

Documentation For Eastern Oyster Nitrogen Mass Balance (Ninigret Pond)

A. Filtration of Particulate Nitrogen

Filtration rate is about 50 liters/day/individual oyster (Pietros and Rice, 2003)

1. As of 2017, the estimated oyster population of Ninigret Pond is **421,500** individual mature oysters.

Total existing and proposed aquaculture leases in Ninigret Pond (December 2014) is 50.4 acres

As of 2013, total Rhode Island Aquaculture leases was 176.55 acres

As of 2013, total oysters sold for consumption was 6,398,979

Therefore, matures oysters per acre= 36,245

(these data come from: 2013 Annual Status Report, CRMC Aquaculture in Rhode Island)

Mature oysters in Ninigret Pond= acreage in Ninigret Pond/total Salt Pond acreage (2012)= $20.1/87.1=23\%$ times 36,245 oysters/acre= 8,364 oysters/acre in Ninigret Pond (2012)

For 2015, add 30.3 acres to Ninigret Pond and to the total acreage under cultivation; 50.4 acres in Ninigret Pond and 206.9 acres under cultivation

Using the 2012 data from the CRMC Report (2013), we calculate (50.4 acres)(8,364 oysters/acre) **421,545 mature oysters in Ninigret Pond** projected for the year 2017.

2. As of 2017, oyster population of Ninigret Pond times filtration of particulate nitrogen= 50 liters/day/individual times 120 days per year times 421,545 individual oysters= **2.53×10^9 liters**. (120 days is 4 months, June-September, when growth of oysters is maximum at temperatures greater than 20 degrees C)

3. Particulate Nitrogen in Water Column of the Western Basin of Ninigret Pond is 460 ± 43 ug/L. (SPC Water Quality Monitoring Database: www.saltpondscoalition.org)

4. Average Mass of Particulate Nitrogen Filtered by 421,545 Oysters in Ninigret Pond is: $(460 \text{ ug/L})(3.59 \times 10^9 \text{ Liters})= 1,646 \text{ kg Particulate N} \times 0.9= \mathbf{1,481 \text{ Kg N}}$ (3.59×10^9 Liters is the volume of water in the Western Basin of Ninigret Pond)

B. Ammonium Excretion by *Crassostrea virginica*

1. From Table 1 in Ray (2014), the average of four studies gives a rate of **39 μM NH_4^+ /gm DW/day**. (assume 1 gm dry tissue weight of oyster)

2. As of 2012, there were 8,364 oysters in Ninigret Pond. As of 2017, there would be **421,545** oysters in Ninigret Pond (if we use CRMC Annual Status Report of Aquaculture) or **1,423,000** in the Pond (if we use Roberts seed oyster planting figure, CRMC File Number 2014-10-119, and assume 32% survival from seed to mature oysters (Art Ganz, personal communication and Murray and Hudson (2010))

3. Maximum feeding activity of *Crassostrea virginica* that consume particulate nitrogen (organic particulate matter, phytoplankton) occurs at water temperatures of between 20 and 28 degrees C. (Newell and Mann, 2012)

For the western basin of Ninigret Pond, these temperatures occur in the months of June-July-August-September (SPC Monitoring Database). That is, 120 days assuming 30 days per month.

4. The estimated mass of NH_4^+ excreted by mature oysters in Ninigret Pond is:
(39 μM NH_4^+ /1 gm DW/day)(14 $\mu\text{g}/\mu\text{M}$)(120 days)(421,545) = **27.6 Kg N/yr**,
and (39 μM NH_4^+ /1 gm DW/day)(14 $\mu\text{g}/\mu\text{M}$)(120 days)(1,423,000) = **93.2 Kg N/yr**
The average of these two estimates is **60.4 Kg N/yr**.

C. Nitrogen Removed from Ninigret Pond by Annual Harvest of Oyster Aquaculture Leases

1. Nitrogen removed by a single mature oyster is **0.77 gm N/yr** (this figure from Dr. Dale Leavitt, Roger Williams University)

2. Estimated nitrogen removal by oyster aquaculture in Ninigret Pond, projected to 2017.

Low estimate: (421,545 oysters)(0.77 gm N/yr) = **324.6 Kg N/yr**

High estimate: (1,423,000 oysters)(0.77 gm N/yr) = **1,095.8 Kg N/yr**

Average = 710 Kg N/yr

D. Annual (2017) Deposition of Biodeposits Nitrogen (Feces and Pseudofeces) by Ninigret Pond Oyster Aquaculture

1. Using biodeposition data from Haven and Morales-Alamo (1966):

April, 12 days- 0.98 gm/animal/week

June, 25 days- 1.32 gm/animal/week

August, 14 days- 1.56 gm/animal/week

Average; = 1.29 \pm 0.29 gm/animal/week

Estimated biodeposition for April to September, 26 weeks

2. Low estimate, mass deposition of biodeposits: (1.29 gm/animal/week)(26 weeks)(421,545 animals) = 14.14×10^6 gm/yr

High estimate, mass deposition of biodeposits: 11.29 gm/animal/week)(26 weeks)(1,423,000 animals)= 47.73×10^6 gm/yr

3. Using nitrogen content of biodeposits from Table 1 in Newell et al. (2005), 4.8 ± 0.44 mg N/gm,

Then low estimate of Nitrogen deposition for 2017 biodeposits in Ninigret Pond:
(14.14×10^6 gm/yr biodeposits)(4.8 mg N/gm)= **67.9 Kg N/yr**

And, high estimate of Nitrogen deposition for 2017 biodeposits in Ninigret Pond:
(47.73×10^6 gm/yr biodeposits)(4.8 mg N/gm)= **229 Kg N/yr**

Average= 149 Kg N/yr

E. Regeneration of Nitrogen (Ammonium) from Oyster Biodeposits in Ninigret Pond

1. Difference in NH_4^+ regenerated flux from sediment with biodeposits versus sediments without biodeposits= 2.782×10^6 $\mu\text{g}/\text{m}^2/\text{yr}$ (data from R. R. Holyoke, 2008)

2. 50.4 acres of oyster beds in Ninigret Pond (2017)= 203,969 m^2

3. Benthic flux of NH_4^+ from oyster biodeposits in Ninigret Pond: (2.782×10^6 $\mu\text{g}/\text{m}^2/\text{yr}$)(203,969 m^2)= **567 Kg N/yr**

References

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