NS&T Program

National Status and Trends Program
for Marine Environmental Quality

SOUTH FLORIDA

Mussel Watch sampling site at Joe Bay (TAMU/GERG)

National Oceanic and Atmospheric Administration
National Ocean Service
National Centers for Coastal Ocean Science
Center for Coastal Monitoring and Assessment

1999
Regional Reports Series 2

Status and Trends of Contaminant Levels in Biota and Sediments of SOUTH FLORIDA

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BACKGROUND

As part of its continuing mission to bring important results into the public arena, the NOAA National Status and Trends (NS&T) Program has prepared this summary of its findings in South Florida.

The South Florida ecosystem has been subject to considerable environmental change during the past 50 years due to increased human population and activities. This unique ecosystem includes the Everglades National Park, Florida Bay, Biscayne Bay, the Ten Thousand Islands, the Florida Keys and the Greater Miami-Ft. Lauderdale metropolitan area (Figure 1).

The Everglades National Park, at the southern end of Florida, is a low, flat region, mostly under water. The Everglades is predominantly a river, about 6 in. deep, which originally flowed for more than 160 km from north of Lake Okeechobee through most of the center of South Florida into Florida Bay and the Gulf of Mexico. Drainage canals constructed since the turn of the century to meet the demand for dry land for residential and agricultural use have changed both the rate and direction of freshwater outflow. The coastal ecosystem of the Everglades is composed of six habitats: Florida Bay; the coastal prairie; vast mangrove forests and waterways; cypress swamps; the true everglades, which is an extensive freshwater marsh dotted with tree islands and occasional ponds; and the driest zone, the pine-and-hammock rockland. Underlying the entire Park is porous limestone covered by a thin mantle of marl and peat which provides soil for rooting plants. The Everglades fauna and flora are a blend of tropical species, most of which migrated from the Caribbean islands, and species from the Temperate Zone, which embraces all of Florida. The coastal mangrove forests, traversed by thousands of estuarine channels and containing numerous bays and sounds, are extremely productive biologically (Cantillo *et al.*, 1997).

Florida Bay is a coastal lagoon, on average less than 3 m deep. During most years, Florida Bay is a negative estuary where evaporation exceeds freshwater input resulting in a hypersaline (>35‰) environment. Salinities greater than 50‰ have been routinely measured, and maximum levels of approximately 70‰ have been observed. Florida Bay is a source of biogenic carbonate sediments. The bottom of the Bay is dominated by seagrasses, especially *Thalassia testudinum* (turtle grass). Florida Bay has been subject to environmental change caused by anthropogenic reduction of freshwater flow into the Bay from the Everglades and the introduction of pollutants into the ecosystem. Seagrass dieoffs, algal blooms, shifts in biodiversity, fauna and flora population changes, and other phenomena are being observed with increasing frequency. The reduction of freshwater is, in part, the result of the construction of drainage canals built after the turn of the century.

The reduction of freshwater flow may have resulted in increased salinities in Florida Bay where even in its natural state, evaporation exceeded freshwater inflow. The water flow pattern of Florida Bay was also altered by the

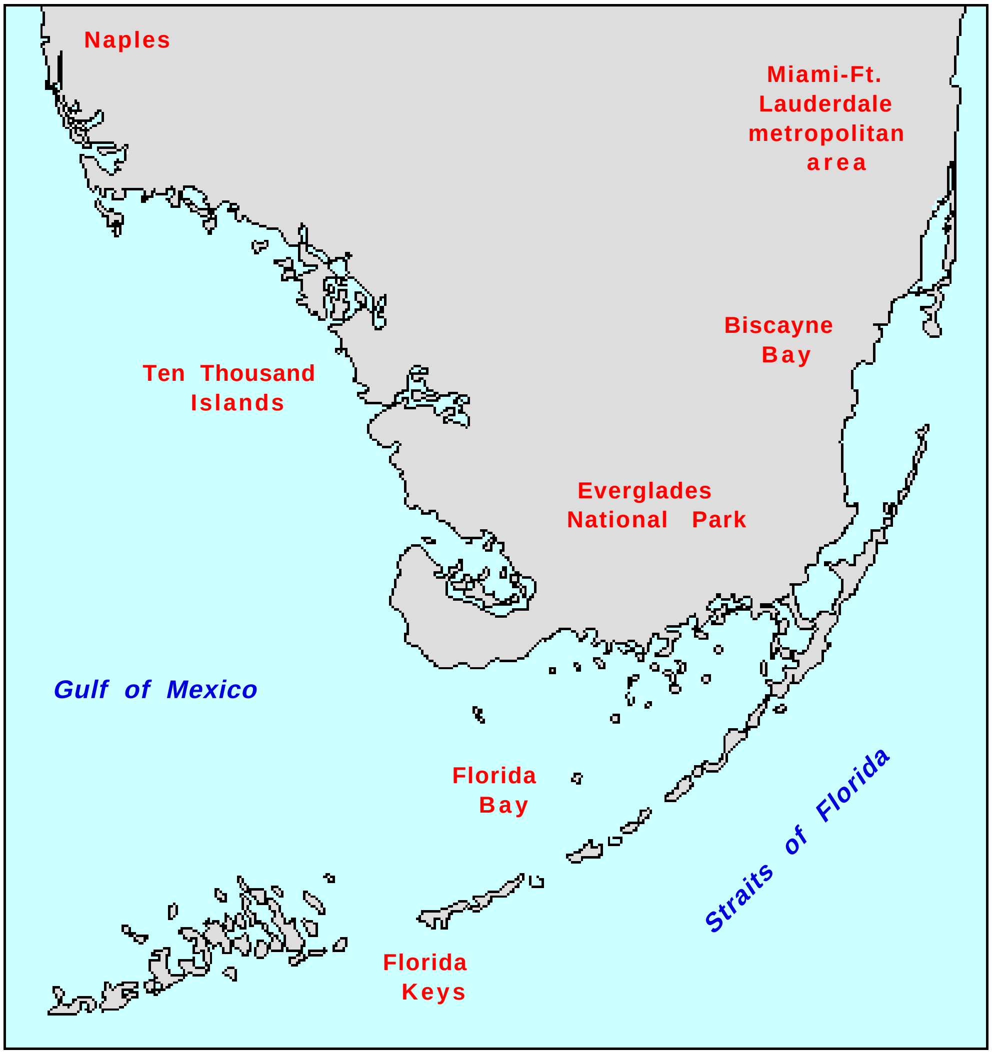


Figure 1. South Florida.

construction of the railway line connecting Key West to the mainland, and the subsequent conversion of this railway line into the Florida Keys Overseas Highway.

The Florida Keys encompass the 345 km long Florida Reef Track, the only living tropical coral reef along the mainland United States. The ecosystem on the northern side of the reef is similar to that of Florida Bay and the shorelines are characterized by mangrove communities. Urban development has resulted in riprap and gravel beaches, rocky shores, and seawalls. There are few sand beaches in the Florida Keys. The coral species most abundant in the Florida Reef Track are *Montastrea annularis*, *M. cavernosa*, *Acropora palmata*, *A. cervicornis*, *Diploria* spp., *Siderastrea siderea*, and *Colpophyllia* spp. Many of these species have been affected by coral bleaching, and white band and black band disease. Also, low water temperatures resulting from the passage in recent years of severe cold fronts have stressed or killed many corals. The ecosystem has been impacted by excessive amounts of nutrients from Florida Bay and the Keys and by over-development of the Keys, and has been damaged by large vessels through ship groundings and minor oil spills.

The Ten Thousand Islands area on the southwest coast of Florida consists of mangrove forests, salt marshes, islands, and man-made drainage canals. Rookery Bay is in the northern section of the Ten Thousand Islands. It receives freshwater from local runoff, ground water seepage and discharge from Henderson Creek. Naples Bay lies to the north and is adjacent to the City of Naples. The shoreline of Naples Bay has been altered by land development and construction of seawalls.

Biscayne Bay is a large shallow subtropical lagoon located on the east coast of Florida. The northern portion is surrounded by the cities of Miami and Miami Beach and is heavily developed. There are many man-made islands in the Bay, some used for residential purposes and one is used as the Port of Miami. The southern portion of the Bay remains essentially undeveloped. The coastline of the southern portion consists of mangrove forests and hardwood hammocks.

The Miami-Ft. Lauderdale metropolitan area is on the east coast of Florida between the boundaries of the Everglades National Park and Biscayne Bay. The rate of population increase in the southeast has been one the highest in the Nation and is projected to have the highest population growth rate of all regions, further stressing the ecosystems within the Southeast. Eastern Florida counties which include the Miami-Ft. Lauderdale metropolitan area are expected to grow at the fastest rate of any counties in the Southeast U.S. and are projected to have the highest population density in the Southeast United States by 2010.

NATIONAL STATUS AND TRENDS PROGRAM

Our Nation's estuaries and coastal waters receive chemical wastes from industrial, municipal, and agricultural sources. In recent decades, as industrialization has grown and diversified, complex mixtures of synthetic organic compounds, trace elements, and nutrients have been discharged into US coastal waters.

In addition to coming from industrial sources, contaminants are released to the environment in the course of our daily lives. For generations, chemicals from such non-point sources as agricultural runoff, urban runoff and non-agricultural insect and plant control programs have added significantly to the total burden of coastal contaminants. Airborne transport is another significant source of contaminants to coastal ecosystems. In recent years, coastal contamination has become more of a concern as population growth in these areas has continued to increase steadily. In response, an evolving national effort is underway to determine the extent and impact of contaminants on coastal and estuarine areas and to develop management strategies.

The Center for Coastal Monitoring and Assessment (CCMA), in the National Centers for Coastal Ocean Science (NCCOS) of NOAA's National Ocean Service, conducts a variety of environmental monitoring and assessment studies that are pertinent to NOAA's Environmental Stewardship mission, as outlined in its Strategic Plan: "A Vision for 2005". These studies focus on three long-term goals:

- Assess the status and trends of environmental quality in relation to levels and effects of contaminants and other sources of environmental degradation in US marine, estuarine, and Great Lakes environments;
- Develop diagnostic and predictive capabilities to determine effects of contaminants and other sources of environmental degradation on coastal and marine resources and human uses of these resources;
- Develop and disseminate scientifically sound data, information, and services to support effective coastal management and decision making.

NOAA's NS&T Program, managed by CCMA, was initiated in 1984 to determine the status of, and to detect changes in, the environmental quality of the nation's coastal waters. This program monitors contaminant levels through the **Mussel Watch Project,** which determines concentrations of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyl (PCB) congeners, several pesticides, butyltins, and selected trace elements in sediment and mollusk samples from U.S. coastal waters (Table 1). Data are used to determine

TABLE 1

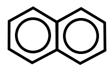
Organic contaminants and major and trace elements determined as part of the NS&T Program.

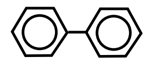
(Number below chemical structure is the Chemical Abstracts Service registry number.)

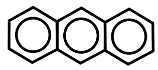
Polycyclic aromatic hydrocarbons

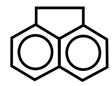
Low molecular weight PAHs
(2- and 3-ring structures)

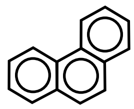
1-Methylnaphthalene
1-Methylphenanthrene
2-Methylnaphthalene
2,6-Dimethylnaphthalene
1,6,7-Trimethylnaphthalene
Acenaphthene
Acenaphthylene
Anthracene
Biphenyl
Fluorene
Naphthalene
Phenanthrene

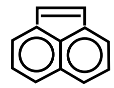

Naphthalene
91-20-3

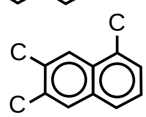

Biphenyl
92-52-4


Anthracene
120-12-7

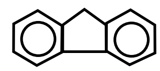

Acenaphthene
83-32-9

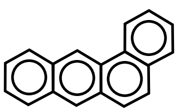

Phenanthrene
85-01-8

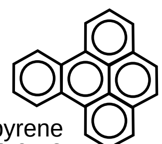

Acenaphthylene
208-96-8

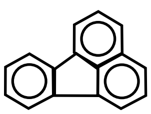


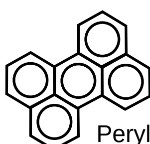
1,6,7-Trimethylnaphthalene
2245-38-7

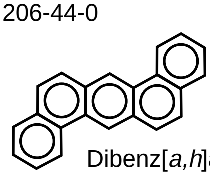

Fluorene
86-73-7

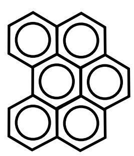

Benz[*a*]anthracene
56-55-3


Benzo[*e*]pyrene
192-97-2


Fluoranthene
206-44-0


Perylene
198-55-0


Dibenz[*a,h*]anthracene
53-70-3

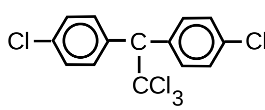

Benzo[*ghi*]perylene
191-24-2

High molecular weight PAHs
(4-, 5-, and 6-rings)

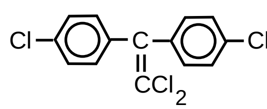
Benz[*a*]anthracene
Benzo[*a*]pyrene
Benzo[*b*]fluoranthene
Benzo[*e*]pyrene
Benzo[*ghi*]perylene
Benzo[*k*]fluoranthene
Chrysene
Dibenz[*a,h*]anthracene
Fluoranthene
Indeno[1,2,3-*cd*]pyrene
Perylene
Pyrene

Chlorinated pesticides

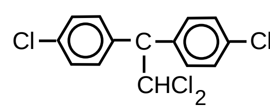
2,4'-DDD
4,4'-DDD
2,4'-DDE
4,4'-DDE
2,4'-DDT
4,4'-DDT



4,4'-DDT
50-29-3



4,4'-DDE
72-55-9



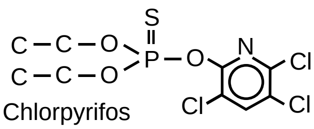
4,4'-DDD
72-54-8

TABLE 1 (cont.)

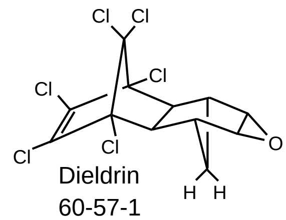
Organic contaminants, and major and trace elements determined as part of the NS&T Program.

(Number below chemical structure is the Chemical Abstracts Service registry number.)

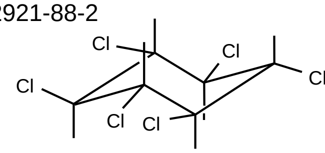
Aldrin
Chlorpyrifos
cis-Chlordane
Dieldrin
Endosulfan-II
delta-Hexachlorocyclohexane
gamma-Hexachlorocyclohexane (Lindane)
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
alpha-Hexachlorocyclohexane
beta-Hexachlorocyclohexane
Mirex
cis-Nonachlor
trans-Nonachlor
Oxychlordane



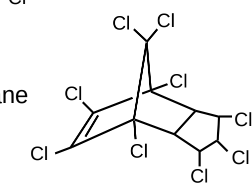
Chlorpyrifos
2921-88-2



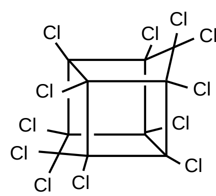
Dieldrin
60-57-1



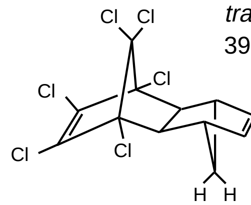
gamma-Hexachlorocyclohexane
58-89-9



trans-Nonachlor
39765-80-5



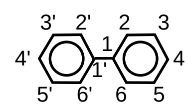
Mirex
2385-85-5



Aldrin
309-00-2

Polychlorinated biphenyl congeners (IUPAC numbering system)

PCB 8, PCB 18, PCB 28, PCB 44, PCB 52, PCB 66, PCB 101, PCB 105, PCB 118, PCB 128, PCB 138, PCB 153, PCB 170, PCB 180, PCB 187, PCB 195, PCB 206, PCB 209

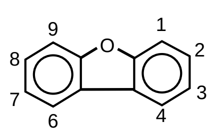


PCB parent structure

Planar PCBs (PCB 77, PCB 126, PCB 169)

Chlorinated dibenzofurans

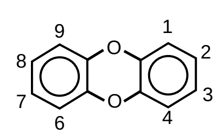
2,3,7,8-Tetrachlorodibenzofuran
1,2,3,7,8-Pentachlorodibenzofuran
2,3,4,7,8-Pentachlorodibenzofuran
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,6,7,8-Hexachlorodibenzofuran
2,3,4,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-Hexachlorodibenzofuran
1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,2,3,4,7,8,9-Heptachlorodibenzofuran
Octachlorodibenzofuran



Dibenzofuran parent structure

Chlorinated dibenzodioxins

2,3,7,8-Tetrachlorodibenzo-*p*-dioxin
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin
Octachlorodibenzo-*p*-dioxin



Dibenzo-*p*-dioxin parent structure

TABLE 1 (cont.)

Organic contaminants, and major and trace elements determined as part of the NS&T Program.

(Number below chemical structure is the Chemical Abstracts Service registry number.)

Major and trace elements

Al	-	aluminum	Cu	-	copper	Ag	-	silver
Si	-	silicon	Zn	-	zinc	Cd	-	cadmium
Cr	-	chromium	As	-	arsenic	Hg	-	mercury
Mn	-	manganese	Se	-	selenium	Tl	-	thallium
Fe	-	iron	Sn	-	tin	Pb	-	lead
Ni	-	nickel	Sb	-	antimony			

Organotins

Monobutyltin^{3+}, dibutyltin^{2+}, tributyltin^{+}, tetrabutyltin

the extent and temporal trends of chemical contamination on a nationwide basis and to identify which coastal areas are at greater risk in terms of threats to environmental quality. The Mussel Watch network consists of more than 280 sites. The **Quality Assurance Project** is designed to document sampling protocols, analytical procedures, and laboratory performances of the Mussel Watch Project and is an integral part of the NS&T Program.

SURVEY METHODS

Mussel Watch Project sites are sampled at regular intervals (biennially in winter for mollusks, less frequently for sediments). The sites are designed to describe national and regional distributions of contamination. Mussel Watch sites are selected to represent large coastal areas and to avoid small-scale patches of contamination, or "hot spots." Sites selected for monitoring are generally 10 to 100 km apart. Where possible, sites were selected to coincide with historical monitoring sites such as the Environmental Protection Agency's Mussel Watch sites sampled during the 1970s, and to complement sites sampled through state programs such as the California Mussel Watch Program (Lauenstein, 1996).

Mollusks (mussels or oysters) and sediments are collected at each Mussel Watch Project site. Several species of mollusks are collected: blue mussels (*Mytilus edulis*) from the US North Atlantic; blue mussels (*Mytilus* species) and California mussels (*M. californianus*) from the Pacific coast; eastern oysters (*Crassostrea virginica*) from the South Atlantic and the Gulf of Mexico; smooth-edge jewelbox (*Chama sinuosa*) from the Florida Keys; Caribbean oyster (*C. rhizophorae*) from Puerto Rico; Hawaiian oysters (*Ostrea sandvicensis*) from Hawaii; and zebra mussels (*Dreissena polymorpha* and *D. bugensis*) from the Great Lakes. Coastal and estuarine mollusks are collected by hand or dredged from intertidal to shallow subtidal zones, brushed clean, packed in dry ice, and shipped to the analytical laboratory. Sediments are collected using a grab sampler and the top two centimeters are removed for analysis. The mollusk and sediment samples are usually shipped to the laboratory within a day of collection.

In the laboratory, molluscan samples are composited to include about 20 or 30 individuals for oysters and mussels, respectively. The molluscan composite samples and sediment

Mangrove forest (NOAA Photo Collection, NOAA Central Library)

samples are analyzed for organic and metal contaminants. The sampling and analytical protocols are described in detail in Lauenstein and Cantillo (1993, 1998). Data are also available from the NS&T **Benthic Surveillance Project** that analyzed contaminant levels and effects in sediment and fish from over 100 sites in 1984 through 1992. This Project's sediment data are combined with those of the Mussel Watch Project data in this report.

The NS&T Mussel Watch and Benthic Surveillance sites in South Florida and nearby coastal areas are shown in Figure 2. The site names, acronyms, latitudes and longitudes, years of data available and human populations within 20 km of the sites are listed in Table 2.

The average concentrations of major and trace elements and of categories of organic compounds are shown graphically in the Appendices. Appendix II provides graphical representations of trace element and organic concentrations in oysters through time at selected sites.

RESULTS AND DISCUSSION

Status

Oysters

Crassostrea virginica specimens have been collected at seven Mussel Watch sites in South Florida. The NS&T sites are: North Miami Maule Lake (NMML), Biscayne Bay Princeton Canal (BBPC), Florida Bay Joe Bay (FBJB), Florida Bay Flamingo (FBFO), Everglades Faka Union Bay (EVFU), Rookery Bay Henderson Creek (RBHC) and Naples Bay (NBNB). The site at Princeton Canal was sampled for two years until the native oyster population disappeared and sampling was moved south to Gould's Canal (BBGC).

South Florida data were compared to the nationwide NS&T median and 85th percentile values. Concentrations above the 85th percentile are in the highest 15% of the data set and are used to indicate "high" concentrations. Percentiles are robust with

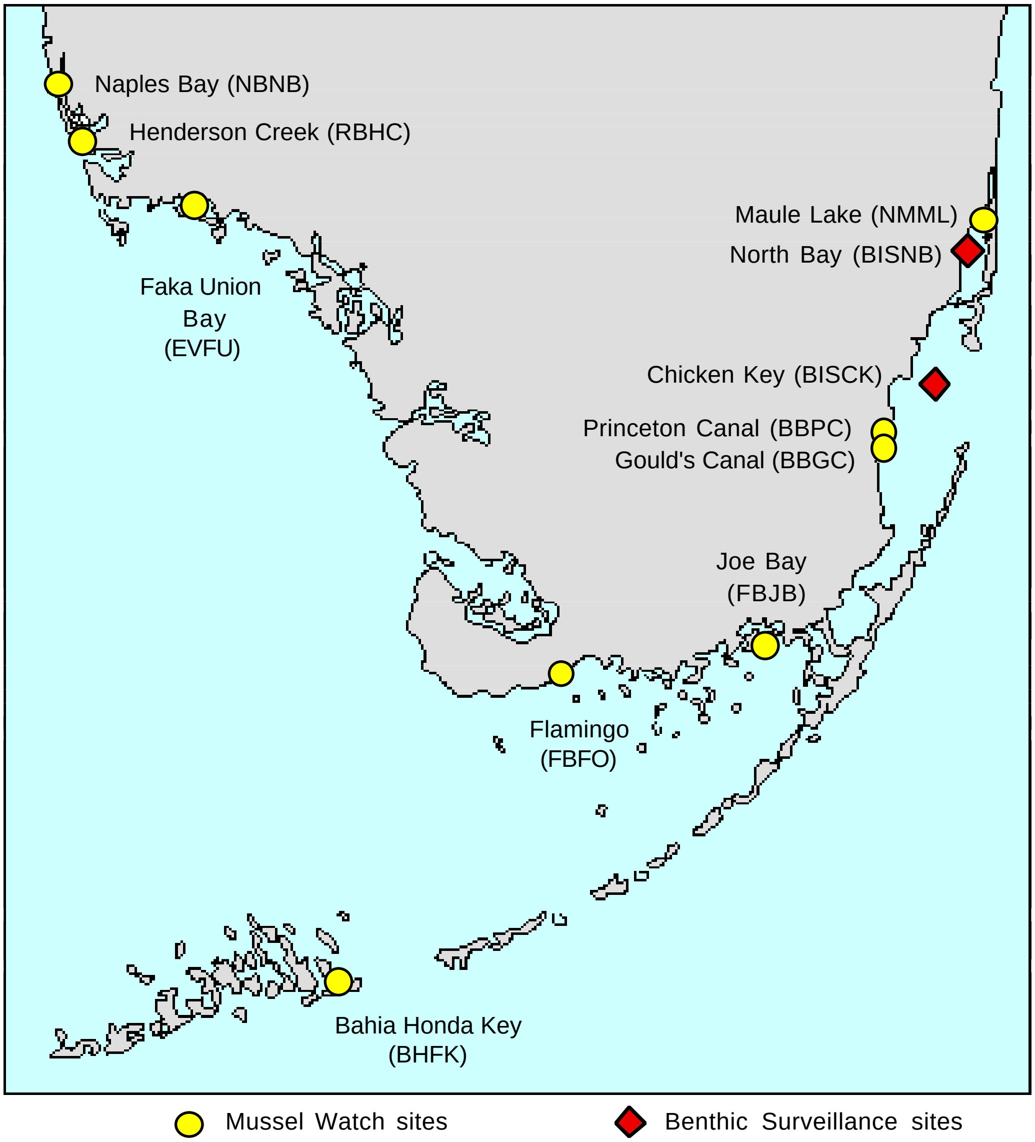


Figure 2. NS&T Mussel Watch and Benthic Surveillance sampling sites in South Florida.

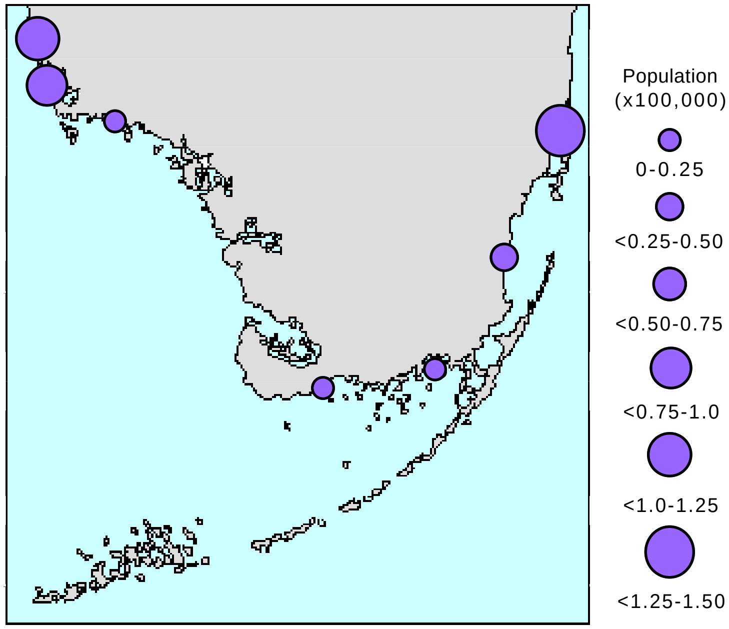


Figure 3. Population within 20 km of sampling site.

regard to both outliers and concentrations below the detection limit. The NS&T medians and 85th percentiles are listed in Table 3.

Oysters and mussels are not equal in their ability to concentrate trace elements (O'Connor, 1993). The trace elements Ag, Cu, and Zn are concentrated to a greater extent by oysters relative to mussels. Conversely, Cr and Pb are concentrated at more than three times the level in the mussels than in the oysters. Therefore, only the NS&T nationwide oyster data were used to compare to the Ag, Cr, Cu, Pb and Zn South Florida oyster data. The differences in bioaccumulation between oysters and mussels for the other elements and the organic analytes are not sufficiently great as to prevent the combination of the data from the two bivalves.

The mean analyte concentrations in oysters collected in South Florida were generally below the NS&T 85th percentile values. Exceptions were found at sampling sites near urban areas (Figure 3). Mean annual concentrations above the NS&T 85th percentile values were found at Maule Lake (Cu, Zn, Pb, ∑BTs), Gould's Canal (Cu, ∑BTs), Naples Bay (Cu, As, Ag, ∑BTs), and Henderson Creek (Cr, As).

Exceptions to the connection between human population and high contaminant levels were found at three sites. Mean annual concentrations were higher than the NS&T 85th Percentile at Faka Union Bay (Cr), Flamingo (Cu, As, ∑PAHs), and Joe Bay (Cr, Se, Hg and endosulfan II). The Flamingo and Joe Bay sites receive water from inland locations and thus may reflect contamination related to land use. The Flamingo site is located at the only marina in that area of South Florida and some of the contaminant levels may be the result of boating activities.

Tributyltin, as it leaches from antifouling paints, inhibits the attachment of marine organisms to surfaces coated with the paint. Tributyltin (TBT) breaks down to dibutyltin (DBT) and monobutyltin (MBT). Vessels and boats coated with tributyltin antifouling paints and vessel repair facilities are major sources for the release of tributyltins into the marine environment. The highest levels of ∑BTs (TBT+ DBT+MBT) in South Florida were found at the Maule Lake site and are possible indicators of heavy boating activity in the area.

TABLE 2

NS&T sampling sites in South Florida.

Site	Site code	Latitude (N)	Longitude (W)	Years of tissue data*	Population$^{\Delta}$ (20 km of site)
Mussel Watch Project					
Crassostrea virginica (Eastern oyster)					
Maule Lake	NMML	25° 56.13'	80° 08.77'	8	1,310,765
Gould's Canal	BBGC	25° 31.39'	80° 18.85'	6	329,729
Princeton Canal	BBPC	25° 31.13'	80° 19.75'	2	329,729
Bahia Honda Key ◊	BHKF	24° 39.52'	81° 16.43'	3	10,137
Joe Bay	FBJB	25° 12.53'	80° 32.00'	4	19,945
Flamingo	FBFO	25° 08.27'	80° 55.25'	4	253
Faka Union Bay	EVFU	25° 54.08'	81° 30.78'	10	3,246
Henderson Creek	RBHC	26° 01.50'	81° 44.20'	10	91,001
Naples Bay	NBNB	26° 06.85'	81° 47.20'	10	117,791
Benthic Surveillance Project					
Lagodon rhomboides (Pinfish)					
North Bay	BISNB	25° 48.9'	80° 09.6'	1	-
Chicken Key	BISCK	25° 36.9'	80° 17.6'	1	-

$^{\Delta}$ 1990 Census.
* Years of tissue data available through 1997.
◊ *Chama sinuosa* (Smooth-edged jewel box) is collected at this site. Since this is the only NS&T where this species is collected, the data was not used in this document.

Ibis (NOAA Photo Collection, NOAA Central Library)

TABLE 3

NS&T Mussel Watch Data medians and 85th percentile values (1986 - 1997)
(Medians and percentiles were determined using the average at each site across all sampled years. Element data in µg/g dry wt. unless noted, and organic data in ng/g dry wt.).

Oyster data only

	Cr	Cu	Zn	Ag	Pb
n	128	128	128	128	128
Median	0.69	140	2200	2.3	0.51
85th percentile	1.1	290	4600	5.0	0.82

Mussel and oyster data

	Ni	As	Se	Cd	Hg
n	281	281	281	281	280
Median	1.9	9.2	2.8	2.8	0.10
85th percentile	2.1	16	3.9	5.9	0.21

	∑DDTs	∑PCBs	∑PAHs	∑Cdane	∑Dieldrin
n	280	280	268	280	280
Median	33	100	300	10	5.1
85th percentile	140	450	1200	32	15

	Mirex	Hexachloro-benzene	Lindane	Endrin	∑BTs
n	280	280	280	45	250
Median	0.24	0.23	1.2	0.38	54
85th percentile	1.2	1.1	2.8	2.3	200

Sediment data (Calculated using Mussel Watch Program sediment data only.)

	Al (%)	Si (%)	Cr	Mn	Fe (%)
n	223	178	222	199	223
Median	2.4	3.0	54	370	2.1
85th percentile	4.8	36	120	740	3.7

	Ni	Cu	Zn	As	Se
n	223	223	223	223	207
Median	17	14	67	6.9	0.38
85th percentile	36	47	130	12	0.74

	Ag	Cd	Sn	Sb	Hg
n	223	223	223	178	223
Median	0.11	0.19	1.3	0.47	0.057
85th percentile	0.59	0.56	3.1	1.8	0.22

TABLE 3 (cont.)

NS&T Mussel Watch Data medians and 85th percentile values (1986 - 1997)
(Medians and percentiles were determined using the average at each site across all sampled years. Element data in µg/g dry wt. unless noted, and organic data in ng/g dry wt.).

	Tl	Pb	TOC (%)	∑DDTs	∑PCBs
n	145	223	220	224	224
Median	0.073	18	1.0	2.9	15
85th percentile	0.56	40	2.4	18	80

	∑PAHs	∑Cdane	∑Dieldrin	Mirex
n	224	224	224	224
Median	380	0.51	0.30	0.002
85th percentile	2300	3.1	1.9	0.36

	Hexachloro-benzene	Lindane
n	223	224
Median	0.14	0.04
85th percentile	0.92	0.47

∑DDTs: The sum of concentrations of DDTs and its metabolites, DDEs and DDDs.
∑PCBs: The sum of the concentrations of homologs, which is approximately twice the sum of the 18 congeners.
∑PAHs: The sum of concentrations of the 18 PAH compounds.
∑Cdane: The sum of *cis*-chlordane, *trans*-nonachlor, heptachlor and heptachlorepoxide.
∑Dieldrin: The sum of dieldrin and aldrin.
∑BTs: The sum of the concentrations of tributyltin and its breakdown products dibutyltin and monobutyltin (as ng Sn/g dry wt.).
n: Number of data points (roughly equivalent to the number of sampling sites).

Aldrin transforms into dieldrin. Thus these compounds may follow similar pathways in the environment. The sums of the concentrations of these pesticides in oysters collected in South Florida were mostly below the NS&T median. Levels of hexachlorobenzene, lindane and mirex were also very low as reflected by oyster body burden levels.

Sediment

The levels of trace elements in sediments from South Florida are below the NS&T 85th percentile in most cases. The sediments collected at the Maule Lake and Gould's Canal sites have higher concentrations of most contaminants than sediments collected at the other sites. Average analyte concentrations in sediment that are higher than the NS&T 85th percentile values were found for Se at Maule Lake, Gould's Canal and Naples Bay; Pb at Maule Lake; ∑PCBs at Maule Lake; the sum of dieldrin and aldrin at Maule Lake and Gould's Canal; and total chlordane pesticides at Gould's Canal. The levels of most pesticides in sediment were very low, and in most cases below the method detection limit.

Trends

Contamination trends at the NS&T sites around the US from 1986 through 1995 have been identified by statistically comparing yearly average concentrations in mollusk samples from each of the 186 sites that were sampled for at least six years. Calculations for each chemical at each sampling site showed increasing, decreasing, or no trend over time. The most common observation was no trend, but in the cases where trends were found many more were decreasing than increasing. Contamination nationwide is decreasing for chemicals whose use has been banned, such as chlordane, ∑DDTs, and dieldrin, or severely curtailed, such as tributyltin and Cd. For other chemicals there is no evidence, on a national scale, for either increasing or decreasing trends (O'Connor, 1996). Table 4 shows the numbers of sites in South Florida and nationwide with Increasing (I), Decreasing (D), or No Trends (NT) in concentrations of each chemical.

The numbers in Table 4 are the result of a statistical test (Spearman Rank Correlation) that will identify random sequences as real trends 5% of the time. Since 186 sites nationwide were examined for each chemical, about 10 of the trends per chemical could be due to random variations. That is why we have not given much weight to the relatively few trends that appear for most of the trace elements and for PAHs.

Statistical correlations were also developed for the median (50th percentile) value of chemical concentrations among all sites sampled in each year from 1986 to 1995 versus year. These plots of annual medians show, at this national level of aggregation, decreasing trends for Cd, Cu in mussels, Zn in mussels, all the chlorinated organics, ∑PAHs, and ∑BTs. While the Cu, Zn, and ∑PAHs decreases were not evident in the site-by-site results.

Decreasing trends are anticipated because all the monitored chlorinated hydrocarbons have been banned for use in the United States and tributyltin has been banned as a biocide on small boats. Annual use of cadmium in the U.S. decreased over the period of 1986 through 1995.

The number of increasing and decreasing contaminant trends in South Florida are noted in Table 4. The levels of ∑BTs show decreasing trends at the sites in Maule Lake, Gould's Canal, Faka Union Bay, Henderson Creek and Naples Bay reflecting restrictions placed on the use of these chemicals.

Decreasing trends were found in levels of As in Naples Bay and Henderson Creek, of Hg in Gould's Canal, of Se at Maule Lake and Gould's Canal, of Cd at Maule Lake, and of Zn and Cu at Naples Bay. Possible decreasing trends were also found for Hg, and increasing trends for Cu and Zn at Flamingo. The trends found at the Flamingo site should be viewed with caution as there were only four years of monitoring data for these locations as of this writing.

CONCLUSIONS

In general, chemical contamination in South Florida, as determined using the results of the NS&T Program, are relatively low and in some instances contaminant levels are decreasing. Areas with high concentrations of some NS&T analytes were found near high human populations. The levels of butyltins are decreasing at many of the sites.

ACKNOWLEDMENTS

The authors wish to thank the numerous field and laboratory teams at Battelle Ocean Sciences Texas A&M University, and Marcia Orencia and A. E. Theberge (NOAA Central Library) for graphics support.

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Lauenstein G. G., and A. Y. Cantillo (eds.) (1993). Sampling and Analytical Methods of the NOAA National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992: Vol. I - IV. NOAA Tech. memo. NOS ORCA 71. NOAA/NOS/ORCA, Silver Spring, MD.

TABLE 4

Temporal trends in chemical concentrations measured nationally at 186 Mussel Watch Project sites and at five South Florida area sites (NMML, BBGC, EVFU, RBHC, NBNB) for which data exist for the years 1986-1997.

Aggregated chemicals*	Trend I	Trend D	Trend NT	Element	Trend I	Trend D	Trend NT
∑Cdane	1	81 (1)	104	As	11	11 (2)	164
∑DDTs	1	38	147	Cd	3 (1)	28 (1)	155
∑Dield	1	32	153	Cu	7 (1)	14	165
∑PCBs	1	37	148	Hg	7 (1)	9	170
∑PAHs	3 (1)	3	180	Ni	6	8	172
∑BTs	0	18 (5)	168	Pb	14	9	163
				Se	8 (2)	9	169
				Zn	7 (2)	9	170

I - Increasing, D - Decreasing, NT - No trend. Increasing and decreasing trends for South Florida are given in parentheses.
* Individual organic compound concentrations have been aggregated into these groups:
∑DDTs: The sum of concentrations of DDTs and its metabolites, DDEs and DDDs.
∑Cdane: The sum of *cis*-chlordane, *trans*-nonachlor, heptachlor and heptachlor epoxide.
∑PCBs: The sum of the concentrations of di-, tri-, tetra-, penta-, hexa-, hepta-, octa-, and nonachlorobiphenyls.
∑PAHs: The sum of concentrations of the 18 PAH compounds.
∑BTs: The sum of the concentrations of tributyltin and its breakdown products dibutyltin and monobutyltin (as tBT/g dry wt.).

NS&T Mussel Watch site area in Naples Bay (TAMU/GERG)

Lauenstein G. G., and A. Y. Cantillo (1998) Sampling and analytical methods of the National Status and Trends Program Mussel Watch Project: 1993-1996 update. NOAA Technical Memorandum NOS ORCA 130, 233 pp.

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O'Connor (1996) Trends in chemical concentrations in mussels and oysters collected along the US coast from 1986 to 1993. Mar. Environ. Res., 41:183-200.

NS&T DATA AND INFORMATION PRODUCTS

Data and information resulting from CCMA activities are made available to users and the scientific community at large in different formats and media.

NOAA Technical Memoranda provide detailed accounts of methods, data summaries, and results of various NS&T Program projects and related activities, such as sediment toxicity surveys, analytical methods, and sediment quality assessments.

Digitized data and program information about the NS&T program are available via electronic mail. Presently, data from the Mussel Watch project (1984-1994) and the Benthic Surveillance project (1984-1992) can be retrieved by downloading from the NCCOS Information Service which can be accessed at (http://ccmaserver.nos.noaa.gov). New data sets are added to the Service as they are digitized and checked for accuracy. The data sets can also be requested from CCMA.

Scientific publications containing the results of CCMA projects are published as research papers in journals, books, and proceedings of professional conferences. The publications are authored by CCMA staff, contractors, and collaborators. A cumulative list of these publications is issued periodically.

Mangroves (NOAA Photo Collection, NOAA Central Library)

For further information on the NS&T Program or to obtain a list of available publications, write:

Oyster shells.

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National Status and Trends Program
NOAA/NOS/NCCOS/CCMA
1305 East/West Highway
Silver Spring, MD 20910

Phone: 301 713 3028
Fax: 301 713 4388

APPENDICES

Appendix I
Sediment data

Appendix II
Trace element and organic trends in oysters

Appendix I

Sediment data

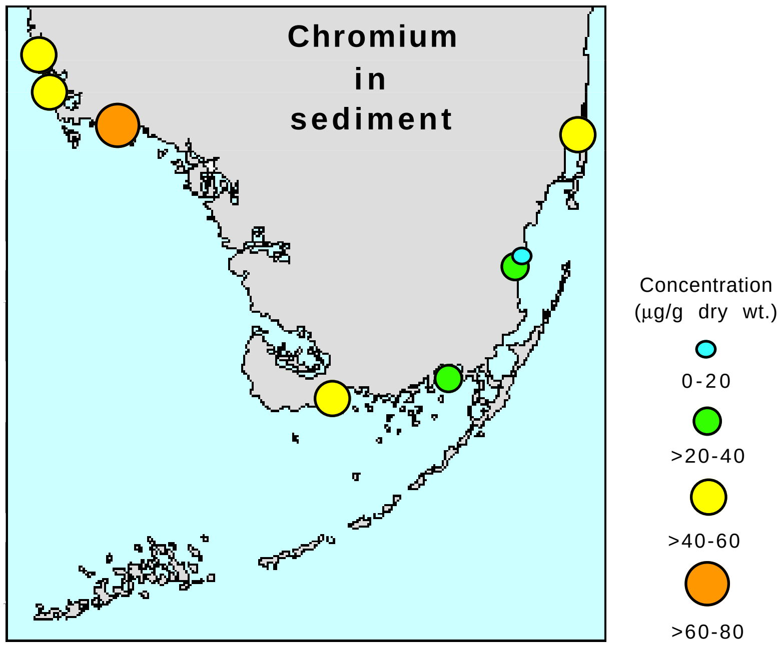

Figure I.1. Chromium in sediment (µg/g dry wt.).

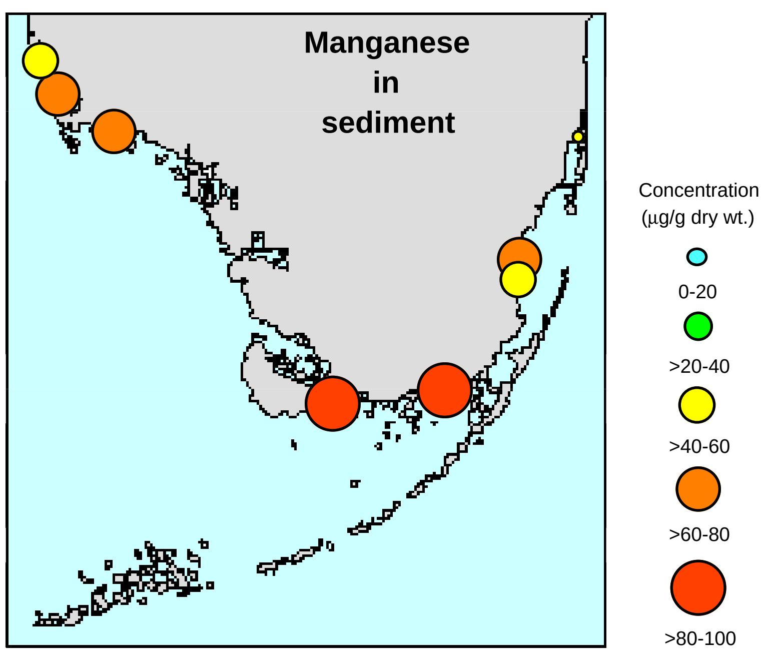

Figure I.2. Manganese in sediment (µg/g dry wt.).

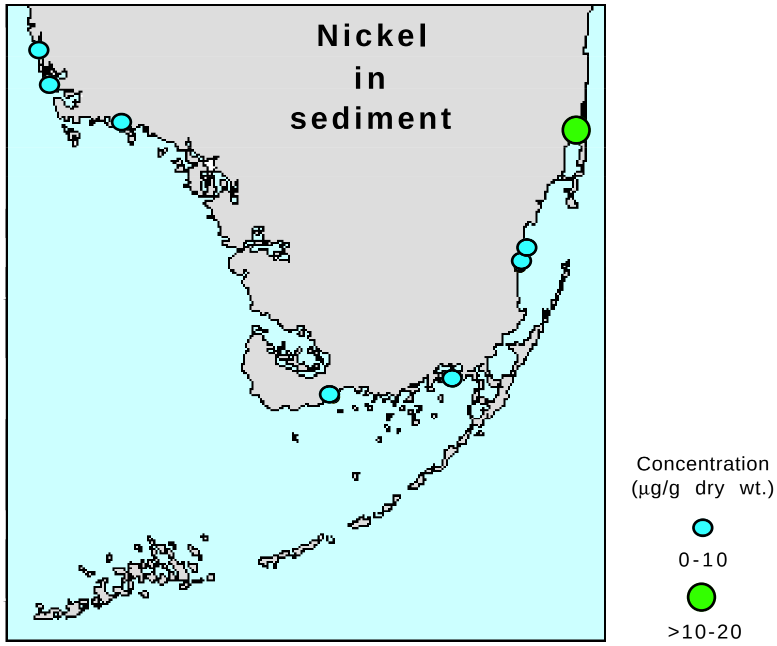

Figure I.3. Nickel in sediment (µg/g dry wt.).

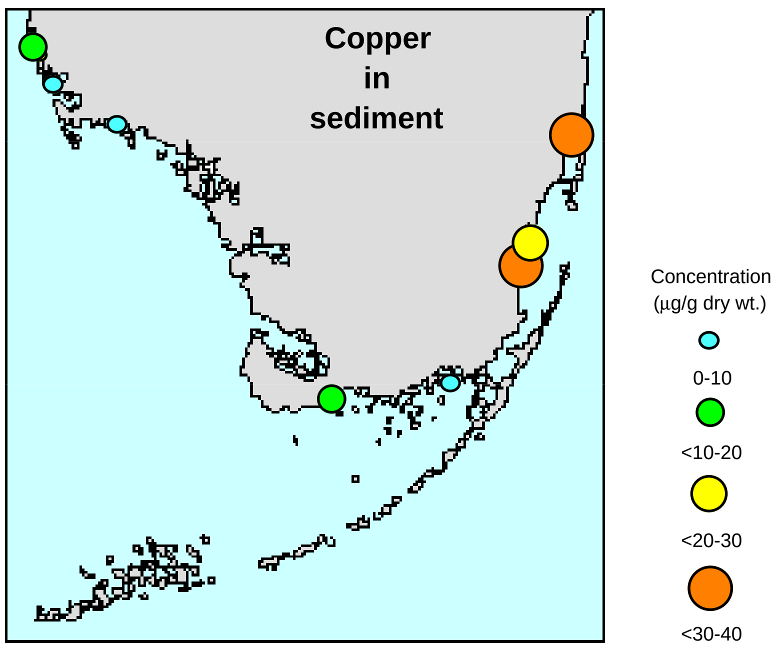

Figure I.4. Copper in sediment (µg/g dry wt.).

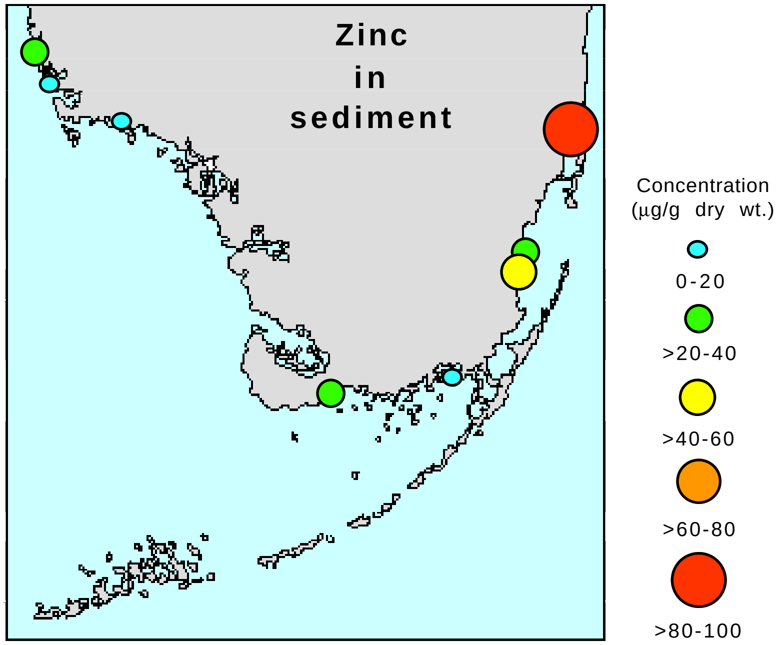

Figure I.5. Zinc in sediment (µg/g dry wt.).

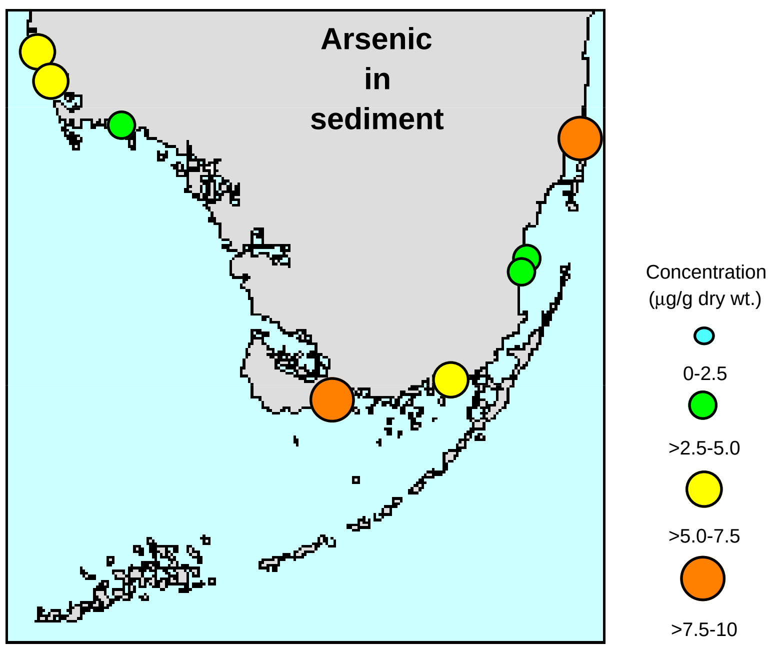

Figure I.6. Arsenic in sediment. (µg/g dry wt.).

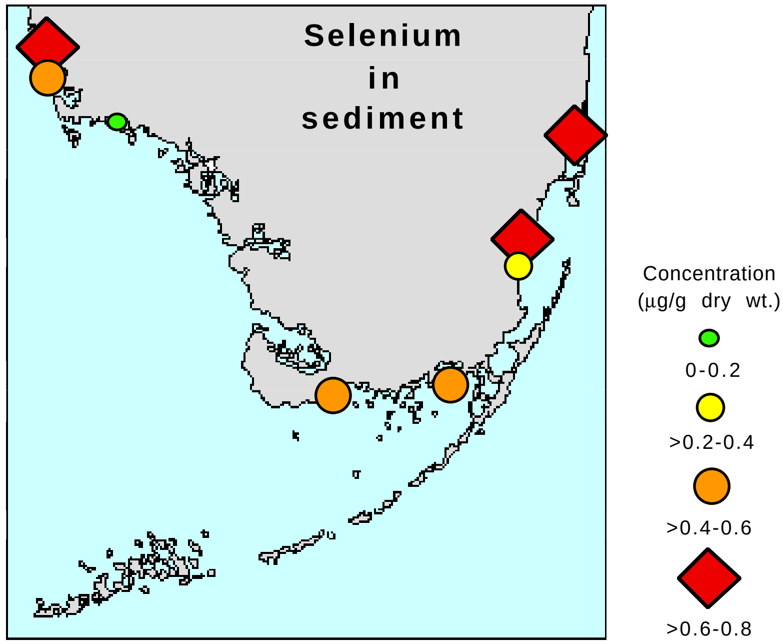

Figure I.7. Selenium in sediment. Concentrations noted with a diamond are above the NS&T 85th percentile (µg/g dry wt.).

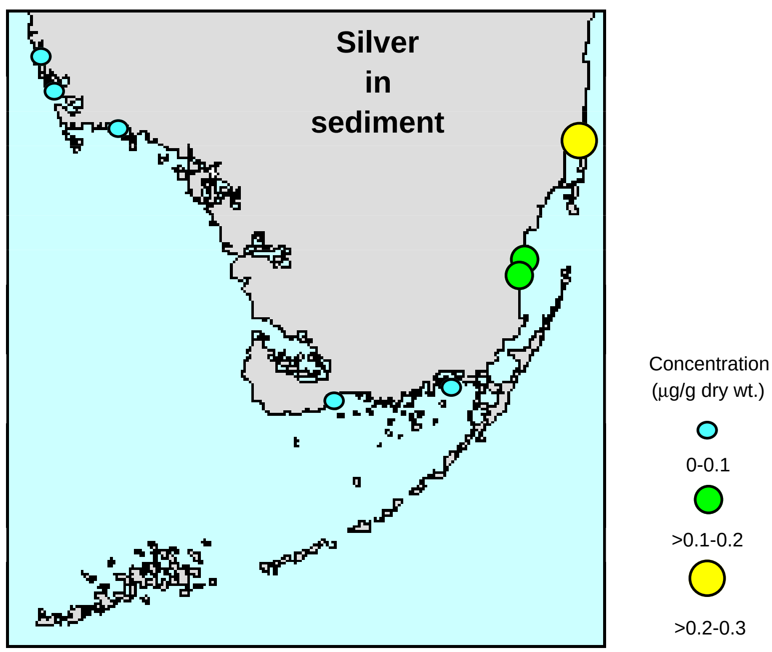

Figure I.8. Silver in sediment (µg/g dry wt.).

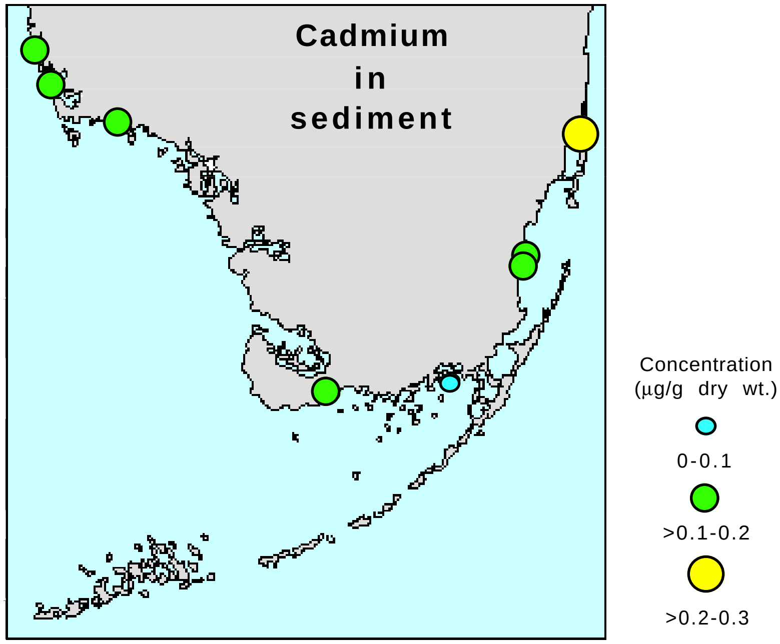

Figure I.9. Cadmium in sediment (µg/g dry wt.).

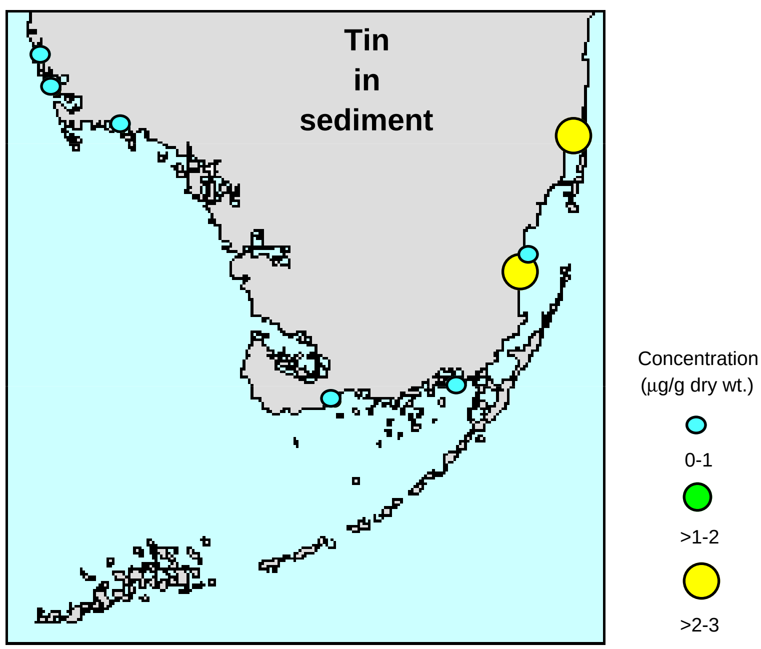

Figure I.10. Tin in sediment (µg/g dry wt.).

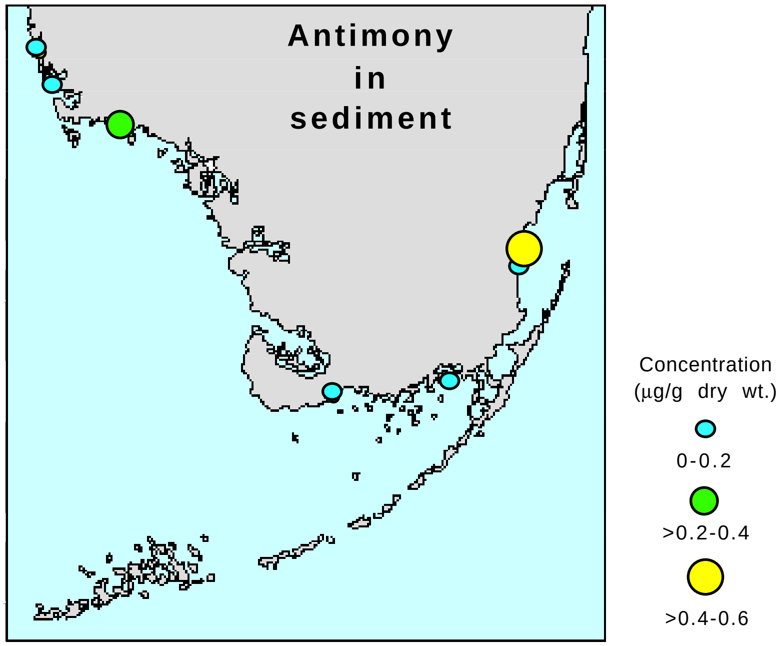

Figure I.11. Antimony in sediment (µg/g dry wt.).

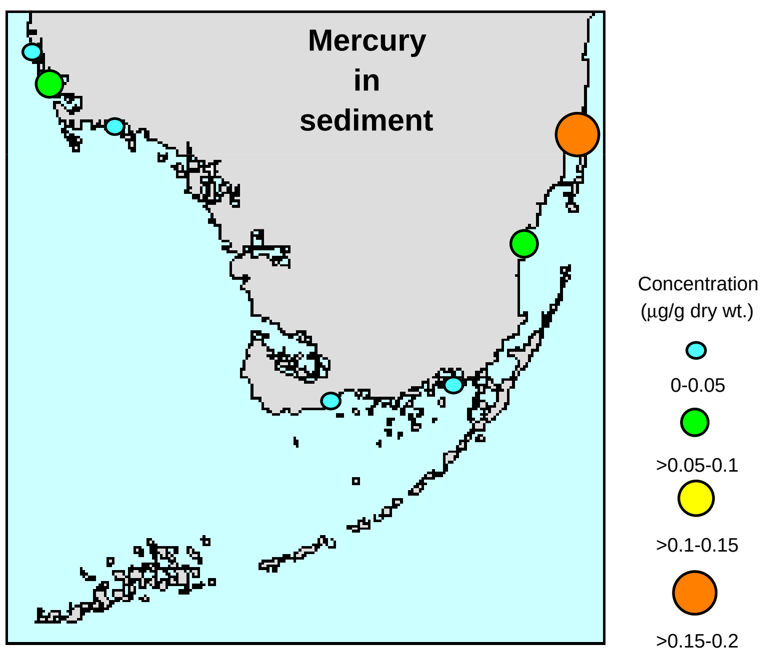

Figure I.12. Mercury in sediment (µg/g dry wt.).

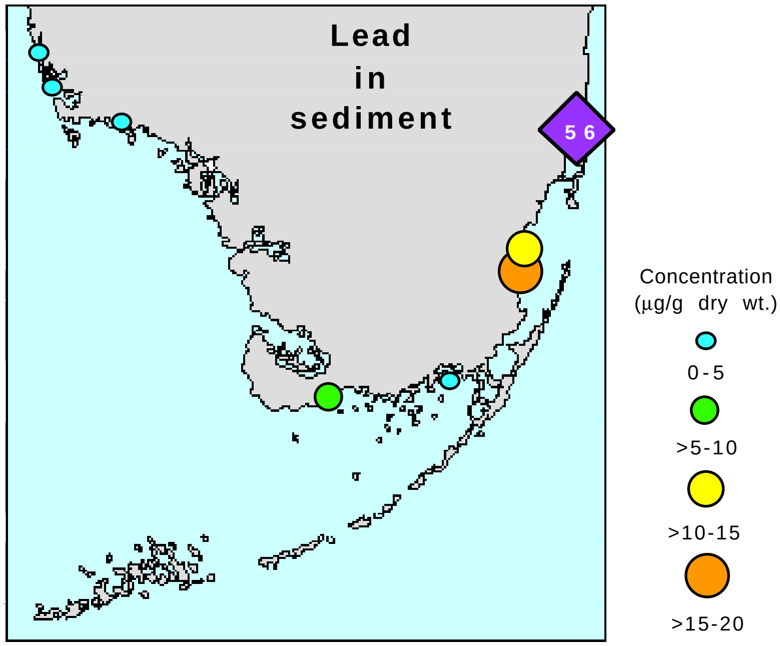

Figure I.13. Lead in sediment. Concentrations noted with a diamond are above the NS&T 85th percentile (µg/g dry wt.).

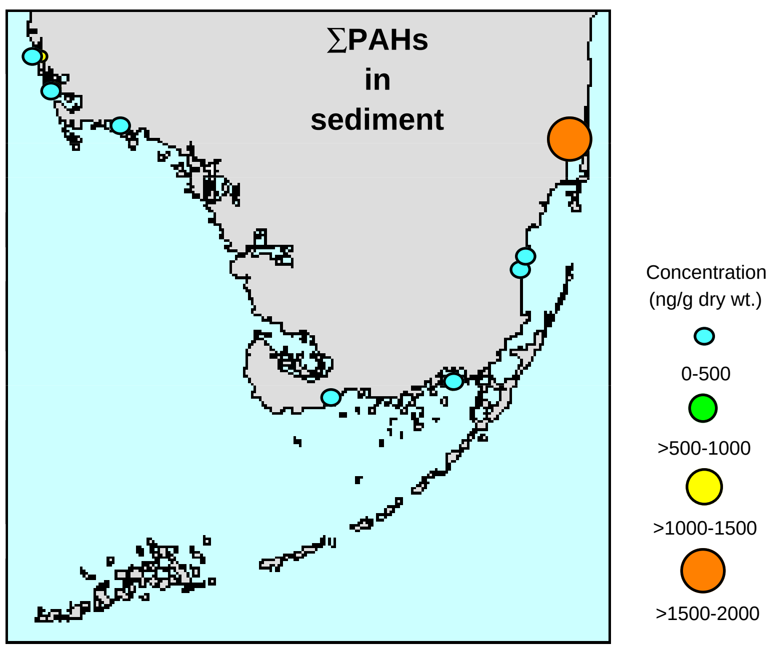

Figure I.14. Total PAHs in sediment (ng/g dry wt.).

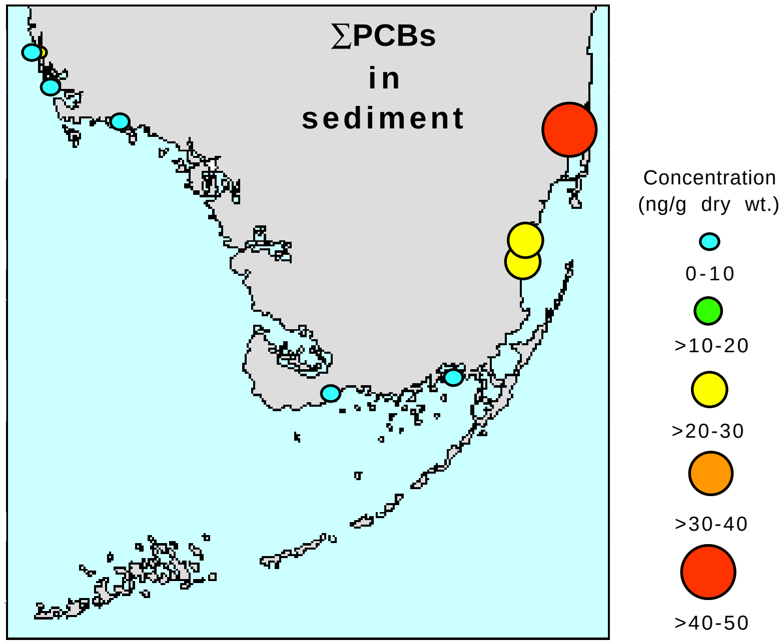

Figure I.15. Total PCBs in sediment (ng/g dry wt.).

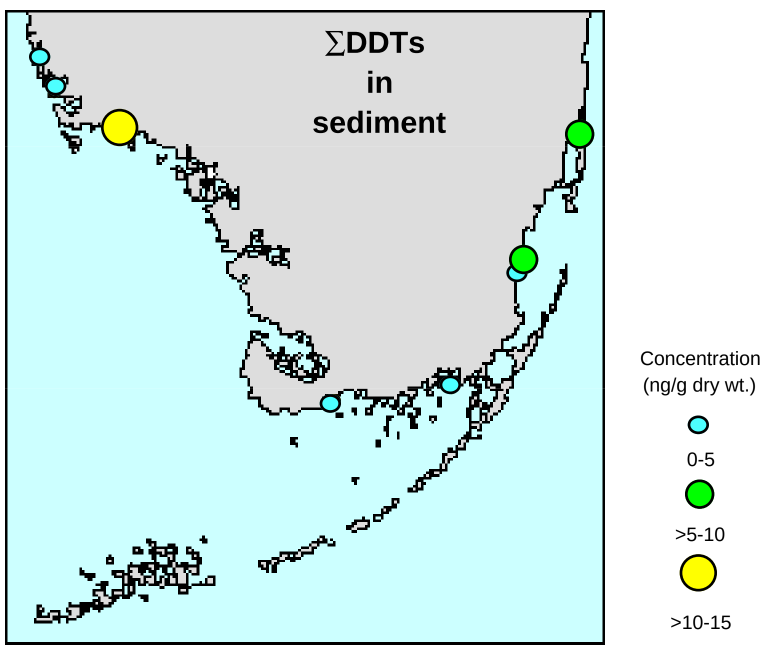

Figure I.16. Total DDTs in sediment (ng/g dry wt.).

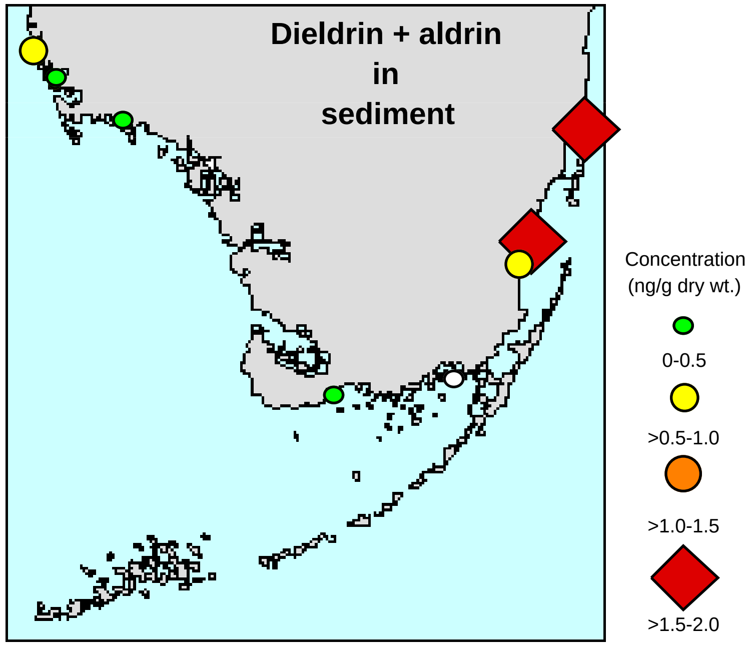

Figure I.17. Dieldrin and aldrin in sediment. White circle indicates values below the detection limit. Concentrations noted with a diamond are above the NS&T 85th percentile (ng/g dry wt.).

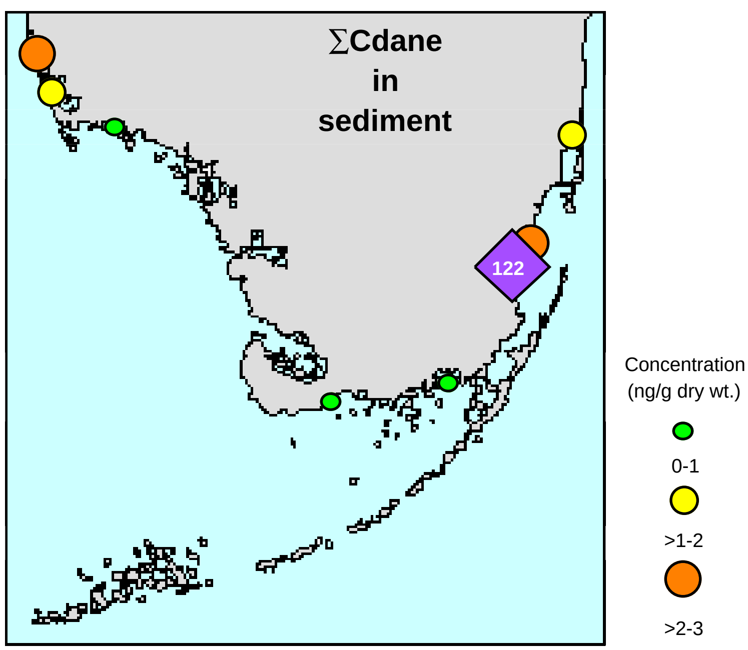

Figure I.18. Total chlordane in sediment. Concentrations noted with a diamond are above the NS&T 85th percentile (ng/g dry wt.).

Trace element and organic trends in oysters

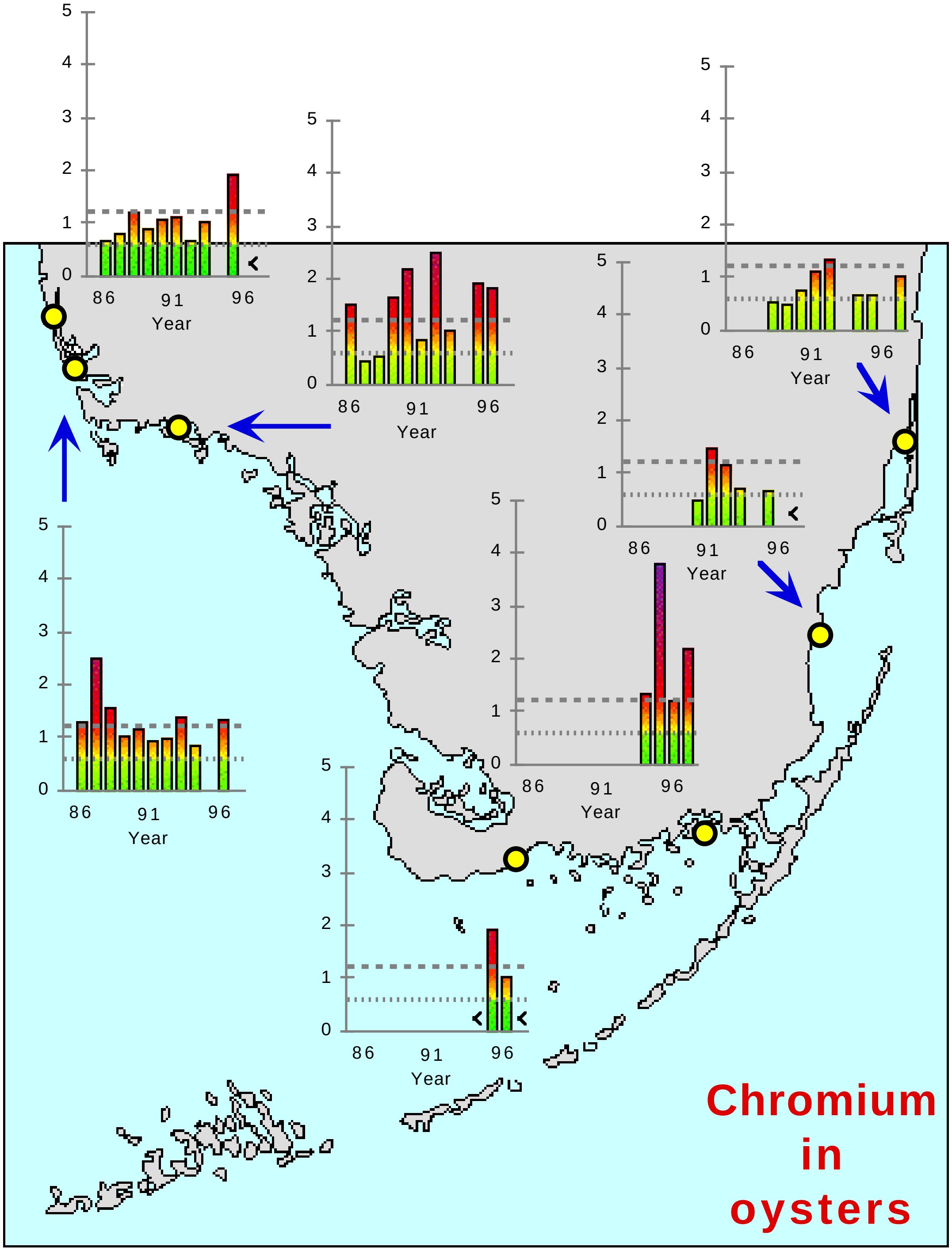

Figure II.1. Chromium trends in oysters. A "<" used to indicate values below the limit of detection. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

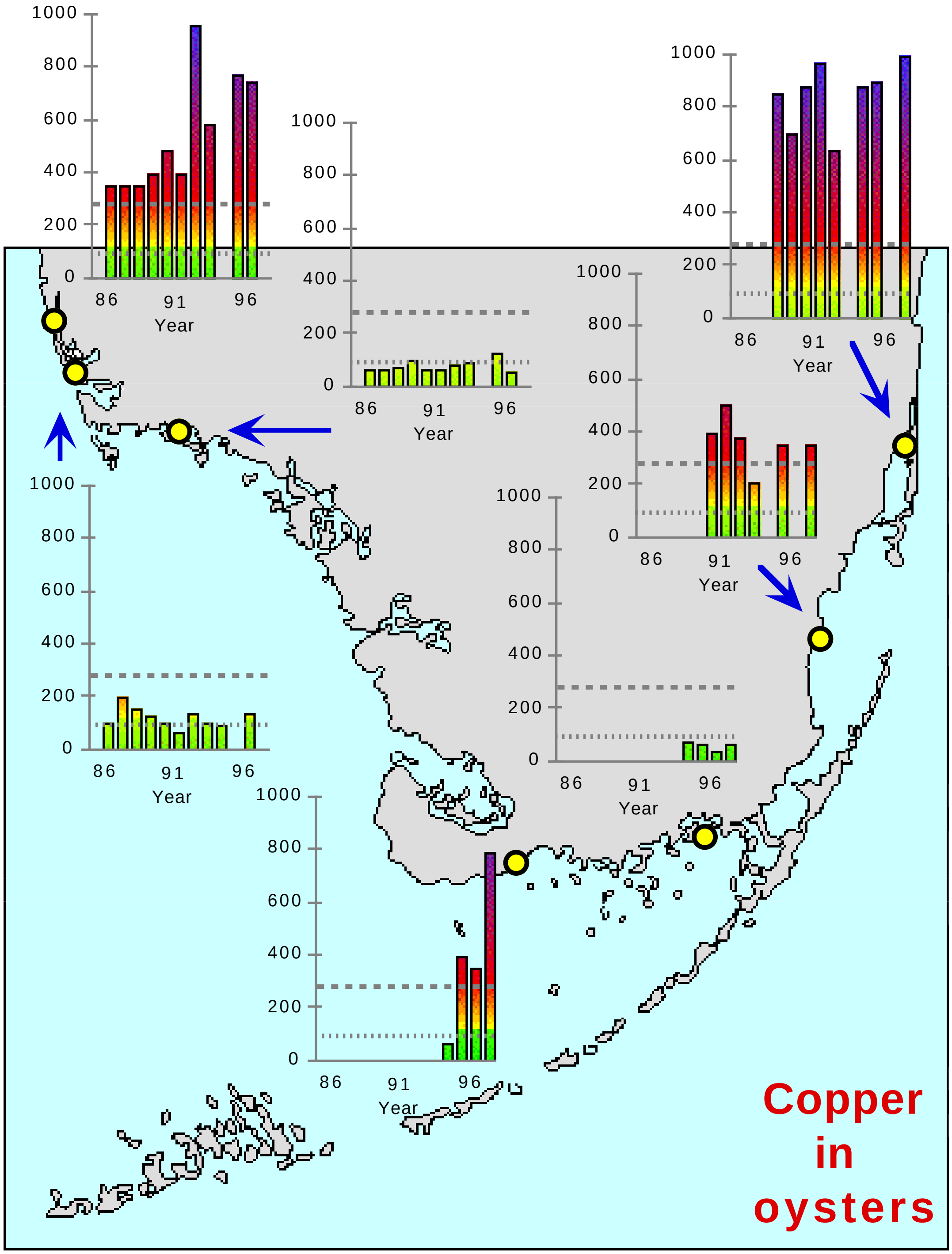

Figure II.2. Copper trends in oysters. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

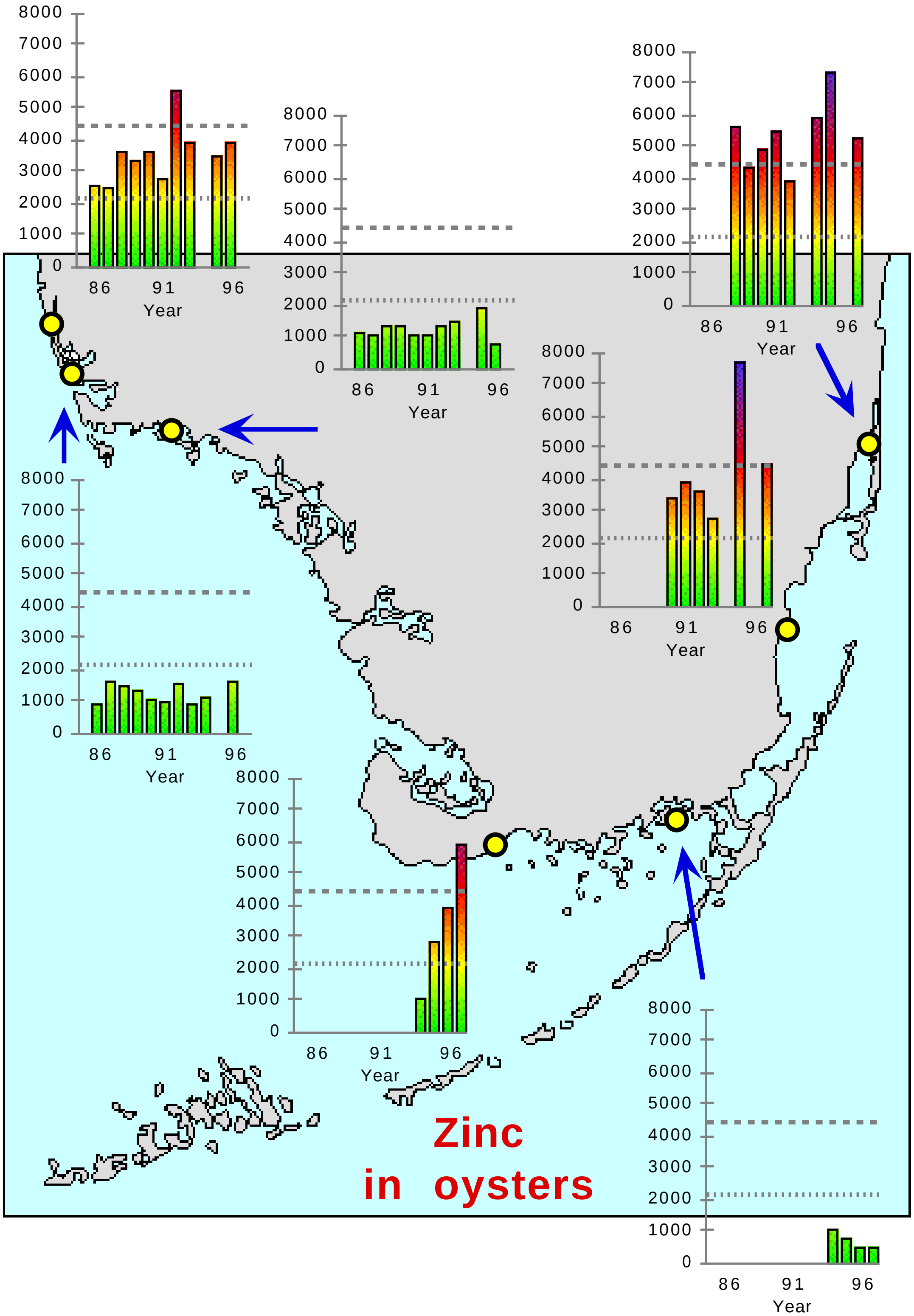

Figure II.3. Zinc trends in oysters. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

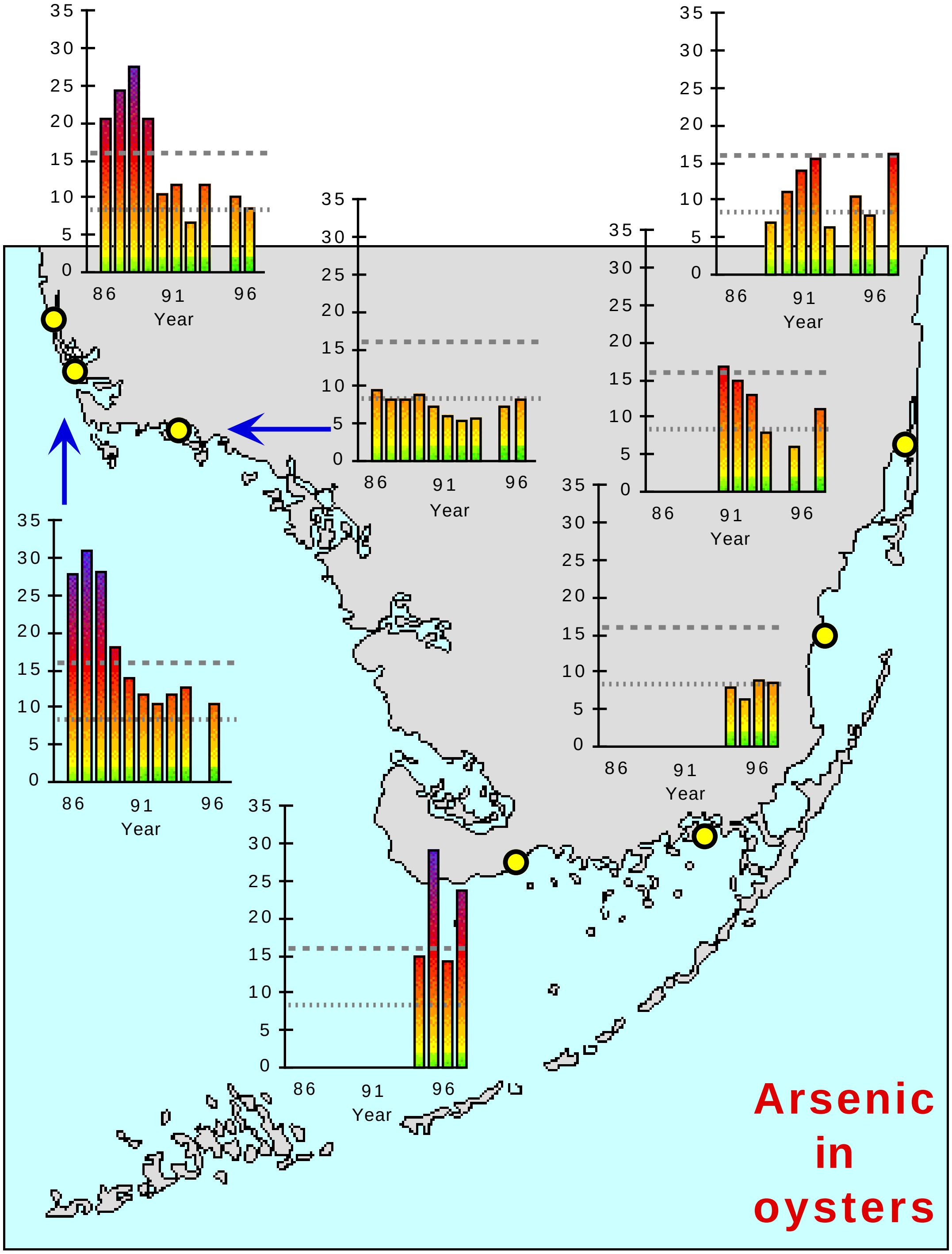

Figure II.4. Arsenic trends in oysters. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

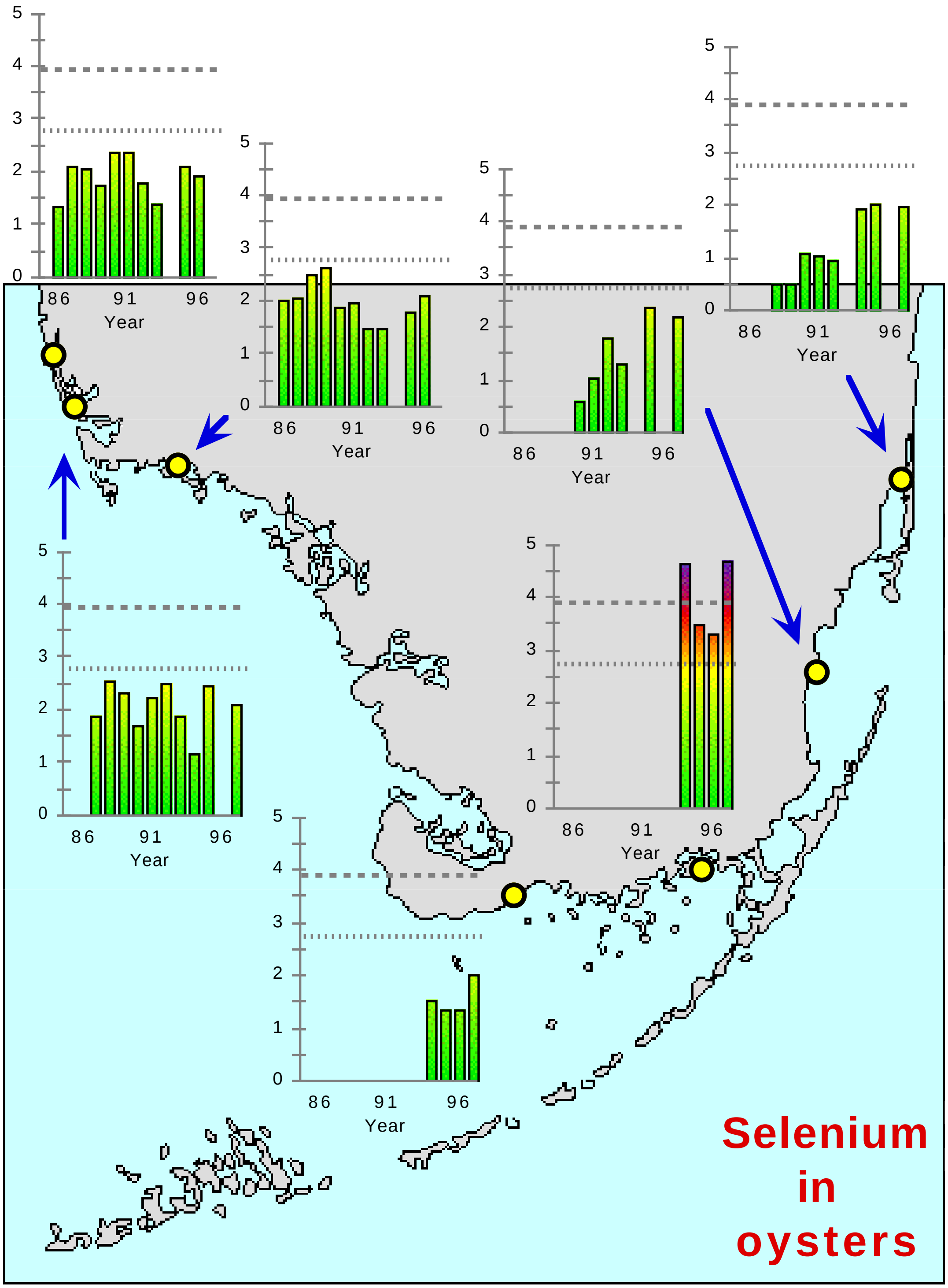

Figure II.5. Selenium trends in oysters. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

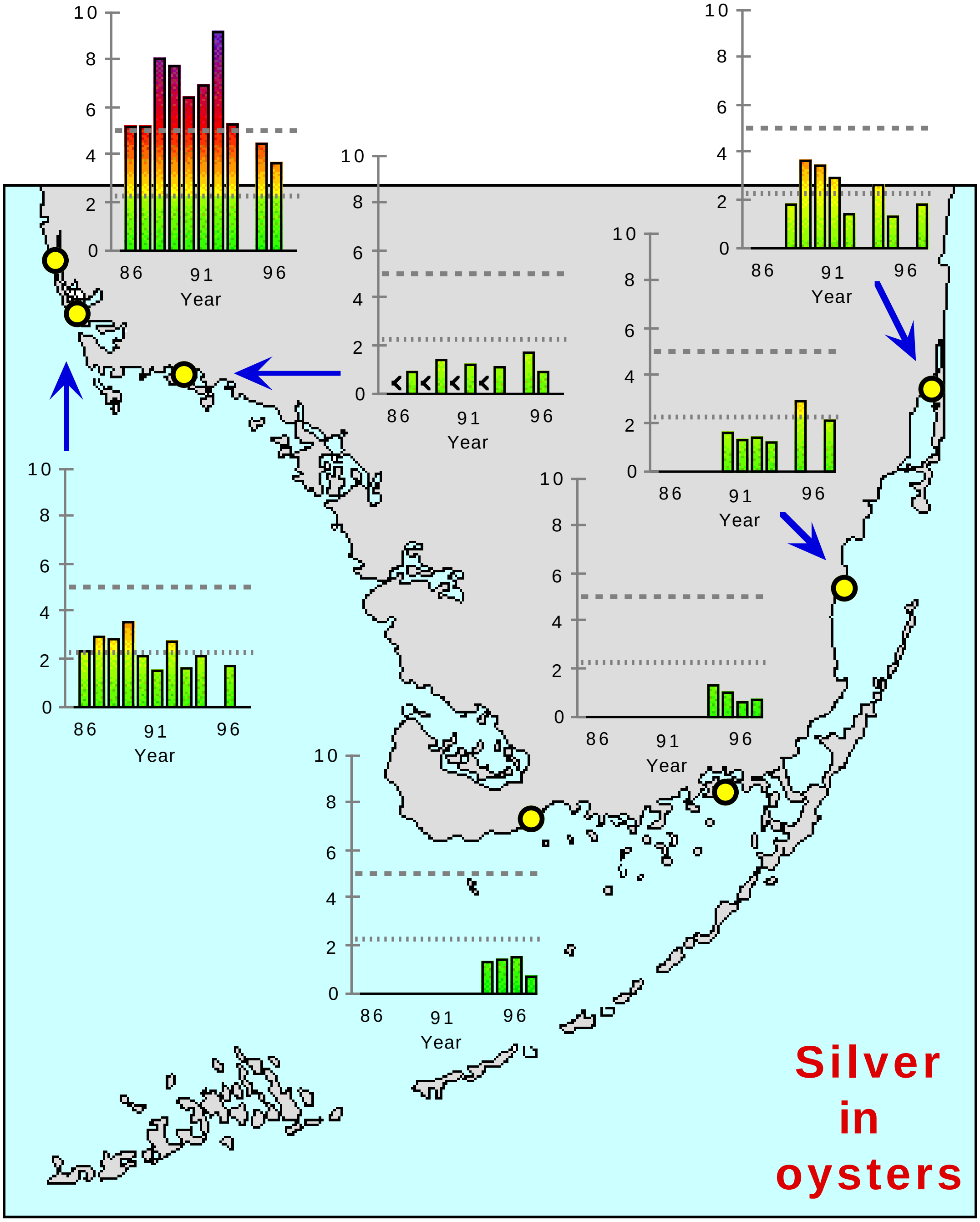

Figure II.6. Silver trends in oysters. A "<" used to indicate values below the limit of detection. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

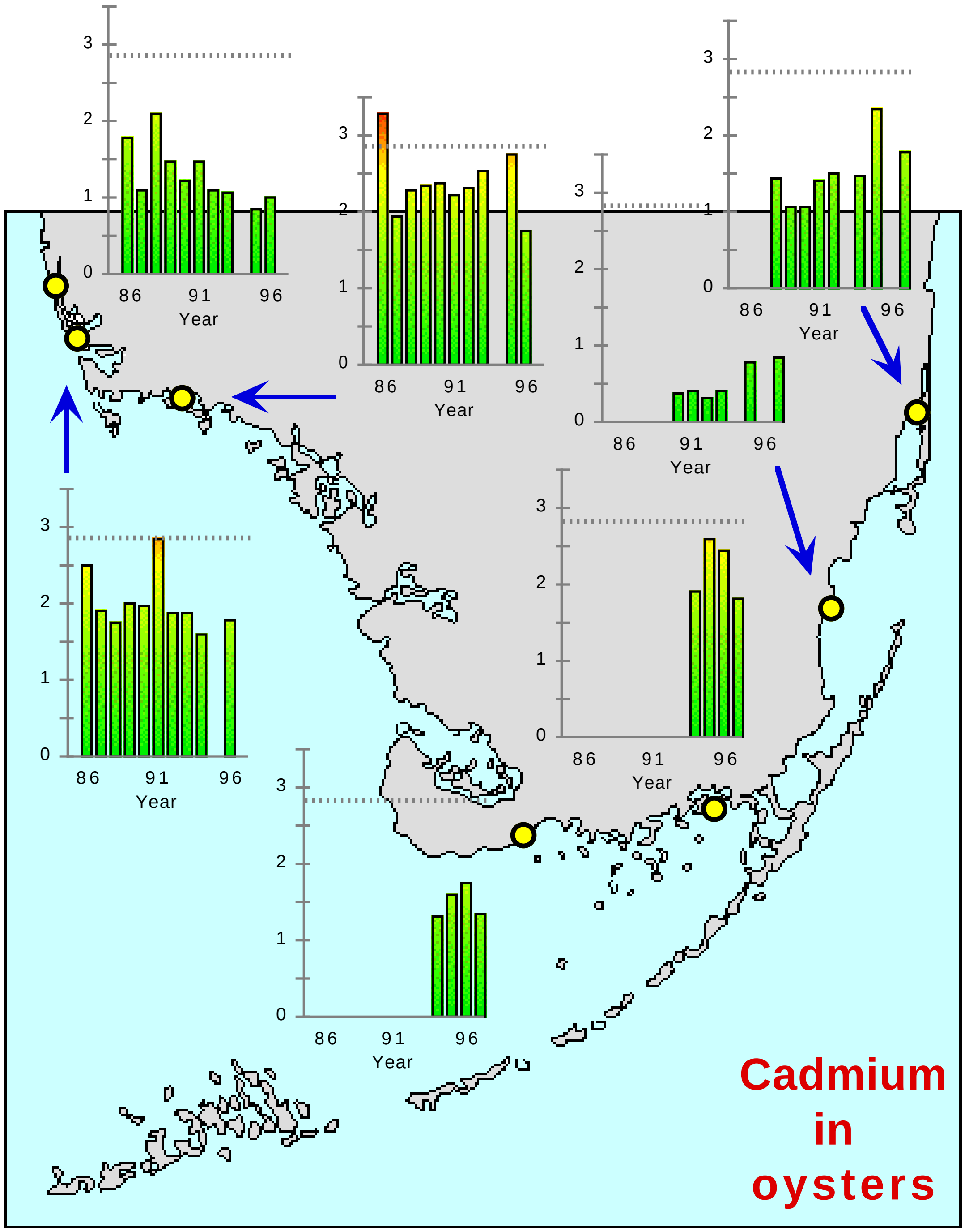

Figure II.7. Cadmium trends in oysters. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

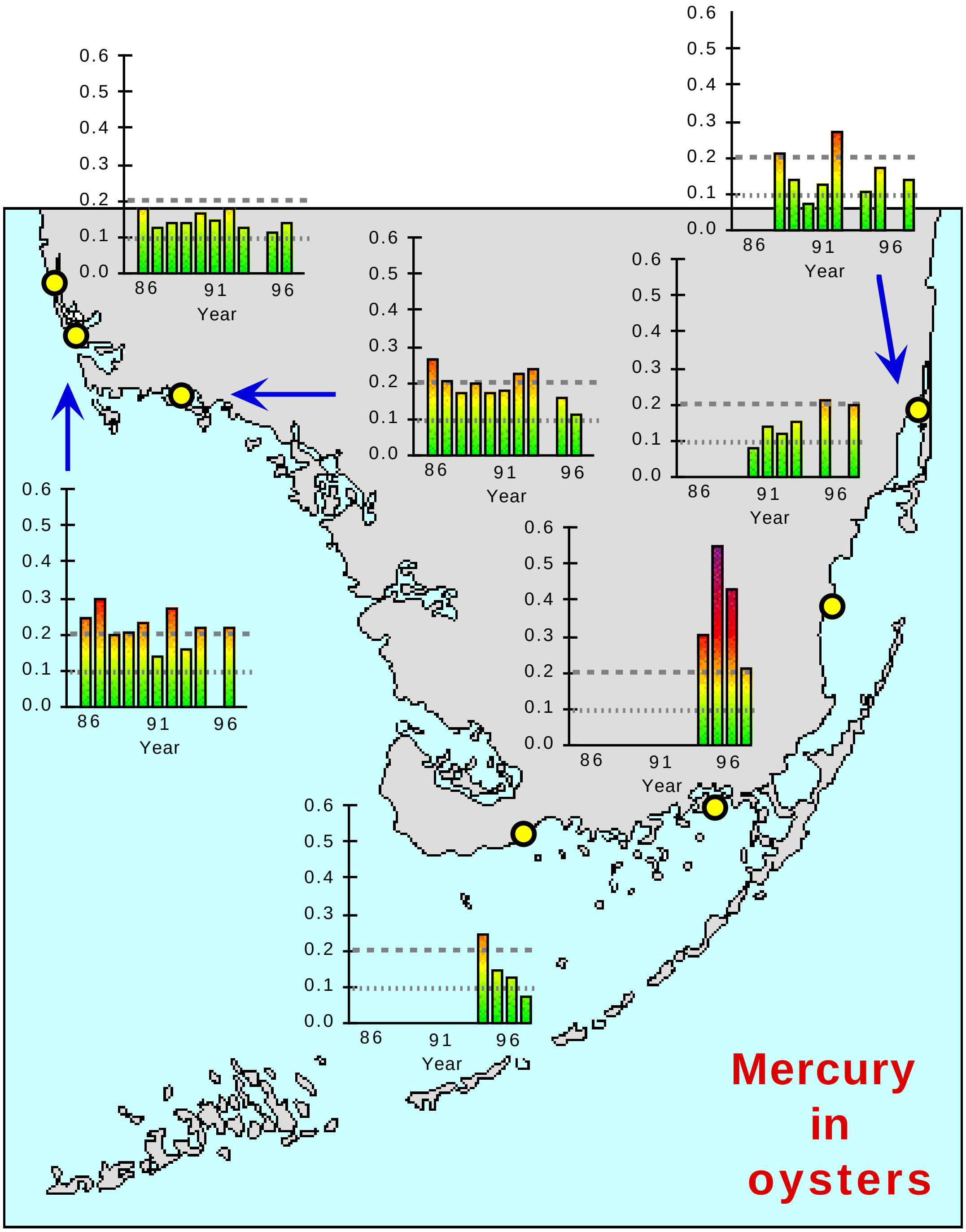

Figure II.8. Mercury trends in oysters. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

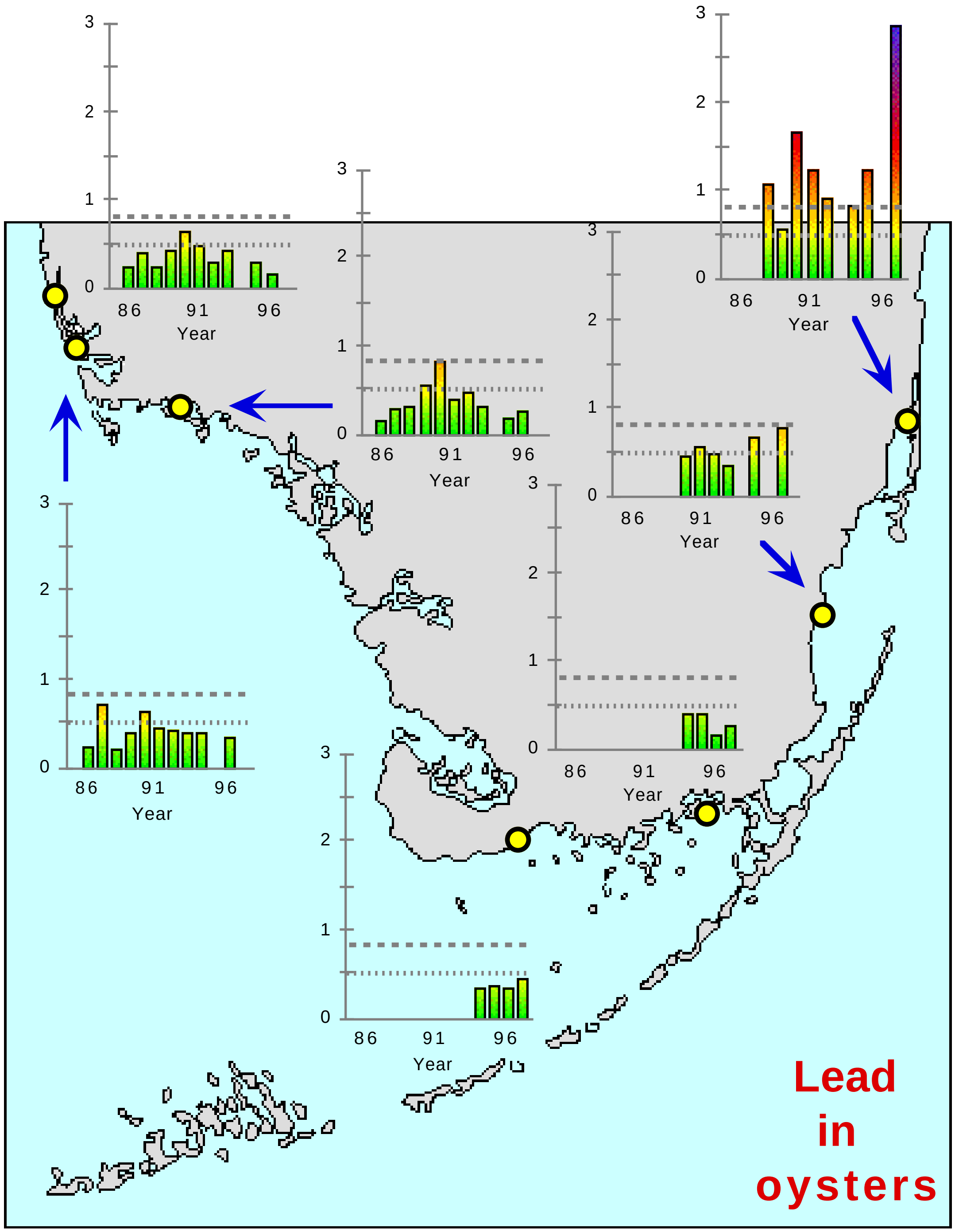

Figure II.9. Lead trends in oysters. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (µg/g dry wt.).

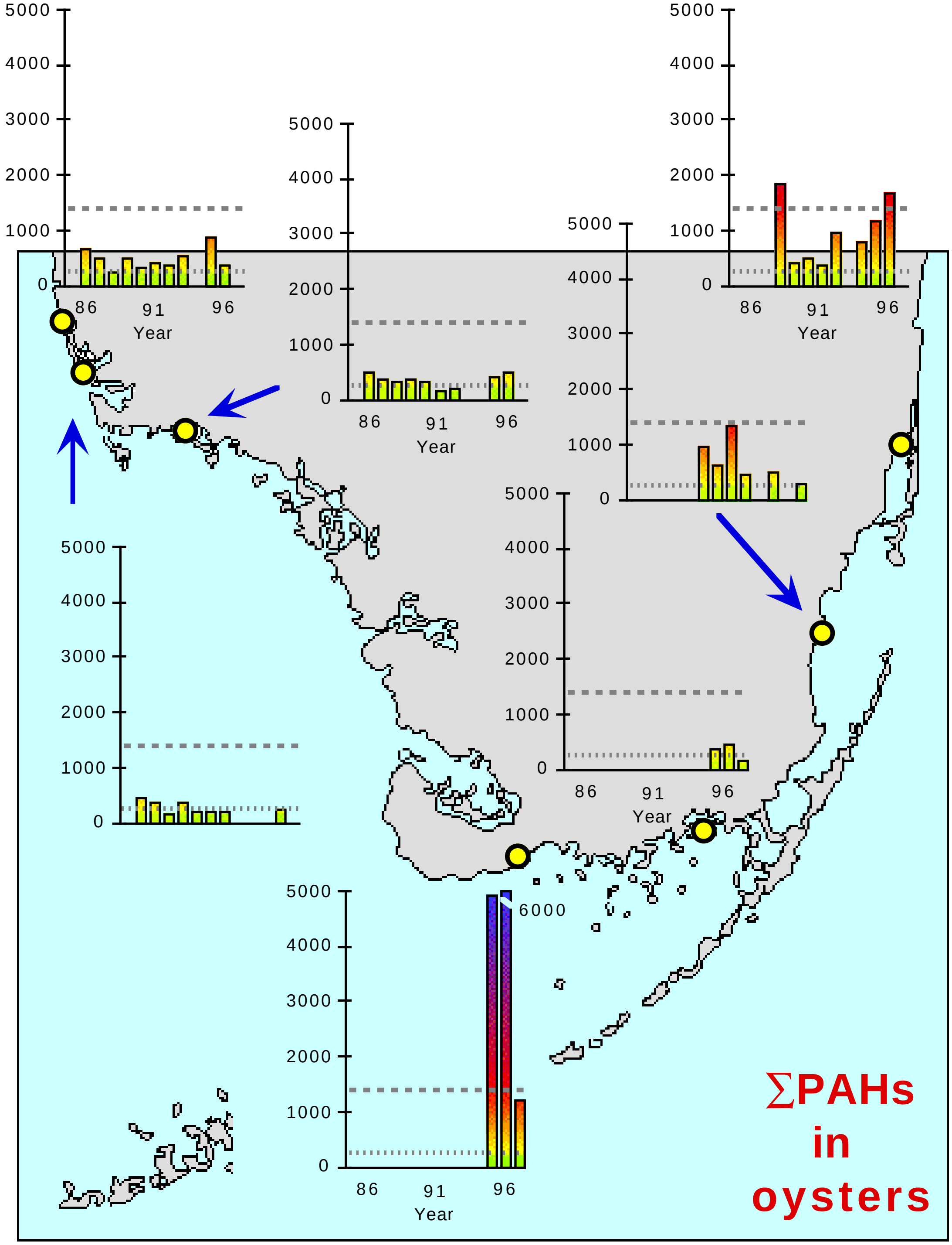

Figure II.10. Total PAHs trends in oysters. Dotted blue line is NS&T median. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (ng/g dry wt.).

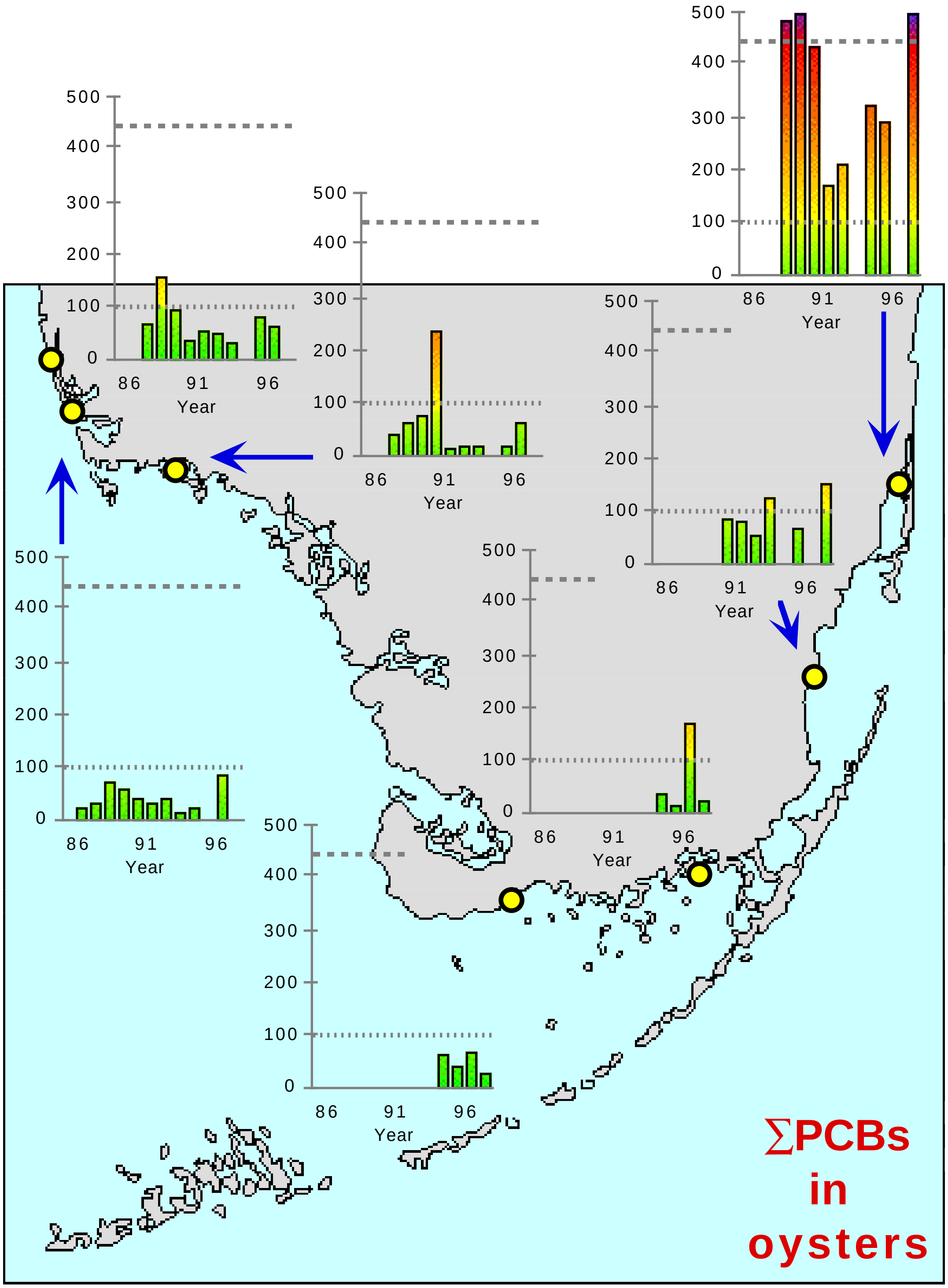

Figure II.11. Total PCBs trends in oysters. Dotted blue line is NS&T median. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (ng/g dry wt.).

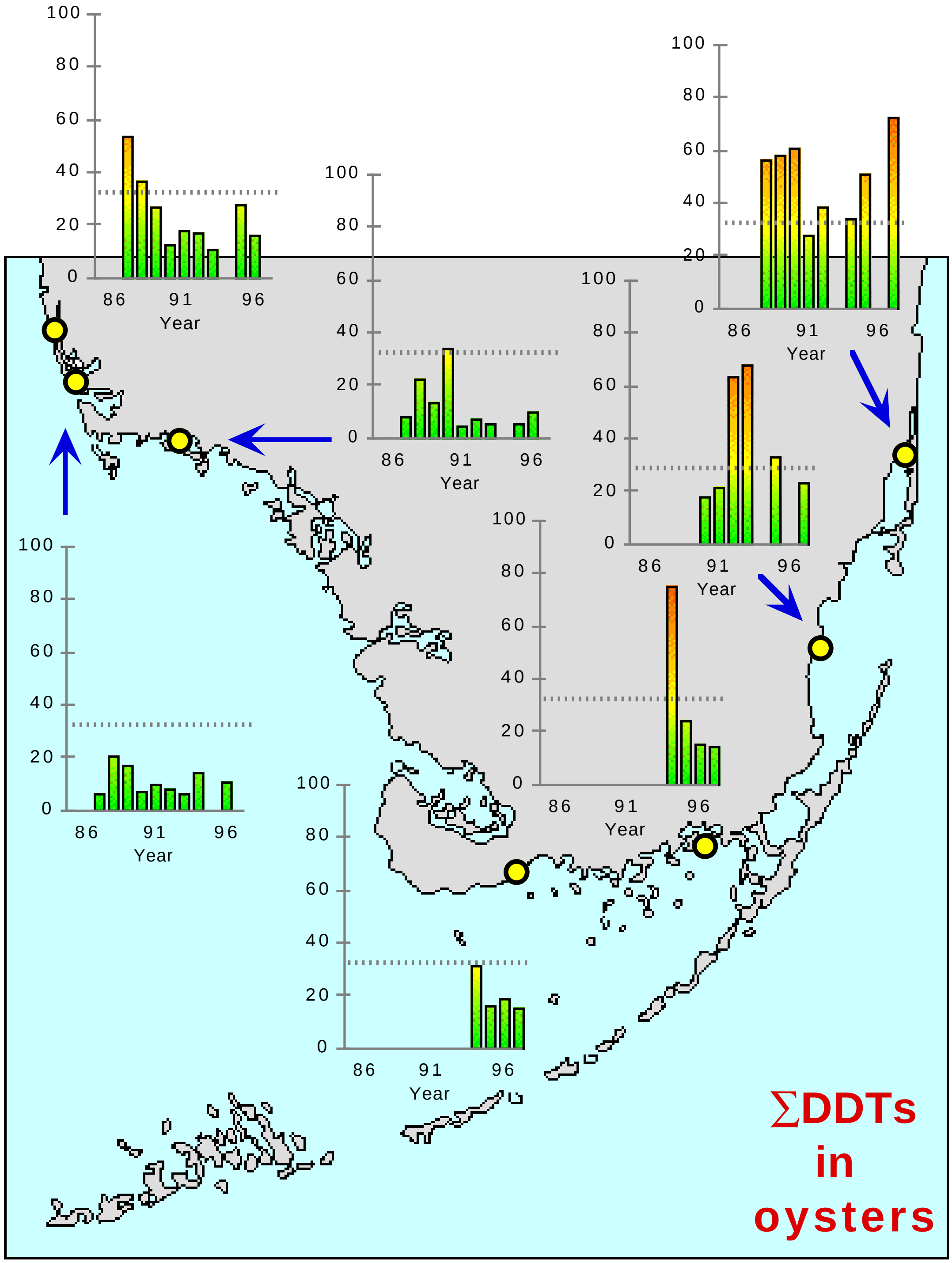

Figure II.12. Total DDTs trends in oysters. Dotted blue line is NS&T median. No values were below the NS&T nationwide 85th percentile (ng/g dry wt.).

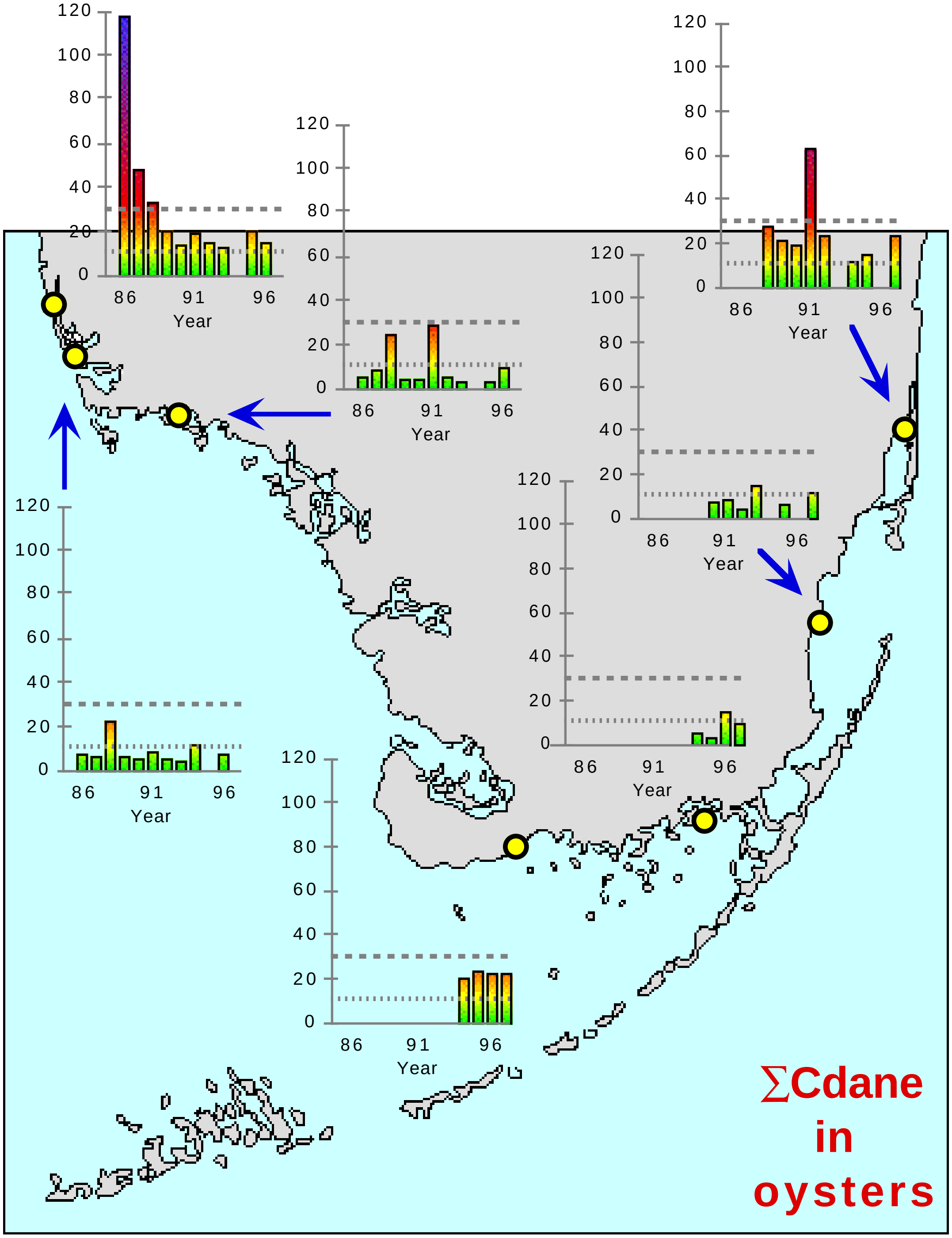

Figure II.13. Total chlordane trends in oysters. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (ng/g dry wt.).

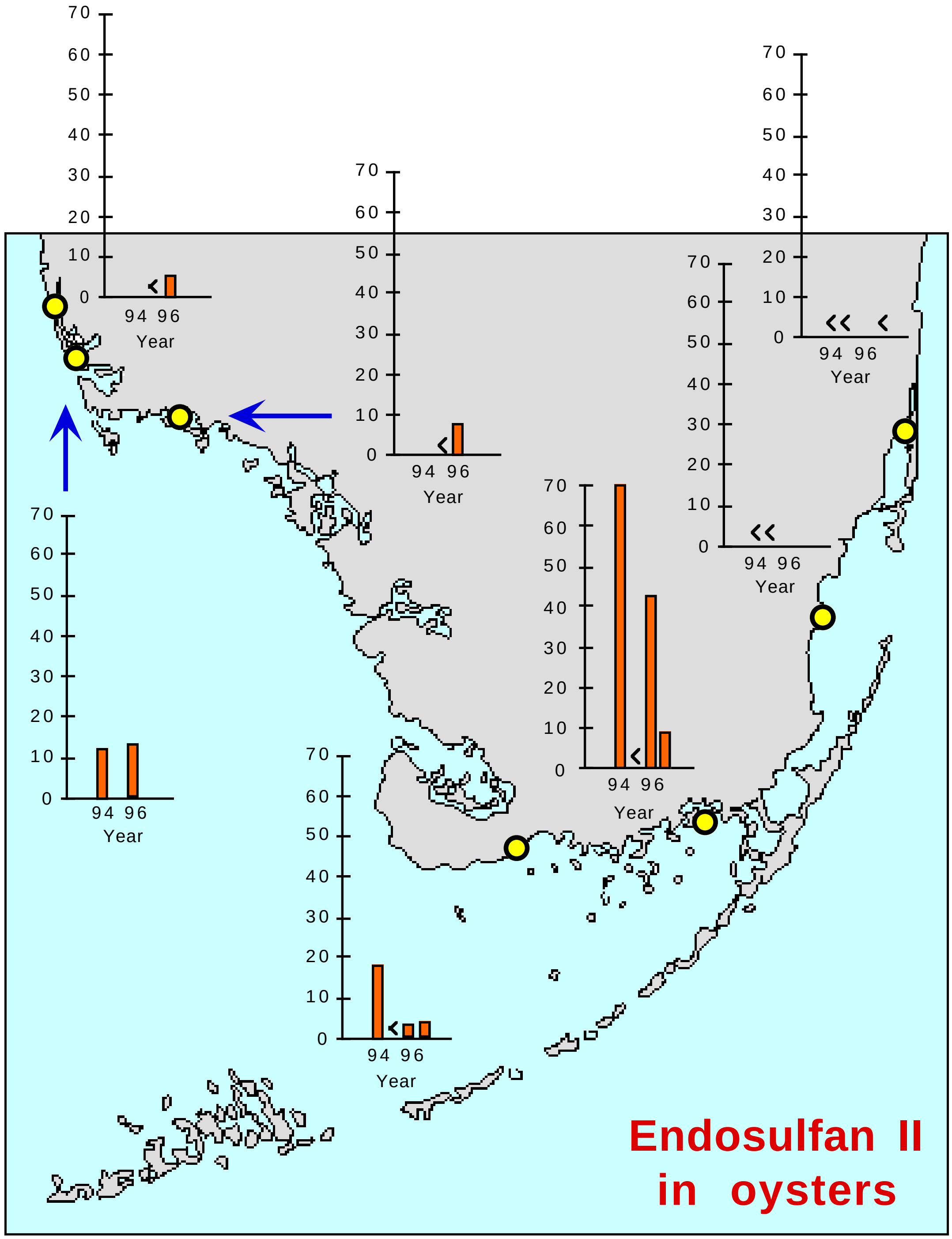

Figure II.14. Endosulfan II trends in oysters. Data from samples collected before 1995 not used. A "<" used to indicate values below the limit of detection (ng/g dry wt.).

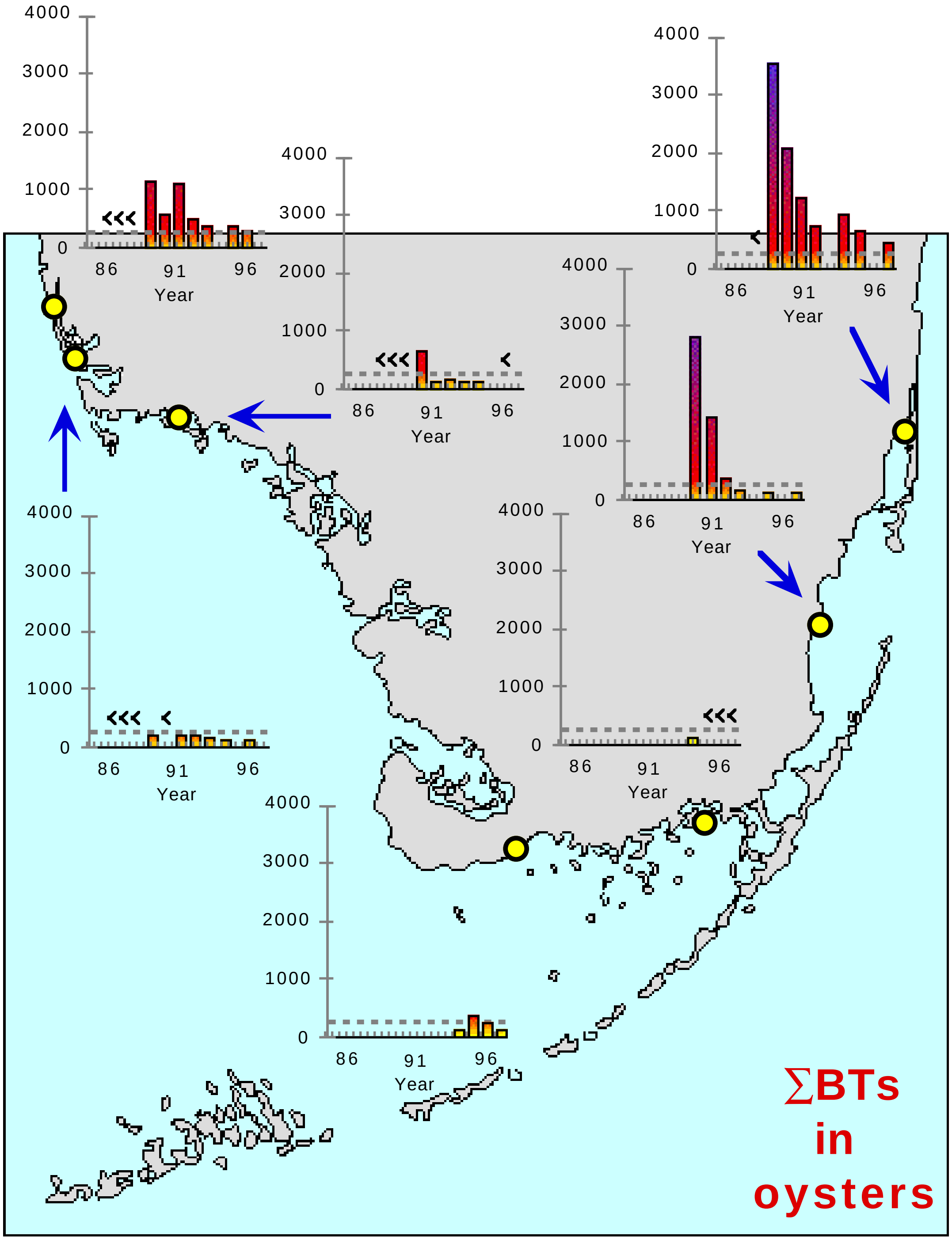

Figure II.15. Total tributyltins trends in oysters. A "<" used to indicate values below the limit of detection. Dotted blue line is NS&T median and dashed red line is NS&T nationwide 85th percentile (ng Sn/g dry wt.).