

"Green" Clams

Assessing, Quantifying, and Promoting the Value of Ecosystem Services Provided by the Hard Clam Aquaculture Industry in Florida

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Introduction: Ecosystem Services



- Transformation of natural assets supplied by ecosystems into beneficial goods and functions that humans value
- Those generated by bivalves are widely acknowledged, but not well-quantified or valued for most specific populations
 - Values depend on location
 - Requires site-specific studies for validation and use in decision-making

Introduction: Ecosystem Services (ES)

- Bivalves and shellfish farms are ecosystem service providers
 - Regulating services: Improve water quality / Store carbon
 - Supporting service: Nutrient cycling
 - Provisioning service: Provide food
 - Cultural services: Recreation, ecotourism, and heritage
- ES have not been quantified or valued for the Florida hard clam farming industry
 - Provides over 600 jobs and produces 180 million clams annually
 - Economic impact of \$53 million estimated in 2007 (Adams et al. 2008)



OBJECTIVES

- Conduct literature reviews
- Identify and address ecosystem services information gaps
- Determine feasible range of ecosystem values
- Disseminate research results

Conduct Literature Reviews

- Searched literature for information
 - ES provided by shellfish
 - Clam farming in particular
 - ES related to nitrogen removal and carbon storage
 - ES valuation associated with bivalve culture
- Used search engines:
 - Web of Knowledge
 - Google Scholar
 - Science Direct
 - Springer Link



Conduct Literature Reviews

- Information on ES summarized and reported include
 - Bivalve species
 - Ecosystem service
 - Unit of analysis
 - Quantitative measure of service
 - Valuation associated with bivalve culture
- Valuation of ecosystems
- Valuation of ES from bivalves
- Studies on carbon storage by timber rotation
- Nitrogen removal from wastewater
- Nitrogen abatement costs

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"Green" Claims: Estimating the Value of Environmental Benefits (Ecosystem Services) Generated by the Hard Clam Aquaculture Industry in Florida

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What are Ecosystem Services?

The benefits of species on our planet include habitat, nutrient cycling, and soil stabilization. These services are provided by ecosystems that allow us to live. Ecosystem services are the benefits of ecosystems that we rely on for our survival. Ecosystem services are the benefits of ecosystems that we rely on for our survival. Ecosystem services are the benefits of ecosystems that we rely on for our survival.

Value of Ecosystem Services

Value of Ecosystem Services	Value of Ecosystem Services
\$1.44/bm	\$40.04/bm
\$1.44/bm	\$10.84/bm
\$1.44/bm	\$116.07/bm
\$1.44/bm	\$72.90/bm
\$1.44/bm	\$0.71/bm
\$1.44/bm	\$118.89/bm
\$1.44/bm	\$9.73/bm
\$1.44/bm	\$18.20/bm
\$1.44/bm	\$32.60/bm
\$1.44/bm	\$24.38/bm
\$1.44/bm	\$28.80/bm
\$1.44/bm	\$31.28/bm
\$1.44/bm	\$33.00/bm

Figure 4: Harvested clam farms from an aquaculture farm located in Florida (east coast).

Literature

Adams, C.M., L. Sturtevant, and J. Sturtevant. 2012. "The Value of Ecosystem Services Generated by the Hard Clam Aquaculture Industry in Florida." *University of Florida IFAS Environmental Data Information Source*. EIMS 2012. 7 pp.

Authors	Species and Study Area	Sample	Measure of the service	Cost
Frey et al. 2009	Bivalve culture (Crassostrea virginica) in Florida Bay	1500000 m ² in 1000000 m ² of Florida Bay	Net N removal from N ₂ and N ₂ O emissions	\$11.7 to \$22.08/t C
Fry et al. 2011	Mariculture shellfish system in Florida Bay	2000 m ² of shellfish culture	Carbon sequestration (kg CO ₂ eq. per ha per year)	\$15.76 to \$140 per 10 ³ lb of harvest
Higgins et al. 2011	Bivalve culture in Chesapeake Bay	Oyster harvest and shell	Removal of nitrate, total nitrogen, and total phosphorus	\$6.52 to \$7.39/t of CO ₂ eq. per year
Mirani and Murphy 2012	Mariculture shellfish system in Florida Bay	2000 m ² of shellfish culture	CO ₂ sequestration (kg CO ₂ eq. per ha per year)	\$5 to \$43.33/t C
Holmes and Murphy 2014	Hard clams in coastal MA	21 harvested and 21 not harvested	CO ₂ sequestration (kg CO ₂ eq. per ha per year)	\$18.13/t C with timber harvest, \$58.13/t C without timber harvest
Rice 2001	Soft-shell clams in the Pamlico River estuary of North Carolina	1.1 ha of clam culture	Filtration rate (m ³ of water per m ² of clam per day)	\$76.13 to \$20.24/t C
Blagoder and Kemp 2003	Soft-shell clams in the Pamlico River estuary of North Carolina	Sample collection in October 2001 and August 2002	Filtration rate (m ³ of water per m ² of clam per day)	\$48 - \$120/t C
Sturtevant et al. 2013	Hard clams in Florida Bay	2000 m ² of shellfish culture	CO ₂ sequestration (kg CO ₂ eq. per ha per year)	\$85 (Delaware), \$709 (IL)
Fry et al. 2013	Hard clams in Florida Bay	2000 m ² of shellfish culture	CO ₂ sequestration (kg CO ₂ eq. per ha per year)	Average of \$1381 C/t bivalve value

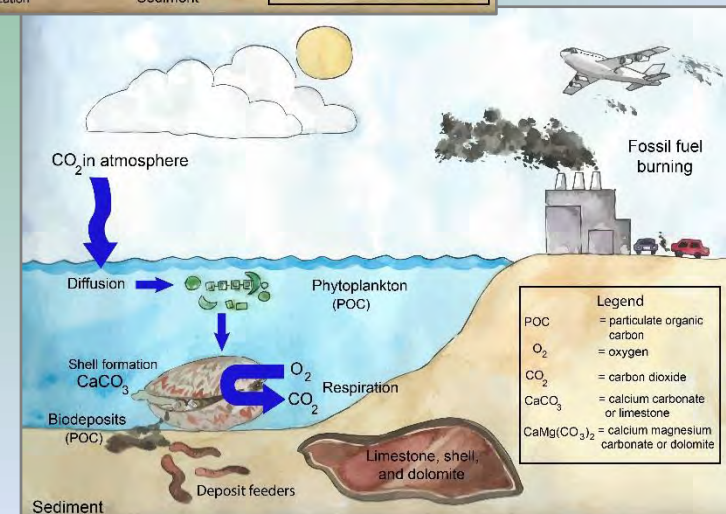
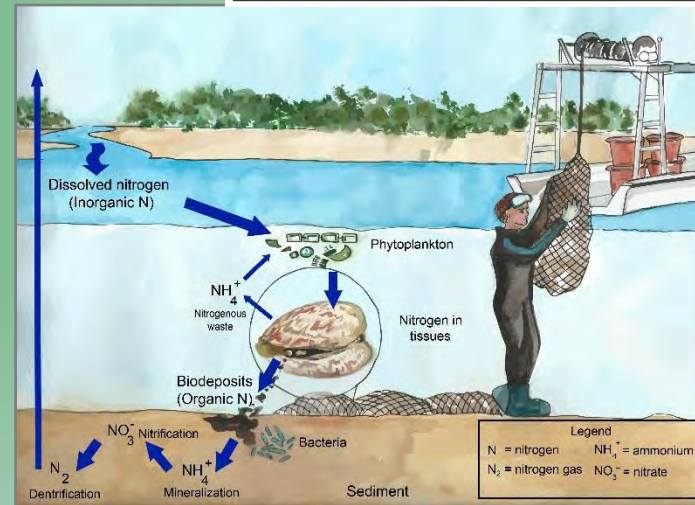
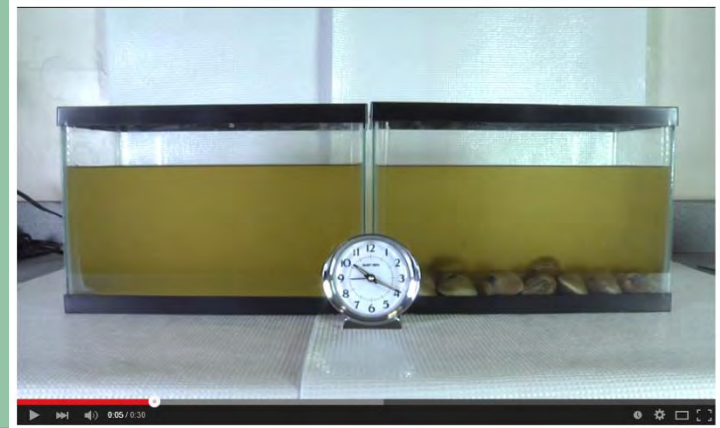
Reviews can be accessed at website: <http://sheliffish.ifas.ufl.edu/environmental-benefits/>

Address ES Info Gaps

- Examined three environmentally beneficial ES provided by clam farming
 - Water filtration
 - Carbon (C) storage
 - Nitrogen (N) removal
- Identified key ES knowledge gaps in literature
- Measurements not available for harvest-sized clams at water temperatures found in Florida

Water filtration video, N and C cycle illustrations can be accessed at website:

<http://shellfish.ifas.ufl.edu/environmental-benefits/>



Address ES Info Gaps

- Conducted laboratory measures to address information gaps
 - Clearance (filtering) rates measured as decrease in light absorbance of algal and detrital suspensions using fiber-optic colorimeter
 - C and N amounts determined by measuring contents of clam tissue and shell using stable isotope mass spectrometry
- Other measures determined
 - Nitrogen excretion
 - Oxygen uptake / respiration



References: Baker and Hornbach 1997, 2001, 2008; Dame 1996; Engleman et al. 1985; Hornbach et al. 1991; Verardo et al. 1990

Address ES Info Gaps

- Clams incorporate N from their food (phytoplankton) into tissues and shell
- Clams also store C in shells and tissues, but also process CaCO_3 while they grow
- At harvest, accumulated N and C is removed from the water
- N and C extraction values determined and used in valuation



Clam Grade	Shell Width (inches)	Shell Length (inches)	Water Filtration (gal/day)	N Removed (grams)	C Stored (grams)
Littleneck	1.03	1.88	4.5	0.09	2.76
Button	0.92	1.67	3.5	0.07	1.97
Pasta	0.80	1.49	2.7	0.06	1.37

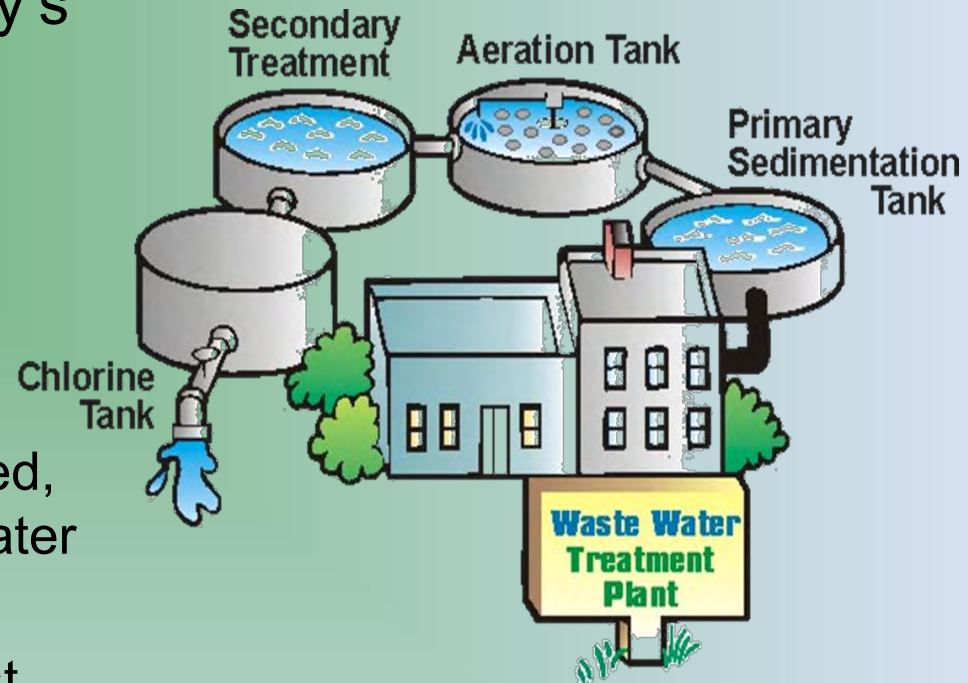
Valuation of ES provided by Clams



- ES provided automatically as a result of natural functions
 - “Free goods” that society does not have to pay for
 - Un-priced and at risk of being lost when ecosystems are lost or degraded
- Accepted methods used for estimating monetary value of ES
- Replacement cost method uses market information to obtain a conservative estimate of a feasible alternative
 - Quantity of ES is determined; then cost of providing service with human-made alternatives is estimated (e.g., wwt plant, planting new trees)

Valuation of ES provided by Clams

- Calculated costs that would be incurred to replace the industry's services with the next best alternative
- For N removal, values based on costs of wastewater treatment plants in Florida cities
 - Values per pound of N removed, ranged from \$3.44 for Clearwater to \$5.22 for Fort Myers
 - Based on land values and cost of living, factors that affect the cost of treatment plants



Valuation of ES provided by Clams

- For C storage, creation and maintenance of pine tree plantations used as a possible alternative to clam production
- Costs included pine production, as well as land value in an alternative use
- In counties with high urban, agricultural, or commercial land values, opportunity cost high
 - Highest values (\$119.01 per ton) for Collier County
 - Lowest values (\$0.71 per ton) in rural Franklin County



Disseminate Research Results



SEAWATER FILTERING

544 million gallons of seawater were filtered per day by the statewide production of 136 million clams*.



NITROGEN REMOVAL

25.4 thousand pounds of nitrogen were removed from the coastal waters.



CARBON STORAGE

760.6 thousand pounds of carbon were sequestered from the coastal environment.



ECONOMIC VALUE

Value of these benefits was estimated at \$99,680, which represents the public good value provided to Florida citizens at no cost.

- Florida hard clam aquaculture provides economic values for ecosystem services generated by the industry
- These values based on production results from 2012 FL Aquaculture Survey
- Infographics poster developed by UF IFAS Dept. Agricultural Education and Communication



Home > Environmental Benefits

Environmental Benefits

"Green" Clams: Estimating the Value of Environmental Benefits (Ecosystem Services) Generated by the Hard Clam Aquaculture Industry in Florida

[Introduction](#) | [Water Filtration](#) | [Nitrogen Removal](#) | [Carbon Storage](#) | [Value of Benefits](#) | [More info](#)

Shellfish (oysters, clams, mussels, etc.) provide a favorable environment for the coastal and estuarine waters in which they are grown. In turn, shellfish farming can provide local communities with a variety of ecosystem services, whose value can be quantified. The results of a University of Florida (UF) study conducted in 2015 demonstrate the unique sustainability of Florida hard clam aquaculture. Three environmentally-beneficial ecosystem services (water filtration, nitrogen removal and carbon storage) provided by clam farming were examined. Efforts focused on assembling values for ecosystem services specific to clam culture. Measurements, particularly for harvest-sized clams at water temperatures found in Florida, are not available through the literature. To address these information gaps, pertinent laboratory measures were determined. Read further for a description of these ecosystem services, their value estimates, and how they relate to Florida's "green" clam culture industry.

WHAT ARE ECOSYSTEM SERVICES?

The transformation of a set of natural resources supplied by ecosystems into beneficial goods and functions that humans value. An ecosystem is a complex system of plant, animal, fungal, and microorganism communities and their associated non-living environment interacting as an ecological unit.

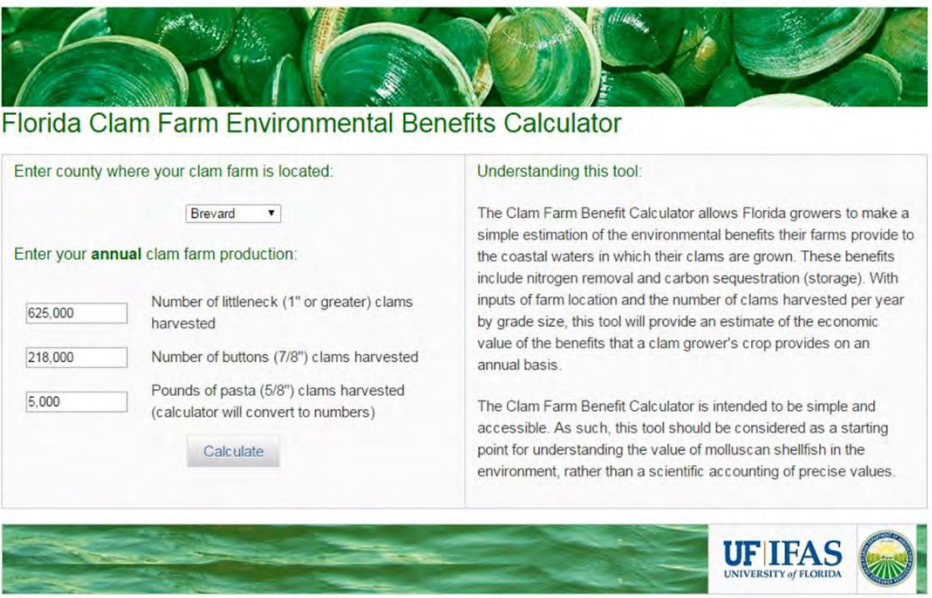
Disseminate Research Results

- All project results posted to new topic page on website, *Online Resource Guide for Florida Shellfish Aquaculture*

Go to <http://shellfish.ifas.ufl.edu/environmental-benefits>

Disseminate Research Results

- *Clam Farm Benefits Calculator* allows growers to inform buyers, consumers, and resource managers that shellfish aquaculture is a sustainable “green” industry
- With inputs of farm location and # clams harvested per year by grade size, the *Calculator* provides an estimate of the economic value of ES a grower’s crop provides on an annual basis



Florida Clam Farm Environmental Benefits Calculator

Enter county where your clam farm is located:
Brevard

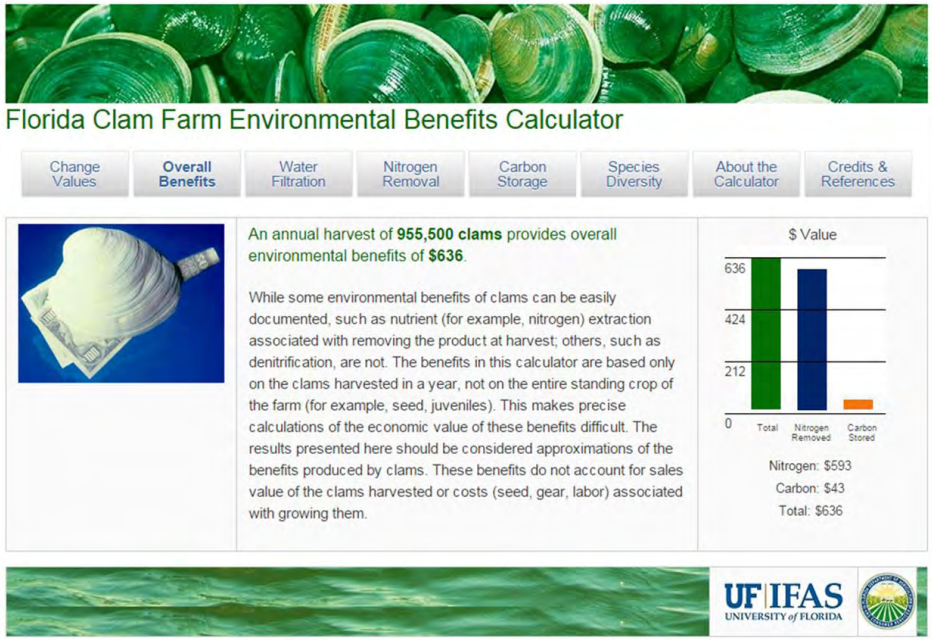
Enter your **annual** clam farm production:

625,000 Number of littleneck (1" or greater) clams harvested
218,000 Number of buttons (7/8") clams harvested
5,000 Pounds of pasta (5/8") clams harvested (calculator will convert to numbers)

Calculate

Understanding this tool:
The Clam Farm Benefit Calculator allows Florida growers to make a simple estimation of the environmental benefits their farms provide to the coastal waters in which their clams are grown. These benefits include nitrogen removal and carbon sequestration (storage). With inputs of farm location and the number of clams harvested per year by grade size, this tool will provide an estimate of the economic value of the benefits that a clam grower's crop provides on an annual basis.
The Clam Farm Benefit Calculator is intended to be simple and accessible. As such, this tool should be considered as a starting point for understanding the value of molluscan shellfish in the environment, rather than a scientific accounting of precise values.

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Florida Clam Farm Environmental Benefits Calculator

Change Values Overall Benefits Water Filtration Nitrogen Removal Carbon Storage Species Diversity About the Calculator Credits & References

An annual harvest of **955,500 clams** provides overall environmental benefits of **\$636**.

While some environmental benefits of clams can be easily documented, such as nutrient (for example, nitrogen) extraction associated with removing the product at harvest, others, such as denitrification, are not. The benefits in this calculator are based only on the clams harvested in a year, not on the entire standing crop of the farm (for example, seed, juveniles). This makes precise calculations of the economic value of these benefits difficult. The results presented here should be considered approximations of the benefits produced by clams. These benefits do not account for sales value of the clams harvested or costs (seed, gear, labor) associated with growing them.

\$ Value

Category	Value
Total	636
Nitrogen Removed	424
Carbon Stored	212

Nitrogen: \$593
Carbon: \$43
Total: \$636

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Florida Clams
Produced Naturally in Florida, USA

Home Our Clams Our Farmers Our Industry Try Some



Florida farm-raised clams are delicious and nutritious. Ask for them at your favorite seafood supplier!



About our Industry
Clam farming provides healthy food, clean jobs and economic revitalization to coastal communities throughout Florida. Read about our production and economic statistics.



Environmental Benefits
Environmentally friendly and sustainable, the clam industry provides ecosystem services and improves the quality of the coastal waters in which our crops are grown. Learn more.



About our Farms & Farmers
Clam farming supports small businesses in 11 Florida coastal counties. You can find out more about our clam growing areas and meet some of our clam farmers here.

Calendar of Events

CLAMmunications

Where to Buy



About our Clams
The commercial production of clams is highly regulated. Learn about the federal and state programs in place to ensure public health and safety and to preserve the environment.



Try Some!
For consumer information on how to buy, handle, store and prepare clams as well as cooking tips and easy recipes using our delicious and nutritious clams, click here.

Clam Farming 101:
From the Hatchery to your Plate

Hatchery **Nursery** **Growout** **Harvest**

Clam Farming *By the Numbers*

Disseminate Research Results

- *Florida Clams* website designed and produced to showcase the industry
- Working platform to promote cultured clams as environmentally friendly and benign

Go to

<http://www.flaclams.com>

ACKNOWLEDGEMENTS

- University of Florida graduate students
 - Angelo (Jason) Spadora, SFRC Fisheries & Aquatic Sciences
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- Motionbuzz Multimedia developed *Environmental Benefits* webpages
- Dacing Tree, Inc. developed web-based *Clam Farm Calculator* which was inspired by the National Tree Benefit Calculator
- Ada Lang developed the *Florida Clams* website
- Nitrogen and carbon cycles illustrated by Anna Hinkelday
- Clam filtration video created by UF IFAS Communications
- Funding
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