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Aquaculture potential of Pacific short-fin eel *Anguilla obscura*, in a novel aquaculture system

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Purpose of the Study

1. This paper presents preliminary findings from a study investigating the growth rates and survival of juvenile Pacific shortfin eels (*Anguilla obscura*) within a controlled aquaculture environment in Fiji. The primary goal of this research is to assess the aquaculture potential of Fiji native freshwater eel aquaculture. Commercial Japanese freshwater eel aquaculture systems were tested for Fiji native freshwater eels and these systems were compared to assess the viability of culturing Fiji native freshwater eels. The study also compares growth rates of Fiji native freshwater eels with those systems and species from various other countries.

Background of the Research

2. There are three distinct stages/systems during the grow-out culture of freshwater eels and these are:
    - Introducing a starter feed to glass eels
    - Weaning the glass eels from the starter feed to a commercial formulated feed
    - Grow out culture of eels
3. Warm, stable temperatures in tropical aquaculture enhance feeding and metabolic efficiency.
4. Specific Growth Rates (SGRs) in tropical systems range from 1.5–2.5% per day (Hirt-Chabbert et al. 2014).
5. Temperate regions experience seasonal temperature fluctuations, leading to SGRs of 0.5–1.0% per day during cooler periods.
6. Growth rates vary due to species specific traits, environmental conditions, and farming practices.

Methodology

Collection and setup

7. Glass eels were collected from the Navua River estuary in Fiji, with species identification verified by Dr. Chinthaka, SPC Inland Aquaculture Specialist, based on morphological characteristics. A total of 150 glass eels were randomly selected and divided into three groups of 50 individuals, each subjected to specific feeding regimens and environmental conditions in a controlled setup.
8. To ensure best growth assessments over the 12-month period, a controlled aquaculture system was setup at the SPC Narere eel laboratory. The eels were acclimatised without feeding for 24 hours and housed in triplicate 150-litre tanks (1×1.5 m^3; 50 eels per tank) in a closed indoor laboratory environment. Daily manual water exchanges and regular waste siphoning were conducted to keep optimal water quality.

Data collection and analysis

Growth monitoring

9. Eels were weighed every three weeks, focusing on weight rather than length, to accurately track growth over time and to minimise stress. Statistical analyses, including ANOVA, were used to compare growth rates across regions at different feeding regimens and to evaluate growth rate and survival rates in a grow-out aquaculture system. Overall growth and survival rates were calculated at the conclusion of the study to assess total mortality and monthly growth rate (weight/g) from the first introduction to the aquaculture system.

Feeding trials

Starter feed trial

10. The first feeding experiment aimed to find the most effective starter feed, comparing a fresh feed formulated in the lab (made from squid, yellowfin tuna belly, and shrimp), a second fresh formulated feed (made with boiled yellow fin tuna belly) and a third live feed (*Artemia*). Results showed that *Artemia* was the most effective starter feed, yielding higher survival rates and active feeding behaviours, while formulated feeds were not easily accepted leading to high mortality in tanks.

Weaning phase trial

11. The weaning phase trials aimed to transition conditioned glass eels successfully feeding on *Artemia* to a commercial Japanese freshwater eel feed (Higashimaru Co Ltd, High-tension feed) to support growth and sustainable aquaculture. Over four days, *Artemia* was gradually reduced while high-tension feed was increased, using different feed-to-water ratios across trials. By day 4, the eels were fully on high-tension feed, followed by *ad libitum* feeding of 50% high-tension feed from day 5 onward. The trials monitored feed acceptance, growth, survival, and behaviour, focusing on minimising stress and maintaining water quality. The results showed a 97% survival rate over three weeks for all three systems tested, with eels adapting well to the artificial feed and no significant acceptance differences between the various weaning systems tested. Stress-reducing measures, such as dim lighting and limited tank movement, were effective, making the weaning process successful.

Grow-out feed transition

12. Eels that had been successfully weaned to the commercial Japanese eel feed were then fed *ad libitum* (approximately 50% ABW/day) twice daily over 10 months to assess growth potential.

Water quality monitoring

13. Key water parameters, including temperature, salinity, and dissolved oxygen, were checked daily, while pH, ammonia, nitrate, and nitrite levels assessed weekly to ensure best growth conditions. These factors were supported within ranges suitable for tropical aquaculture.

Results

14. The results indicated that eels responded differently to feeding regimens. The formulated feed showed varied growth rates, while live feed yielded higher survival rates and active feeding. Although the grow out systems were successfully incorporated, growth comparisons with other species of

freshwater eels highlighted Fiji's lower growth rate of 0.27–0.29 grams/month compared to advanced systems in Japan and Europe.

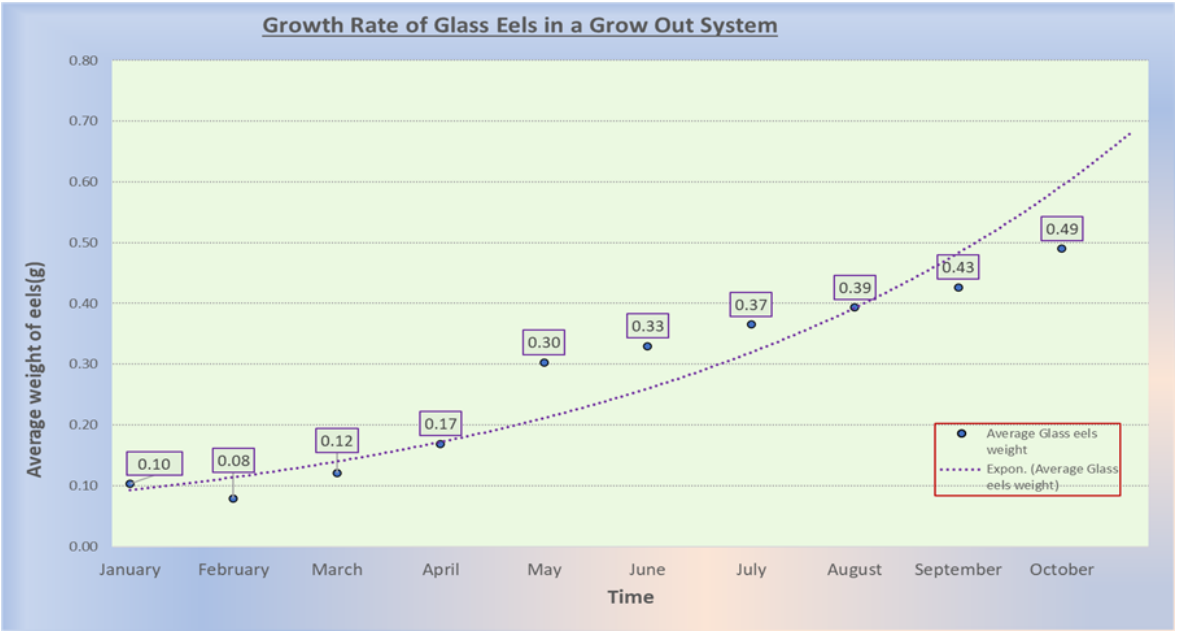

Figure 1. Average growth rate of Fijian *A. obscura* in grow out system

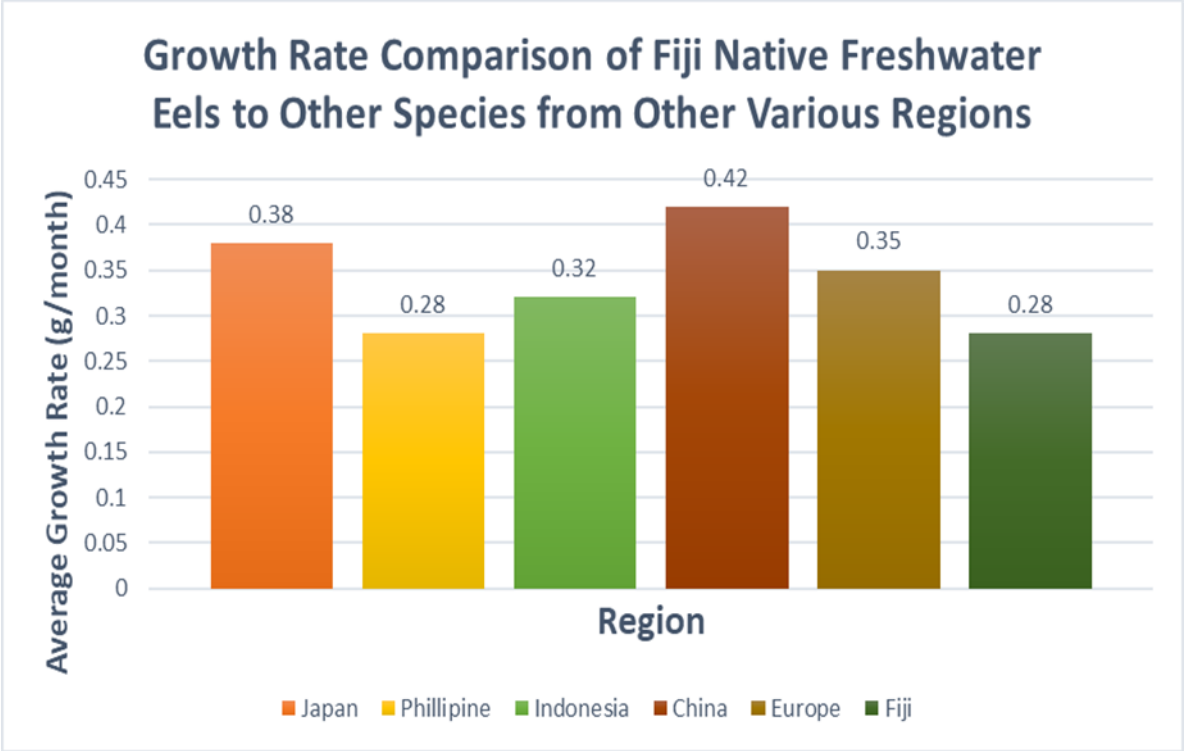

Figure 2. Average monthly growth rate of freshwater eels in different regions

Conclusions and recommendations

15. Growth rates of freshwater glass eels show significant variation across different aquaculture regions due to species specific traits, environmental conditions, and farming practices. In regions with advanced systems, such as Japan and China, growth rates for *Anguilla japonica* can reach 0.3–0.45 grams per month and 0.4–0.6 grams per month, respectively. Europe follows with growth rates of 0.2–0.4 grams per month for *Anguilla anguilla*. In contrast, regions like Fiji, Indonesia, and the Philippines report slower growth rates, ranging from 0.25–0.35 grams per month for *Anguilla luzonensis* in the Philippines and 0.25–0.4 grams per month for *Anguilla bicolor* in Indonesia, while Fiji's *Anguilla obscura* achieved 0.27–0.29 grams per month. These findings underscore the importance of species characteristics, feed and water quality, and aquaculture management practices. Regions with temperate species of freshwater eels and advanced culture techniques consistently achieve higher growth rates, highlighting the global need to adopt improved methods and implementing species specific culture management systems. Implementing best practices and advanced systems, such as recirculating aquaculture systems (RAS), could significantly boost eel farming, contributing to food security and economic growth in tropical regions. While commercial Japanese freshwater eel feeds have reported optimal nutrition for Japanese eels this may not be optimal for tropical eels. Future research should prioritise optimised feeding strategies and RAS to reduce stress and enhance growth and survival, particularly in Fiji and the wider Pacific.

Recommendations

- **Adopt advanced technologies:** Implement recirculating aquaculture systems (RAS) in Fiji to optimise growth conditions for Pacific short-fin eels, minimising stress during critical growth phases and improving overall growth rates.
- **Enhance water quality management:** Maintain stable and ideal environmental conditions within aquaculture systems through automated water quality monitoring and management practices to reduce stress on eels.
- **Refine dietary practices:** Investigate and implement improved feeding strategies tailored to the nutritional needs of Pacific short-fin eels to boost growth rates and overall health.
- **Conduct comparative research:** Undertake studies comparing growth rates and farming practices of eels in Fiji with those in Japan and Europe to identify best practices that can be adapted locally.
- **Invest in training and capacity building:** Provide training for local aquaculture farmers on advanced farming techniques, water management, and dietary strategies to enhance the sustainability and productivity of eel farming.
- **Focus on local species:** Prioritise research on the unique characteristics and growth potential of Pacific short-fin eels to develop tailored aquaculture solutions that align with local environmental conditions.
- **Encourage collaboration:** Foster partnerships between local farmers, research institutions, and government agencies to facilitate knowledge exchange and the development of effective aquaculture practices.

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