sciences Building** for an in-depth history of the urchin problem and its management

Port Phillip Bay sea urchin stock assessment 2019/2020

The University of Melbourne and Deakin University

Tristan Graham, Paul Carnell, Fletcher Warren-Myers and Steve Swearer

(KP) **Kirk Point**
15 + 9.9 per m^2

(WT) **Williamstown**
8.4 + 5.1 per m^2

(SK) **St Kilda**,
5.6 + 5.9 m^2

(PC) **Point Cooke**
5.1 + 5.1 m^2

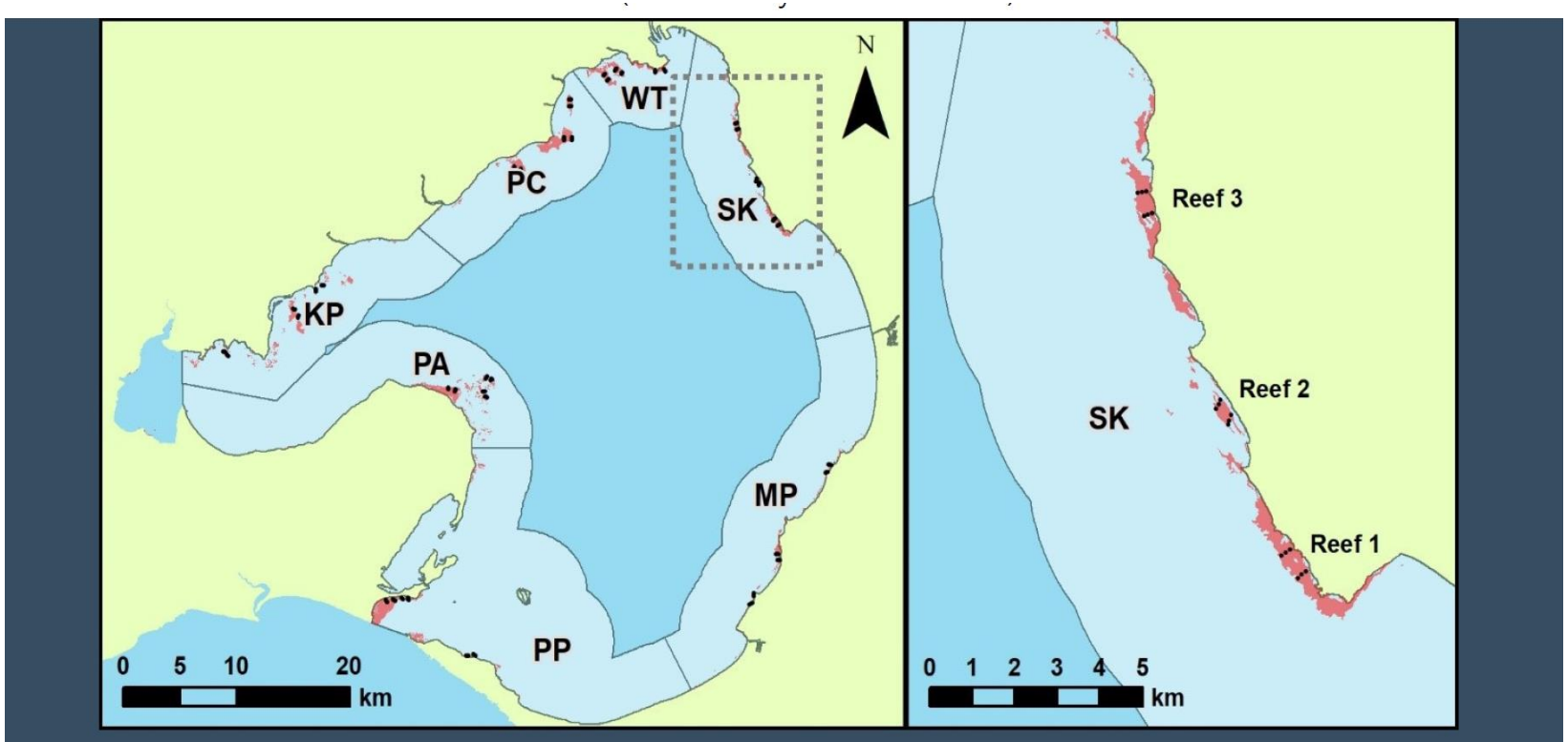


FIGURE 1. Distribution of surveys in Port Phillip Bay. Pink polygons = rocky reefs, black dots = subsites. PP = Port Phillip Heads, PA = Portarlington, KP = Kirk Point, PC = Point Cook, WT = Williamstown, SK = St Kilda, MP = Martha Point. Subset shows distribution of subsites across three reefs in the St Kilda region.

See **Tristan Graham's** talk on **Thursday** at **12:15** in the **Physics Building** for more detailed information

4000 tonnes of urchins in Port Phillip Bay

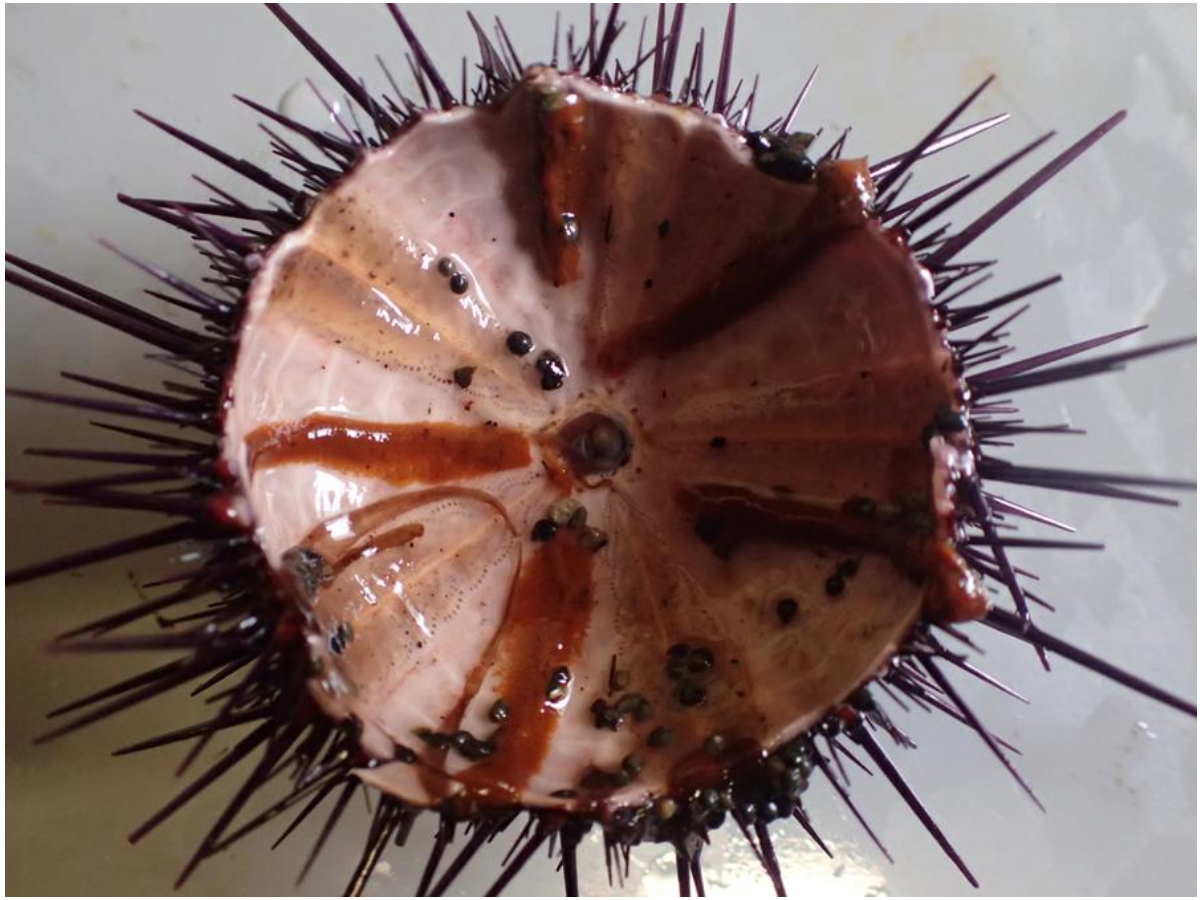
Urchin Barrens vs. Healthy reefs

Species biodiversity - low
Juvenile fish habitat - poor
Benthic community structure - altered
Overall reef productivity - low

- Species biodiversity - high
- Juvenile fish habitat - optimal
- Benthic community structure – Diverse and healthy
- Overall reef productivity - high

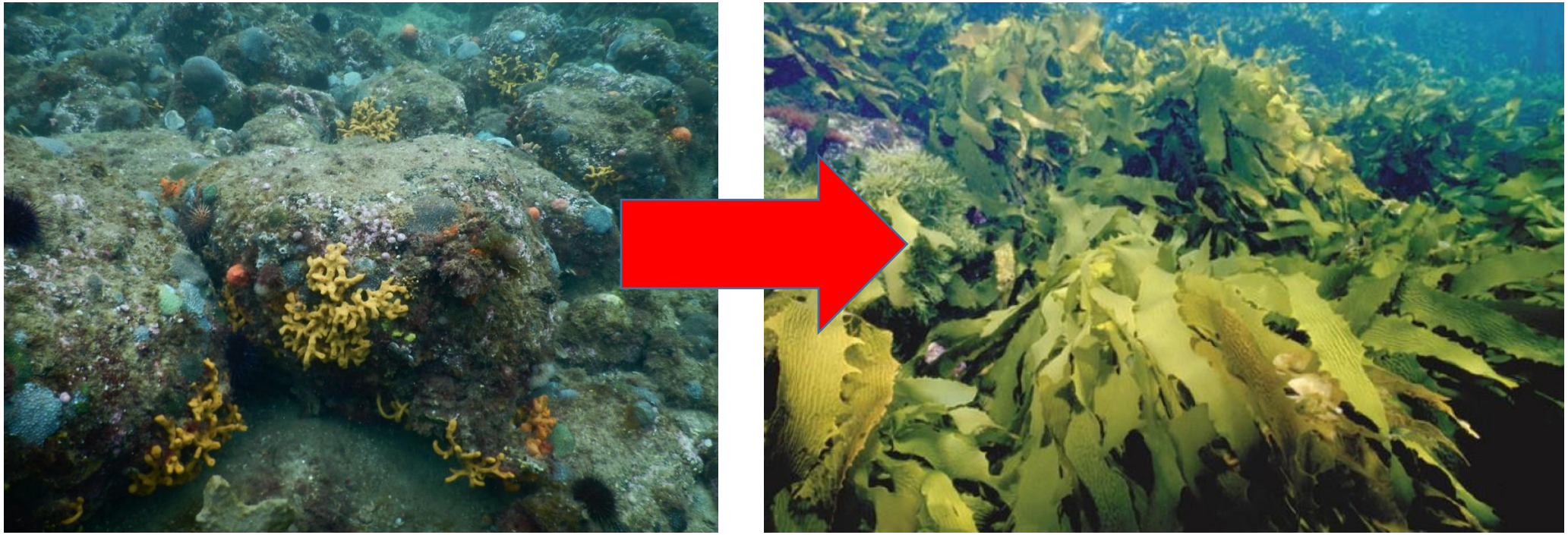
Urchins from healthy reefs

Urchins from barrens



Port Phillip Bay

Drive to restore barren reefs back to the healthier kelp reef state



Port Phillip Bay

1st step required is to

Remove the urchins!

Volunteer or commercial culling?

(No short term financial return with tax payers footing the bill for culling)

Local commercial fishery?

(Wild caught can bring $200 kg on local markets, but fishers generally don't harvest barrens)

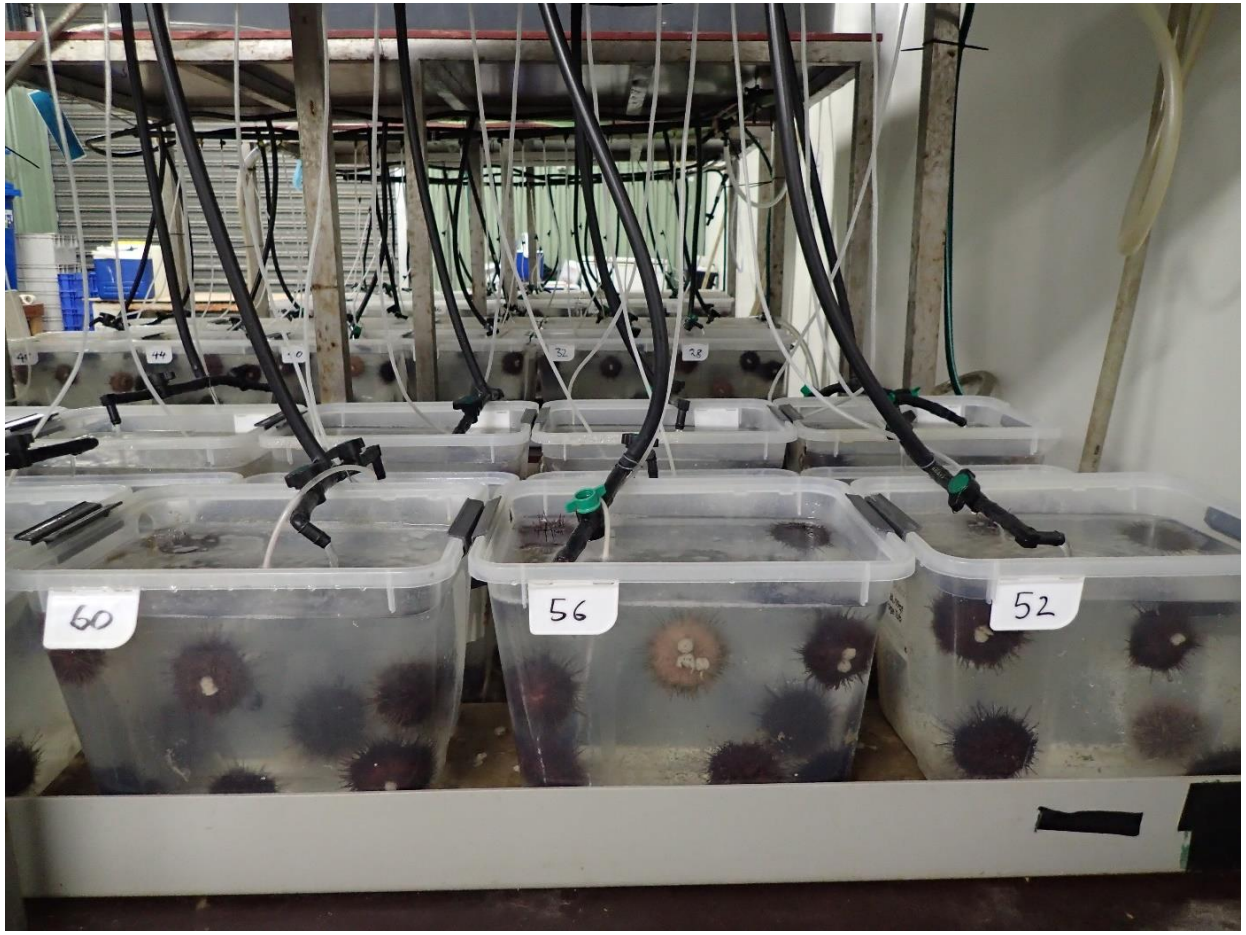
Removal for roe enhancement Aquaculture ?

(Urchin roe is worth up to $400 Kg in international markets, we just need to produce it)

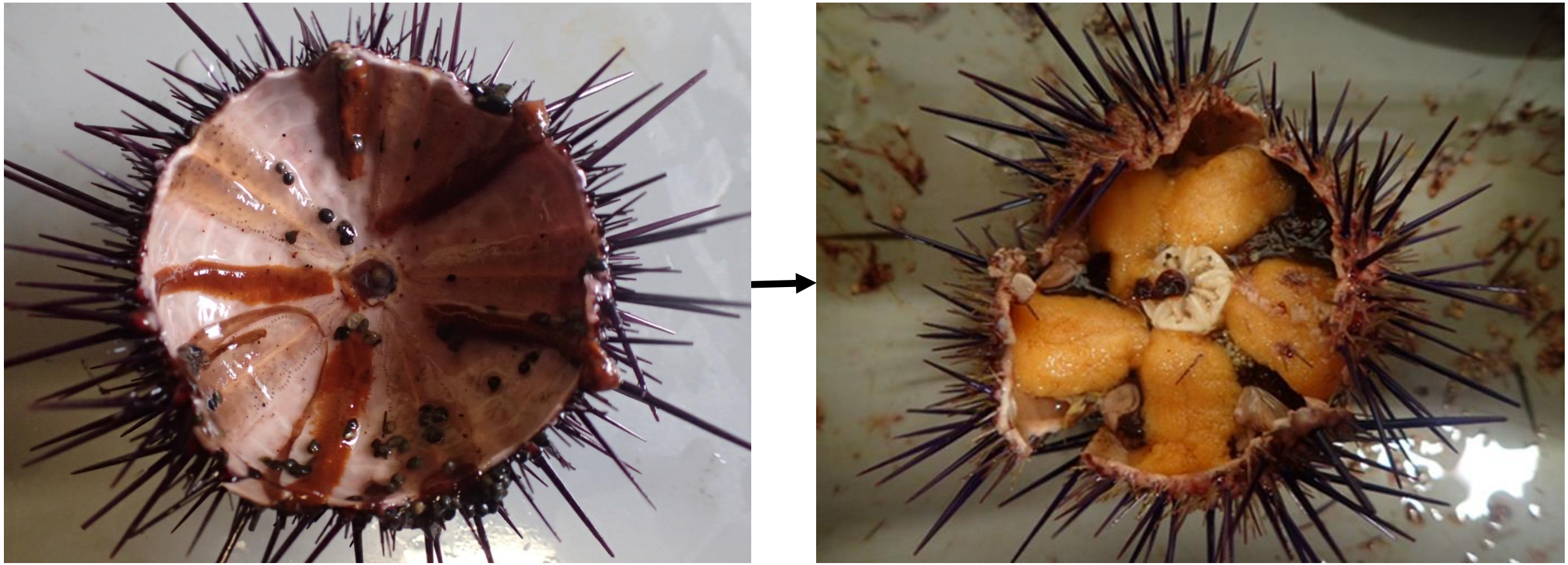
What is so great about sea urchin roe?

International sea food delicacy, and is a highly valuable commodity if produce right
Can sell for upwards of $400 kg in japan

Can we use aquaculture to control the urchin problem?



After enhancement



Problems to solve

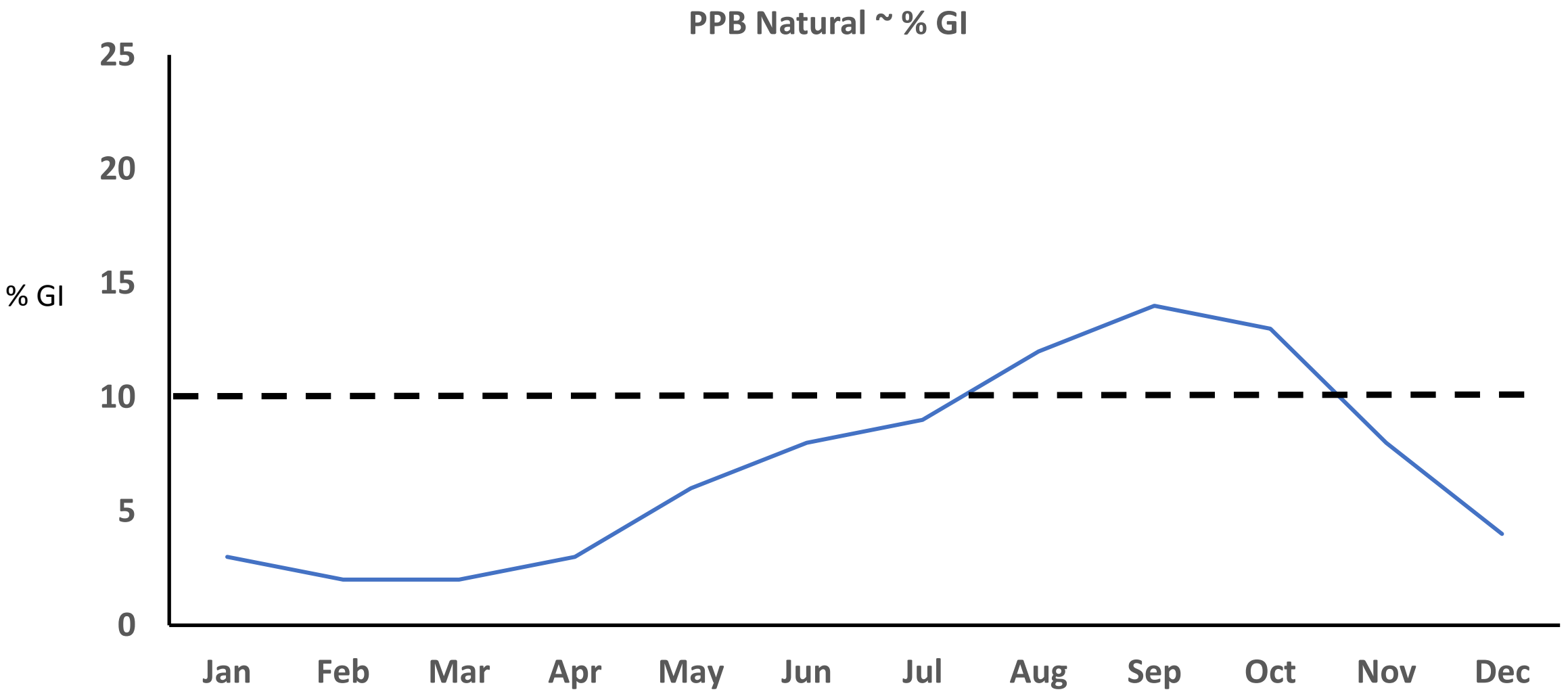
1) **Season for harvesting roe:** Extend the roe production season.

2) **Collecting urchins for enhancement:** Develop an efficient collection method.

3) **Develop a feed to maximise gonad quantity and quality (%GI):** What is the optimal feed type for roe enhancing.

4) **Stocking Density** – Urchins live in 2-dimential space (i.e. benthic). Does density influence roe enhancement.

Roe Season?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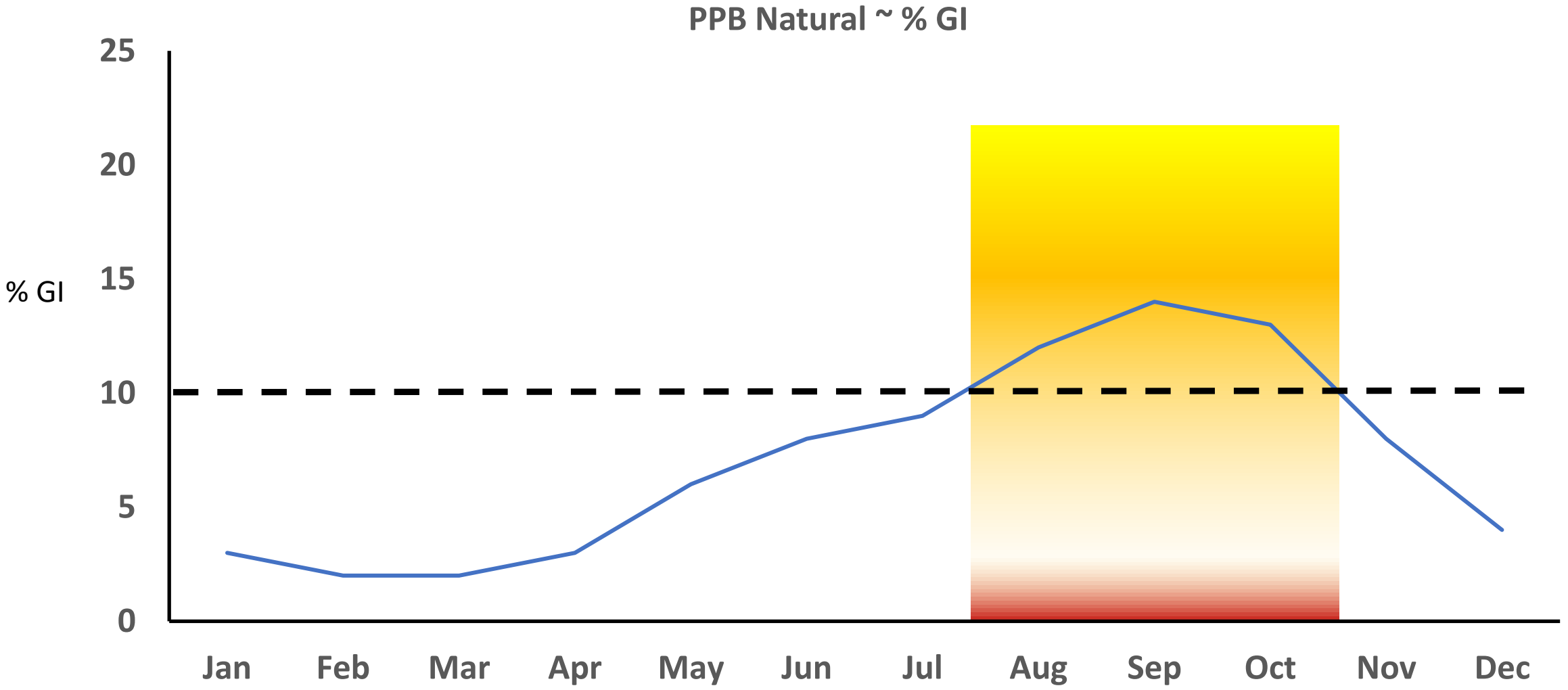
Roe Season?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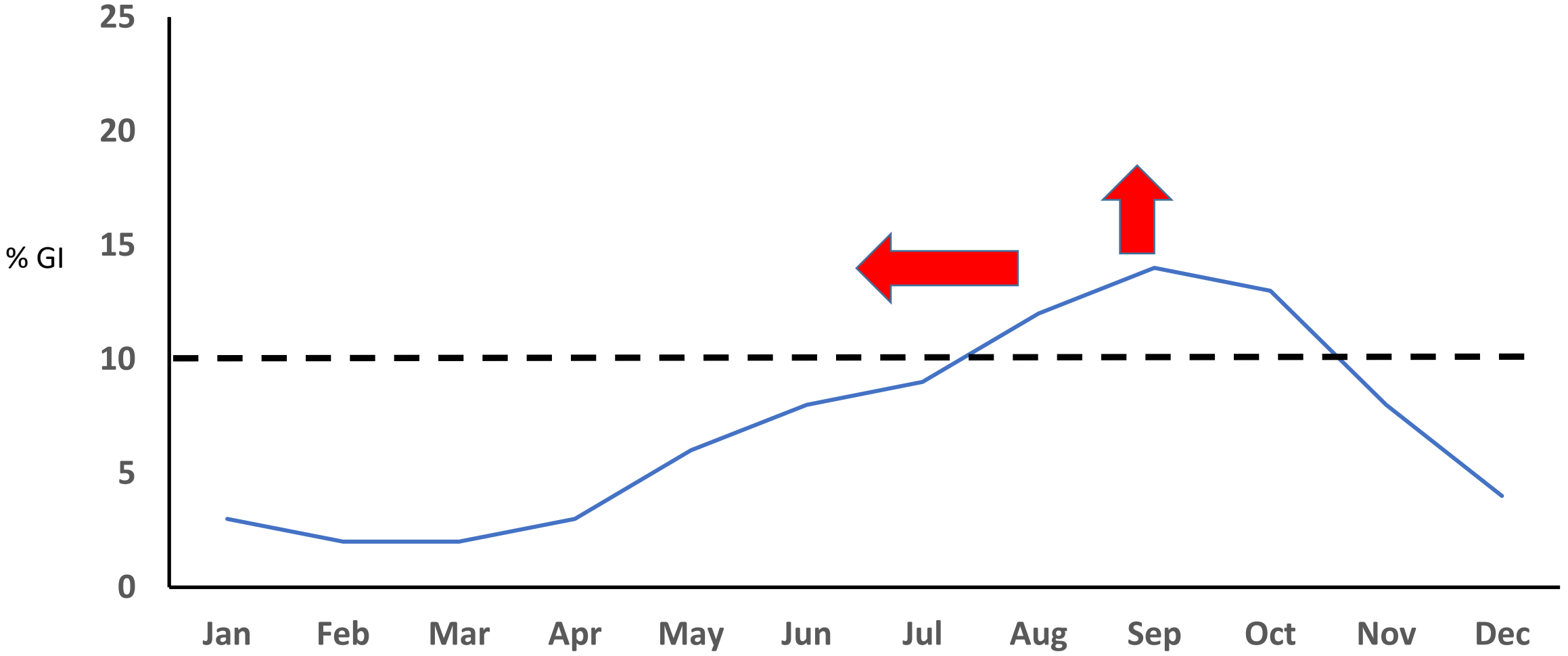
PPB Natural vs Enhanced ~ % GI
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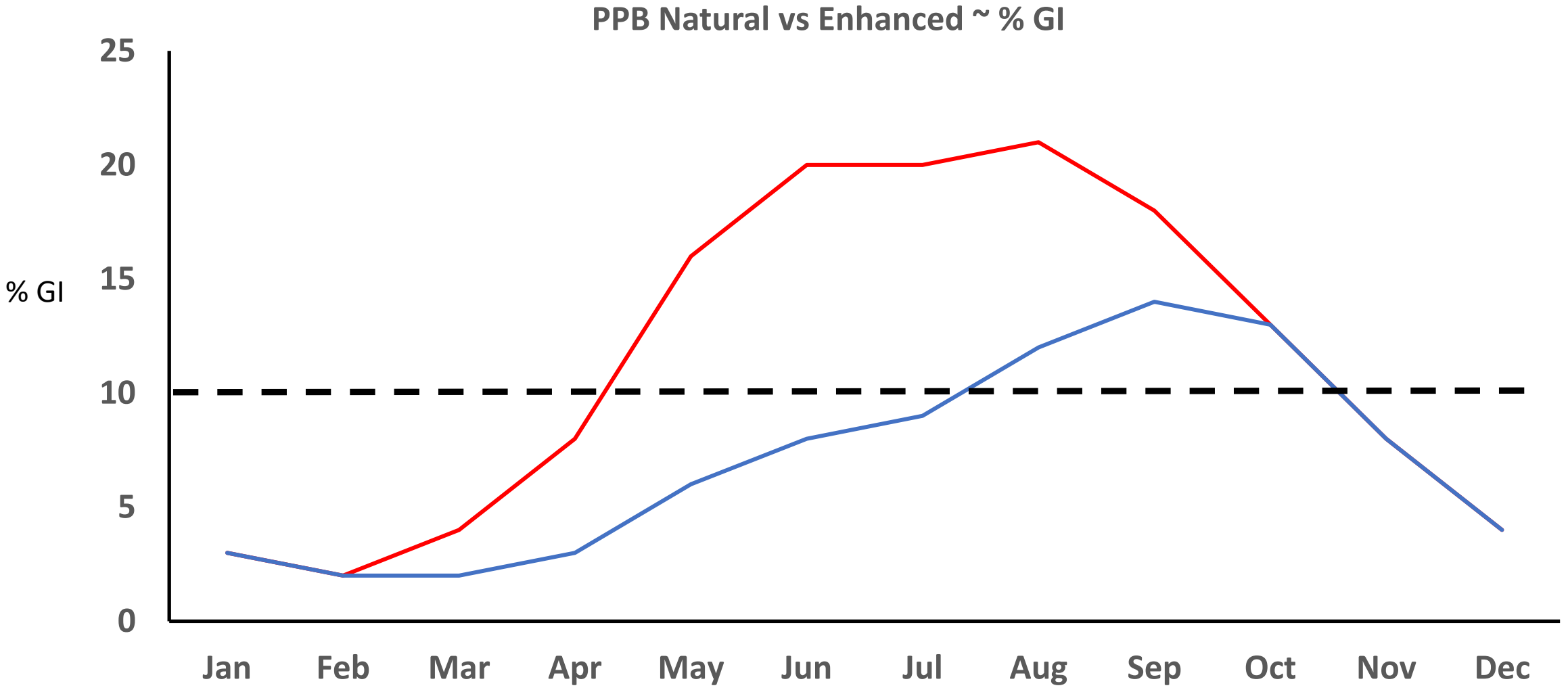
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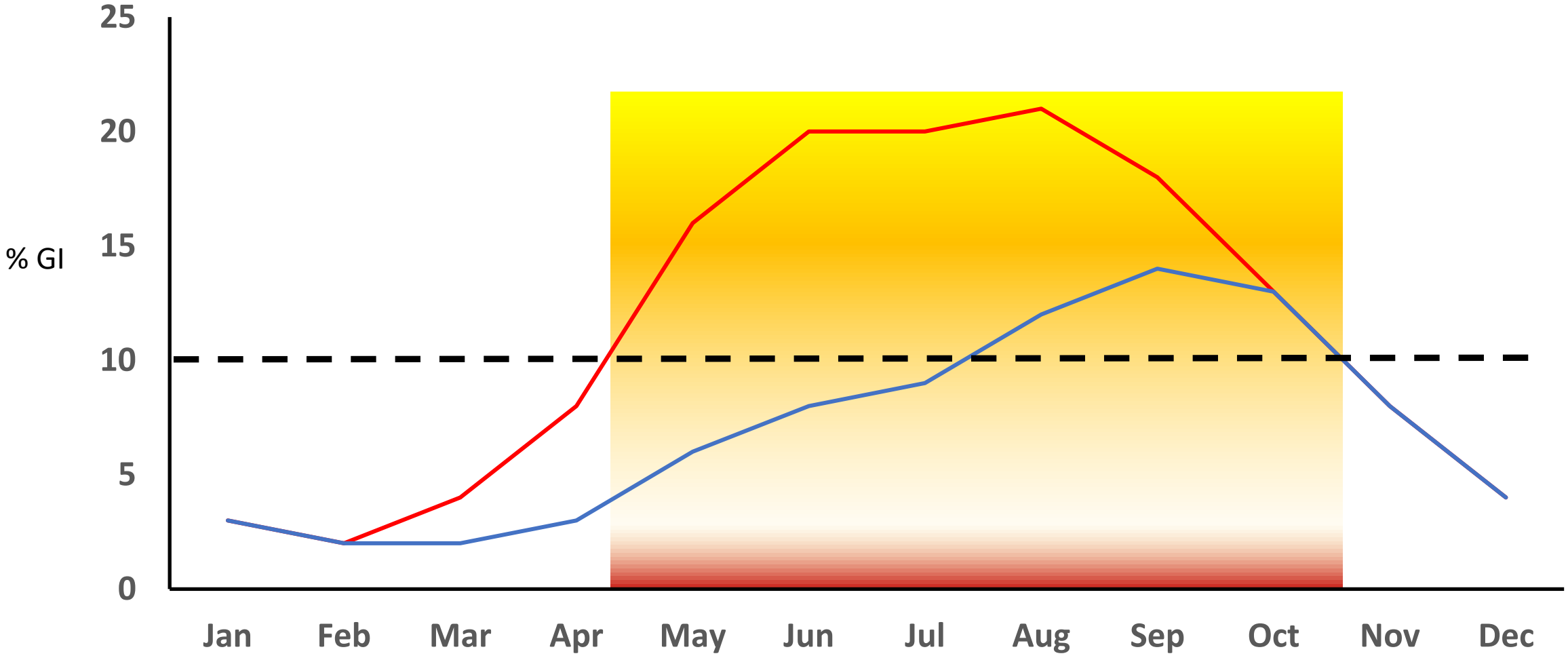
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Collecting urchins from barrens

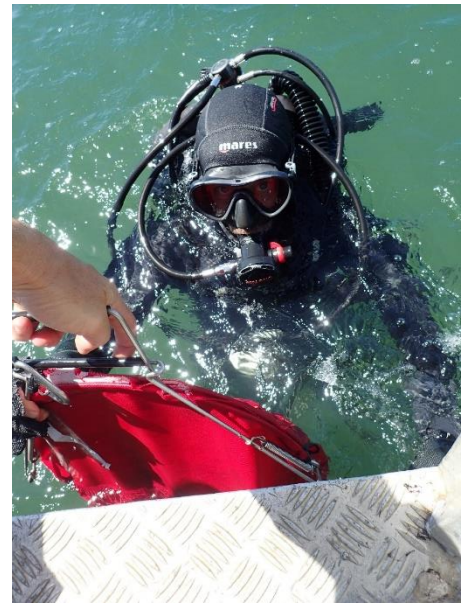
Collecting urchins from barrens

1) Divers **gently hand picking** (GHP) urchins and placing them in containers for transport before packed in chilli bins.

2) Using a garden **hook and catch bag** (HCB) as fast as they can and then tipping them directly into the chilli bins.

Urchins where then transported in seawater aerated with pure oxygen back to the facility for roe enhancement

Tested each collection method 3 times



Warren-Myers et al. (2019) Harvest method does not affect survival and condition during gonad enhancement of an overabundant sea urchin. Aquacult Enviro Interact.

Collecting urchins from barrens

Compared external condition, and looked for damaged during collection

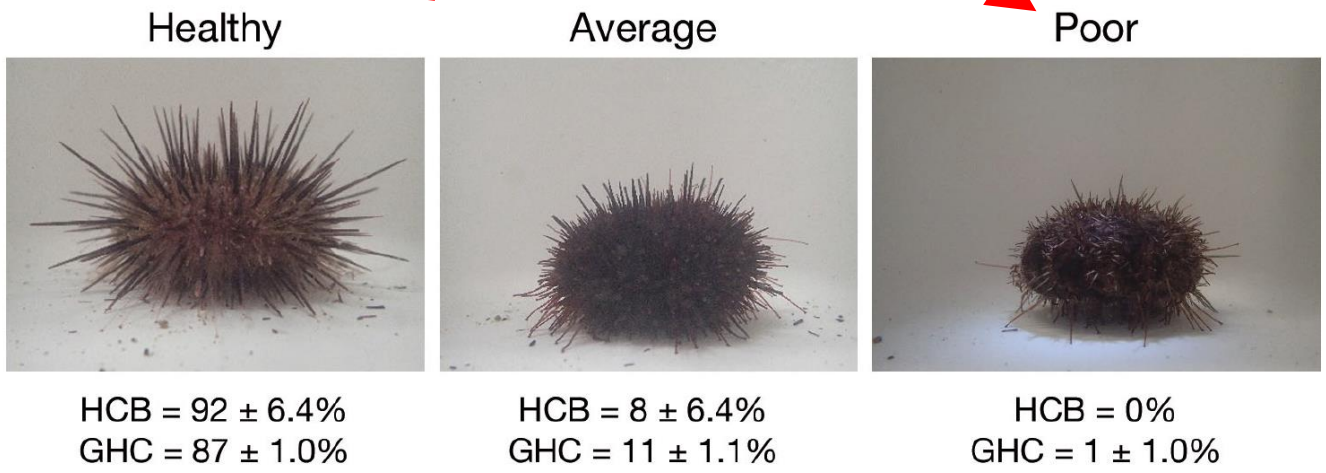


Fig. 1. Urchin external condition. Proportion of urchins classified as (a) healthy (no spine loss), (b) average (<25% spine loss) or (c) poor (>25% spine loss or with scarring) after 12 wk of roe enhancement (mean ± SE). Collection methods were HCB: hook and catch bag; GHC: gentle hand and container

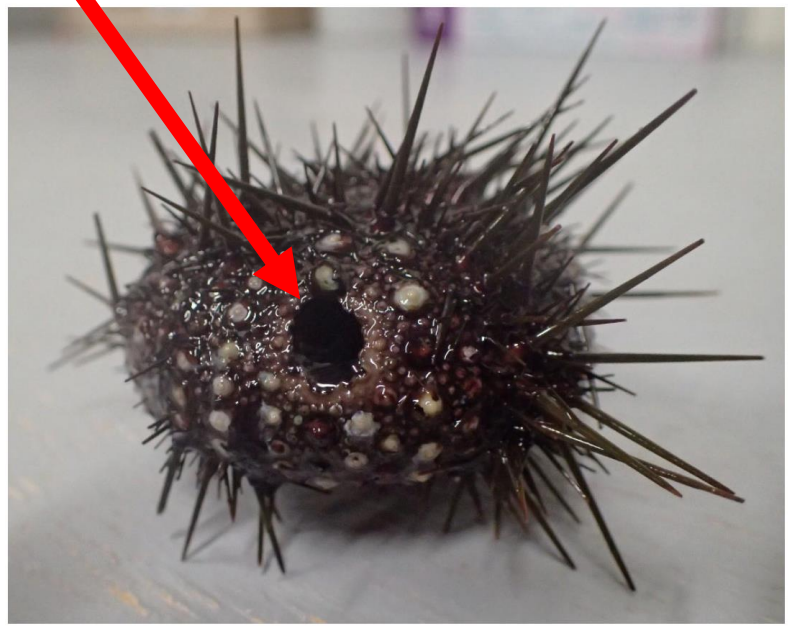


Fig. 2. Urchin test damaged during collection using the hook and catch bag collection method

Warren-Myers et al. (2019) Harvest method does not affect survival and condition during gonad enhancement of an overabundant sea urchin. Aquacult Enviro Interact.

Collecting urchins from barrens

Compared gonad quality and quantity

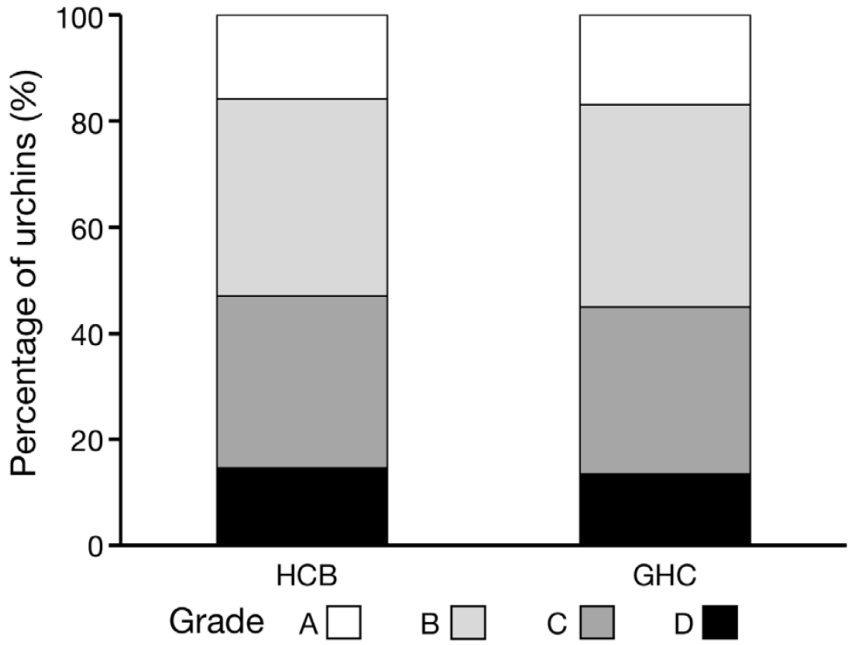


Fig. 3. Comparison of urchin roe grades between 2 different collection methods, i.e. hook and catch bag (HCB) and gentle hand and container (GHC). Grading method based on Pert et al. (2018)

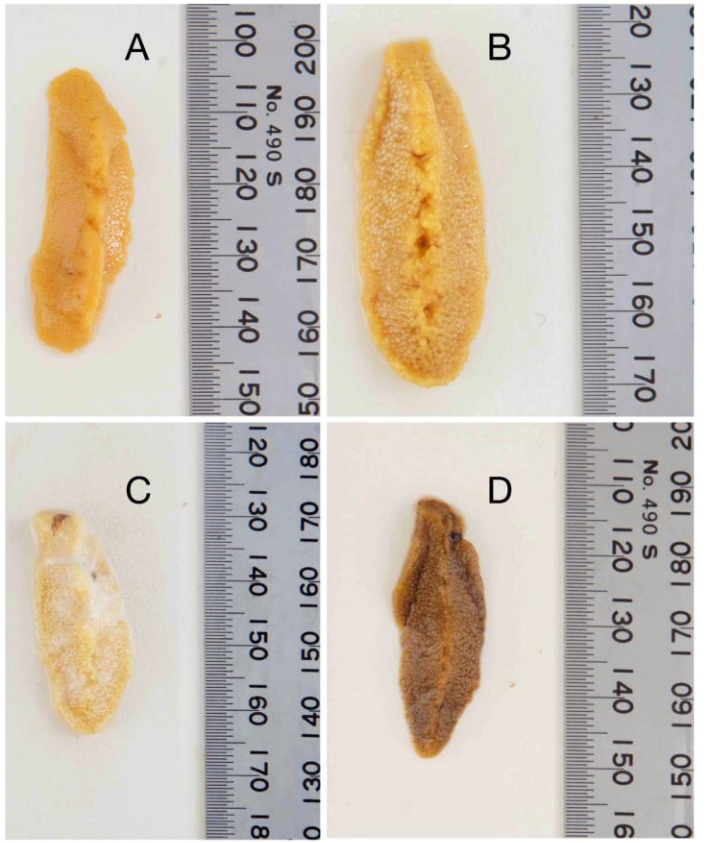


Fig. 1. Expt 2: grade system for assessing *Heliocidaris erythrogramma* roe quality calculated from gonad colour, texture and firmness. (A) A-grade gonads, premium quality; (B) B-grade gonads, high commercial quality; (C) C-grade gonads, mediocre; (D) D-grade gonads, not of commercial quality. Scale in mm

Figure from Pert et al. 2018

Warren-Myers et al. (2019) Harvest method does not affect survival and condition during gonad enhancement of an overabundant sea urchin. Aquacult Enviro Interact.

Optimal method
Divers with a hook and catch bag
Collect 400+ urchins an hour
98% survival rate

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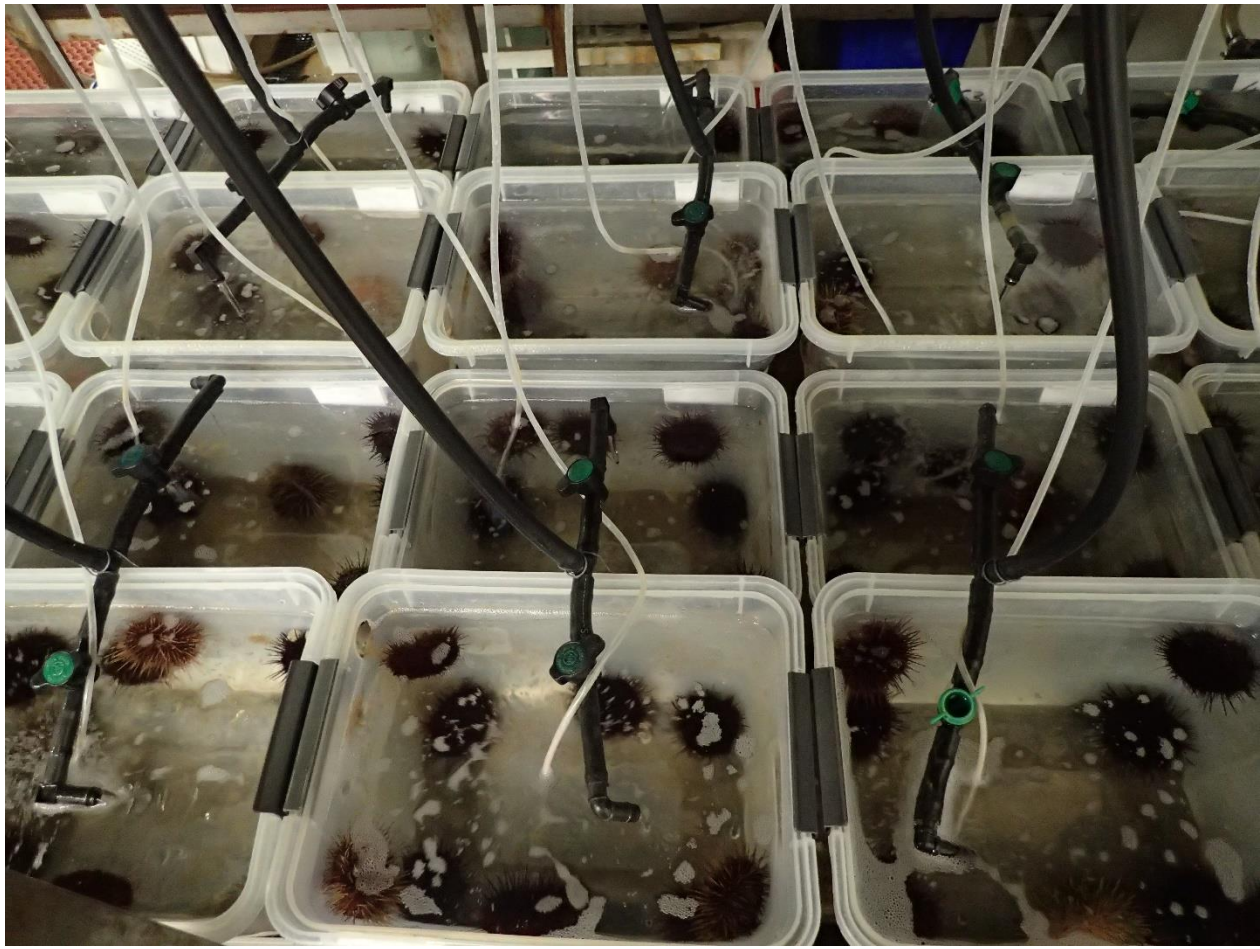
Developing an optimal urchin feed



Developing an optimal urchin feed

- Produced pelleted feeds (Nutrition and Seafood Laboratory (NuSea.Lab)



- Tested 18 feed types with varying amounts of

- protein (3 levels),

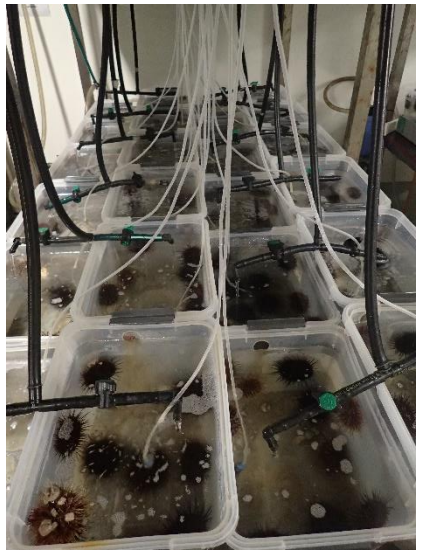
- lipid (3 levels)

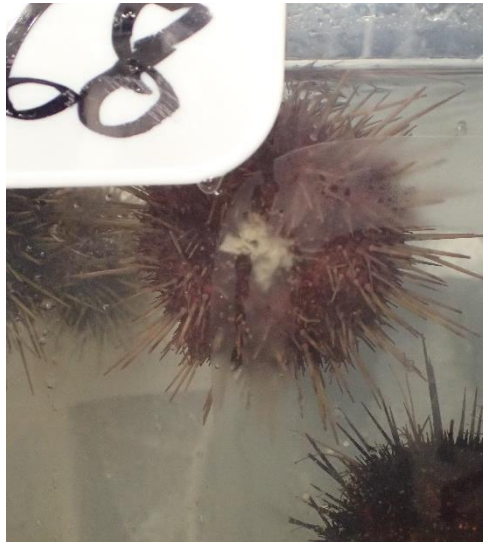
- and seaweed supplement content (single vs multiple)

AIM: determine an optimal base feed for *H. erythrogramma*

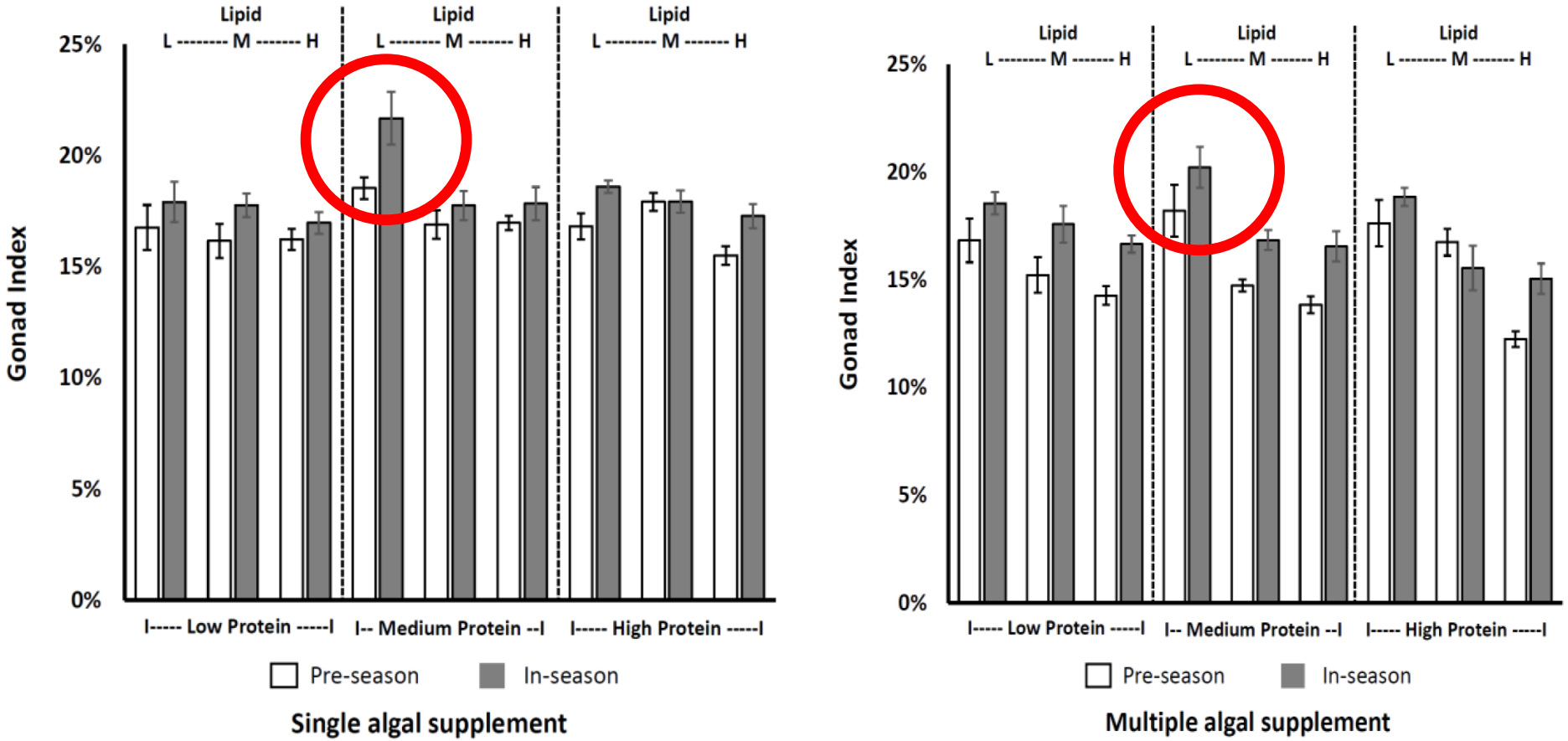
Developing an optimal urchin feed

- 12 week feeding trials
- 72 tanks, 4 tanks per feed type
- 2 runs, April to July and July to October



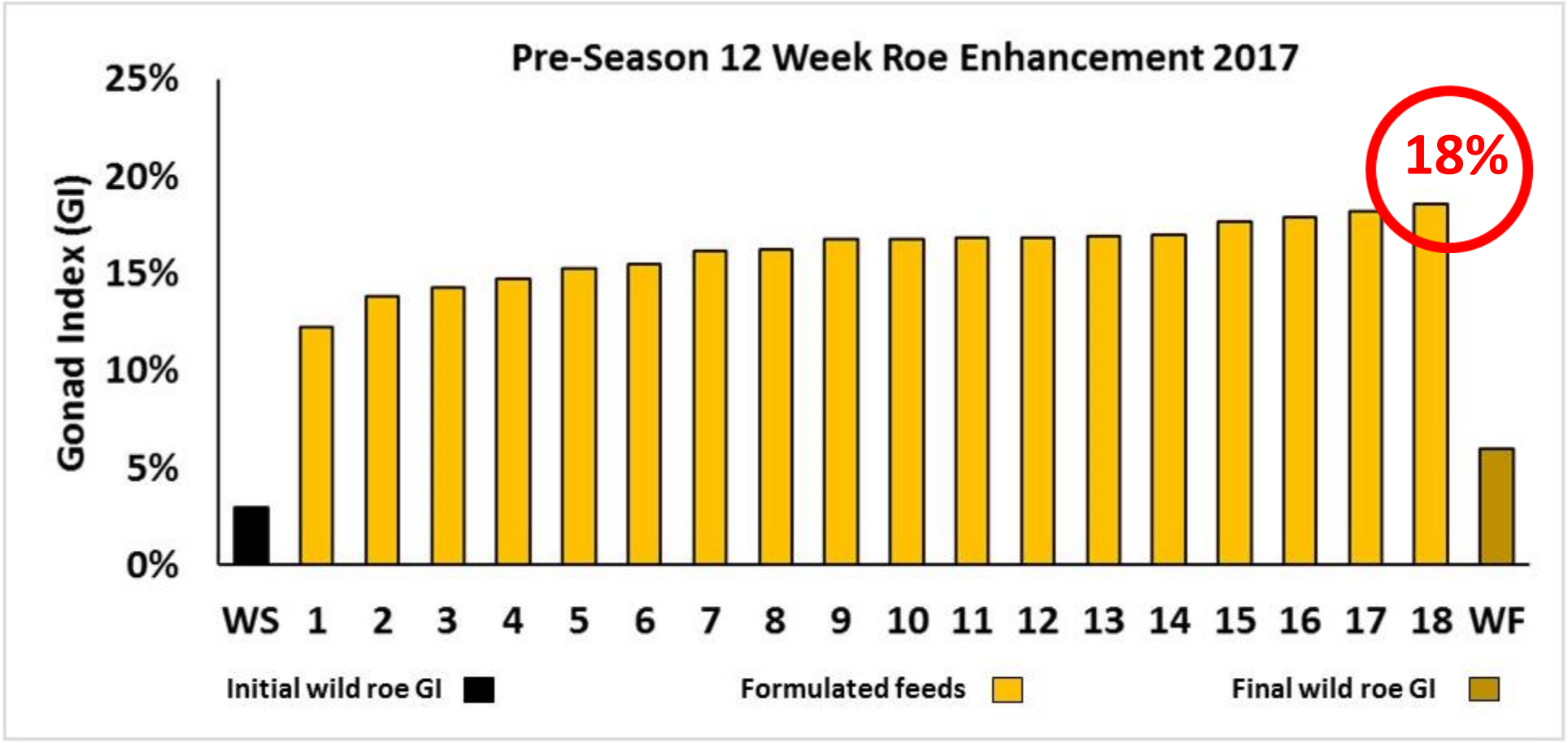


GI's of up to 22%



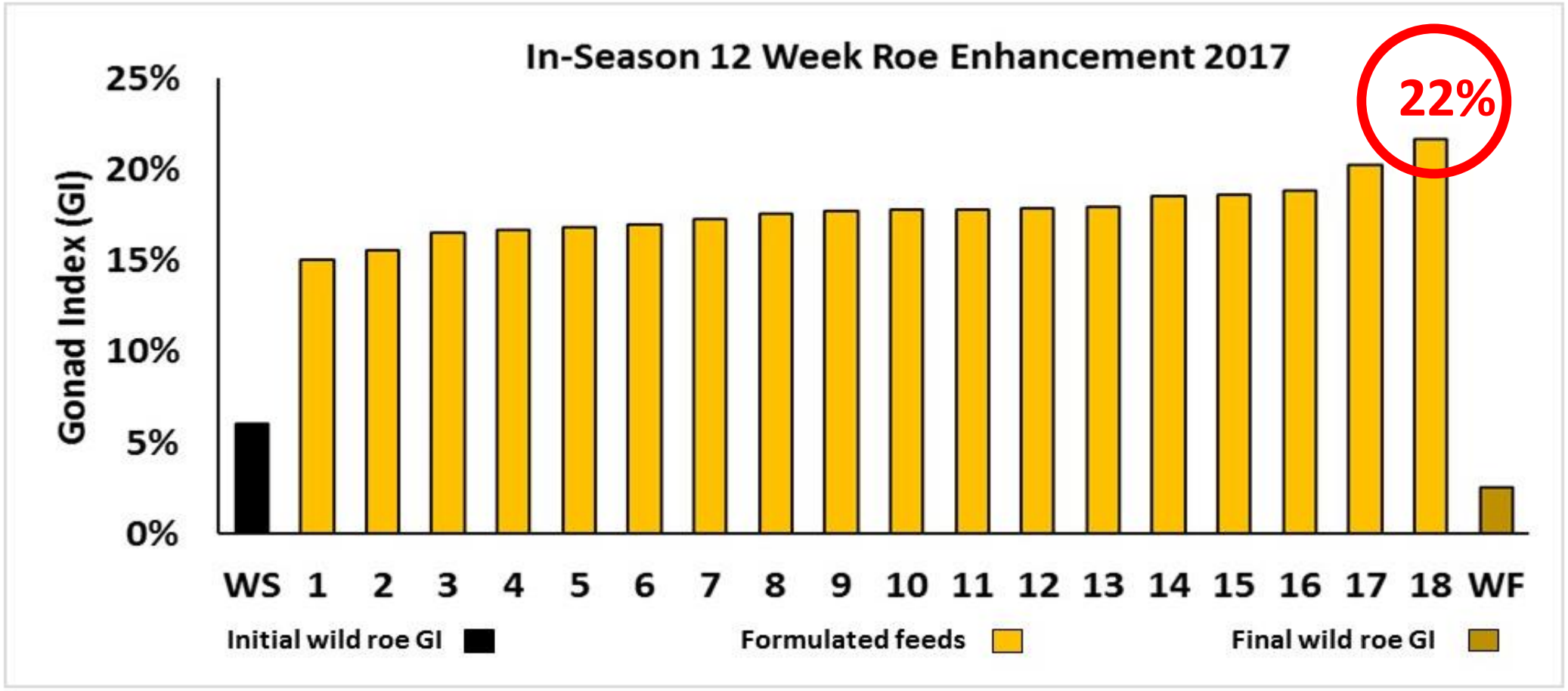
Warren-Myers, et al. (2021). The balancing act: Protein, lipid and seaweed dietary levels to maximize gonad quantity in a wild-caught sea urchin. Aquaculture Nutrition, 27(4), 1019-1030.

2) April - July



18 - Medium protein level, Low lipid + single algal supplement

2) July - October



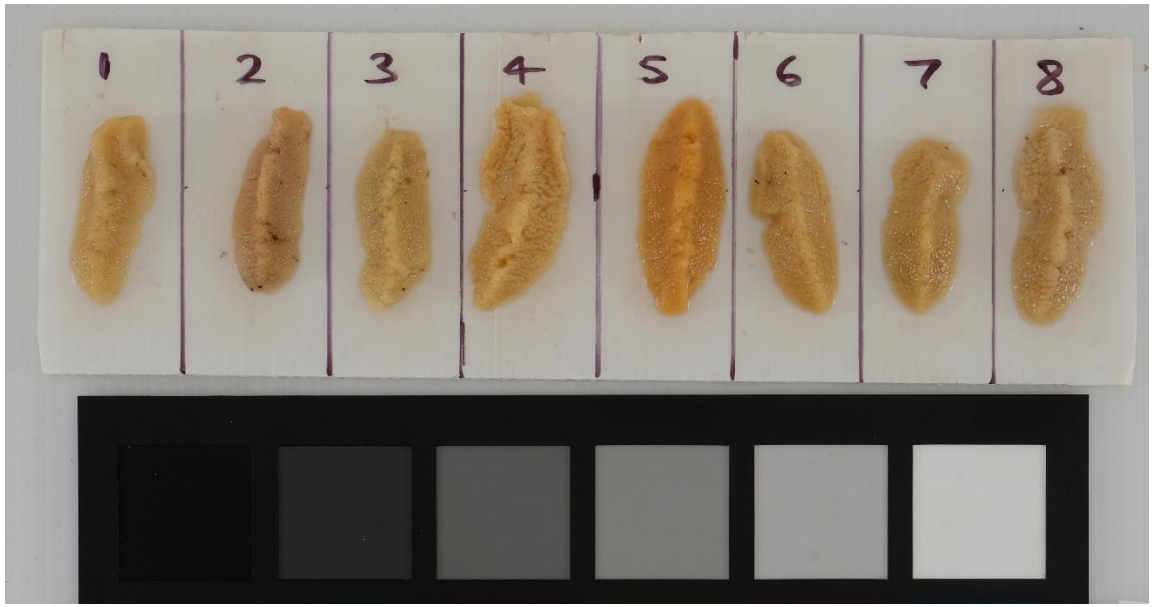
18 - Medium protein level, Low lipid + single algal supplement

Improving gonad quality (variation in algal additives)

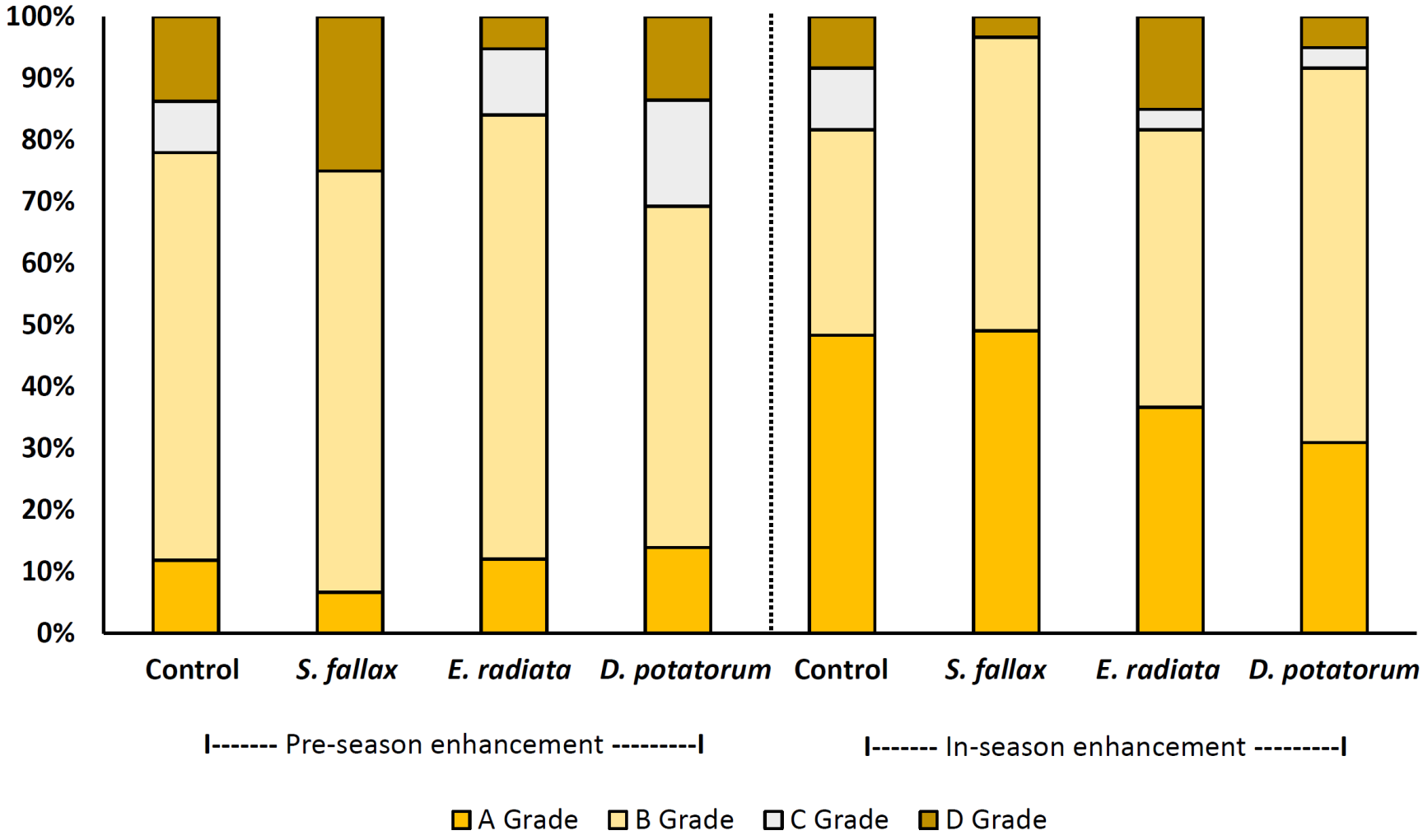
- Use the optimal pelleted feed (Nutrition and Seafood Laboratory (NuSea.Lab)

- Add a range of seaweed types

Improving gonad quality
Consistent colour and texture

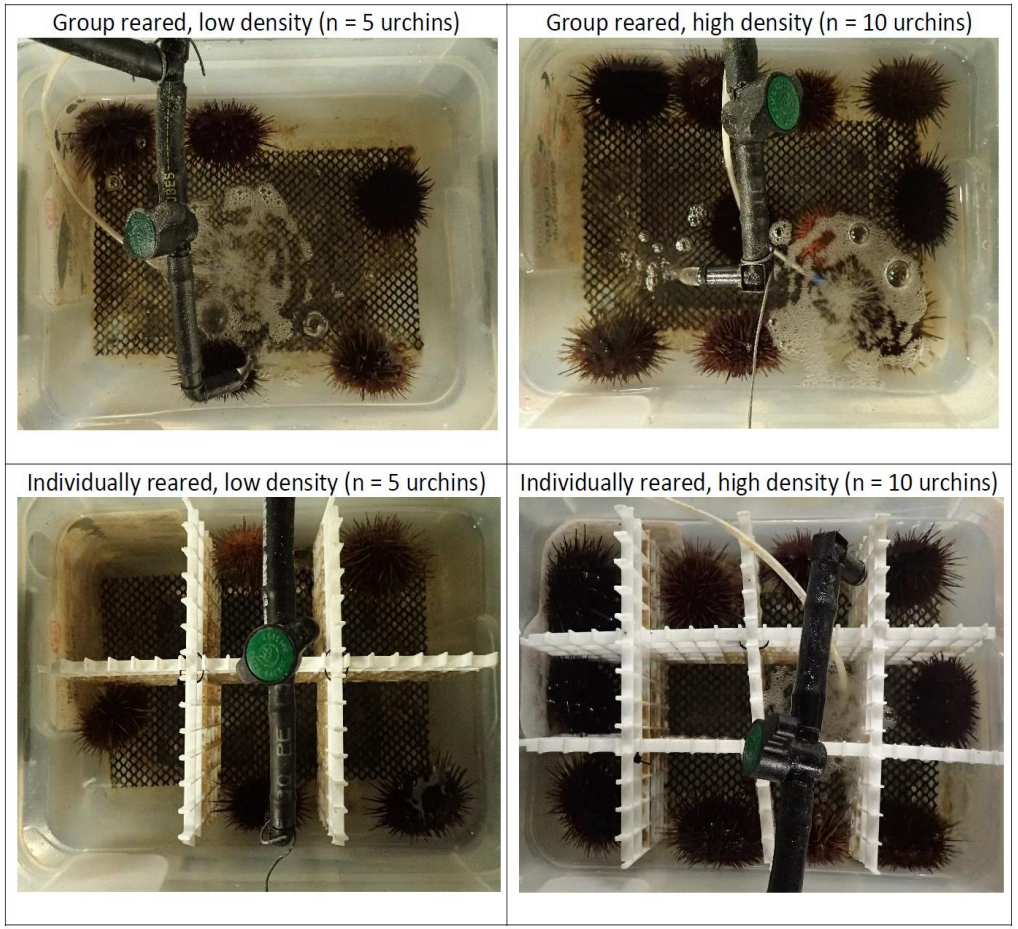


Improving gonad quality



Warren-Myers et al (2022) Algal supplements in formulated feeds: Effects on sea urchin gonad quality. Aquaculture, 548, 737673.

Stocking density and cage effects



1. Does density matter

(5 per tank vs. 10 per tank)

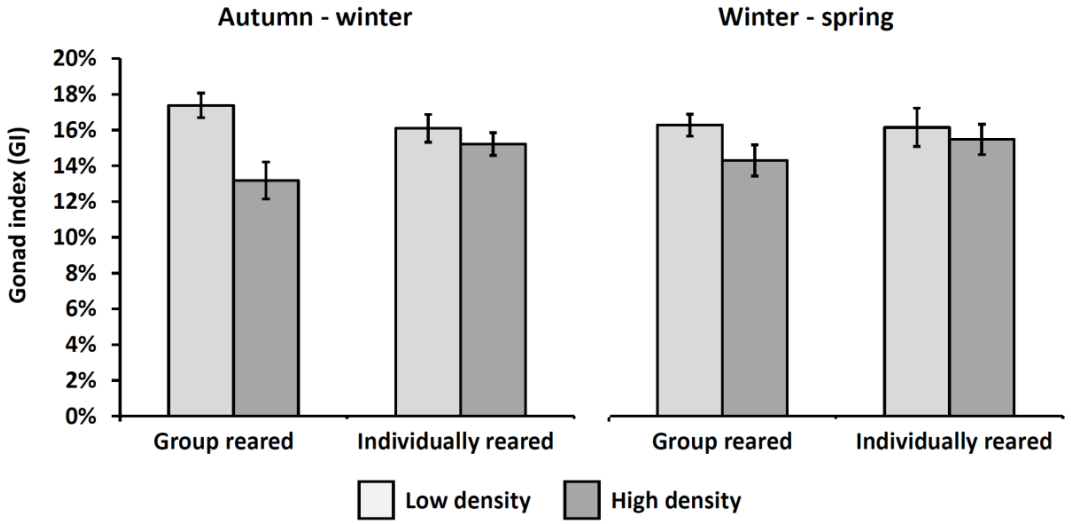
(n = 6 tanks per treatment)

2. Does separating urchins matter

(individual caged culture vs. group culture)

(n = 6 tanks per treatment)

Stocking density and cage effects

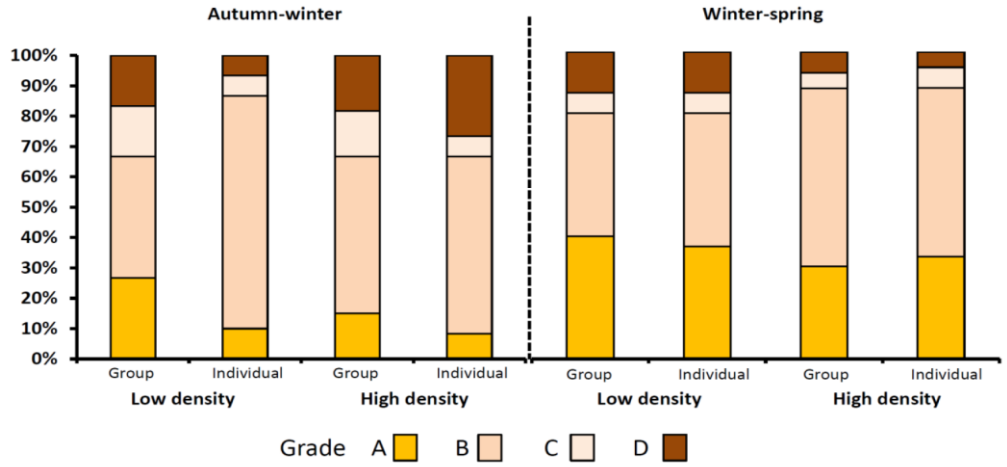


Low density better than high density

Higher density = reduced %GI

But, at high density, individually housing urchins will minimised the effect of higher density.

High density individual > high density group



Seasonal difference on gonad grades only

Warren-Myers et al. (2020). Stocking density and rearing environment affect external condition, gonad quantity and gonad grade in onshore sea urchin roe enhancement aquaculture. Aquaculture, 515, 734591.

Summary

1) Urchins handle transport well.
2) Roe enhance to >20% GI in 12 weeks over a 6 month window.
3) Produce good quality product
4) Culturing environment can effect gonad enhancement

Next step – is this feasible at large scale?

Roe enhancement aquaculture

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