

## 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

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

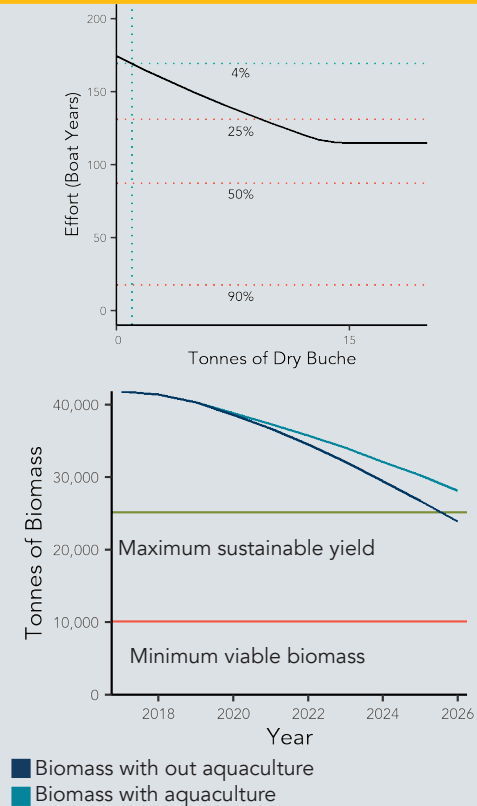
1.5 tonnes - would decrease poaching effort by 4%

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

### 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

References:  
 INAPESCA, I. N. D. P. Y. A. Evaluacion de la Poblacion de Totoaba (*Totoaba macdonaldi*) en el Golfo de California. 1-98 (CITES Seventieth meeting of the Standing Committee, 2018).  
 Findley, L. 2010. *Totoaba macdonaldi*. The IUCN Red List of Threatened Species 2010: e.T22003A9346099. <http://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T22003A9346099.en>. Downloaded on 16 April 2019.  
 Tensen, L. Under what circumstances can wildlife farming benefit species conservation? *Global Ecology and Conservation* 6, 286-298 (2016).  
 Environmental Investigation Agency. (2019). *Illegal Trade Seizures: Totoaba*. Dataset.

## Conservation benefits of commercial aquaculture for an endangered species



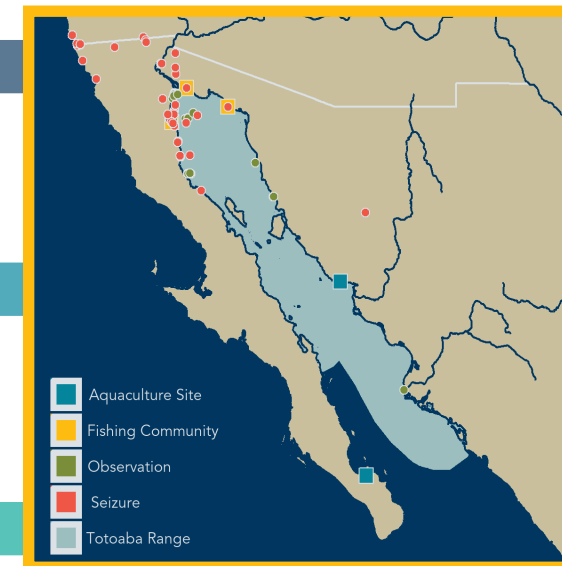
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### Why totoaba?

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 classified as Critically Endangered (IUCN 2010). East Asian demand for totoaba swim bladder, known as buche, has skyrocketed in the last 10 years leading to significant poaching. This illegal harvest not only threatens the demise of totoaba, but also the vaquita marina, a rare porpoise often entangled in gill nets set by poachers. Current law enforcement actions such as increasing marine patrols, closing historic fishing grounds, and banning gill nets have proven insufficient to eliminate poaching. The best available data estimates that around 1400 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, legal producers would flood the market. 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.



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-Quiñonez et al. 2015, Natural Earth 2019)



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



### What is buche?

Internal organ that regulates buoyancy

Highly valued in China for large size, thickness, and medicinal properties

Can sell for over \$20,000 per individual

### Acknowledgements:



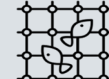
We would like to sincerely thank everyone who has helped us in this work over the last year. In particular our advisor Dr. Steve Gaines, external advisor Dr. Miguel Angel Cisneros, Dr. Andrew Plantinga, and Professor James Salzman. This project also received valuable assistance from Fernando Cavalin and Eric Peterson of Earth Ocean Farms.

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## What factors are needed for analysis?

### What is the status of the wild population?

-  Juvenile Recruitment
-  Natural Mortality
-  Poaching Effort

#### Fishery



## What are the key findings that influence wild totoaba biomass?

### RESULT: Totoaba cannot persist with current levels of poaching

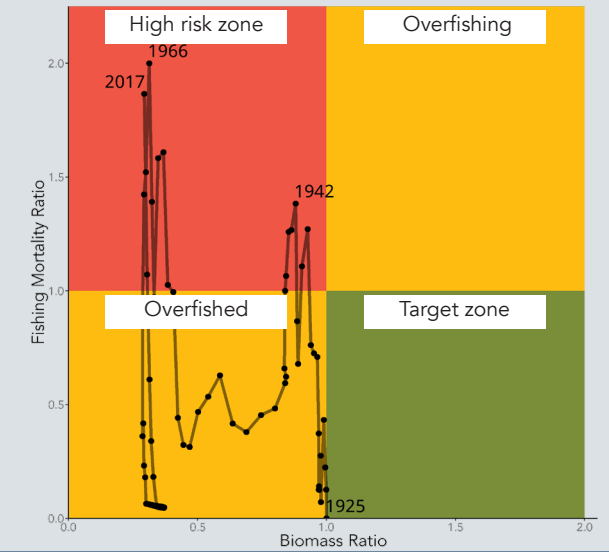
Totoaba is overfished and overfishing is ongoing.

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

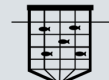


Poaching targets mature fish and drives the continuing decline of the wild population.

Recruitment cannot sustain the ongoing illegal harvest.

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



### What yield and profit can aquaculture generate?

-  Biomass Density
-  Growth Rates
-  Costs and Revenues

#### Aquaculture

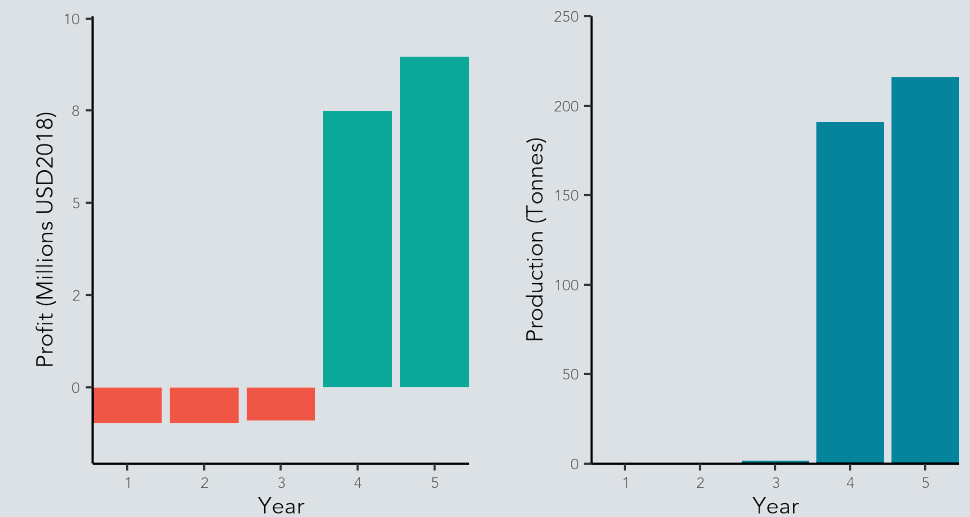


### RESULT: Farming totoaba is scalable to meet a significant portion of market demand

One cage harvested after five years produces 216 tonnes of whole fish. This results in 1.5 tonnes of dried that could enter 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.



### How sensitive are buche prices to changes in supply?

-  Individual Buche Weight
-  Quantity Supplied
-  Choke Price

#### Market



### 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 and approaches a 90% reduction in price from 15 tonnes of commercially produced buche.

