

# Revised DMMP Framework for Dioxins in Dredged Material

## Why is the DMMP Framework Being Revised?

- ❖ The DMMP agencies are in the process of developing new guidelines for determining the suitability of dredged material that contains dioxins for open-water disposal.
- ❖ Previous dioxin guidelines were based on an evaluation of human risk for a specific area (Grays Harbor) that has been shown not to be applicable to Puget Sound conditions.
- ❖ The DMMP agencies are coordinating this process with the Puget Sound Initiative, which is addressing the quality of Puget Sound as a whole.

## What Has Been Done So Far?

- ❖ The first step in this process was to receive stakeholder input through response to a questionnaire that was available via the US Army Corps of Engineers (USACE) website in May 2007.
- ❖ With input from the questionnaire, the DMMP Dioxin Work Group has developed potential options for a revised dioxin framework—for consideration and discussion at public meetings.

## The Process Forward and Timeline

### September-November 2007

- ❖ The next step in the process is to receive input on the potential options from a wide variety of interested parties; including Tribes, Ports, Agencies, Environmental Groups, and Community Members during a series of public meetings.
- ❖ **Public meetings will be held from September 26 to October 16**, in different regions of Puget Sound.
- ❖ **Technical workshops will be conducted in late October and early November** for in-depth discussion of the science and data related to dioxin exposure and risk, defining “background” concentrations of dioxin in sediments and tissues, and other topics relating to the development of interpretive guidelines.

### November 2007-March 2008

- ❖ The DMMP Agencies will review the outcomes of the public meetings and technical workshops and develop a recommendation for a revised framework for dioxins in dredged material.

### March-May 2008

- ❖ The DMMP agencies framework recommendation will be presented as an issue paper at the Sediment Management Annual Review Meeting (SMARM) 2008 for public comment.
- ❖ SMARM is generally held each May to obtain public input on proposed changes to the DMMP Management Plans. Additionally, disposal site management actions and changes, Ecology cleanup activities, and USEPA Regional cleanup activities are discussed.
- ❖ SMARM attendance is open to the public. SMARM is generally hosted by the Seattle District Corps of Engineers and is held at Federal Center South, Seattle, WA. Closer to SMARM 2008, more information will be posted on the Dredged Material Management Office (DMMO) homepage:  
<http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=dmmo&pagename=home>

## Where to Provide Input on the Framework Options and Process

- ❖ Following the public meeting, you can send input to the DMMP Dioxin Group at: [dioxin.project@floydsnyder.com](mailto:dioxin.project@floydsnyder.com). **Please submit input by November 15, 2007.**

Additional information regarding the public meetings and contact information can be found at [http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=DMMO&pagename=Dioxin Work Group](http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=DMMO&pagename=Dioxin%20Work%20Group)

# The Dredged Material Management Program (DMMP)

## What is the DMMP?

- ❖ The US Army Corps of Engineers, USEPA, Washington State Departments of Ecology and Natural Resources run this cooperative program for the assessment of dredged material and monitoring of disposal sites.

## How is Dredged Material Assessed?

- ❖ Chemical, bioassay, and bioaccumulation testing are used to assess the quality of dredged material. Results from these tests are compared against established guidelines to determine the suitability of dredged material for disposal at the DMMP disposal sites.

## Where are the DMMP Disposal Sites?

- ❖ The maps at right show the five non-dispersive and three dispersive sites in Puget Sound and five dispersive sites on the Pacific coast. Non-dispersive sites have low current velocities so that disposed dredged material remains on-site. Dispersive sites have much higher current velocities and disposed material is quickly dispersed. Non-dispersive sites are monitored regularly, while dispersive sites are only subject to occasional bathymetric surveys to ensure that dredged material is being dispersed as predicted.

## How are Non-dispersive Sites Monitored?

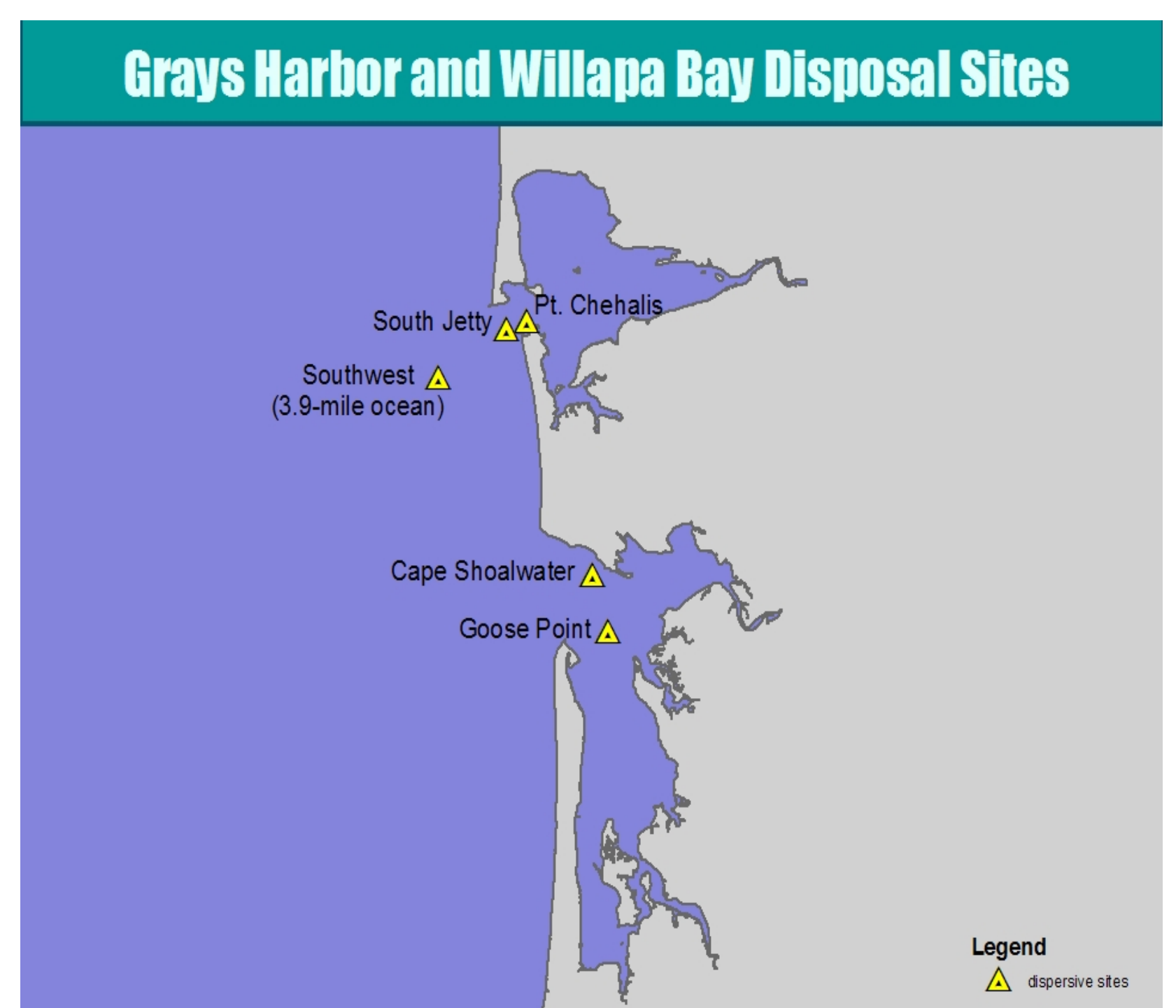
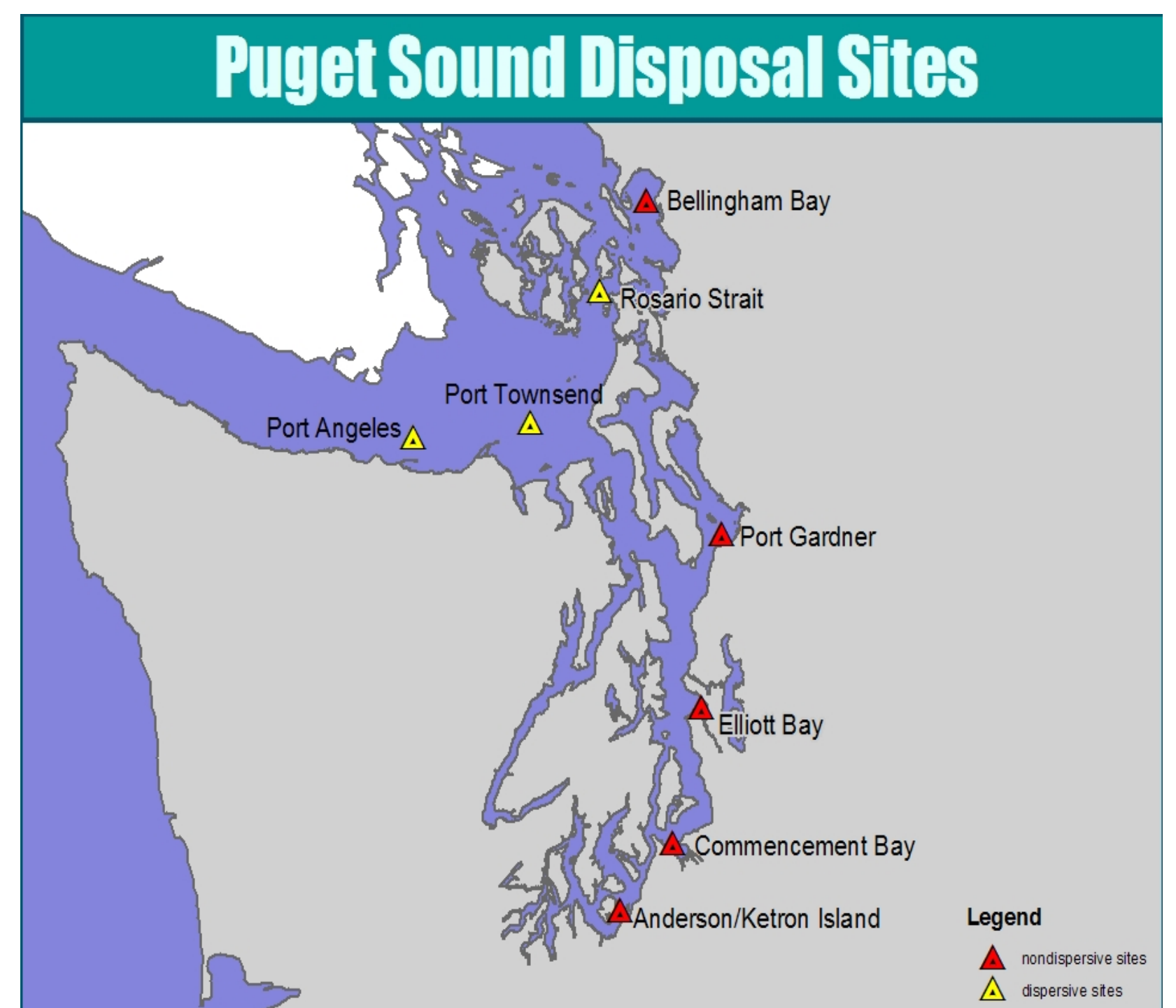
- ❖ Sediment image profiling technology is used to map the footprint of disposed material.
- ❖ Chemical analyses and bioaccumulation testing provide feedback regarding the concentration of chemicals of concern on-site and help detect any off-site movement of dredged material.
- ❖ Bioassays are conducted on sediment from within the disposal site to ensure that benthic organisms are not being impacted beyond "Site Condition II."
- ❖ Benthic surveys provide an indication of sediment quality and help track trends in benthic populations over time.

## What are "Site Management Conditions" and What is "Site Condition II"?

- ❖ During the Puget Sound Dredged Disposal Analysis (PSDDA) study, management goals were formulated for the disposal sites and are referred to as "site management conditions" or simply "site conditions."
- ❖ Site Condition I (no adverse effects) applies to dispersive sites, and means no benthic biological effects exceed guidelines indicating acute or chronic toxicity, and human health risks are not greater than 1 in 100,000 estimated incremental lifetime cancer risks.
- ❖ Site Condition II (minor adverse effects) applies to non-dispersive sites, and means some benthic biological effects may exceed acute or chronic toxicity guidelines (but limits the number and intensity of these exceedances), and human health risks are not greater than 1 in 100,000 estimated incremental lifetime cancer risks.
- ❖ Comparison points for determining significance of biological effects are Puget Sound or coastal reference areas, such as Carr Inlet or North Bay in Grays Harbor.

## How do Site Management Conditions Relate to Dioxins?

- ❖ Dioxin risk associated with human cancer will drive this process, since dioxin levels that are associated with acute or chronic effects in wildlife are presumed to be much higher than levels that are associated with human cancer risk from ingestion of seafood.



Additional information regarding the public meetings and contact information can be found at:

[http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=DMMO&pagename=Dioxin Work Group](http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=DMMO&pagename=Dioxin%20Work%20Group)

# Dioxins and Dioxin-like Compounds

## What are These Compounds?

- ❖ Three dioxin-like compounds are illustrated in Figure 1, including the polychlorinated dioxin-furan group (PCDD/F) and polychlorinated biphenyls (PCBs). Different combinations of numbers and positions of chlorine atoms have different toxicities. Toxicity is thought to be associated with the plate-like structures at each end of the molecule that are caused by the presence of chlorine (Cl) atoms. Dioxin toxicities are orders of magnitudes greater than those of PCBs.
- ❖ Since dioxin-like compounds all act through the same toxicity mechanisms, cumulative effects for these compounds must be considered.
  - USEPA, the National Research Council, numerous states, and the World Health Organization (WHO) have recommended adoption of “toxicity equivalency factors” (TEFs), which convert the chemical concentrations to an equivalent concentration of 2,3,7,8-TCDD, which is the most toxic compound of this group (Van den Berg et al. 2005).
  - The concentration of dioxin-like compounds times their TEFs equals the “toxic equivalence” (TEQ), which indicates the combined toxicity for an environmental sample.

## What is the Basis for Concern about These Compounds?

- ❖ These compounds are carcinogenic and toxic (ATSDR fact sheets), although there is scientific controversy regarding how to estimate effects at low doses (such as those Americans commonly receive). The USEPA addresses the toxicity of these compounds in a protective manner (USEPA 2003).
- ❖ PCDD/F result unintentionally from many industrial processes and persist in the environment where they tend to concentrate in fats, and magnify in the food web.
- ❖ Air deposition as well as historic discharges from industries such as chlorine pulp mills, wood treatment, and pesticide manufacturing provide sources for PCDD/F in sediments.
- ❖ Dioxins are also produced by natural events, including forest fires and volcanic activity.

## How am I Exposed to PCDD/F?

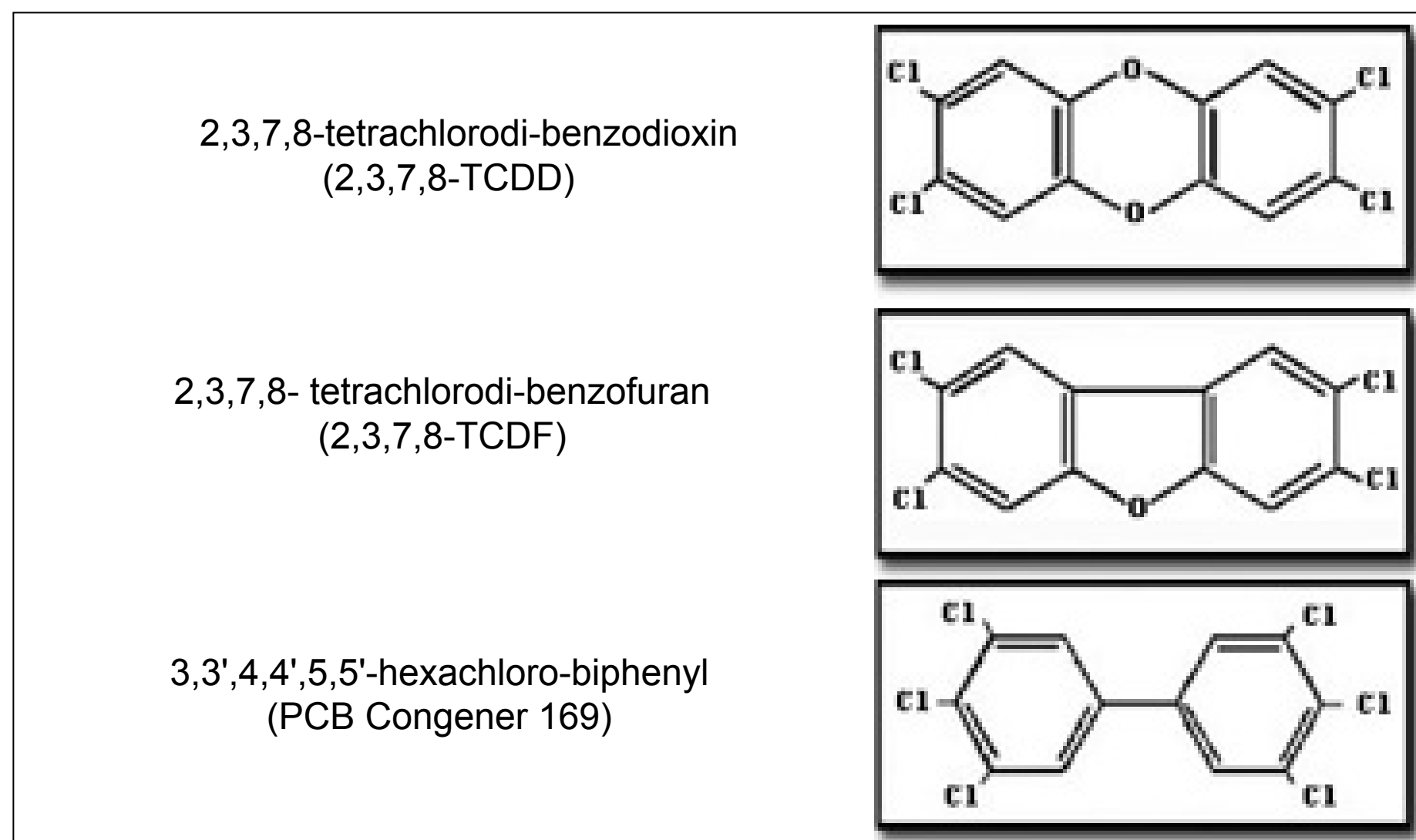
- ❖ For a typical American, the primary source of dioxins is dietary, including beef, pork, fish, and dairy products (Figure 2). Seafood contributes about 7% of the total intake. However, some populations, such as subsistence Tribal consumers, may eat higher levels of seafood, which increases its importance.
- ❖ TEQ data for PCDD/F in seafood species in Puget Sound are provided in Figure 3. For example, if a recreational fisher consumes 54 g of average crab meat (0.52 picograms/g), this would represent 28 pg of TEQ, similar to the daily intake of TEQs in dairy food.
- ❖ Figure 4 presents TEQ data for seafood around the world; comparison to Figure 3 shows that Puget Sound is fairly representative of what is found elsewhere.

## What is Being Done to Reduce My Exposure to PCDD/F?

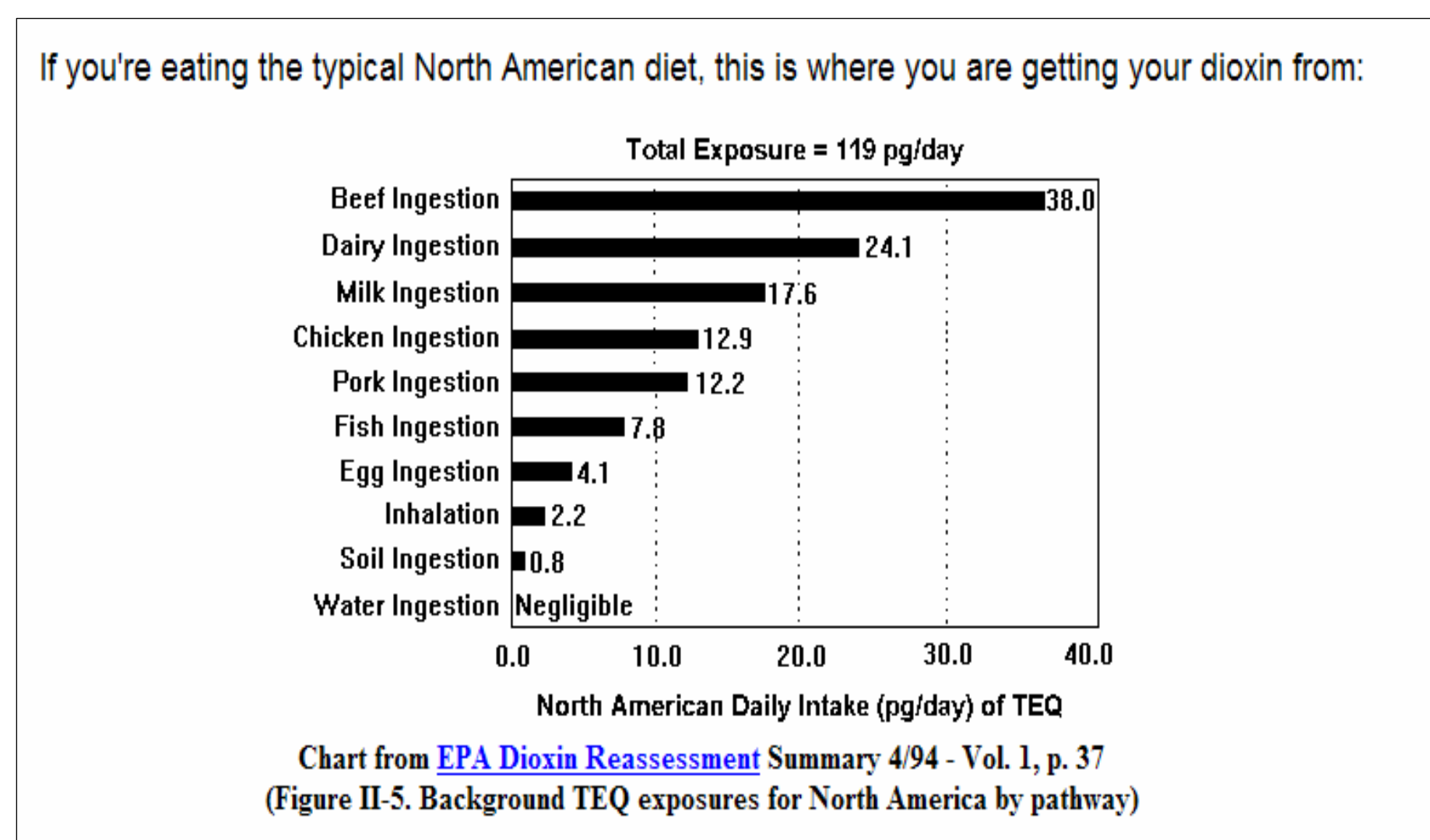
- ❖ The USEPA and States are making efforts to reduce releases of these compounds to the environment by working with industries to close off sources (such as combustion byproducts), by stopping production of pesticide sources, and by regulating surface waters. Observed environmental levels have declined by about 89% from 1987 (USEPA 2003).
- ❖ The US Department of Agriculture (USDA) tracks the downward trend in food.
- ❖ Posted signs warn against eating seafood from affected waterways, and suggest limiting contact with water and sediments where warranted.

# Dioxins and Dioxin-like Compounds

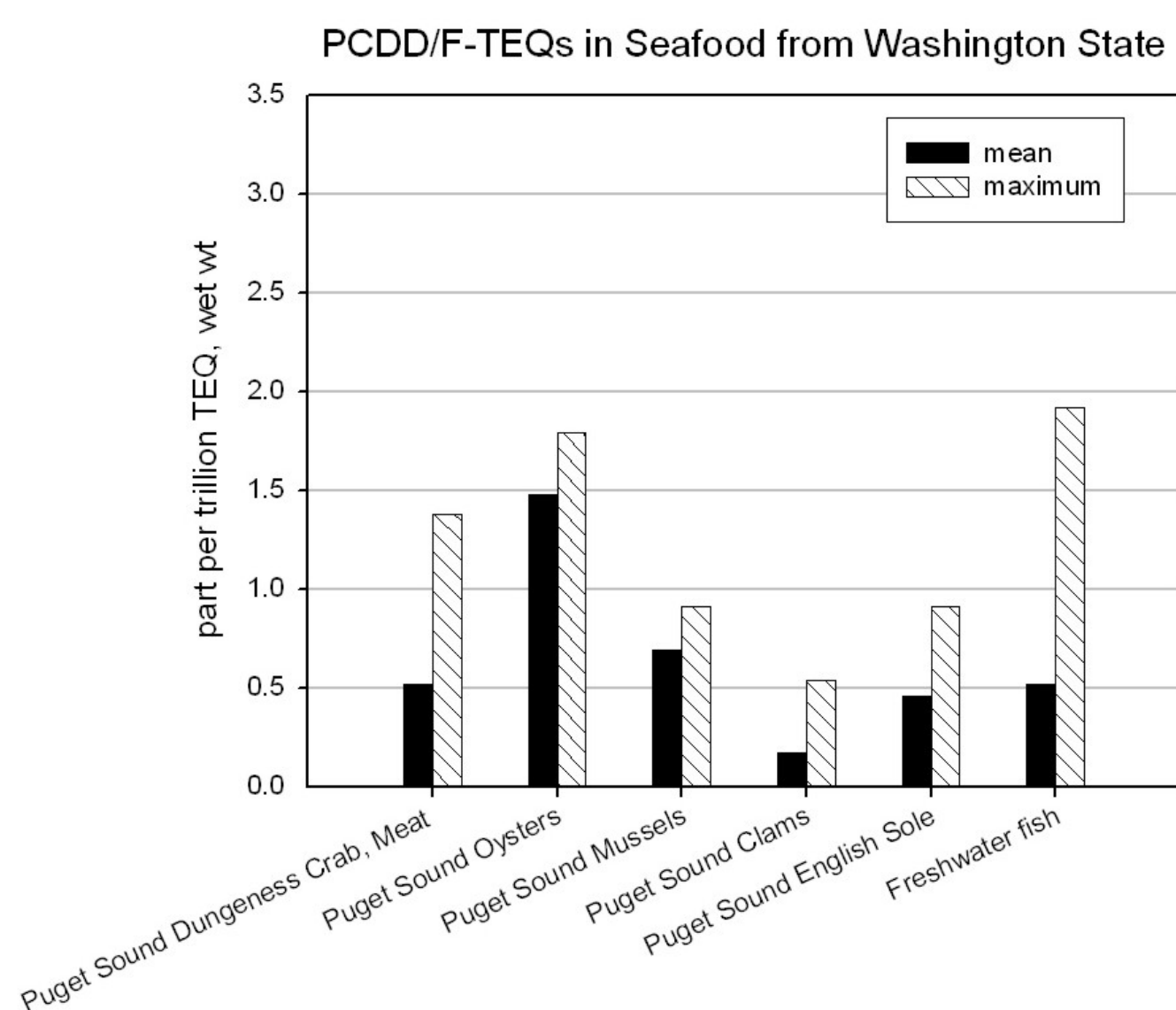
**Figure 1. Dioxin-like Compound Basic Structures**



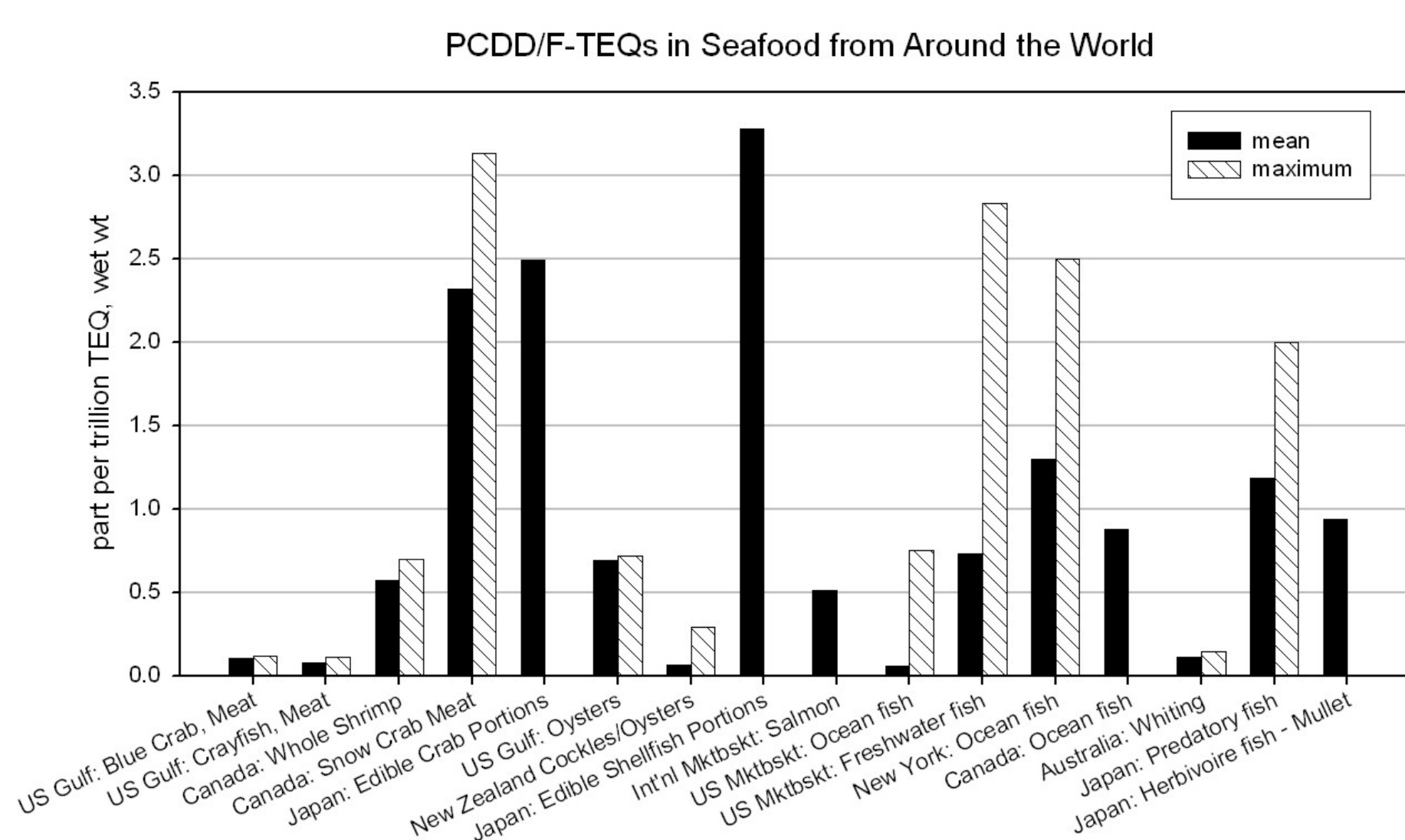
**Figure 2. PCDD/F Intake in a Typical American Diet (USDA)**



**Figure 3. PCDD/F TEQ in Puget Sound Seafood**



**Figure 4. PCFF/F TEQ in Seafood around the World**



**Notes:**

For Figures 3 and 4, data older than 15 years were excluded. References for the data sources are provided in the meeting handouts.

Dungeness crab butter is not shown in Figure 3, since there are no world-wide numbers available for comparison. The mean and maximum dioxin TEQ values for crab butter are 5.7 ppt and 14.9 ppt, respectively

# How Does the DMMP Currently Address Dredged Material Containing Dioxins under the Interim Approach?

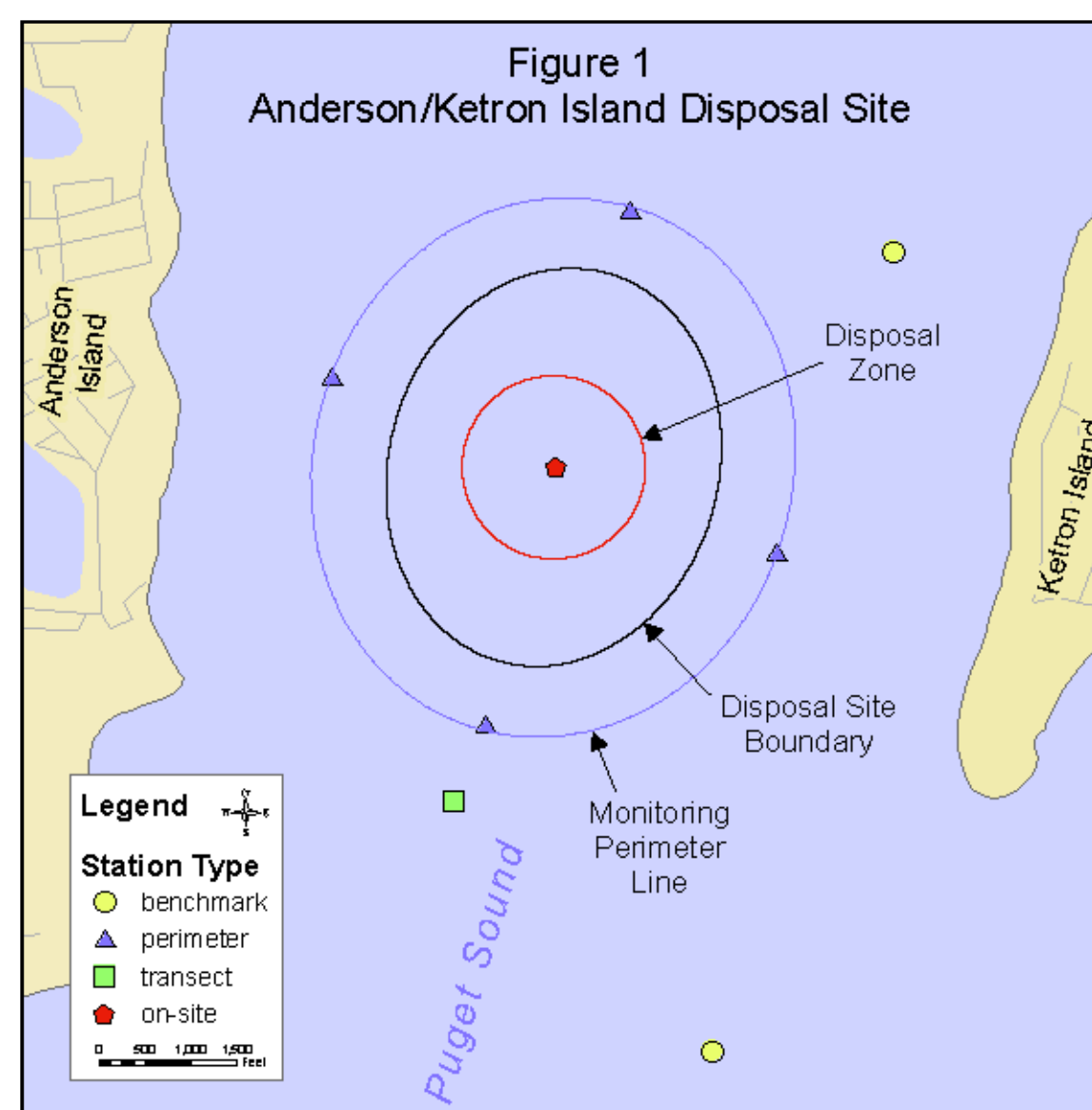
An interim approach, described below, is currently in place until there are revised guidelines in 2008.

## Which Dredging Projects Need to Test for Dioxins?

- ❖ The need for sediment testing of dioxins is determined on a case-by-case basis where there is reason to suspect presence of these chemicals (e.g., based on proximity to current or historical point sources and/or as documented by existing data from the area). Point sources include chlor-oxide bleach process pulp mills, chlor-alkali or chlorinated solvent manufacturing plants, phenoxy herbicide use and handling areas, and former wood treatment sites. Areas with high PCB concentrations are also likely to have dioxins present.

## How are Suitability Determinations Made for Disposal of Dredged Material Containing Dioxins?

- ❖ Based on a comparison of dioxin in test sediments to disposal-site or reference background.
- ❖ For non-dispersive sites, background is defined using disposal-site sediment dioxin data generated as part of DMMP site monitoring.
- ❖ Disposal-site sediment dioxin concentrations are determined from perimeter, transect, and benchmark locations (Figure 1).
- ❖ Dioxin concentrations in any given dredged material management unit may not exceed site maximum (Table 1).
- ❖ Average dioxin concentrations (weighted to the volume of each dredged material management unit) cannot exceed mean site concentration.
- ❖ For dispersive sites, background is defined using sediment dioxin data from nearest reference site.
- ❖ The available reference site dioxin data are limited to Carr Inlet and Sequim Bay. It is dredger's responsibility to sample nearest reference site if data are not available.
- ❖ Bioaccumulation testing for dioxin is currently not used to determine suitability for either dispersive or non-dispersive sites.



## Why Have This Interim Approach?

- ❖ To have a predictable and consistent approach to facilitate current dredging projects.
- ❖ Insures that continued dredged material disposal will not result in a significant increase in sediment dioxin at disposal sites.

## How Has it Been Implemented?

- ❖ Dioxin values calculated in Table 1 exclude dioxin data from on-site stations and outliers.
- ❖ For comparative purposes, the dioxin TEQ concentrations (ng/kg-dw) detected in the two reference areas were; Carr Inlet (mean = 0.52, maximum = 0.78) and Sequim Bay (mean = 0.24, maximum = 0.36).

Note: Mean and maximum sediment dioxin toxic equivalence (TEQ) values are derived from three sediment samples in Sequim Bay and three sediment samples in Carr Inlet.

Disposal Site	Mean	Maximum
Port Gardner	4.1	5.2
Anderson Ketron	3.6	6.8
Bellingham Bay	6.9	10.5
Elliott Bay	8.0	10.6
Commencement Bay	2.1	4.1

Additional information regarding the public meetings and contact information can be found at [http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=DMMO&pagename=Dioxin\\_Work\\_Group](http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=DMMO&pagename=Dioxin_Work_Group)

# Revised DMMP Framework Options for Dioxins in Dredged Material

- ❖ The DMMP Dioxin Work Group developed a range of five potential new framework options; risk- and background-based options. Risk assessment options are based on protecting human health via seafood consumption.
- ❖ Based on what is known about food webs and trophic level transfers of contaminants, being protective of human health is believed to be protective of wildlife (marine mammals and birds).
- ❖ Risk-based Options 1 and 2 may result in sediment numbers that are less than existing concentrations throughout Puget Sound. Therefore, a tiered approach could be utilized, to evaluate a risk option, but default to a background option.
- ❖ Likely all options, except Option 5, are applicable to both non-dispersive and dispersive disposal sites.

## Option 1: One Set of Numbers for Puget Sound Based on Risk Assessment

- ❖ Acceptable tissue levels and possibly related sediment concentration determined by risk assessment
- ❖ Using assumptions that relate to all of Puget Sound
- ❖ Assuming Tribal subsistence seafood consumption
- ❖ Uses generic disposal site assumptions

### Considerations

- Risk-based numbers likely less than existing non-urban conditions—therefore may not be implementable
- Protective of human health and wildlife
- Would significantly impact ability to dispose of dredged material at the DMMP sites, with significant economic impacts to harbor users
- If not dredged, material would remain in more biologically active harbor areas
- Risk assessment results are subject to change with changing dioxin science
- Within current regulations and consistent with current programs

## Option 2: Multiple Sets of Numbers, One Set for Each Disposal Site Based on Risk Assessment

- ❖ Acceptable tissue levels and related sediment concentration determined by risk assessment
- ❖ Using site-specific assumptions that relate to each non-dispersive disposal site
- ❖ Assuming Tribal subsistence seafood consumption

### Considerations

- Risk-based numbers likely less than existing non-urban conditions—therefore may not be implementable
- Protective of human health and wildlife
- More realistic elevation because using disposal site-specific conditions
- Would significantly impact ability to dispose of dredged material at the DMMP sites, with significant economic impacts to harbor users
- If not dredged, material would remain in more biologically active harbor areas
- Risk assessment results are subject to change with changing dioxin science
- Within current regulations and consistent with current programs

## Option 3: One Set of Numbers for Puget Sound Based on Non-urban Reference Area Background

- ❖ Acceptable tissue levels and acceptable sediment concentration based on existing data for reference areas (e.g., Carr Inlet)
- ❖ Characterizing naturally-occurring or globally-distributed man-made dioxin concentrations

### Considerations

- Risk to human health and wildlife at disposal sites would not be greater than from existing conditions at remote areas of Puget Sound
- Would require dredged sediments to be cleaner than existing conditions in the regions surrounding individual disposal sites
- Would significantly impact ability to dispose of dredged material at the DMMP sites, with significant economic impacts to harbor users
- If not dredged, material would remain in more biologically active harbor areas
- Very limited current availability of reference site dioxin data
- Background conditions at non-reference areas are likely to provide consistent conditions over time
- Within current regulations and consistent with current programs

## Option 4: Multiple Sets of Numbers, One Set for Each Puget Sound Basin, Based on Representative Area Background

- ❖ Acceptable tissue levels and sediment concentration based on existing area background concentrations within Puget Sound basins
- ❖ Each set of numbers for each basin are applicable to the disposal sites located within that basin

### Considerations

- Risk to human health and wildlife at disposal sites would not be greater than from existing conditions in the region of Puget Sound where the disposal site is located
- Basin area background concentrations are realistic representations of Puget Sound existing conditions. Would be less restrictive for disposal than Option 3, which uses non-urban reference background
- Potentially less impact on ability to dispose of dredged material at the DMMP sites
- Could stimulate hauling and disposal of dredged material from one basin to another basin
- Representative sampling strategy within each basin would be required to define area background for each basin
- Area background conditions change over time, difficult to determine how and when to re-evaluate guidelines
- May require regulatory change for implementation

## Option 5: Multiple Sets of Numbers, One Set for Each Disposal Site Based on Site-specific Background

- ❖ Acceptable tissue levels and sediment concentration based on existing sediment concentrations in the vicinity around each disposal site
- ❖ Different for each non-dispersive disposal site

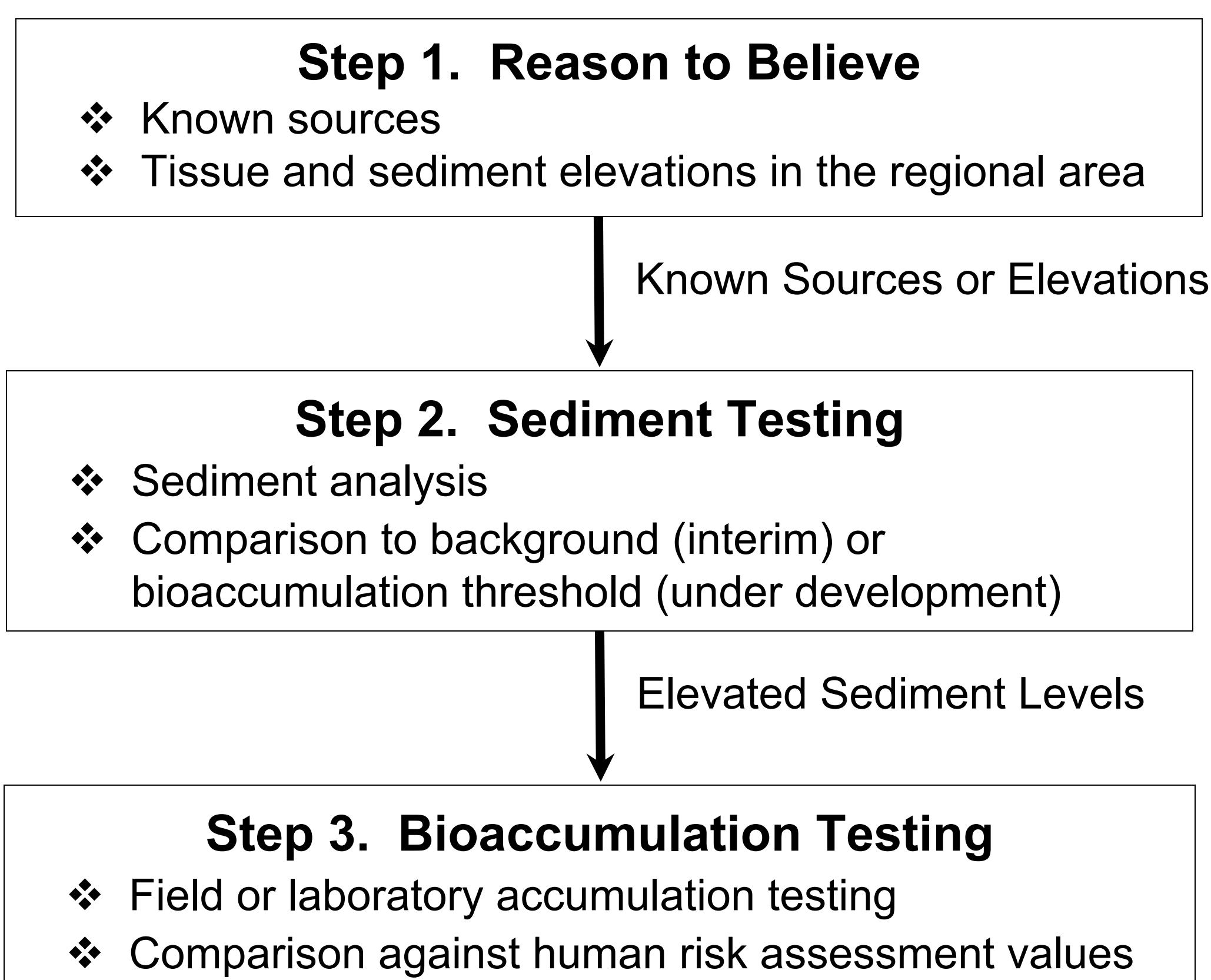
### Considerations

- Risk to human health and wildlife at disposal sites would not be greater than from existing conditions in the vicinity of the disposal sites
- Disposal site background concentrations are a realistic representation of existing conditions in the vicinity of the disposal site. Would be less restrictive for disposal than Option 3, which uses non-urban reference background
- Potentially less impact on ability to dispose of dredged material at the DMMP sites
- Could stimulate hauling and disposal of dredged material from one basin to another basin
- Disposal site area background data has been collected by DMMP for all non-dispersive sites as part of 2006/7 monitoring
- Background conditions change over time, difficult to determine how and when to re-evaluate guidelines
- May require regulatory change for implementation

You can send input to the DMMP Dioxin Group by November 15, 2007 at: [dioxin.project@floydsnyder.com](mailto:dioxin.project@floydsnyder.com)

# Regional Sediment Evaluation Team (RSET) Interim Process

- ❖ RSET is a multi-agency effort that has been formed under the auspices of the Regional Dredging Team (RDT). The RDT works on facilitating communication, coordination, and resolution of dredging issues among the agencies with jurisdiction for dredged material management. RSET is focused on consolidating the existing regional guidance manuals into one "umbrella" document, allowing consistent evaluation of dredging projects across the region. The resulting regional Sediment Evaluation Framework (SEF) will eventually be applicable throughout the Pacific Northwest for both freshwater and marine sediments.
- ❖ RSET members are active participants in the DMMP Dioxin Work Group so that the DMMP agencies can evaluate the consistency between the programs when developing a new DMMP framework for dioxins, which will be utilized by the DMMP in their region-specific management of dredged materials.
- ❖ For more information on RSET and the SEF, visit the following DMMO website:  
<http://www.nws.usace.army.mil/PublicMenu/Menu.cfm?sitename=dmmo&pagename=RSET>



<b>Assumptions for Risk Assessment</b>		
Population at risk (10 <sup>-6</sup> risk level)	g/day	years exposure
General population in a coastal state	54	30
High-end recreational or mid-range subsistence	177	70
High-end Tribal subsistence	593	70

- ❖ Efforts are underway for developing Target Tissue Levels (TTLs) through risk assessment. If values are derived that are greater than regional background levels, the TTLs will be used for comparing tissue levels from bioaccumulation assays (Step 3). If derived TTLs fall to less than background, regional tissue background values will be adopted as TTLs.
- ❖ Similarly, sediment Bioaccumulation Thresholds (BTs) will be developed by back-calculating sediment values from the TTLs. If these derived BTs are greater than sediment background levels, they will be adopted for comparison in Step 2. However, if they fall to less than regional background levels, adopted BTs will default to regional background levels.

# Puget Sound and Grays Harbor Sediment Dioxin Compilation

Maps presenting the available dioxin data are discussed below and are displayed with this poster at Public Meetings. These maps are also available on the website:

[http://www.nws.usace.army.mil/PublicMenu/Doc\\_list.cfm?sitename=DMMO&pagename=Dioxin\\_TEQ\\_maps](http://www.nws.usace.army.mil/PublicMenu/Doc_list.cfm?sitename=DMMO&pagename=Dioxin_TEQ_maps)

## When Were the Data Collected that are Presented in the Maps?

- ❖ Between 1989 and 2007.

## Who Collected the Sediment Dioxin Data?

- ❖ Data represented in these maps are from a variety of sources including dredged material characterization, cleanup projects, and DMMP disposal site monitoring.
- ❖ The most recent and spatially comprehensive data set was collected by the DMMP over a 2-year period (2006 and 2007), and included sampling of sediments and tissues at all five of the PSDDA non-dispersive sites.

## What Data are Included?

- ❖ Data from 44 sediment surveys.
- ❖ The maps depict sediment dioxin data from both grab samples (surface 10 cm) and core samples (varying depths).
- ❖ Where more than one sample was taken from a given location, the sample with the highest TEQ concentration is shown.
- ❖ Sediment samples composited from multiple locations are shown at the mean latitude and longitude for those locations.
- ❖ All data are presented as total TEQ calculated using mammalian toxic equivalency factors (TEFs) published by the World Health Organization (WHO) in 2006.
- ❖ Undetected congeners were included in the TEQ summations by multiplying one-half the detection limit for the congener by its TEF.

## What Data are Omitted?

- ❖ Tissue data are not included in these maps. For a summary of dioxin in tissue data from Puget Sound, refer to the Background Information poster (Figure 3).
- ❖ Sediment samples of questionable quality or for which incomplete congener information was available were not included in this summary. The only exception to this latter guideline is the Georgia-Pacific outfall data in Bellingham Bay, an important data set with three missing congeners. Values for this data set are shown with a "+" sign to indicate that the actual values are likely somewhat higher than those shown.
- ❖ Project-specific data that have been collected but not yet released to the DMMP agencies were not included in this summary. However, the general locations of these data are indicated on the maps.
- ❖ The second phase of the Department of Ecology's Budd Inlet investigation is still underway and the data are not yet available.

## What are Reference Areas?

- ❖ There are four reference sediment collection areas in Puget Sound that are used by the DMMP: Holmes Harbor, Carr Inlet, Samish Bay, and Sequim Bay.
- ❖ These are areas that have been demonstrated to have few or no local sources of human-caused contamination.
- ❖ Reference sediments are used in the DMMP program as a point of comparison to identify potential effects of contaminants in dredged material.
- ❖ Sediments from Carr Inlet and Sequim Bay are the only reference locations in Puget Sound for which we have dioxin data.