National Water Quality Monitoring Council
San Jose, CA
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NOAA's Mussel Watch Project: Context, Challenges and Future

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NOAA's Mission Statement

Understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs

NOAA's Mission Goals

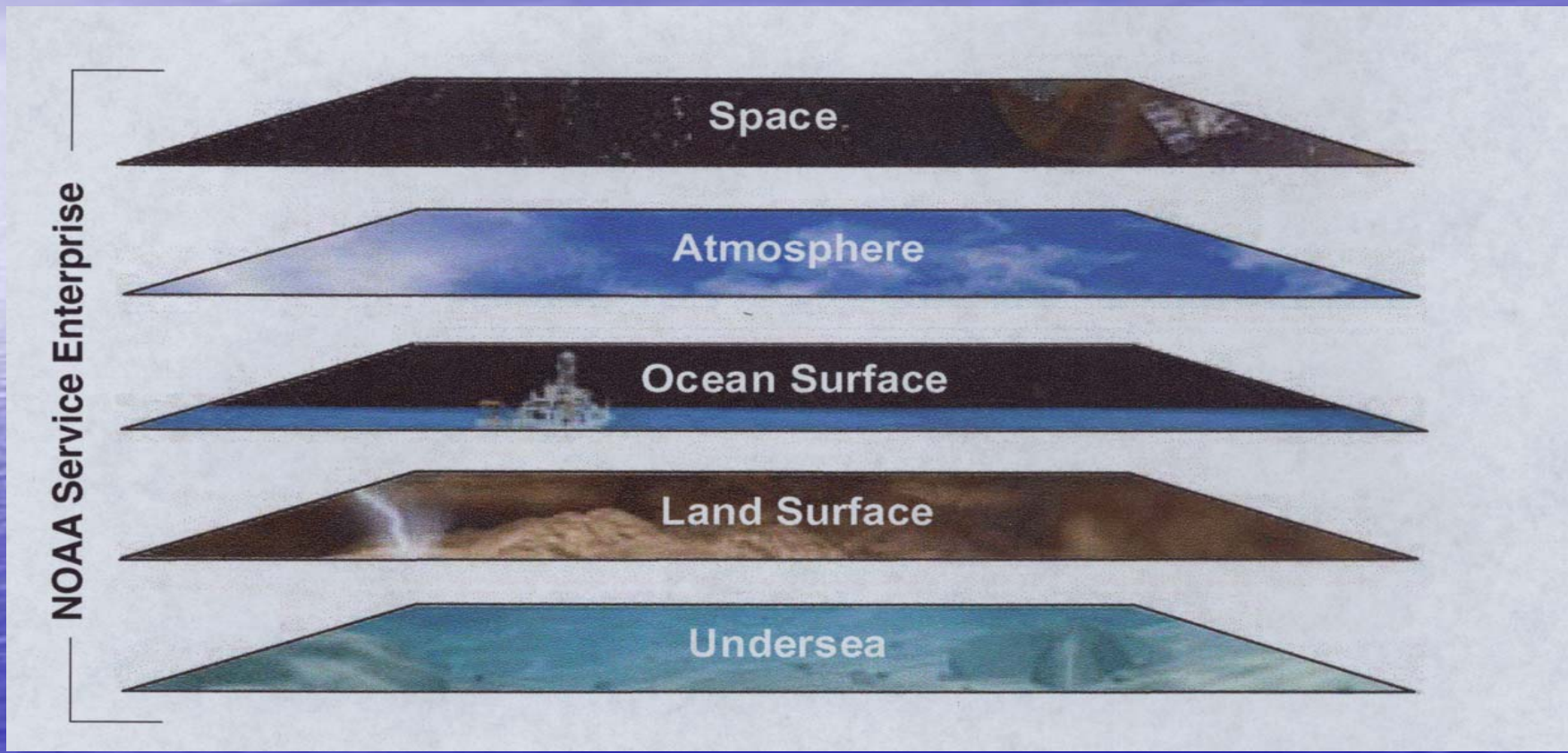
1. Protect, restore and manage the use of coastal and ocean resources through ecosystem-based management
2. Understand climate variability and change to enhance society's ability to plan and respond
3. Serve society's needs for weather and water information
4. Support the Nation's commerce with information for safe, efficient, and environmentally sound transportation

Earth observations have been at the heart of NOAA's mission throughout its existence. In fact, environmental information is our lifeblood.

Vice Admiral Conrad C. Lautenbacher, Jr. U.S. Navy (Retd.)
Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator

Strategic Direction for NOAA's Integrated Global Environmental Observation and Data Management System (July 2004)

Environmental observations from all domains that affect planet Earth using existing and evolving technologies – *NOAA Information Service Enterprise*

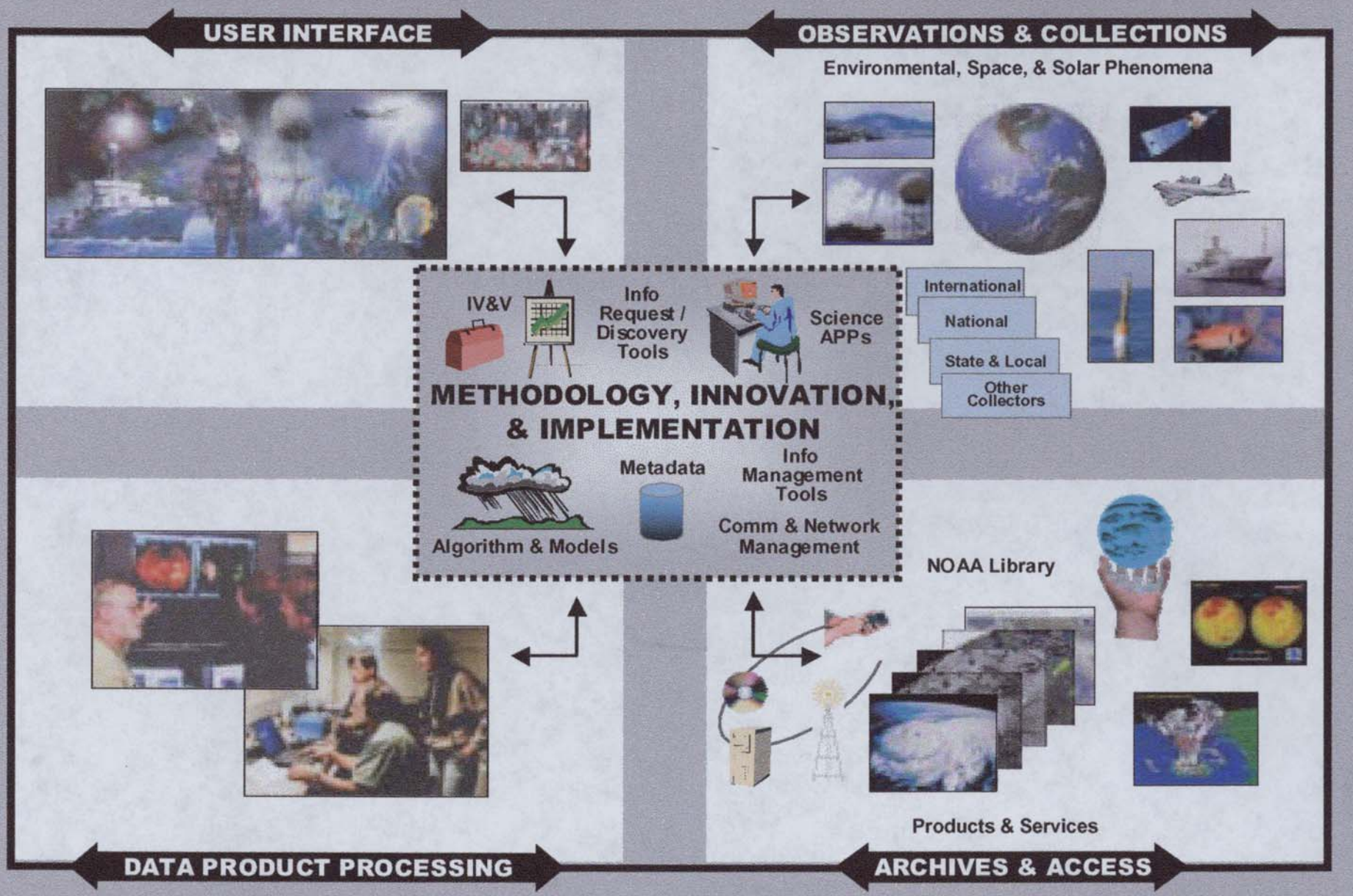


One of ISE goals: ***Determine Federal agency environmental observation requirements***

NOAA Observing System Architecture (NOSA)

- First-ever review of NOAA observing systems – started in August 2002
- Included only NOAA-owned, -operated, or –funded systems
- NOSA includes 99 separate observing systems measuring 225 different environmental parameters (ref: NASA's Global Change Master Directory)
  - NOAA's NS&T is one such system
- NOSA is a critical step toward an "integrated global environmental observation and data management system" and the NOAA Information Service Enterprise (ISE) -- 2004
- The Ecosystem-based Management Enterprise (EME) will be the focus of 2005

NOAA INFORMATION SERVICE ENTERPRISE



NOAA Leadership and Support Services

Environmental stressors posing challenge to sustainability of natural resources [CENR/NSTC]

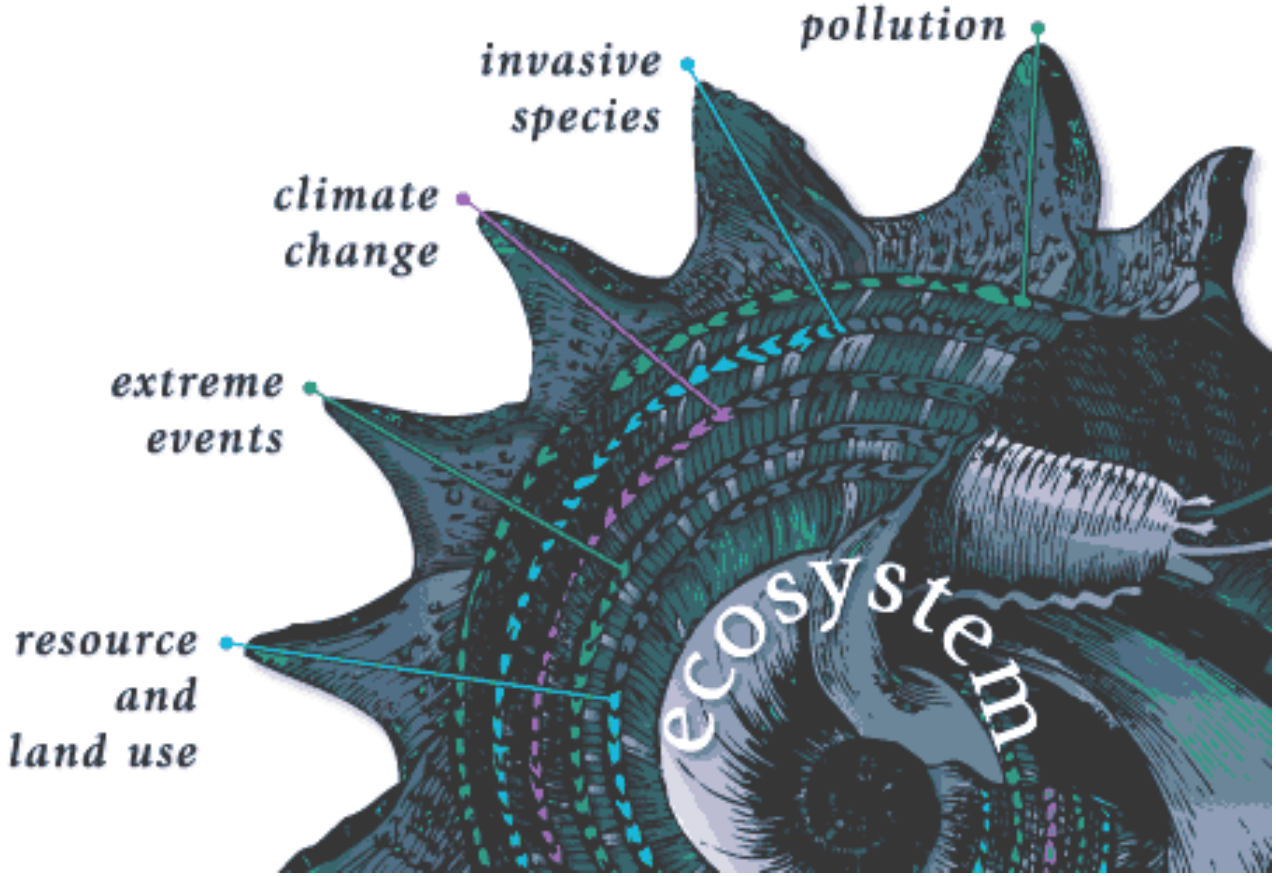
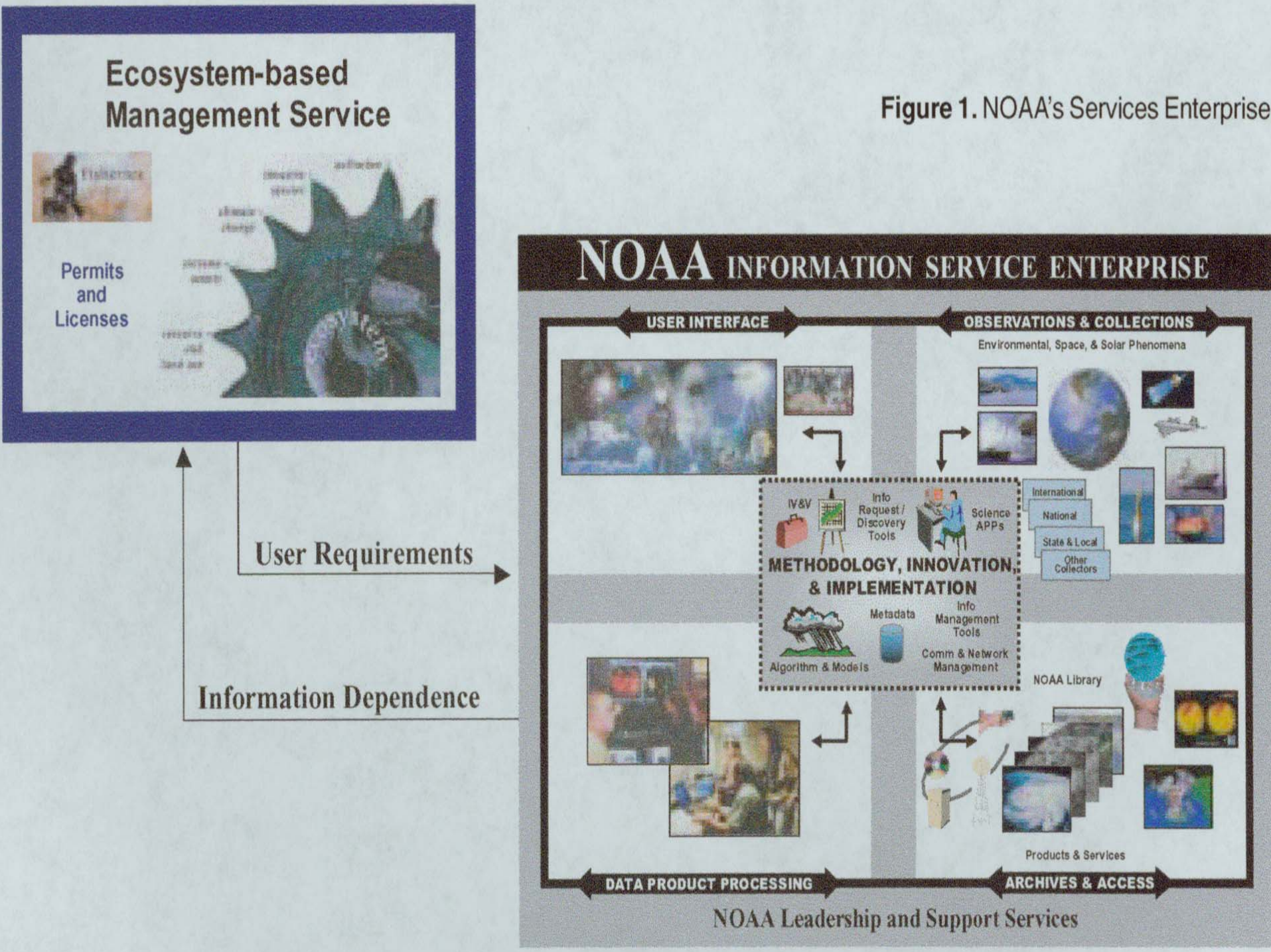


Figure 1. NOAA's Services Enterprise



NOAA's National Status and Trends Program

Nutrients and Eutrophication

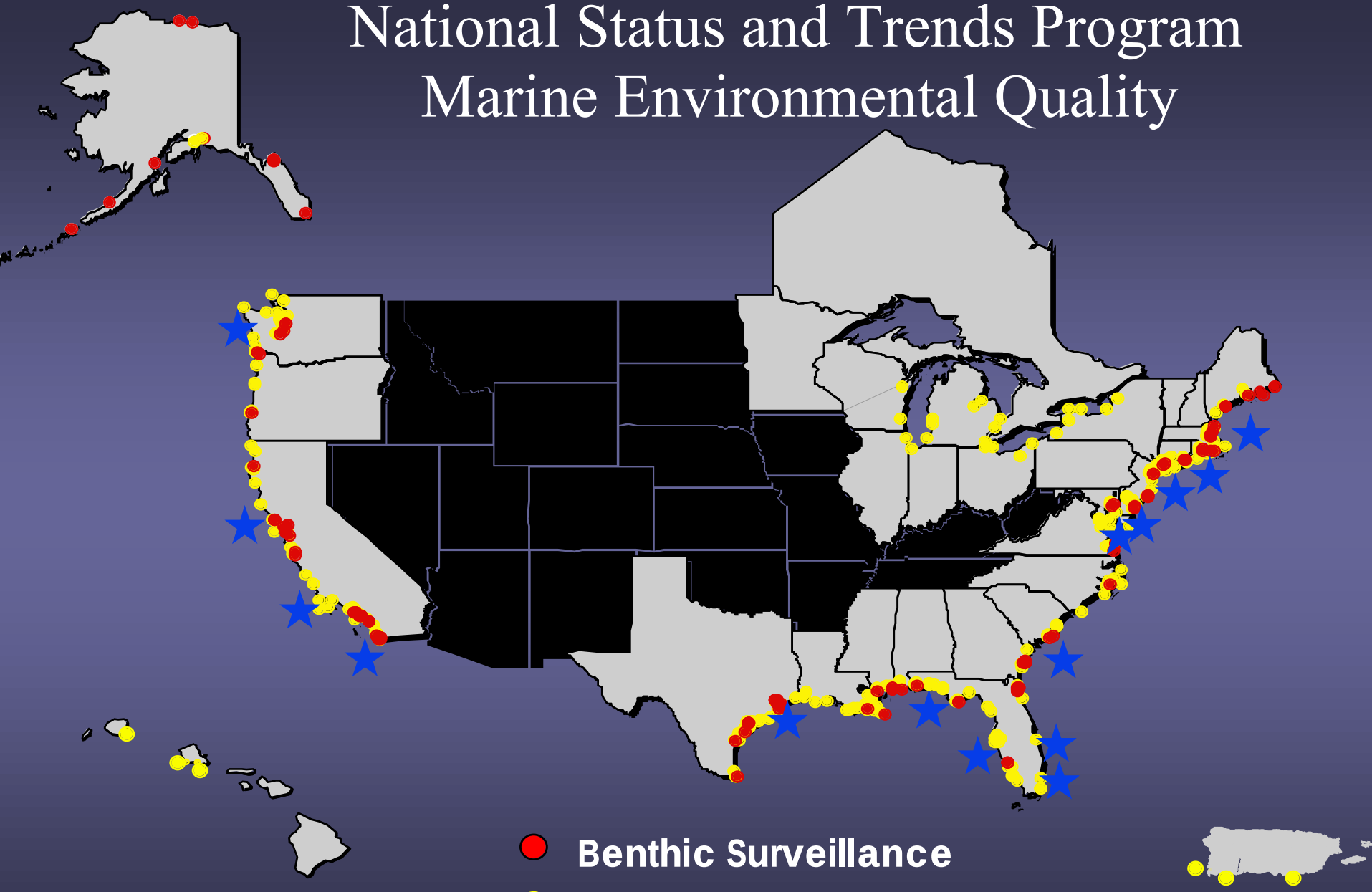
Bioeffects Assessments

- Sediment Toxicity
- Fish/Bivalve Biomarkers
- Sediment Quality Guidelines
- Ecological Indices
- Regional and Topical Assessments
- National Coastal Condition Report

Coastal Monitoring

- Mussel Watch
- Quality Assurance
- Specimen Banking
- Historical Trends

National Status and Trends Program
Marine Environmental Quality



Mussel Watch: Analyte Categories

- Pesticides (22)
- PAHs (30)
- PCBs (18 congeners)
- Mono-, Di-, and Tributyltin
- Major and trace elements (16)
- (Dry weight, Gonadal index, lipid content)

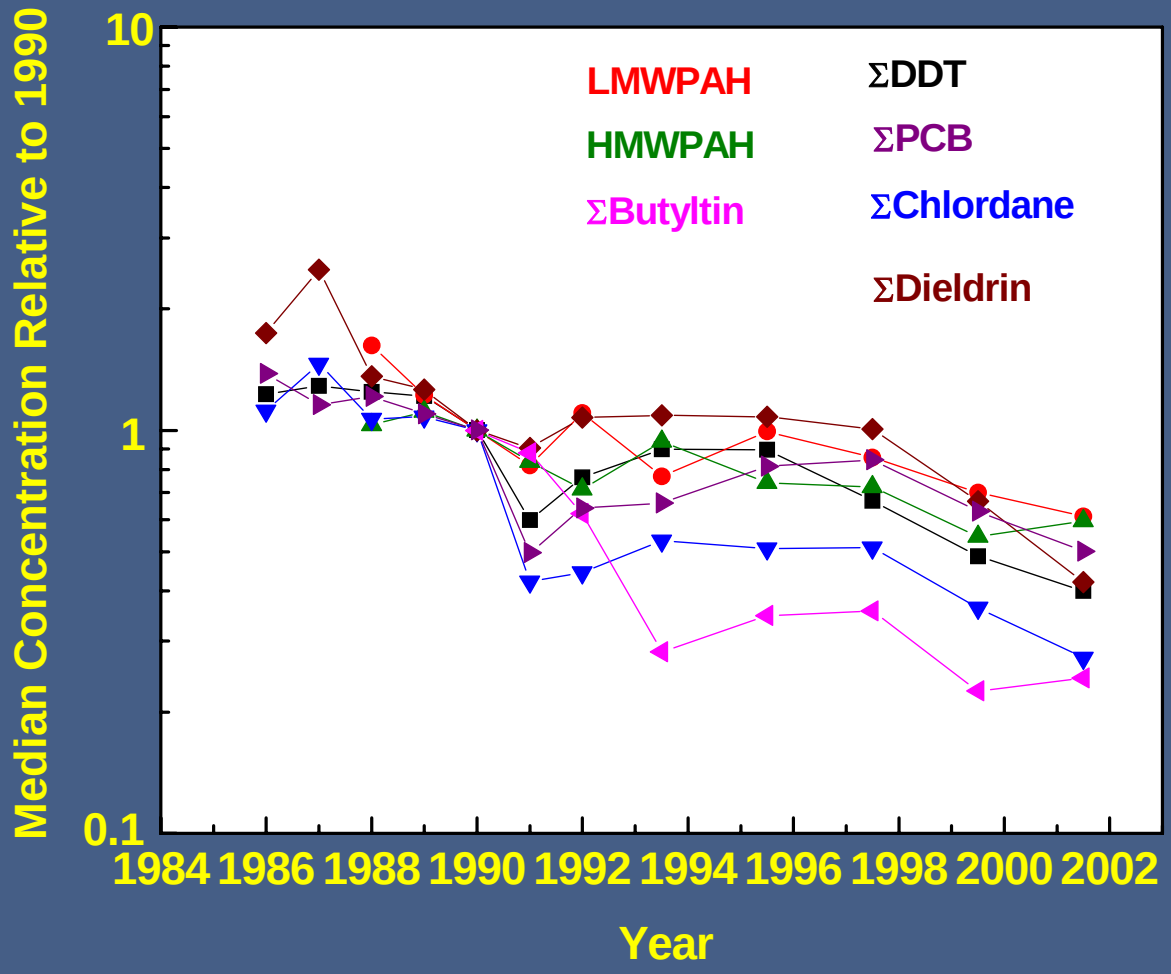
Temporal Trends in Chemical Concentrations Measured Nationally at 206 Mussel Watch Project Sites

	Trend		
Organics	I	D	NT
∑Chlordane	1	85	120
∑DDTs	1	54	151
∑Dieldrin	4	32	170
∑PCBs	5	30	171
∑PAHs	18	26	162
∑BTs	0	100	106
HCB	16	7	183
Lindane	3	31	172
Mirex	17	6	183

	Trend		
Element	I	D	NT
As	9	15	182
Cd	7	20	179
Cu	9	10	187
Hg	13	14	179
Ni	11	6	189
Pb	11	12	183
Se	14	4	188
Zn	7	15	184
Total	146	467	2889

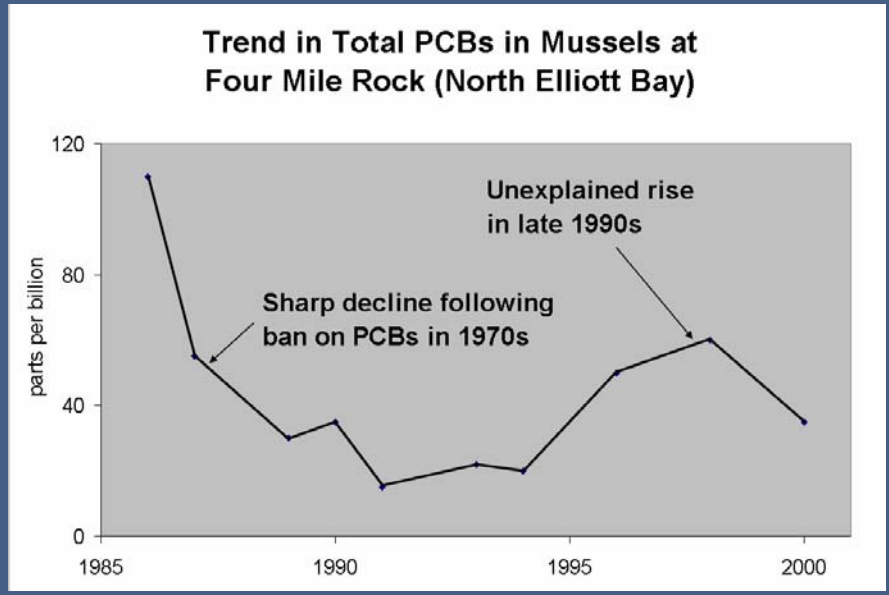
I - Increasing, D - Decreasing, NT - No trend.

Trends in Organic Contaminants in Oysters



Patterns in Coastal Contamination – Puget Sound

- 16-Year data record
  (1986-2001)
- Three Patterns
  - A general decline
  - Consistently higher values in central Puget Sound
  - Interruption of downward trend in mid-1990s
- Data demonstrated recalcitrant nature of PCBs in the environment
- PCB Median: 110 ppb; 85th percentile: 420 ppb



We cannot be certain that PCBs will decline at the dramatic rate observed in the 1970s and 1980s; the need for continued monitoring is obvious.

[Puget Sound's Health 2002]

Mussel Watch data used for assuring seafood safety

In 2000, shipments of farm-raised oysters from BC were returned by Hong Kong due to elevated cadmium [exceeding 2 ppm wet; 13 ppm dry]

- Mussel Watch: Only source of background data on Cd in shellfish in the region
  - National median: 3 ppm (dry wt)
  - 85th percentile: 6 ppm (dry wt)
  - Much higher concentration off Cape Flattery, WA (3 to 10 ppm, dry)

Mussel Watch data used for assuring seafood safety -- 2

- Mussel Watch data and other data prompted Canadian Government (Health Canada) to issue oyster consumption guidelines:
  - 460 g (12) oysters per month
- Concern about:
  - Immune system compromise
  - Neurotoxin
  - Teratogen
- Oysters from a farm in Shelton, WA showed high values: 3.6 ppm wet
  - But the U.S. FDA “action level” for Cd is 4 ppm for molluscs and 3 ppm for crustaceans

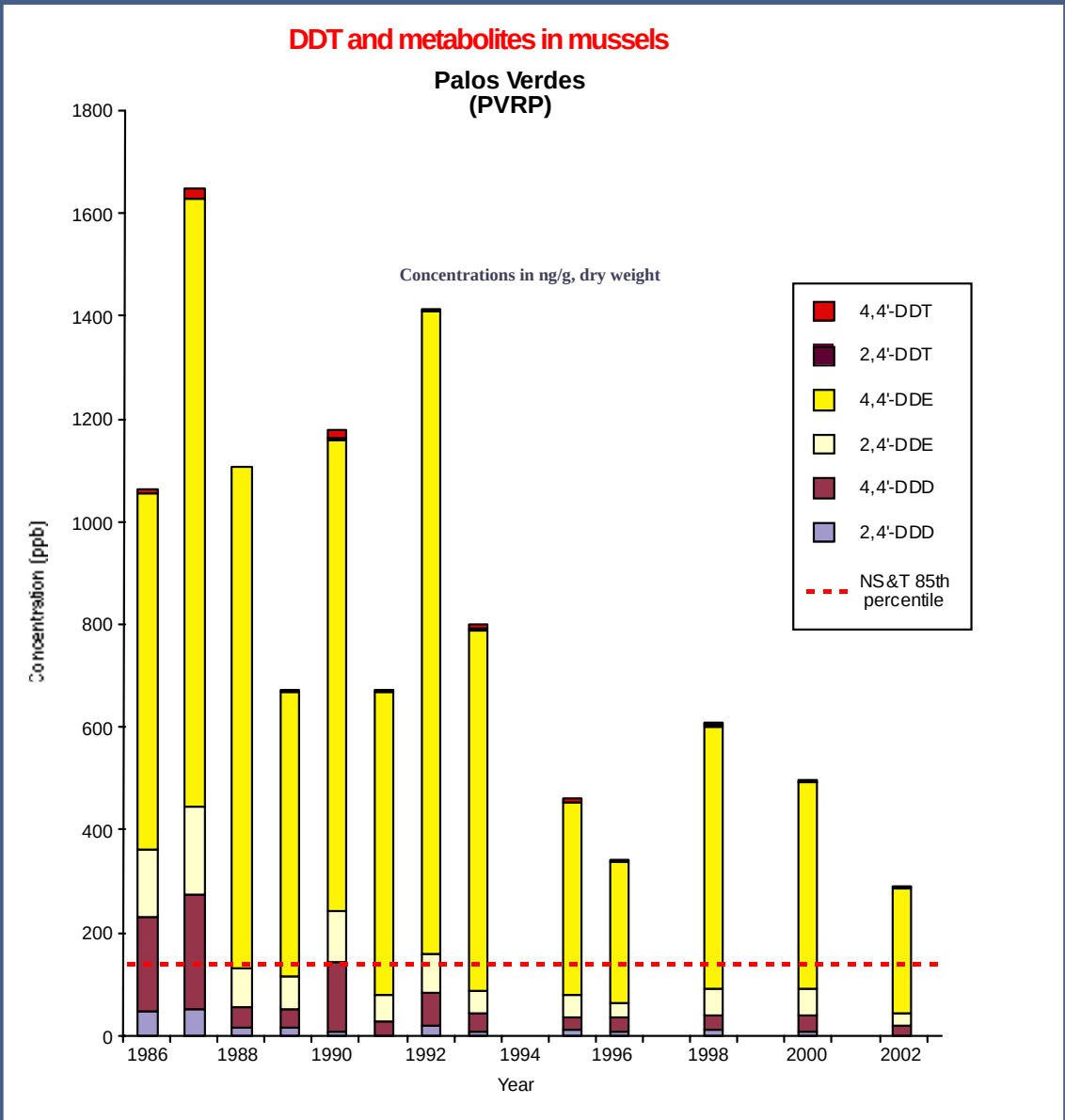
DDT Contamination off California

- Mussel Watch data
  - Showed high levels of DDT in the Palos Verdes area (exceeding 1600 ppb)
  - Data were used, along with other data to trace food web pathways to bird species that were obviously being harmed
- Data on harmful effects of DDT on fish were not conclusive

Courtesy: USGS

- 1,800 tons of DDT were discharged into sewer lines (1947-71)
- Concern about injury to resources (eagles, brown pelican, etc.)
- Largest known DDT contamination in the world

DDT in Palos Verdes Mussels



Mercury in the Gulf of Mexico

Data Sources

1. Site-specific data from GOOMEX platforms
2. Short-term data from Gulf of Mexico Program
3. Mussel Watch offers the only region-wide, long term record of mercury
   - *Limited to oysters*
   - *Limited to total mercury*
   - *Coastal sites*

- High level of mercury in fish (and human hair)
- Many species exceeding consumption advisories (0.3 ppm)
- Concern about Hg input from petroleum drilling
- President appointed a Multi-Agency Task Force (2002)

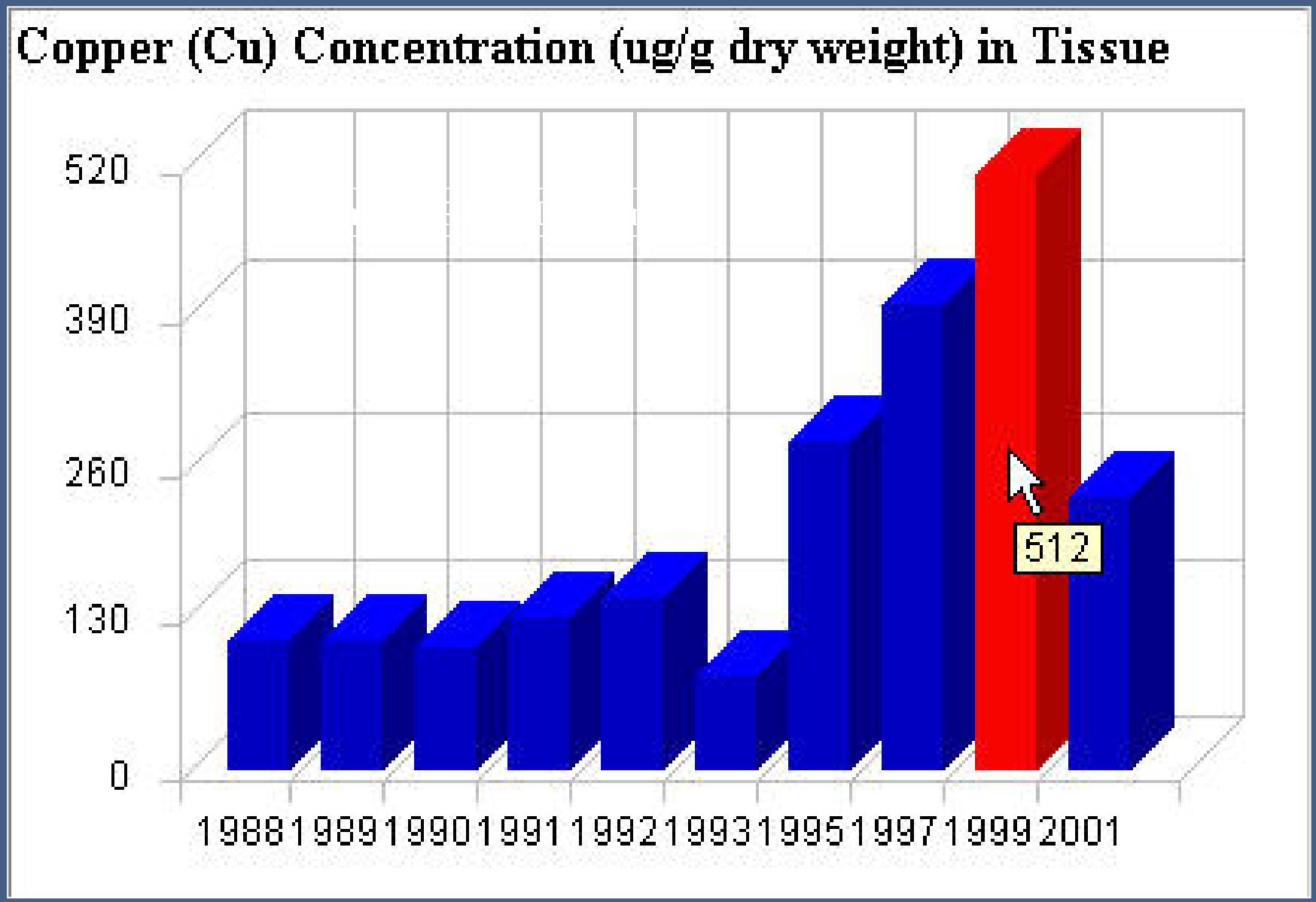
Mercury in GOM – Mussel Watch Data

Region	States	Median	Range
Eastern GOM	FL, AL, MS	0.03	0.001 – 0.14
Western GOM	LA, TX	0.02	0.004 – 0.36

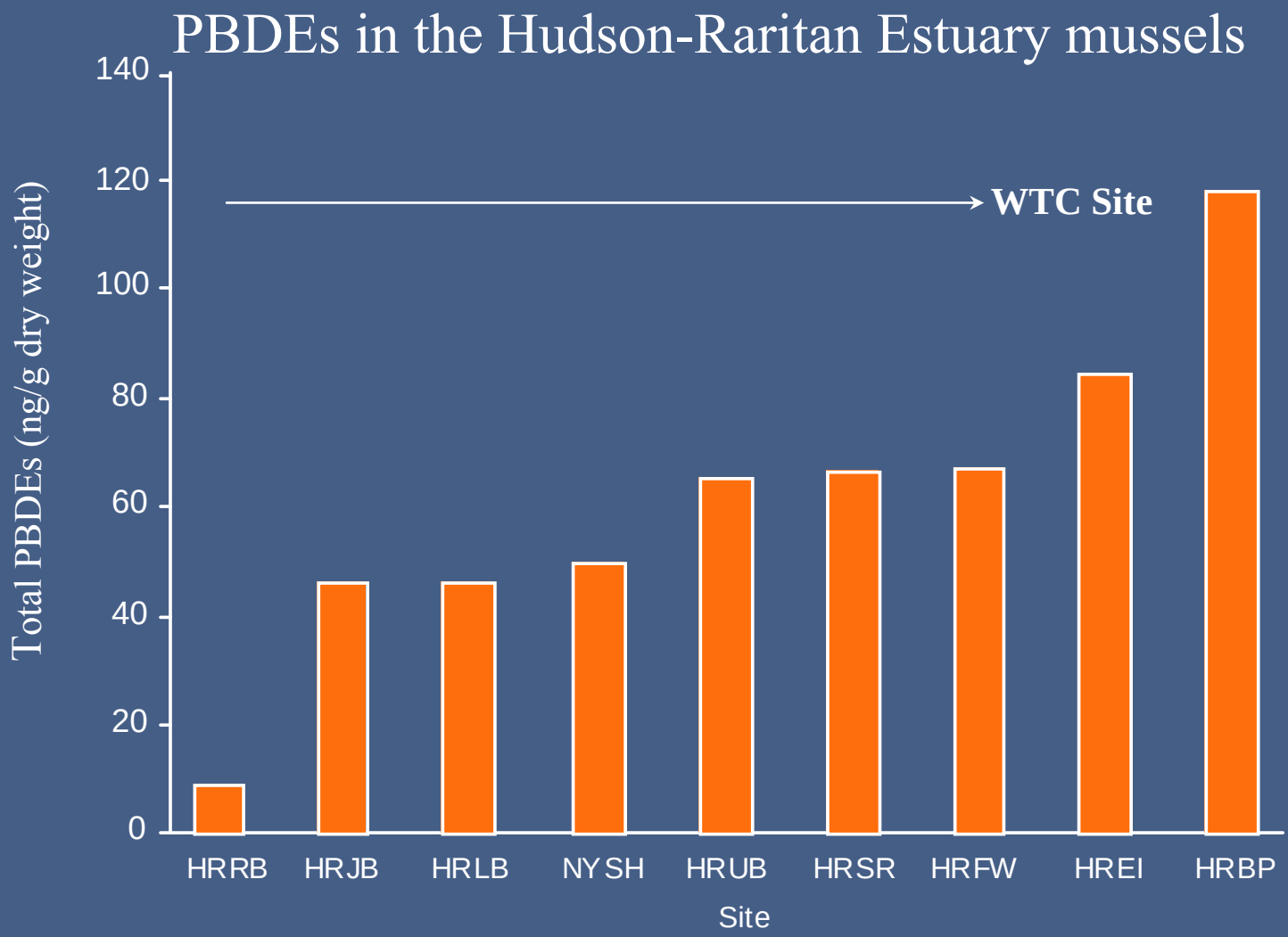
Concentration, ppm wet weight, of total mercury

NS&T and other data point to:

- Widespread distribution of mercury
- Need to account for mercury input
  - From the atmosphere
  - Runoff and river outflow – both dissolved and associated with particles
- Need for a collaborative research program


Copper (Cu) Concentration (ug/g dry weight) in Tissue
520
390
260
130
0
512
1988
1989
1990
1991
1992
1993
1995
1997
1999
2001

World Trade Center Site Contaminant Assessment



Leadership in Expanding the Concept of QA/QC in Environmental Measurements

- In collaboration with NIST, NRC Canada, and others
  - Development of Standard Reference Materials
  - Inter-laboratory comparison exercises resulting in improved performance and results
  - Documentation of sampling protocols and analytical procedures
  - Provided funding and guidance to the International MW Project
- QA/QC has now become institutionalized, i.e., it is now a requirement for states and regional organizations, as well as federal agencies, involved in environmental quality measurements.

Changing Expectations from Monitoring Programs

- New users; increasing number of stakeholders
- Increased number of parameters
- Improved public access to data and instant Internet products
- Higher burden of proof for data integrity
- Application of new and emerging technologies (e.g., smart systems)
- Fast-response data streams and documented methods

Need for a Data Portal

- 18 years of data (nearly 1 million records) and growing at a rate of 15,000 new records per year.
- One single authoritative database –
  No spawning of multiple data copies without the ability to trace authenticity and duplicating effort.
- A metadata library and data dictionary.
- Efficient data auditing that ensures data errors are systematically documented and corrected.

What are your customers looking for… *Data*, *Information*, or *Knowledge*?

- *Information* comes from data analysis.
- *Knowledge* comes from the right quantity and quality of information.

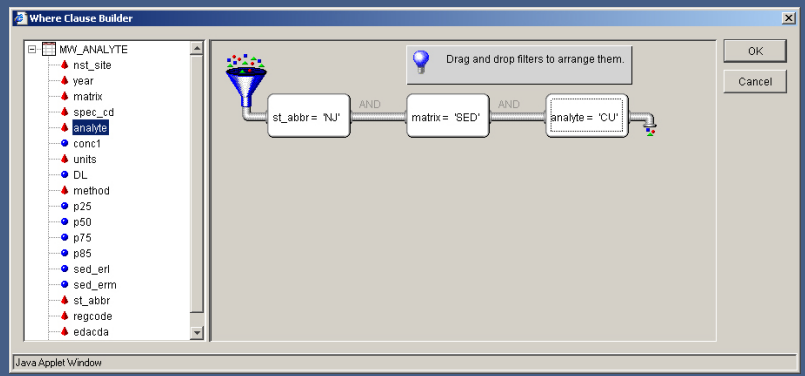
NS&T Data Portal users can produce *Information* from *Data* using web based analysis and visualization tools. For example:

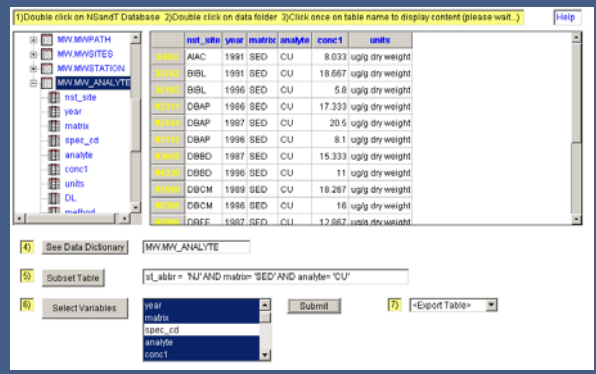
- Visual Analysis: e.g., mapping and graphing
- Numerical Analysis: e.g., statistics

If you must download data …
limit the download to your specific needs.

Example 1: Data access, with data query & download

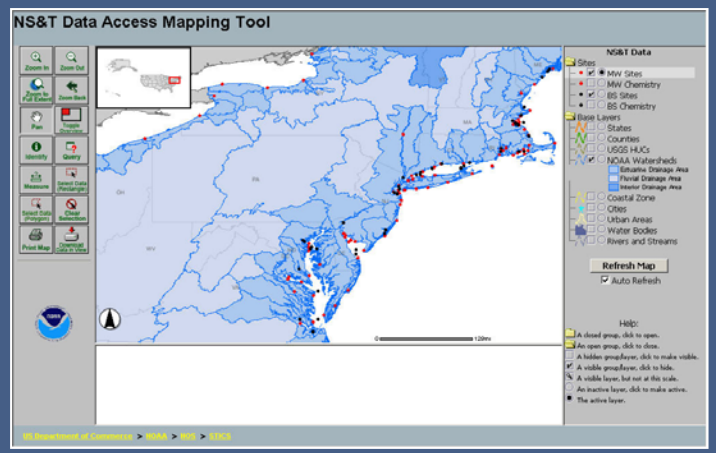
Movie





Example 2: Data access, query and download from a map

Movie



Beyond Data Download:

Examples of Web Tools

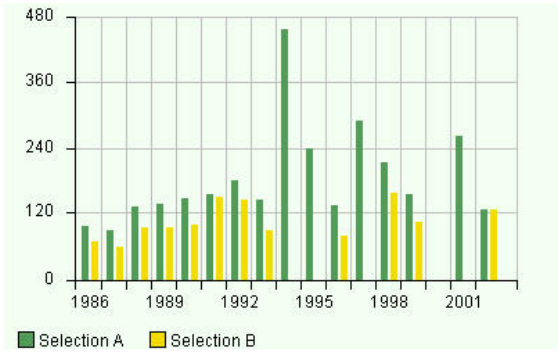
for data visualization and analysis

Analysis & Visualization Tools

- Concentration Distribution
- Study Area Comparison
- Analyte Search
- Site Profile
  - Temporal Trends
  - Ranking
- Mapping

Suppose a Mussel Watch data user wants to view temporal trends in the mean copper (Cu) levels of the Tampa Bay Watershed relative to the mean level for the entire state of Florida.

Trends Comparison State vs Watershed for Copper (Cu) (CU) concentration (ug/g dry weight)



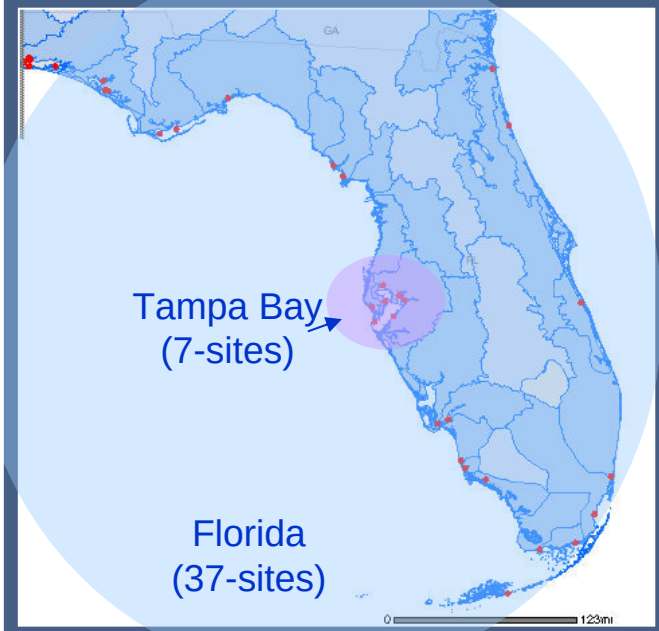
Study Area Comparison Tool

State of FL

Selection A		
State Name	Year	Concentration
Florida	1986	100
Florida	1987	91
Florida	1988	136
Florida	1989	140
Florida	1990	150
Florida	1991	158
Florida	1992	184
Florida	1993	147
Florida	1994	459
Florida	1995	241
Florida	1996	137
Florida	1997	292

Tampa Bay Watershed

Selection B		
Sub-Watershed Name	Year	Concentration
Tampa Bay	1986	71
Tampa Bay	1987	62
Tampa Bay	1988	98
Tampa Bay	1989	97
Tampa Bay	[illegible]	102
Tampa Bay	1991	153
Tampa Bay	[illegible]	149
Tampa Bay	[illegible]	91
Tampa Bay	1996	82
Tampa Bay	1998	161
Tampa Bay	1999	107
Tampa Bay	2002	130



Movie
Back

U.S. Commission on Ocean Policy
Chapter 15: Creating a National Monitoring Network

- 15-1: National Water Quality Monitoring Network (NOAA, USGS, EPA)
- 15-2: Adequate coverage of coastal waters and upland areas; link to IOOS (NOAA)
- 15-3: Linkage with management objectives; performance measures; network design; core variables; periodic reviews (NOAA, USGS, EPA)

15-1: NOAA, USGS and EPA ... develop a national water quality monitoring network ... include a federally funded backbone ... to determine long-term water quality trends and conditions.

My observation: Recommendation is consistent with provisions of the National Coastal Monitoring Act (33USC 2801): Long-term collection, consistent methods, assimilation and analysis of data to measure environmental quality of the Nation's coastal ecosystems.

NCMA provided implementation responsibility jointly to NOAA and EPA

A. For toxic chemicals (including PBT chemicals)

Mussel Watch Project (NS&T Program) is the only nationwide monitoring program for US coastal waters and estuaries

It can serve as the backbone for obtaining quality-assured data on variables and parameters that are nationally significant.

There are 17 different program for “water and habitat quality” responding to legislative mandates from 13 different statutes.

B. NERRS SWMP (System Wide Monitoring Program)

Data loggers

Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET)

C. Linkages with air monitoring exist

They can be strengthened [Air Toxics Monitoring Network, National Dioxin Air Monitoring Network, etc.]

D. Linkage with USGS National Water Quality Assessment Program

CAFO?, pharmaceuticals, Gulf of Mexico hypoxia forecasting

15-2: NOAA should assure that the monitoring network ... includes both coastal areas and upland areas that affect them ... and is linked to IOOS

My observations:

A – Tough call for NOAA due to sheer number of "environmental monitoring programs"

- FGDC identified 2,000 environmental monitoring programs in South Florida ; NOAA identified ca. 450 (in 1998)

B – IOOS is still a "state of mind"

- "Created" by the U.S. National Ocean Research Leadership Council (NORLC) as the U.S. contribution to the GOOS
- Reports to Congress (1999 and 2000)
- Inter-agency Office: Ocean.US to coordinate development of the IOOS
- NOAA is to assure that IOOS is implemented

- Requires within NOAA (Weather Service, SWMP, etc.) coordination, and inter-agency dialogue.
  - Informal contacts and cooperation already exist – need a more formalized mechanism and sharing of responsibilities.
- Follow-up “outreach” and collaboration with other Federal agencies and non-Federal entities

15-3: NOAA, USGS and EPA ... design and describe the water quality monitoring network ... link to user needs and documentation of management success ... assure periodic reviews and redirection, if needed.

My observation:

A very challenging task: questions of scales, variables, frequency of sampling [nutrients vs. pathogens vs. PBTs], and cost sharing

However, a precedent exists

Section 503(d) of NCMA [33 USC 2803] called for “intensive Coastal Water Quality Monitoring Programs” in specific geographical areas [to be nominated by the National Research Council.

A. Agree on the purpose of such a program

1. More effective land-use plans and coastal zone regulations that would contribute to improved water quality and protect coastal ecosystems -- CZMA, CZARA
2. More effective pollution control [technologies] and abatement strategies [policies and procedures] – Clean Water Act
   - National Estuary Program – Section 320
   - Non-Point Source Management Programs – Section 319
   - National Pollution Discharge Elimination System (NPDES) – Section 402
   - Threatened and Impaired Waters List – Section 303(d)

B. Agree on program components

1. Identify water quality issues and problems
2. Clear link issues with objectives of the monitoring program
3. Identify water quality and biological parameters in relation to those objectives
4. Formulate a monitoring scheme, i.e., “intensive monitoring” in relation to existing Federal, state and local monitoring
5. Describe data quality objectives and quality control protocols
6. Specify implementation requirements
7. Describes methods of periodic assessments, and the manner by which the program may be modified time to time.

C. Implement the program in specific waterbodies

1. Federal responsibilities
2. Non-Federal cost-sharing and responsibilities

U.S. Commission on Ocean Policy

Presence and toxicological significance of "new" chemicals, i.e., contaminants of emerging concern.

NS&T Program data

Pharmaceuticals

- Chesapeake Bay, San Francisco Bay

Perfluoroctane sulfonate (PFOS) – stain resistant coatings

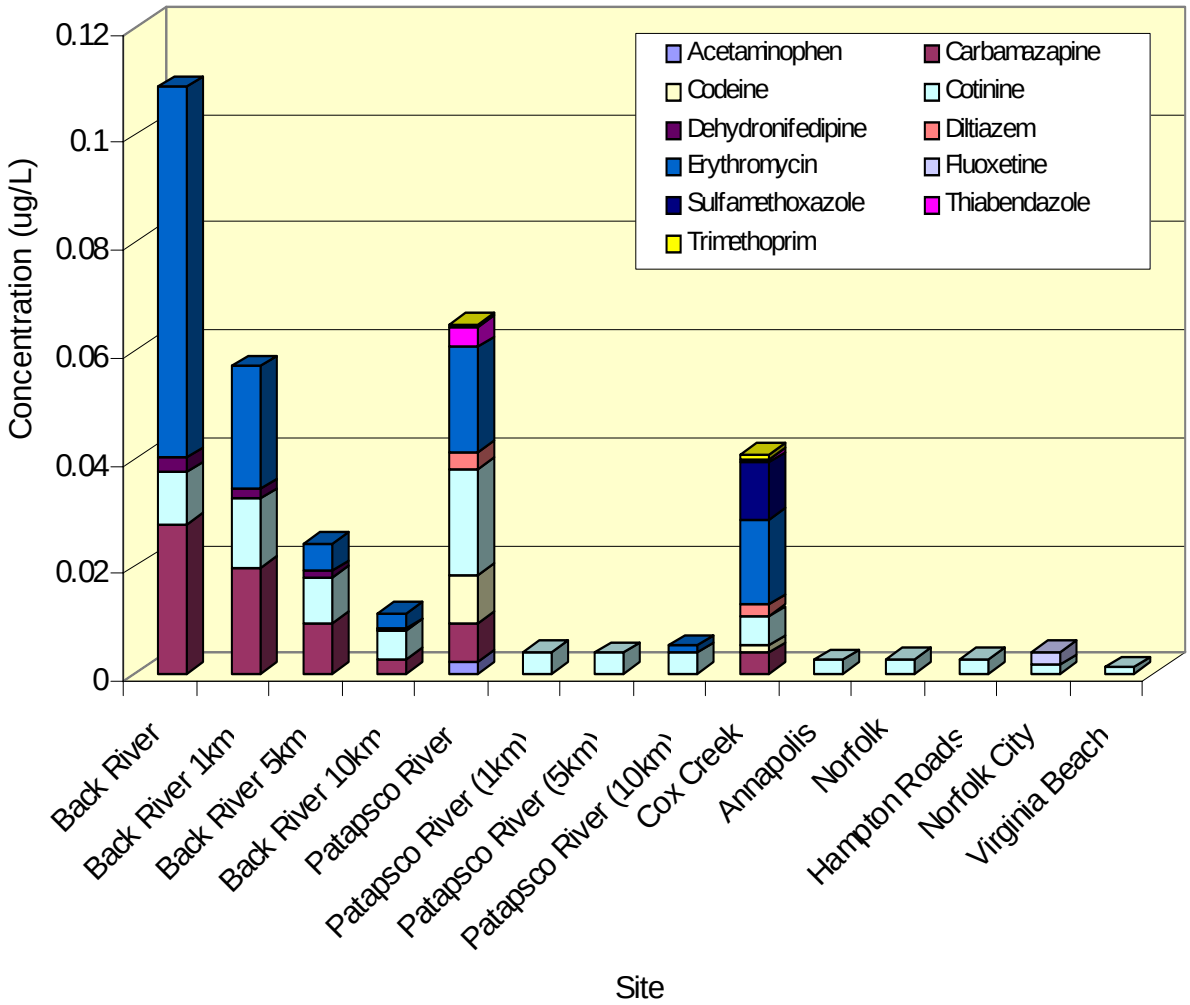
- Gulf of Mexico and Chesapeake Bay

Alkylphenol polyethoxylates (APEs) – detergents, surfactants

- Chesapeake Bay, St. Lucie Estuary

Polybrominated diphenylethers (PBDEs) – fire retardant chemicals

- World Trade Center, Northeast Coast


Concentration (ug/L)
0.12
0.1
0.08
0.06
0.04
0.02
0
Acetaminophen
Carbamazapine
Codeine
Cotinine
Dehydronifedipine
Diltiazem
Erythromycin
Fluoxetine
Sulfamethoxazole
Thiabendazole
Trimethoprim
Back River
Back River 1km
Back River 5km
Back River 10km
Patapsco River
Patapsco River (1km)
Patapsco River (5km)
Patapsco River (10km)
Cox Creek
Annapolis
Norfolk
Hampton Roads
Norfolk City
Virginia Beach
Site

Other “Priority” Contaminants

not identified by US COP – found in human tissues, suspected carcinogens, long-range transport

- ***Polychlorinated naphthalenes*** (PCNs) – widely used in lubricants, solvents, wood preservatives, dyes and sealants; formed during combustion of PAHs; elicit biological effects similar to PCBs, dioxins
- ***Short-chain chlorinated paraffins*** (SCCPs) – water repellant and flame retardant chemicals, plastics, paints, sealants; very sketchy information on biological effects but suspected carcinogen
- ***Pentachlorophenol*** (PeCP) – broad spectrum, low cost pesticide, current use largely limited to treatment of lumber; bioaccumulates in fish, suspected carcinogen (questionable?)
- ***Octachlorostyrene*** (OCS) – industrial by-product in the production of chlorine, magnesium, aluminum; binding affinity to both androgen and estrogen receptors, its metabolite (4-hydroxy heptachlorostyrene) affects thyroid hormone function

Epilogue

1. Consistent, long-term and nationwide monitoring is a requirement under Federal legislation
2. Ambient monitoring, in itself, does not link well with specific management issues as many of them are localized and contaminant-specific
3. Dual purpose of environmental monitoring – defining the status and trends, and providing data to support management decisions – necessitates a tiered approach
   - *Sparsely distributed network over a broad spatial extent -- Federal*
   - *Embedded within the network, regionally intensive monitoring that is tailored to support specific resource management needs – State, local (Federal partnership)*
   - *Ensuring comparability of data (QA/QC, NEMI, MDCB) – Federal*
4. Stronger and formalized mechanisms are needed to foster inter-agency coordination to assure a “national water quality monitoring network”
5. Environmental monitoring, assessment and related research (e.g., biomarkers) should be integrated within a policy framework (ICM, PSIR)