MAPPING OF WHATCOM COUNTY MARINE RESOURCES COMMITTEE CLAM SURVEY RESULTS

Prepared For:
Whatcom County Marine Resources Committee

Prepared By:
Harvest Management Division
Lummi Natural Resources Department

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Introduction

From 2004 to 2006, the Whatcom County Marine Resources Committee conducted clam surveys in nine general areas in Whatcom County (Figure 1), primarily using volunteer survey crews.

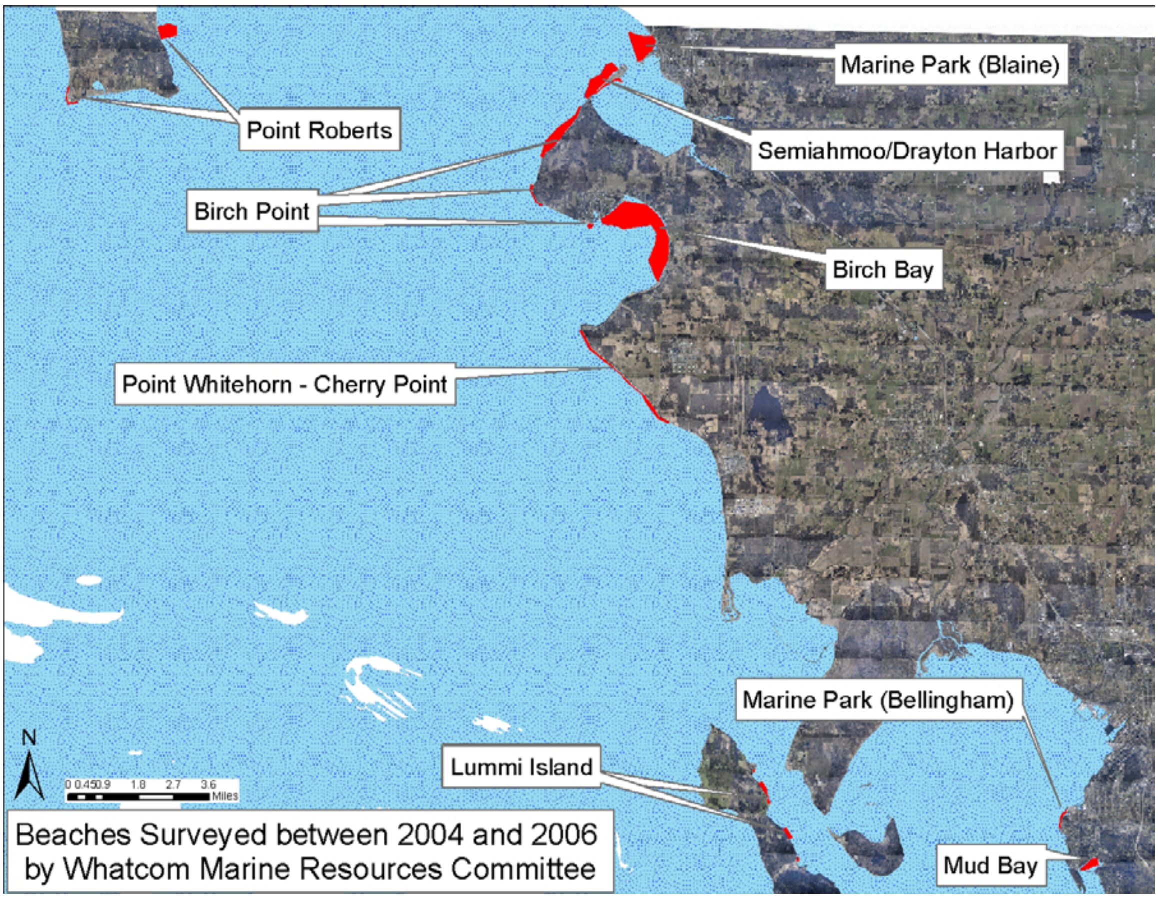

Figure 1. Beaches surveyed by Whatcom County Marine Resources Committee.

In general, survey design followed similar principles to that used by Washington Department of Fish and Game clam survey protocols: that is, sampling locations were arranged into 'transects' that typically were oriented perpendicular to the shoreline, and 'quadrats' that were evenly spaced along the transect lines. At each sampling location, a circular hoop with an area of 1 ft^2 was used as a template and the ground inside was excavated to a depth of 1 foot. The spoil from the hole was placed on a plastic sheet and any clams found were identified and counted. (Holes were not excavated if located in standing water.)

In addition to counting clams, volunteers also subjectively characterized the substrate at each sampling location.

The field methodology used by these crews allowed for spatial analysis of the results because each sampling location (quadrat) was spatially-located using hand-held GPS units, or else the spatial location for each hole could be estimated using the GPS-located transect end points in combination with knowledge about distance between holes along the transect.

This report presents the results of the spatial analysis of the clam survey results in map form, and also provides some comments/recommendations on the survey field methodology used in the surveys.

Spatial Analysis Methodology

Clam survey data was provided in a Microsoft Excel spreadsheet format for each of the nine ‘beaches’ surveyed. Several quadrats on some beaches were missing spatial location information and in these cases, linear interpolation or extrapolation was used to estimate the spatial location for the quadrats.

Because some quadrats were not excavated, but did have substrate information, two different datasets were created for each beach:

- The first dataset (clam results) contained only those quadrats that were actually excavated or else could confidently be assumed to contain no clams (for example, if the quadrat was located on bedrock then zero clams were assumed to be present).
- The second dataset (substrate results) contained all quadrats where substrate information had been recorded, regardless of whether clam information was available.

Both of these datasets were then exported into dbase format.

ESRI ArcMap 9.1 GIS software was used to import the dbase files for each dataset, then display the results as an Events layer. These events layers were then exported as point shapefiles. The clam results shapefiles are located in the \Shapefiles\Clams folder, and the substrate results shapefiles are located in the \Shapefiles\Substrates folder.

Because some portions of surveyed beaches were contiguous with areas surveyed on other beaches, it made sense to also create two ‘composite’ areas. One of these maps combines the birch bay survey and a contiguous portion of the Birch Point survey (General Birch Bay Area), and the other combines the Marine Park (Blaine), Semiahmoo/Drayton Harbor, and the contiguous portion of the Birch Point survey (General Drayton Area). Merging survey points from the relevant survey shapefiles created point shapefiles for these areas.

A polygon shapefile was then created to delineate the contiguous areas of each beach surveyed. Where unusually large gaps existed between transects the contiguous area was truncated to reflect that the area between transects was not sampled. The procedure used was to terminate the contiguous area at a distance equal to c. half the ‘normal’ distance between transects.

The polygon shapefiles for each of the nine beaches, and the two composite areas are found in the \Shapefiles\SurveyAreas folder.

Each area polygon shapefile was then converted into a 5-ft resolution raster grid file containing a zero value for each cell in the grid. This was achieved using the ‘Convert Features to Raster’ utility found in the Spatial Analyst extension to the ArcMap software.

The raster files representing the area of each of the 9 beaches and the two composite areas are found in the \Rasters folder.

The next step in the process was to use the species-specific attribute information at each beach to produce an interpolated density raster for each of the 9 beaches and the two composite areas. This was achieved using the ‘Interpolate to Raster>Inverse Distance Weighted’ utility in the Spatial Analyst extension. The parameters used to generate the layers in this analysis were Power=2, Search Radius Type=Variable, Number of Points = 3, Output Cell Size = 5 (or 10 for some of the larger beach areas).

This utility produces a temporary raster layer that covers the full vertical and horizontal extent of the point layer used to produce it. Because the beaches are not perfect, north-oriented rectangles it is necessary to ‘trim’ the result to include only the area to be included in the beach results. This process is achieved by means of the ‘Raster Calculator’ utility in the Spatial Analyst extension. Essentially, this process adds the values of cell in one raster layer to the values of cells in another raster layer. Cells without values (no data) cannot be added and are ‘removed’ from the final layer (turned into no data). By adding the raster beach area layer to the interpolated density raster, a new, temporary raster is produced that contains the spatial extent of the area raster with values from the interpolated density raster. This temporary raster was then converted into a permanent grid file using the ‘Make Permanent’ utility in the right-click menu of the ArcMap software.

These final species-specific raster grids can be found in \Rasters\Clams and then in a subfolder, which corresponds to each beach and composite area examined.

A series of maps was then created, by beach and area, to show the distribution of clams on the beach based on the survey results. The ArcMap projects (.mxd files) used to create each map are located in the \Rasters\Clams folders within beach-specific subfolders. Each species has its own project.

The same process was then followed to create raster files representing substrate index values (instead of species values). For this layer, however, the input point files used were those in the second dataset for each beach and composite area (because these contained more points with data).

The values in the final substrate layer cells are interpolated from ‘index values’ at each sampling point that represent substrate pairs. The higher the value, the coarser the substrate is (Table I).

Table I. *Substrate pairings and corresponding Substrate Index Score*

Substrate 1	Substrate 2	Index Score
Mud	Mud	1
Mud	Sand	2
Sand	Sand	3
Mud	Gravel	4
Sand	Gravel	5
Gravel	Gravel	6
Mud	Cobble	7
Sand	Cobble	8
Gravel	Cobble	9
Cobble	Cobble	10
Bedrock	Bedrock	11

Maps were then created showing substrates superimposed by the sample points. The size of the yellow points on these maps is proportional to the count of clams found at each location. Zero value points obviously have no size, therefore, a second layer of points exists beneath the proportionally-sized layer to indicate where zero-counts were obtained (pink-red dots). The ArcMap projects (.mxd files) used to create each map are located in the \Rasters\Substrates folders within beach-specific subfolders. Each species has its own project.

Results

Although the purpose of this report is primarily to map the survey results, some numerical data can also be obtained from the map layers produced. Table II shows the average density of clams estimated to be present within the surveyed area for each beach and the relative abundance of clams found across all 9 beaches surveyed in Whatcom County.

Table II. *Spatially Averaged Clam Density by Beach and Species (Calculated to 2 decimal places)*

	Horse Clams	Varnish Clams	Manila Clams	Native Littleneck Clams	Macoma Clams	Cockles	Butter Clams	Eastern Softshell Clams
General Drayton Area	0.14	0.51	0.31	0.69	0.76	0.06	0.39	0.10
General Birch Bay Area	0.06	3.35	0.03	0.09	0.90	0.04	0.09	0.07
Birch Bay	0.06	3.46	0.04	0.05	0.93	0.04	0.06	0.07
Birch Point	0.21	0.03	0.04	1.03	0.63	0.08	0.30	0.01
Lummi Island	0.04	0.10	0.05	0.62	2.27	0.22	0.19	0.05
Marine Park (Bellingham)	0.21	0.03	0.11	1.98	0.18	0.17	1.08	0.13
Marine Park (Blaine)	0.09	1.28	0.59	0.01	1.31	0.01	0.02	0.17
Mud Bay	0.03	0.06	2.50	2.07	2.54	0.00	0.58	0.43
Point Roberts	0.00	10.40	0.11	0.01	0.09	0.09	0.03	0.05
Point Whitehorn	0.24	0.23	0.10	1.15	1.27	0.01	0.53	0.10
Semiahmoo/Drayton Harbor	0.11	0.33	0.38	1.50	0.46	0.08	0.98	0.24
Whatcom County Average	0.11	1.77	0.44	0.94	1.08	0.08	0.42	0.14

Generally speaking, the most abundant clam species found in the surveys was the Varnish Clam, which is a relatively recent arrival in the area and is thought to have come here via British Columbia as a result of larvae in Ballast water.

The maps produced by this analysis are attached as an appendix. They are arranged according to beach with the first map being a view of the substrate index, and alternating pairs of maps for each species in turn follows this. The first of these maps is the substrate superimposed with counts of the species at each hole. The second map is that of the interpolated distribution of the same species.

All maps produced in this report are also saved as Adobe Portable Document Format (pdf) files in the \PDF folder.

Discussion

During the course of this analysis several issues arose that should be carefully considered in any future clam survey work organized by the MRC.

Firstly, counts of clams can be quite misleading to people interpreting maps like these. For example, it is not uncommon to find numerous seed clams in a survey and few adults. A map based on such data can be heavily skewed towards very young clams that may, or may not, survive and grow. The lack of any size information, or field protocol that limits results to clams above a certain size, strongly limits the usefulness of the data in terms of quantifying the resources available on the beach, or even guiding potential clam harvesters to the best locations on a beach.

Secondly, volunteers subjectively evaluating substrate require some careful guidelines and education to ensure consistency in results between different volunteers. An example of this is apparent when reviewing the substrate map for Mud Bay. It is likely that different people were present on the different transects and that the same ground was described as sand by one team, and as ‘mud-sand’ by the other team. Calibrating the people who make subjective assessments of this kind is vital to ensure data integrity.

Likewise, careful guidelines should be given on ‘how’ to assess the substrates. Do volunteers assess the substrate prior to excavation of the hole (basing it solely on the surface substrate layer) or do they assess the composition of the substrates in the spoil from digging the hole? I would recommend the latter. Do they record only the most dominant substrate, or up to two substrates if it is a mixed-substrate environment, or up to three?

Another question to be considered is whether to try to excavate ‘flooded’ holes or continue with the practice of not excavating quadrats where standing water is present. The main issue with digging a hole in standing water is that the sides of the hole are likely to collapse (thereby changing the area of the hole to something other than 1 ft^2), and flooded holes become very muddy during digging and finding clams in the dirty water becomes more difficult.

In this analysis, flooded holes were removed from the point layer and the values of adjacent un-flooded holes were interpolated to fill in for the missing area. Other possible choices would be to assume no clams in those locations (use a zero value at each affected point) or else assume the beach-average is true at those locations (use the average value of all sampled points on the beach wherever a hole was not dug). Of these three options, I believe that interpolating values from the closest actual values is the best course. However, it is still potentially susceptible to bias. If beach locations that are covered in standing water contain different species, or different abundances of species, than the remainder of the beach then interpolating data from un-flooded holes to fill in the blanks for flooded holes will be misleading.

I should also note that ‘Macoma’ clams are not actually a single species in the sense that ‘Butter clams’ are a species. Macoma is a native genus of shellfish that locally contains several species (e.g., *Macoma nasuta*, *Macoma balthica*, *Macoma secta*, and *Macoma irus*). It is possible that the Macoma clam counts in these surveys aggregate several of these species together and artificially inflate densities for this ‘species’.

If the MRC intends to continue clam survey work I would suggest that trying to ‘fill in the blanks’ spatially would be a better endeavor than re-surveying previously surveyed areas. However, if beaches are to be resurveyed then placing transects between previously surveyed transects will help to improve the resolution of future mapping efforts when combined with the existing data.