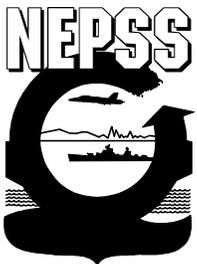




Marine Environmental Update



NMFS Lists Nine West Coast Populations of Salmon and Steelhead Under ESA

The National Marine Fisheries Service today added nine populations of salmon and steelhead in [Washington and Oregon](#), including metropolitan Portland and Seattle, to the endangered species list – marking the first time federal protection under the Endangered Species Act (ESA) has been extended to salmon found in streams in heavily-populated areas of the Pacific Northwest. The salmon populations listed, known as evolutionary significant units (ESUs), range from sockeye salmon in Washington’s Olympic Peninsula to Chinook salmon found in the heavily urbanized area of Puget Sound. The ESUs listed are:

Four Chinook salmon (*Oncorhynchus tshawytscha*) ESUs:

1. Puget Sound Chinook (threatened)
2. Lower Columbia River Chinook (threatened)
3. Upper Columbia River spring-run Chinook (endangered)
4. Upper Willamette River Chinook (threatened)

Two chum salmon (*Oncorhynchus keta*) ESUs:

1. Hood Canal summer run chum (threatened)
2. Columbia River chum (threatened)

Two steelhead (*Oncorhynchus mykiss*) ESUs:

1. Upper Willamette River steelhead (threatened)
2. Middle Columbia River steelhead (threatened)

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One sockeye salmon (*Oncorhynchus nerka*) ESU:

1. Ozette Lake sockeye (threatened)

Whereas the previous listings in the more sparsely settled areas of the Northwest affected chiefly agriculture, logging, irrigation, fishing, and hydroelectric power generation, the new listings may also impact manufacturers, large municipal waste facilities, real estate development, and other urban interests. Therefore, the development of recovery plans for these fish is closely intertwined with the Federal Water Pollution Control Act (Clean Water Act), including the formulation of total maximum daily load allocations and the renewal of the National Pollutants and Discharge Elimination System (NPDES) permits for point source dischargers. Recovery of the region's salmon runs means that the NMFS will be working with the EPA and delegated state programs to make sure that permit activities under the Clean Water Act have endangered species act coverage. Improvements in the control of nonpoint source pollution from the timber industry, agriculture, and local governments will also be sought, in addition to stricter control over storm water runoff in urban areas.

At this time, no immediate regulations will apply to state and private activities in the areas where salmon populations are listed as threatened. However, because it is listed as an endangered species, any accidental or incidental "take" of Upper Columbia River spring Chinook would require a permit. In the future, fisheries service staff will work closely with its partners to develop "tailor-made" regulations that would include state and local conservation initiatives.

The agency is deferring its decision on [four additional Chinook salmon \(ESUs\)](#): the Snake River fall-run, the southern Oregon and California coastal, the California Central Valley fall-run and the California Central Valley spring-run. The fisheries service will use the six-month extension to resolve areas of scientific disagreement about the ESUs. A final determination will be made in September.

Federal Register, Volume 64, Number 56, March 24, 1999, pp. 14307-14328.

[Press release NOAA 99-R115, March 16, 1999.](#)

Environment Reporter, Volume 29, Number 45, March 19, 1999, pp. 2276-2277.

EPA To Expand Impaired Waters Definition Beyond Pollutants

The Environmental Protection Agency is expected to propose an expansion of the process for listing water bodies that do not meet water quality standards in order to set pollutant load allocations. The expected proposal to revise the total maximum daily loads (TMDLs) program under the Federal Water Pollution Control Act (Clean Water Act) will focus on the term "pollution" rather than just "pollutant." The definition of the word "pollution" could be made to include such things as impairment to habitat, barriers to fish passage, and atmospheric deposition.

The Clean Water Act requires states to designate uses for their water bodies and to set water quality standards to reflect those uses. Under Section 303(d), states must submit to the EPA lists of waters not



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meeting the standards. They then must allocate pollutant loadings among dischargers that will bring the water body back into compliance with the standard.

Water bodies are classified into four categories:

1. Water bodies that do not meet the water quality criteria because of exceedance in one or more pollutants, thus requiring a TMDL to be developed;
2. Water bodies that already have a TMDL, but are not meeting the set TMDL;
3. Water bodies impaired by something other than a pollutant, like a fish barrier or dam, for which a TMDL is not required; and
4. Water bodies for which the basic technology "minimums" would achieve water quality standards but have not yet been applied.

The states generally believe that TMDLs should be integrated with the watershed management cycles on a five-year rotation. Several environmental groups, however, have made it known through lawsuits that they believe that the States are already moving too slowly in the TMDL process.

Another area the new TMDL program is seeking to rectify concerns helping states set priorities for listing and developing TMDLs. Essentially, the states would be guided to group impaired water bodies as either "high," "medium," or "low" priority, instead of trying to list them in order of impairment. Water bodies near a drinking water intake or those with the presence of an endangered species would be listed as "high quality" water bodies. The proposal would also include incentives in priority listing, for example, impaired water bodies that have approved habitat conservation plans could be listed as a lower priority. The proposal to improve the program based on a federal advisory committee is expected soon.

Environment Reporter, Volume 29, Number 42, February 26, 1999, pp. 2128-2129.

EPA To Unify Lists for PBT Pollutant Control

The Environmental Protection Agency plans to unify the efforts of its different offices to develop one list of persistent, bioaccumulative, and toxic (PBT) pollutants to target for reduction after complaints by State environmental agencies saying that having multiple lists is confusing. Under the Multinational PBT Strategy released in November of 1998, the EPA identified 12 pollutants that it will initially focus on for emissions reduction. Those pollutants correspond with an agreement the EPA made with Canada in 1997 to set reduction targets for 12 chemicals to reduce releases of these PBT's into the Great Lakes by the year 2006. The EPA's Office of Solid Waste (OSW) has its own draft list of 53 PBT pollutants developed for hazardous waste generators to use in voluntarily minimizing those pollutants in their waste water streams. The Office of Solid Waste plans to pare down its list of 53 pollutants when it issues a final PBT list in September 1999.



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Chemicals listed in the Great Lakes Binational Toxics Strategy:	Chemicals listed in the OSW's Waste Minimization PBT List Docket:	
Aldrin/dieldrin	1,1-Dichloroethane	Endosulfan, alpha-
Benzo(a)pyrene	1,1,1-Trichloroethane	Endosulfan, beta-
Chlordane	1,2-Dichlorobenzene	Fluoranthene
DDT (+DDD+DDE)	1,2,4-Trichlorobenzene	Fluorene
Hexachlorobenzene (HCB)	1,2,4,5-Tetrachlorobenzene	Furans (PCDF)
Alkyl-lead	1,3-Dichlorobenzene	Heptachlor
Mercury and mercury compounds	1,4-Dichlorobenzene	Heptachlor epoxide
Mirex	2-Methylnaphthalene	Heptachlorobenzene
Octachlorostyrene	2,4,5-Trichlorophenol	Heptachlorobutadiene
PCBs	4-Bromophenyl phenyl	Hexachlorocyclohexane, gamma-
PCDD (Dioxins)	Acenaphthene	Lead
PCDF (Furans)	Acenaphthylene	Mercury
Toxaphene	Anthracene	Methoxychlor
	Antimony	Naphthalene
	Arsenic	Nickel
	Benzo(g,h,i)perylene	Nitrobenzene
	Beryllium	Octachlorostyrene
	Bis(2-ethyhexyl)	Pentachlorobenzene
	Butyl benzyl phthalate	Pentachloronitrobenzene
	Cadmium	Pentachlorophenol
	Chloroform	Phenanthrene
	Chromium	Phenol, 2,4,6-tris (1,1- dimethylethyl)
	Copper	Phenol
	Cyanide	Polycyclic aromatic compounds
	Dibutyl phthalate	Pyrene
	Dioxins (PCDD)	Selenium
		Zinc



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The unified list is expected to have about 20 to 25 pollutants on it. The Office of Solid Waste's list may have a core set of pollutants that would correspond to the EPA-wide list, and possibly have an addendum of other PBT pollutants that are of special concern to OSW's program.

Environment Reporter, Volume 29, Number 47, April, 2, 1999, pp. 2378-2379.

Environmental Protection Agency, [The Canada-United States Strategy for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes Basin.](#)

Environmental Protection Agency, [Environmental Fact Sheet – EPA Releases RCRA Waste Minimization PBT Chemical List](#), EPA530-F-98-028, November 1998.

Regulatory Definition of “Discharge of Dredged Material” Revised

The Army Corps of Engineers and the Environmental Protection Agency are promulgating a final rule amending the Federal Water Pollution Control Act (Clean Water Act) Section 404 regulation that defines the term “discharge of dredged material,” (also known as the Tulloch Rule). This action revises that definition to conform with the results of a lawsuit (*National Mining Association vs. U.S. Army Corps of Engineers, 1998*) holding that by asserting jurisdiction over any redeposit of dredged material, including incidental fallback, the agencies had exceeded their statutory authority under the Clean Water Act.

The Tulloch Rule defined “discharge of dredged material” as: “Any addition of dredged material into, including any redeposit within, the waters of the United States.” The term includes, but is not limited to the following “...any addition, including any redeposit, of dredged material, including excavated material, into the waters of the United States which is incidental to any activity, including mechanized landclearing, ditching, channelization, or other excavation.” The definition has been modified in two ways. First, the word “any” is deleted as a modifier for the term “redeposit”. Secondly, “incidental fallback” is excluded from the definition of “discharge of dredged material.” Further information is available at <http://www.epa.gov/owow/wetlands/revise.html>.

Federal Register, Volume 64, Number 89, May 10, 1999, pp. 25119-25123.

EPA Analytical Methodology Updates

Test Procedures for the Analysis of Oil and Grease and Non-Polar Material

Effective June 14, 1999, EPA Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry (hereafter [Method 1664](#)) is approved for use in EPA's Clean Water Act (CWA) programs. This action also deletes Method 9070, and adds revised Method 9071B, which



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addresses the use of n-hexane instead of CFC-113 as the extraction solvent, in a manner consistent with the reference of Method 1664 in its use of n-hexane in Method 1664, for use in EPA's Resource Conservation and Recovery Act (RCRA) programs. Method 1664 is also approved for determination of non-polar material (NPM) as silica gel treated n-hexane extractable material (SGT-HEM) to support phaseout of use of CFC-113 for determination of NPM in EPA's CWA and RCRA programs. [Method 9070](#) will be deleted from SW-846, and [Method 9071B](#) will be included as Update IIIA. The EPA, however, is not withdrawing approval of the use of chlorofluorocarbon (CFC)-based methods, but strongly encourages dischargers/generators/industrial users to modify existing permits to specify Method 1664 instead of waiting for existing permits to expire.

The terms "oil and grease" and "non-polar material" are used in order to differentiate between what they mean in other methods. Non-polar material is used instead of TPH (total petroleum hydrocarbons). Because the nature and amount of the material extracted depends on the solvent used, the term "method-defined analyte" is used to identify oil and grease. The name "n-hexane extractable material (HEM)" reflects that it is the material extracted by normal hexane (n-hexane) that is being measured by Method 1664. Other changes also include Quality Control elements. A matrix spike duplicate is now required and the maximum size of an analytical batch has been set at 20 samples.

These actions are being taken as a part of EPA's effort to reduce dependency on use of CFCs to protect Earth's ozone layer and to meet the CFC phaseout agreed to in the Montreal Protocol and required by the Clean Air Act Amendments of 1990. Method 1664 uses normal hexane (n-hexane) as the extraction solvent in place of 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113; Freon-113), a Class 1 CFC.

Federal Register, Volume 64, Number 93, May 14, 1999, pp. 26315-26327.

Revised Analytical Method for Mercury in Water

The Environmental Protection Agency amended the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* under Section 304(h) of the Clean Water Act effective July 8, 1999, by adding EPA Method 1631, Revision B: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry. EPA Method 1631 measures mercury at the low levels associated with ambient water quality criteria (WQC). EPA has promulgated WQC for mercury at 12 parts-per-trillion (ppt) in the National Toxics Rule, and published a criterion for mercury at 1.3 ppt in the Water Quality Guidance for the Great Lakes System. The version of Method 1631 promulgated in this regulation includes changes to the method based on public comments to the proposal (63 FR 28867, May 26, 1998). These changes increase measurement reliability at WQC levels. The EPA recommends the use of clean sampling and laboratory techniques in conjunction with EPA Method 1631 to preclude contamination at the low ppt levels necessary for mercury determinations. The EPA has published guidance documents on sampling and clean rooms for trace metals, including mercury.

Federal Register, Volume 64, Number 109, June 8, 1999, pp. 30417-30434.



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National Water Quality Criteria Technical Corrections Published

The EPA has published corrections (to correct technical errors) to the National Recommended Water Quality Criteria that was republished in the Federal Register on Thursday, December 10, 1998 (63 FR 68354). A copy of this document (EPA-822-Z-99-001) is available through the EPA National Service Center for Environmental Publications or online at <http://www.epa.gov/OST/standards/wqcriteria.html>. The original December, 1998, document can be found at <http://www.epa.gov/fedrgstr/EPA-WATER/1998/December/Day-10/w30272.htm>.

Federal Register, Volume 64, Number 77, April 22, 1999, p. 19781.

Coral Reef Task Force Reports Available

On June 11, 1998, President Clinton issued Executive Order 13089 dealing with coral reef protection. The major points of this order were:

- All Federal agencies whose actions may affect U.S. coral reef ecosystems must identify the actions that may harm coral reefs; utilize their programs and authorities to protect and enhance the ecosystems; and, to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems.
- Federal agencies are responsible for the implementation of measures to monitor, research, manage, restore, and reduce impacts from pollution, sedimentation, and fishing, in conjunction with the Coral Reef Task Force, fishery management councils, state/local agencies, *etc.*
- It established the Coral Reef Task Force to oversee all policy and Federal Agency responsibilities are complied with and met. They are to play a role in:
 1. coordinating the mapping and monitoring of coral reef ecosystems;
 2. developing and implementing research strategies aimed at identifying the major causes and consequences of coral reef degradation;
 3. developing, recommending, and securing implementation of measures necessary to reduce and mitigate coral reef ecosystem degradation and to restore damaged coral reefs; and
 4. assess the U.S. role in international trade and protection of coral reef species and implement appropriate strategies and actions to promote conservation and sustainable use of coral reef ecosystems worldwide.

Draft recommendations and reports presented to the Coral Reef Task Force in March are available online for review at <http://coralreef.gov/draftrec.html>.

Integrated Sediment Characterization – A Demonstration At Pearl Harbor, Hawaii

By Sabine E. Apitz and Victoria J. Kirtay, Environmental Sciences Division, SSC SD.¹

Introduction/Background

Knowing the geographic extent of sediment contamination within a bay or estuary does not provide sufficient information for a site manager or stakeholder to make optimal decisions on how to manage sediments deemed an ecological risk or regulatory violation. Interactions between contaminants and sediment components, the mode of introduction of contaminants into the sediments, postdepositional weathering and diverse mobility characteristics control behavior of contaminants in marine sediments, their bioavailability, risk, and the best approach to their management.

There are many reasons to address contaminant levels and potential behaviors in a sediment, and the depth of detail required for each is different. When sediments are examined for regulatory compliance, the primary goal is to be sufficiently protective that no sediment which may have the potential to negatively impact the environment slips through a site assessment. To this purpose, relatively crude tools are sufficient, as long as they are designed to err in the direction of protectiveness. On the other hand, once sediments have been designated as either of potential concern or uncontaminated, a less blunt instrument is required to allow for more focused, cost-effective and environmentally-protective management of the sediments in question, as well as better delineating the extent of impacted sediments. The potential consequences are enormous – a sufficient understanding of intrinsic recovery processes may prevent the unnecessary outlay of millions of dollars, or signal those sites on which limited resources should be focused for ecological risk reduction.

Improved decision-making processes can be developed if contaminant distributions and behaviors at the micro- and macro-scales are understood. In such an approach, either sample collection for a site assessment can be guided, or gaps between “standard” data points can be interpolated with on-site field screening tools such as field-portable X-ray fluorescence (FPXRF) for metals, fluorescence for polycyclic aromatic hydrocarbons (PAHs) and the use of bioluminescent phytoplankton for toxicity assessment. Sediments are then divided up into sediment management units (SMUs). A characterization of these SMUs may include an assessment of contaminant/sediment biogeochemistry, including in situ contaminant fluxes, contaminant concentration, mass, organic content and surface area distribution as a function of grain size, intrinsic microbial health and activity, sediment toxicity, and other sediment characteristics which will impact bioavailability, risk, and management choices. With such information in hand, a site manager can make a streamlined and informed decision about what remedial options are available, based upon the site specific sediment characteristics, allowing for rapid progress toward a

¹ For further information on how the use of the integrated sediment field screening tools discussed in this article can increase the effectiveness of sediment characterization efforts and make sediment remediation program efforts more cost effective, contact Jeff Grovhoug, SPAWARSYSCEN D362, 53475 Strothe Road, San Diego, CA, 92152; (619) 553-2773, DSN 553-2773; e-mail: d362@spawar.navy.mil.



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decision and completion. Thus, advanced characterization of SMUs of concern can bridge the gap between raw concentration and toxicity data obtained from chemical and biological analysis of the sediments (site assessment) and intelligent sediment management plans (feasibility studies and site management) by offering a guide to meaningful interpretation of the data.

Sediment Assessment

Before any extensive studies are carried out in the sediments of a coastal area of concern, an initial site assessment must be carried out to delineate the geographic extent of impact (in three dimensions - latitude, longitude and sediment depth). The Navy has carried out such an assessment in a groundbreaking, regional way, examining the distribution of potentially anthropogenic chemicals and impact throughout the Pearl Harbor region. Initial site assessment results in sediment units which can fall into three basic categories: Type I – severely contaminated (and thus ready for examination of remedial options), Type II – questionable (elevated levels found, but impact not certain), or Type III – not of concern.

Sediments are usually categorized as Type I when they are impacted by relatively high levels of one or more contaminants, and they are determined to have the potential to cause immediate ecological impact. Extensive contaminant risk, fate, or behavior studies are usually not needed at these sites, since the issue is quite clear-cut. Such sediments usually justify rapid action such as removal and containment, in order to expedite progress towards reuse of the site. Since such sites generally have a mix of contaminants causing concern, and the problems are considered urgent, most treatment technologies are deemed too expensive and slow to justify. If sediments are categorized as Type III they are eliminated from further consideration. Again, such areas can be removed from further study, and reuse of the site can be initiated.

An effective initial field screening focuses immediate cleanup resources to critical sites and removes attention from clean sites. Thus, in an ideal case, a sizable portion of a sediment site may be rapidly moving towards management and closure. This leaves the more difficult, questionable Type II sediments to deal with. These sediments often only have one or a limited number of contaminants causing concern (though many may be present at low levels). Often it is unclear what the extent of potential impact and bioavailability of contaminants is in such sediments. In many cases, sediments in this category can be a substantial proportion of the total site under investigation, so it is important that higher-level, more extensive studies of these sediments are carried out to determine what the fate and effects of contaminants at the site might be, what the biogeochemical controls of contaminant behavior are at the site, what intrinsic processes are underway which may be aiding in natural recovery, and what relatively low-cost technologies might aid in sediment recovery or impact mitigation.

The technologies which can be brought to bear on the initial site and risk assessment which ranks sediments in the three types above and moves those of concern to rapid, usually containment-based cleanup, can be described as first-order. Most are screening tools and assessment technologies that, though often innovative, are clear-cut, providing analytical results which lead to clear decision pathways. Those which take a closer look at questionable sediments can be described as second order – most of

these examine complex processes such as contaminant/sediment biogeochemical interactions, microbial ecology, and long-term fate and effects which will drive less clear-cut judgments at a site.

Integrated Site Demonstration – Preliminary Results

Scientists from the Space and Naval Warfare Systems Center, San Diego (SSC SD), Environmental Sciences Division, carried out an integrated sediment characterization demonstration at Pearl Harbor in February 1999 (see [Marine Environmental Update, Vol. FY99, No. 2](#)). The goals of this integrated demonstration were manifold. One goal was to carry out a demonstration of several sediment Research, Development, Test & Evaluation projects in an integrated manner at a Navy site with extensive site assessment data available, and at sediment sites with different geochemical characteristics and contaminants of concern. Another goal was to test and demonstrate the applicability of sediment characterization tools to problems at Pearl Harbor, individually and together. It was not the goal of these demonstrations to gather sufficient information to carry out complete risk assessments or management recommendations at these sites. Ultimately, the intent was to utilize advanced sediment characterization tools as appropriate to assist in Pearl Harbor sediment management.

Two sites were selected for the site demonstrations – a region of Middle Loch and a region at Bishop Point (Figure 1). These two sites were selected because they were not in high-traffic areas which might impact operations, and because they represented sites which appeared to have similar levels of metals but different levels of anthropogenic organic compounds, percent fines and natural organic matter. Thus, effects of sediment type on both assessment tools and contaminant behavior could be compared.

Some of the results of this demonstration are still pending, but much of it is synopsized below.

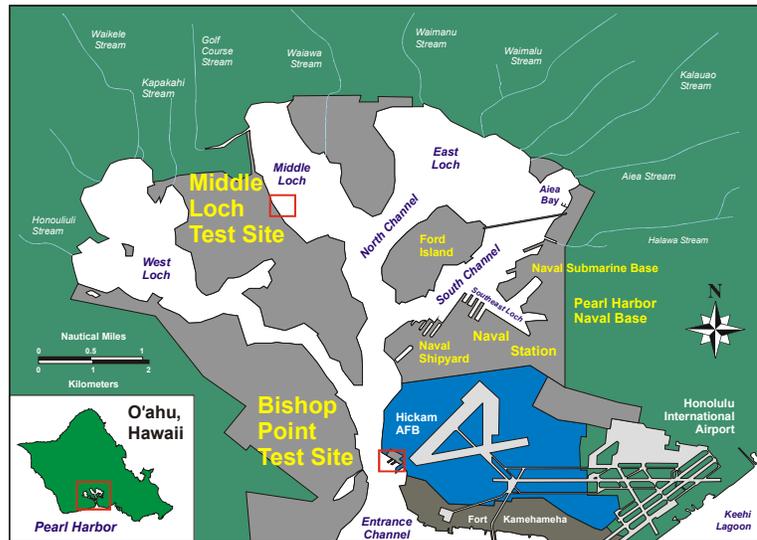


Figure 1. Pearl Harbor, Hawaii, integrated sediment characterization demonstration site locations.

Delineating an Area of Concern by Rapid Field Screening

Field screening for PAHs at Bishop Point can help fine tune an area of concern. Elevated total PAH (tPAH) concentrations in Strata 2 and 3 (Figure 2) appear to be associated with the inboard region near the quay wall and piers. This can focus and minimize the area requiring more extensive study or

management. Field screening values for different analytes showed that the contaminants did not closely co-associate at this site (Figure 3).

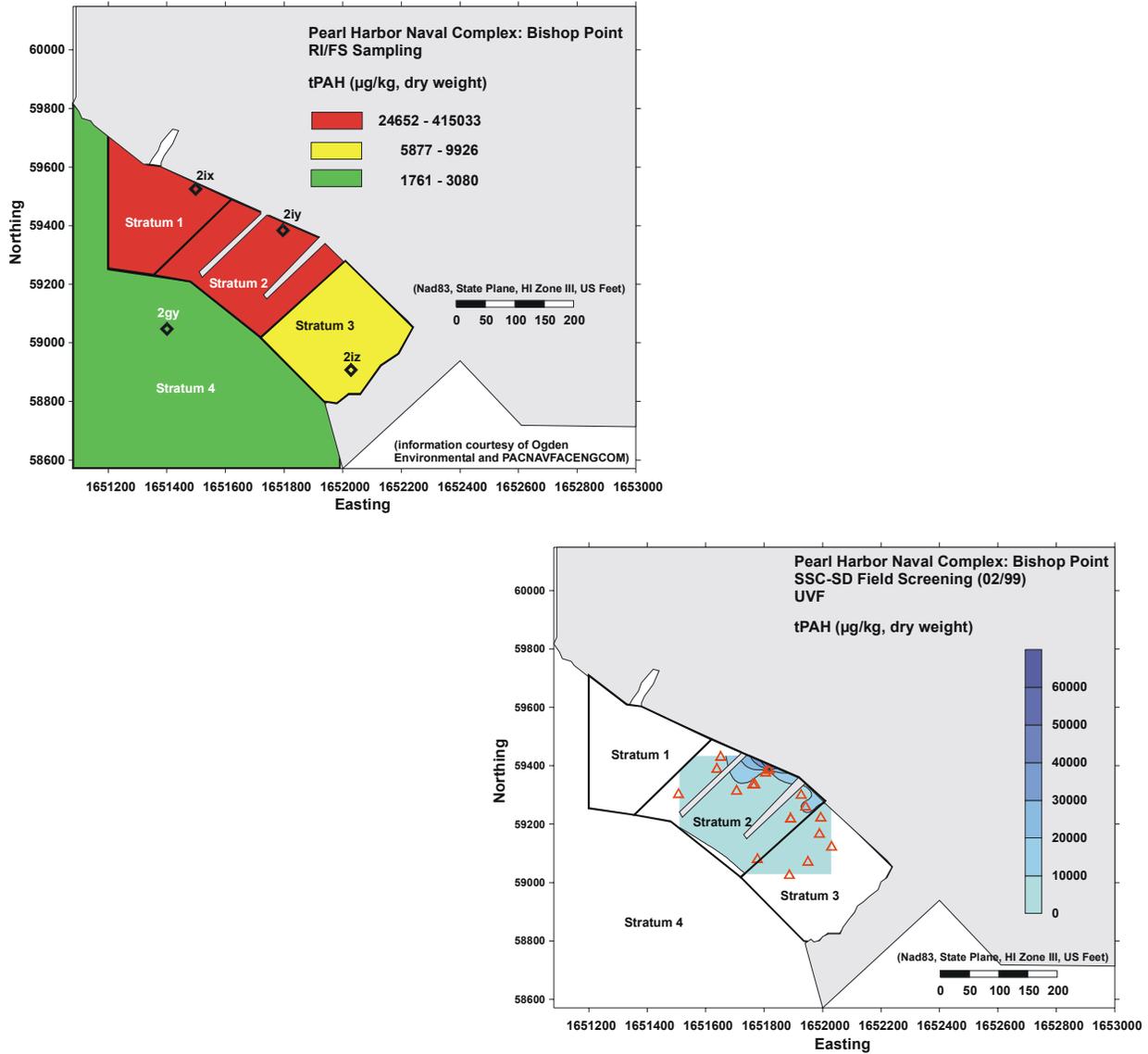


Figure 2. Bishop Point demonstration site sediment tPAH concentrations, Remedial Investigation/Feasibility Study (RI/F/S) sampling vs. Ultraviolet Fluorescence (UVF) field screening.



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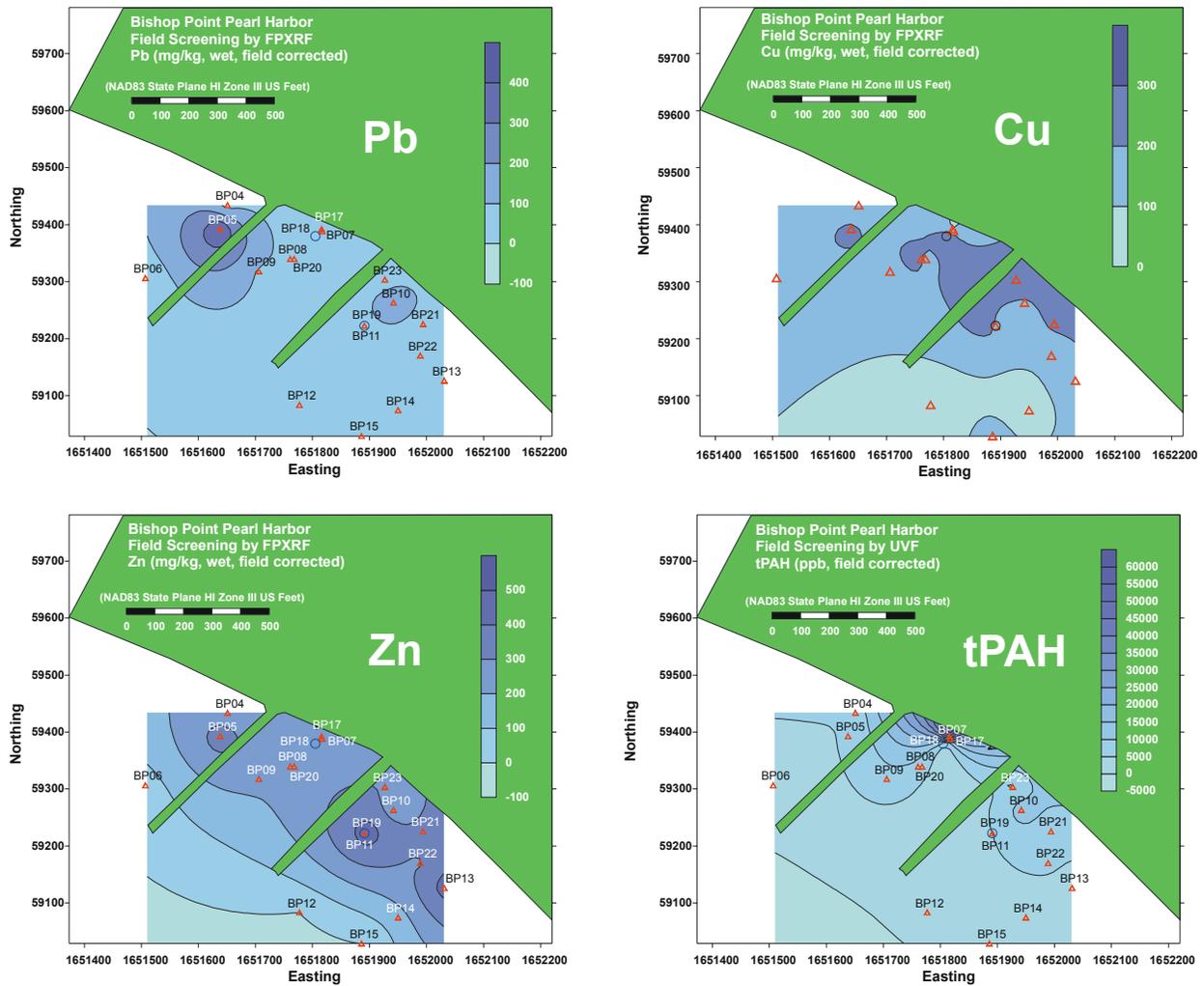


Figure 3. Bishop Point demonstration site sediment field screening results for lead, copper and zinc by Field-Portable X-Ray Fluorescence and tPAH by Ultraviolet Fluorescence.

Other field screening tools utilized during this demonstration lent insight into sediment biogeochemical characteristics which can control contaminant mobility, fate and behavior (Figure 4).



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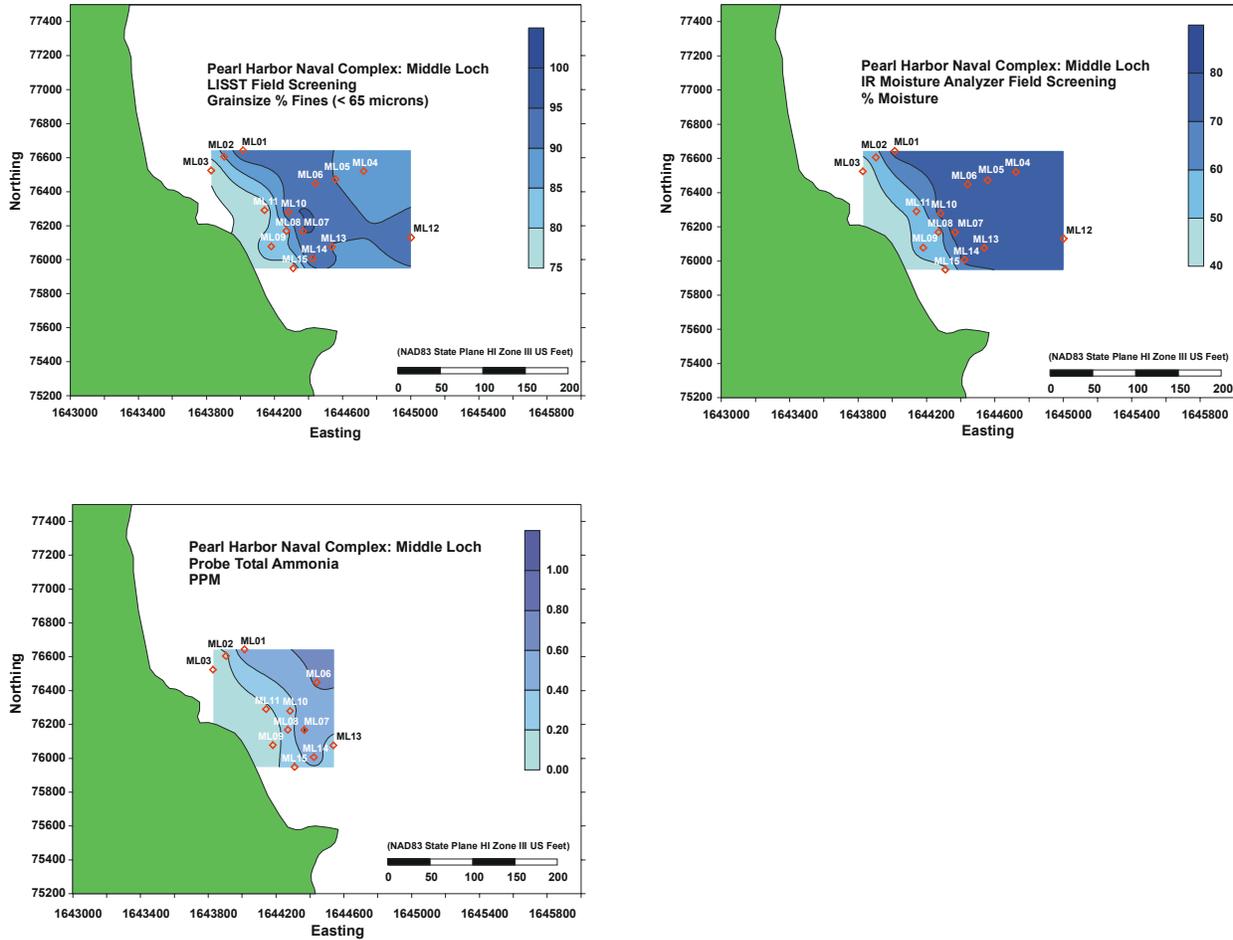


Figure 4. Middle Loch demonstration site sediment field screening results for grain size (Laser In-Situ Sediment Scattering Transmissometer), % moisture (Infrared Moisture Analyzer) and total ammonia (probe).

QwikSed Toxicity Results at Middle Loch and Bishop Point

Analysis of the QwikSed bioassay (see [Marine Environmental Update, Vol. FY98, No. 4](#), for information on the QwikLite/QwikSed bioassay) toxicity field screening data from the Middle Loch and Bishop Point demonstration sites (Figure 5) revealed no significant sediment toxicity at the Middle Loch site. However, 70% of the stations at the Bishop Point demonstration site exhibited significant toxicity. It is interesting to note that field screening data showed that total PAH sediment concentrations were ten times higher at the Bishop Point site than at the Middle Loch site.



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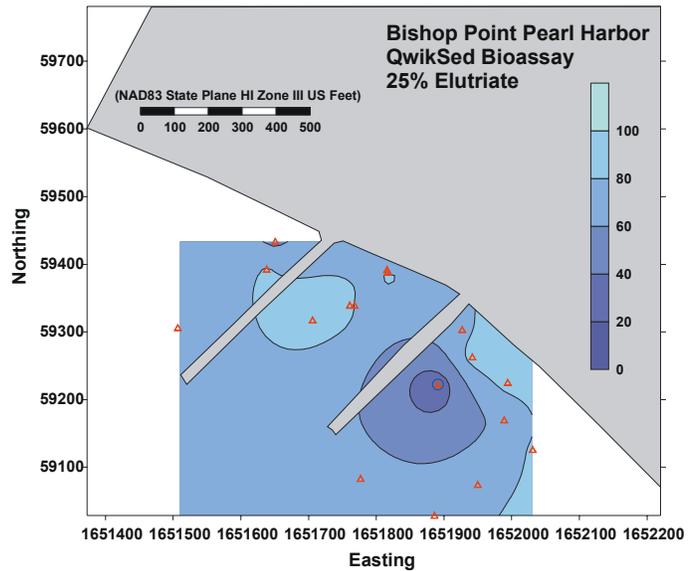
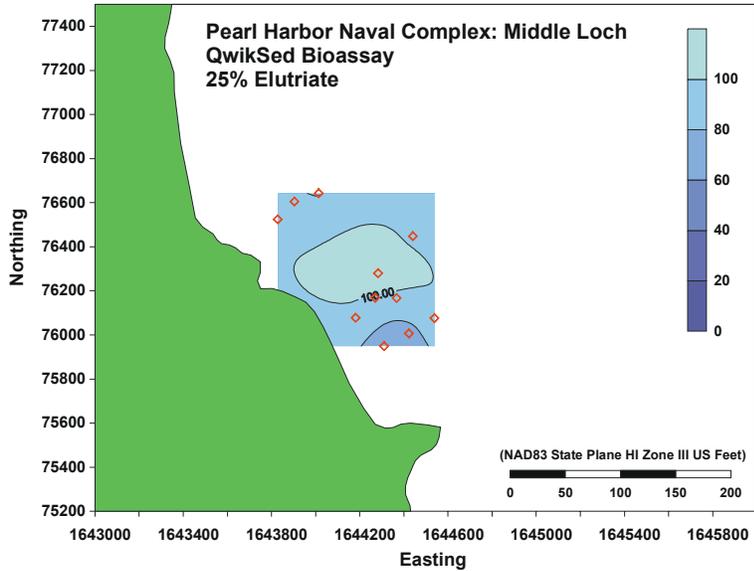


Figure 5. QwikSed bioassay results for the Middle Loch and Bishop Point demonstration sites.

Integrating Field Screening Results

When the results of multiple screening tools are integrated, one can begin to examine the effects of various management criteria on site classification. Individual screening tools can map the distribution of individual analytes or parameters, but risk assessment, hazard ranking and site management is generally driven by multiple parameters. Thus, when screening tools are integrated, one obtains insight into the



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“whole system” – how contaminants co-associate with each other and with biological indicators. How multiple parameters are combined depends upon the regulatory criteria and management goals, which must be defined *a priori*. The relative impact of different priorities to site ranking can also be investigated. In the following examples (Figure 6 and Figure 7), screening results for one metal (Zn), total PAHs and one toxicity assay (QwikSed) were combined.

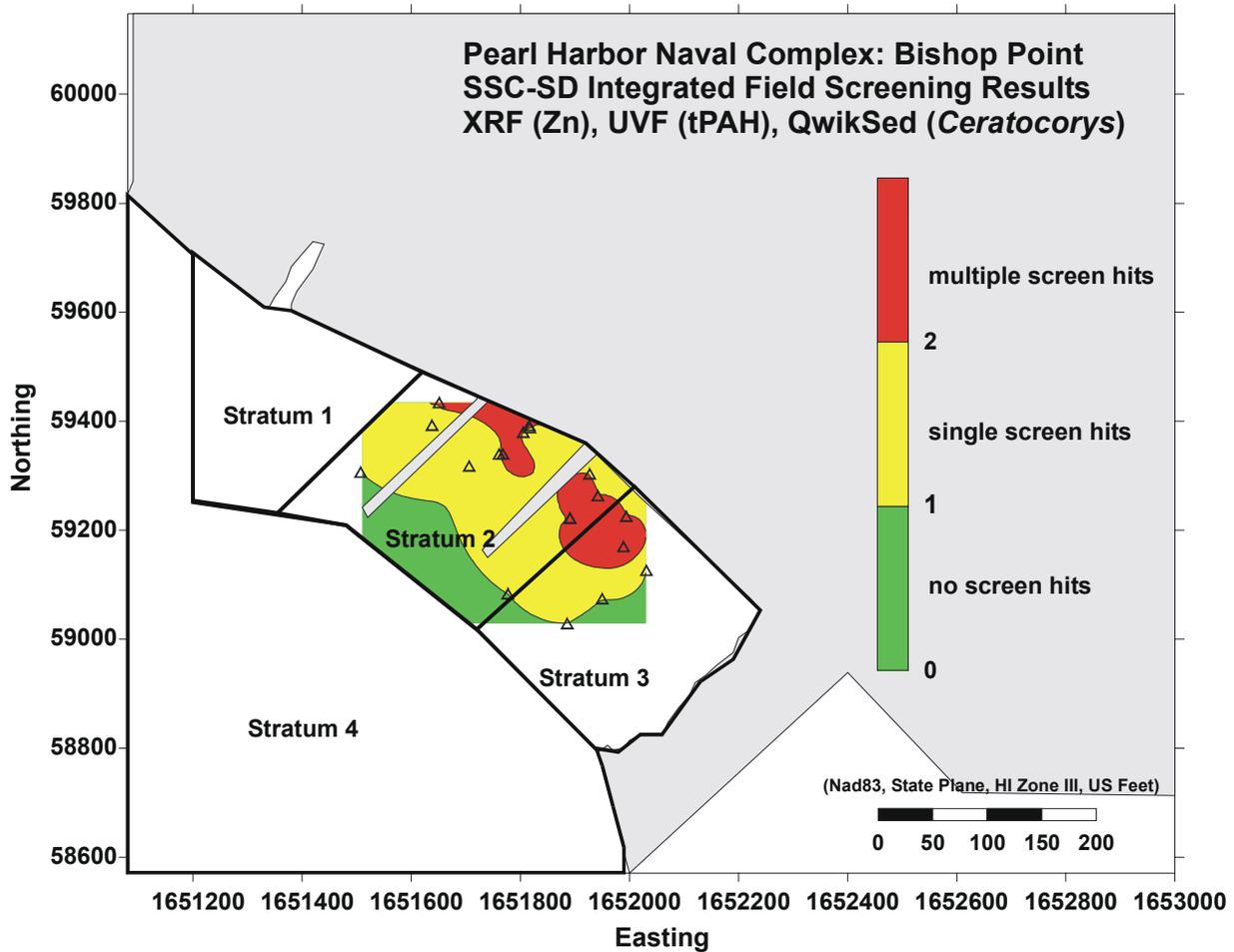


Figure 6. Bishop Point demonstration site integrated field screening results. Screening criteria “hits” are defined as: zinc concentration >250 ppm; tPAH concentration >Effects Range-Low (ERL); and QwikSed bioluminescence output <80% of control.



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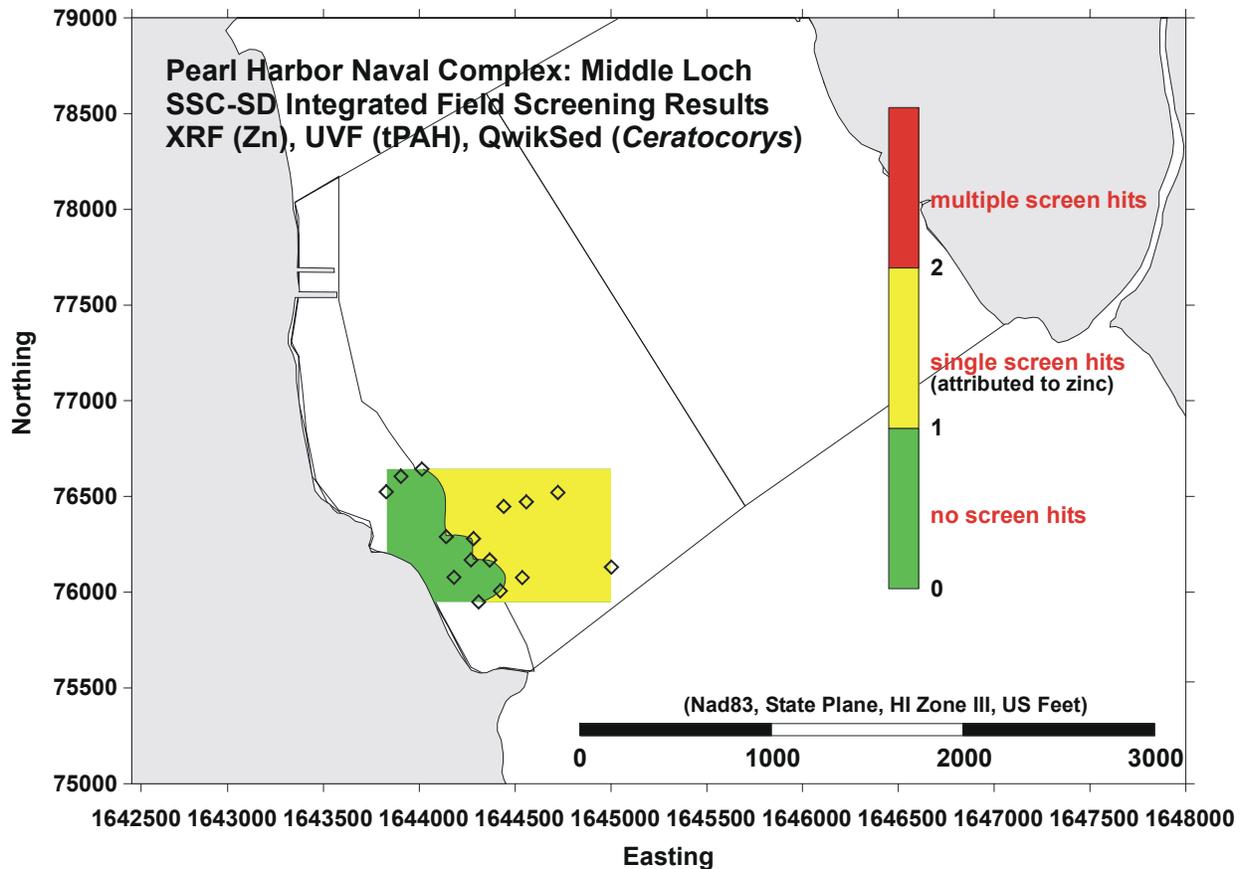


Figure 7. Middle Loch demonstration site integrated field screening results. Screening criteria “hits” are defined as: zinc concentration >250 ppm; tPAH concentration >ERL; and QwikSed bioluminescence output <80% of control.

Benthic Flux Sampling Device

The [Benthic Flux Sampling Device](#) (BFSD) was deployed at one site each in Middle Loch and Bishop Point, with the location of the BFSD guided by field-portable XRF and GPS. The BFSD isolates a volume of water at the sediment – seawater interface for a chosen period of time. Water collected over the deployment time can be analyzed to determine changes in metals’ concentrations over time. Changes in concentration over time are used to quantify fluxes of metals from, or into, the sediment (sediment/seawater exchange). Fluxes indicate contaminant mobility and help in determining contaminant mass balance, fate and availability, as well as amenability to different management strategies.

Middle Loch and Bishop Point show similar metals fluxing, but significant differences in flux rates. In general, Bishop Point fluxes for metals were higher than those at Middle Loch. Metal flux rates can be



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used to quantify the contribution of sediments to overall exposure in Pearl Harbor. Flux measurements can be used to determine if an exposure pathway exists between the sediments and a specified endpoint. Flux measurements can be used to quantify the natural rate at which metals are attenuated in sediments.

Copper flux at the Middle Loch site was $\sim 15 \mu\text{g}/\text{m}^2/\text{day}$ (Figure 8). Sediment grabbed from the same site had 189 ppm Cu (total digestion). On the other hand, Cu flux at the Bishop Point site was $\sim 112 \mu\text{g}/\text{m}^2/\text{day}$ (Figure 9). Sediment grabbed from the same site had 241 ppm Cu (total digestion). The different Cu fluxes from sediments with similar Cu concentrations shows that examining bulk sediment values alone does not tell the whole story – sediments with different geochemistry, *etc.*, but the same contaminant levels may cause very different impacts.

The need to examine site-specific geochemistry is particularly important at a non-continental site, such as Pearl Harbor, which has sediments with natural geochemistries which are different than “typical” continental sites (for which the bulk to chemistry/toxicity correlations such as ERL/ERM² have been generated).

Looking at the Big Geochemical Picture: Comparisons with Ambient Trends

When sediment copper concentrations are plotted against sediment iron concentrations for the Bishop Point site (Site 2) and the Middle Loch site (Site 4), the following differences were observed (Figure 10):

² Long, E.R. D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. *Environmental Management*. Vol. 19, No. 1, pp. 81-97.

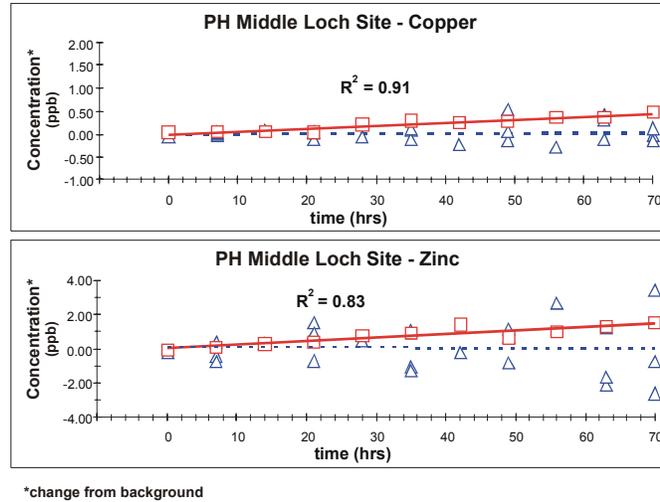


Figure 8. Cu and Zn values in BFSD sample and control bottles over time at the Middle Loch demonstration site.

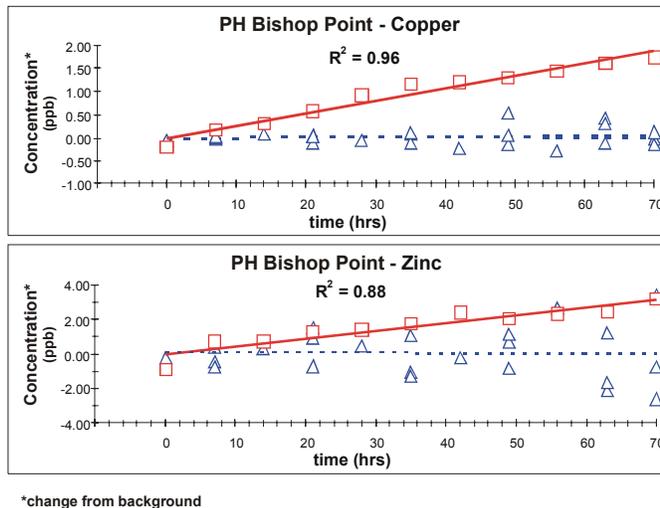


Figure 9. Cu and Zn values in BFSD sample and control bottles over time at the Bishop Point demonstration site.



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- Site 4 samples were iron-rich, with copper concentrations consistent with the ambient trend;
- Site 2 samples were iron-poor, with copper above the ambient trend; and
- The elevated copper in Site 4 samples is probably of natural origin, not requiring remediation.

It is clear from the above observations that some sites within Pearl Harbor which have high concentrations of metals (“hits”) require closer examination to determine if those metals are truly of concern. Some tools available for such an examination are the use of the BFSM to examine in situ mobility, examination of site-specific toxicity of these sediments, and a more thorough geochemical characterization of sediments at these sites to determine potential sources of the metals of interest, or the mineralogical controls of metal behavior at the sites.

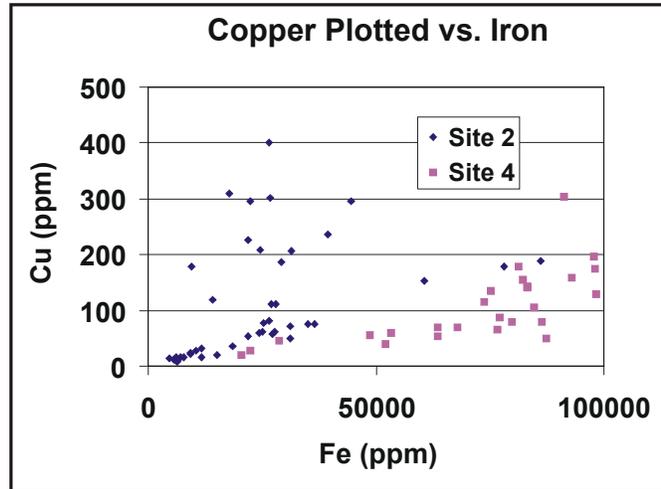


Figure 10. Sediment copper concentrations plotted against iron for the Bishop Point and Middle Loch demonstration sites.

In order to examine these and other issues, sediment cores were collected at the two sites, and these cores were brought back to SSC SD for detailed geochemical characterization. Based upon field screening results, sediment regions were laid out into regions which might be managed as a unit. Cores collected within each of these sediment management units, or SMUs, were homogenized, and the analysis of these cores is still underway. Sediments from each SMU were sent to a contract laboratory for bulk analysis of a suite of organic and inorganic contaminants. Sediments have undergone size separation. Each size fraction, as well as the bulk sediment samples, is being analyzed for contaminant concentration, natural organic content, specific surface area and, where appropriate, sediment mineralogy. This suite of analyses will provide information about the geochemical characteristics which can affect contaminant behavior and risk, and provide insight into potential contaminant sources and management strategies (Figure 11).



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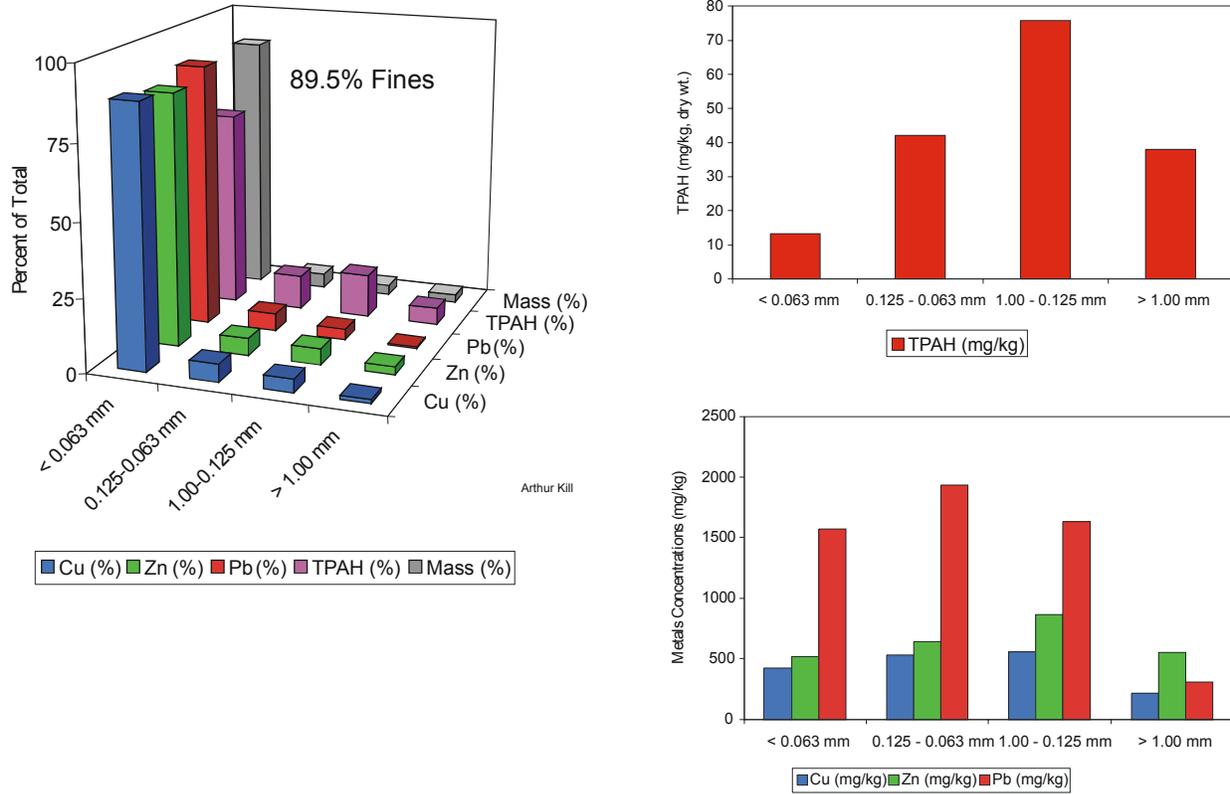


Figure 11. Hypothetical potential management strategy based on SMU geochemical "fingerprint." In this example, contaminants are not associated with a specific sediment grain size fraction. Also, the "fine" fraction constitutes the highest proportion of the mass. The high lead content of the "fine" fraction signals a potential problem during dredging – controls should be considered.

Conclusion

With integrated and advanced sediment characterization information in hand, a site manager can make a streamlined and informed decision about what remedial options are available, based upon site-specific sediment characteristics, allowing for rapid progress toward a decision and completion. Thus, BFSR results, 3D characterization and advanced characterization of SMUs of concern can help bridge the gap between raw concentration and toxicity data obtained from chemical and biological analysis of the sediments (site assessment) and intelligent sediment management plans (feasibility studies and site management) by offering a guide to meaningful interpretation of the data.



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About the Marine Environmental Update

This newsletter is produced quarterly by the Marine Environmental Support Office (MESO), and is dedicated specifically to inform the Navy about marine environmental issues that may influence how the Navy conducts its operations. MESO is located at the Space and Naval Warfare Systems Center, San Diego, California. The mission of MESO is to provide Navy-wide technical and scientific support on marine environmental science, protection and compliance issues. This support covers a broad spectrum of activities, including routine requests for data and information, technical review and consultation, laboratory and field studies, comprehensive environmental assessments, and technology transfer. Significant developments in marine environmental law, policy, and scientific advancements will be included in the newsletter, along with references and points of contact for further information.

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