Gulfwatch and Microbial Source Tracking Laboratory

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Environmental Contaminants

- Status and trends
- Pollution source identification

Gulf of Maine

GULFWATCH PROGRAM

- Toxic contaminant monitoring program in the Gulf of Maine;
- Blue mussel as sentinel species;
- Volunteers in US & Canada, & all 5 jurisdictions;
- Standardized methods, 1991 to 2008

- Support for chemical analyses, data interpretation analysis and outreach by the:

GULFWATCH PROGRAM

•Ubiquitous blue mussels are used as the indicator of habitat/biological exposure to toxic chemicals;

•Modeled after and nearly identical to the NOAA *Mussel Watch* program;

•Long-term sampling at sites on a rotational basis to provide wide spatial and temporal baseline of data.

INORGANIC CONTAMINANTS

Metals

Ag, Al, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Zn

ORGANIC CONTAMINANTS

Aromatic Hydrocarbons

Naphthalene
1-Methylnaphthalene
2-Methylnaphthalene
Biphenyl
2,6-Dimethylnaphthalene
Acenaphthylene
Acenaphthalene
2,3,5-Trimethylnaphthalene
Fluorene
Phenanthrene
Anthrasene
1-Methylphenanthrene
Fluoranthrene
Pyrene
Benzo[a]anthracene
Chrysene
Benzo[b]fluoranthrene
Benzo[k]fluoranthrene
Benzo[e]pyrene
Benzo[a]pyrene
Perylene
Indo[1,2,3-cd]pyrene
Dibenz[a,h]anthracene
Benzo[g,h,I]perylene

Chlorinated Pesticides

Hexachlorobenzene (HCB)
gamma-Benzenehexachloride (BHC)
Heptachlor
Heptachlor epoxide
Aldrin
Lindane
cis-Chlordane
trans-Nonachlor
Dieldrin
alpha-Endosulfan
beta-Endosulfan

DDT and Homologues

2,4'-DDE
2,4'-DDD
2,4'-DDT
4,4'-DDE
4,4'-DDD
4,4'-DDT

PCB Congeners

PCB 8, PCB 18, PCB 28, PCB 29,
PCB 44, PCB 50, PCB 52, PCB 66,
PCB 77, PCB 87, PCB 101, PCB 105,
PCB 118, PCB 126, PCB 128, PCB 138,
PCB 153, PCB 169, PCB 170, PCB 180,
PCB 187, PCB 195, PCB 206, PCB 209

GULFWATCH PROGRAM

USES

- Management & Policy
- Monitoring
- Impact/Damage & Remediation Assessment
- Education
- Aquaculture & Commercial Fishing

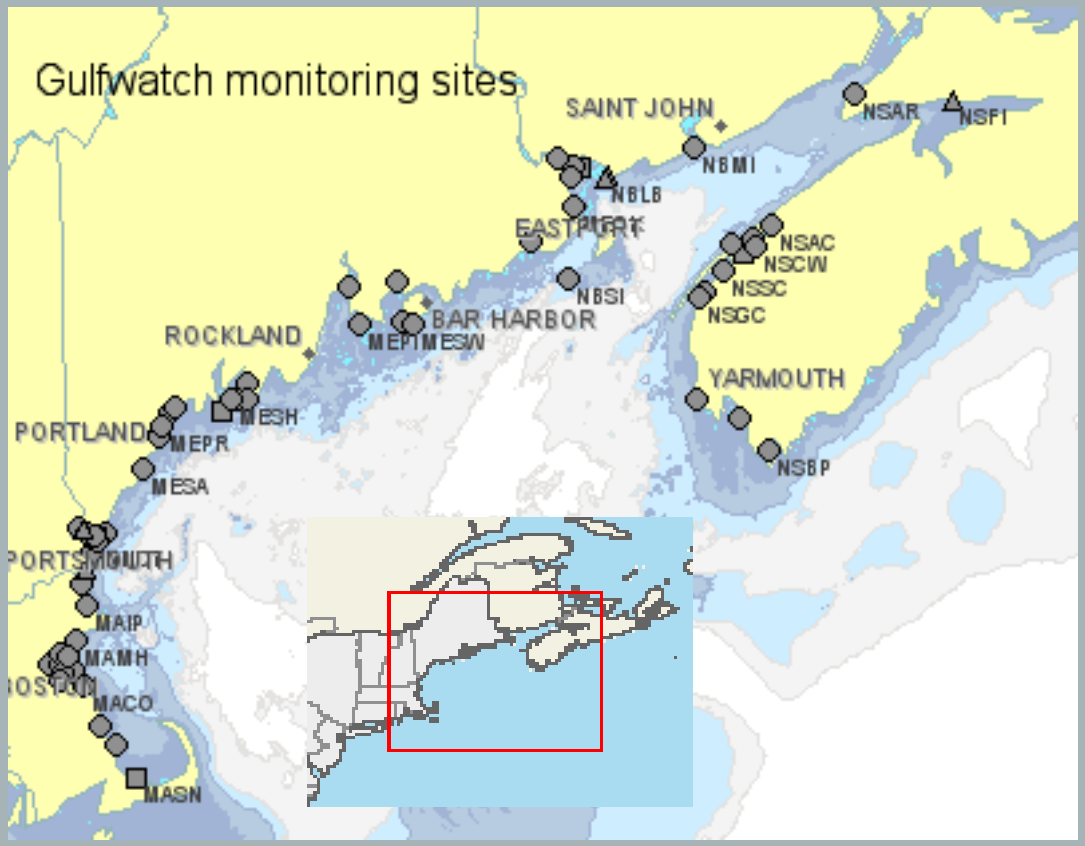
GULFWATCH PROGRAM

In the Gulf of Maine there have been ~100 sites where blue mussel samples have been analyzed

In New Hampshire, there have been ~20 sampling sites, including the unique analysis of oysters and soft shell clams

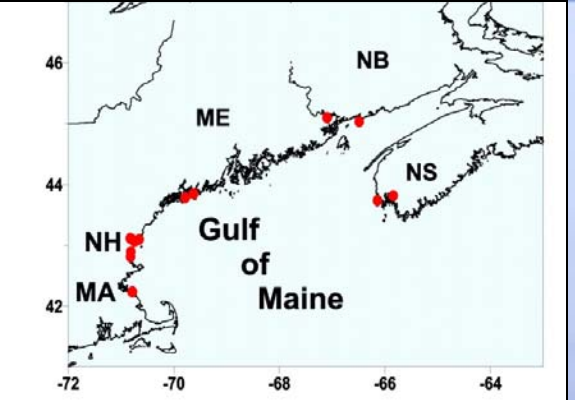
Overview of Gulfwatch Sampling Sites

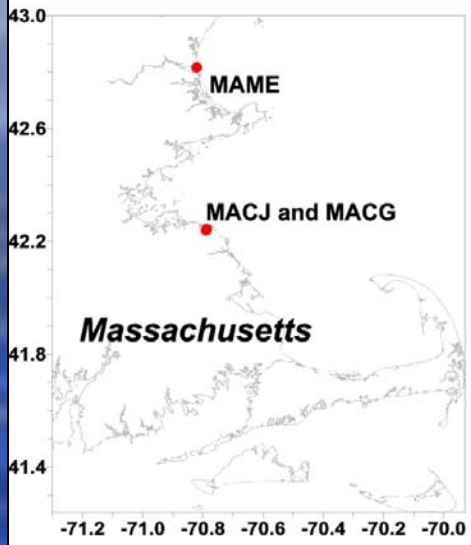
- *international contaminants monitoring program involving three states and two provinces*

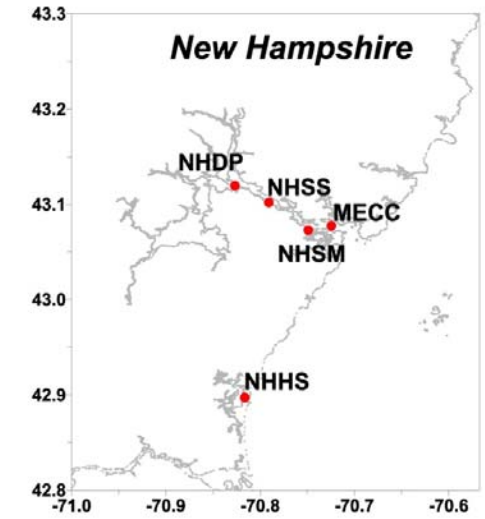


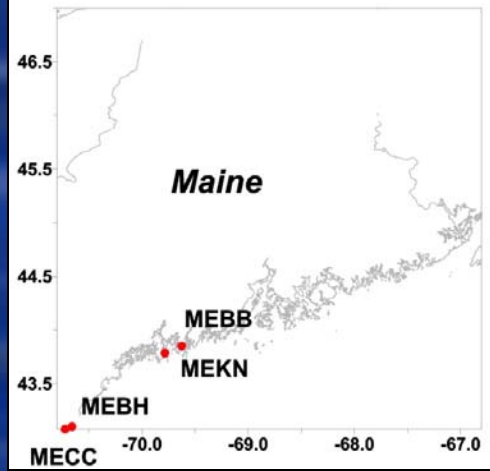
Each fall, blue mussels (*Mytilus edulis)* are collected from inter-tidal areas in coastal embayments around the Gulf of Maine and Bay of Fundy.

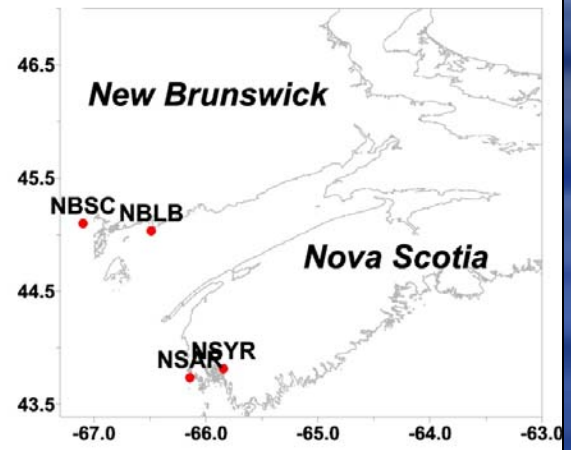
2006 Gulfwatch Sites



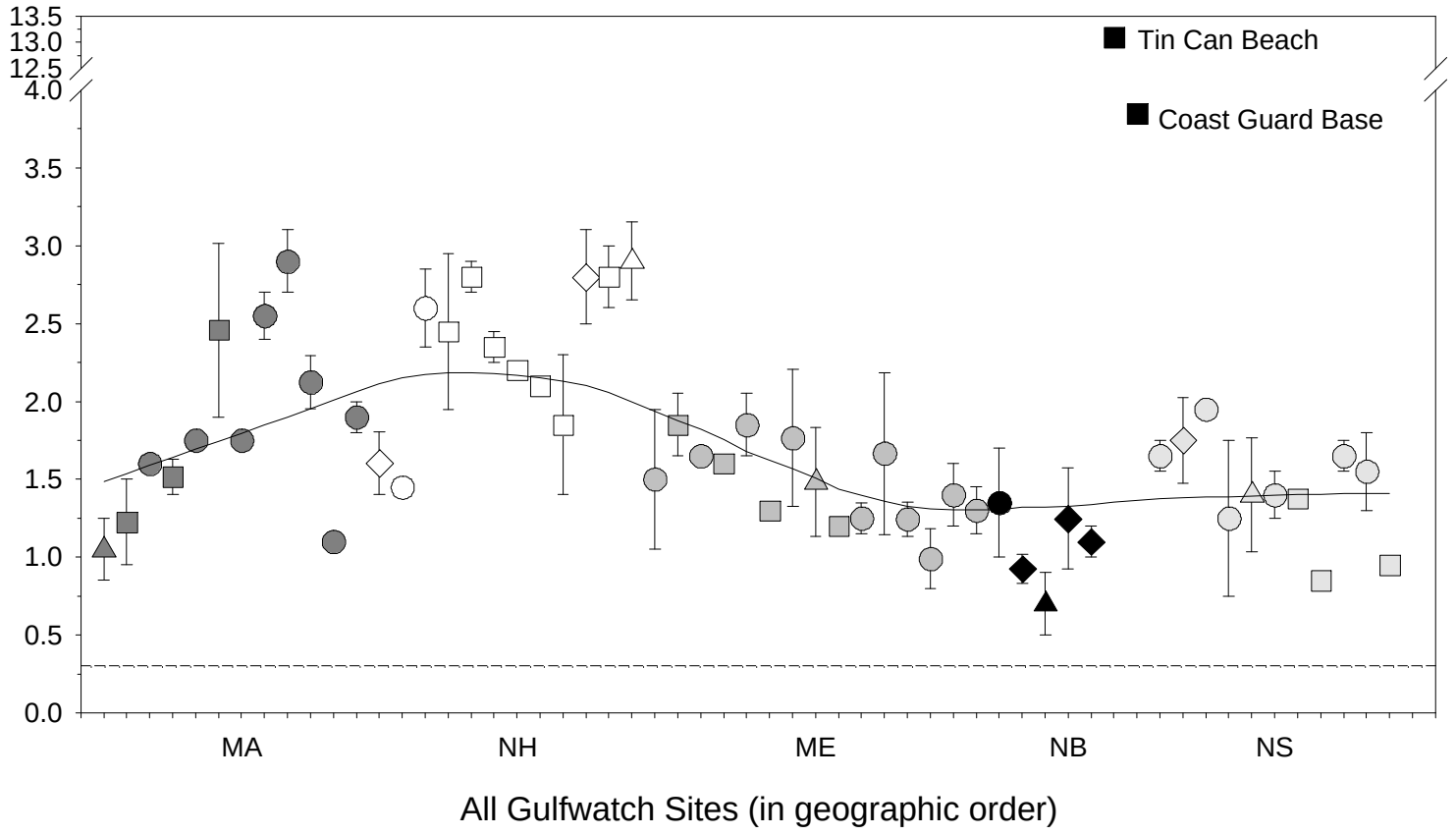




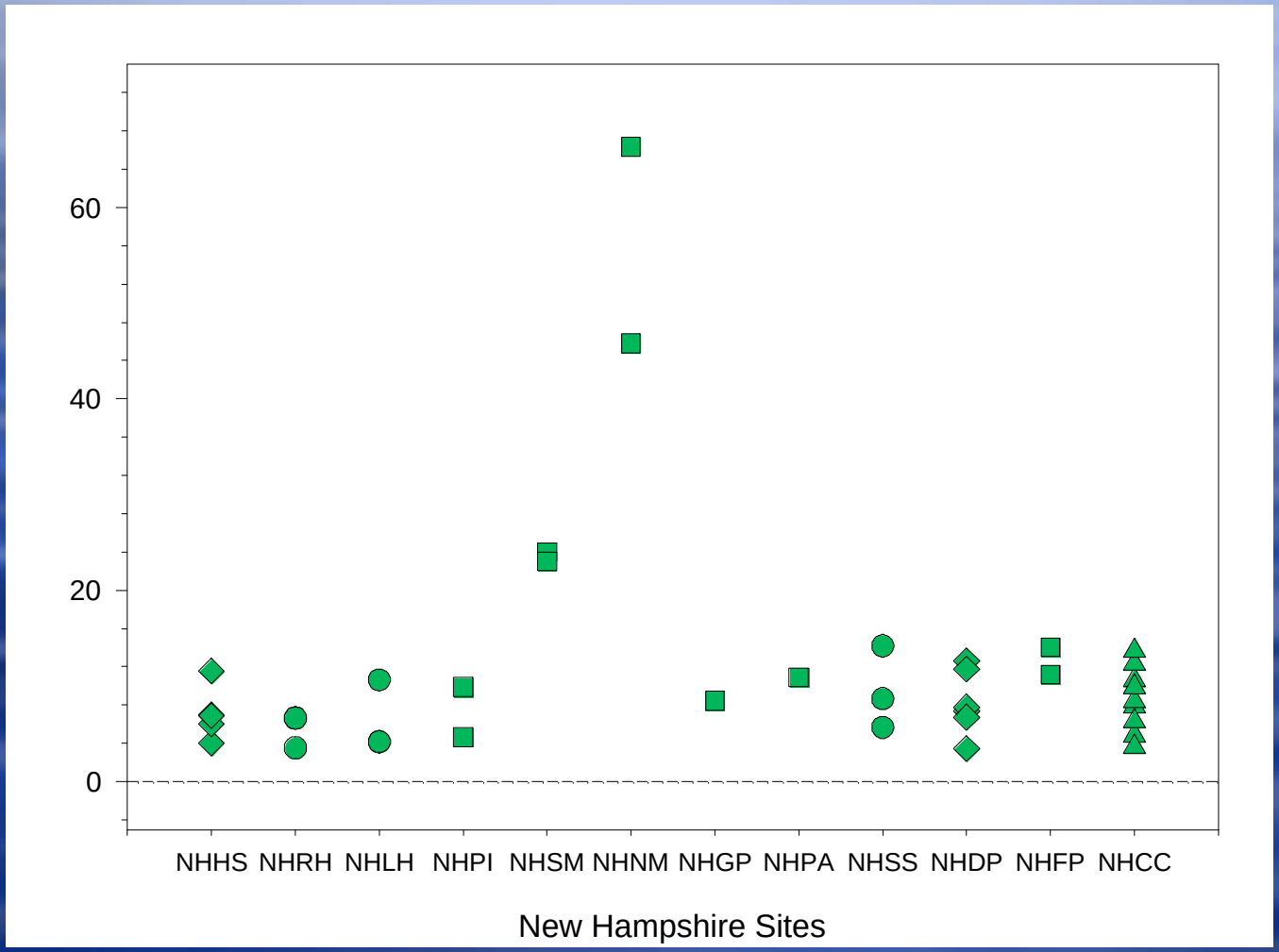




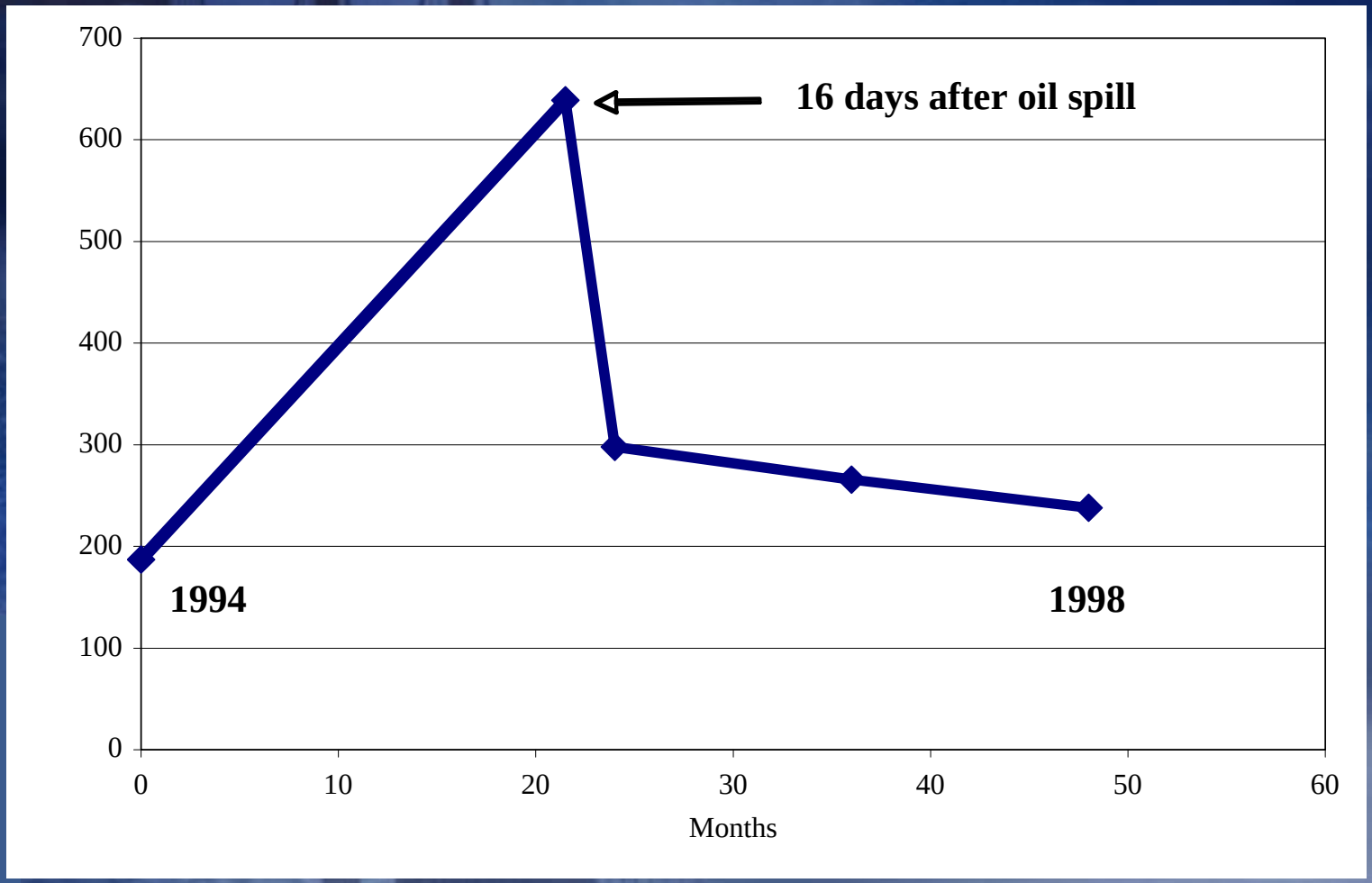
Chromium concentrations (ppm) in blue mussels: 1993-2001



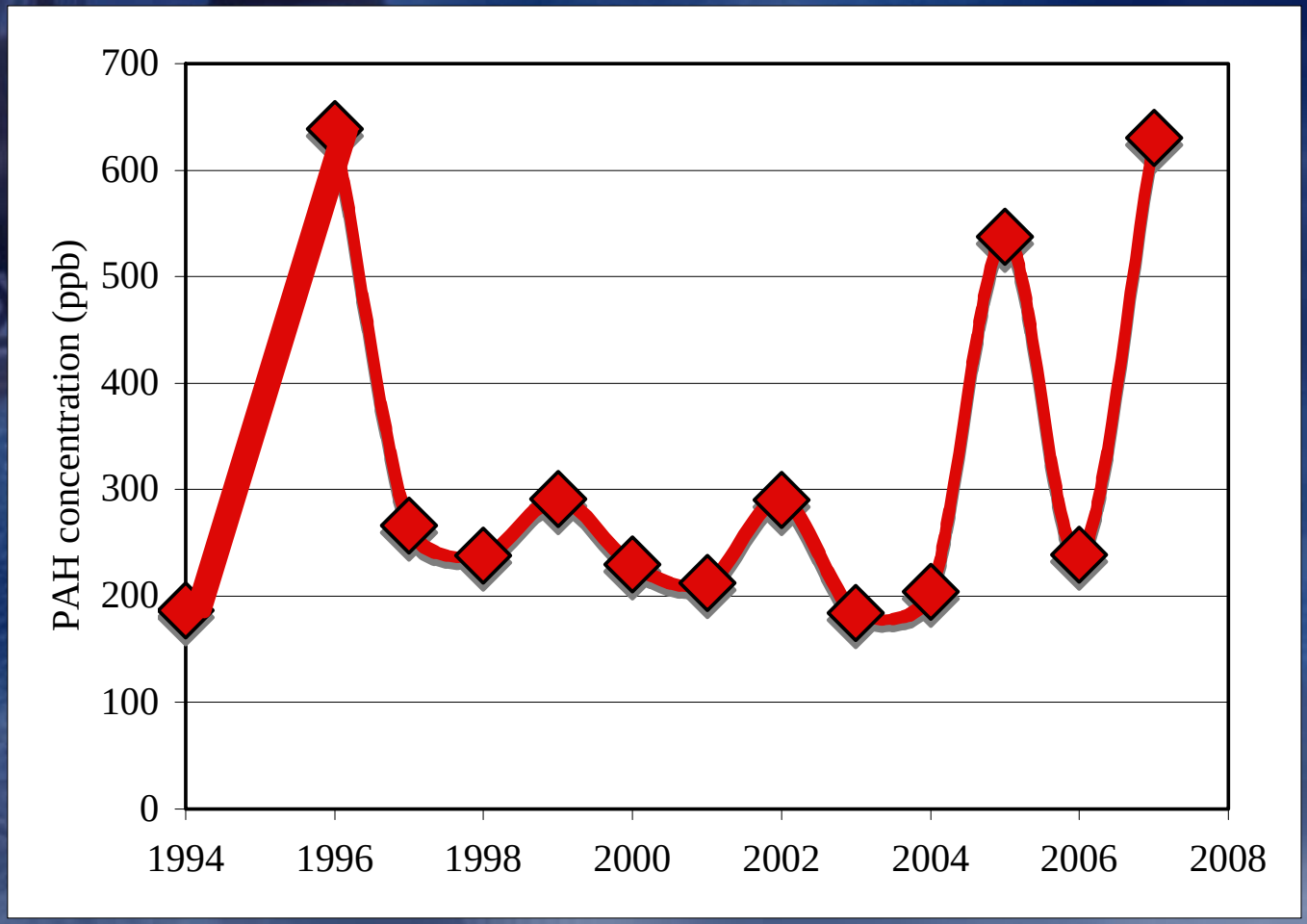
Total DDT concentrations (ppb) at NH sites: 1993-2001



PAHs (polycyclic aromatic hydrocarbons)
Contamination and recovery in Dover Point mussels



PAH concentrations at NHDP: *Detection of oil spills*



Summary of Information

- Oil spill detection and recovery
- Status of historical and present-day pollution sources
- Cross-referencing to oysters & soft shell clams (human consumption)
- Provides local and regional perspective on contaminants
- Relate to national Mussel Watch program

NHDES and *Gulfwatch*

- NHDES supporting agency within the GOM Council
- Direct involvement of Coastal Scientist
- Support for some NH sites and different species
- Sample collection & processing
- Shellfish Program applications: harvest area classification guidance
- Key indicator for 305 (b) report and “State of the Estuaries” report
- Impact assessment for management efforts to reduce pollution sources

MICROBIAL SOURCE TRACKING

- Approach using one or a variety of methods and target microorganisms; intended to identify the fecal sources impacting a water system

MICROBIAL SOURCE TRACKING

- identify source(s) as human/non-human, or actual source species
- Track pollution sources in space and time
- determine most significant sources at beaches to support management actions

MICROBIAL SOURCE TRACKING in New Hampshire

- NHDES selected *Escherichia coli* ribotyping as the best available method in 1999 & supported initial research and development
- Application in NH began in 2000 & has continued with Shellfish, Beach Inspection, & Coastal programs, Watershed Management Bureau participation
- Purchase of a RiboPrinter in 2003 (NHDES, CICEET, UNH support)

RIBOTYPING

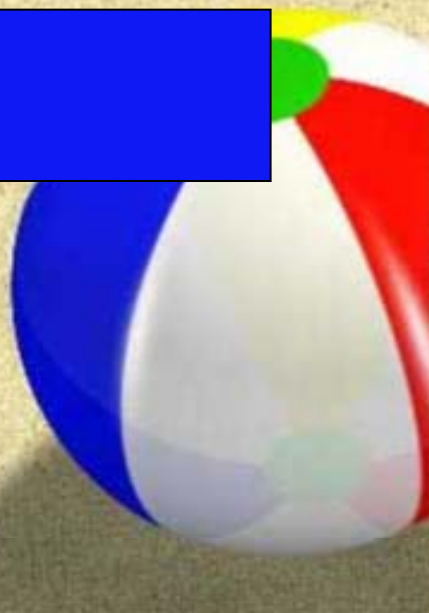
- Isolate *Escherichia coli* from sources in study area to create a ‘known source library’
- Isolate *Escherichia coli* from water samples
- Compare ribotyping DNA pattern of water samples with those from library (best match)
- Identify source species!

Who/what
is the culprit
of fecal
contamination?

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

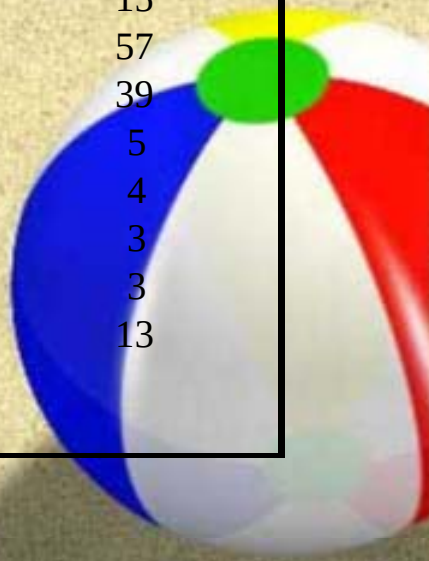
Sample

Ribopattern analysis results for sample from Atlantic Coast tributary



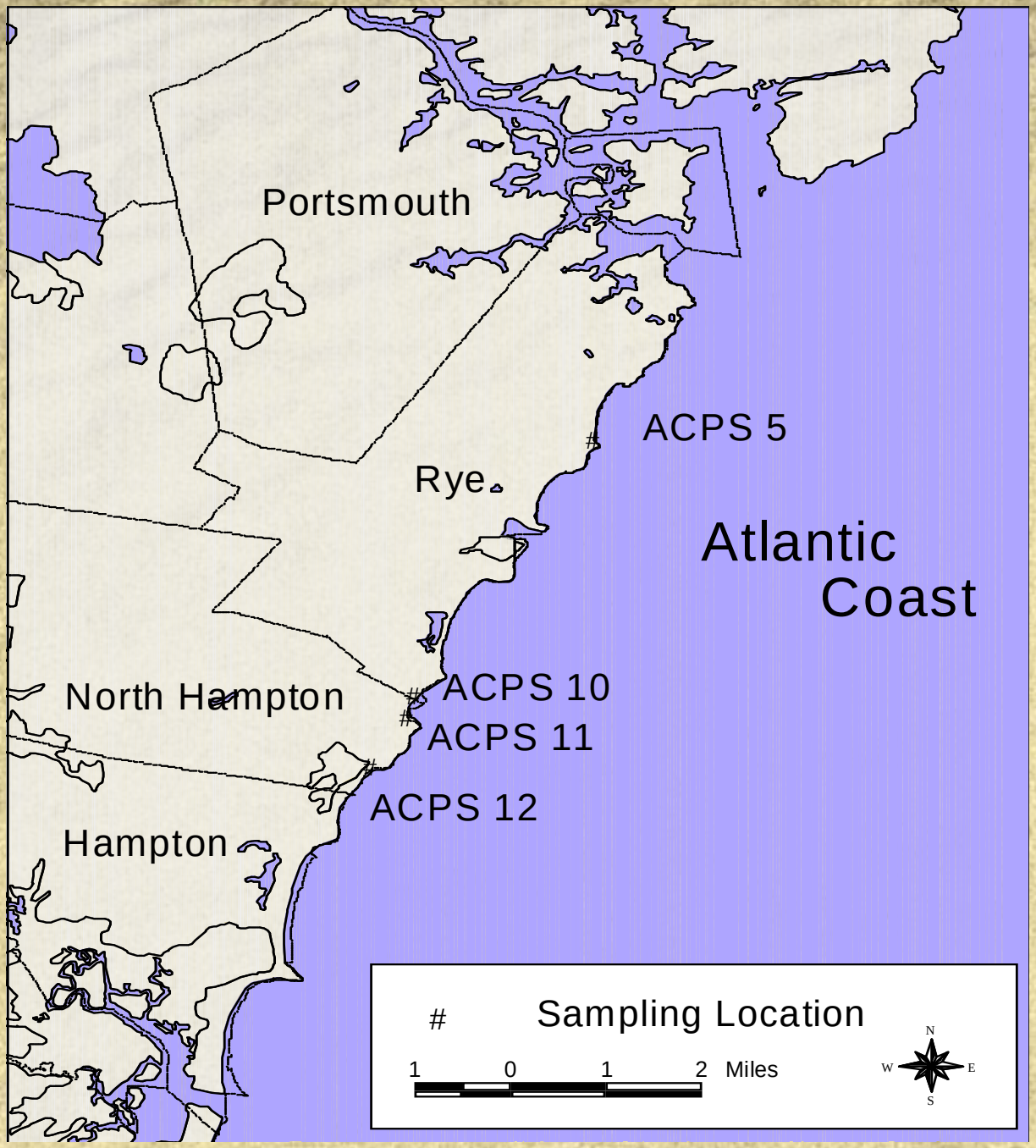
Regional Known Source Library

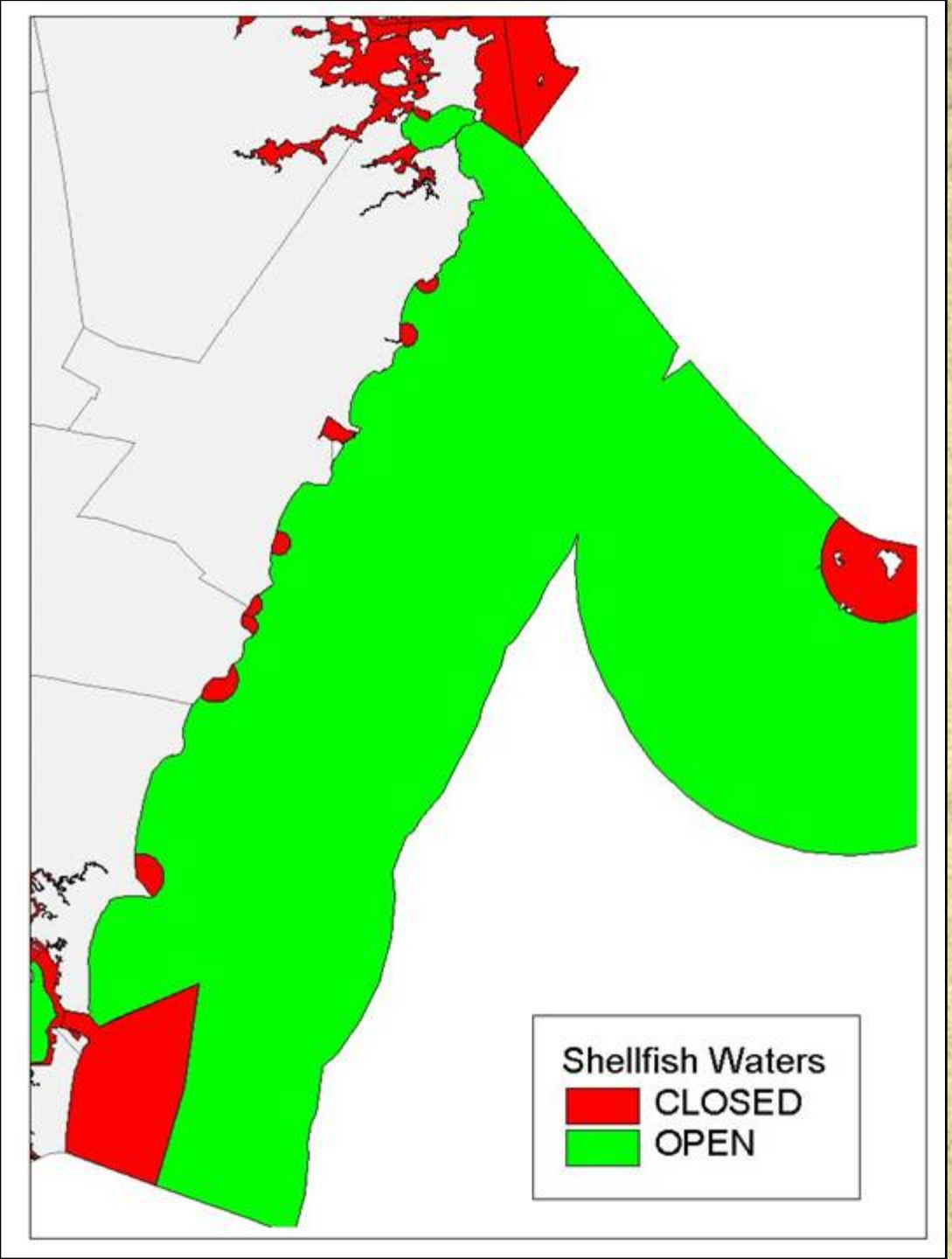
Species category	Source species	# of Isolates	Species category	Source species	# of Isolates
DOMESTIC ANIMALS			**"HUMANS"**		
136	alpaca	3	***245***	septage	16
	buffalo	5		wastewater	127
	chicken	3		humans	102
	cow	79	**PETS**		
	goat	4	***104***	cat	43
	horse	28		dog	61
	pig	12	**BIRDS**		
	sheep	2	***151***	cormorant	12
WILD ANIMALS				duck	15
335	coyote	38		geese	57
	deer	94		gull	39
	mouse	2		pigeon	5
	muskrat	22		robin	4
	otter	14		sparrow	3
	raccoon	84		starling	3
	rabbit	27		wild turkey	13
	red fox	49			
	skunk	5	**TOTAL = 971 ribopatterns**		



--> 31 species/sources, 5 TYPES

MST Study Sites at NH Atlantic Coast Beaches





Shellfish Harvesting Classification near Atlantic Coast Beaches (2004)

Water Quality in Tributaries to Atlantic Coast Beaches

SAMPLING SITES	*E. coli* CONCENTRATIONS (cfu/100 ml)	
	Wet Conditions	Dry Conditions
Parsons Creek Pirates Cove Beach	273	51
Bass Beach Brook Bass Beach	200	143
Chapel Brook Bass Beach	784	18
Little River Northside & States beaches	993	31
All Sites	**577**	**45**

Source Species Types Identified at Atlantic Coast Beaches, NH

Species type	Wet	Dry
Human	15%	24%
Wild animals	30%	29%
Pets	1%	2%
Birds	5%	8%
Livestock	5%	0%
Unknown	44%	37%
Total	100%	100%

Source Species Types Identified at Lake Beaches, NH

Source Type	Pawtuckaway State Park Nottingham	Sand Dam Village Town Beach Troy	Mill Pond Town Beach E. Washington
Human	10%	0%	7%
Birds	**15%**	**52%**	**40%**
Livestock	**20%**	**16%**	**33%**
pets	0%	8%	0%
Wild animals	10%	0%	3%
Identified	**55%**	**76%**	**83%**
Unknown	45%	24%	17%

Quality of LOCAL known source library dictated % identification;
(Most significant bird species was Canada geese)

Main Applications

- TMDLs: Little & Hampton/Seabrook harbors, three lake beaches
- Shellfish Program sanitary surveys
- Storm water modelling at NH coastal beaches
- ~30 surveys & research projects

Wider Applications

- Continued research to optimize application
- WWTF influent/effluent studies
- Sea gull transport of pathogens from landfills/WWTF ponds to marine environment

RESULTS SUMMARY

- Different source species and types suggest different management strategies
- Helps to focus pollution source reduction efforts & resources in right place