**2023 Semiahmoo – Drayton West & Lummi Bay**
**Clam Survey Report**

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**Executive Summary**

Lummi Natural Resources conducted a stock assessment survey of harvestable Manila clams on tidelands within Lummi Nations Usual and Accustom area (U & A) in the summer of 2023. The results from this survey provide critical data for the management of the commercial Manila clam fishery and provide the basis for setting harvest quotas. Lummi Natural Resources surveys three beaches; two on-reservation: Lummi Bay and Portage Bay, and one off-reservation beach, Semiahmoo or Drayton Harbor. Beaches are surveyed on a bi-annual basis. This year Semiahmoo and Lummi Bay were surveyed.

Sustainable harvest recommendations for the 2023 – 2024 clam fishery season are covered in a separate technical document (SharePoint > Natural Resources > Public > ___Harvest Management > Tech Reports > Harvest).

*Semiahmoo*

The mean biomass estimate of harvestable Manila clams for Semiahmoo is 70,826 lb. This is a significant reduction compared with the mean biomass estimates between 2016 – 2020 which ranged between 221,046 lbs – 174,371 lbs respectively. The total survey area, 34.3 acres, was comparable with previous surveys, however the average clam density was roughly a magnitude lower than previous year's densities, 0.047 lbs/$ft^2$.

*Lummi Bay*

The mean biomass estimate of harvestable Manila clams for Lummi Bay is 2,005,825 lbs. A total of 1,210.7 acres was surveyed within Lummi Bay across all three management areas (20A-S1B, 20A-S1C, 20A-S1D&E), which is comparable to the survey area covered in previous years. The average clam density ranged between 0.033 – 0.048 lbs/$ft^2$ for the different management areas is an increase in average clam density from previous years.

## Survey Objectives

The purpose of the 2023 Manila clam survey was to provide critical data for the management of the commercial Manila clam fishery. This work estimates the harvestable biomass of Manila clams on beaches within Lummi Nations Usual and Accustom area (U & A). Semiahmoo or Drayton Harbor and Lummi Bay were surveyed between May – August 2023.

## Methods

### Field Protocol

Beaches were surveyed following the Lummi Survey Protocol (Dolphin 2013), a modification of the standard Washington State adopted protocol (Campbell 1996), consistent with past survey methods. Surveys were carried out using a systematic random design with a series of parallel transects to determine the legal pounds per square foot of Manila clams. The sample clam densities are spatially weighted and the weighted average for each management area is then multiplied by the total surveyed area to estimate the total biomass of legal-size Manila clams

Table 1. Beach specific survey design

| Survey Area | Steps between Transect Lines | Steps between Quadrats | Quadrat Area |
|---|---|---|---|
| Lummi Bay – S1C, S1D&E | 200 | 60 | 9 $ft^2$ |
| Lummi Bay – S1B | 100 | 60 | 9 $ft^2$ |
| Semiahmoo – Drayton West 001 | 45 | 10 | 5 $ft^2$ |

The 2023 Semiahmoo clam survey was conducted between May 7th – 9th, 2023 during low tides. The Lummi Bay clam survey took place between June 6th – August 1st, 2023 during low tides. The surveys took a total of 16 days to complete (Semiahmoo = 3 days, Lummi Bay – 13 days). The surveys covered a total of 34.3 acres at Semiahmoo and 1210.7 acres at Lummi Bay.

For full method description, see Hintz 2018.

### Data Processing

In contrast to previous years, Semiahmoo survey data including GPS coordinates, quadrat size, and individual shell widths were entered into an excel spread sheet. Previously the data was entered into a custom-built Microsoft Access database. This data base has been retired and the new database was under construction during the Semiahmoo data input period. The Lummi Bay survey data was entered into the new LNR WebApp Clam Database built by Craig Dolphin.

Beach-specific shell-width-weight relationships for Manila clams were used to estimate individual clam weights based on the shell-width data that is collected in the field (unpublished data, Dolphin 2005).

The legal size threshold shell width (equivalent to a shell length of 38mm) was estimated to be 20mm for Semiahmoo, while the more globular/walnut-shaped clams at Lummi Bay had a threshold shell width of 21mm. All threshold weights are counted as half.

For full method description, see Hintz 2018.

**Data Analysis**

Clam density can vary between and within management areas. Therefore, Thiessen or Voronoi polygons (Dolphin, 2004a) are used to analyze the survey data to remove potential spatial bias using ArcGIS 10 (ESRI), with ArcMap, ArcCatalog, and ArcToolbox. All spatial analysis is performed on each bay and management area independently (i.e. Lummi Bay 20A – S1B, S1C, S1D&E, and Semiahmoo).

Calculate total biomass and accuracy

From the Thiessen polygon output data we calculate: the total area surveyed, the spatially weighted average clam density, precision of the density estimate, total clam biomass estimate for the management area, and 95% confidence intervals for the biomass estimate. The estimations of error around the spatially weighted mean need to be calculated based on a weighted variance. All of these calculations were performed in R programming, software for statistical computing. The Hmisc package was used to calculate the weighted mean and variance.

These calculated values are used to estimate the total biomass of harvestable clams for each beach management area. The spatially weighted mean clam density ($lb/ft^2$) is multiplied by the total area surveyed to determine the mean biomass estimate. To calculate the lower and upper biomass estimate the weighted mean clam +/- 95% Confidence Interval is then multiplied by the total area.

**Results:**

*Semiahmoo*

The average density of clams for Semiahmoo was ~0.047 $lb/ft^2$, an order of magnitude lower than previous average densities (Table 2) and varied throughout the clam band (Figure 2). A total of 246 sample locations were surveyed during the 2023 clam survey covering a total of 34.3 which was comparable to previous survey years. The mean estimated harvestable biomass of Manila clams within Semiahmoo was 70,826 lbs (Table 3).

**Table 2.** Summary of Semiahmoo clam survey results from 2023, 2020, 2018, 2016, and 2015.

| Year | 2023 | 2020 | 2018 | 2016 | 2015 |
|---|---|---|---|---|---|
| Area | 34.28 | 36.94 | 33.06 | 36.80 | **18.25** |
| Density | **0.0474** | 0.1084 | 0.1412 | 0.1379 | 0.1660 |
| Estimated average biomass | **70,826** | 174,371 | 203,266 | 221,047 | 131,956 |

**Table 3.** Summary of the estimated Manila Clam biomass determined from the 2023 clam survey for Semiahmoo (20A - 001).

| Management area | Acres surveyed | Quadrat area ($ft^2$) | # Of Voronoi polygons | Average clam density $lb/ft^2$ | Statistical precision (%) | Lower Biomass Estimate | **Mean Biomass Estimate** | Upper Biomass Estimate |
|---|---|---|---|---|---|---|---|---|
| 20A-001 | 34.28 | 5 | 246 | 0.0474 | 19.94 | 56,705 | **70,826** | 84,948 |

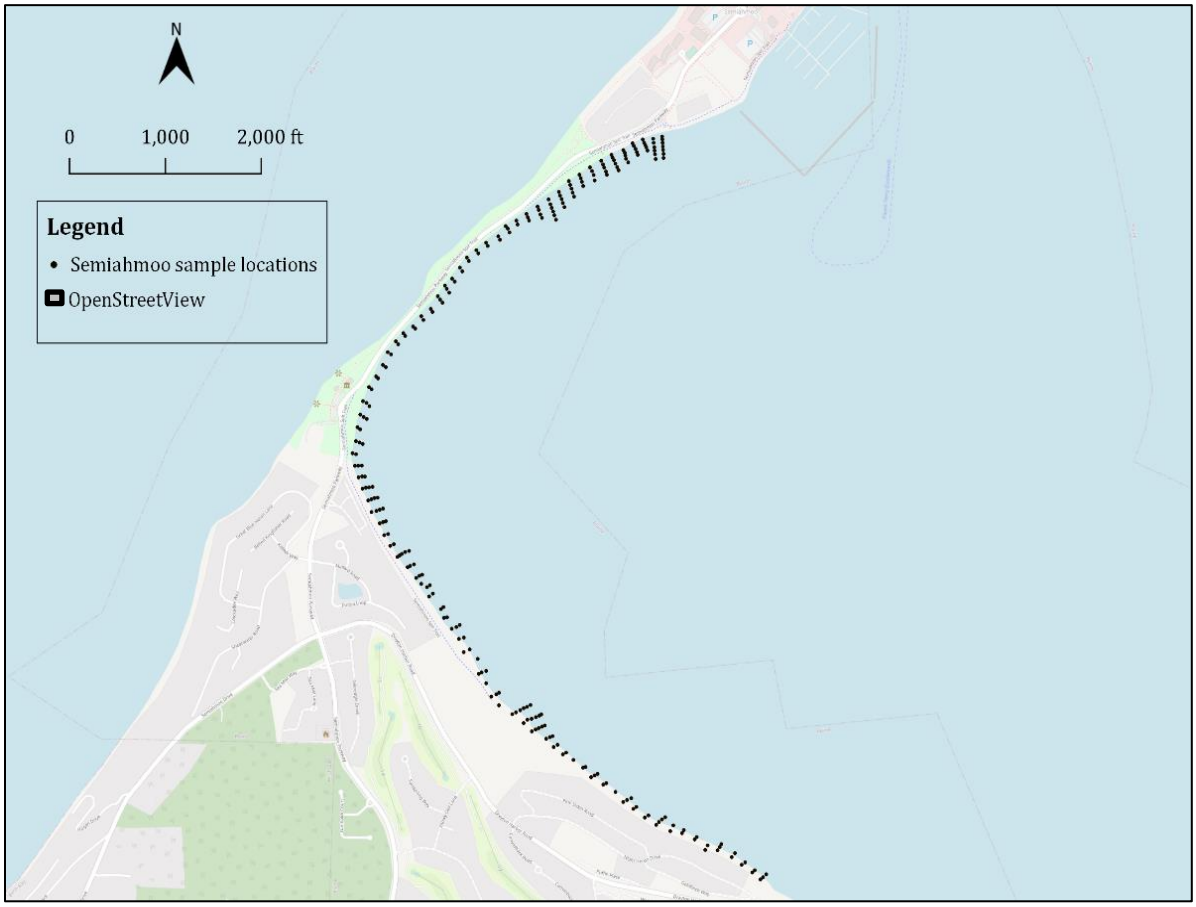


**Figure 1.** Survey sample locations (246 points) for the 2023 Semiahmoo clam survey

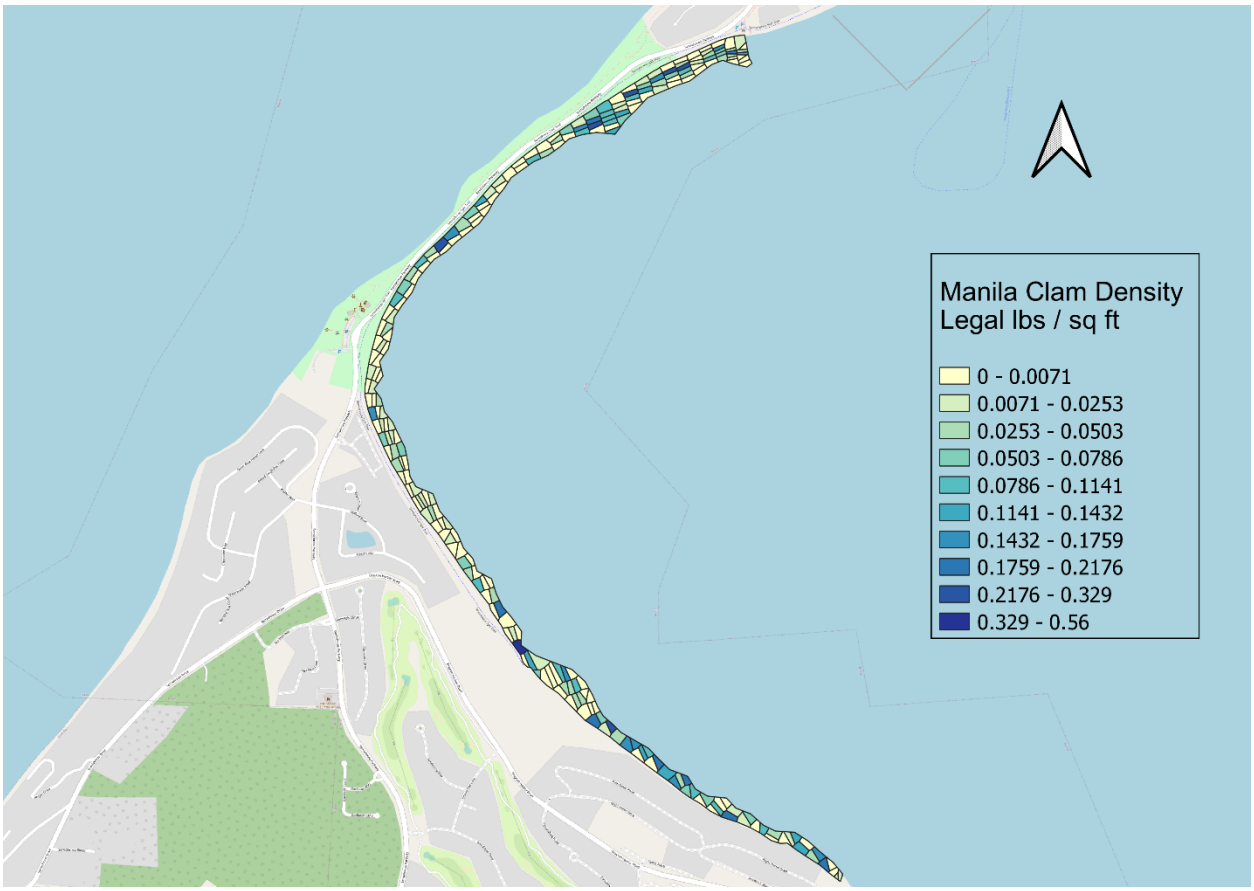


**Figure 2.** Legal Manila clams densities within Semiahmoo based on the 2023 clam survey represented within Thiessen polygons.

*Lummi Bay*

The average clam density at beaches within Lummi Bay ranged between 0.033 – 0.048 and vary spatially within the clam band (Table 4; Figure 3 – 5). A total of 958 sample locations were surveyed during the 2023 Lummi Bay clam survey covering 1210.7 acres of beach. This area was comparable to previous surveys years. The total survey area includes a portion of Lummi Bay which is closed to harvest. The biomass estimate was calculated for the total harvestable area, which was 1101.11 acres. The total harvestable biomass of Manila clams within the three management areas of Lummi Bay was 2,005,825 lbs (Table 2).

**Table 4.** Summary of the estimated Manila Clam biomass determined from the 2023 clam survey for Lummi Bay (20A – S1B, S1C, S1D&E). The figures below represent data collected within the harvestable area within Lummi Bay.

| Management area | Acres surveyed | Quadrat area ($ft^2$) | # Of Voronoi polygons | Average clam density $lb/ft^2$ | Statistical precision (%) | Lower Biomass Estimate | **Mean Biomass Estimate** | Upper Biomass Estimate |
|---|---|---|---|---|---|---|---|---|
| 20A-S1B | 222.21 | 9 | 254 | 0.048 | 16.29 | 385,774.63 | **460,837.10** | 535,899.56 |
| 20A-S1C | 226.32 | 9 | 223 | 0.033 | 27.28 | 234,894.36 | **323,008.88** | 411,123.40 |
| 20A-S1D&E | 652.58 | 9 | 446 | 0.043 | 13.97 | 1,051,325.56 | **1,221,978.70** | 1,392,631.84 |

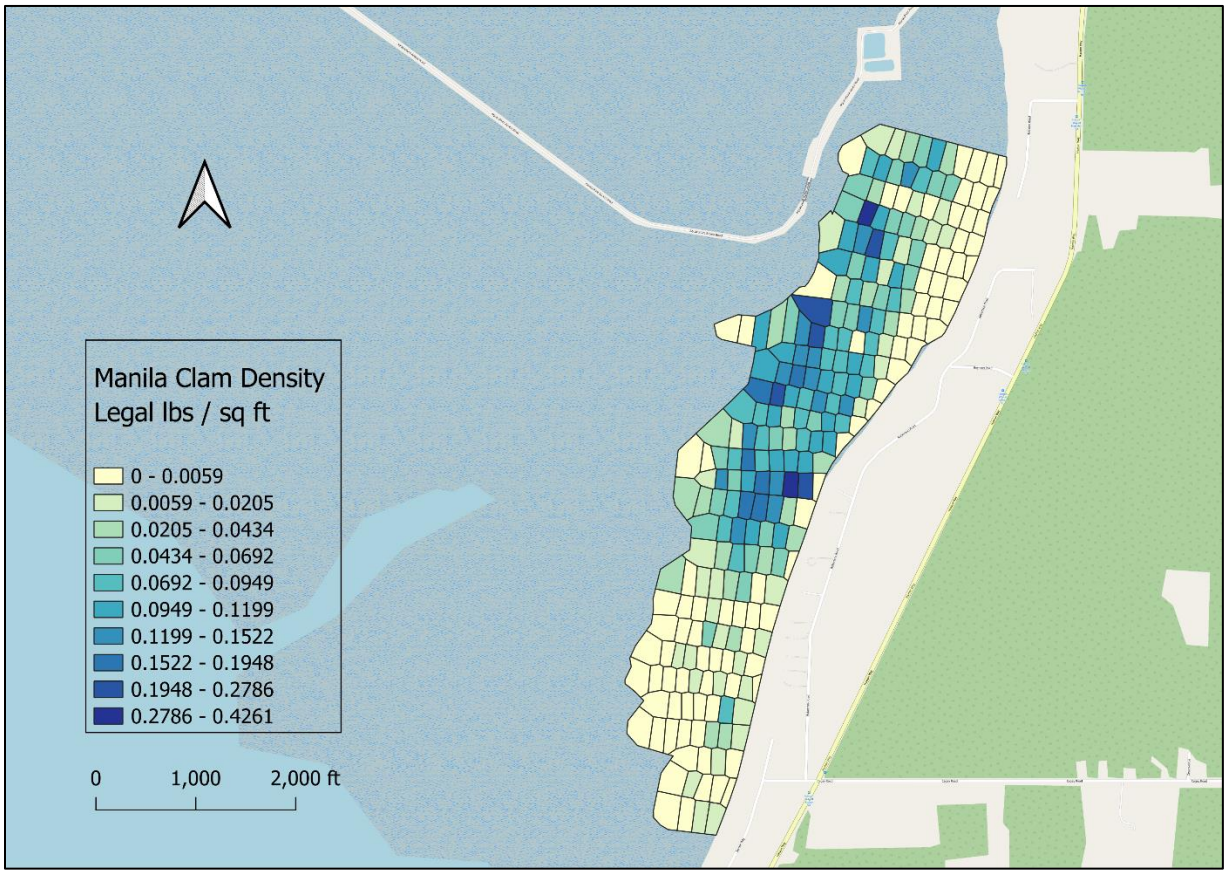


**Figure 3.** Legal Manila clam densities within Lummi Bay, 20A – S1B based on the 2023 clam survey represented within Thiessen polygons.

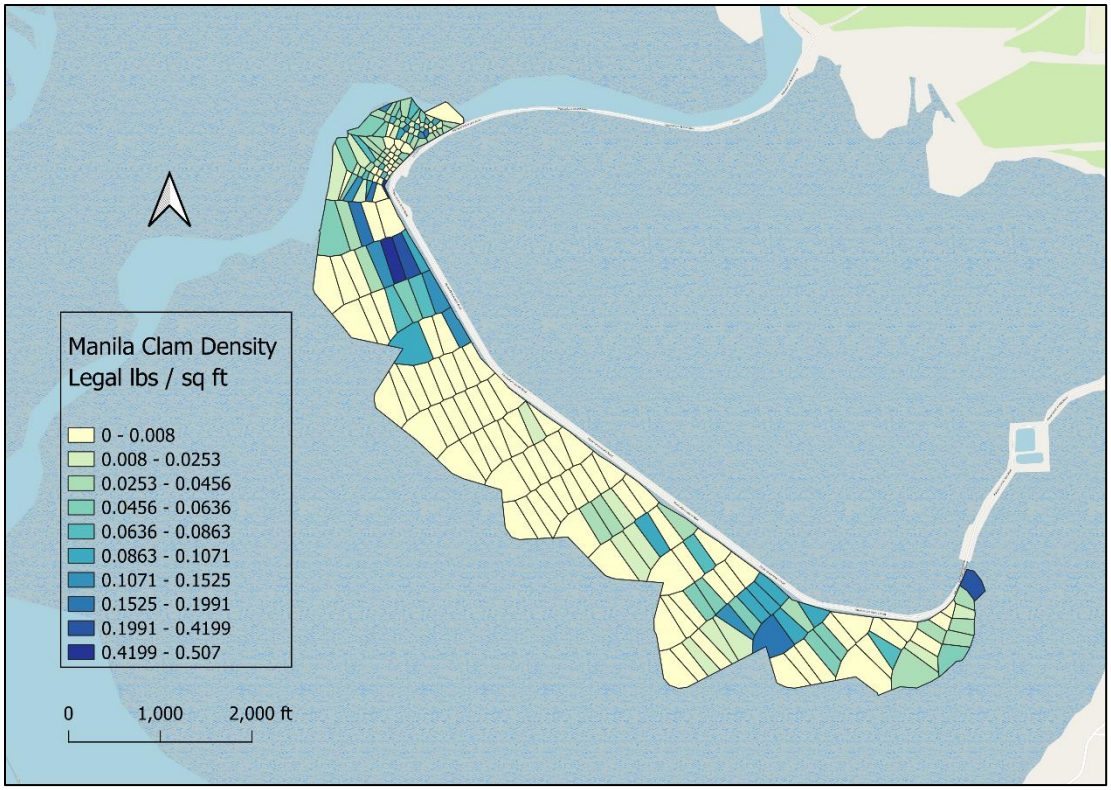


**Figure 4.** Legal Manila clam densities within Lummi Bay, 20A – S1C based on the 2023 clam survey represented within Thiessen polygons.

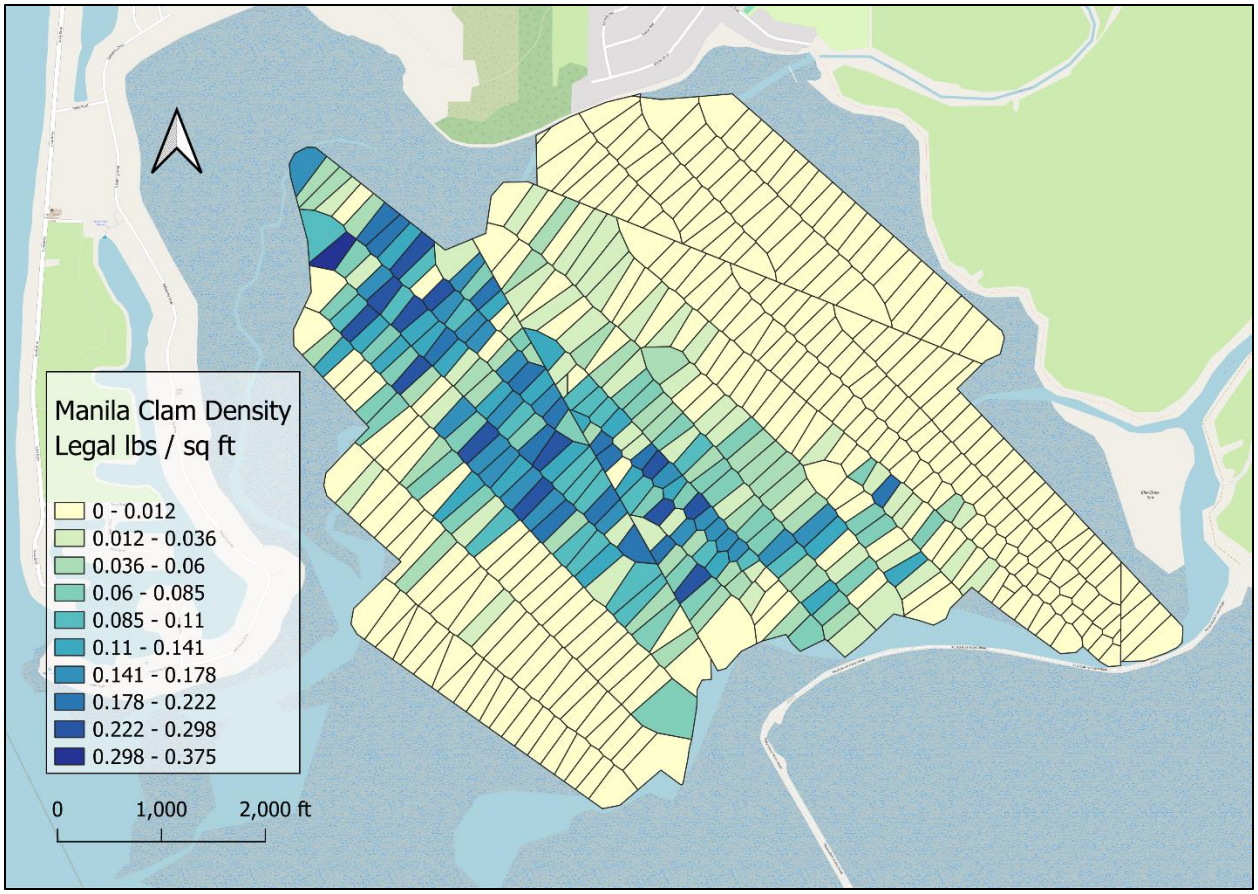


**Figure 5.** Legal Manila clam densities within Lummi Bay, 20A – S1D&E based on the 2023 clam survey represented within Thiessen polygons.

## References

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