Marine Benthic Habitat Mapping of the San Juan Island National Historical Park
by H. Gary Greene and Sandy Wyllie-Echeverria

Dr. H. Gary Greene is a marine geologist/geophysicist that has been investigating the Pacific Ocean seafloor for over four decades and pioneered the application of geology and geophysics to the characterization of marine benthic habitats. His specialty is in the spatial analysis of seafloor conditions that are critical to conservation and sustainability of bottom fisheries.

Dr. Sandy Wyllie-Echeverria’s strong interest in the connection between botanical observation and evolutionary development fuels his research projects in seagrass ecology, reproductive ecology and ethnobotany. For nearly three decades this interest has taken him to sites throughout the Northeastern Pacific, Northern Atlantic and Mediterranean.

Research scientists at Friday Harbor Labs (FHL), University of Washington (UW), constructed a series of thematic maps for the use of San Juan Island National Historical Park (SAJH) personnel to evaluate and manage the Park’s nearshore and offshore resources. This work was done in response to the U.S. National Parks Service’s (NPS) interest to map the submerged lands within its marine and lagoon shoreline park boundaries and to understand the aquatic processes that play a role in the formation, distribution and disturbance of coastal and submarine resources in and around park boundaries. These maps were constructed primarily using multibeam echosounder bathymetric data, but a new technique was implemented that could lead to the use of more modern technology such as drones.

Valuable marine living resources such as rockfish (Sebastes spp.) and Dungeness crab (Metacarcinus magister, previously Cancer magister) habitat and the seagrass, Zostera marina (eelgrass), an important recruitment habitat, are present on the seafloor within and adjoining the submerged lands of the SJAH. However, maps delineating the specific location and interconnectedness of these resources did not exist prior to this work as shallow-water nearshore and intertidal areas...
are difficult to map using conventional boat-based acoustic instruments. Therefore, one of our goals was to develop a shoreline mapping protocol that could be used at other NPS shoreline parks. Our technique is based on (1) extending onshore mapping units offshore through the use of existing geologic maps and field checking of onshore mapping, (2) the use of terrestrial LiDAR and geo-referenced air photographs (collected during low tides) to fill in the “white zone” (data gap area), and (3) the collection of bottom sediment grab samples and nearshore underwater video (collected during high tides) to validate interpretations.

Tectonic and glacial processes shaped the habitats of the SJAH so that rock outcrops interspersed with glacial sediments result in diverse substrate types. Rockfish (Sebastes spp.) and other bottomfish, such as greenlings (Family: Hexagrammidae) and lingcod (Ophiodon elongatus), prefer the hard rocky areas while flatfish (for example: English sole (Parophrys vetulus)) and crustaceans (for example: Dungeness Crab (Metacarcinus magister)) can be found on the relatively flat unconsolidated sediment floors. The diversity of habitat types is higher near rocky points than in the restricted bays. While the bays are primarily dominated by soft unconsolidated sediment (both of glacial and marine origin), mainly sand and mud with local areas of hard bedrock outcrops found near the heads (points) of bays and surrounding areas. To fill in the shallow-water nearshore areas air photos were collected using a fixed camera on a fixed-wing aircraft (Fig. 1).

The habitat maps constructed using both marine acoustics and air photos show potential marine habitats, representing substrate types, geomorphology, seafloor process or other attribute that may be used as a habitat by a specific species or assemblage of organisms (Fig. 2). The seafloor imagery interpretation and habitat type delineation were based on knowledge of the geology of the seafloor and seafloor processes in the study area.

Twenty-eight distinct potential benthic habitat types were defined in the intertidal and shallow subtidal regions of American Camp. We found 19 consisting of unconsolidated sediments, three as mixed soft over hard substrate, five as hard substrate and one as vegetated substrate in an Inland Sea megahabitat covering a total of 12,346,213 m² (100% of the mapped area) (Fig. 3). Z. marina (eelgrass) covers 2,239,588 m² or 18% of the area making this one of the largest eelgrass meadows in the San Juan Archipelago Area defined as beach covers 17,759 m² (0.1%). The dominant potential habitat types were defined by substrate type and/or landward extent (Fig. 3).
habitat type in the area mapped is soft unconsolidated sediment, which covers 8,838,279 m² (72% of the mapped area). Hard rock exposures mapped in the area cover 1,211,416 m² (10% of total mapped area), while hard pinnacles and boulders cover 15,345 m² (0.1% of total mapped area) for a total of hard ground covering 1,226,761 m² (10% of the mapped area). The highly fractured and differentially eroded bedrock, pinnacles and boulders can provide excellent habitat for rockfish (Sebastes spp.) and the sandy part of the beaches can be recruitment habitat for the PSL (Pacific Sandlance, Ammodytes hexapterus).

Fifteen distinct potential benthic habitat types were defined from the interpreted data sets from English Camp with seven consisting of soft, unconsolidated sediment, three as vegetated unconsolidated substrate of eelgrass (Z. marina) and sea lettuce (Ulva lactuca), and sand with unidentified vegetation. Two habitat types are of mixed soft over hard substrate, and five are hard substrate, two of which are anthropogenic. All habitat types are located in an Inland Sea megahabitat covering a total area of 1,289,896 m² (100% of the total area mapped). These potential habitats include hard basement and bedrock seafloor outcrops restricted to the coastal nearshore and pinnacles, shallow bays and current scoured channels of mud and sand, soft, unconsolidated beach sand and intertidal mud flats, and channels with boulders, cobbles, and pebbles locally covering bedrock (Fig. 4). The dominant potential habitat type in the English Camp area is soft, unconsolidated sediment, which covers an area of 1,274,489 m² (99% of the area mapped), including beach sediment and sand, gravel, pebbles, and cobbles, which cover an additional 48,971 m² (4% of the mapped area), vegetated sediment of primarily eelgrass and sea lettuce, which cover 47,319 m² (4% of the mapped area), intertidal mud flats and channels, which cover another 144,336 m² (11% of all the mapped area), and other unconsolidated sediment, which cover 1,034,690 m² (80% of the mapped area).

The San Juan Island National Historical Park has a diverse and resources-rich submerged land area. Both hard, glaciated rock outcrops and soft Quaternary (glacial and marine) sediment filled bays (Garrison and Griffin bays) exists within or adjacent to the Park. These substrates provide habitat for rockfish, crustaceans, and forage fish. Eelgrass beds present in both American and English camps provide refugia for a multitude of biological organisms and acts as recruitment habitat for many fishes and can readily mapped and monitored using air photos, a technology readily adaptable to using drone aircraft as a scientific platform.

Information from the following three publications contributed to the study described in this issue of Tide Bites:

