Puget Sound Naval Shipyard & Intermediate Maintenance Facility

Project ENVVEST Community Update: Guide to Accompanying Compact Disk (CD)

August 2006

Ecology Publication Number 06-10-054

Contents

List of Acronyms and Abbreviations Used

ADCP – Acoustic Doppler Current Profiler
ASTM – American Society for Testing and Materials
CD – Compact Disk
CH3D – Curvilinear hydrodynamics in 3-dimensions
COB – City of Bremerton
CoBI – City of Bainbridge Island
CoPO – City of Port Orchard
CSO – Combined Sewer Overflow
CuCC – Copper Complexation Capacity
DMR – Discharge Monitoring Report
DOC – Dissolved Organic Carbon
EC_{50} – Effect Concentration for 50th percentile
Ecology – Washington State Department of Ecology
ENVVEST – ENVironmental InVESTment
EPA – Environmental Protection Agency
FC – Fecal coliform bacteria
HSPF – Hydraulic Simulation Model FORTAN
KCHD – Kitsap County Health District
KPUD – Kitsap Public Utility District
MCUL – Maximum Cleanup Level
MEL – Manchester Environmental Lab (EPA/Ecology)
MM5 – weather model (mesoscale model)
NPDES – National Pollutant Discharge Elimination System
OUB – Operable Unit "B" (marine sediments)
PAHs – polycyclic aromatic hydrocarbons
PCBs – polychlorinated biphenyls
POM – Princeton Ocean Model
PSAMP – Puget Sound Ambient Monitoring Program
PSNS&IMF – Puget Sound Naval Shipyard & Intermediate Maintenance Facility
ROD – Record of Decision
SEDQUAL – Sediment quality database
SQS – Sediment Quality Standard
SSWM – Surface and Storm Water Management
TMDL – Total Maximum Daily Load or Water Quality Improvement Project studies are conducted to determine the amount of pollutant loading that a given water body can receive and still meet water quality standards
UW – University of Washington
WDFW – WA State Department of Fish and Wildlife
WDOH – WA State Department of Health

Introduction

The Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF), the Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and other technical stakeholders are cooperating in an ENVironmental inVESTment (ENVVEST) project to develop and demonstrate alternative strategies for protecting and improving the ecological integrity of Sinclair and Dyes Inlets and their surrounding watershed in the Puget Sound, WA.

Project ENVVEST will allow environmental protection strategies to be focused on the pollutants that have the highest potential to adversely affect the health of the watershed. Key elements include the development of a unified monitoring and modeling program and electronic database for the Inlets. The contents of this compact disk (CD) are provided as an update of activities being conducted by Project ENVVEST. This document contains a summary of recent progress and provides links to obtain more detailed information about the project. For more information about Project ENVVEST please contact:

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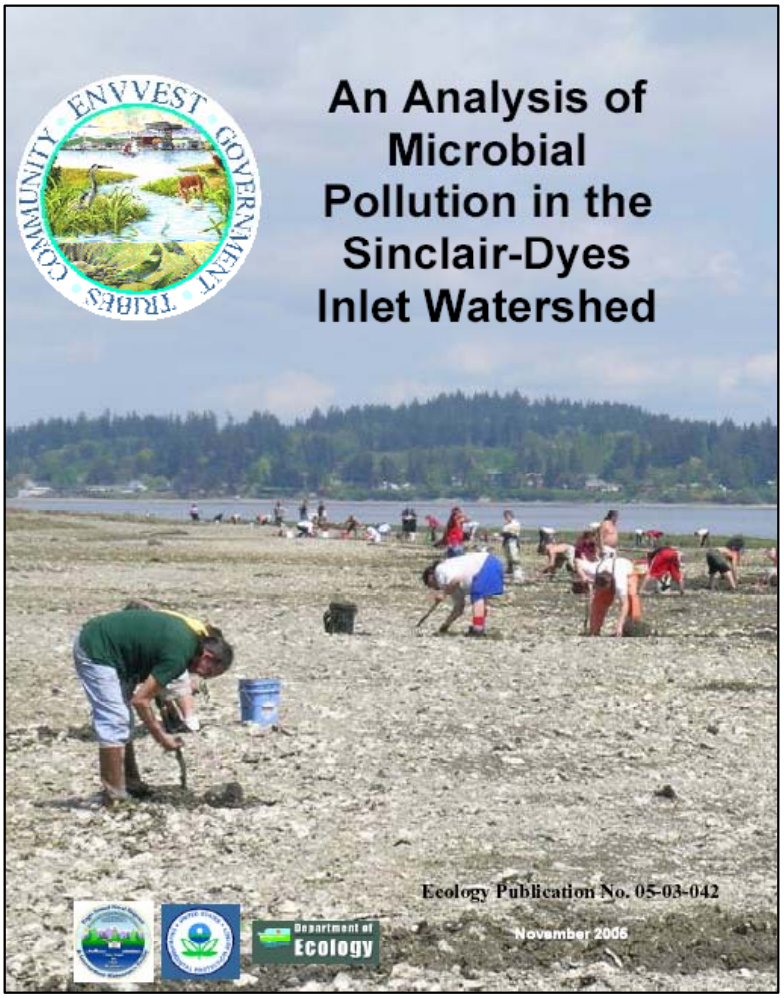
Fecal Coliform TMDL Study for Sinclair and Dyes Inlets

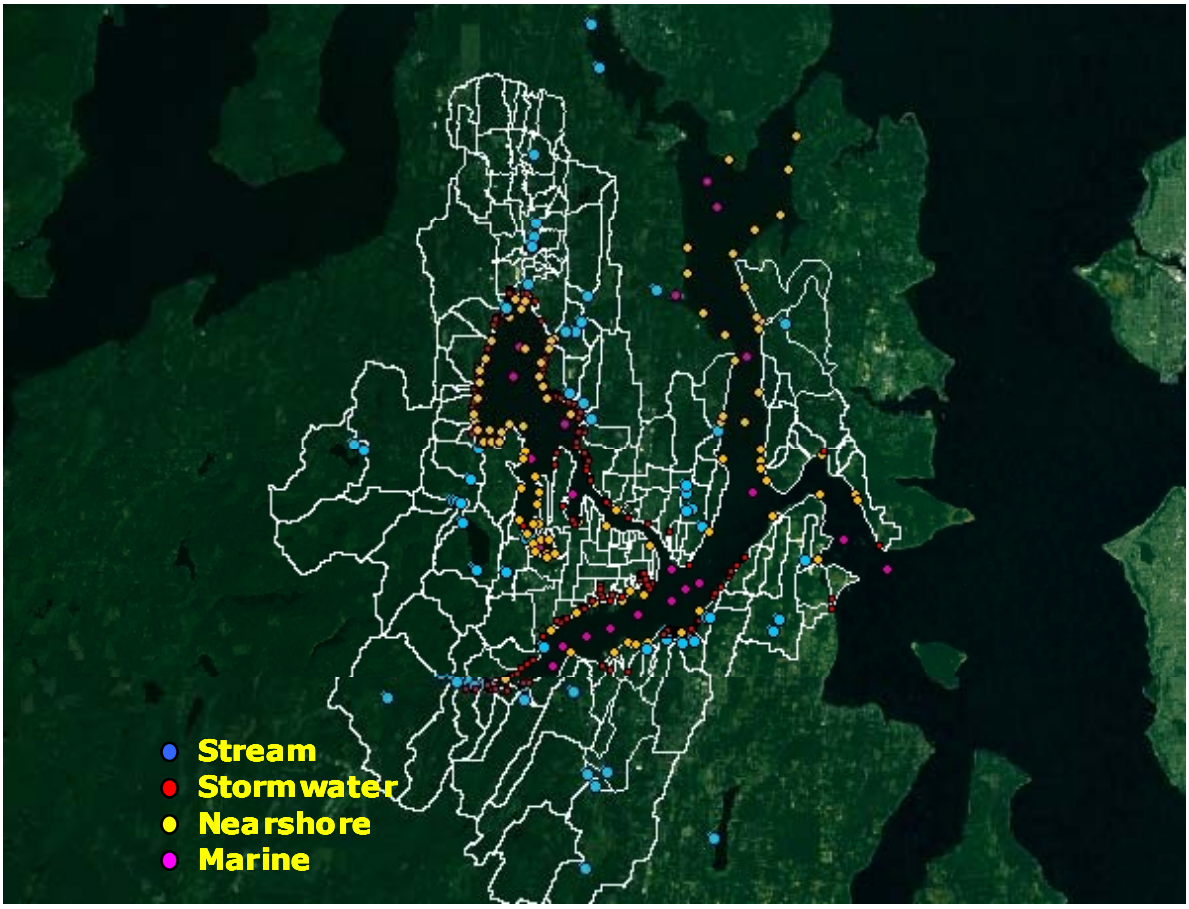
Under the Clean Water Act, Ecology has the authority to establish water quality standards for surface waters of the state and develop water quality improvement plans (Total Maximum Daily Load, or TMDL plans) for pollutants, where the waters do not meet water quality standards. In Sinclair and Dyes Inlets watersheds, PSNS&IMF and EPA are working with Ecology as part of Project ENVVEST to develop a TMDL for fecal coliform (FC) bacteria. Under the partnership, the Navy as technical lead has designed and carried out a study that meets Ecology and EPA requirements for a TMDL and the first part of the TMDL technical study has been completed (May et al. 2005). The TMDL will establish the capacity of the two inlets to accept discharges of FC bacteria from streams, stormwater outfalls, sewage treatment plants, and surface runoff, and still meet water quality standards.

Microbial pollution occurs when FC bacteria from diverse sources such as failing septic systems, leaks from sewer infrastructure, and releases of pet, livestock and wildlife waste cause surface waters to exceed state water quality standards. The pollution can result in the loss of beneficial uses of the water body for drinking, swimming and shellfish harvesting. The goals of the study were to identify microbial pollution problems within the watershed and to provide a comprehensive assessment of microbial pollution from all identifiable sources (ENVVEST 2002b, Johnston et al. 2004). In addition to data collected during the study period from spring 2001 to summer 2005, the study relied on historical data collected by the Kitsap County Health District (KCHD 2002, 2003a, 2004), the Washington State Department of Health (WDOH, Determan 2001, 2003, WDOH 2005a,b), and Kitsap County Surface and Storm Water Management (SSWM 2002a, b).

The study found numerous sources of bacterial pollution in the watershed that could impact water quality and shellfish harvesting areas. In general, microbial pollution was higher in subwatersheds with greater population densities, in areas with a greater percentage of impervious area, and in areas served by older sewer infrastructures or onsite wastewater treatment (septic) systems.



Cover of technical report showing Suquamish Tribal members harvesting clams in Dyes Inlet.



Sampling stations and watershed boundaries used during the microbial pollution TMDL study for Sinclair and Dyes Inlets. The watershed scale is the appropriate scale to address environmental issues and engage stakeholders including Kitsap County, Cities of Bremerton, Port Orchard, and Bainbridge Island, the Suquamish Tribe, Karcher Creek Sewer District, Kitsap Public Utilities District, and others.

Exceedances of the water quality standards for bacteria were more likely in streams with higher stormwater inputs and in streams draining areas with more development. Increased bacterial pollution levels and exceedances of water quality standards were also more likely following major storm events due to increased stormwater runoff entering marine waters via streams and stormwater outfalls. Elevated bacterial pollution levels in nearshore areas appeared to be localized and persisted for only a short period after storm events or during extended periods of rainfall. But, elevated chronic bacterial pollution was persistent in some nearshore and estuarine areas where shoreline development was intense or where urbanized streams and stormwater outfalls were common. Microbial pollution levels found during storm season sampling were about ten times higher than those for non-storm periods, especially for nearshore sites adjacent to highly urbanized drainage basins. Investigations of the relationship between bacterial pollution and land-use showed that the loss of natural forest cover and the increase in impervious surfaces associated with suburban and urban levels of development were significantly correlated with pollution levels and exceeding water quality standards.

The value of an integrated watershed approach to water-quality management was demonstrated during this project. The number and variety of sources for bacterial pollution throughout the study area does not support a conventional “end-of-pipe” approach to pollution control. Elevated bacteria concentrations may indicate the presence of viruses and human pathogens that can be filtered from marine waters and concentrated by shellfish. The WDOH monitoring program for shellfish growing areas relies on water quality measurements of bacteria to determine whether

shellfish can be safely harvested. The safety of marine and freshwater beaches for swimming also is determined by measurements of indicator bacteria. Therefore, the detection, quantification, and correction of existing sources of bacterial pollution should be a high priority for watershed and water-resource managers, as should the development and implementation of an effective prevention program.

- An analysis of microbial pollution in the Sinclair-Dyes Inlet Watershed
- Winter 2004 FC Sampling and Logistics Plan

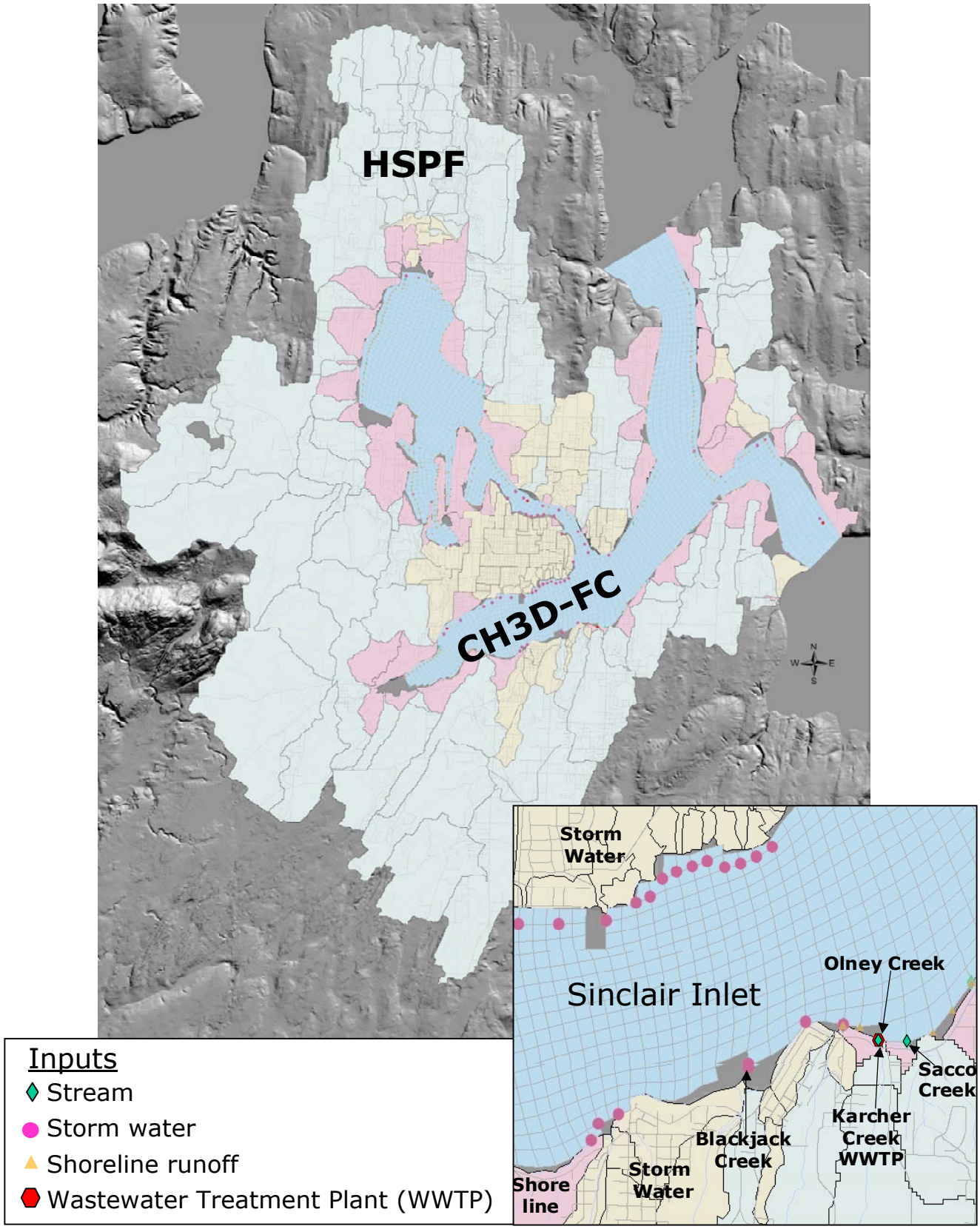
Integrated Modeling of the Sinclair and Dyes Inlet Watershed

An integrated model that links a model of the watershed (hydraulics simulation program FORTRAN – HPSF) with a model of the marine waters in Sinclair and Dyes Inlets (curvilinear hydrodynamics in 3 dimensions – CH3D) has been developed as part of Project ENVVEST (Johnston et al. 2003a). The integrated model is capable of simulating runoff from the watershed and explicitly includes discharges (pour points) from streams, stormwater outfalls, shoreline drainage areas, and wastewater treatment plants. Previously, the CH3D model was used to simulate combined sewer overflows (CSOs) in the Port Washington Narrows (Wang et al. 2005) and the modeling results contributed to the re-opening of shellfish beds in Northern Dyes Inlet to commercial harvesting (WDOH 2003b, Dunagan 2003). Currently, the integrated model simulates 137 separate discharges into the Inlets consisting of 39 streams, 50 stormwater outfalls, 44 shoreline drainage areas, and 4 treatment plant outfalls consisting of the City of Bremerton's (COB's) main treatment plant in Sinclair Inlet and the east side treatment facility in the Port Washington Narrows, the Karcher Creek/City of Port Orchard (CoPO) treatment plant, and the City of Bainbridge Island's (CoBI) Fort Ward treatment plant in Rich Passage.

The integrated model is being used to simulate the total microbial pollutant load into the Inlets from as many sources as possible. The loading analysis conducted as part of the FC bacteria pollution TMDL study (May et al. 2005) was used to assign microbial pollution loads for each of the stream, stormwater, and shoreline pour points draining from the watershed. Data from the wastewater treatment plants' National Pollutant Discharge Elimination System (NPDES) Discharge Monitoring Reports (DMRs) submitted to Ecology were used to simulate microbial pollution loads from the treatment plants.

The model is being used to simulate weather conditions and pollutant loads for water year 2003 (Oct. 1, 2002 to Sept. 30, 2003) and storm events sampled in 2004 to compare to field data collected during those periods. The modeling results are currently being reviewed by Ecology and the ENVVEST Technical Working Group to evaluate model performance and define the modeling scenarios that will be simulated to support water cleanup plans for microbial pollution in the Inlets.

- Simulation Examples and Data Animation Page
- Sinclair/Dyes Inlets Water Quality Improvement Project (TMDL)



The integrated wastershed (HSPF) and receiving water (CH3D-FC) model is capable of modeling runoff and transport of pollutants from streams (green watersheds), stormwater catchments (yellow watersheds), and shoreline areas (pink watersheds), as well as discharges from wastewater treatment plants (insert).

Storm Event Sampling

A major effort to conduct storm event and base flow sampling and ambient monitoring in the Inlets was planned and executed by Project ENVVEST during 2004-2005 (Johnston et al. 2005a). The major emphasis of the sampling was to collect storm event samples from streams and storm water outfalls that were being monitored for flow within the watershed. Additional goals were to obtain data to support total loading and modeling analysis of heavy metal and toxic organic contaminants, nutrients, and suspended particulates discharged into Sinclair and Dyes Inlets Brandenberger et al. 2005a, 2005b, 2005c), develop preliminary data on contaminant levels in nonpoint source runoff in Gorst at the head of Sinclair Inlet, and assess the impact of storm event runoff on the water quality of the Inlets. Also, in cooperation with Ecology's Manchester Environmental Laboratory (MEL), a subset of streams and selected storm water outfalls were screened for pesticide and herbicide compounds.

The data obtained from this sampling effort is being used to develop relationships between water quality and watershed hydrology, land use, land cover, and support further development of the integrated watershed and receiving water models being implemented for the Sinclair and Dyes Inlet watershed (Skahill 2004, 2005, Skahill and Johnston 2005, Skahill and Doherty 2006, Wang et al. 2005). The modeling will provide the basis for calculating total maximum daily loads for key environmental contaminants within the watershed.

- 2005 Storm Event Sampling and Logistics Plan
- Data Directory

Actual measurements of chemicals and bacteria in stormwater draining from the watershed can be used to calculate loading as a function of upstream land use.

Ambient marine monitoring was conducted to measure the impact of runoff on receiving waters and obtain data needed to verify modeling results.

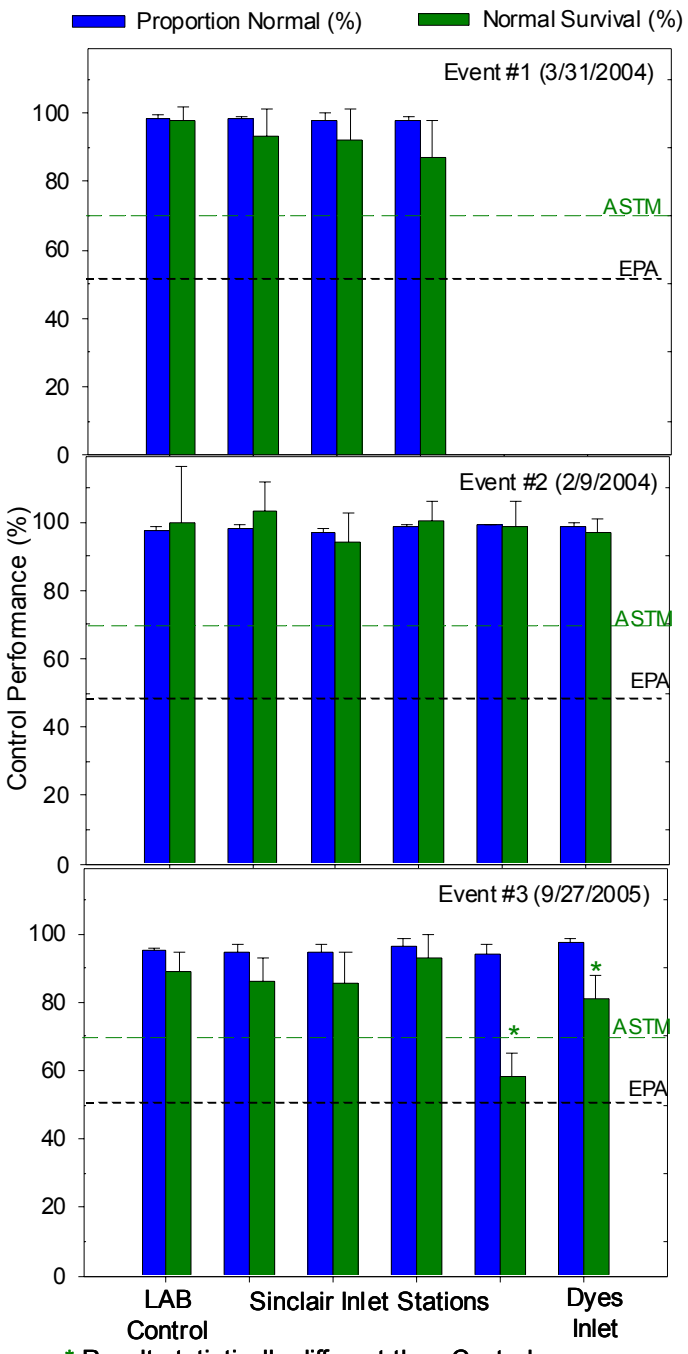
Ambient Water Quality Monitoring

Ambient water quality monitoring was conducted by Project ENVVEST to assess the impact of storm event runoff on the water quality of the Inlets, evaluate the potential ecological significance of discharges in the Inlets, and provide data that can be used to support the development of a Phase II alternative regulatory strategy for the Shipyard. The marine sampling was primarily focused on heavy metals (copper, cadmium, lead, and zinc) because these metals are of most concern for regulation under the Shipyard's NPDES permit. Additionally, metals (copper) were identified as the next parameter group to be addressed following completion of the FC TMDL Study in the Project ENVVEST Technical Work Masterplan (ENVVEST 2002b, 2002c). The work also complemented the sediment studies by quantifying the current loading of contaminants into the Inlets. Furthermore, developing a total loading analysis for copper and other metals would be the necessary first step in developing alternative regulatory strategies aimed at addressing NPDES requirements. Additional studies related to storm water monitoring and potential effects of discharges on the receiving waters included a dye study of drydock discharges from the Shipyard (Katz et al. 2004b, Katz and Blake 2004) and an evaluation of copper toxicity in the receiving waters of Sinclair Inlet (Rosen et al. 2004a, 2004b).

The dye study measured the amount and spatial extent of dilution of discharges from the dry docks under normal operational conditions as the discharges mixed into Sinclair Inlet. Data from the dye study should prove useful in validating numerical plume models that can be used to address a variety of discharge and tidal conditions at these locations (Katz and Blake 2004).

The study of copper toxicity evaluated the bioavailability of copper in Sinclair Inlet by spiking ambient water samples from Sinclair and Dyes Inlets with various concentrations of copper prior to conducting laboratory bioassays with mussel embryos (Rosen et al. 2004a, 2004b). Spiking copper into ambient Sinclair Inlet water resulted in EC_{50} (concentration causing an effect in 50% of the test animals) values averaging 40-60% higher, on a dissolved basis, than laboratory water spiked with same concentrations of copper. This indicates that conditions within the Inlets were responsible for reducing the toxicity of copper to mussel embryos by a factor of 1.4, based on the three sampling events used for the study.

The ambient water samples from Sinclair Inlet were not toxic to mussel embryos during the test, and had dissolved copper concentrations (range 1.0 – 1.6 µg/L, Brandenberger et al. 2006c) that were about two to three times lower than the ambient water quality criteria for continuous (3.1 µg/L [chronic]) and about 4 times lower than maximum (4.8 µg/L [acute]) exposure. Copper complexation capacity (CuCC), a chemical measure of bioavailability based on free copper measurements, and dissolved organic carbon (DOC) correlated very well ($r^2 > 0.7$) with copper effect levels (EC_{50}) indicating that measurements of CuCC and/or DOC may be a low cost alternative for evaluating site-specific toxicity of copper in Sinclair Inlet (Rosen et al. in prep).



* Result statistically different than Control
ASTM (American Society of Testing and Materials) and EPA acceptable thresholds are also shown

Results of copper toxicity studies showed no indication of ambient toxicity in the waters of the Inlets. The toxicity detected at two stations during event #3 was due to a toxic algae bloom that was present during the sampling event.

- 2005 Storm Event Sampling and Logistics Plan
- Data Directory

Watershed Monitoring

Since water year 2000 (WY2000), the Kitsap Public Utilities District (KPUD) has monitored and developed continuous records of stream flow for the major streams within the study area. Data on precipitation and other meteorological data are also monitored by KPUD and the City of Bremerton (COB) for the study area. These data have been combined with historical stream data collected by the KPUD (1999a, 1999b) to develop a very extensive record of hydrological data to model stream flow with the watershed model.

Chico Bay near the mouth of Chico Creek in Dyes Inlet. Photo from Ecology's shoreline atlas (http://apps.ecy.wa.gov/shorephotos/).

As part of the In-Stream and Storm Water Flow Sampling conducted by The Environmental Company (TEC), thirteen storm water drainage basins were also monitored for flow. The storm water outfalls selected for flow monitoring were determined by a technical evaluation of 35 storm water outfalls (including streams and other urbanized natural drainage areas) located within the City of Bremerton, City of Port Orchard, City of Bainbridge Island, Kitsap County, and the Shipyard (see Table ES-1 of TEC 2003b). The 35 outfalls selected for evaluation were selected from more than 150 storm water outfalls and channelized streams (> 12 inches in diameter) located within the study area. The outfalls were ranked based on the ability to obtain accurate flow rates and flow-weighted composite samples, logistics, health and safety concerns, watershed characteristics, and cost. The final list of 13 stations selected for monitoring were the highest-ranking stations that would provide the most representative data on storm water outfalls within the study area, based on the cost and equipment available for the sampling effort.

This sampling was made possible by cooperation among PSNS&IMF, COB, Kitsap SSWM, CoBI and CoPO to share equipment and provide access to stream and stormwater conveyance systems. Due to the ongoing efforts of KPUD, SSWM, COB, CoBI, PSNS&IMF and Project ENVVEST, the critically important stream and stormwater flow-monitoring network developed for the study is continuing to collect data. Watershed studies are also being conducted to monitor habitat quality. By partnering with Kitsap County's Stream Team a county-wide benthic macro-invertebrate sampling program has been established. An assessment of salmonid passage and habitat characteristics was also conducted for culverts along the Navy's railroad line from Shelton to Bangor (May et al. 2004).

- Storm Water Flow and Storm Event Sampling
- Data Directory

Sediment Studies

Integrating contaminated sediment clean up and restoration issues within the larger perspective of watershed management are especially critical in populated coastal and estuarine areas with multiple sources of stress from urbanization and development as well as sediment contaminated from past sources. Historically, Sinclair and Dyes Inlets were polluted with discharges of

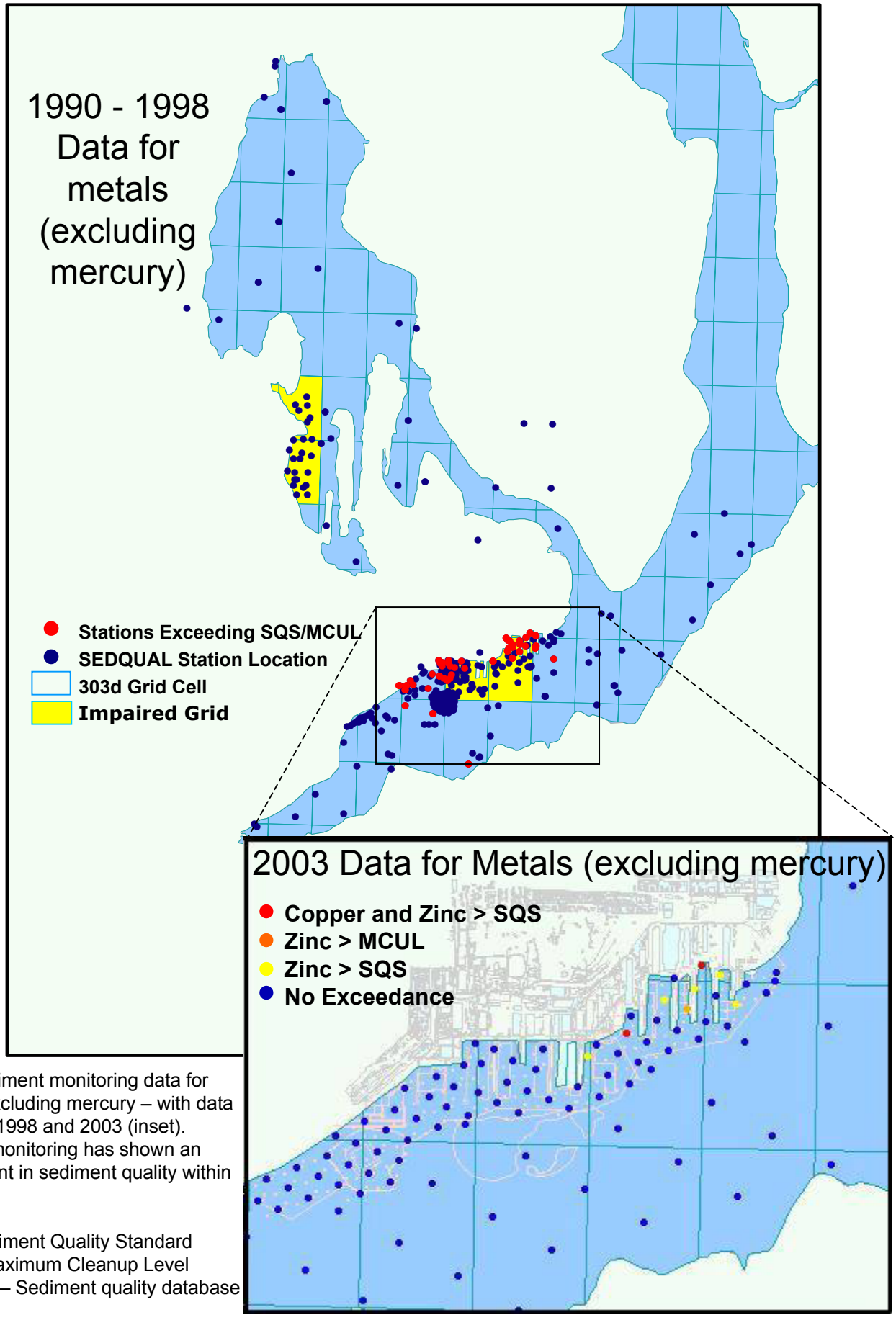
contamination from military installations, industrial activities, municipal outfalls, and other nonpoint sources. As part of the Record of Decision (ROD) to remediate contaminated sediments near PSNS&IMF in Sinclair Inlet, sediments were dredged from contaminated areas, placed in an adjacent confined aquatic disposal pit, and covered with clean material dredged to deepen the navigational channel and turning basin (Operational Unit B Marine – OUB, U.S. EPA 2000, URS 2001). Other cleanup activities included restoring shoreline areas to minimize contaminated soil infiltration, improving shoreline habitat, and conducting cleaning, inspection, and repair of the Shipyard's stormwater system (U.S. EPA 2004, Leisle 2005, ATSDR 2005). Concurrently, major improvements to Bremerton's combined sewer and stormwater system have significantly reduced CSOs and achieved improvements in the water quality of the Inlets (COB 2006).

Historical trends of contamination in the Inlets obtained from age-dated sediment cores collected from areas of sediment accumulation in Sinclair and Dyes Inlets showed that maximum contamination levels occurred between the 1940s and 1960s followed by a decreasing trend of contamination in the most contaminated cores for the more recent deposits (Crecelius et al. 2003). Sediment cores collected by previous studies from the main basin of the Puget Sound also showed that maximum pollution levels occurred between 1945 and 1965 followed by a trend of decreasing contamination in more recent deposits (Bloom and Crecelius 1987, Lefkovitz et al. 1997). These trends are similar to trends of mercury deposition reported in ice cores sampled from the Upper Fremont glacier in the Wind River Range of Wyoming (isolated from local sources of mercury contamination), which showed peaks of contamination associated with volcanic eruptions, pre-industrial gold mining, World War II manufacturing, and the increase of industrialization in the 20th Century followed by a decreasing trend of mercury deposition after 1970 (Schuster et al. 2002). Sedimentation rates for the Inlets, estimated from the age-dated cores, ranged from 0.06 g/cm^2/yr to 0.20 g/cm^2/yr (dry sediment) and the thickness of the contaminated layer of sediment ranged from 0-15 cm to 0-45 cm (Crecelius et al. 2003).

Surface sediments (0-10 cm) were also sampled throughout the Inlets to develop a map of sediment texture needed to model contaminant transport and assess changes in sediment texture following cleanup and dredging activities (McLaren 2004). Between 1997/1998 and 2003 (following cleanup dredging) the surface sediments in Sinclair and Dyes Inlets changed significantly in texture by becoming coarser (from medium to coarse silt), suggesting that coarser sediment was deposited in the Inlets between the sampling periods (McLaren 2004). It is unlikely that coarser grain size will affect long-term sedimentation rates because the currents and amount of suspended sediment available for deposition control the rate of sediment accumulation.

To further address contaminated sediments in the Inlets, a study plan was developed and executed in conjunction with OUB monitoring (Kohn et al. 2003, Kohn et al. 2005b) to address sediment contaminants listed on the 1998 303(d) list for the Inlets. The study was conducted to determine the current levels of toxic metal and organic contamination in the sediments, verify whether any sediment grids should be on the 303(d) list, and determine whether there has been a decrease in sediment contamination since cleanup and source reduction activities at PSNS&IMF and Jackson Park have been conducted. Ecology also conducted a study to assess sediment toxicity in Ostrich Bay (Blakley 2005) and found toxicity exceeding the biological regulatory criteria for sediment quality at six of the 12 sampling stations. The cause of the observed sediment toxicity is currently unknown (Blakley 2005).

A change in the 303(d) listing policy for sediment, implemented by Ecology for the 2004 list, resulted in fewer sediment listings for Sinclair and Dyes Inlets on the 2004 list than was on the 1998 list (Ecology 2005). Additionally, an evaluation of the most recent sediment data collected



Map of sediment monitoring data for metals – excluding mercury – with data from 1990-1998 and 2003 (inset). Sediment monitoring has shown an improvement in sediment quality within the Inlets.

SQS – Sediment Quality Standard
MCUL – Maximum Cleanup Level
SEDQUAL – Sediment quality database

in 2003 (Kohn et al. 2005a, Kohn et al. in prep) showed improvement in the number of chemicals meeting sediment quality standards in Sinclair and Dyes Inlets. However, mercury and some toxic organic compounds are still listed in Category 5 (polluted waters that require a TMDL). Category 2 listings (waters of concern) include listings for groups of toxic, persistent organic compounds known as PCBs (polychlorinated biphenyls) and PAHs (polycyclic aromatic hydrocarbons) as well as silver, cadmium, and sediment toxicity. Category 2 listings do not automatically require a TMDL but more data are necessary to determine the severity and extent of the impairment.

- Metals Verification Study Final Report
- Data Directory

Biota Sampling

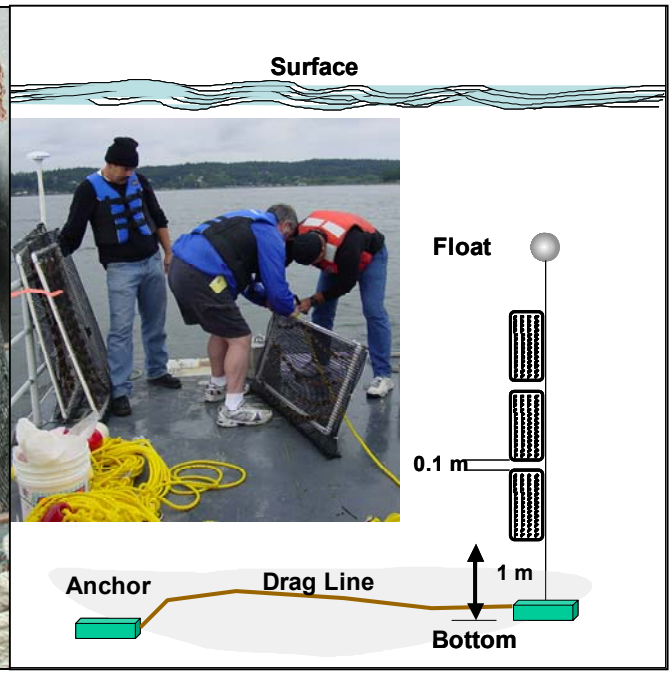
Evaluating the deposition and transport of contaminants within Sinclair and Dyes Inlets and assessing the impact of these contaminants on the local marine biota requires the cooperation of the various stakeholders conducting environmental monitoring programs in the region. The Puget Sound Ambient Monitoring Program (PSAMP) is a multi-agency effort to monitor the health of Puget Sound. The spatial and temporal trends in contaminant exposure in Puget Sound fish and macro-invertebrates and the effects of contaminant exposure on the health of these resources is assessed by trawl sampling at various sampling stations throughout Puget Sound (WDFW 2003).

Sorting the 2005 PSAMP demersal fish catch. Photo by Tom Ostrom, Suquamish Tribe.

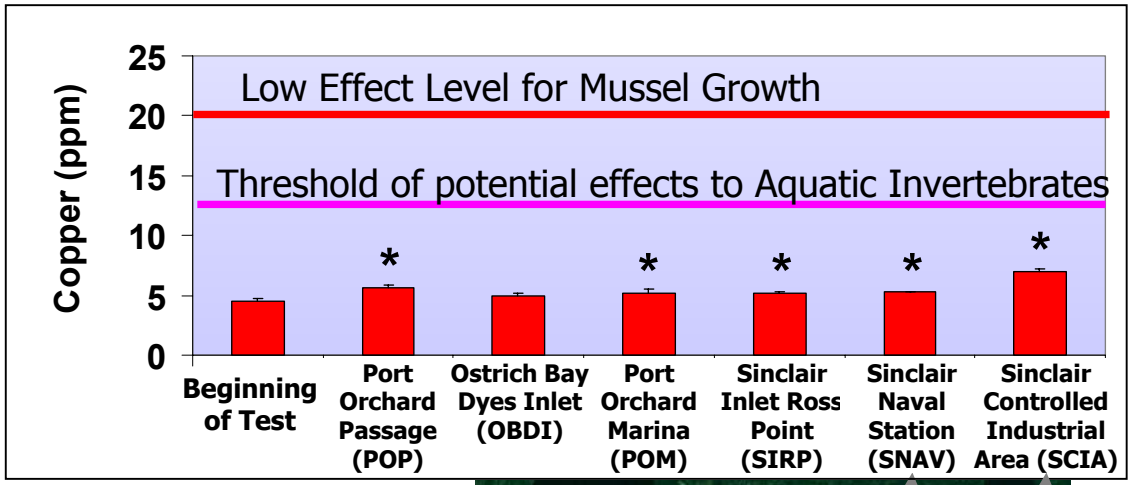
In order to increase the data yield from these efforts, Project ENVVEST collaborated with WDFW to collect additional biological samples for contaminant bioaccumulation analysis (Brandenberger et al. 2006a) and the collection of selected tissue samples to measure biomarkers of sublethal stress. To learn more about water quality and the protection of natural resources in Sinclair Inlet, caged mussels were deployed from June – September 2005 (84 days) at locations inside the Shipyard and at reference locations within the Inlets. The mussels were obtained from a mussel culturing facility near Shelton, Washington, placed in nylon cages, and deployed near the bottom. At the end of the deployment the mussels were retrieved to measure their growth, overall health, and the level of contaminants they accumulated during their stay in the Inlets. The results showed that the mussels remained healthy throughout the deployment. Although copper levels increased slightly at 5 of the 6 sites, the levels did not appear to accumulate to harmful levels (Brandenberger et al. 2006b, Salazar et al. 2006). See figure on next page.

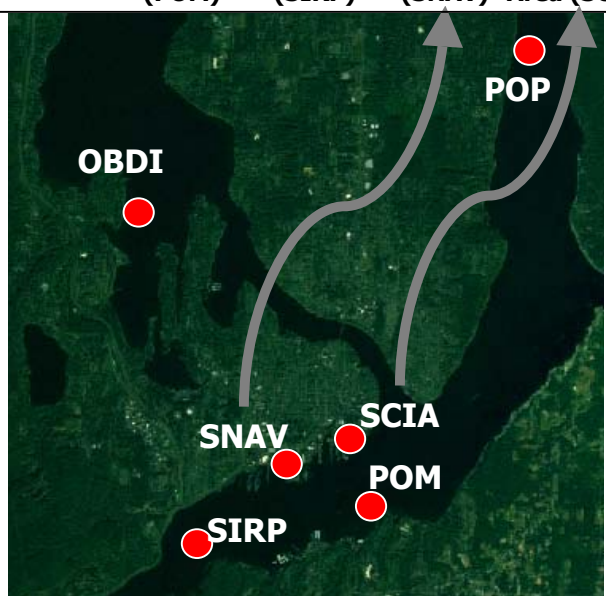
- Biological Sampling and Analysis Plan
- Data Directory

Demersal fish trawl in Sinclair Inlet. Photo by Tom Ostrom, Suquamish Tribe.



Configuration of caged mussel deployment.

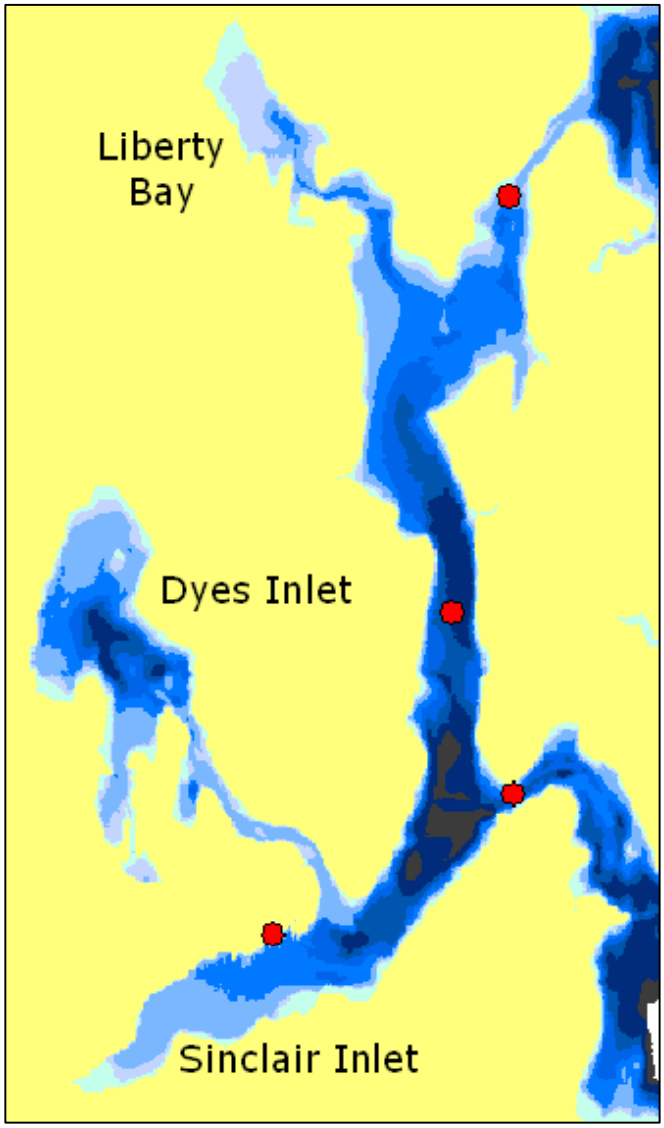




Results of copper levels accumulated by mussels during the deployment (* indicates levels were statistically higher than at the beginning of the test).

Current Meter Study

The inlet-scale integrated model for the Sinclair and Dyes Inlet watershed has been developed to simulate hydrodynamic mixing and transport, dynamic loading from the surrounding watershed, and exchange with the greater Puget Sound. In a related effort, being conduct by the University of Washington (UW), a Puget Sound-scale circulation model has been developed using the Princeton Ocean Model (POM) to simulate velocity, temperature, salinity, and mixing within the Puget Sound (Kawase 2002). Recently, the Puget Sound POM circulation model was programmed to use wind and rain from the MM5 weather model (mesoscale model, Albright and Mass 2002) to simulate the resulting Puget Sound circulation every 24-hours (Sarason 2004, 2005).



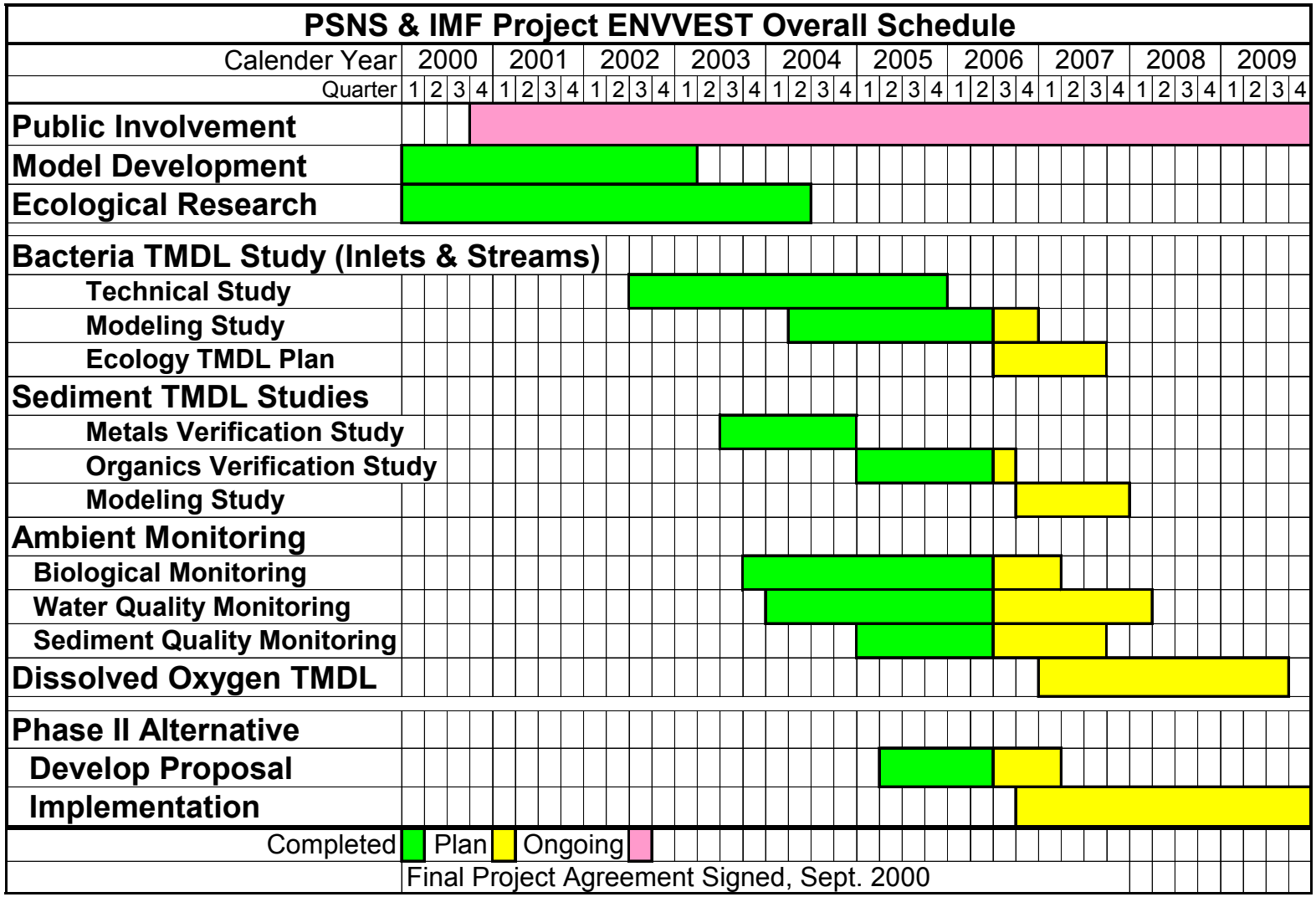
Depth contours and location of current meter monitoring stations.

As part of the Puget Sound Marine Environmental Modeling partnership, the inlet-scale CH3D model for Sinclair and Dyes Inlets has been expanded to include Port Orchard Passage, Liberty Bay, and Agate Passage. This will facilitate coupling with the POM circulation model and, eventually, result in the ability to simulate the exchange of constituents between the Inlets and the Puget Sound (Johnston and Wang 2005).

To support this work, the Navy and Ecology executed a current meter study to collect the data needed to calibrate and verify the expanded model. Three upward-looking Acoustic Doppler Current Profilers (ADCP) were deployed on the bottom at strategic locations within the passages to obtain continuous current records during the Fall of 2005 (Johnston and Albertson 2005). The deployment included the full range of tidal conditions and representative storm events that occurred during the Fall 2005 (Sep. – Dec. 2005). Data from this study will be used to calibrate and verify linking between the inlet-scale CH3D model and the Puget Sound-scale POM circulation model.

- Current Meter Sampling Plan
- Data Directory

Schedule



Since the Final Project Agreement was signed in September 2000, Project ENVVEST has leveraged model development and ecological research to conduct technical studies that are assisting Ecology in addressing impairments listed on the 1998 303(d) list for the watershed. The bacterial TMDL study addresses listings in the Inlets and tributary streams, the sediment TMDL studies are addressing numerous metal and toxic organic listings in the sediments of the Inlets, and ambient monitoring studies are helping to address tissue residue listings and document the quality of water and sediment in the Inlets. Future work may also address low dissolved oxygen in the Inlets. All work for Project ENVVEST was performed to support the development of a Phase II proposal to regulate discharges at PSNS&IMF. The Phase II proposal is intended to result in increased efficiency and/or effectiveness of the Shipyard's environmental program.

Summary

Significant progress has been made on the technical study of fecal coliform bacteria in Sinclair and Dyes Inlets, which has benefited from the collaboration and cooperation of many stakeholders in the watershed. The study, when combined with modeling of FC bacteria inputs from numerous watershed sources under critical loading conditions, will form the basis of Ecology's bacteria TMDL for the two inlets. The model simulates inputs of bacteria from streams, stormwater outfalls, and nonpoint source runoff into the Inlets and is being verified with data collected from the watershed and the nearshore and marine waters of the Inlets. Progress has also been achieved sampling stormwater and streams during storm events, evaluating sources of contamination from the watershed, and assessing contamination in the sediments of the Inlets. In addition, the accumulation of contaminants in the food chain is being assessed by analyzing species of fish and invertebrates from Sinclair Inlet and reference areas in the Puget Sound for metals, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons. Project ENVVEST has accumulated a wealth of new data that can help provide a better understanding of the current environmental conditions in Sinclair and Dyes Inlets. This understanding will provide a basis for improving the efficiency and effectiveness of the Shipyard's environmental compliance program and assure the protection of aquatic resources.

Mt. Rainer from Port Orchard Passage on a clear day.

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A-D

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