

AQUACULTURE OF *SARDINHAS*: SMALL, INDIGENOUS FISH (SIF) AS LOW COST, HIGHLY NUTRITIOUS, DELICIOUS FOODS

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Small Indigenous Fish (SIF) as Food

Social Ecology SIF in
North America

Building a *Sardinhas*
Aquatic Food System

Ending Comments



SMALL, INDIGENOUS FISH HAVE MANY WELL KNOWN BENEFITS!

**Nutritious - vitamin A, omega3's,
micronutrients, etc.**

More Accessible

More Affordable

Less wasteful

Cashion et al. (2017)

**Most fish destined for
fishmeal production are
food-grade fish.**

Fish Fisheries 18, 837–44.

**Have considerable potential to increase
seafood consumption**



AffairsCloud

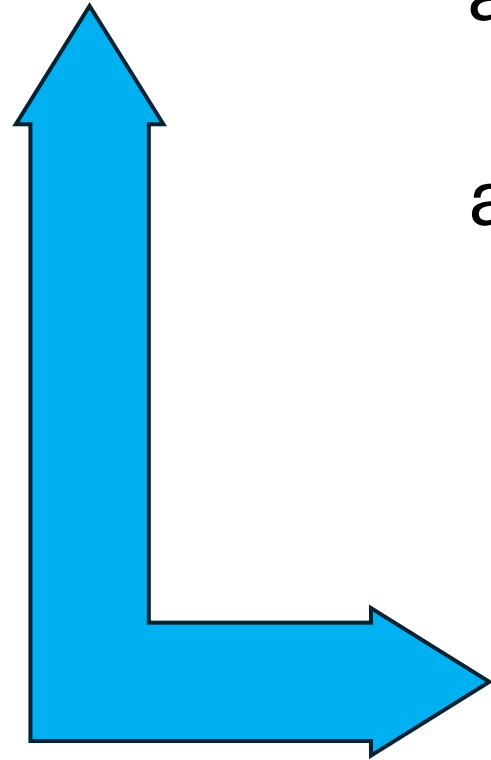


Majluf, P. et al. (2017).
The little fish that can
feed the world. *Fish
Fisheries* 18, 72-77.

Global Markets

Expansion of fed animal agriculture (chickens, pigs, pets, etc.) and aquaculture (salmon, shrimp, tilapia, etc.) uses 18 to 35 MMT

Local Realities



Local

Fish are Too Expensive Fish Consumption is Declining in Too Many Places

- *Senegal (2009 to 2018) fish consumption **declined 50%**
- *South & SE Asia **declining supply** - “trash” fish now used for expanding fed aquaculture
- *EU “**sharp decline** in seafood consumption” due to rising seafood prices”
(EU Fish Market Report 2024)
- *USA seafood consumption is **stagnant/declining**. Prices were 120% higher in 2024 v. 1997 >overall inflation rate (US Bureau of Labor Statistics)

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**Social-Ecology SIF in
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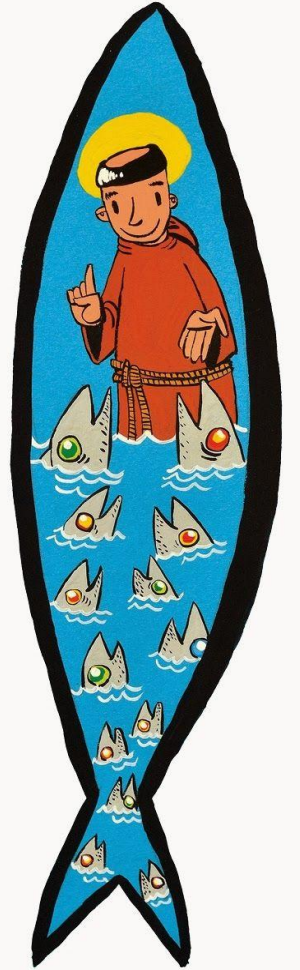




Benedicite omnia que inveniuntur in aquis Domino Dan. 3. 29.
Appena Antonio invita i pesci ad udirlo, escono dall'acqua, e in loro linguaggio benedicono il Signore. Imitiamoli nell'obbedienza alle divine chiamate ed uscendo dall'acqua immondo del peccato lodiamo il Signore.

St. Anthony of Pádua
Devoted to the
poor/disadvantaged...

Sardines are food
of the poor but
TRANSFORMED into
cultural icons





Social-Ecology of SIF in North America

“Rough Fish”

Rypel, A. et al. (2021)

Goodbye to “Rough Fish”: Paradigm
Shift in the Conservation of Native
Fishes. *Fisheries* 46(12) doi:
10.1002/fsh.10660



1800's: intensive river netting and fish processing on riverboats led to the labelling of many native North American fish as “**rough fish**”

Biologists used this to develop the concept that native fish limited the maximum sizes of preferred gamefish populations...Biologists led large scale attempts to destroy native fish by promoting intensive netting and ***whole ecosystem poisoning***

The legacy of this “rough fish” concept persists in parts of societies today but is CHANGING!





TNC Minnesota (2024) with Anglers/Conservationists

Minnesota first state to pass protections for
26 species of “rough fish”

**Legislation is a model to protect freshwater native fish
biodiversity**

“Tin Fish Date Night”

“from millennials to boomers to Gen Z just trying different types of tinned fish and then filming themselves eating it...The internet ate it up....led to many new consumers...



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North American indigenous fish as **SARDINHAS**

**Central place in the diets
of Indigenous First Nations

**Golden shiner was among
fish species consumed by
Harvard College students
(1651–1674) (Singer 1982)

**The golden shiner “is said
to be an excellent panfish”
(Forbes and Richardson 1908)



Zweig, R. (1977) The saga of the solar algae ponds.
Journal of the New Alchemists 4: 63-68.



Costa-Pierce, B. (1982)
Construction and use of
solar silos as mass
algal/fish culture units.
Aquacultural Engineering 1:
239-244.





Applied R&D 2024 –

Our first choice for *sardinhas* aquaculture development given our hyperlocal approach was to use a SIF widely abundant and tolerant (and delicious!) –

The golden shiner (*Notemigonus crysoleucas*)



Results (2024) -

- *successfully moved/acclimated fish from *bait shops* to ~3 m³ algal tanks
- *created dense blooms with recycled fertilizer (our program in urine diversion – *longer stories there*)
- *acclimatized fish to dense algal cultures, first using commercial feeds
- *since these are lower trophic level fish, experimented with bioflocs using various agricultural meals to fully replace commercial feeds



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Results (2024) –

****fish reproduced in solar algae ponds**

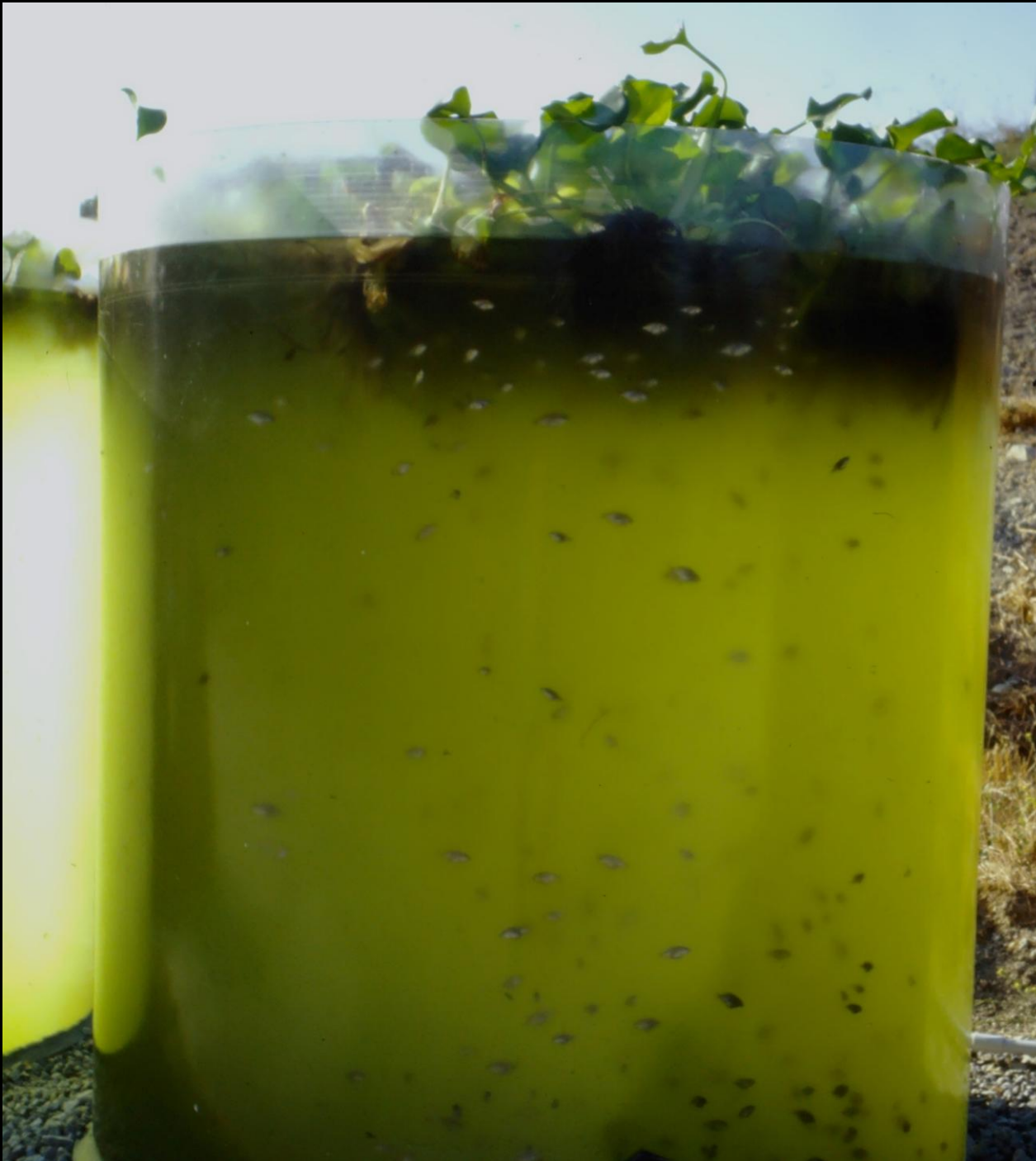


Results (2024) -

*Continued R&D on integrations to irrigate/biostimulate agriculture...

*All energy from solar energy





Phase 1

Hatchery Solar Pond
Nursery Solar Pond

Growout Solar Ponds
700 sardines in 3000 liters

First Culinary Explorations

Sardinhas com óleo



Make **confit** - Cure 6 small fish in a 50/50 mixture of coarse sea salt and caster (“superfine” “bakers” sugar) for 15’
Rinse well and pat dry
Heat oil to 60°C (120°F), add course crushed pepper corns, oregano and confit for 3’, until just cooked

Put fish into a clean, lidded jar and top up with olive oil. Can be refrigerated for a few weeks





Ending Comments



It's more productive to focus on trying to improve a situation, rather than attempt to solve it.

“Solutions” are often small-scale because much new understanding reveals new information that changes approaches.



Barrackpore Declaration (2010)



- (1) Conserve SIF by **protecting their natural habitats...**
- (2) Examine incorporating SIF into **polyculture** practices...
- (3) Enhance/Protect **access rights** to SIF as foods...
- (4) Promote SIF for enhancing **nutrition and food security**
- (5) Protect **traditional knowledge and farmer/family innovations** in the use of SIF

Are we wanting
you/companies
to consider
growing/processing
and eating
NATIVE bait?

Yes...

3200 MT (USDA 2023)



Ecological Aquaculture International



THANK YOU! MUITO OBRIGADO(A) !

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The Dominant System



The Transition

THE SYSTEM OF INFLUENCE

THE PIONEERS

HOSPICE WORK

DEATH / COMPOST

3200 MT Baitfish

USDA (2023)

CONNECT PIONEERS AND BUILD NETWORKS

The Emergent System

OUTLIERS / EDGE CASES

FORM COMMUNITIES OF PRACTICE, NOURISH AND GROW IN INFLUENCE

