EMAP Indicators and EPA's Reports on the Environment

Jay Messer
National Center for Environmental Assessment

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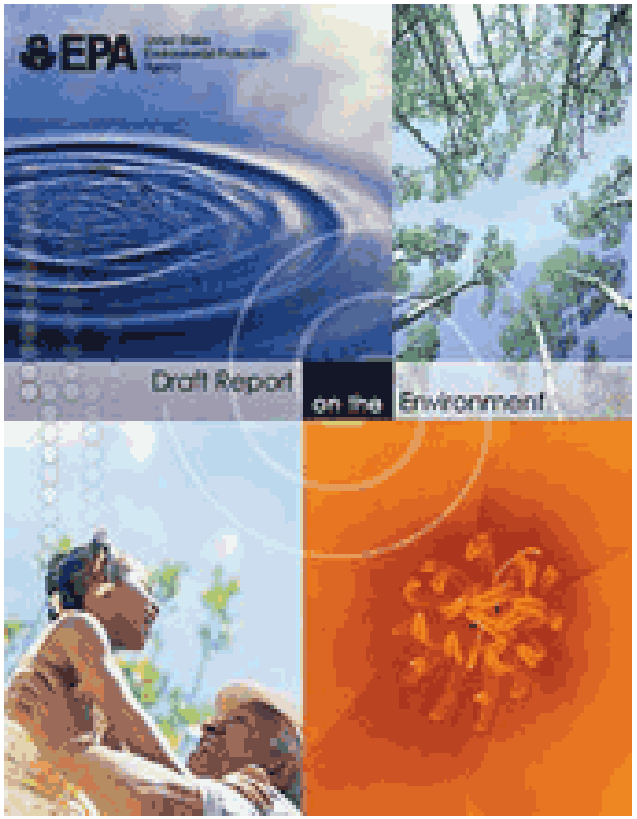
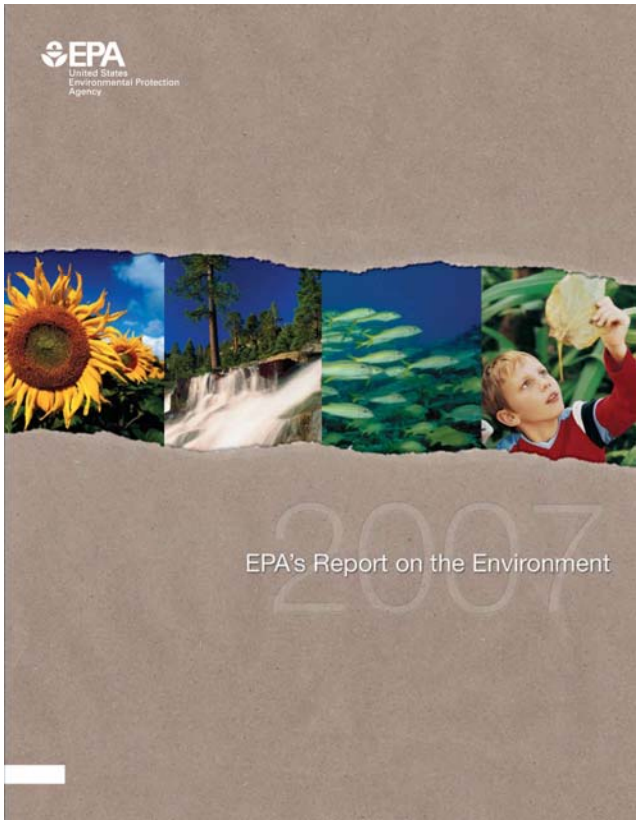
EPA's Reports on the Environment





“ My goals for the Agency are to make our air cleaner, our water purer and our land better protected. These are the results that we are working hard to achieve. Our progress towards these goals will be the measure of our success. ***To know whether we are making progress toward these goals, we need high quality information about the state of the environment. –***

Christine Todd Whitman, November, 2001

Draft Report on the Environment-2003

• Established Steering Committee	Dec 2001
• Identified themes and questions	Jan-Feb 2002
• Submitted indicators	March-April 2002
• Reviewed indicators	April-May 2002
• Drafted and reviewed report	June-May 2003
• Released DROE	June 2003
• Held public listening sessions	Nov 2003-Feb 2004
• Held SAB review	March 2004

Draft Report on the Environment-2003 TD

- Asked 63 questions about trends in air, water, land, human health, and ecological condition
- Contained 143 indicators (EMAP contributed to 33).

Indicator: Benthic Community Index – Category 2

EMAP Estuaries Program has developed indices of benthic condition for estuaries in the conterminous U.S. (Engle and Summers, 1999; Engle, et al., 1994; Van Dolah, et al., 1999; Weisberg, et al., 1997). Benthic macroinvertebrates include annelids, mollusks, and crustaceans that inhabit the bottom substrates of estuaries. These organisms play a vital role in maintaining sediment and water quality, and are an important food source for bottom-feeding fish, invertebrates, ducks, and marsh birds. Measures of biodiversity and species richness, species composition, and relative abundance or productivity of functional groups are among the assemblage attributes that can be used to characterize benthic community composition and abundance. The Heinz report refers to this indicator as Condition of Bottom-Dwelling Organisms (The Heinz Center, 2002).

Assemblages of benthic organisms are sensitive to pollutant exposure (Holland, et al., 1987, 1988; Rhoads, et al., 1978; Pearson and Rosenberg, 1978; Sanders, et al., 1980; Boesch and Rosenberg, 1981), and they integrate responses to disturbance and exposure over relatively long periods of time (months to years). Their sensitivity to pollutant stress is, in part, because they live in sediment that accumulates environmental contaminants over time (Nixon, et al., 1986), and because they are relatively immobile.

Reference sites were used to calibrate the indices similar to the approach used to calibrate fish IBI scores in fresh water ecosystems. The references cited above describe the approaches used for calibration and scoring in various estuarine provinces. These indices were calibrated for the respective estuarine province in which they were developed. While the development and calibration process was similar among provinces, the specific thresholds reflect the estuarine conditions within that province. In general, good condition means that less than 10 percent of the coastal waters have low benthic index scores. Fair condition means that between 10 and 20 percent of the coastal waters have low benthic index scores. Poor condition means that greater than 20 percent of the coastal waters have low benthic index scores.

What the Data Show

Benthic community index scores have been assessed for the Northeast, Southeast, and Gulf Coastal Areas. For the Northeast, Southeast, and Gulf Coastal areas, 56 percent of the coastal waters were assessed in good condition, 22 percent in fair condition, and 22 percent in poor condition based on benthic index scores (Exhibit 5-35).

Associations of biological condition with specific stressors indicate that, of the 22 percent of coastal areas with poor benthic condition, 62 percent had sediment contamination, 11 percent had low dissolved oxygen concentrations, 7 percent had low light penetration, and 2 percent showed sediment toxicity (EPA, ORD, OW, September 2001).

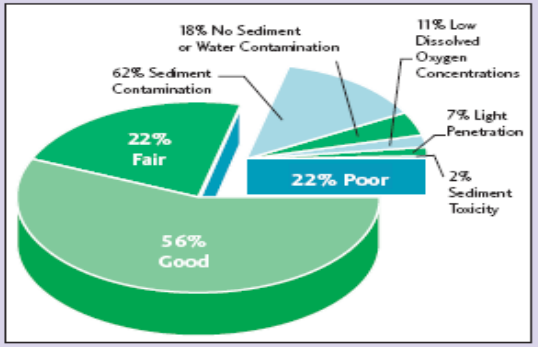
Indicator Gaps and Limitations

Benthic community index scores have been assessed only for the Northeast, Southeast, and Gulf Coastal areas. Samples have been collected in all coastal areas, including Alaska, Hawaii, and Island Territories, but these data have not been assessed. A complete assessment of coastal condition is anticipated in 2003.

Data Source

The data source for this indicator was *National Coastal Condition Report*, U.S. Environmental Protection Agency, September 2001, using data from the Environmental Monitoring and Assessment Program, Estuaries Program. (See Appendix B, page B-46, for more information.)

Exhibit 5-35: Benthic Community Index (BCI) scores for coastal waters in good, fair, or poor condition, 2000



Coverage: Northeast, Southeast, and Gulf Coastal areas

Source: EPA, Office of Research and Development and Office of Water. *National Coastal Condition Report*. September 2001.

EMAP Indicators in the DROE

- National Coastal Condition Report (12)
- Mid-Atlantic Integrated Assessment (6)
- Sustainable Forests (10)
- 2001 National Land Cover Dataset (6)

Peer Review and Public Comment on DROE

- **Make questions more internally consistent and clearly linked to EPA's mission**
- **Clearly define "indicator"**
- **Establish formal criteria for indicator selection**
- **Treat gaps and limitations more consistently**

Revisions Based on Peer Review and Public Comments

Questions

- EPA agreed on a set of 27 questions that it considers to be important to the Agency's mission to protect the environment and human health. The report is organized around these questions.
- Example: "What are the trends in outdoor air quality and their effects on human health and ecological systems?"

Indicator Definition

- For EPA's Report on the Environment, “an indicator is a numerical value derived from actual measurements of a pressure, state or ambient condition, exposure, or human health or ecological condition over a specified geographic domain, whose trends over time represent or draw attention to underlying trends in the condition of the environment.”

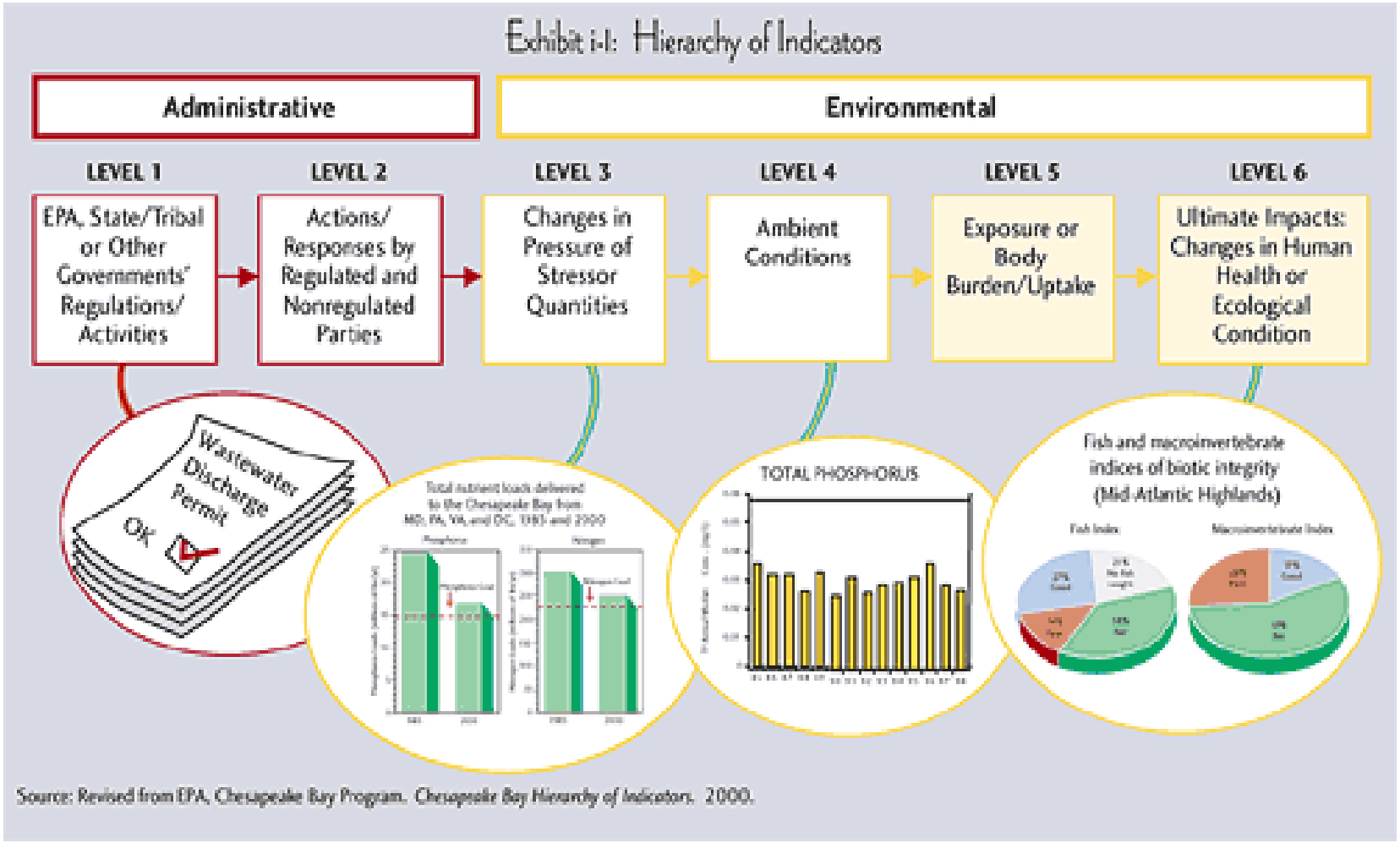


Exhibit i-1: Hierarchy of Indicators
Administrative
Environmental
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
LEVEL 5
LEVEL 6
EPA, State/Tribal or Other Governments' Regulations/ Activities
Actions/ Responses by Regulated and Nonregulated Parties
Changes in Pressure of Stressor Quantities
Ambient Conditions
Exposure or Body Burden/Uptake
Ultimate Impacts: Changes in Human Health or Ecological Condition
Wastewater Discharge Permit
OK
TOTAL PHOSPHORUS
Fish and macroinvertebrate indices of biotic integrity (Mid-Atlantic Highlands)
Source: Revised from EPA, Chesapeake Bay Program. Chesapeake Bay Hierarchy of Indicators. 2000.

6 Indicator Criteria

- The indicator is useful. It answers (or makes an important contribution to answering) a question in the ROE.
- The indicator is objective. It is developed and presented in an accurate, clear, complete, and unbiased manner. The indicator is transparent and reproducible.
- The specific data used and the specific assumptions, analytic methods, and statistical procedures employed are clearly stated.

6 Indicator Criteria (cont.)

- The underlying data are characterized by sound collection methodologies, data management systems to protect their integrity, and quality assurance procedures.
- Data are available to describe changes or trends, and the latest available data are timely.
- The data are comparable across time and space, and representative of the target population. Trends depicted in the indicator accurately represent the underlying trends in the target population.

Comparison of DROE and ROE 07 Indicator Review

DROE

Internal Review

Reviewers considered

- Data quality
- Scientific basis
- Utility
- Limitations

Reviewers looked at “data quality” forms, not the actual indicator write-ups and graphics

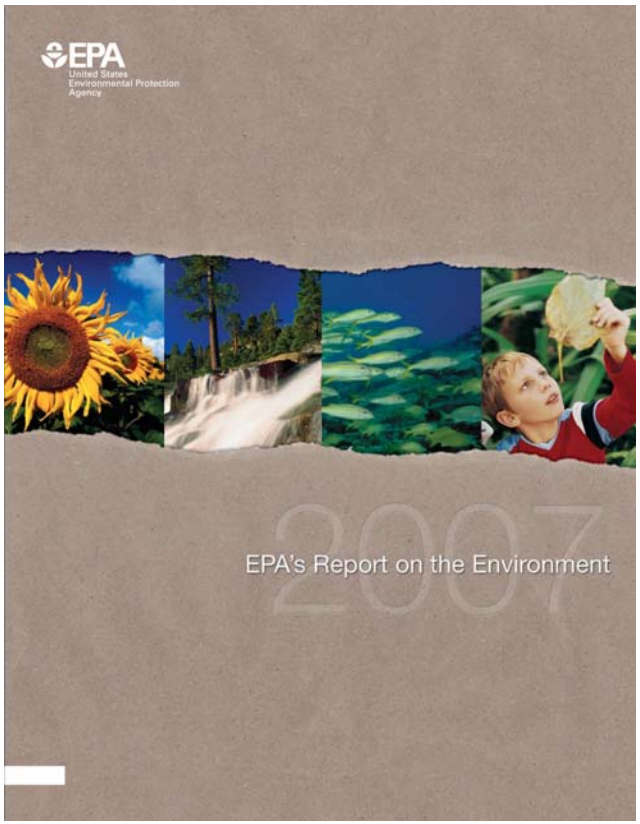
ROE07

Public external review

Reviewers considered

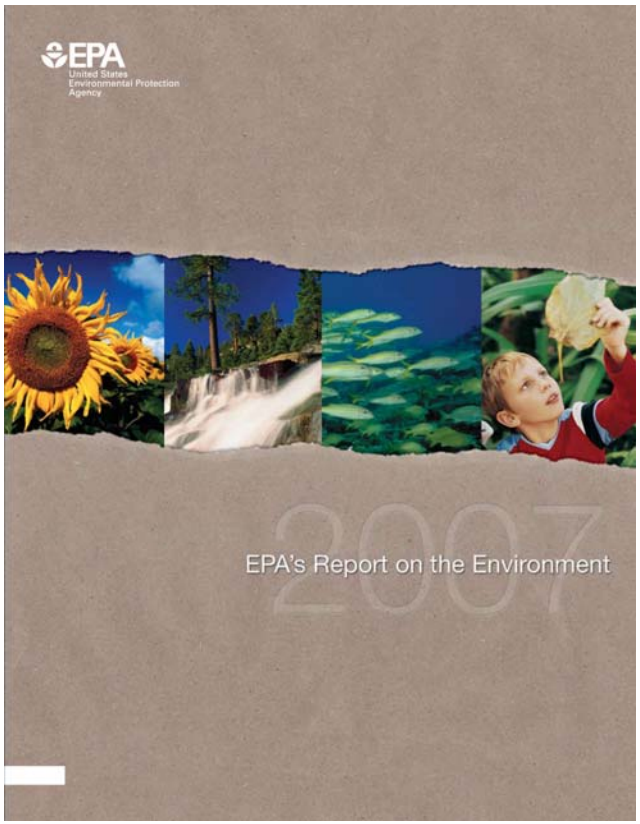
- Definition
- Six criteria
- Limitations
- Overall recommendation
- Based on indicator write-ups, graphics, and metadata forms

Report on the Environment-2007



- 27 questions about trends in air, water, land, human health, and ecological condition
- 87 peer-reviewed indicators

ROE 07 Regionalization



- 25 national ROE indicators are broken down by EPA Region
- 10 national ROE indicators are broken down by other "regions"
- 9 Regional Pilot indicators

ROE 07 Indicator Spreads

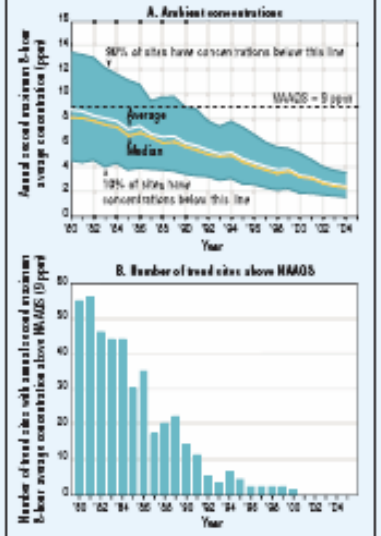
- **Introduction**
- **What the Data Show**
- **Limitations**
- **Data Sources**
- **References (appendix)**
- **Metadata forms (*e*ROE)**

Carbon Monoxide Emissions continued

numerous state, tribal, and local agencies. Different data sources use different data collection methods, and many of the emissions data are based on estimates rather than actual measurements. For most fuel combustion sources and industrial sources, emissions are estimated using emission factors. Emissions from on-road and nonroad sources were estimated using EPA-approved modeling approaches (U.S. EPA, 2005).

NEI data have been collected since 1990 and cover all 50 states and their counties, D.C., the U.S. territories of Puerto Rico and Virgin Islands, and some of the territories of federally-recognized American Indian nations. Data are presented for 1990 and from 1996 to 2002, prior to 1996, only the 1990 data have been updated to be comparable to the more recent inventories.

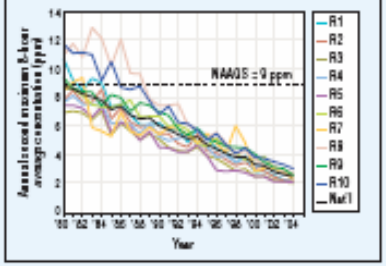
Exhibit 2-3. Ambient CO concentrations in the U.S., 1980-2004[a]



[a]Coverage: 160 monitoring sites nationwide (out of a total of 425 sites measuring CO in 2004) that have sufficient data to assess CO trends since 1980.

Data source: U.S. EPA, Air Quality System, 2005

Exhibit 2-4. Ambient CO concentrations in the contiguous U.S. by EPA Region, 1980-2004[a]



What the Data Show

Only CO emissions from anthropogenic sources are included in the NEI. However, CO emissions from biogenic sources were estimated for 2002 to provide a sense of the relative contributions of natural versus anthropogenic emissions (Exhibit 2-1, panel B). Nationally, biogenic emissions were estimated to contribute approximately 5 percent to the CO emissions from all sources during 2002.

Nationwide estimated anthropogenic CO emissions have decreased 33 percent between 1990 and 2002, the most recent year for which aggregate NEI emissions estimates are available (Exhibit 2-1, panel A). Almost the entire emissions reduction is attributed to decreased emissions from on-road mobile sources. In 2002, mobile sources (both on-road and nonroad sources combined) accounted for 91 percent of the nation's total anthropogenic CO emissions. The CO emissions reductions are reflected in corresponding reductions in ambient concentrations (the CO Concentrations indicator, p. 2-16).

Net estimated anthropogenic CO emissions declined in all EPA Regions between 1990 and 2002 (Exhibit 2-2). The largest decrease (8.95 million pounds) occured in Region 5, and the smallest decrease (1.74 million pounds) occurred in Region 8.

Indicator Limitations

Comparable CO emissions estimates through the NEI are available only for 1990 and 1996-2002. Data for 1991-1995 are not provided due to differences in emission estimation methodologies from other inventory years which could lead to improper trend assessments.

CO emissions from "miscellaneous sources," including wildfires, are not included in the total emissions. Yearly fluctuations in wildfire emissions have the potential to mask trends in anthropogenic emissions and therefore have been excluded from the trends graphics. Details on emissions from miscellaneous sources can be found at http://www.epa.gov/ttn/chief/eiinformation.html.

The emissions data for CO are largely based on estimates that employ emission factors generated from empirical and engineering studies, rather than on actual measurements of CO emissions. Although these estimates are generated using well-established approaches, the estimates have uncertainties inherent in the emission factors and emission models used to represent sources for which emissions have not been directly measured.

The methodology for estimating emissions is continually reviewed and is subject to revision. Trend data prior to any revisions must be considered in the context of those changes.

Not all states and local agencies provide the same data or level of detail for a given year.

Data Sources

Summary data in this indicator were provided by EPA's Office of Air Quality Planning and Standards, based on raw CO emissions data in EPA's National Emissions Inventory (NEI) (U.S. EPA, 2006) (http://www.epa.gov/ttn/chief/net/2002inventory.html). This indicator aggregates the raw NEI data by source type (anthropogenic or biogenic), source category, and EPA Region. ❖

[[NOTE: References will be at the end of each chapter]]

INDICATOR | Ambient Carbon Monoxide Concentrations

Carbon monoxide (CO) gas forms primarily when carbon fuels are not burned completely. Elevated ambient air concentrations of CO are hazardous because inhaled CO enters the bloodstream and reduces the amount of oxygen that the blood can deliver to the body's organs and tissues. If exposure concentrations are high enough, potentially serious cardiovascular and neurological effects can result. Visual impairment, reduced work capacity, reduced manual dexterity, poor learning ability, and difficulty in performing complex tasks are all associated with exposure to elevated CO levels (U.S. EPA, 2000).

Motor vehicle exhaust currently accounts for the majority of CO emissions nationwide, and as much as 95 percent of CO emissions in cities with high traffic congestion. Other anthropogenic emissions sources of CO include fossil fuel combustion for heating and power generation, metals processing, and chemical manufacturing. The highest ambient air concentrations of CO often occur during nighttime inversion conditions, which trap pollutants near ground level. These conditions are most frequently observed during the cold winter months (U.S. EPA, 2003).

This indicator presents ambient CO concentrations in parts per million (ppm) from 1980 to 2004, based on continuous measurements averaged over 8-hour time frames. The 8-hour standard is indicative of exposures occurring over a sustained period of time, for example, an outdoor worker's exposure over the course of a work day. This indicator displays trends in the second highest annual 8-hour average CO concentrations for 160 sites that have consistent data for the period of record in the National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS) network, and other special purpose monitors. It also shows trends in the average 8-hour measurements in each EPA Region. This indicator's exhibits display the National Ambient Air Quality Standard (NAAQS) for CO as a point of reference, but the fact that the national or any regional 8-hour values fall below the standard does not mean that all monitoring sites nationally or in the EPA Region also are below the standard. The indicator displays trends in the number of the 160 sites nationwide at which CO concentrations exceeded the 8-hour standard, but this statistic is not displayed for each EPA Region.

What the Data Show

The 2004 CO concentration averaged across 160 monitoring sites nationwide was 72 percent lower than that for 1980, and is the lowest level recorded during the past 25 years (Exhibit 2-3, panel A). The downward trend in CO concentrations in the 1990s parallels the downward trend observed in CO emissions, which has been attributed largely to decreased emissions from mobile sources (the CO Emissions indicator, p. 2-13). In addition, of the 160 sites comprising this trend (out of 425 total monitoring sites that were operating in 2004), the number reporting CO concentrations above the CO standard declined to zero over the same period (Exhibit 2-3, panel B).

Also shown on Exhibit 2-3 (panel A) are the 90th and 10th percentiles based on the distribution of annual statistics at the monitoring sites. This provides additional graphical representation of the distribution of measured concentrations across the monitoring sites for a given year. Thus, the graphic displays the concentration range where 80 percent of measured values occurred for that year.

ROE 07 Chapter Text

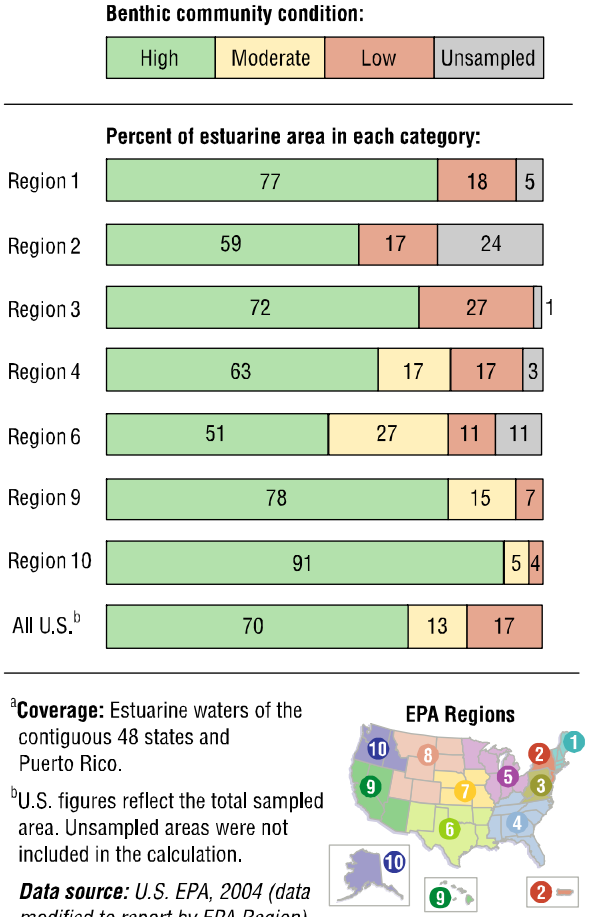
For each of the 27 questions

- **Introduction – scope of the question**
- **Indicator Spreads**
- **Discussion**
  - **Summary of what the indicators say about the question**
  - **Important gaps, limitations, and challenges**

EMAP Indicators Retained or Revised in ROE 07

- **Coastal Benthic Communities**
- **Coastal Fish Tissue Contaminants**
- **Coastal Sediment Quality**
- **Coastal Water Quality**
- **Forest Extent and Type**
- **Land Cover**
- **Forest Fragmentation**
- **Carbon Storage in Forests**
- **Ozone Injury to Forest Plants**

Exhibit 3-28. Coastal benthic communities index for the contiguous U.S. and Puerto Rico, by EPA Region, 1997-2000[a]

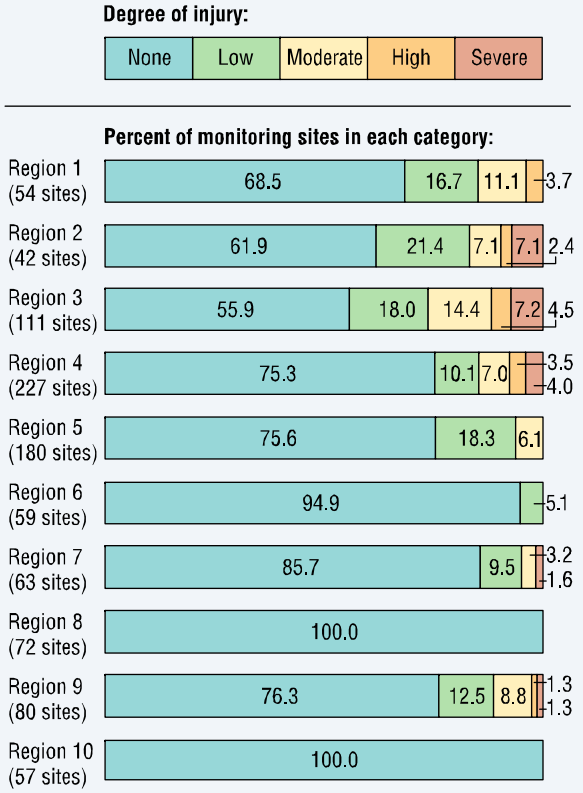


[a]**Coverage:** Estuarine waters of the contiguous 48 states and Puerto Rico.

[b]U.S. figures reflect the total sampled area. Unsampled areas were not included in the calculation.

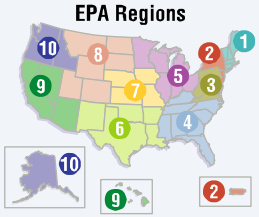
Data source: *U.S. EPA, 2004 (data modified to report by EPA Region)*

Exhibit 2-17. Ozone injury to forest plants in the U.S. by EPA Region, 2002[a]



[a]**Coverage:** 945 monitoring sites, located in 41 states.

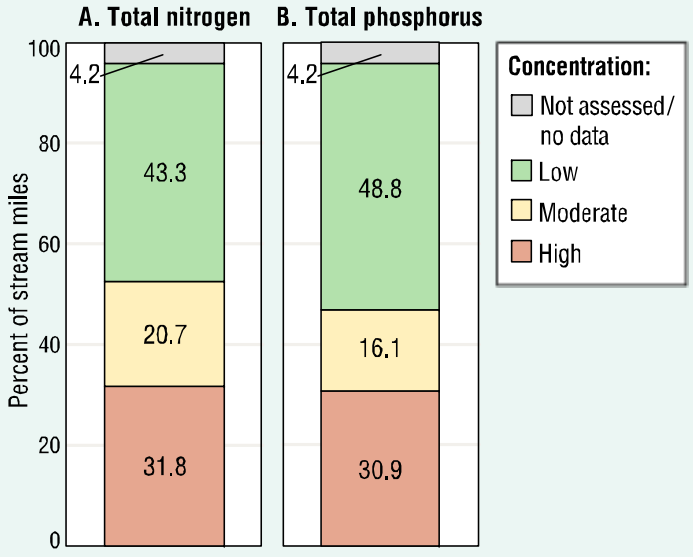
Data source: *USDA Forest Service, Forest Health Monitoring (FHM) Program database*



New EMAP Indicators in ROE 07

- Lake & Stream Acidity
- Benthic Macroinvertebrates in Wadeable Streams
- Nitrogen and Phosphorus in Wadeable Streams
- Streambed Stability in Wadeable Streams
- Wetland Extent, Change, and Sources of Change
- Contaminants in Lake Fish Tissue

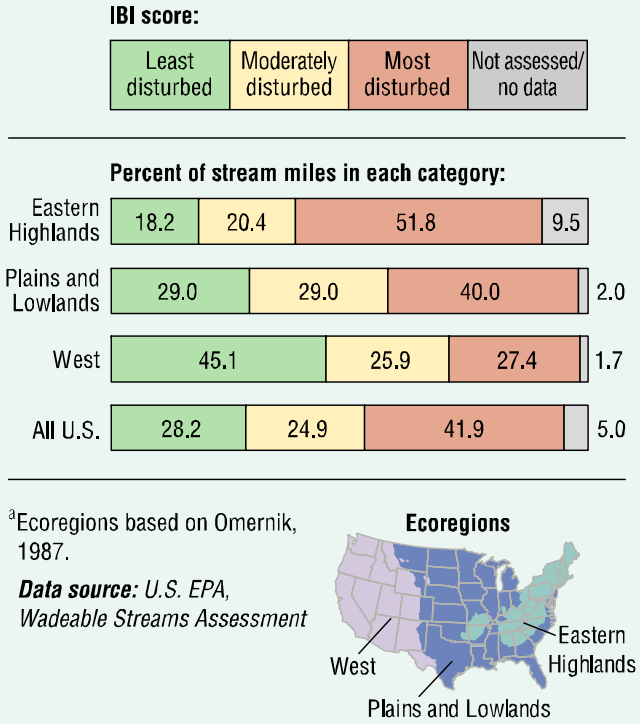
Exhibit 3-6. Nitrogen and phosphorus in wadeable streams of the contiguous U.S., 2000-2004[a]



[a]Compared with minimally disturbed reference sites. See text for definitions of the categories shown in the figure.

Data source: *U.S. EPA, Wadeable Streams Assessment*

Exhibit 3-12. Index of Biological Integrity (IBI) for benthic macroinvertebrates in wadeable streams of the contiguous U.S., by ecoregion, 2000-2004[a]



[a]Ecoregions based on Omernik, 1987.

Data source: *U.S. EPA, Wadeable Streams Assessment*

Exhibit 3-40. Lake fish tissue PBT contaminant concentration estimates for predators (fillets) in the contiguous U.S., 2000-2003

Contaminant	Number of samples	Number of samples above MDL[a]	Percentiles for fillet tissue concentrations (ppm)[b]						
			5th	10th	25th	50th (median)	75th	90th	95th
Mercury	486	486	0.059	0.089	0.177	0.285	0.432	0.562	0.833
Total PCBs	486	486	0.000351	0.000494	0.001000	0.002161	0.008129	0.018159	0.033161
TEQ dioxins/furans only	486	395	*	*	*	6×10^{-9}	46×10^{-9}	109×10^{-9}	318×10^{-9}
Total inorganic arsenic	486	2	*	*	*	*	*	*	*
Total chlordane	486	96	*	*	*	*	*	0.003617	0.008266
Total DDT	486	378	*	*	*	0.00147	0.00694	0.01966	0.03057
Dicofol	486	15	*	*	*	*	*	*	*
Dieldrin	486	24	*	*	*	*	*	*	0.001193
Total endosulfan	486	18	*	*	*	*	*	*	*
Endrin	486	3	*	*	*	*	*	*	*
Heptachlor epoxide	486	6	*	*	*	*	*	*	*
Hexachlorobenzene	485	0	*	*	*	*	*	*	*
Lindane (gamma BHC)	486	28	*	*	*	*	*	*	0.000994
Mirex	486	10	*	*	*	*	*	*	*
Toxaphene	486	0	*	*	*	*	*	*	*

[a]MDL = method detection limit; MDLs are available online at http://www.epa.gov/waterscience/fishstudy.

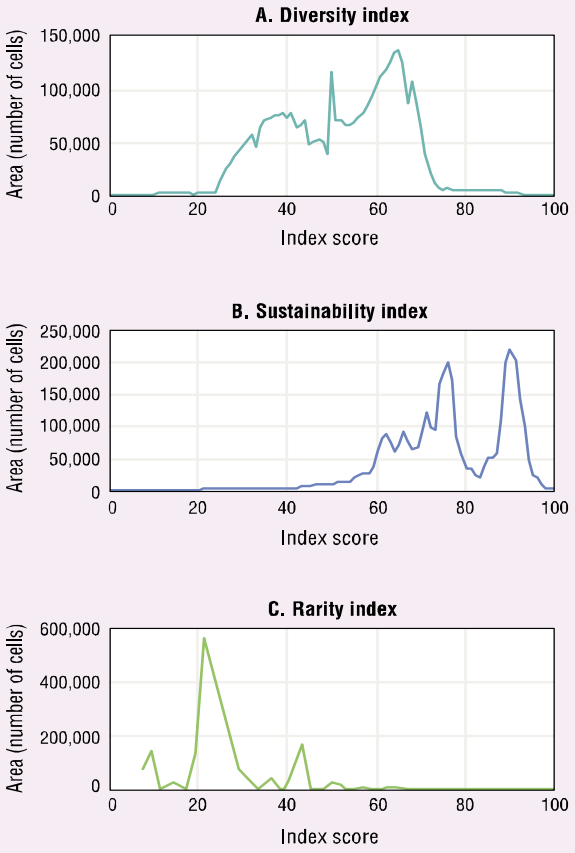
[b]* = less than MDL

Data source: *U.S. EPA, National Study of Chemical Residues in Lake Fish Tissue*

New Regional Pilot EMAP Indicators in ROE07

- Ecological Connectivity in EPA Region 4 (depends on MRLC)
- Land Cover in the Puget Sound/Georgia Basin (depends on MRLC)
- Relative Ecological Condition of Undeveloped Land in EPA Region 5 (depends on MRLC)
- Non-Indigenous Species in the Estuaries of the Pacific Northwest (depends on NCCR)

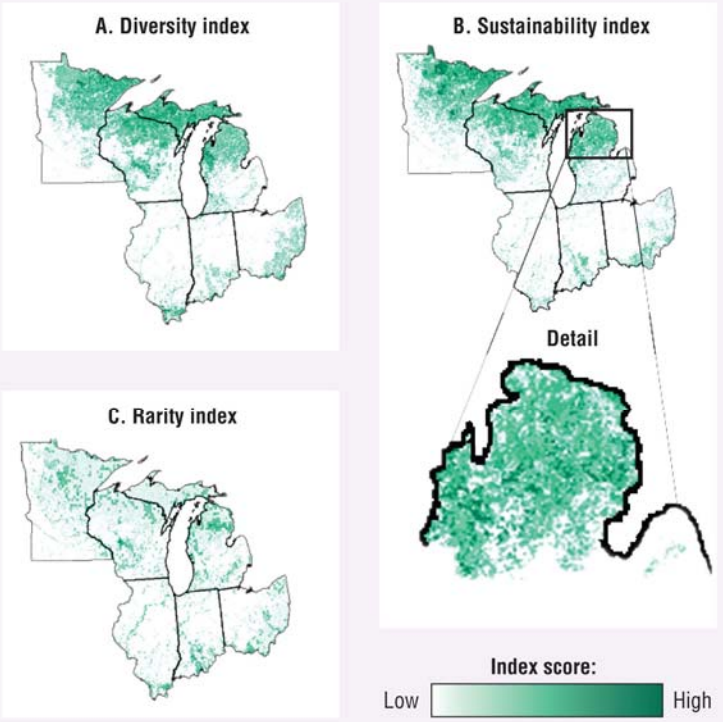
Exhibit 6-7. Distribution of index scores for the relative ecological condition of undeveloped land in EPA Region 5, 1990-1992[a]



[a]**Coverage:** Undeveloped land in EPA Region 5, based on the 1992 National Land Cover Dataset (NLCD). For this analysis, "undeveloped" land is any land that the NLCD classifies as bare rock/sand/clay, deciduous forest, evergreen forest, mixed forest, shrubland, grasslands/herbaceous, woody wetlands, emergent herbaceous wetlands, or open water.

Data source: *U.S. EPA Region 5*

Exhibit 6-8. Relative ecological condition of undeveloped land in EPA Region 5, 1990-1992[a]



[a]**Coverage:** Undeveloped land in EPA Region 5, based on the 1992 National Land Cover Dataset (NLCD). For this analysis, "undeveloped" land is any land that the NLCD classifies as bare rock/sand/clay, deciduous forest, evergreen forest, mixed forest, shrubland, grasslands/herbaceous, woody wetlands, emergent herbaceous wetlands, or open water.

Data source: *U.S. EPA Region 5*

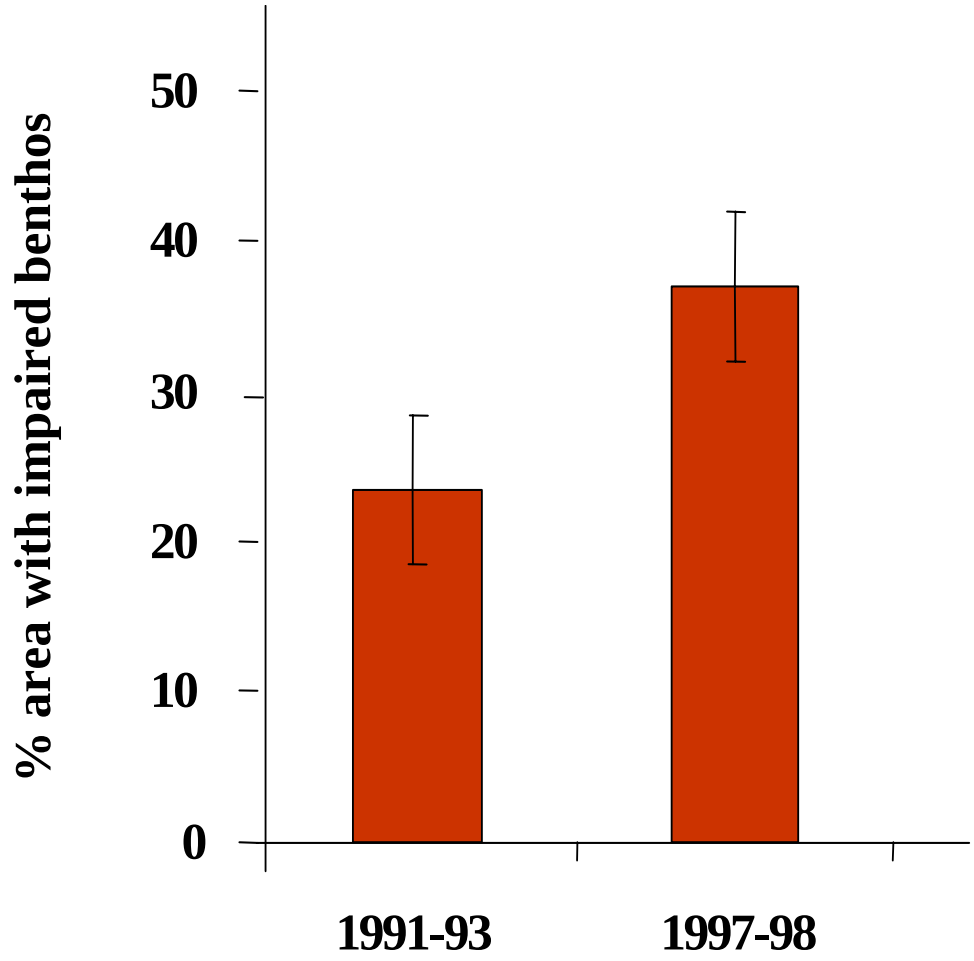
EMAP Indicators Dropped in ROE 07

- Total organic carbon in sediments
- Coastal fish diversity
- Coastal fish abnormalities
- Tree Condition
- Soil Compaction
- Soil Erosion
- Altered Fresh Water Ecosystems
- Percent Urban Land Cover in Riparian Areas
- Agricultural Lands in Riparian Areas
- MAIA/NSWS regional indicators

Next Steps

- SAB Review (July 2007)
- Indicator Research
  - Better ways to quantify uncertainty
  - Better ways to regionalize and scale indicators
  - Analyze sensitivity of indicator to management actions
- ROE and strategic planning

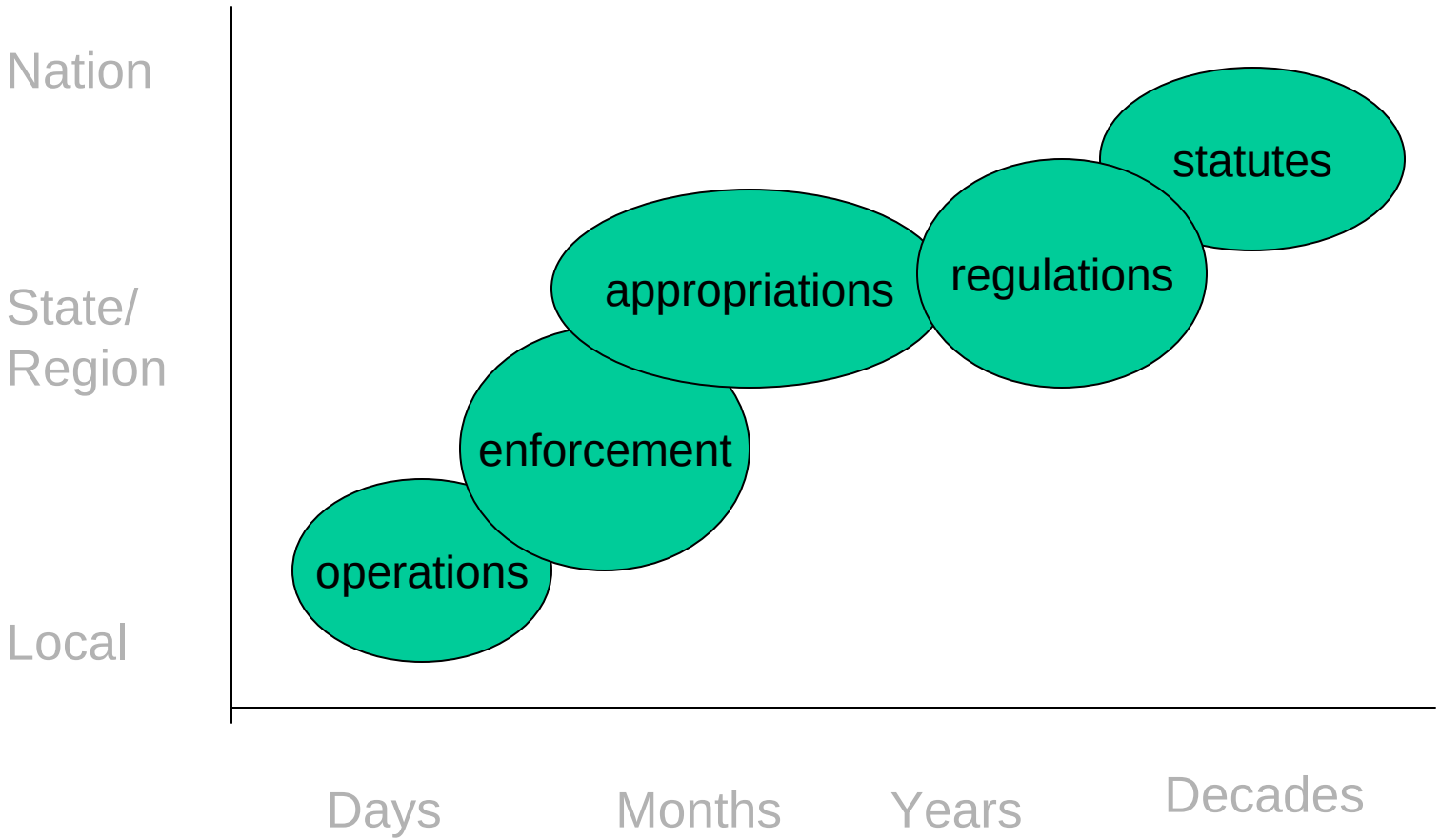
EMAP indicators provide comparable, representative data with known confidence



Appropriate scale

- Are we concerned about
  - a family?
  - a community?
  - a state or region?
  - the nation?
  - the globe?
- Each target may require an indicator with a different time and space scale.

Hierarchy and Scale



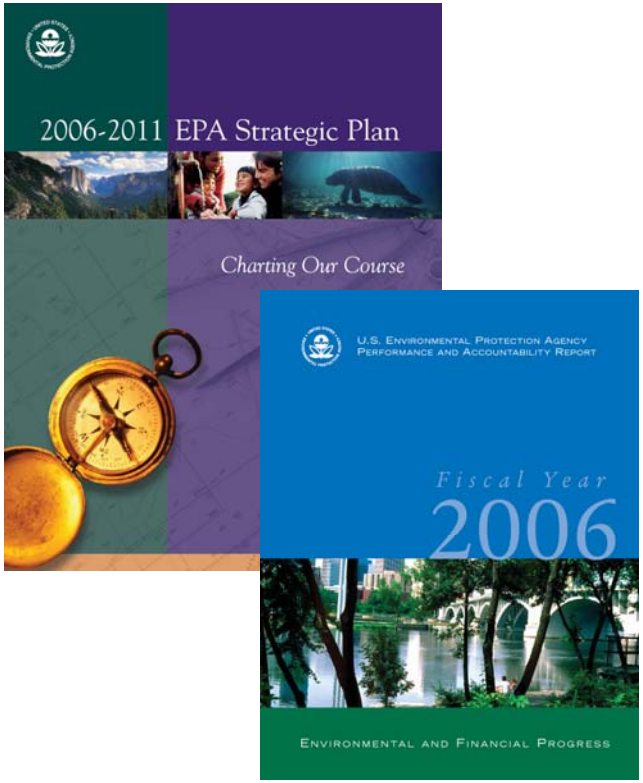
ROE and Strategic Planning

The ROE should:

- complement EPA's strategic planning efforts
- identify important gaps in information that hinder our decisions about how to invest in the future.

- EPA Administrator Steve Johnson

EPA's Strategic Plan & Performance Report



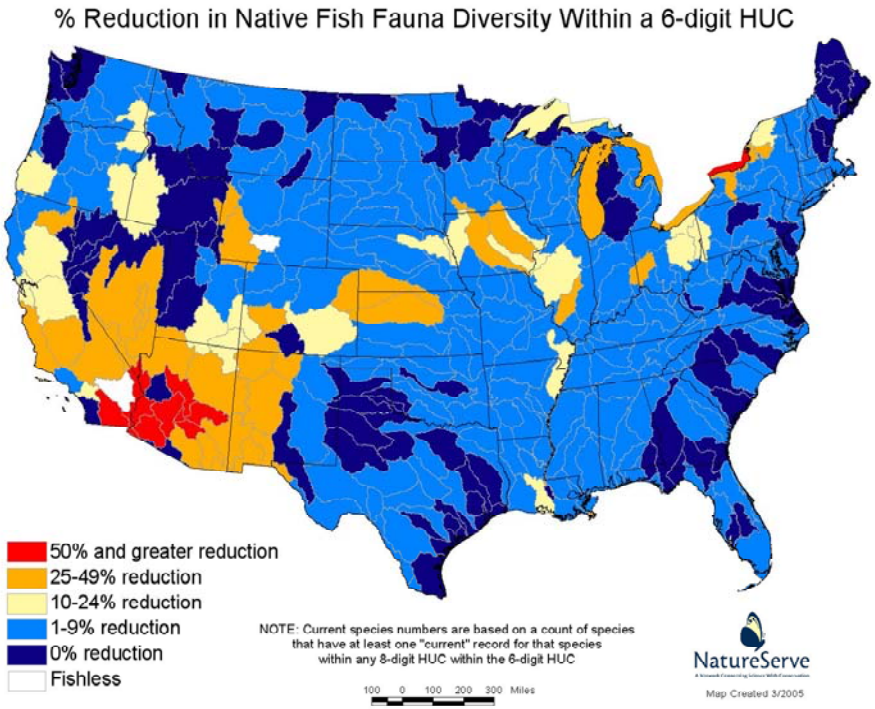
- EPA Strategic Plan
  - Sets the Agency's goals, objectives, and strategic targets.
- EPA Annual Performance Report
  - Reports on achievement of goals, objectives, and strategic targets.

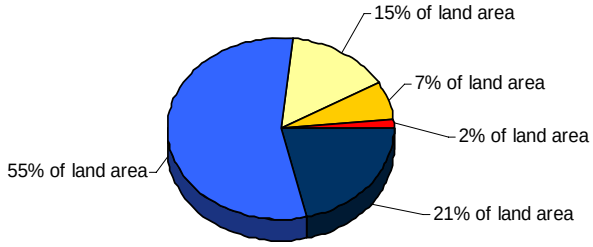
How can the ROE inform strategic thinking at EPA?

- Cross-Office/Region pilot study is ongoing
- Possibilities:
  - Identify trends that need attention
  - Identify important gaps and limitation
  - Improve measures and indicators technically

Identify trends that need attention

Figure 128-1.





Identification of important gaps

- No human or ecological effects indicators related to most questions
- Few indicators for:
  - Indoor air and ambient air toxics
  - Drinking water, groundwater, and recreational water, releases to water, and water quality in lakes
  - Ambient levels of TSCA and RCRA chemicals
  - Ecological condition

Research needs

- Develop indicators to fill important gaps
- Use technology to improve cost-effectiveness of indicators
- Solve scaling problems (especially for ecological indicators)
- Quantify and communicate uncertainty

Why bother ?

Indicators enhance the public dialog about the state of the environment and provide an opportunity for strategic analysis of EPA's overall success in its mission to protect human health and the environment.