

Conservation benefits of commercial aquaculture for an endangered species

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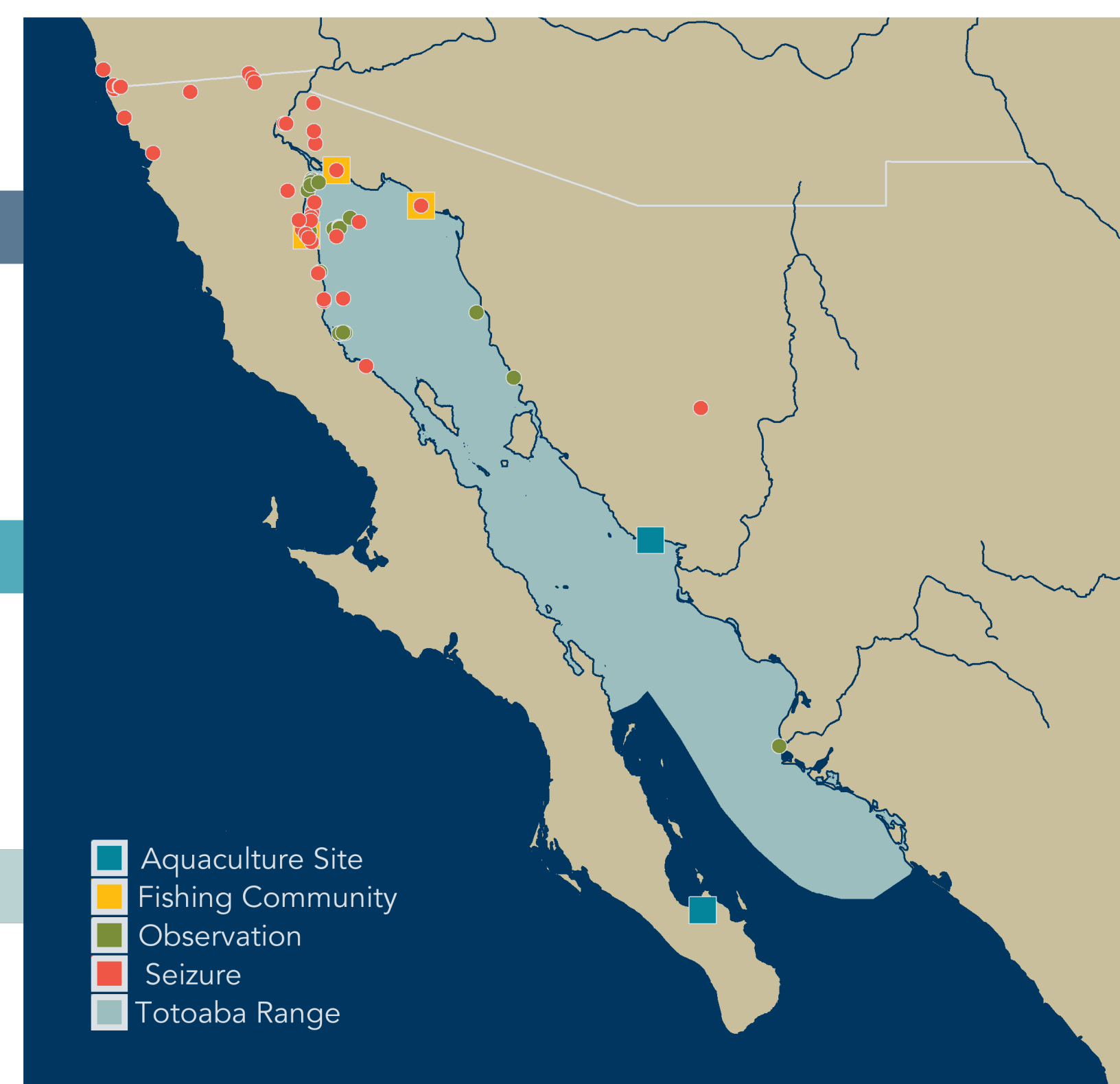
Why totoaba?

Totoaba (*Totoaba macdonaldi*) are the largest member of the croaker family, growing to lengths of over two meters and weighing over 100kgs. This species is endemic to the Gulf of California and is currently listed as Critically Endangered (Findley L., 2010). Ongoing poaching for totoaba swim bladder, known as *buche*, has led to significant overfishing. Current law enforcement efforts have failed and around 1,400 tonnes of totoaba are illegally harvested each year (Cisneros-Mata, 2018).

The proposed alternative solution is to reduce poaching through commercial offshore aquaculture. In theory, producers would flood the market with legal product. This would decrease prices on the illegal market and reduce the high economic incentive for poachers. However, no comprehensive assessment currently exists to evaluate whether aquaculture could be a viable conservation strategy for this species.



Project Goal:
Analyze the potential of commercial aquaculture to reduce poaching and recover wild totoaba.



Observations of totoaba and seizures of totoaba products are most common in the Upper Gulf, near the Colorado River Delta where totoaba aggregate to reproduce. (Environmental Investigation Agency 2017, Valenzuela-Quintero et al. 2015, Natural Earth 2019)

What is Buche?

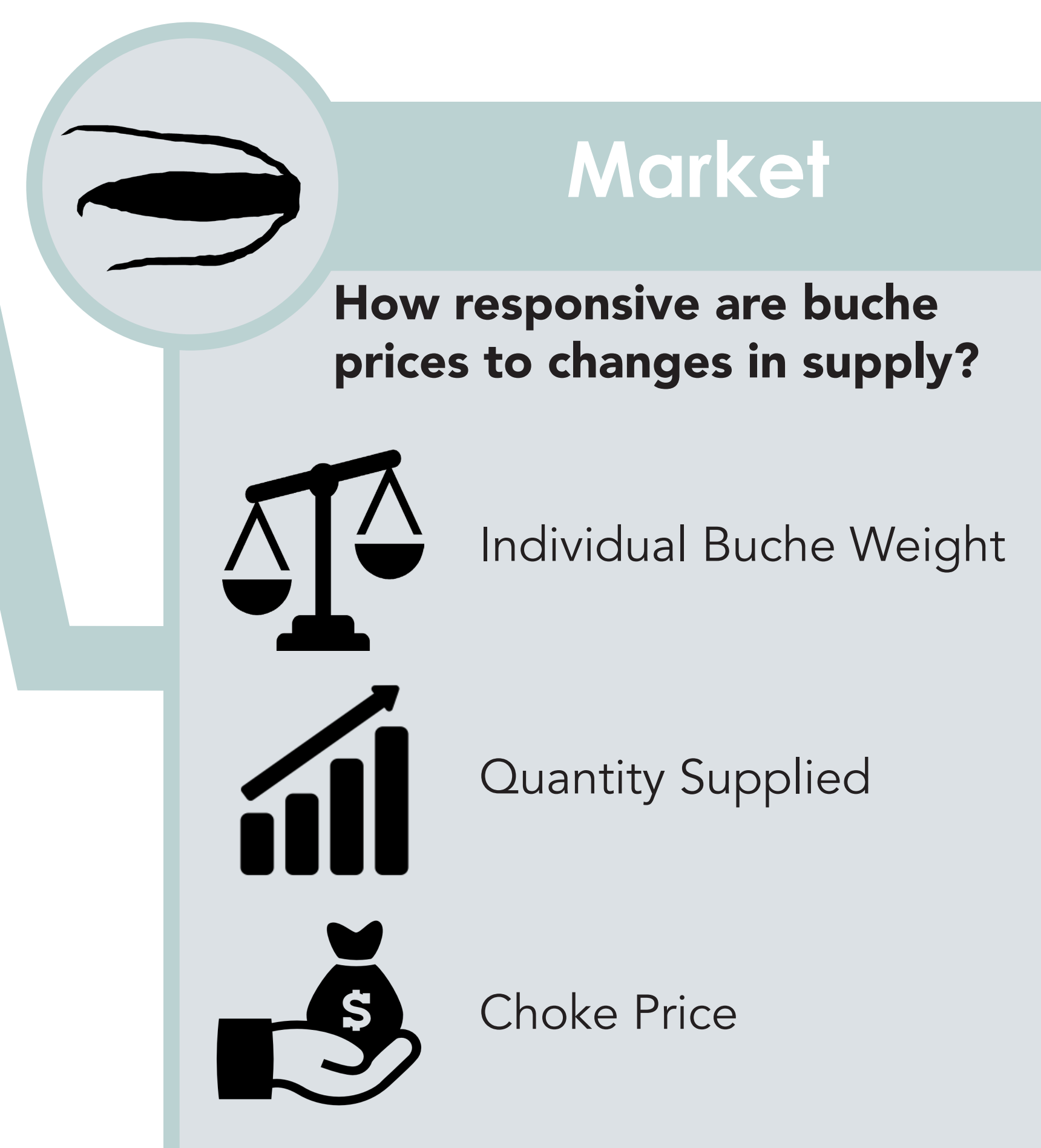
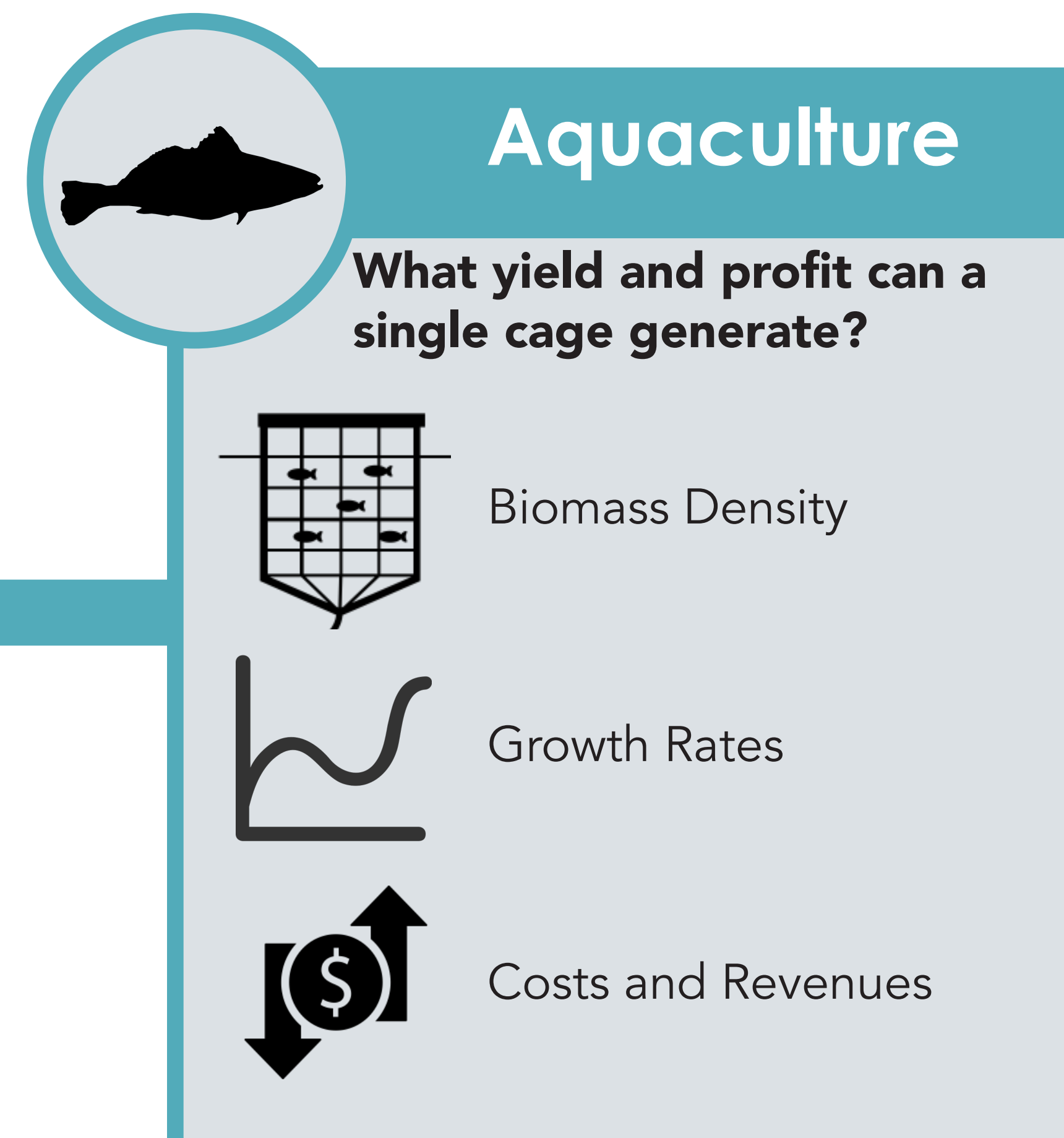
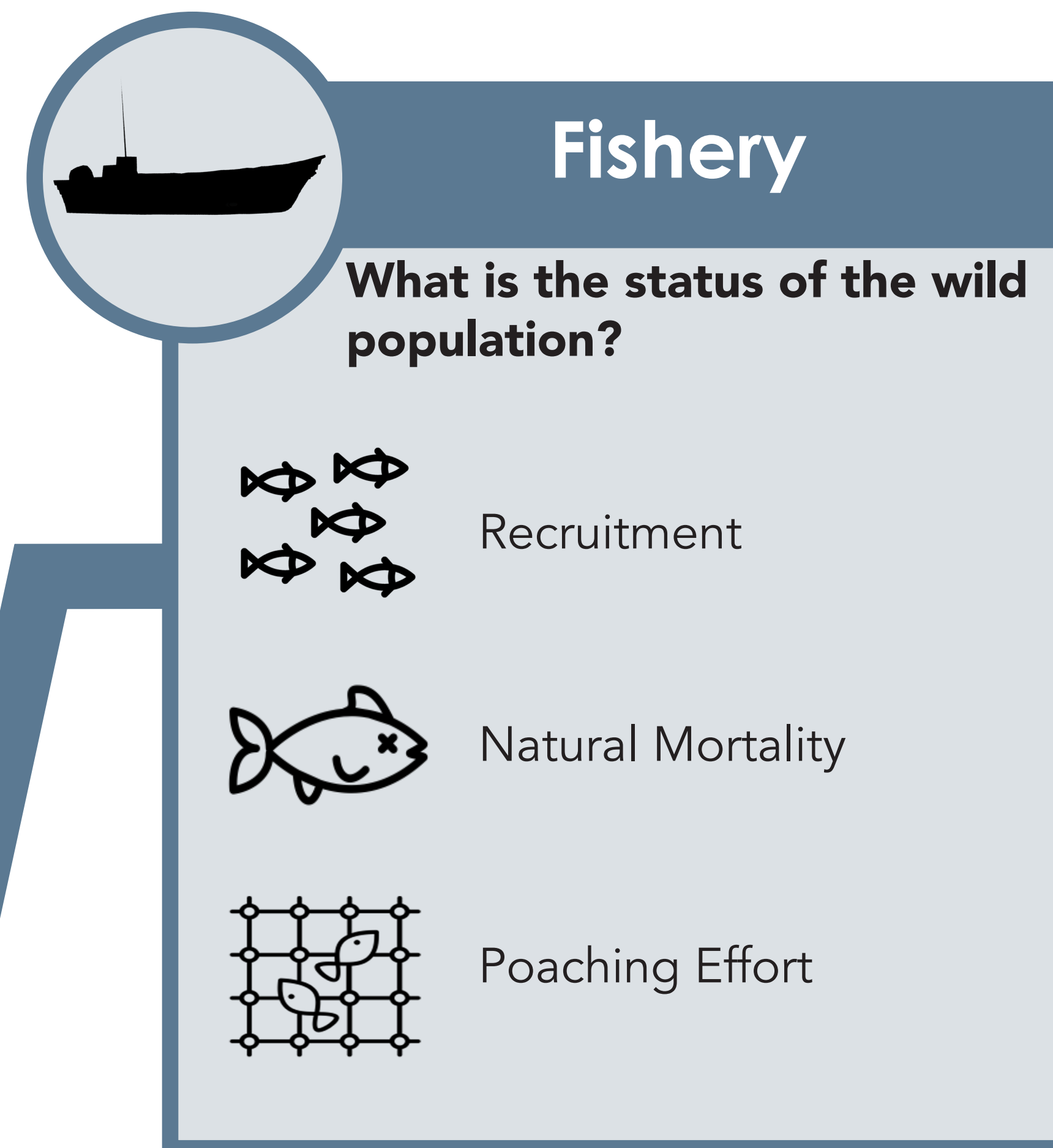
Buche, is the internal organ in totoaba that regulates buoyancy and is used for communication during spawning.

It is highly valued in East Asia for its medicinal properties, with larger buche used as gifts or investments.

Known as 'gold coin maw', totoaba buche are renowned for their exceptional size and can reach values exceeding \$20,000 each.



Approach



Key findings

RESULT: Totoaba cannot persist with current levels of poaching

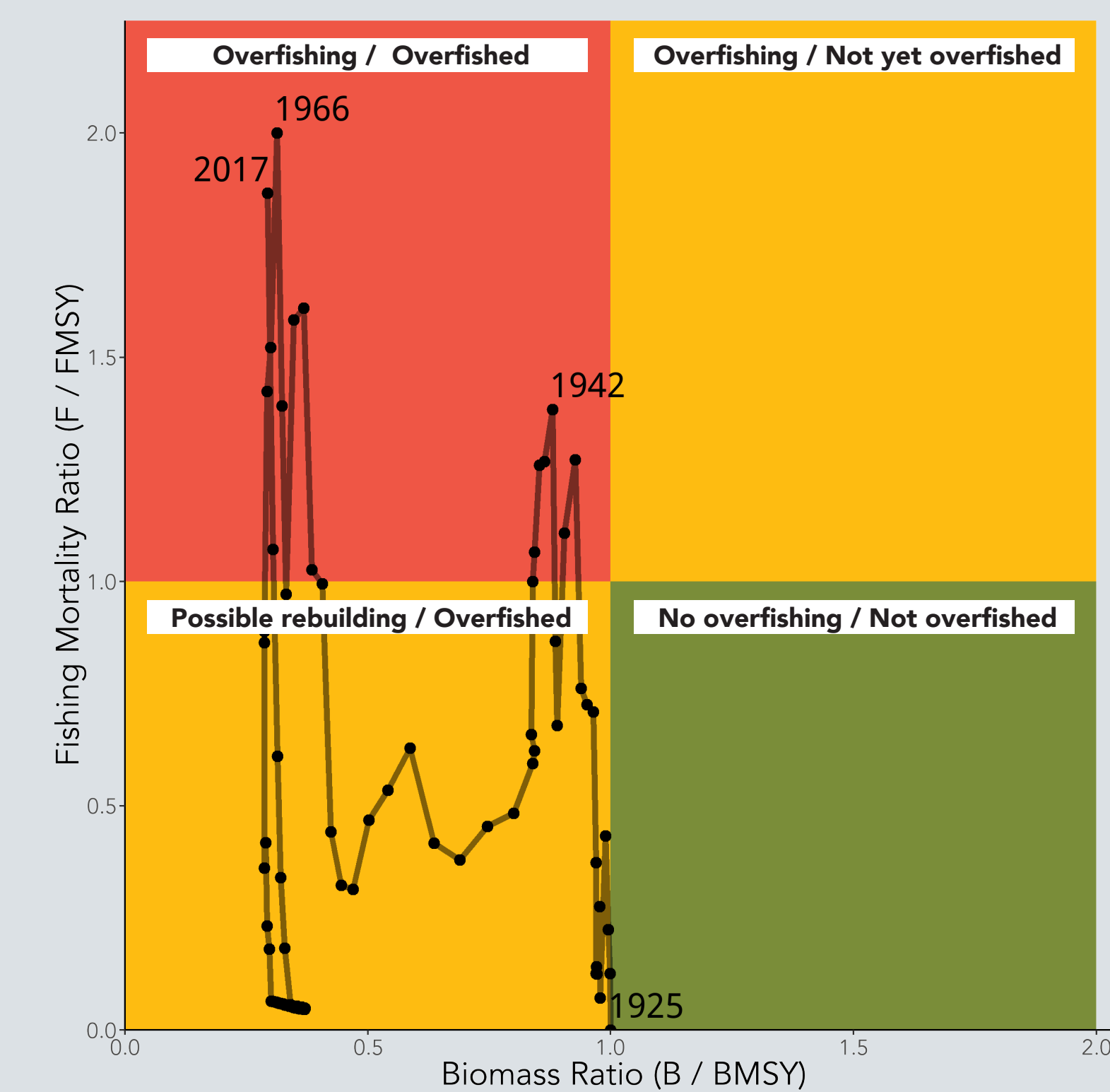
Totoaba is overfished and overfishing is ongoing.

In 2017, $B/BMSY = 0.25$ (overfished) and $F/FMSY = 1.8$ (overfishing).

Poaching targets mature fish and drives the continuing decline of the wild population.

Recruitment cannot sustain the ongoing illegal harvest.

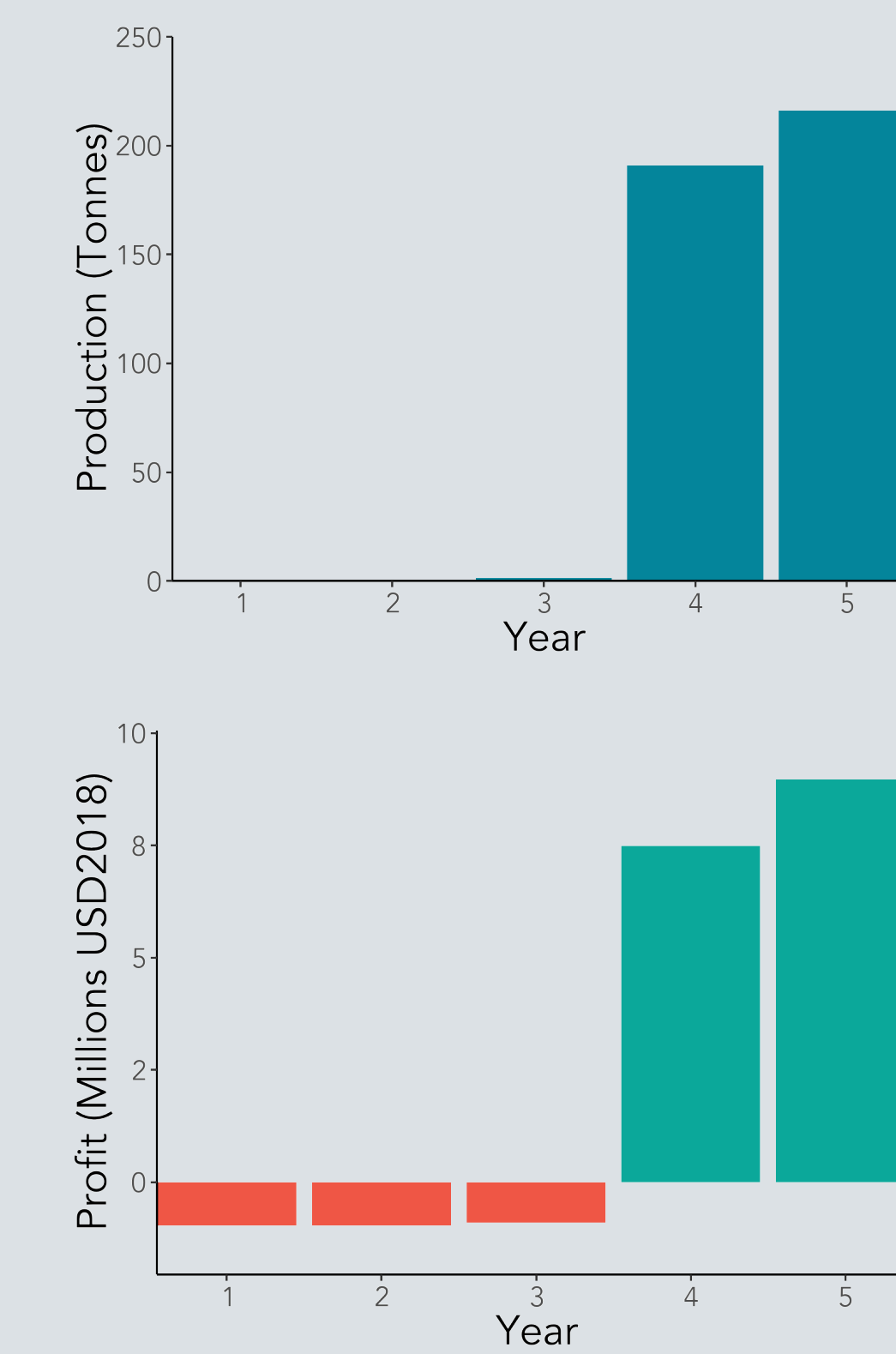
A near-term decrease in poaching is critical to ensure a future for wild totoaba.



RESULT: Totoaba aquaculture is scalable to meet a substantial portion of market demand

One cage harvested after five years produces 216 tonnes of fish.

This results in 1.5 tonnes of dried buche entering the market.



RESULT: Totoaba aquaculture is extremely profitable.

Forecasted profit using a one-cage scenario is approximately USD \$13.5 million over a five-year harvest cycle.

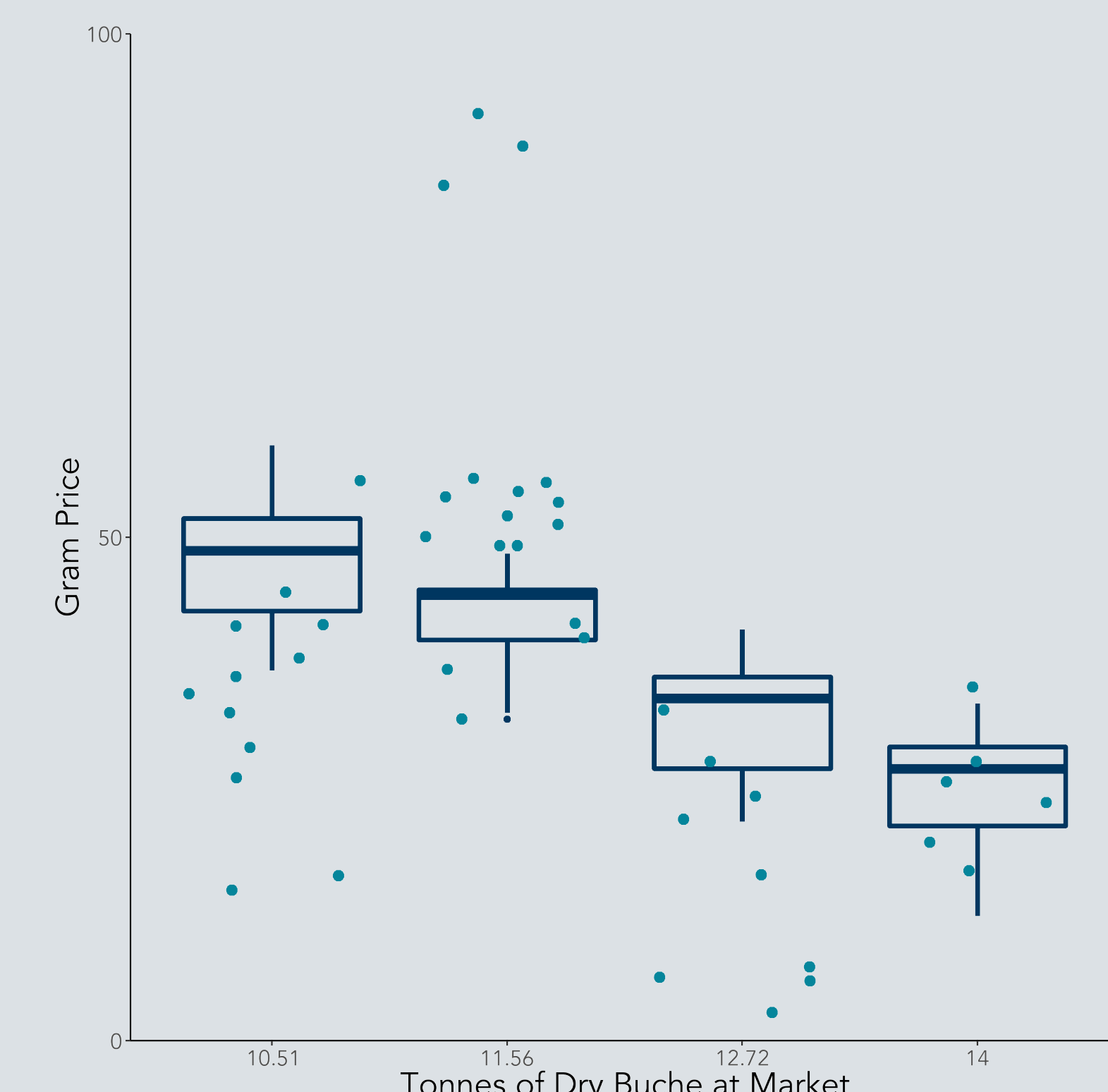
Totoaba aquaculture is lucrative, even when prices are far below those of poached wild totoaba.

RESULT: Buche prices are drastically decreased with aquaculture.

The price of buche is quantity elastic and is responsive to both illegal and legal supply.

Price is reduced by more than \$5/gram for every additional tonne of dry buche supplied to market.

End-market prices could be reduced by 50% with just over 8 tonnes of commercially produced buche and approach a 90% reduction with 15 tonnes.



Can this endangered species be saved?

Our analysis indicates that commercial aquaculture of totoaba buche has the potential to decrease poaching effort. As production enters the market, prices for illegal buche will decline and reduce economic incentives for poachers. While single cage production of 1.5 tonnes of dried buche has limited effects, increasing production to 15 tonnes has the following impacts:

- 90% Reduction in prices received by poachers
- 68% Decrease in overall poaching effort
- 43% Increase in reproductive biomass

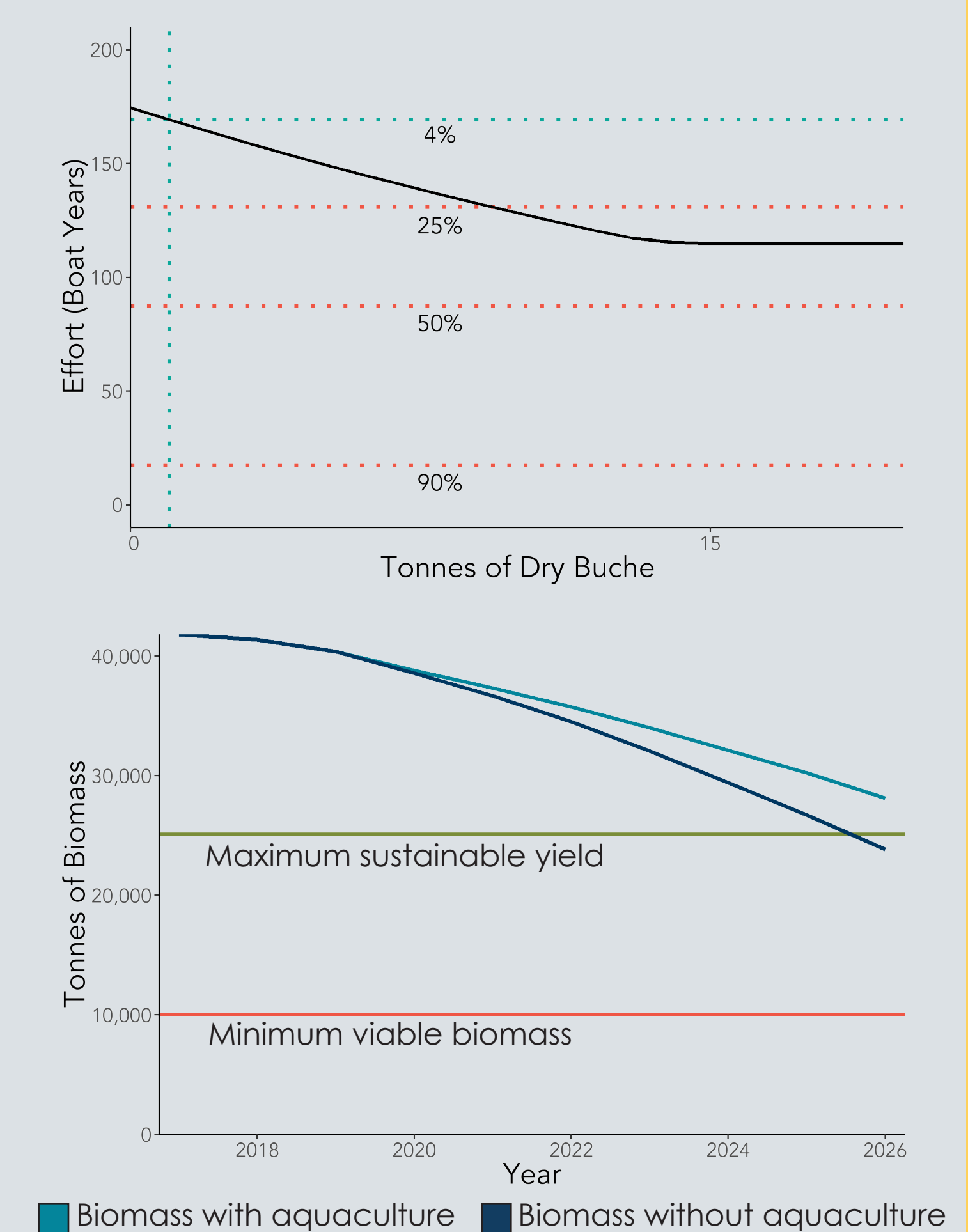
Although insufficient as a singular solution to arrest poaching, commercial aquaculture relieves pressure on the totoaba population and buys time for additional management strategies to be implemented in the Gulf of California.

Benefits to wild biomass

RESULT: Increasing annual production of dry buche results in lower poaching effort:

1.5 tonnes (current capacity) - would decrease poaching effort by 4%

15 tonnes - would decrease poaching effort by 68%, resulting in an additional 12,900 tonnes of wild fish



RESULT: If current production reaches the Asian market, it has the following effects:

Projected totoaba reproductive biomass increases by 17%

4,200 tonnes of reproductive biomass remains in the wild

Further research

Our findings are an important step toward understanding commercial aquaculture's role for totoaba conservation. However, additional research in the following areas would help clarify the potential of aquaculture to generate conservation benefits for this species:

1. Implications of a legalized export market for commercially produced buche
2. Analysis of consumer preferences for farmed vs. wild products in Asian markets



Acknowledgements:

We would like to thank everyone who has helped us in this work over the last year. In particular our advisor Steve Gaines, external advisor Miguel Angel Cisneros-Mata, and PhD advisor Julia Lawson. This project also received valuable assistance from Fernando Cavalin and Pablo Konietzko of Earth Ocean Farms. Additional thanks to Professor Andrew Plantinga, and Professor James Salzman.

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