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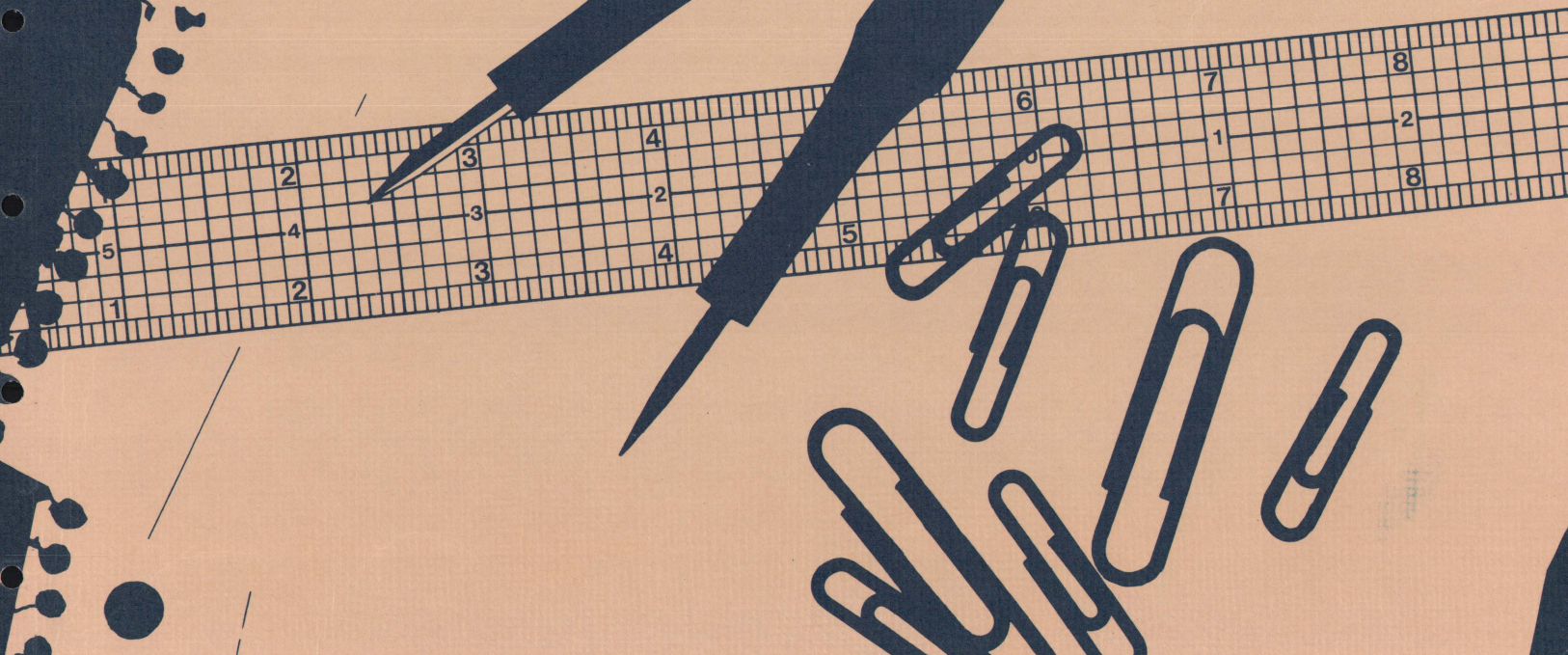


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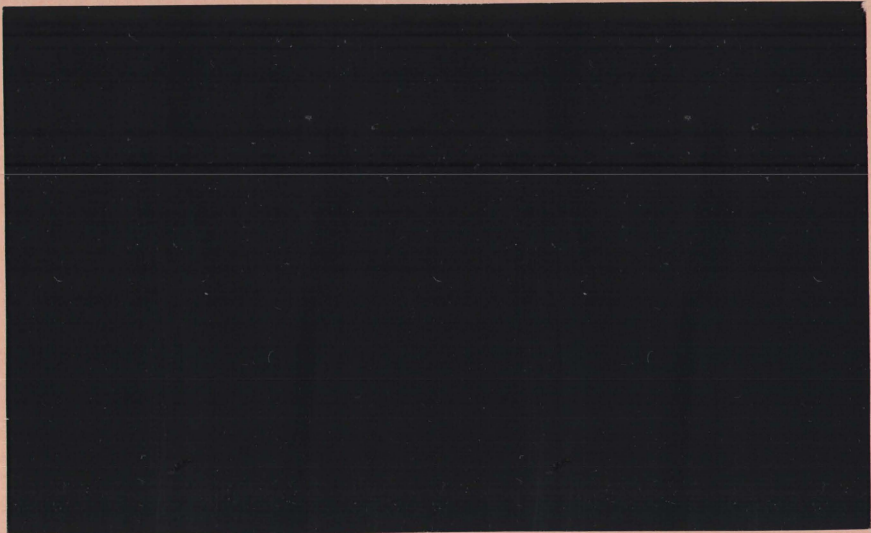
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Measures and Degrees
of Marine Ecosystem Degradation

Harold M. Stanford
J. R. Schubel



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Northeast Office
Office of Marine Pollution Assessment
National Oceanic and Atmospheric Administration
and
Marine Sciences Research Center

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Summary of an Informal Workshop

3 February 1982

under a

Cooperative Agreement between

NOAA's Office of Marine Pollution Assessment

and

SUNY's Marine Sciences Research Center

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J.R. Schubel

J. R. Schubel

INTRODUCTION

The Marine Protection, Research and Sanctuaries Act, Public Law 92-532 (1972), authorizes the Administrator of the Environmental Protection Agency to issue permits for the ocean dumping of nondredged materials "where the Administrator determines that such dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." The Act's requirement that unreasonable degradation not occur is to be the determining factor in deciding whether or not dumping of nondredged material can occur in marine waters.

The Office of Marine Pollution is convening a formal meeting, 23-26 February 1982, to address the general topic of unreasonable degradation -- in the overall context of "human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." To help prepare for this formal meeting, the Marine Sciences Research Center (of the the State University of New York) and the Northeast Office (of the Office of Marine Pollution Assessment) held an informal workshop on 3 February 1982 to examine that portion of the overall topic that deals with measures and degrees of marine ecosystem degradation. This more limited topic addresses scientific areas, and does not involve judgements of whether or not the degradation is unreasonable. J. R. Schubel will present this Working Paper to the upcoming, formal meeting on unreasonable degradation.

This report summarizes the important conclusions of the informal Workshop. It was written with due consideration for the discussion that occurred during the Workshop, but it should not be interpreted as a report

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that has been endorsed in full by all participants because they have not had an opportunity to review it.

WORKSHOP PARTICIPANTS

A total of 13 people, from five organizations participated in the informal workshop.

Marine Sciences Research Center

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THE PROCEDURE

The Workshop participants were asked to consider the following scenario. Two sites have been designated on the continental shelf for the disposal of sewage sludge. One site has never been used for disposal of

sewage sludge and is pristine. The other site is not now receiving any sewage sludge but in the past has been used extensively for sewage sludge disposal, and must be considered degraded by any reasonable criteria one might use to measure environmental and ecosystem degradation. Both sites are scheduled to receive sewage sludge beginning one year from now and for a period of at least five years thereafter. At that time a decision will be made whether the dumping should be continued or stopped.

Your job: select those indices of degradation that should be applied to these sites. The indices should be those that will have the greatest likelihood of demonstrating the degree of degradation that can be attributed to the five years of sewage sludge dumping.

The participants were told further that they should assume that support would be provided to make the required observations, and that in six years they could be called back. They were told that at that time they would be asked to document the degree of degradation but that they would not be asked to decide whether the degradation observed was "reasonable" or "unreasonable."

With this as background and after considerable discussion, the Workshop participants settled on the indices of ecosystem degradation summarized in Table 1.

TABLE 1. Potential Indices of Marine Ecosystem Degradation

Sediment Toxicity	Toxicant Burdens e.g., Mussel Watch	Infaunal Feeding	Benthic Degradation	Fish/Shellfish Disease	(P/R) ⁿ Heterotrophy	% of Area 2 ml/l O ₂	Areal Extent of Site and Sphere of Influence	Duration of Impact	Species Diversity	Reproductive Potential	Fishery Yield	Flushing Rate	Avian Reprod.
(1)	(2)	(3)	Species list (4)	Frequency of Occurrence (5)	(6)	(7)	(8)	(9)	(10)	X	X	X	X

INDEX

- (1) Sediment Contaminant Burden (concentrations and forms of contaminants)
- (2) Toxicant Burdens in Organisms - {
 - Benthic Filter Feeder;
 - Benthic Deposit Feeder; Non-Migratory fish;
 - Plankton} Selection of test organisms will depend upon the characteristics of the site.
- (3) Infaunal Feeding - Relative Abundance of Different Feeding Types
- (4) Changes in Abundance of Dominant Species Types
- (5) Fish/Shellfish Disease - - Percent incidence
- (6) Autotrophic/Heterotrophic Production (Primary and Secondary Production at different trophic levels)
- (7) Apparent Oxygen Utilization (Redfield's old concept re O₂ and nutrients) is another, related measure
- (8) - (9) Defining the area of "impact" distribution of intensity of "impact" in time and space)
- (10) Species Composition (indicator species) should also be considered
- (X) These indices were considered to be too costly to determine and not sufficiently diagnostic to be given a high priority.

Comments

Some of the comments made by participants that led to the selection of indices summarized in Table 1 are paraphrased below.

- o Emphasis should be placed on measurements that can be made in the field, rather than presumptions, extrapolations of laboratory studies, etc.
- o We have to contend with what is "measurable," not what is "significant."
- o Those measures of degradation chosen should be relatable to ecosystems that are most and least susceptible to impact.
- o Perhaps we will have to consider separate approaches for on-shelf and over-shelf areas.
- o To the extent possible, we must consider natural variability and in this context evaluate the added anthropogenic impacts. We must assess departures from the normal range.
- o Anthropogenic materials must be addressed under two categories: those found in nature and those that are "synthetic."
- o Care must be taken in examining "trends" -- those that are "natural" must be distinguished from those that are man-related, and involve a shift from a "baseline."
- o Nutrients force the system; because nutrients influence the toxicity of other inputs, particular attention must be paid to them.
- o Measures of degradation that are useful are those that:
 - a. Can be obtained with the least expense.
 - b. Can be most reliable.
 - c. Have small fluctuations over years.
 - d. Can be related to historical data.
 - e. Integrate as a measure of the ecosystem, not just a species.

- o One or two measures of degradation for an ecosystem will not suffice; more are needed.
- o Biomass effects and toxic effects are tied together; both must be considered.
- o Examination of detrital food chains may be more instructive than examination of phytoplankton.
- o Indices chosen for a particular ecosystem need to be consistent over time and space.
- o As regards consistency over time and space, bottom values might be most appropriate.
- o Flushing rates, needed for determining cause-effect relationships, are considered in most of the indices in the listing.
- o Special attention is necessary to bioaccumulation of toxics, which are not addressed in the Ocean Dumping Act.
- o Concern should be placed primarily on what is known to affect indices for measuring degradation, not what might.
- o A number of parameters are common to several indices; at least species composition, biomass, and trophic level interactions must be known for each area of concern.
- o Baseline studies must be accomplished for an area for a long enough period to "validate" the indices.
- o Organisms present at an area of concern are the ones which should be used for any bioassays.
- o We must consider that at almost all coastal sites some level of pollution already exists.

- o There is a need to define functionally the boundaries of ecosystems considered; this must be done before discussing "the ecosystem" in much detail.
- o Pelagic systems, as well as benthic ones, must be accounted for if the pelagic system is maintained in the area of concern.
- o Just how do we get a "handle" on the sensitivity of a system to pollution?
- o A linking of body burdens to reproduction could be most useful.
- o What priorities should be assigned to the indices on the board (later listed in Table 1)? This question was not answered by the end of the Workshop.
- o It should be pointed out that in England a great deal of analogy (comparing known actions/reactions in areas similar to ones being addressed) is used.
- o A hierarchy of indices, based on fundamentals, should be developed to see which are the most important; as an example, interactions and processes are based on burdens.
- o Contaminant burdens in sediments aren't important, just their availability.
- o Organisms selected for attention must be selected based upon the character of the waste; as an example, filter feeders are important for particulate wastes.
- o There should be a focus, perhaps, on lower forms, because that's where most of the "action" is; there is little involvement, relatively speaking, of higher forms.

- o A problem with using diversity index is that attention is paid to the most dominant or abundant species which are probably not the most "important."
- o A critical population might be more important than the areal extent of an impact.
- o The time over which measurements are made is most important. In some "MERL" experiments, bacteria were "wiped out" initially from contaminant inputs, but recovered thereafter.

