MEMORANDUM

TO:	Coalition partners and stakeholders
FROM:	Henry Sharpe, FBU President
DATE:	February 3, 2022
SUBJ:	wastewater discharge modeling

As discussed briefly in our information meeting last week and reported in this week's *Ellsworth American*, Frenchman Bay United commissioned Dr. Chris Kincaid, a highly regarded physical oceanographer from the Graduate School of Oceanography at URI, to create detailed modeling of how the discharge from the proposed American Aquafarms' project would affect Frenchman Bay.

I am pleased to provide you with more detailed information about Dr. Kincaid's work and how it tells a very different story from what American Aquafarms has presented to the Maine Department of Environmental Protection (DEP) in its discharge applications now under review. Please feel free to share this information with your members and others who share our commitment to stopping this project.

Key points about the model

1. Our model is based on the Regional Ocean Modeling System (ROMS), a widely accepted and proven platform for modeling coastal currents and chemical discharge plumes in tidal estuaries. Our principal investigator Dr. Kincaid has done similar work over many years for the Rhode Island Department of Environmental Protection and for the Narragansett Bay Commission. Our current ROMS model is derived from from Dr. Kincaid's work as the current modeler in a multi-institutional NOAA research project to study the impact of climate change on ocean currents along the Northeast continental shelf.

2. Nutrient transport models using simulated "float releases" show **that 90-95% of the waste discharged from the pens and barges will be retained in the bay, that it does not flush, and that previously discharged waste recirculates back to the lease sites to concentrate** (see slide 1 below). This waste is transported throughout the upper bay, therefore demonstrating adverse impact to the entire region. And finally, this waste will transport to shallow embayments (recesses along the coastline) where it will become bioavailable and likely to cause algal blooms that produce eutrophication (see video simulations below).

3. "Dye plume" simulations that model diffusion and mixing show that in just 30 days – let alone the 20-year term of the proposed lease – **large areas of the bay** (approximately a mile wide by two miles long) around each lease site (see yellow areas in slide 2) **would exceed the DEP's nitrogen concentration limits**, known as "20% of the remaining assimilative capacity", for areas without eelgrass. Still larger areas (greenish areas in slide 2) will exceed similar limits established for areas with eelgrass populations. Both of these areas include populations of eelgrass according to the DMR eelgrass maps (see green diamonds in slide 2). Within both these areas, periodic daily peak concentrations are shown to exceed the threshold limits by 2-3 times (see slide 3).

4. The DEP applications indicate that American Aquafarms expects to use feed very efficiently, in the top percentile of the industry's performance (slide 2a). We feel **it would be prudent to consider feed usage that instead reflects the industry average feed consumption. If so, our analysis suggests that 39% more nitrogen would be introduced to the bay**. Our dye plume models predict these discharge levels would create correspondingly larger areas that exceed the threshold limits, with correspondingly higher concentrations of nitrogen in each of those areas (slide 2b).

5. So far, after approximately one month of simulation, the trends over time for retention of waste shown by the "float release" models, and the increasing nitrogen concentrations indicated by the "dye plume" models, **show no sign of abating or establishing equilibrium: water quality continues to decrease.**

6. The "Permitted Loads" calculated in the applications depend on a requirement that is not satisfied in this situation: clean water at the baseline nitrogen concentration that continually flushes waste from the discharge sites. Since waste is instead shown to recirculate to the discharge sites, thereby degrading water quality over time, the calculation methods used by American Aquafarms are inappropriately applied. They produce a Permitted Load that overstates the assimilative capacity of the bay, and understates the adverse impact of the proposed discharges. Our simulations of the Permitted Load proposed by American Aquafarms show that **within 30 days, nitrogen concentrations in most of the inner bay would use 100% of the bay's assimilative capacity** (black line in slide 4)**. This would be likely to trigger widespread algal blooms, eutrophication, and make all future discharges (say from the Bar Harbor Waste Treatment plan) prohibitively expensive or impossible.** The simulation suggests therefore that the proposed Permitted Loads would produce results that, by any standard, are not credible, and would not be permitted.

7. Our models are conservative because, like the applications, they assume discharge waste concentrations will be constant. However, **the models indicate that because currents carry previously discharged waste back to the intakes at the pen and barge discharge sites, discharged waste must concentrate over time.** If this compounding growth in discharge concentrations were included in the model, the model would more accurately reflect reality, and the predicted results would be significantly worse. Our modeling efforts will evaluate the impact of these compounding discharges in future iterations.

Video simulations

We have produced videos showing the trajectory of floats released from both pens over ten day-time frames. The videos complement slide 1 and demonstrate:

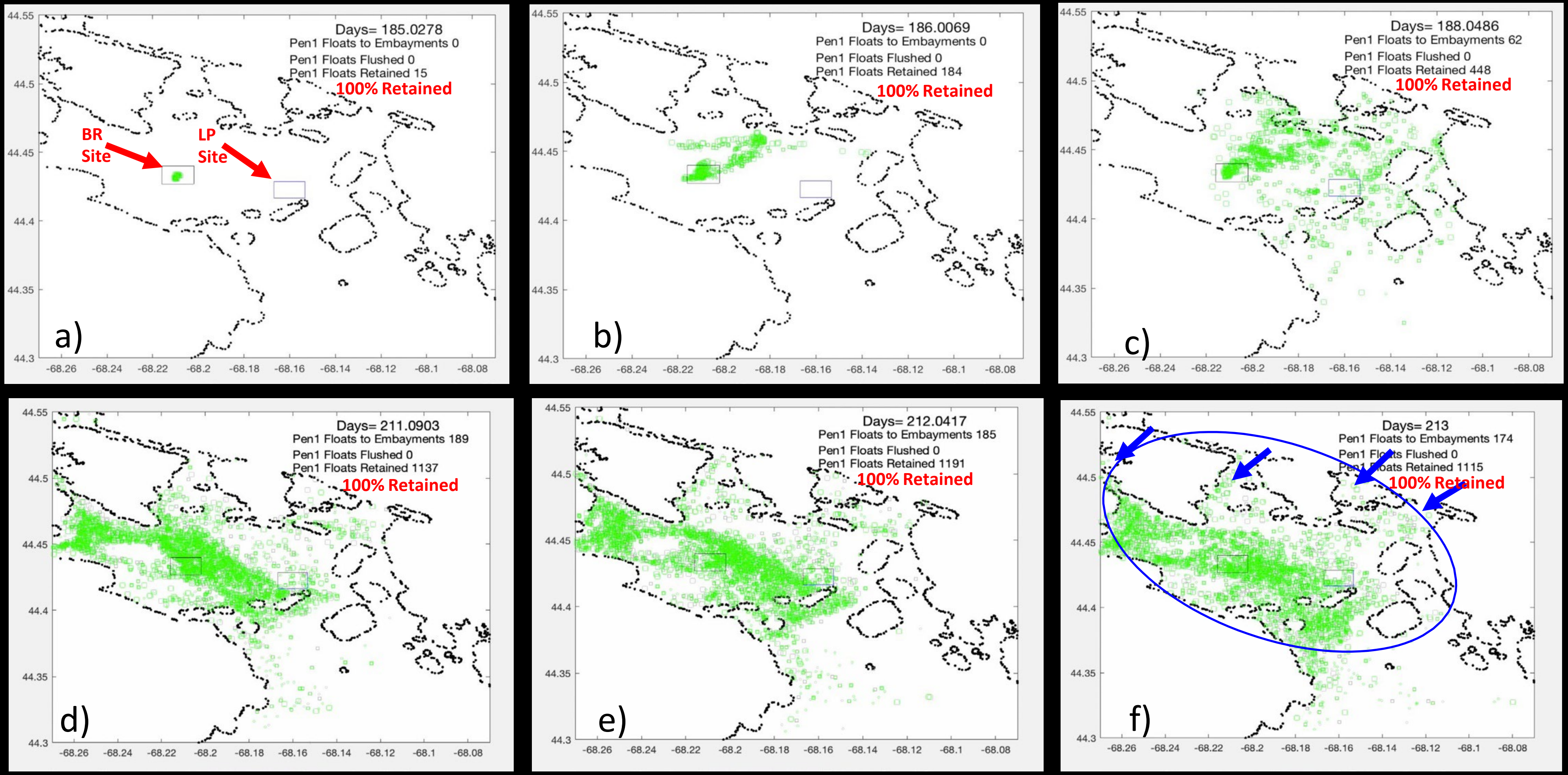
- Eddies and gyres are clearly resolved by the model
- Jets appear between islands and also transporting discharges into the norther rivers
- Currents recirculate back to both sources, therefore concentrating waste
- Discharge sites have combined impact on each other

Here are the links:

Video of Long Porcupine 10-day float release, days 203-213
Video of Bald Rock 10-day float release, days 203-213

1) UNDERSTANDING NUTRIENT TRANSPORT

FLOAT RELEASES from BALD ROCK SITE – Day 3 to Day 30 – Studies for the LP site produce similar results



- 90+% of float releases are retained in the upper bay and do not flush.
- Waste is transported throughout the bay, demonstrating regional impact.
- Waste is transported into shallow embayment nursery regions where nitrogen is likely to become bioavailable.
- Waste is seen to recirculate back to the original discharge sites in gyres and eddies where it will concentrate as new waste is added.
- Waste recirculates between lease sites: there is combined impact between the sites.
- No equilibrium is seen to develop with these trends over multiple float releases.

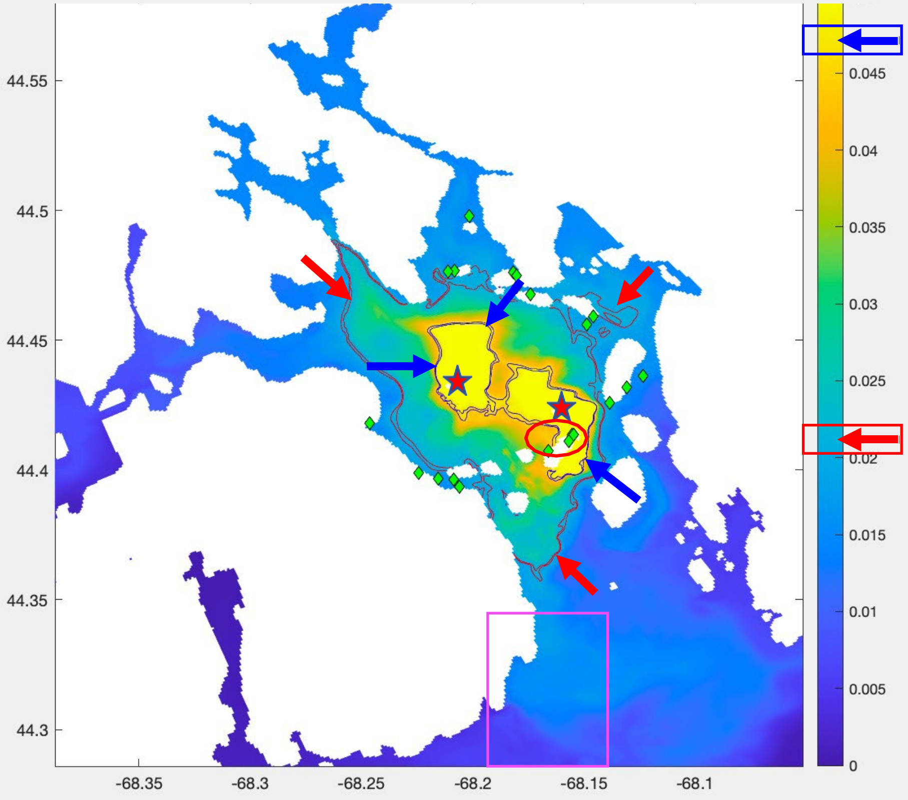
2. NITROGEN CONCENTRATION & USE of REMAINING ASSIMILATIVE CAPACITY RELATIVE TO BASELINE AT SITES

Dye Plume model evaluating spatial and temporal distribution of nitrogen concentrations and comparing impact of Feed Conversion Ratio 0.9 vs 1.25: DAY 33

Added nitrogen concentrations from salmon farm (mg/L)

Feed Conversion Ratio, FCR =0.9

As shown in the application, almost the highest feed efficiency in the industry

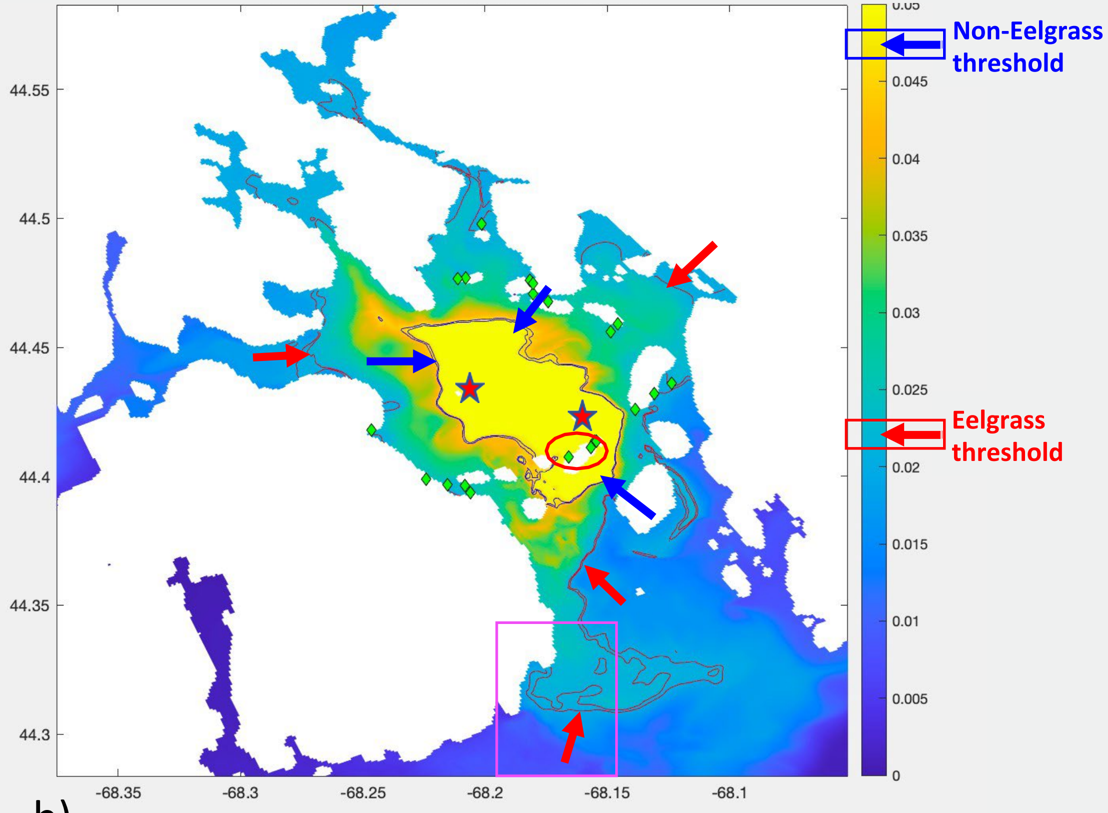


a)

Added nitrogen concentrations from salmon farm (mg/L)

Feed Conversion Ratio, FCR = 1.25

The industry average feed efficiency –> 39% more nitrogen

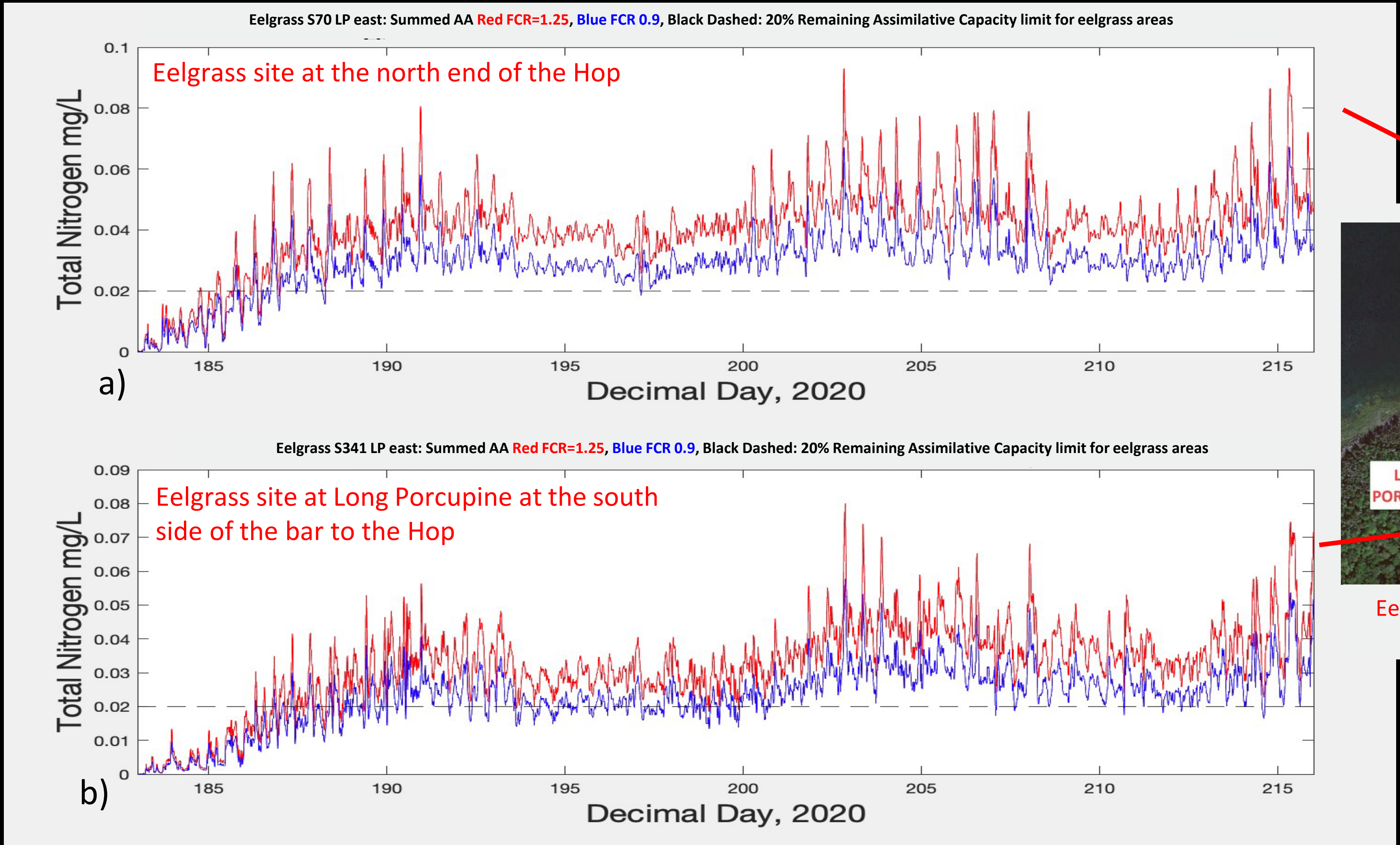


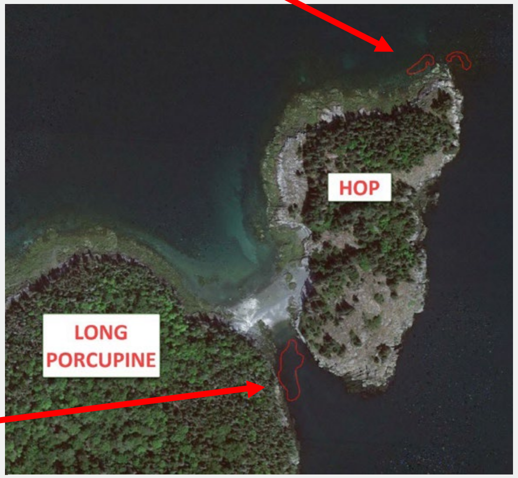
b)

- Red Stars show the two lease sites. Red oval shows locations discussed in the next slide.
- **Green Diamonds are some of the areas where DMR GIS maps show eel grass populations.**
- **Red line delineates regions where the nitrogen concentration = 0.021mg/L, or 20% of the remaining assimilative capacity threshold for eel-grass areas.**
- **Blue line delineates regions where the nitrogen concentration = 0.047mg/L, or 20% of the remaining assimilative capacity threshold for non-eel-grass areas.**
- Yellow color is TN of 0.05 mg/L (*or greater*) added to the bay by the AA discharges. This concentration exceeds both thresholds for remaining assimilative capacity.
- **Pink Boxes show regions of Class SA water where water quality is reduced.**

3. NITROGEN CONCENTRATION vs TIME for nearby eelgrass sites at the Hop and on Long Porcupine Island

Minimum concentrations are at the 0.021 mg/L threshold for 20% of the remaining assimilative capacity in areas with eelgrass – Peaks are 2-3x regulated threshold





Eelgrass populations as shown on DMR GIS Eelgrass map

Black-dashed line: 20% of remaining assimilative capacity level = 0.021 mg/L for waters near eel grass sites.
Red line: TN estimated at sites from combined AA pen and barge inputs assuming Feed Conversion Ratio, FCR = 1.25 = Industry average & likely case.
Blue line: TN estimated at sites from combined AA pen and barge inputs assuming Feed Conversion Ratio, FCR = 0.90 = Value from AA application & best possible case.

4. "PERMITTED LOAD" based on the applications' Far Field Dilution Calculations: Day 33

Use of this calculation methodology requires conditions that are not satisfied. This image shows the impact of discharges at the inappropriate, so-called "Permitted Load"

The American Aquafarms calculates a "PERMITTED LOAD" for nitrogen discharges based on the assumption that waste discharges are always washed away with clean water at the background nitrogen concentration level.

This condition is only true for discharges into non-tidal rivers, for example at a pulp mill on a river. Our models show this condition is not met in this tidal estuary where waste recirculates back to the discharge sites and continually concentrates.

Further, our model provides much more spatial and temporal detail of nitrogen concentrations, one informed by the diffusion physics, with a time-tested and proven method that deliver much more quantitative, high-resolution results than the simple rule-of-thumb estimates delivered by the far field dilution methods used in the application.

Use of this so-called and inappropriately calculated "PERMITTED LOAD" overstates the bay's assimilative capacity and understates the impact of discharges from the proposed salmon farm.

The image on the right demonstrates the projected impact of a waste discharge at the so-called "PERMITTED LOAD" by Day 33:

- **The entire bay exceeds the nitrogen concentration threshold for areas without eelgrass (Blue arrows and blue contour).**
- **A larger area (Red arrows and contour) exceeds the threshold concentration for areas with eelgrass.**
- **Approximately 80% of the inner bay would use 100% of the remaining assimilative capacity (Black line), a far greater nutrient load than the 20% usage the "Permitted Load" is supposed to deliver.**

AA Leases showing discharge at lower total 'Permitted Load':
LP pen=0.8145 mg/L, BR pen = 0.5170 mg/L.
Both barges at the lower BR concentration = 5698 mg/L

Spatial distribution of Predicted Nitrogen concentration (mg/L) following discharges from farm at so-called "Permitted Load" concentrations, Day 33