NOAA Technical Memorandum ERL GLERL-114

# Proceedings of the Workshop
# The Environmental Implications of Cargo Sweeping in the Great Lakes

David F. Reid
NOAA, Great Lakes Environmental Research Laboratory, Ann Arbor, MI 48105

Guy A. Meadows
University of Michigan, Cooperative Institute for Limnology and Ecosystems Research
Ann Arbor, MI 48105

Great Lakes Environmental Research Laboratory
Ann Arbor, Michigan
September 1999

UNITED STATES
DEPARTMENT OF COMMERCE

William Daley
Secretary

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

D. James Baker
Under Secretary for Oceans
and Atmosphere/Administrator

NOTICE

 This is GLERL Contribution No. 1139.

The Workshop was held at the University of Michigan North Campus Commons in Ann Arbor, MI, September 27-28, 1994, and was sponsored by the U.S. Coast Guard - Ninth District. The Workshop was convened by David F. Reid and Guy A. Meadows.

This publications is available as a PDF file and can be downloaded from GLERL's web site: www.glerl.noaa.gov. Hard copies can be requested from the GLERL Publications Unit, 2205 Commonwealth Blvd., Ann Arbor, MI 48105. pubs.glerl@.noaa.gov.

## Table of Contents

# EXECUTIVE SUMMARY

## I. Overview

"Cargo sweeping" is the practice of removing the residues of dry bulk cargoes, such as iron ore, coal, grain, and various rock materials, from the deck and holds of cargo vessels. Such residues occur after most loading or unloading operations. Cleanup is accomplished by washing the decks and cargo spaces with water, which is then discharged over the side, usually while underway.

Coast Guard regulations proposed in 1989 would have made the discharge of cargo residues illegal on the Great Lakes, which would have disrupted the continued operations of the U.S. Great Lakes shipping industry. In September 1994 a workshop was held to identify the research needed to provide a scientific basis for regulatory decisions. Three separate work groups, Risk to Fisheries & Habitat, Sediment Accumulation & Toxicity, and Water Column Impacts, were convened. Each group was asked to consider and identify what we already know and what gaps there are in our knowledge and understanding related to cargo sweeping, what further information or studies are needed, and how best to obtain the requisite information.

- All three groups identified the need for comprehensive information on the composition of the commodities, especially relative to impurities and added chemicals that might prove environmentally harmful. Such information should be obtained by literature searches and direct analyses of the composition.

- Each group indicated the need for studies to determine the bioavailability and bioaccumulation of cargo components and impurities that may be toxic.

- Each group identified a series of other information gaps and questions in need of answers, and recommended various approaches to obtain needed information.

## II. Summary of the Risk to Fisheries & Habitat Work Group Report

This group was asked to consider the potential for changes in bottom habitat character and quality that might result from an accumulation of cargo residues in a particular area over time.

The group identified and discussed four critical bottom habitats (plant bed, mud/silt, sand, and rocky shoals) and seven potential risks posed by the discharge of commodities (smothering and suffocation, osmotic stress, toxicity, nutrient enrichment, change in bottom substrate composition, filling of interstitial spaces in bottom substrate, and esthetics).

This group concluded that residues of cement, grain, coarse limestone, and wood pulp or chips from vessels are not likely to cause serious environmental damage or produce negative impacts on plants and animals in the Great Lakes. Residues of taconite pellets and finely divided limestone, coal, sand, and possibly slag may adversely alter coarse- and rocky-substrate habitat by filling interstitial spaces. There is a critical lack of knowledge and, therefore, a strong need for research to determine if exposure to iron ore, taconite pellets, coal, coke, rock salt, millscale, and slag causes any measurable toxic effects in Great Lakes plants and animals.

The group concluded that specific research is needed to properly determine and evaluate the environmental implications of cargo residues and recommended four general activities to accomplish this: (1) detailed chemical analyses of specific commodities, (2) literature searches, (3) laboratory experiments, especially toxicity bioassays and determination of oxygen demand, and (4) related field testing and measurements.

## III. Summary of the Sediment Accumulation And Toxicity Work Group Report

This work group was charged to address the potential effects of cargo residues that reach and accumulate in soft-bottom sediments. They formulated scientific questions required to address the potential effects of cargo residues and identified a two-tiered approach to answer the most important questions, which are:

1. Does cargo sweeping adversely affect bottom sediments or the biota that reside in or near this sediment?

2. What are the chemical compositions of the cargo commodities?

3. Are the deposited materials in the sediment from cargo sweeping activities toxic or bioaccumulated by benthic organisms?

4. Is deposition of cargo residues changing the physical structure of the bottom sediments, e.g., increasing the amount of hard substrate, therefore changing the habitat for the benthos?

5. How do cargo sweeping activities relate and compare to other discharges of similar or the same compounds into the Great Lakes?

The work group noted that data on the chemical composition of the dry cargoes would be extremely helpful in designing experiments and field studies. This information would also provide a foundation for simple loading calculations to determine the potential signal against baseline that would need to be examined. In addition, they concluded that a literature survey of benthic community data relative to sediment composition and location of the shipping tracks is required to allow the best experimental design for field studies.

## IV. Summary of the Water Column Impacts Work Group Report

This group considered the possible affects that cargo sweeping activities might have in the water column.

They evaluated the dry bulk commodities for both toxicological and water quality effects. The group concluded that short-term changes in local turbidity thay may result from cargo sweeping events would be of little demonstrable environmental consequence within the water column. However, the potential for toxic chemicals to be introduced into the water column from the bulk commodity residues and of any materials used in treating those commodities could not be properly evaluated. Some additional concerns were expressed regarding possible effects on biotic communities growing proximal to the air-water interface and the sediment-water interface.

Four major issues were identified by the group:

1. **Cargo statistics:** detailed information is required regarding which bulk cargoes are carried and which result in the need for cargo sweeping.

2. **Chemical composition of the cargo:** such information is needed to prioritize research into the possible environmental effects.

3. **Physical characteristics of the discharge "plume":** chemical and biological analyses should be considered in the context of the physical properties of the discharge (plume) in the near- and far-field.

4. **Environmental effects:** the bioavailability, solubility, toxicity, and nutrient potential of the materials found in dry bulk cargoes should be determined.

The group recommended that the necessary statistical data on materials shipped, the detailed chemical composition of these materials, and the amounts of such materials discharged to waters of the Great Lakes due to cargo sweepings under normal and worst case conditions, be compiled. They reached consensus that the dispersal of materials from cargo sweepings, once introduced into the water column, is insufficiently known. The group recommends that modeling studies of the dispersal of particulate materials having the physical characteristics of the various types of cargo residues introduced into the Great Lakes be conducted, with verification by appropriate field experiments.

## V. Overall Workshop Recommendations

1. An appropriate scientific basis for regulatory and procedural decisions is lacking, therefore, an aggressive multifaceted research program should be initiated to explore a myriad of information gaps and related questions and concerns. Such a research program should fully explore, measure, and evaluate the environmental implications of cargo residue discharge in the Great Lakes through a series of literature searches, laboratory and field studies, measurements, and experiments.

2. A group of Great Lakes scientists should be formed to advise the Coast Guard and Lake Carriers' Association on specific areas or sensitive fisheries habitats that may be at risk from cargo sweeping, on a case by case basis.

3. Although the Interim Enforcement Policy proposed by the U.S. Coast Guard (see Reid *et al.*, 1994) was only specifically addressed by the Fisheries and Habitat Group, it is worth noting that they expressed concern about permitting cargo sweeping in new areas, that is, areas other than those historically used for sweeping, and recommended that consideration be given to continuing cargo sweeping activities in the same areas used historically for that purpose, until there is a scientific basis for changing that practice.

David F. Reid
Workshop Co-chair

Guy A. Meadows
Workshop Co-chair

# A. THE CARGO SWEEPING WORKSHOP

## I. Overview

Cargo sweeping is the practice of removing the residues of dry bulk cargoes, such as iron ore, coal, grain, various rock materials, etc., from the deck, holds, and cargo tunnels of cargo vessels. Such residues occur after most loading or unloading operations. Residues must be cleaned-up for crew safety as well as for assuring that new cargoes do not become contaminated with the remains of previous cargoes. Cleanup is accomplished by washing decks and cargo spaces with water, which is then discharged over the side, usually while underway. This practice has been common for over 100 years in the Great Lakes.

In 1989 the U.S. Coast Guard proposed regulations to implement Annex V of the *International Convention for the Prevention of Pollution from Ships*, commonly referred to as “Marpol 73/78”, or “Marpol”. Annex V regulates the discharge of “garbage” from ships, and establishes an international regimen designed for the high seas. However, the enabling legislation in the U.S., which took the form of amendments to the *Act to Prevent Pollution from Ships* and to Coast Guard regulations in 33 C.F.R. 151.51 et seq., extended this regimen to the inland waters of the U.S., including the Laurentian Great Lakes. In their announcement of proposed regulations, the U.S. Coast Guard served notice that, under the mandate of the new legislation, the discharge of cargo residues into the waters of the Great Lakes would be prohibited. The Great Lakes carriers (Lake Carriers’ Association) protested this plan and identified threats to the health and safety of their shipboard personnel, as well as economic impacts that could shutdown the U.S. Great Lakes shipping industry. As a result, in September 1993 the U.S. Coast Guard put into effect “an interim enforcement policy designed to provide a reasonable balance between the need to protect the environment of the lakes against any possible harm while taking account of the need for safe (and continued) operation of commercial bulk carriers” (parenthetical note added by D. Reid).

While implementing the interim policy, which allows the shippers to continue their cargo sweeping operations (with restrictions) on the Great Lakes, the Coast Guard also identified the need to produce a final regulation, and they also recognized that it should be based on sound scientific information and analysis. There was, therefore, a somewhat urgent need to involve the scientific community to develop better scientific information and understanding about the possible environmental effects of cargo residues. The first step occurred when the Coast Guard Ninth District asked the National Oceanic and Atmospheric Administration’s Great Lakes Environmental Research Laboratory (NOAA/GLERL) in Ann Arbor, Michigan, to form an *ad hoc* Scientific Steering Committee to review what information was available and advise them on the environmental implications and effectiveness of their interim regulations. A second goal was to convene a scientific workshop to identify information and research needed to understand and evaluate the environmental implications of cargo sweeping. The Steering Committee Report was submitted in August 1994, a month prior to this workshop (Reid *et al*., 1994), and is attached herein as Appendix VI.

## II. Workshop Goals

The workshop was designed to bring together members of the scientific, shipping, and Coast Guard communities to share information and discuss the environmental implications of cargo sweeping in the Laurentian Great Lakes.

The specific goals of the workshop were to identify:

1. what are the scientific questions that must be answered in order to have a sound scientific basis for final U.S. Coast Guard cargo sweeping regulations, and

2. how do we obtain the information needed to answer those questions?

## III. Workshop Organization

The workshop was organized around an opening half-day session during which information about cargo sweeping, ranging from what, why, and how, to legislative and regulatory considerations, were presented. After receiving a charge from the workshop organizers, the attendees broke into three different work groups:

Risk to Fisheries & Habitat
Leader: J. Gannon (National Biological Survey, now the USGS, Biological Resources Division)
Sediment Accumulation & Toxicity
Leader: P. Landrum (NOAA/GLERL)
Water Column Impacts
Leader: G. Stoermer (University of Michigan)

Each group met for the rest of the afternoon and next morning to identify what we already know and what gaps there are in our knowledge and understanding related to cargo, what further information or studies are needed, and how best to obtain the requisite information, such as:

- chemical analyses of specific commodities (for what)?
- literature searches?
- laboratory experiments?
- field work?
- all of or a combination of the above?
- other activities?

Appendix I is the agenda from the workshop, Appendix II is a list of attendees, and Appendix III is the suggested strategy and report outline proposed for the breakout groups.

## IV. Background Materials

The following documents provided background information and were handed out at the workshop (see "References", below):

Martec Ltd., 1984.
Hamburg Maritime Research, 1988.
Melville Shipping Ltd., 1993.
Reid *et al*., 1994.

In addition, a subsequent publication, Reeves and Perry (1995) provides a good overview of the historical and regulatory aspects of this issue.

## V. References

Hamburg Maritime Research Institute (Institut an der Fachhochschule Hamburg), *Marine Pollution Due to the Transport of Solid Bulk Cargoes by Ships,* Jacobi, H., H.-J Golchert, L. Ivens, and J.C. Riedel-Lorjè, a report commissioned by the Federal Environmental Agency, February 1988.

Martec Ltd., *An Assessment of Dry Granular Bulk Cargo Losses at Loading and Unloading Ports,* (a report to Environment Canada, Hull, Quebec), December 1984.

Melville Shipping Ltd., *Review and Investigation of Procedures Governing the Discharge of Non-Regulated*

*Cargo Residues from Ships into the Great Lakes.* SSC File No. 014SS.T8080-2-6861/B (a report to the Canadian Coast Guard - Ship Safety, Ottawa, Ontario), December 1993.

Reid, D.F., P. Landrum, G. Meadows, J. Gannon, and E. Stoermer. *Review of U.S. Coast Guard Interim Enforcement Policy*, Report of the Cargo Sweeping Scientific Steering Committee, NOAA/Great Lakes Environmental Research Laboratory, Contribution #. (See Appendix VI of this Workshop Report) (1994).

Reeves, E. and L. Perry. *Marpol V and Cargo Residues in the Great Lakes*. Update of a presentation to the Great Lakes and Great Rivers Section of the Society of Naval Architects and Marine Engineers Conference in St. Catherines, Ontario, Canada, on May 6, 1994. U.S. Coast Guard, Ninth District, Port Safety and Environmental Protection Branch, Cleveland, OH (1995).

## B. REPORT OF THE RISK TO FISHERIES AND HABITAT WORK GROUP

### VI. Introduction

The group's charge was to assess the risks posed by cargo residue discharges (deck sweeping/hosing and tunnel pumping) from lake carriers to fishery resources and their habitats in the Great Lakes. Our approach was to define the types of nearshore aquatic habitats which could be damaged by these practices. We identified four types of habitat: plant bed, mud/silt, sand, rocky shoals. Then, by reference to a diagram of a typical Great Lakes harbor and nearshore area, we identified, by number, six potential risks posed by the discharge of commodities listed in Reid *et. al*., 1994 to fish and other aquatic life that live in those habitats (Table 1). These risks are summarized in a habitat:commodity matrix (Table 2).

Table 1. Risks posed by cargo discharges (by sweeping and tunnel pumping) from lake carriers to fishery resources and their habitats in the Great Lakes.

1. Smothering and suffocation
2. Osmotic stress
3. Toxicity
   a. acute
   b. chronic
4. Nutrient enrichment
   a. Enhanced productivity
   b. Over-enrichment and algal blooms
5. Change in bottom substrate composition
   a. Physical - from deposition of commodity
   b. Biological - e.g. enhanced algal growth
   c. Habitat creation
6. Filling of interstitial spaces in bottom substrate
7. Esthetics
   a. Commodity visible on shoreline and beaches

Subsequent discussions produced a list of 25 scientific issues, information gaps, and needed scientific studies. Each was prioritized based on its relevancy to the recommended interim policy, and whether it could be obtained through (1) review of existing literature and data, (2) laboratory studies, or (3) field studies. In addition, the group critiqued the interim policy recommended in the steering committee's report.

Table 2. Habitat: commodity matrix showing suspected ecological impacts of commodity discharges, including those impacts of greatest importance. Numbers refer to risks identified in Table 1.

| Habitat | Plant bed | Mud-silt | Sand | Rocky Shoals |
|---|---|---|---|---|
| Commodities | | | | |
| Iron ore | 1, 3 | 1, 3? | 0 | 1,6 |
| Coal-coke | 5b, 3, 1 | 3, 1, 5b | 3, 1, 6 | 3, 1, 6 |
| Limestone | 1? | 5a, 5c | 5c, 6<br>Site dependent | 5c, 6 |
| Gypsum | 0? | 1? | 0 | 1? |
| Cement | No sweepings or deck washing (not released into lakes) | | | |
| Potash | 4a | 4a | 4a | 4a |
| Fertilizer | 4a | 4a | 4a | 4a |
| Urea-SD | Minor | Minor | Minor | Minor |
| Grain | 4a | Minor - fine dust | | |
| Float dust | 2? | 2? | 2? | 2? |
| Salt | 3? | 3? | 3? | 3? |
| Wood-pulp | ? | ? | ? | ? |
| Lake Michigan Foundry Sand | 0? | 1? | 0 | 1, 6<br>Minor |
| Other Millscale | 3? | 1, 3 | 1, 3 | |
| Slag | 3? | 1, 3 | 1, 3 | 1, 6 |

## VII. Work Group Participants

| | |
|---|---|
| John Clark | International Joint Commission |
| Mark Coscarelli | Michigan Dept. of Natural Resources |
| Michelle Dallafior | Office of Senator John Glenn (Ohio) |
| Thomas Edsall | National Biological Survey (*now U.S. Geological Survey, Biological Resources Division*) |
| John Gannon | National Biological Survey (*now U.S. Geological Survey, Biological Resources Division; Group Leader*) |
| Anjanette Hintz | U.S. Fish and Wildlife Service |
| David Jude | University of Michigan |
| Joseph Leach | Ontario Ministry of Natural Resources |
| Douglas Lee | University of Connecticut |
| Bruce Manny | National Biological Survey (*now U.S. Geological Survey, Biological Resources Division; Reporter*) |
| Thomas Morris | Canadian Coast Guard |
| Laurie Perry | U.S. Coast Guard |
| George Ryan | Lake Carriers' Association |
| David Van Bunt | Lake Carriers' Association |
| Katherine Weathers | U.S. Coast Guard |

## VIII. Commodities

The only information provided to the group about commodities was that in the review of the interim policy by the Scientific Steering Committee. The group chose to first evaluate those commodities carried in largest quantity, then the others.

The potential environmental impacts of greatest concern to the group were smothering and suffocation, toxicity, and filling-in of interstitial spaces by discharges of taconite pellets/iron ore and coal-coke. It is believed that discharges of coal have the potential to cause reduced algal growth on the bottom. Discharges of finely-divided limestone have the potential to fill interstitial spaces in coarse and rocky-substrate habitat types, thereby reducing local biological productivity.

Conversely, discharges of limestone chunks have the potential to create habitat with interstitial spaces that could result in increased local biological productivity.

Representatives from the Lake Carriers' Association provided the following general information:

- most iron (90%) is carried as taconite pellets, not raw ore;
- cement is transported without residues, because it is handled in a vacuum line aboard specially-equipped vessels;
- the quantity of wood chips or pulp shipped aboard lake carriers is very small and may be zero;
- only a few shipments per year of urea move through the lakes on foreign vessels -- nearly all "fertilizer" shipped on lake carriers is potash.

1. What Do we Already Know?

   (a) The Interim Policy states that the only washdowns permitted in harbors are following loading or unloading limestone; residues of other cargoes must be discharged outside of harbors.

   (b) Dr. Peter Chapman reported that impurities in coal, such as PAHs (polycyclic aromatic hydrocarbons) and selenium, and in taconite, such as chromium, leach out only slowly in the normal pH of water in the Great Lakes (7-9). But, under acidic conditions that often prevail in soft (mud/silt) bottom sediments in the lakes such impurities would leach out more quickly. According to Dr. Bruce Brownawell, PAHs in coal are not bioavailable. Yet PAH levels around coal deposits on the bottom of the ocean often exceed sediment quality criteria.

   (c) Sand carried by lake carriers is mined on land from dunes near Ludington and Freeport, MI.

   (d) Gypsum is shipped from only two ports, both in Michigan -- Alabaster and Port Gypsum, and is used almost exclusively for production of drywall board.

   (e) Foreign, saltwater ships bring in steel and take grain, wood chips, and a little fertilizer out of the Great Lakes.

   (f) Urea is carried about twice per year on the Great Lakes by saltwater vessels.

   (g) Potash is shipped about five times per month aboard lake carriers.

   (h) Grain loading is tightly controlled and produces little cargo residue, just "fugitive" hulls and dust. Grain is not pumped from the tunnel of lake carriers before loading the next commodity.

   (i) No U.S. carriers transport wood chips.

(j) MiIlscale, a by-product of steel making, is ground to small diameter and taken to Gary, Indiana to extract remaining iron.

(k) It was also noted that rainbow trout fingerlings are routinely raised to edible size in iron ore mines in Minnesota, which suggests that iron ore and anything leachable from it into water are probably not toxic to trout.

2. Potential to Cause Environmental Damage

About 60 U.S. and 60 Canadian vessels carry 165 million tons of dry cargo during about 15,000 transits per year in and out of about 80 ports on the Great Lakes. A conservative estimate of the magnitude of the total impact assumes that 3/4ths of those transits each generates an average of 500 lbs. of cargo sweepings. The annual loading of cargo sweepings to the Great Lakes would then be 2,812 short tons. Unfortunately, an adequate environmental damage assessment awaits full knowledge of toxic substances, if any, in the various commodities, and exactly when, where, and how they are discharged. George Ryan of the Lake Carriers' Association reported that the amount of cargo residue discharge has recently been reduced by about 50% aboard vessels in the fleet by good housekeeping measures.  An estimated 5% of some cargoes is lost in port as "fugitive" dust during loading.

3. Issues and Information Gaps

A number of issues, information gaps, and scientific studies were considered and ranked by the Fisheries and Habitat Work Group.  The following were considered to be priority topics for further investigation and study:

(a) **Issue: Toxicity**

(1) Do commodities contain toxic impurities and if so, at what concentration, especially, taconite, coal, gypsum, rock salt, slag and millscale? Do contaminants leach out of taconite pellets in acidic, mud/silt lake sediments?

(2) Is the anti-caking agent (sodium hexacyanoferrate(II) in rock salt toxic to aquatic organisms?

(3) Are polycyclic aromatic hydrocarbons (PAHs) in coal toxic to aquatic organisms?

(4) Can lumps of coal be colonized by aquatic plants and animals? Is coal dust toxic to aquatic macro-phytic plants?

The best approach would be to perform exposure, bioassay studies in natural lake water to determine the toxicity of each suspected commodity impurity. Test organisms would include those sensitive to foreign substances and characteristic of the four main Great Lakes habitats:

| **Habitat** | **Test Organism** |
|---|---|
| mud-silt | burrowing mayflies |
| sand | scuds |
| rock | lake trout eggs and fry |
| plant beds | eggs and fry of yellow perch and northern pike, snails |

The criteria for "toxicity" would be the concentration lethal to 50% of the test organisms during a 4-day, bioassay exposure (96-hr LC 50).

(b) **Issue: Water Column Effects**

1) Do fish larvae feed on finely divided commodity discharges; are fish larvae in the water column harmed by eating fine particles of any commodity? For example, do fish larvae that concentrate near the water surface, such as whitefish, eat coal or iron ore dust? If so, how much dust can they eat before exhibiting chronic or acute effects?

2) Are fish eggs in the water column harmed by exposure to commodity discharges? For example, are floating eggs of freshwater drum or eggs of yellow perch and northern pike attached to vegetation adversely affected by exposure to coal or iron ore dust?

c) **Issue: Smothering**

1) Do any of the commodities cause a reduction in the dissolved oxygen needed by aquatic life?

2) In finely divided form, does any commodity create a biological oxygen demand in the water column or on the lake bottom?

3) Do small particles in commodity discharges onto rocky habitat physically clog interstitial spaces and bury fish eggs incubating there?

4) In the water column, how much of each commodity is required to lower the dissolved oxygen level to 5 milligrams per liter (5 ppm), the minimum concentration for good fish populations and aquatic life in fresh water (U.S. EPA, 1977. Quality criteria for water. Office of Water and Hazardous Materials, U.S. Environmental Protection Agency. Washington, D.C. 256 pp.)?

(5) On the lake bottom, in each of the habitat types, how much of each commodity is required to lower the dissolved oxygen level to 1 milligram per liter (1 ppm), the minimum concentration for survival by desirable, benthic invertebrates that are indicators of good environmental quality?

(d) **Issue: Natural Variability**

Can an impact from cargo discharges on benthic plant and animal communities be distinguished from natural temporal and spatial variability in such communities?

The best approach would be to review the variability of long-term, Great Lakes data sets on benthic plant and animal communities including both the published and “gray” literature. This information could be summarized by habitat type.

(e) **Information Gaps**

(1) How are commodities distributed over the lake bottom along shipping lanes used historically for cargo sweeping?

(2) Do zebra mussels colonize coal, limestone, and other hard commodities discharged onto the lake bottom? Are such discharges creating habitat for such nuisance organisms where it did not exist before cargo sweeping began?

(3) Is water depth more important than distance from shore? What criteria define an “adequate” water depth for discharge of each commodity? Why discharge 12 miles out from shore when “adequate” depth exists 2-3 miles from shore?

(4) Are variances to the 12-mile rule (see Interim Regulations) warranted in some areas or with some cargoes? Criteria that should be included are (1) water depth, (2) lake bottom type, (3) biological

activity, and (4) type of commodity. The best approach would be to identify a committee of scientists to establish defensible scientific criteria for cargo discharges within the 12 mile rule of the Interim Enforcement Policy and to evaluate port and commodity combinations that are of special concern to the Coast Guard and Lake Carriers' Association.

(5) What is the aerial extent of cargo discharge impacts? What percentage of each lake bottom is presently affected by cargo discharges? Needed from the Lake Carriers' Association are maps showing where ships have traditionally discharged cargo sweepings. Ideally, the maps would show (1) portions of ship tracks preferred for such discharges, (2) portions of tracks used for continued sweeping, (3) what commodities have been discharged on each track, and (4) how many years each commodity has been discharged on each track. George Ryan agreed to prepare such maps and provide them to the U.S. Coast Guard.

(6) Flushing of residues from cargo holds, conveyor tunnels, and self-unloader booms appears to result in much larger commodity discharges than deck sweepings (i.e., discharge of cargo residues by hosing-off the deck with water). More accurate estimates of the amount of each commodity that is flushed out under the worst of conditions are needed.

4. Other Issues and Information Gaps

The following questions were also considered the Fisheries and Habitat Work Group, but were given lower priority:

(a) Do acidic conditions in lake sediments leach toxic substances from discharged commodities?

(b) Do coal discharges adsorb PAHs from the Great Lakes environment and benefit habitat quality on the lake bottom?

(c) Can any of the coarse-grained commodities, especially limestone chunks, provide a healthy suitable habitat for desirable aquatic life, e.g., perhaps limestone chunks being deposited in existing sandy or rocky areas diversify the habitat? How much of each commodity in coarse, large-diameter form can be safely discharged onto rock bottom areas?

(d) How much of each commodity in finely divided form can be safely discharged onto mud, silt, and sand habitats without lowering dissolved oxygen or burying desirable benthic animals?

(e) Would wrecked (sunken) ships loaded with commodities of interest be good field sites for evaluation of the environmental effects on benthic plant and animal communities?

(f) At what rate do small particles of each commodity settle in lake water?

## IX. Recommended Approaches

1. Need chemical analyses of specific commodities.

2. Conduct literature searches on the following topics:

(a) How pure is each commodity? What data exist on possible toxic impurities in each commodity?

(b) Search mining literature for acidity and toxic substances, such as selenium and PAHs, that can leach from coal.

(c) Are there data concerning whether or not finely divided coal adsorbs contaminants, such as selenium and PAHs, from the water column or interstitial water?

3. Laboratory experiments

(a) Conduct toxicity (96-hr LC 50) bioassays of each commodity using standard organisms (midge larvae, oligochaete worms, fathead minnows) and protocols recommended by the American Society for Testing of Materials (ASTM).

(b) Determine the biological oxygen demand per unit weight of each commodity in finely divided form on representative sediments from each of the four example habitat types.

4. Field work

(a) Investigate whether sensitive, sessile benthic animals inhabit areas along shipping lane segments used historically and during the Interim Policy to discharge cargo residues. For example, do burrowing mayflies inhabit sediments along outbound shipping lanes from the ports of Detroit and Toledo in western Lake Erie? What animals and plants live on the lake bottom in and along shipping lanes out of Port Huron in southern Lake Huron? What fisheries habitats are traversed by such segments?

(b) Conduct "worst case studies" on the benthic community in sediments of:
   1. Duluth Harbor where up to 2 feet of taconite pellets cover the bottom;
   2. surrounding major historical shipwrecks which contained large amounts of specific commodities as cargo.

(c) Field bioassays could be developed based on caged organisms, sediment traps, and measures of BOD at the sediment water interface and within interstitial spaces.

**X. Other Considerations**

The Fisheries and Habitat Group reviewed and discussed the Interim Enforcement Policy covered in the report by the Ad Hoc Scientific Steering Committee (Reid *et al.*, 1994). The group endorsed the rule that no cargo sweeping take place in connecting channels and in Lake St. Clair (already a long-standing practice of the Lake Carriers' Association members). However, the wisdom of permitting cargo sweeping in areas other than those used historically for sweeping was questioned, but the Group could not reach a consensus opinion.

The group addressed several specific requests from the Lake Carriers' Association which are not met by the interim policy, including:

1. A washing zone in western Lake Erie -- vessels unloading limestone in the Port of Detroit need to pump stone from their tunnels before taking on coal in Toledo Harbor. Under the Interim Policy they pump out their tunnels as they circle offshore in the western basin. After discussion, the group decided to recommend that such carriers pump the stone out in the shipping channel leading from the deep (36-foot) hole to Maumee Bay. This practice would concentrate the cargo sweepings in one approved stretch of the channel that is dredged periodically. Any commodities discharged in this stretch that are later found to be toxic can be removed to a confined disposal facility.

2. Variances to the 6- and 12-mile rule in northwestern Lake Superior, northeastern Lake Michigan, and southwestern Lake Huron.

3. A variance to the 12-mile rule in central Lake Huron around the Yankee Reef fish spawning area.

The group's recommendations on each of these needs were summarized by Dr. John Gannon (Group Chair) in a letter to Cdr. M. Eric Reeves dated October 7, 1994 (Appendix IV).

## XI. Conclusions

1. Residues of cement, grain, coarse limestone, and wood pulp or chips on/in vessels will likely cause no-to-minor environmental damage or negative impacts on plants and animals in the Great Lakes.

2. Residues of taconite pellets and finely divided limestone, coal, sand, and possibly slag may adversely alter coarse and rocky-substrate habitat by filling interstitial spaces.

3. Specific research is needed to determine if exposure to iron ore, taconite pellets, coal, coke, rock salt, millscale, and slag causes any measurable toxic effects in Great Lakes plants and animals.

## XII. Recommendations

1. A group of Great Lakes scientists should be formed to advise the Coast Guard and Lake Carriers' Association on specific areas or sensitive fisheries habitats that may be at risk from cargo sweeping, on a case by case basis.

2. Specific research to evaluate the environmental implications of cargo residues should be conducted to provide a scientific basis for decisions.

3. Consideration should be given to permitting cargo sweeping on the same areas used historically for that purpose until there is a scientific basis for changing that practice.

## C. REPORT OF THE SEDIMENT ACCUMULATION AND TOXICITY WORK GROUP

### XIII. Introduction

The work group was charged to address the potential effects of cargo residues that reach and accumulate in soft-bottom sediments. Specifically, the work group formulated scientific questions required to address the potential effects of cargo residues and identified approaches required to answer the most important questions.

### XIV. Work Group Participants

| | |
|---|---|
| Dale Baker | Minnesota Sea Grant Extension |
| Neely Bostick | U.S. Geological Survey |
| Bruce Brownawell | SUNY at Stony Brook |
| Allen Burton | Wright State University |
| Peter Chapman | EVS Environmental Consultants |
| Lorraine Filipek | U.S. Geological Survey |
| Susan Fisher | Ohio State University |
| Chris Ingersoll | National Biological Survey (*now U.S. Geological Survey, Biological Resources Division*) |
| Peter Landrum | NOAA/GLERL (*Group Leader*) |
| Michael Lewis | Geological Survey of Canada |
| Michael Lydy | U.S. Geological Survey (*Reporter*) |
| Dora Passino-Reader | National Biological Survey (*now U.S. Geological Survey, Biological Resources Division*) |
| Susan Tewalt | U.S. Geological Survey |
| Eric Reeves | U.S. Coast Guard |
| Steven Thorp | Great Lakes Commission |
| Christopher Wiley | Canadian Coast Guard - Ship Safety |

### XV. Questions

The work group began with a discussion of the commodities, but because of minimal information about composition of the commodities of interest, their composition, and the bioavailability of toxic components in these commodities when they are deposited in sediments, a different approach was taken. This new approach formulated a list of important questions to address the charge of the Work Group. The questions below were thought to be important to determine the potential impacts of cargo residues on sediment-dwelling organisms. The first question was the most important; however, the first three questions are the most critical to address.

1. Does cargo sweeping adversely affect bottom sediments or the biota that reside in or near this sediment?

2. What are the chemical compositions of the cargo commodities?

3. Are the deposited materials in the sediment from cargo sweeping activities toxic or bioaccumulated by benthic organisms?

4. Is deposition of cargo residues changing the physical structure of the bottom sediments, e.g., increasing the amount of hard substrate, therefore changing the habitat for the benthos?

5. How do cargo sweeping activities relate and compare to other discharges of similar or the same compounds into the Great Lakes?

### XVI. Approach

In order to obtain the data to answer the questions, the Work Group outlined a two-tiered approach for conducting an assessment:

1. Tier I: Assessing the Toxicity and Bioaccumulation of Cargo-Residue-Associated Contaminants to Benthic Communities.

   (a) **Background:** The objective of the Tier I studies is to determine the potential for toxicity and bioaccumulation of chemical contaminants associated with the deposition of cargo residues in soft-bottom sediments in at least three locations the Great Lakes.

   In the aquatic environment, most anthropogenic chemicals and waste materials, including both toxic organic and inorganic chemicals, eventually accumulate in sediment. Sediment provides habitat for many aquatic organisms and contaminants in sediments may be directly toxic to aquatic life or can be a source of contaminants for bioaccumulation into the food chain. Concentrations of contaminants in sediment may be several orders of magnitude higher than in the overlying water; however, bulk sediment concentrations have not been strongly correlated to bioavailability.

   Partitioning or sorption of a compound between water and sediment may depend on many factors including: the contaminant's aqueous solubility, pH, redox, affinity for sediment organic carbon and dissolved organic carbon, grain size of the sediment, sediment mineral constituents (oxides of iron, manganese, and aluminum), and the quantity of acid-volatile sulfides in sediment. Although certain chemicals are highly sorbed to sediment, these compounds still may be available to the biota. Contaminants in sediments may be directly toxic to aquatic life or can be a source of contaminants for bioaccumulation into the food chain.

   The Tier I assessment will provide data to (1) determine whether contaminants in cargo residues are harmful to or are bioaccumulated by benthic organisms, (2) identify spatial and temporal distribution of contamination within the track lines and in the surrounding areas, (3) determine the relationship between benthic community structure as a measure of toxic effects and bioaccumulation, and (4) investigate interactions among contaminants.

   Assessments of benthic communities have been used to measure interactive toxic effects of complex contaminant mixtures in sediment. A knowledge of specific pathways of interactions among sediments and test organisms is not necessary in order to conduct the assessment; however, data generated in Tier II described below are necessary to establish cause-and-effect relationships.

   Field surveys can provide either a qualitative reconnaissance of the distribution of sediment contamination or a quantitative statistical comparison of contamination among sites. Surveys of benthic communities are usually part of more comprehensive analyses of biological, chemical, geological, and hydrographic data (see Tier II below). Statistical correlations may be improved and sampling costs may be reduced if subsamples are taken simultaneously for sediment toxicity tests, chemical analyses, and benthic community structure.

   The null hypothesis for the Tier I studies is as follows: benthic communities inhabiting shipping tracts are not impacted by the deposition of cargo residues on soft-bottom sediments. If results from the Tier I studies nullify this hypothesis (e.g., impacts are observed), Tier II studies are required to determine cause-effect relationships and factors controlling the bioavailability of contaminants associated with cargo residues deposited on soft-bottom sediments. A tiered-testing strategy includes a hierarchy of studies with the studies in each successive tier becoming progressively more rigorous, complex, informative, and costly.

   (b) **Methods:** The Tier I assessment should be conducted at a minimum of three locations in the Great Lakes where historic releases of cargo residues have been deposited on soft-bottom sediments. The steps to be taken at each of the three locations are:

(1) identify track lines by use of charts and personal communications,

(2) use sonar sweeps to locate footprints of deposited cargo residues within a track line,

(3) design sampling plan for benthic community and sediment analyses,

(4) collect sediments from stations within a trackline and from the surrounding reference areas,

(5) split the sediment sample into a subsample for benthos and a subsample for sediment analyses,

(6) sieve the benthos subsample to: (a) isolate and preserve benthos for taxonomy and bioaccumulation measures, and (b) qualitatively identify the presence of cargo residues,

(7) process the sediment analysis subsample for physical and chemical characterizations, and

(8) sort benthos subsamples for taxonomic identifications and residue analyses. Steps 4 through 7 would be performed on the ship at the sampling location.

Appendix V contains the Work Groups' recommended methods for each of these eight steps.

2. Tier II: Assessing Cause-and-Effect Relationships and Factors Controlling the Bioavailability of Contaminants-Associated with Cargo Residues.

(a) **Background:** Tier II studies would address questions that may arise or remain after completion of Tier I studies, investigate cause-effect relationships for potential contaminant-related effects found in Tier I, and address additional issues that overlap with other work groups. The Work Group did not discuss these approaches in detail, but suggested studies that would contribute to an improved understanding of the questions. The types of studies listed below are not in any specific order and their relative priority would need to be established after the Tier I studies are complete.

Although a variety of approaches could be used to make site-specific decisions, no one single approach can adequately address sediment quality. Overall, an integration of several methods using the weight of evidence is the most desirable approach for assessing the effects of contaminants associated with sediment. Hazard evaluations integrating data from laboratory exposures, chemical analyses, and benthic community assessments (the Sediment Quality Triad) provide strong complementary evidence of the degree of pollution-induced degradation in aquatic communities.

Additional information is needed to identify the specific contaminants that are actually responsible for the observed/measured toxicity. Confirmation of sediment toxicity or the interactive effects of sediment toxicants can be determined using laboratory toxicity tests with field-collected sediments, toxicity identification evaluations (TIEs), or by conducting toxicity tests with chemicals spiked into sediments. Once the probable cause(s) of sediment toxicity has been identified, better decisions can be made regarding options for disposal of specific cargo residues.

The advantages of the Tier II studies include an improved definition of cause-effect relationships, the demonstration of the important processes leading to the effects, and the establishment of pathways and processes leading to a larger ecosystem perspective. Tier II studies could address a wider range of variables than will be addressed under Tier I. Thus, these studies may identify conditions that are unusual or outside the range of the Tier I design. The Tier II studies are very specific studies and will require substantial resources to completely identify issues and will need to be field verified to assure that the findings under controlled conditions actually represent the conditions in the field.

(b) **Laboratory Bioaccumulation Testing:** This testing can be performed with field-collected material or with product mixed into sediment under specified conditions. This testing will directly define the source of material and, in the case of mixed product, would address the issue of potential immediate bioavailability that might be changed with age. The method would provide very strong exposure data and provide a direct measure of constituent bioavailability. Such studies could readily be performed with the Great Lakes amphipod, *Diporeia*, because there is ample literature on methodology (See Suggested Readings).

(c) **Toxicity Testing:** Tests could be performed with either field-collected material or with product added to sediment. This would be an excellent approach to confirm whether benthic community effects observed in the field were due to habitat alteration or to toxic responses. Further, the addition of product to sediment would permit the addition of fresh material for toxicity under a worst case condition. Methods exist for measuring mortality responses as well as growth effects of sediment-associated contaminants. Such testing would be conducted with the organisms designated by U.S. EPA for freshwater toxicity testing or with a variety of organisms that have been identified as useful sediment test organisms by the American Society for Testing and Materials (see list of suggested readings).

(d) **Leaching Studies:** These studies could be used to determine the amount of material that would be available to the ecosystem through the water. It would tend to indicate the amount of bioavailable material for a given product.

(e) **Measures of Porewater Concentrations:** These measures provide the information on the release of toxic constituents after modification due to changes in chemistry that occur in the sediment. Such measures can give good indications of the extent of long-term bioavailability. These porewater samples should be obtained from cores rather than grab samples, because the porewater obtained from grabs may not be representative of porewater in intact sediment cores.

(f) **Expanded Chemical Characterization of Sediment:** The chemistry under Tier I focuses on only a few constituents and sediment characteristics that may drive the bioavailability of product constituents. The Tier II chemistry would be expanded to better define the chemical conditions in the system and provide a better estimate of the conditions that are important for affecting the bioavailability. These chemistry measures would also provide better spatial resolution of cargo residues within sediment habitats.

(g) **Variables:** The impact of multiple variables may effect the conditions under which effects are observed. Variables such as depth, sediment composition and particle size, product composition and particle size, and duration of deposition may modify the tests and measures described above under Tier II and alter the biota response to cargo residue exposure. Thus, to fully understand cause and effect under a second tier of studies, the above studies would need to be conducted under a wide range of conditions for each of the products of importance.

3. Other Considerations

(a) Evaluation of porewater metal concentrations was suggested to have some importance for both sediment exposures and for determining the flux of material to the overlying water over long time periods. Leaching of metals into porewater and subsequent exchange into overlying water could result in exposure to epibenthic and pelagic organisms.

(b) The number of tracks that need to be investigated for a Tier I study was not completely agreed upon. It is clear that there are three general environmental types within the lakes that should be considered -- upper lakes (upper Lake Michigan, Lake Huron, Lake Superior), the lower lakes (Lower Lake Michigan, eastern Lake Erie, Lake Ontario) and the western basin of Lake Erie. It is not clear whether tracks containing the major commodities -- iron ore, coal, and limestone - would need to be investigated separately and in mixture, or whether just considering tracks with mixtures would be sufficient. However, there is some thought that tracks containing these commodities in mixture would have areas that are dominated by one form or another, so the signals may well be separated. The final recommendation is to look at the tracks emanating from three ports containing steel producing facilities - one in lower Lake Michigan, one in Lake Superior and one in western Lake Erie. This approach is thought to be adequate to address the question of impact.

(c) There was considerable discussion on the number of transects and, therefore, samples that would be required to address the question of impacts. This discussion was not resolved by the Work Group, but there appears to be sufficient literature that could provide a design committee with the appropriate information on the variability that would be expected.

(d) Shipwrecks were identified as additional sources of known time-of-product-introduction to sediments. These wrecks are thought to be good supplementary sites for studies where only one cargo would be present and the potential impact could be investigated. Further, the duration of submersion would be known and the impact of this duration could be investigated.

(e) Changes in the substrate are expected to result in alteration of habitat that could result in changes to the benthic community, although not being directly toxic. Increased hard substrate can decrease numbers of organisms which prefer soft-bottom sediments, while possibly providing zebra mussels with a substrate to colonize. These effects may need to be sorted out under Tier II.

(f) Another potential modification of the system is the change in discharge location as a result of the Interim Regulations. In some locations within the lakes the residue discharges are now occurring over new substrate. This provides areas to study the impact of new discharges, old discharges and a mixture, depending on location.

(g) The funds available for studies are often limited. It is clear that with unlimited funds, studies under both Tier I and Tier II would be useful for addressing these issues. However, the Work Group thought that a rough approximation of the costs for Tier I would be useful (Table 3). In this estimate, there was no consideration of overhead, the costs for data analysis, or report generation. However a minimal cost for a QA/QC program was included. Additionally, the costs for the sonar work to map 400 $km^2$ would be on the order of $500,000. Some reduction of these mapping related costs could probable be attained by using U.S. Coast Guard Vessels for some of the operations.

(h) There was a suggestion that the experimental design for Tier I be reviewed by a scientific steering committee. This committee should not only develop an initial design, but should oversee a review of the data and interpretation of results from the studies. Such an independent committee could provide an independent scientific oversight.

## XVII. Recommendations

Little information was available at this workshop on the chemical composition of the dry cargoes being transported across the Great Lakes. However, the Work Group felt that assembling this information would be extremely helpful in the design of experiments and field studies. This information would also provide a foundation for simple loading calculations to determine the potential signal against baseline that would need to be examined.

A literature survey of the benthic community data relative to sediment composition and location of the shipping tracks is required to allow the best experimental design for the Tier I field studies. Data sets held by Dr. Trefor Reynoldson and Dr. Kristin Day from the Canada Centre for Inland Waters and other data sets found in the literature may provide an initial indication of the impacts or absence of impacts from deposition of cargo residues, as well as an indication of benthic community variability.

Table 3: Sample Collection and Analytical Costs (1994 dollars) for Tier I Studies at One Location

| Activity | Cost Per Sample | Cost per Location[1] |
|---|---|---|
| Collection & Shipment | $ 125 | $ 3,750 |
| Benthos Identification | $ 300 | $ 9,000 |
| Sediment Analyses | | |
| Physical Characterization | $ 100 | $ 3,000 |
| Chemical Analyses (metals, PAH, AVS, porewater metals) | $ 650 | $19,500 |
| Benthos Residue Analyses (metals and PAH) | $ 500 | $15,000 |
| **TOTAL:** | **$1,675** | **$50,250** |

[1] Assuming three samples per station and ten stations per location

## XVIII. Suggested Readings


American Society for Testing and Materials: Standard guide for collection, storage, characterization, and manipulation of sediment for toxicological testing, Philadelphia: ASTM E 1391-94. ASTM Annual Book of Standards Volume 11.04.

American Society for Testing and Materials: Standard Guide for conducting sediment toxicity tests with freshwater invertebrates, Philadelphia: ASTM E 1383-94. ASTM Annual Book of Standards Volume 11.04.

American Society for Testing and Materials: Standard guide for designing biological tests with sediments, Philadelphia, ASTM E 1525-94 . ASTM Annual Book of Standards Volume 11.04.

Chapman, P.M. Sediment quality criteria for the sediment quality triad-An example. *Environ. Toxicol. Chem.* 5:957-964 (1986).

International Joint Commission. Procedures for the assessment of contaminated sediment problems in the Great Lakes. Sediment Subcommittee and its Assessment Work Group to the Great Lakes Water Quality Board Report to the International Joint Commission, Dec. 1988.

Landrum, P.F., G.A. Harkey, and J Kukkonen. Evaluation of Organic Contaminant Exposure in Aquatic Organisms: The Significance of bioconcentration and Bioaccumulation. In. M.C. Newman and C. Jagoe, eds. *Quantitative Ecotoxicology: A Hierarchial Synthesis*, Lewis Publishers, Ann Arbor, (In Press).

Lee, H., B.L. Boese, J. Pelletier, M. Windsor, D.T. Specht, and R.C. Randall. Guidance Manual: Bedded Sediment Bioaccumulation Tests, Report No. 600/R-93/183, U. S. Environmental Protection Agency, Newport, OR (1993).

U.S. Environmental Protection Agency. Sediment classification methods compendium. EPA 823-R-92-006, Washington, DC (1992).

U.S. Environmental Protection Agency. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. EPA 600/R-94/024, Duluth, MN (1994).

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. Evaluation of dredged material proposed for discharge in inland and near coastal waters. Report number pending, Washington, DC (1994).

U.S. Environmental Protection Agency. ARCS Assessment Guidance Document, EPA-905-B94-002 Chicago, IL, 247 p. (1994).

## D. REPORT OF THE WATER COLUMN IMPACTS WORK GROUP

### XIX. Introduction

Cargo sweepings, as applied here, is a general term applied to materials discharged from Great Lakes dry bulk carriers during normal cargo handling operations. These materials consist of cargo residues, any additives which may be added to bulk cargoes to improve handling characteristics (e.g., anti-caking agents), small amounts of debris (e. g., paint chips) derived from the ship's deck and cargo holds, and small amounts of other materials such as lubricants, surfactants, and stack emissions associated with normal ship operations. These materials are introduced to waters of the Great Lakes by a number of processes including wind induced movement of fine materials and materials washed from decks by intent, rainfall, or waves. However, the greatest bulk of discharge is associated with deck washing and cargo tunnel cleaning. In either case, the initial contact between the commodity and the lake occurs in the water column. This is a somewhat arbitrary designation, but as used here it, "water column" includes that portion of the lake from the water's surface to immediately above, but not including the bottom sediments.

Because large particles of dense material settle rapidly and would be expected to be rapidly transported to the sediments this group focused on the potential environmental effects of the finer grained and readily dissolvable fractions of the commodities, and those light fractions which might either float of be entrained in the water column for relatively long (> 1 day) periods. Both short-term and long-term effects were considered. Although, we were primarily concerned with effects on the indigenous biota we also considered the aesthetic effects of floating materials, a subject which has not been adequately addressed (EVS Consultants 1994). In a general sense, we conclude that the likelihood of deleterious effects in the water column is small, but recognize that this conclusion is based more upon conjecture than upon established fact. Further research and demonstration is needed to provide a positive demonstration that cargo sweepings do not harm beneficial uses of Great Lakes waters and the biotic communities which inhabit the water column.

### XX. Work Group Participants

| | |
|---|---|
| Ellen McDonald | Ohio State University |
| Richard Harkins | Lake Carriers' Association |
| Barry Lesht | Argonne National Lab. (*Reporter*) |
| Andrew Prior | Melville Shipping Ltd. |
| Eugene Stoermer | University of Michigan (*Group Leader*) |
| James Whitaker | Chester Environmental |

### XXI. Assessment of Commodities

After initial discussion and analysis it is the consensus of the work group that short-term changes in local turbidity which may result from cargo sweeping events would be of little demonstrable environmental consequence within the water column. It is not so clear, however, that introduction into the water column of bulk commodities and of any materials used in treating those commodities would be similarly benign. Some additional concerns were expressed regarding possible effects on biotic communities growing proximal to the air-water interface and the sediment-water interface. We therefore evaluated the environmental effects of the several commodities identified by the Steering Committee in terms of their potential for both toxicological and water quality effects. Although the work group recognized that the amount of material entering the water as a result of any single cargo sweeping is likely to be small, the group chose to consider plausible worst-case conditions for a single event and potential or demonstrated cumulative effects. No substances were eliminated from analysis on the basis of conjecture. The evaluations of the individual commodities appear below. A summary of those evaluations appears in Table 4.

1. **Taconite and iron ore:** information presented at the workshop indicated that almost all iron ore is now carried in the form of pelletized taconite so these two categories were combined. Although sparingly soluble,

this material could introduce biologically effective quantities of certain elements into Great Lakes waters, particularly in oligotrophic regions. Of particular concern is the possibility of both toxicological and nutrient effects of trace metals contained in the taconite.

2. **Coal:** coal may have toxicological and water quality effects. Of further concern are soluble materials (e.g., glycol) that may be added to coal shipments to facilitate their handling.

3. **Coke**: coke is considered to be similar to coal for possible water column effects. Information presented to the group indicates that it is routinely shipped as bulk cargo on lakes.

4. **Limestone:** no toxic or water quality effects within the water column are attributed to limestone. It may effect benthic plant communities, but there is insufficient information to determine the possible importance or extent of such effects. Under certain conditions, fine particulate limestone may adversely affect neuston communities.

5. **Gypsum:** no toxicological or water quality effects are attributed to gypsum. It may effect benthic plant communities, but there is insufficient information to determine the possible importance or extent of such effects. Under certain conditions, fine particulate gypsum may adversely affect neuston communities.

6. **Cement:** no toxicological or water quality effects within the water column are attributed to cement. It may effect benthic plant communities, but there is insufficient information to determine the possible importance or extent of such effects. Under certain conditions, fine particulates from cement may adversely affect neuston communities. However, information presented at the workshop indicates that cement cargoes are handled with specialized equipment which minimizes residues.

7. **Potash:** potash may have both toxicological and water quality effects.

8. **Fertilizer:** fertilizer may have both toxicological and water quality effects. There is some question, however, about whether fertilizer is carried as a dry bulk cargo, particularly since this category is separated from potash, one common constituent of most fertilizers, in tonnage reports.

9. **Grain:** although grain itself is not considered to have toxicological effects, some question was raised about herbicides, pesticides, and other fumigants with which the grain may be treated before shipping. Such materials may be soluble and may have toxicological effects. Because grains are a bioavailable carbon source and are of low density, they may float and be colonized by biota indigenous to the surface layer. These biota may concentrate toxic materials also found in grain residues in the surface layer.

10. **Rock Salt:** salt entering the lake will dissolve and increase the local salinity. Both toxicological and water quality effects are possible. Materials used to treat the salt before shipping may also have toxicological and water quality effects.

11. **Sand and Gravel:** no toxicological or water quality effects are attributed to sand and gravel. They may effect benthic plant communities, but there is insufficient information to determine the possible importance or extent of such effects.

12. **Clay and refractories:** no toxicological or water quality effects were attributed to clay and refractories. They may effect benthic plant communities, but there is insufficient information to determine the possible importance or extent of such effects. Under certain conditions, fine particulates associated with these cargoes may adversely affect neuston communities.

13. **Wood pulp:** if wood pulp consists only of raw untreated wood chips, it would have a water quality effect

similar to grain, but no toxicological effect. Processed wood pulp, however, has a potential for toxicological effects due to chemical amendments during processing.

14. **Slag:** because slag is a result of smelting, it may concentrate trace impurities that could have toxicological and water quality effects.

15. **Mill scale:** because mill scale is a ferrous product, it may contain trace metals that could have toxicological and water quality effects.

After reviewing and summarizing the list of commodities, the group felt that several common issues were obvious. Rather than develop questions on a commodity-by-commodity basis, the group decided that a more general, methodological approach would be more productive. It is clear that completely satisfactory evaluations of the possible effects of cargo sweepings will demand further evaluation and research.

## XXII. Scientific Issues and Questions

The following four questions could be applied to all of the commodities that have been identified as having potential environmental effects in the Great Lakes water column.

(a) What dry bulk commodities are subject of cargo sweeping and how much is transported?

(b) What is the complete chemical composition of the discharged materials?

(c) What are the physical and transport properties of the discharge “plume” in the near field and far field.

(d) What are the toxicological and nutrient properties of the discharged materials.

Table 4: Potential for water column effects from dry bulk commodities shipped on the Great Lakes.

| Commodity | Toxic Effects | Water Quality Effects | Rank |
|---|---|---|---|
| Taconite/iron ore | ? | ? | 1 |
| Coal | ? | ? | 2 |
| Coke | ? | ? | 2 |
| Limestone | – | ? | 10 |
| Gypsum | – | ? | 10 |
| Potash | ? | ? | 4 |
| Fertilizer | ? | ? | 5 |
| Grain | – | ? | 6 |
| Rock Salt | ? | ? | 3 |
| Sand & Gravel | – | ? | 10 |
| Clay & Refractories | – | ? | 10 |
| Wood Pulp | ? | ? | 9 |
| Slag | ? | ? | 7 |
| Mill Scale | ? | ? | 8 |

Note: Materials for which the effects are suspected or unknown are indicated by a question mark. Materials that are known or strongly suspected to have no effect in the water column are indicated by a minus sign. The ranking indicates the preferred order of analysis based on the amount shipped and the potential for possible effect.

## 1. Issues

(a) **Cargo statistics.** There was some confusion during the workshop regarding exactly which bulk cargoes are carried and which were subject to cargo sweeping. On the basis of currently available statistics, it is not entirely clear which of the materials transported on the Great Lakes are handled as bulk cargo subject to cargo sweeping. There is also considerable concern regarding possible additions of noxious chemicals during the cargo handling processes, in the form of anti-caking agents, antifreeze, etc. We feel that, at a minimum, a thorough review of data and statistics by independent experts is necessary.

(b) **Composition of the cargo.** Such information is needed to prioritize research into the possible environmental effects. Much of this information is probably available from the literature, but it was not clear to the work group if trace constituents have been adequately analyzed for the various types of cargoes and their multiple sources represented in the Great Lakes trade. From the point of view of water column effects, emphasis should be place on determining the constituents of the materials that would have fairly long residence times in the water column (i.e., the fine size fractions) and on those portions that may dissolve. Bulk descriptive information (e.g., that found on Material Safety Data Sheets) will not be sufficient for evaluation of the specific environmental effects. On the other hand, it is possible that some studies have been done on the chemical composition major bulk commodities -— taconite and coal. Emphasis should be placed on determination of bioactive constituents. Any materials that are added to or used to treat the bulk cargo should be determined as well.

(c) **Physical characteristics of the discharge "plume."** Chemical and biological analyses should be considered in the context of the physical properties of the discharge (plume) in the near- and far-field. It will be important to determine the range of discharge quantities and to use these values in analysis of dispersal of materials in the water. Assuming a worst case, in which all of the material is deposited at once, physical models of dispersal can be developed that would place an upper bound on the concentrations of materials found in the water and on the dose experienced by the indigenous biota in the near-field. Information needed for these models would include the size and density distribution of the discharged materials. The model would be expected to simulate the concentration field, extent, and movement of the discharged material as a function of time. Presently available models may not be adequate to predict concentrations in the far-field, particularly for discharges containing a variety of particle sizes.

(d) **Environmental effects.** We need to determine the bioavailability, solubility, toxicity, and nutrient potential of the materials found in dry bulk cargoes. The emphasis of these studies should be on the overall effects of the materials actually entering the water on the species found in the waters of the Great Lakes. While some information on effects may be found from existing laboratory studies, especially for taconite and coal, further experiments using either field mesocosms or laboratory microcosms will be desirable.

## 2. Approach

The recommended approach has several elements and implied decision points. We feel that it also builds the basis for appropriate regulatory actions, up to and including convincing experimental demonstrations of minimal environmental damage.

Further review of actual bulk cargo transport may serve to eliminate some of the materials currently listed (e.g. Portland cement) from consideration and may possible highlight additional areas of potential concern. It is conceivable that thorough review may also reveal the presence of physical materials (e.g. asbestos) within dry bulk cargoes so potentially damaging to human health that more stringent regulation need be contemplated. In any case, confident knowledge of actual quantities of materials shipped and the fraction of these materials introduced to Great Lakes waters by cargo sweeping, is the first necessary element of a rational regulatory approach.

The next necessary element is quantitative knowledge of the range of concentrations of potentially bioactive materials in Great Lakes dry bulk cargoes. In this regard, it should be noted that concerns regarding materials entering the water column include:

(a) Potential chemical toxic effects.

(b) Potential chemical stimulatory effects.

(c) Potential physical effects.

(d) Synergistic effects.

Given the facts that some trace constituents may be biologically affective in picogram, or possible lower, quantities (Lin and Schelske, 1979) and that there exists very little experimental data concerning most potentially sensitive Great Lakes populations, due caution should exercised in assuming a no-harm condition on the basis of chemical analysis alone.

The limits of possible effects could more reasonably be estimated from a combination of accurate and precise knowledge of the quantities and chemical composition of materials introduced plus estimates of the dispersal of materials in the water column. The group felt that thoughtful exercise of existing models, or relatively simple modifications of existing models, would be capable of providing reasonable estimates. Further model development and testing may be necessary to satisfactorily treat with effects in the far field or effects of discharges which have a continuous range of particle sizes.

Realistically, however, it appears that confident evaluation of water column effects will be best and most economically accomplished by direct experiment. Assessment of potential effects from *a priori* information would demand detailed knowledge of the effects of several tens of chemical species on the several hundred biological species which occur in the water column of the Great Lakes. Most of the required information is currently lacking, and obtaining it would be a daunting undertaking, since accuracy of chemical measurements required approaches the current state of the art, there exists very limited physiological information on important biological populations, and many of these populations have not been successfully cultured.

### 3. Additional Concerns

One aspect of the potential effects of cargo sweepings that the work group found particularly frustrating were possible effects on biotic communities, particularly plant communities, which grow in the proximity of the surface. A very highly specialized and generally poorly known biotic community, the neuston (organisms that depend on and/or inhabit the surface film of a body of water), inhabits the air-water interface in most lakes. However, there does not appear to be much data concerning the neuston in the Great Lakes (Fuhs, 1982). It is known that nutrients and contaminants (Rice *et al.*, 1982, Armstrong and Elzerman, 1982) are concentrated in the surface micro-layer of the Great Lakes. The contribution of cargo sweepings to such surface concentrations is presently unknown.

Plant communities which grow attached to surfaces, but which project into the water column, are also a source of possible concern. During closing summations in the workshop it became apparent that these communities were not extensively considered by any of the break-out groups. Extensive and highly diverse algal and bryophyte communities are known to exist on various substrates on the bottoms of the Great Lakes to depths of ca. 40 m (Stoermer, 1981, Henson, 1984). Although incompletely known, such communities are apparently extremely diverse (Stoermer, 1975), inhabit a variety of substrate types (Kingston *et al.*, 1979, Stevenson and Stoermer, 1981, Edsall *et al.*, 1991) . Such communities may be particularly sensitive to particulate materials discharged to the water column because they could be subject to physical smothering, in addition to nutrient or toxic effects.

## 4. Recommendations

(a) It is clear that the first two elements discussed are generic to all aspects of the cargo sweepings question. This work group will not recommend specific methods or approaches, but will emphasize the need for independently verifiable statistics and analyses. We support a general recommendation that the Coast Guard compile and verify, or cause to be compiled and verified, the necessary statistical base on materials shipped, the detailed chemical composition of these materials, and the amounts of such materials discharged to waters of the Great Lakes due to cargo sweepings under normal and worst case conditions.

(b) It was the consensus of the group that the dispersal of materials from cargo sweepings, once introduced into the water column, was insufficiently known. We therefore recommend that the Coast Guard conduct, or cause to be conducted, modeling studies of the dispersal of particulate materials having the physical characteristics of the various types of cargo sweepings introduced into the Great Lakes. We also feel it highly desirable that these models be verified by appropriate field experiments.

(c) The work group considered the most important issue, potential harm, particularly difficult to resolve for the water column. The reasons for this are the very large number of potentially bioactive materials involved, the large number of species which could be affected, and the current status of knowledge concerning such communities in the Great Lakes. This problem is particularly difficult because of the current body of scientific opinion which holds that modifications of organism communities are the most sensitive index of undesirable ecological change and the growing incorporation of this paradigm into public perception, policy, and law:

> *"..it is paradoxical that so much effort in "ecotoxicological" studies has been devoted to metabolic parameters, that is, production, decomposition, and nutrient cycling, for it appears that ecological stress must be very extreme before these activities are significantly disrupted. Far more sensitive and far more important in the case of organisms valued by humans or by higher organisms in the food chain, are the changes in species composition which occur. It appears that early indications of stress at the ecosystem level would be detected far more readily by changes in the species composition of the biotic community than by changes in community metabolism or chemical cycling, for the latter are among the most robust ecosystem-level parameters"* (Schindler, 1985).

An adequate demonstration using the traditional organism-by-organism, chemical-by-chemical bioassay approach would be a daunting undertaking. Because the presumption of minimal harm is quite strong, we recommend the alternative approach of microcosm or mesocosm experiments using actual Great Lakes water column assemblages and actual cargo sweeping materials at a range of concentrations including the worst plausible case determined from data gathered or determined from implementation of recommendations 1 and 2 above. Experiments of this type have proven highly useful in detecting and nutrient and toxic effects in sensitive communities, in the Great Lakes and in other aquatic systems (Schelske, 1984). We therefore recommend that the Coast Guard solicit plans for such experiments from laboratories with demonstrated expertise in analysis of Great Lakes water column communities.

(d) Since little, if any, information exists concerning the potential or realized effects of cargo residues on plant communities growing on surfaces but projecting into the water column, we recommend that research be undertaken to explore and, if possible, quantify, such potential effects and their importance.

(e) In the case of neuston communities, effort should be directed to determining what, if any, fraction of cargo residues are trapped in surface films. If these experiments or observations prove positive, experiments should be designed to determine the range of residence times for such materials and their effects on biota living in neuston communities. Since there appears to be no information on this topic specific to the Great Lakes, the first elements of this task will, of necessity, be observational.

(f) Potential problems associated with the effects of cargo sweepings on benthic plant communities which project into the water column are equally poorly known, but perhaps more tractable. Based on material presented at the Workshop, it appears feasible to locate ship tracks under which there have been deposited fairly extensive deposits of cargo residues over time. A first order assessment of potential problems should be available from comparison of communities which have historically been affected by cargo sweepings and communities at the same depth and occupying the same substrates at localities remote from extensive ship traffic.

In order to implement these studies, it will be necessary to use well equipped and trained divers, or underwater vehicles. Program design should assure adequate observations of all major substrate types upon which cargo residues may be deposited. It should also be realized that a historical study will likely provide a "worst case" scenario, since cargo handling procedures have likely improved in recent decades, and certain types of materials, such as coal ash, which were previously discharged in large quantities, are no longer being discharged to Great Lakes waters.

## XXIII. Literature Cited


Armstrong, D.E. and A.W. Elzerman. Trace metal accumulation in surface microlayers. *J. Great Lakes Res*. 8: 282-287 (1982).

Edsall, T.A., E.F. Stoermer, and J.P. Kociolek. 1991. Periphyton accumulation at remote reefs and shoals in Lake Superior. *J. Great Lakes Res.* 17: 412-418 (1991).

EVS Consultants. Final Report: Qualitative Assessment of Cargo Residue Washdown in the Great Lakes. Prepared for Squire, Sanders and Dempsey, Cleveland Ohio. 55 pages plus appendages (1994).

Fuhs, G.W. Microbiota in surface films: An historical perspective. *J. Great lakes Res.* 8: 312-315 (1982).

Henson, E.B. Notes on the benthic alga Dichotomosiphon from the Straits of Mackinac area of Lakes Michigan and Huron. *J. Great Lakes Res.* 10: 85-89 (1984).

Kingston, J.C., R.L. Lowe, E.F. Stoermer, and T.B. Ladewski. Spatial and temporal distribution of benthic diatoms in northern Lake Michigan. *Ecology* 64: 1566-1580 (1983).

Lin, C.K. and C.L. Schelske. Effects of Nutrient Enrichment, Light Intensity and Temperature on growth of Phytoplankton from Lake Huron. United States Environmental Protection Agency, Environmental Research Laboratory Duluth, EPA-600/3-79-049. 63 pp. (1979).

Rice, C.P., B.J. Eadie, and C.M. Erstfeld. Enrichment of PCB's in Lake Michigan surface films. *J. Great lakes Res.* 8: 265-270 (1982).

Schelske, C.L. In Situ and Natural Phytoplankton Assemblage Bioassays. p. 15-47. In: *Algae as Ecological Indicators* ( E. Schubert, ed.). Academic Press, London (1984).

Schindler, D.W. The Coupling of Elemental Cycles by Organisms: Evidence from Whole-Lake Experiments. p. 225-250. In: *Chemical Processes in Lakes* (W. Strumm, ed.) John Wiley and Son, New York (1985).

Stevenson, R.J., and E.F. Stoermer. Quantitative differences between benthic algal communities along a depth gradient in Lake Michigan. *J. Phycol.* 17: 29-36 (1981).

Stoermer, E.F. Diatoms associated with bryophyte communities growing at extreme depths in Lake Michigan. *Proc. Iowa Acad. Sci.* 88: 91-95 (1981).

# Appendix I: Workshop Agenda

**Tuesday, September 27**

| | |
|---|---|
| 8:15 a.m. | Introduction and Overview |
| | *G. Meadows (CILER), D. Reid (NOAA)* |
| 8:30 a.m. | What, Why, & How of Cargo Sweeping |
| | *G. Ryan (Lake Carriers' Association)* |
| | Cargo Characteristics and Methods of Handling Cargo Residues in Holds and Tunnels |
| | *R. Harkins (Lake Carriers' Association)* |
| | Methods of Handling Residues on Decks and the Impacts of regulations on Safety |
| | *D. Van Brunt (USS Great Lakes Fleet, Inc.)* |
| 9:25 a.m. | Legislative Background - MARPOL V and the Enabling Legislation |
| | *CDR. E. Reeves (USCG, Ninth District)* |
| 10:00 a.m. | BREAK |
| 10:20 a.m. | Summary & Overview of the Melville Report |
| | *A. Prior (Melville Shipping, Ltd.)* |
| 10:55 a.m. | The Scientific Steering Committee Review of the USCG Interim Enforcement Policy |
| | *D. Reid (NOAA/GLERL)* |
| 11:30 a.m. | Scientific Issues Based on Present Knowledge |
| | *P. Chapman (EVS Environmental Consultants)* |
| 12:00 p.m. | LUNCH |
| 1:30 p.m. | Follow-up & Charge |
| | *D. Reid (NOAA/GLERL)* |
| | *G. Meadows (CILER)* |
| 2:00 p.m. | Breakout Groups Convene |
| | *Water Column Impacts -- G. Stoermer (University of Michigan)* |
| | *Sediment Accumulation & Toxicity -- P. Landrum (NOAA/GLERL)* |
| | *Risk to Fisheries & Habitat -- J. Gannon (National Biological Survey)* |
| 3:15 p.m. | BREAK |
| 3:30 p.m. | Breakout Groups continue |
| 5:00 p.m. | Breakout Group Progress Reports & Key Issues |
| 5:45 p.m. | Adjourn for Evening |

**Wednesday, September 28**

| | |
|---|---|
| 7:45 a.m. | Coffee & Refreshments |
| 8:15 a.m. | Recap of Progress |
| | *G. Meadows (CILER)* |
| | *D. Reid (NOAA/GLERL)* |
| 8:30 a.m. | Breakout Groups Reconvene |
| 10:00 a.m. | BREAK |
| 10:30 a.m. | Breakout Groups continue |
| 12:00 p.m. | LUNCH |
| 1:15 p.m. | Breakout Groups Reconvene - wrap-up |
| 2:30 p.m. | Final Plenary Session/Breakout Groups Reporting |
| **4:00 p.m** | **Close** |

# Appendix II: Workshop Participants

Mr. Dale Baker
Minnesota Sea Grant Extension
2305 East 5th St.
Duluth, MN 55812
Work: 218-726-8108 FAX: 218-726-6556
Email: dbaker@d.umn.edu
Working Group: Sediment Tox.

Mr. Robert Beck
Naval Architecture & Marine Engineering
University of Michigan
Ann Arbor, MI 48109
Work: 734-764-0282 FAX: 734-936-8820
Email: bob_beck@um.cc.umich.edu
Working Group: Floating

Dr. Neely H. Bostick
U.S. Geological Survey
Denver Federal Center, MS 972
Denver, CO 80225-0046
Work: 303-236-0581 FAX: 303-236-7738
Working Group: Sediment Tox.

Dr. Bruce Brownawell
Marine Sciences Research Center
SUNY at Stony Brook
Stony Brook, NY 11794-5000
Work: 516-632-9411 FAX: 516-632-8820
Working Group: Sediment Tox.

Dr. Allen Burton
Biological Sciences Dep't
Wright State University
Dayton, OH 45435
Working Group: Sediment Tox.

Dr. Peter M. Chapman
EVS Environmental Consultants
195 Pemberton Avenue
North Vancouver, British Columbia
Canada V7P2R4
Work: 604-986-4331 FAX: 604-662-8548
Working Group: Sediment Tox.

Dr. John L. Clark
International Joint Commission
100 Ouellette, 8th Floor
Windsor, Ontario Canada N9A 6T3
Work: 519-257-6709
Working Group: Floating

Mr. Mark Coscarelli
Michigan Dept. of Natural Resources
Office of the Great Lakes
P.O. Box 30028
Lansing, MI 48909
Work: 517-373-3588 FAX: 517-335-4053
Working Group: Fisheries & Habitats

Ms. Michele Dallafior
Office of Senator John Glen
503 Hart Senate Office Bldg.
Washington, D.C., 20510
Work: 202-224-4229 FAX: 202-224-7983
Working Group: Floating

Mr. John Distin
4900 Society Center
127 Public Square
Cleveland, OH 44114-1304
Work: 216-479-8530 FAX: 216-479-8780
Working Group: Floating

Mr. Thomas Edsall
USGS, Biological Research Division
Great Lakes Science Center
1451 Green Rd.
Ann Arbor, MI 48105
Work: 734-994-3331, X235 FAX: 734-994-8780
Working Group: Fisheries & Habitats

Dr. Lorraine H. Filipek
U.S. Geological Survey
MS972, Box 25046
Lakewood, CO 80225
Work: 303-236-3329 FAX: 303-236-7738
Email: lfilipek@dncrdso.cr.usgs.gov
Working Group: Sediment Tox

Dr. Susan Fisher
The Ohio State University
1735 Neil Ave.
Columbus, OH 43210
Working Group: Sediment Tox.

Dr. John Gannon
USGS, Biological Research Division
Great Lakes Science Center
1451 Green Rd.
Ann Arbor, MI 48105
Work: 734-994-3331, Ext 237 FAX: 734-994-8780
Email: john_e_gannon@usgs.gov
Working Group: Fisheries & Habitats

Mr. Richard W. Harkins
Lake Carriers' Association
614 Superior Avenue, West
Cleveland, OH 44113-1383
Work: 216-621-1107 FAX: 216-241-8262
Working Group: Floating

Ms. Anjanette Hintz
U.S. Fish & Wildlife Service
Federal Bldg., Rm 204
145 Water St.
Alpena, MI 49707
Work: 517-356-3052
Working Group: Fisheries & Habitats

Mr. Neil Hunter
Canadian Ship Owners Association
350 Sparks Street, Suite 705
Ottawa, Ontario K1R 7S8
Work: 613-232-3539 FAX: 613-232-6211
Working Group: Floater

Dr. Christopher Ingersoll
National Biological Survey
4200 New Haven Rd.
Columbia, MO 65201
Working Group: Sediment Tox.

Dr. David Jude
CGLAS, 3116 IST Bldg., 2099
University of Michigan
2200 Bonisteel Blvd.
Ann Arbor, MI 48109-2099
Work: 734-763-3183
Working Group: Fisheries & Habitats

Dr. Peter F. Landrum
NOAA/GLERL
2205 Commonwealth Blvd.
Ann Arbor, MI 48105-2945
Work: 734-741-2945 FAX: 734-741-2055
Email: landrum@glerl.noaa.gov
Working Group: Sediment Tox.

Dr. Joseph H. Leach
Ontario Ministry of Natural Resources
Lake Erie Fisheries Station, R.R. No. 2
Wheatley, Ontario Canada N0P 2P0
Working Group: Fisheries & Habitat

Dr. Barry M. Lesht
Argonne National Laboratory
9700 S. Cass Ave.
Argonne, IL 60439
Work: 708-252-4208 FAX: 708-252-5498
Email: bmlesht@anl.gov
Working Group: Water Column

Dr. Michael Lewis
Geological Survey of Canada
P.O. Box 1006
Dartmouth, Nova Scotia
Canada B2Y 4A2
Work: 902-426-7738 FAX: 902-426-4104
Email: mlewis@agcrr.bio.ms.ca
Working Group: Sediment Tox.

Dr. Michael Lydy
Department of Biological Sciences
Wichita State University
1845 N. Fairmont
Wichita, KS 67260-0026
Work: 316-689-3111 FAX: 316-689-3772
Email:
Working Group: Sediment Tox

Dr. Bruce Manny
USGS, Biological Research Division
Great Lakes Science Center
1451 Green Rd.
Ann Arbor, MI 48105
Work: 734-994-3331, x255 FAX: 734-994-8780
Working Group: Fisheries & Habitats

Dr. Ellen McDonald
The Ohio State University
Civil Engineering - 470 Hitchcock Hall
2070 Neil Ave.
Columbus, OH 43210
Work: 614-292-6420 FAX: 614-292-3780
Email: mcdonald.136@osu.edu
Working Group: Water Column

Dr. Guy Meadows
Naval Arch. & Marine Engineering
The University of Michigan
Ann Arbor, MI 48109-2145
Work: 734-764-5235 FAX: 734-936-8820
Email:gmeadows@engin.umich.edu
Working Group: Floater

Mr. Tom Morris
Canadian Coast Guard, AMSEB
344 Slater St.
Ottawa, Ontario Canada K1A 0N7
Work: 613-991-3170 FAX: 613-954-4916
Working Group: Fisheries & Habitats

Dr. Dora R. Passino-Reader
USGS, Biological Research Division
Great Lakes Science Center
1451 Green Rd.
Ann Arbor, MI 48105
Work: 734-994-3331, X229 FAX: 734-994-8780
Working Group: Sediment Tox.

Ms. Laurie Perry
U.S. Coast Guard, Ninth District
1240 E. 9th St.
Cleveland, OH 44199-2060
Work: 216-522-3968 or 522-3994 FAX: 216-522-3261
Working Group: Fisheries & Habitats

Mr. Andrew Prior
Melville Shipping, LDT
350 Sparks St., Suite 1007
Ottawa, Ontario Canada K1R 7S8
Work: 613-238-1840 FAX: 613-238-1291
Email: melville@gabriel.resodox.net
Working Group: Floating

CDR. Eric Reeves
U.S. Coast Guard, Ninth District
1240 E. 9th St.
Cleveland, OH 44199-2060
Work: 216-522-3994 FAX: 216-522-3261
Working Group: Sediment Tox.

Dr. David Reid
National Oceanic & Atmospheric Administration
Great Lakes Environmental Research Laboratory
2205 Commonwealth Blvd.
Ann Arbor, MI 48105-2945
Work: 734-741-2019 FAX: 734-741-2003
Email: reid@glerl.noaa.gov
Working Group: Floater

Mr. George J. Ryan
Lake Carriers' Association
614 Superior Ave., West
Cleveland, OH 44113-1383
Work: 216-621-1107 FAX: 216-241-8262
Working Group: Floater

Dr. Eugene Stoermer
University of Michigan
M19 IST Bldg 2099
2200 Bonisteel Blvd.
Ann Arbor, MI 48109-2099
Work: 734-764-5238
Email: stoermer@umich.edu
Working Group: Water Column

Ms. Susan Tewalt
U.S. Geological Survey, MS 956
Reston, VA 22092
Work: 703-648-6437 FAX: 703-648-6419
Email: stewalt@nords.er.usgs.gov
Working Group: Sediment Tox.

Mr. Steve Thorp
Great Lakes Commission
400 Fourth St.
Ann Arbor, MI 48103
Work: 734-665-9135 FAX: 734-665-4370
Email: sthorp@glc.org
Working Group: Sediment Tox.

Mr. David Van Brunt
USS Great Lakes Fleet, Inc.
227 West First St.
Duluth, Minnesota
Working Group: Floater

Lt. JG. Katherine Weathers
U.S. Coast Guard, Ninth District
1240 E. 9th Street
Cleveland, OH 44199-2060
Work: 216-522-3994 FAX: 216-522-3261
Working Group: Water Column

Mr. James B. Whitaker
Chester Environmental
P.O. Box 15851
Pittsburgh, PA 15244
Work: 412-269-5848 FAX: 412-269-5865
Working Group: Water Column

Mr. Chris Wiley
Canadian Coast Guard
Ship Safety
201 N. Front St.
Sarnia, Ontario Canada N7T 8B1
Work: 519-383-1837 FAX: 519-383-1997
Working Group: Sediment Tox.

## Appendix III:  Suggested Strategy for Breakout Groups

SUGGESTED APPROACH

I. Focus on commodities listed in Committee report (Reid *et al.*, 1994).

II. Start with the Committee report, and:

1. Discuss, categorize, and prioritize each commodity in terms of environmental risks/threats and perceived significance to the Great Lakes ecosystem, if any (agree with CR, disagree with CR, modify CR).

2. Starting with the highest priority, identify scientific issues and questions associated with each commodity that must be resolved or answered in order to make scientifically defensible assessments of the environmental impacts of in-water disposal.

3. Identify what we already know and what gaps there are in our knowledge and understanding of each such issue or question, what further information or studies are needed to resolve them, and how best to obtain the requisite information, such as:

   a) chemical analyses of specific commodities (for what)?
   b) literature searches?
   c) laboratory experiments?
   d) field work?
   e) all of or a combination of the above?
   f) other activities?

REQUESTED BREAKOUT GROUP REPORT OUTLINE

I. General Comments

II. Categorize, prioritize, and discuss each commodity in terms of environmental risks/threats and perceived significance to the Great Lakes ecosystem, if any.

III. Starting with the highest priority commodity, identify issues associated with each commodity that must be resolved/answered in order to make scientifically defensible assessments of the environmental impacts of over-water disposal.

IV. For each such issue, identify the information needed to resolve the issue and the recommended approach to obtaining the requisite information:

- chemical analyses of specific commodities (for what)?
- literature search and desktop exercise?
- laboratory experiments?
- field work?
- all of or a combination of the above?
- other activities?

V. Recommendations (remember, the recommendations from the workshop will be used to develop one or more Requests for Proposals by which the Coast Guard will develop a sound scientific basis for final regulations).

## Appendix IV: Text of a Letter from John Gannon to CDR Eric Reeves with Additional Recommendations from the Fisheries and Habitat Work Group

October 7, 1994

Cdr. M. Eric Reeves, Chief
Marine Port and Environmental Safety Branch
Ninth Coast Guard District
1240 E. Ninth Street
Cleveland, OH 44199-2060

Dear Commander Reeves:

The Cargo Sweeping Workshop was held in Ann Arbor, Michigan, September 27-28, 1994. I was the moderator for the Fisheries and Habitat Sub-group. I also was the main contributor concerning habitat issues to the report by Reid *et al.* (1994) entitled, "Review of U.S. Coast Guard Interim Enforcement Policy".

One of the agenda items at the workshop was to review from the habitat perspective the Interim Policy and the Cargo Sweeping Scientific Steering Committee's (Reid *et al.* 1994) recommendations. There was general affirmation that prohibiting cargo sweeping within 6-miles of shores and islands and near specific offshore shoals designated on the maps (Reid *et al.* 1994) is generally protective of the most sensitive fish habitats in the Great Lakes. In some areas the recommended nearshore protected zone was extended to 12 miles to compensate for high concentrations of reefs, shoals, and islands that were also designated on the maps.

Workshop participants recognized that the choice of these limits is somewhat arbitrary as there is no definite demarcation between highly sensitive and less sensitive habitat. Consequently, consensus was reached at the workshop that exceptions to the general recommendations could be made without adversely affecting habitat where: (1) deep waters occur within the 6-mile limit; and (2) structured habitat consisting of gravel, cobble, boulders, and submerged bedrock outcrops is absent. Such exceptions should be reviewed on a case-by-case basis by Great Lakes habitat experts.

The following exceptions were specifically discussed at the workshop and the conclusions reached follow:

<u>Lake Huron</u>: Southern portion near Port Huron - The shipping lanes from Port Huron north approximately to Harbor Beach are over sandy bottom in relatively deep water. A 3-mile limit in this area would be sufficiently protective of habitat.

<u>Lake Huron</u>: Mid-lake reef-shoal complex - The rectangular box on the map in Reid *et al. (1994) delineates a proposed lake trout refuge for protection of spawning and nurse*ry habitat on the Yankee Reef - Six Fathom Bank complex. It was recognized that the shipping lanes traversing the southwest corner of the rectangle is over less sensitive deep water habitat. The zone for protecting habitat has been redrawn to conform to the natural contours of the shallow, rocky area (map attached). This approach is consistent with the manner in which zones of protection were drawn for offshore reefs and shoals in the other Great Lakes in Reid *et al.* (1994).

<u>Lake Superior</u>: Northwestern shore - The shoreline from Duluth to approximately Grand Marais, MN is rocky and drops quickly into deep water. The most sensitive habitat in this area is nearshore. Because of the steep drop off, a 3-mile limit in this area would be sufficiently protective of habitat.

Lake Michigan:  Northeastern shore - Shipping lanes pass within the zones recommended as protective of habitat off Big Sable and Betsie Points (Reid *et al.* 1994). Habitat under these shipping lanes is sandy bottom in relatively deep water. A 3-mile limit off these points would be sufficiently protective of habitat.

Lake Erie:  Western basin - Reid *et al.* (1994) recommends no cargo sweeping in the western basin of Lake Erie to protect highly productive and sensitive habitats. A variance has been granted by your office to allow cargo sweeping in western Lake Erie from the Port of Toledo in response to extraordinary economic hardship and safety risk. It was recommended at the workshop to allow cargo sweeping only in the shipping channel off the Maumee River mouth. This would confine cargo sweepings to a known area rather than broadcasting the material over sensitive habitat. The material then would be handled as part of routine maintenance dredging activities on an as needed basis.

Please contact me if you have any questions or require further information concerning these recommendations.

Sincerely yours,

(signed)

John E. Gannon, Chief
Section of Habitat and Contaminant Assessment
National Biological Survey
Great Lakes Science Center
1451 Green Rd.
Ann Arbor, MI  48105

## Appendix V: Recommended Methods for Tier I Assessment

The Sediment Toxicity Work Group recommends that the following steps be conducted for a Tier I assessment: (1) identify track lines by use of charts and personal communications, (2) use sonar sweeps to locate footprints of deposited cargo residues within a track line, (3) design sampling plan for benthic community and sediment analyses, (4) use a PONAR grab to collect sediments from stations within a track line and from the surrounding reference areas, (5) split the sediment grab sample into a subsample for benthos and a subsample for sediment analyses, (6) sieve the benthos subsample to: (a) isolate and preserve benthos for taxonomy and bioaccumulation measures, and (b) qualitatively identify the presence of cargo residues, (7) process the sediment analysis subsample for physical and chemical characterizations, and (8) sort benthos subsamples for taxonomic identifications and residue analyses. Steps 4 through 7 would be performed on the ship at the sampling location.

Detailed Description of Individual Steps

(1) Identify track lines by use of charts and personal communications. Initial locations of probable ports and track locations will be provided through consultation with the Coast Guard and the Lake Carriers Association to identify likely locations of cargo sweeping activities.

(2) Use sonar sweeps to locate footprints of deposited cargo residues within a track line. Lake features have been identified through sonar as a backscatter anomaly. Thus, using acoustic reflectivity mapping, the tracks for cargo sweeping should be identifiable. This approach uses the difference in the density of the cargo residue deposits relative to the soft sediments to identify the location. This approach has been demonstrated to successfully identify such deposits based on limited ground truth.

(3) Design sampling plan for benthic community and sediment analyses. Replicate grab samples would be collected across a gradient from stations located outside the track line (reference stations) and from stations located within the track line (footprints of deposited cargo residues, Figure 2). The number of replicate grabs per station, the number of stations per location, and the station positions would depend on the information gathered in Steps 1 and 2. Published literature also could be used to evaluate spatial variability and establish the required number of replicate grab samples and the number of stations (e.g., Reynoldson and Day data-base). See the section titled “Other Considerations” below for additional detail on sampling design.

(4) Use a PONAR grab to collect sediments from stations within a track line and from the surrounding reference areas. A PONAR grab would be used to collect about the upper 10 cm of the sediment surface. Only grabs which sampled a consistent volume of sediment would be processed.

(5) Split the sediment grab sample into a subsample for benthos and a subsample for sediment analyses. The contents of each grab would be placed into a pan, homogenized, and split into two subsamples.

(6) Sieve the benthos subsample to (a) isolate and preserve benthos for taxonomy and bioaccumulation measures, and (b) qualitatively identify the presence of cargo residues. The benthos subsample would be sieved on deck through a 1.0 mm (perhaps larger) and 0.25 mm sieve with lake water. The materials retained by the 1.0 mm sieve would be observed for the presence of cargo residues; the materials retained by the 1.0 and 0.25 mm sieves would be preserved for later benthos taxonomic identification and residue analyses of the benthos. The materials passing through the 0.25 mm sieve would be washed overboard. A preservative compatible with processing samples for taxonomic identifications and for residue analyses would need to be identified (e.g., while ethanol has been used to preserve benthos samples for taxonomy, it may not be appropriate for preserving benthos samples for residue analyses). Some of the grab collected from footprint stations may not contain evidence of cargo residues in the materials retained by the 1.0 mm sieve (e.g., presence of taconite pellets, magnetic materials, or large coal particles). If a grab does not contain evidence of cargo residues, then all of the material from the grab could be returned to the lake and additional grabs could be collected from the

footprint station in an attempt to obtain more appropriate samples. While replicate subsamples from individual grabs would be stored individually, these replicates might be composited for analysis (e.g., combination of replicate benthos samples from a station for residue analysis) depending on the results of chemical analyses of sediments or on funding limitations. Compositing might consist of combining samples (e.g., organisms, sediment) and chemically analyzing the mixture rather than the individual samples. The chemical analysis of the mixture provides an estimate of the average concentration of the individual samples making up the composite. Compositing also may be used when the cost of analysis is high.

(7) Process the sediment analysis subsample for physical and chemical characterizations. Aliquots of subsample would be preserved on board the ship following standard methods. Analyses performed in the laboratory on these aliquots would include (1) particle size, (2) ammonia, (3) pH, (4) hydrogen sulfide, (5) total organic carbon, (6) polycyclic aromatic hydrocarbons (PAHs), (7) total metals, and (8) porewater metals. A measurement of acid-volatile sulfides and simultaneously extracted metals also may be useful in evaluating metal bioavailability in sediments.

(8) Sort benthos subsamples for taxonomic identifications and residue analyses. This processing would be performed in the laboratory. One subset of the benthos would be taxonomically identified to the lowest practical level (e.g., genus or species) and a second subset of the benthos would be analyzed for residues of concern (e.g., PAHs and metals depending on the results of the sediment analyses of these compounds).

## Appendix VI: Review of the U.S. Coast Guard Interim Enforcement Policy (Reid *et al.*, 1994)

Cargo Sweeping Scientific Steering Committee
(ad hoc)

Review of U.S. Coast Guard Interim Enforcement Policy
August, 1994


David F. Reid, Ph.D., Chairperson
NOAA/Great Lakes Environmental Research Laboratory
2205 Commonwealth Blvd.
Ann Arbor, MI 48105-1593
(734) 741-2019

Peter Landrum, Ph.D.
Research Chemist (Toxicology)
NOAA/Great Lakes Environmental Research Laboratory
2205 Commonwealth Blvd.
Ann Arbor, MI 48105-1593

Guy Meadows, Ph.D.
University of Michigan
Department of Naval Architecture and Marine Engineering
2600 Draper Rd.
Ann Arbor, MI 48109-2145

John E. Gannon, Ph.D.
Section Chief, National Biological Survey
Great Lakes Science Center
1451 Green Road
Ann Arbor, MI 48105-2899

Eugene F. Stoermer, Ph.D.
University of Michigan
M19 IST Building, 2099
Ann Arbor, MI 48109

## Table of Contents

## I. Cargo Sweeping Scientific Steering Committee

At the request of the U.S. Coast Guard, Ninth District, the NOAA Great Lakes Environmental Research Laboratory (GLERL, Ann Arbor, Michigan) assembled an ad hoc scientific steering committee (the Committee) to assist with two tasks relative to the cargo residues issue:

1. to review, critique, and comment on the Coast Guard Interim Enforcement Policy from an environmental standpoint;

2. to plan and hold a workshop on the environmental implications of cargo residue discharges in the Great Lakes and to identify issues that require further investigation, to provide an improved scientific basis for a final policy determination.

The Committee was established and first met in March, 1994. Members are listed on the front cover of this report.

## II. U.S. Coast Guard Interim Enforcement Policy

U.S. Coast Guard Ninth District Instruction 16460.1, 22 September 1993, established an interim policy on the enforcement of 33 CFR 151.66 against the discharge of cargo residues. See Appendix I.

## III. Environmental Considerations

1. Reference Materials

In order to assess the environmental implications of the interim policy, the Committee had first to understand the cargo sweeping process and identify the nature of the materials involved. Several documents were provided by the U.S. Coast Guard for this purpose:

(a) Martec Ltd., An Assessment of Dry Granular Bulk Cargo Losses at Loading and Unloading Ports, (a report to Environment Canada, Hull, Quebec), December 1984.

(b) Hamburg Maritime Research Institute (Institut an der Fachhochschule Hamburg), Marine Pollution Due to the Transport of Solid Bulk Cargoes by Ships, Jacobi, H., H.-J Golchert, L. Ivens, and J.C. Riedel-Lorjè, a report commissioned by the Federal Environmental Agency, February 1988.

(c) Ninth District Instruction 16460.1, Enforcement of Marpol V and Cargo Residues, September 22, 1993.

(d) Melville Shipping Ltd., Review and Investigation of Procedures Governing the Discharge of Non-Regulated Cargo Residues from Ships into the Great Lakes. SSC File No. 014SS.T8080-2-6861/B (a report to the Canadian Coast Guard - Ship Safety, Ottawa, Ontario), December 1993.

(e) Material Safety Data Sheets for Bituminous Coal, Natural Iron Ore, Iron Ore Concentrates, Iron Ore (Taconite) Pellets, Limestone, Dolomite, and Magnesium Agricultural Limestone (Dolomite).

(f) Numerous communications between the U.S. Coast Guard, Ninth District, and the Lake Carrier's Association (Cleveland, OH).

2. The Cargo Sweeping Process

It is the understanding of the Committee that

(a) In the course of loading and unloading dry bulk cargo, some amount of cargo material is spilled or blown onto the deck of the ship, and some cargo material is also left in the holds and tunnels of the ship. The process of cargo sweeping has been carried out for some 70-75 years on the Great Lakes and involves washdown of decks and washout of the holds and tunnels of dry bulk carriers, commencing shortly after leaving port, with the wash water routinely being discharged overboard.

(b) Washdown of the deck of the ship to eliminate cargo residue is necessitated by safety and sanitary considerations; washdown of the holds and tunnels of the ship is also necessary to avoid contaminating one cargo with residue from the previous cargo, i.e., when the type of cargo being carried changes.

(c) The washdown is generally the first order of business upon clearing port and may take 1-6 hours over distances ranging from 28 - 185 km (15 - 100 statute miles) and use 30,000 - 302,000 liters (8,000 - 80,000 gallons) of water. The total amount of cargo residue washed overboard varies depending on the specific cargo, size of the ship and the circumstances of loading or unloading. Estimates range from 95 - 680 kg (200 - 1500 pounds). See Appendic III for conversion factors.

3. The Dry Bulk Cargoes

There are numerous dry bulk cargoes carried via the Great Lakes. Reference (d) included a list of 62 commodities carried by the Canadian shipping industry. The top ten were: coal & peat, iron agglomerates and pellets, wheat, rock salt, cement, potash (potassium salts), dolomite, rape seed, metallic salts and peroxy of inorganic acids, and barley. However, for the U.S. carriers, the principal dry bulk commodities identified for and considered by this Committee are:

(a) **Iron Ore:** consisting of any of the common iron ores, such as hematite and magnetite; primarily iron oxides and hydroxides, may be mixed with small amounts of other common minerals such as clays and quartz (silica); may have associated trace metals. Insoluble in fresh water, sparingly soluble under acidic conditions. The Committee was provided with a Material Safety Data Sheet listing the typical composition of “Natural Iron Ore” as Iron oxide (92.2%), silica (5.4%), aluminum oxide (1.4%), traces (<0.14% each) of phosphorus, manganese, calcium oxide, magnesium oxide, potassium oxide, sodium oxide, and sulfur.

(b) **Taconite:** an iron-bearing chert containing 25-30% hematite and magnetite. It is a low-grade ore that is pelletized for blast furnace reduction. Insoluble in fresh water, but sparingly soluble under acidic conditions. The Committee was provided with a Material Safety Data Sheet listing the typical composition of “Iron Ore Pellets” as iron (65.6%), silica (5.4%), and traces (<0.3% each) of phosphorus, manganese, calcium oxide, magnesium oxide, potassium oxide, sodium oxide, and sulfur.

(c) **Coal:** organic matter that has been subject to high pressure and heat on geologic time scales. Bituminous coal, also called soft coal, is a form of coal that yields pitch and tar as it burns and also produces much smoke and ashes. May contain measurable amounts of polycyclic aromatic hydrocarbons (PAHs). Coal is insoluble in fresh water even under mildly acidic conditions. The Committee received a Material Safety Data Sheet listing the typical composition of bituminous coal as fixed carbon (50-72%), volatile matter, including fused polycyclic hydrocarbons (17-37%), ash (5-13%), moisture (3-8%), sulfur (0.5-1.8%), and elemental and compounds of hydrogen (4.2-5.2%), nitrogen (1.3-1.6%), and chlorine (0.03-0.2%).

(d) **Coke:** a derivative of coal or petroleum; contains only elemental carbon and residual mineral impurities that were present in the original material. Coke is insoluble in fresh water, even under acidic conditions.

(e) **Limestone:** this is natural rock material consisting primarily of calcium carbonate [$CaCO_3$]; when magnesium is also included, it is called dolomite or dolomitic limestone [$CaMg(CO_3)_2$]; the metamorphosed form of limestone is marble. Sparingly (and slowly) soluble in fresh water, increasingly soluble as pH decreases. Could have associated trace minerals and other constituents. The Committee received Material Safety Data Sheets for both limestone and dolomite, listing the typical compositions as calcium and magnesium carbonates (99+%), and silica (<1%).

(f) **Gypsum:** a natural mineral compound, hydrated calcium sulfate [$CaSO_4 \Sigma 2H_2O$], may also include anhydrite ($CaSO_4$). Sparingly soluble in fresh water.

(g) **Cement:** a powdered substance made of calcium oxide [CaO] and clay; may be premixed with washed sand or gravel. Sparingly soluble in water; solubility increases with decreasing pH.

(h) **Potash:** the Committee was not given specific information about the chemical composition, but the term "potash" is generally understood to mean one or more salts of potassium, particularly potassium carbonate [$K_2CO_3$], but possibly potassium hydroxide [KOH], or a mixture of several potassium salts. Often expressed as "$K_2O$", and may be lumped with "fertilizer". All common potassium salts are readily soluble in fresh water.

(i) **Fertilizers:** the Committee was not given specific information about the type(s) and composition(s) of "fertilizers" shipped on the Great Lakes. The Committee made the assumption that these are nitrogen and phosphorus salts, most likely ammonium, potassium, or sodium salts of nitrate, nitrite, and phosphate. Urea [$CO(NH_2)_2$] is another form of nitrogen commonly included in fertilizers. All of these forms of nitrogen and phosphorus are highly soluble in fresh water.

(j) **Grain:** small hard seeds of typical cereal plants, such as wheat, rice, corn, and rye. Insoluble in fresh water, but will decompose over time (days to months).

(k) **Rock salt:** sodium chloride [NaCl], very soluble in fresh water. May have trace amounts of other sea salts associated with it. May contain sodium hexacyanoferrate(II) as an anti-caking agent, which releases cyanide when dissolved in water.

(l) **Sand:** commonly used term for natural rock and mineral detritus with particle sizes ranging from 2 to 1/16 mm diameter, most often composed of quartz and siliceous minerals resistant to chemical weathering. Unwashed sand may have silt and clay mixed in. In general, the minerals that form sand are very insoluble in fresh water.

(m) **Gravel:** commonly used term for natural rock and mineral fragments with diameters in the range of 76 mm to 4.76 mm, the individual pieces usually being more or less rounded.

(n) **Clay and Refractory Materials:** the Committee had no specific compositional information. Clay is a general name given to a suite of very small (<0.005 mm) mineral particles composed of hydrous aluminum and magnesium silicates that are the decomposition products of natural rock weathering. Clays are often active adsorption sites for other elements and organic compounds in water. Clays are insoluble in fresh water.

(o) **Wood pulp:** processed wood that consists of cellulose fibers alone or cellulose with lignin (lignin is an organic compound that acts as a binder for the cellulose fibers in wood). Both are insoluble in fresh water. Some chemicals used to process the original wood chips may be retained with the pulp, including dioxin, a known environmentally hazardous chemical. However, the Committee has no information as to the amounts, if any, of residual processing chemicals that might be associated with the pulp.

(p) **Slag:** this is a generic term applied to a product of smelting that contains, mostly as silicates, those substances left over after the production of the target metal, and having a lower specific gravity that the target metal; also called cinder. For example, the slag of iron blast furnaces is a mixture of calcium, magnesium, and aluminum silicates, while the slag produced by lead and copper smelting furnaces is predominantly iron silicates. No information was provided concerning the exact nature of the Great Lakes material, but the Committee made the assumption that ancillary constituents, such as trace metals associated with the ore, would wind up in the slag. Silicates, in general, are relatively insoluble.

(q) **Millscale:** this is a black scale of magnetic iron oxide formed on iron and steel when heated for rolling, forging, etc. Iron oxides are insoluble in fresh water, but the solubility increases with decreasing pH.

Unless specifically indicated, the actual composition of these materials was not provided to the Committee and the information in the above descriptions is that commonly associated with the specific name used to describe the commodity. Appendix IV provides statistics for some of these commodities for the 1193 navigation season.

4. Environmental Concerns

The Committee considered the potential for each of the commodity types identified for U.S. carriers to cause environmental degradation. The Committee found that each cargo could be classified as either relatively soluble or relatively insoluble, and either biousable-biodegradable or not biousable-biodegradable. The latter classification is for materials that are organic and subject to decomposition (i.e., biodegradable) or that contain nutrient compounds in an available form that would stimulate phytoplankton growth (biousable).

The terms soluble and insoluble are used in a relative sense. Materials that are classified as relatively soluble are those the Committee expects to dissolve rather quickly (minutes to days) in the water column and therefore do not have a high probability of significant long-term accumulation in the sediment zone. Materials that are classified as relatively insoluble are those that the Committee expects to accumulate in sediments and remain for periods of months to decades or longer. However, it must be also be recognized even materials classified as insoluble may decompose or react geochemically over time and eventually dissolve or change in chemical form. In addition, there may be some constituents of the relatively insoluble materials that are soluble or sparingly soluble such that these constituents will dissolve into Great Lakes waters over shorter periods of time. Table 1 summarizes the Committee's general breakdown of the commodities considered.

Table 1: Classification of Primary Dry Cargoes Transported by U.S. Carriers

| | **NOT BIOUSABLE OR BIODEGRADABLE** | **BIOUSABLE OR BIODEGRADABLE** |
|---|---|---|
| **RELATIVELY INSOLUBLE** | Iron ore, taconite, coal, limestone (various forms), sand, gravel, petroleum coke, clay & refractory materials, slag, millscale | Wood pulp<br>Grain |
| **RELATIVELY SOLUBLE** | Rock salt, gypsum, cement | Potash, fertilizers |

The Committee felt that discharge of these materials through the cargo sweeping process must be evaluated for their potential to produce environmental degradation (1) in the water column, (2) in bottom sediments, and (3) especially in important habitats and fish spawning areas. The types of environmental impacts expected include: no significant effects; acute effects (effects that can be identified almost immediately and that have a relatively short - minutes to weeks - expected duration), and chronic effects (long-term effects, possibly not immediate, but duration lasting weeks to years/decades).

Rock salt, fertilizers, gypsum, cement, and potash are all soluble, but may not enter the water column in a completely dissolved state and could reach the bottom before dissolution is complete under certain circumstances. The speed of dissolution will be determined by the solubility, the amount of material, and the particle size. For example, rock salt is very soluble, but if present in large lumps, it is possible that undissolved pieces could reach the bottom before total dissolution occurs, whereas finely powdered rock salt would dissolve completely in the water column. Cement may actually form hardened lumps before becoming sufficiently dispersed. The Committee concluded that these materials may have a potential for acute effects in the water column, but that the risk of harm is low in the open lakes, and any harmful conditions that do arise will not last long nor be widespread given the estimated amounts of material, volume of washwater, and expected dilution associated with a single sweeping event.

Potash and fertilizers have the added potential to stimulate phytoplankton and aquatic weed growth, leading to localized plankton blooms, heavy aquatic weed growths, and possible eutrophication. This would be of concern if it occurred in an area that is already eutrophic. In such an area, the capacity of the local ecosystem to assimilate such the additional plant matter would be low to non-existent. Therefore, multiple or repetitive discharges of fertilizer and potash residues should be avoided in waters known to be eutrophic or mesotrophic with restricted circulation, such as western Lake Erie, Saginaw Bay, Lake St. Clair, and Green Bay (Figure 1).

There are also many bays and harbors that are eutrophic, but the Interim Enforcement Policy does not allow any discharges inside of three miles from land, except where safety considerations require it, so such areas are not a major consideration.

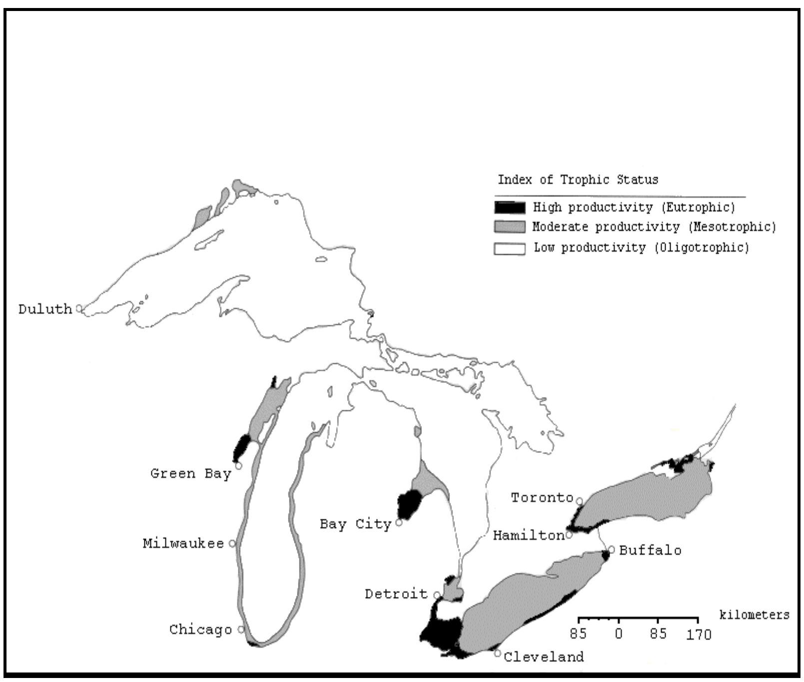



Figure 1. Nutrient-enriched Areas of the Great Lakes. Trophic status was defined by levels of phosphorus, chlorophyll A, and water clarity (Statistics Canada, 1986).

The greatest risk from these materials would be to important habitats and spawning areas where larval and juvenile aquatic organisms may be more susceptible to even short-term habitat degradation. Rock salt, fertilizers, and potash could cause localized stress and/or mortality of biota if their dissolved concentration is great enough (i.e., osmotic problems). Gypsum and cement dust may be more of a threat by producing high turbidity in the water column and/or sudden significant deposition on top of the lake bottom sediments, causing suffocation of local organisms.

The other cargoes under consideration are generally insoluble or not very soluble in the water column. Wood pulp and grain residues are organic, but not generally soluble. Depending on the size and density, wood pulp, grain dust, and powder may remain suspended in the water column for long periods of time, or may sink to the bottom. In either case these materials will biodegrade over time, and are not generally considered toxic in and of themselves. The greatest environmental threat is the possibility of localized mortality via suffocation due to turbidity or depletion of oxygen from the water column, either of which could be detrimental to important habitats and spawning areas. The Committee does not believe that the risk to open lake ecosystems from individual sweeping events is significant given the amount of material involved and the probability of dispersion in the water column. However, the Committee is concerned that the impingement of these materials on important habitats and spawning areas could temporarily degrade the habitats and negatively affect critical larval and juvenile of aquatic organisms. The Committee is also concerned that there may be traces of dioxin and other organics associated with wood pulp, and traces of pesticides and herbicides associated with grain, but had no data with which to address these questions.

Of the insoluble cargoes, barring evidence or information to the contrary, the Committee found that limestone, sand and gravel, clays and refractory materials do not, by themselves, pose a significant risk to open lake ecosystems, especially from individual sweeping events. This assumes that there are no toxic ancillary materials associated with these main cargoes, i.e., trace heavy metals. It was recognized that these types of materials might, under certain conditions, produce short-term degradation in a very localized zone of the water column or bottom sediments by producing high turbidity in the water column and/or sudden significant deposition on top of the existing lake bottom sediment. The immediate threat in both cases would be to local aquatic organisms which might experience stress and/or mortality due to suffocation. The Committee did not consider this to be a significant concern for the open lakes. However, the Committee is concerned that repeated deposition of these materials in important habitats and spawning areas could change the character of those areas and degrade or destroy their use as such. See Section V, below.

The remaining insoluble cargoes, -- iron ore, coal, petroleum coke, millscale, and slag -- were determined by the Committee to have the potential for both acute and chronic environmental impacts and were worthy of more intense scrutiny. In fact, the Committee spent more time considering these materials than any others. The acute threat from these cargoes is the same as noted above for limestone, gypsum, sand, gravel, cement, and clays and other refractory materials, i.e., localized high turbidity in the water column and sudden deposition covering the existing bottom sediments during and immediately after the sweeping operation. As was found for the previous materials, the Committee did not consider these short-term effects to be of significant concern in general, except in important habitats and spawning areas, where they should be avoided.

Of greatest concern to the Committee, however, is the repetitive addition and probable build-up of these materials in bottom sediments and the potential chronic effects on both hard and soft bottom habitats. The concern is two-fold:  (1) iron ores, millscale, and slag all have or may have associated trace amounts of non-ferrous metals, some of which can be quite toxic; coal may have associated trace metals and polycyclic aromatic hydrocarbons have been known to leach from soft coals; therefore, any significant build-up of these materials in bottom sediments may pose a contaminant risk, and (2) if these materials are of sufficient particle size to sink rapidly, they could represent a significant threat to hard spawning and habitat substrates through acute suffocation and long-term habitat degradation.

Iron ores, coal, coke, millscale, and slag are sufficiently insoluble that there is little threat of significant releases of these toxic components to the water column during the time these materials remain suspended, which is a function of particle size and location. In general, small particles may remain in suspension for days, weeks, or even months, and will most likely be swept off to the circulation-determined main depositional areas of the lakes where they will accumulate in the deep bottom sediments. However, larger particles and pieces will settle out relatively close to the point of discharge. Not only will they accumulate in the local sediments, but if discharged over important hard-substrate habitat and spawning areas, their long-term build-up on such substrates could change the physical character and ultimately degrade or destroy the habitat quality and value.

The Committee had no information about the distribution of particle sizes in the sweepings, i.e., the amount by weight that is dust vs. larger pieces and lumps. However, the Committee feels that when integrated over the 70-80 year history of cargo sweeping, the continued discharge of iron ores, coal, coke, millscale, and slag residues pose a greater potential risk to the environment than any of the others considered.

The Committee attempted to further assess this risk of toxicity, focusing on iron ore and coal as the two leading commodities (by weight) transported by U.S. lake carriers. However, there was insufficient specific information about the composition of coal and coke shipped across the Great Lakes to make further assessment. A small amount of data, apparently for iron ore, was provided by the Lake Carriers' Association. Based on the analytical data they provided and assumptions about the amount dissolution, dilution, and dispersion that would occur, the Committee found that the risk of developing acutely toxic metal concentrations in the water column from a single sweeping of iron ore is low. Thus, the discharge of iron ore sweepings was not found to pose a significant acute threat to the ecosystem. However, the Committee still believes that the greatest potential for environmental impact from the cargo sweeping practice is in the accumulation of material from individual sweeping events over the 70+ year history of the practice on the lakes. This is an issue that will require direct study to properly assess.
The Committee also notes that there are other cargoes that may be transported, but in low volume, across the Lakes which have not been considered here. Metal ores, for example, might have a much greater potential for toxicity than iron ore.

## IV. Protection of Habitats and Spawning Areas

The Great Lakes contains a diverse assemblage of native and introduced fish species. Nearly all of them sometime during their life cycle depend on shallow water habitat for their survival and growth. These shallow water zones consist of erosional areas characterized by firm or hard substrates ranging from sand to boulders. Other shallow waters protected from wind action are depositional zones of silt and mud, often containing submergent and emergent aquatic macrophyte beds. Most species of fish use these shallow zones for spawning and nursery grounds (Gannon, *et al*., 1985; Scott and Crossman, 1973).

Shallow water zones are not confined to nearshore areas. Submerged bedrock reefs and gravel shoals, some located at considerable distances from shore, are extremely important fish spawning and nursery grounds. The lake trout (Salvelinus namaycush) depends on these offshore reefs and shoals for spawning. The Great Lakes fisheries management community has designated many of these sites as lake trout sanctuaries and off-limits to exploitation, in an effort to rehabilitate lake trout populations in the Great Lakes (Stanley *et al*., 1987). These sites are also used as spawning and nursery grounds for many other species. Since the lake trout is a sensitive indicator of high water quality, protecting lake trout habitat will effectively protect habitat for the majority of the Great Lakes fish community.

The U.S. Fish and Wildlife Service mapped fish spawning and nursery habitats in the Great Lakes (Goodyear *et al.* ,1982). These maps were used as the basis for making the following recommendations concerning cargo sweeping in the Great Lakes. These recommendations especially focus on protecting fish habitats from acute and chronic toxicity potentially associated with cargo residues. Although aggregates such as limestone, gravel, etc. are non-toxic and actually could provide habitat structure, discharging these materials over sensitive fish habitats should still be avoided. These materials could suffocate bottom organisms and alter the size-composition of bottom materials in ways that could degrade existing habitat.

1. **Great Lakes in General.** The charts accompanying this report (Appendix II) are marked with lines depicting areas we recommend be protected from cargo sweeping operations (hatch marks point into the recommended protected areas). In general the near-shore protected areas are 6 miles wide, with some exceptions necessary to protect off-shore reefs and key habitats. The choice of these lines is somewhat arbitrary as there is no definitive marker by which to identify and separate highly sensitive habitats from less sensitive habitats. However, in general, the firm substrates important as fish spawning and nursery habitats are located within 6 miles of shores and islands. Moreover, the most eutrophic waters and areas containing submergent and emergent aquatic macrophytes are located within the 6-mile limit also. Consequently, disallowing cargo sweeping within the 6-mile limit is generally most protective of all habitats except for those shoals and reefs that are further offshore. Offshore shoals and reefs that should be protected are also marked on the accompanying maps. In some cases the recommended nearshore protected zone had to be extended to 12 miles to compensate for reefs, shoals, and islands. The following discussion is specific for each lake.

2. **Lake Superior.** The 6-mile limit protects near-shore sensitive fish spawning and nursery grounds throughout Lake Superior, including the Apostle Islands area, Michipicoten and Caribou Islands, Thunder Bay, Keweenaw Bay, and Whitefish Bay. A very narrow zone greater than 6-miles exists between Pie Island and the Sibley Peninsula (Thunder Bay) and Isle Royale, but is not wide enough to show on the accompanying map. In order to protect fish habitats around Isle Royale and nearby Fisherman Reef and Bateau Rock, a 12-mile limit is recommended along the southern edge of Isle Royale. In addition, offshore fish spawning reefs associated with Stannard Rock, Superior Shoal, and Southwest Bank require protective zones separate from the contiguous nearshore zone.

3. **Lake Michigan.** The 6-mile limit generally protects near-shore sensitive fish spawning and nursery grounds in Lake Michigan except in the northern portion where there are many islands, shoals, and reefs. It is recommended that the 12-mile limit be employed north of the 45th parallel to fully protect lake trout sanctuary waters and other important fish habitats near the islands. Offshore lake trout spawning reefs (Milwaukee Mid-lake Reef and Julian's Reef) in the southern basin are marked with separate protective zones that should be off limits to cargo sweeping. A small area of water greater than 6 miles from shore occurs in northern Green Bay. However, this area includes sensitive fish habitats associated with Whaleback, Minneapolis, and Drisco Shoals. Consequently, we recommend that cargo sweeping not be allowed in Green Bay unless required for safety reasons. In the latter case, such operations should be in the northern end in waters greater than 6-miles from shore (not marked on the map), but should stay as far from Whaleback, Minneapolis, and Drisco Shoals and the bordering islands as possible.

4. **Lake Huron.** The 6-mile limit is generally protective of the nearshore habitats in Lake Huron. Exceptions are the designated lake trout refuges off Drummond and Cockburn Islands and the mid-lake refuge associated with Six Fathom Bank and Yankee Reef. All of the North Channel area should be off limits to cargo sweeping, even though a small area is more than 6 miles from shore. There are so many sensitive fish habitat areas associated with islands, shoals, and reefs in Georgian Bay that the 6-mile limit is insufficient for environmental protection and the recommended restricted zone as shown on the accompanying map is 12 miles, except in the northwest end where Dawson Rock necessitates an even wider restricted zone.

5. **Lake Erie.** The 6-mile limit is protective of the nearshore habitats in the central and eastern basins of Lake Erie. In western Lake Erie, there are many important habitat areas associated with islands and reefs beyond the 6-mile limit and only a small area is more than 12 miles from shore. It is recommended that cargo sweeping be severely restricted in the western basin of Lake Erie, allowing only those cases for which it is impractical to go elsewhere. In the latter case, the sweeping operations occur at least six-miles from the mainland and the shippers' should stay as far away from islands and charted reefs as possible.

6. **Lake Ontario.** The 6-mile limit is protective of the nearshore habitats throughout the main portion of the lake, except for the fish spawning habitats associated with Mulcaster Patch and Scotch Bonnet Shoal. We recommend that these be protected by extending the restricted zone to 12 miles from the mainland in those areas. The 6-mile limit is also protective of the islands and shoals near the St. Lawrence River mouth and the Bay of Quinte.

## V. Committee Findings

1. There are identifiable potential environmental effects from the discharge of cargo materials into the Great Lakes and cause for concern about the effects of discharges in or near important habitats and sensitive spawning areas.

2. There is insufficient evidence to support finding an immediate or severe risk associated with the interim policy to allow continuation of cargo sweeping discharges of the primary commodities identified in this report. However, there is also a paucity of data and studies on which to base comprehensive risk assessments, and there is a clear need for a comprehensive data compilation and scientific studies related to this issue. In addition, this finding does not apply to materials not specifically included here that may be occasionally transported and that may be toxic.

3. The greatest concern, and greatest potential environmental risk, is associated with cargo residues that are relatively insoluble and which may contain toxic components, such as coal, coke, iron ore, slag, millscale, and other metal ores. These have the potential for long-term accumulation in bottom sediments, and if repeatedly deposited on hard-substrate habitats or spawning reefs, could change the physical character of these habitats and degrade their habitat value.

4. The use of 3, 6, and 12 mile distance-from-shore criteria is arbitrary and these distances are not based on any known environmental factors. Of perhaps greater importance than distance-from-shore is water depth, openness of the discharge area, and proximity to important habitats and sensitive spawning areas. Deeper water and open lake areas allow for more dispersion and dilution compared to shallow and/or confined areas such as western Lake Erie, Lake St. Clair, and bays and harbors. Cargo sweeping should not be allowed close to important habitat and spawning areas. Based on the Committee findings presented in Section V of this report, the application of the arbitrary 6-mile limit does provides sufficient protection in most areas, although there are some exceptions where the 12-mile limit is recommended. See Section V for specifics.

5. The Committee notes that many of the existing shipping lanes are less than 12 miles from shore. One effect of the unmodified Interim Enforcement Policy will be to move cargo sweeping discharges away from the areas that have been receiving these residues for some 70+ years to areas (12 miles out) that have not, typically, received these discharges. If one assumes that there is an environmental risk associated with accumulation of cargo residues in bottom sediments, then the unmodified Interim Enforcement Policy will result *in an expansion* of the area of bottom sediments potentially impacted by cargo sweeping. The Coast Guard should balance this consideration against the impacts of continuing cargo sweeping along existing shipping lanes for another few years while scientific studies are conducted. The latter would add about 7% to the existing potential of environmental damage (i.e., assuming the practice continues for another 5 years before scientific studies are complete, the additional "loading" of material to areas already receiving sweepings is an additional 5 years on top of ª70 years that the practice has gone unabated, or about a 7% potential increase in residues).

6. The issues concerning the environmental effects of cargo sweeping are not fully resolvable without further information, especially the characteristic chemical compositions of the cargoes. There is a growing recognition among the environmental community and regulatory agencies that there are *cumulative* effects of multiple stresses on the ecosystem. There is a need to bring the issue of cargo sweeping to the attention of the aquatic science community, to have a thorough review of the existing scientific literature conducted and

analyzed, to identify the key scientific questions, and to develop well though-out specific laboratory and field studies necessary to answer those questions.

## VI. Committee Recommendations Concerning the Interim Enforcement Policy

1. The Coast Guard may wish to reevaluate the proposed application of a 12 mile enforcement limit to all cargoes. Most cargoes do not appear to pose a sufficient threat to the environment to justify moving their discharge to a new location, except when necessary to protect habitat and spawning areas.

2. For natural materials (such as limestone, sand, gravel, clay, refractory materials, and gypsum), rock salt, potash, fertilizer, cement, grain, seed, and wood pulp, the Committee found no basis to restrict their discharge except as recommended in Section V of this report, to protect habitat and spawning areas. This assumes that the quantities involved in a single sweeping event are the same or less than those assumed for this evaluation (<700 kg). Spawning areas, in particular, should be protected from the possibility of damage caused by long-term build-up of these materials on spawning substrates.

3. The discharge of rock salt, potash, fertilizer, grain, seed, and wood pulp residues should be avoided in western Lake Erie, Lake St. Clair, Saginaw Bay, and Green Bay unless it is absolutely impractical to carry out such operations elsewhere, e.g., vessels exchanging cargo in Toledo.

4. For materials that are known to have a high potential for associated toxic components (iron ore, coal, coke, millscale, and slag) the Coast Guard should rigorously pursue obtaining as much information from the carrier organizations as possible concerning the actual composition, including trace constituents, of these commodities. The Coast Guard may wish to maintain the interim 12-mile enforcement zone for these materials until sufficient information is provided to make a reasonable assessment of contaminant levels and risk to the environment, after which the enforcement policy can be adjusted if appropriate. Iron ore, for example, was evaluated based on information provided by the Lake Carriers' Association and found to pose little acute threat to the ecosystem. The enforcement limit was moved to 6 miles for most areas of the lakes by the Coast Guard on April 7, 1994.

5. In general, the Committee recommends that the Coast Guard, when considering requests for waivers, take into account the expected frequency of cargo sweeping in the waiver area as well as the nature of the material involved. For example, there is a considerable difference in risk potential associated with sweeping operations that will only occur only a few times during the entire navigation season in the area under consideration and operations that will involve quite frequent sweeping operations in the same area.

6. The Committee urges the Coast Guard and the Great Lakes shippers to continue to work together on this problem, and in particular, for the shippers to aggressively seek new procedures and technologies that lessen the amounts of residues that are washed overboard.

These recommendations refer only to the application of the Interim Enforcement Policy and do not represent an endorsement of cargo sweeping discharge into the Great Lakes by this Committee. The Committee believes that the environmental effects of cargo sweeping activities on the Great Lakes require and deserve additional scrutiny that will require substantially more information than the Committee had available for its deliberations.

## VII. References

Gannon, J. E., R. Danehy, J. Anderson, G. Merritt, and A. Bader. The ecology of natural shoals in Lake Ontario and their importance to artificial reef development, p. 113-134, In *Artificial Reefs - Marine and Freshwater Applications*, D'Itri, F. (ed.), Lewis Publ., Chelsea, MI (1985).

Goodyear, C.D., T.A. Edsall, D.M. Ormsby Dempsey, G.D. Moss, and P.E. Polanski. *Atlas of the Spawning and Nursery Areas of Great Lakes Fishes*, U.S. Fish and Wild. Serv. FWS/OBS-82-52, vol. 1-14 (1982).

Scott, W.B. and E.J. Crossman. *Freshwater Fishes of Canada*, Fish. Res. Bd. Canada, Bull. No. 184 (1973).

Stanley, J.G., R.L. Eshenroder, and W.L. Hartman. Sanctuaries for lake trout in the Great Lakes. Coastal Zone '87 Conf., W. W. Div./ASCE, Seattle, WA, p. 3141-3152 (1987).

Statistics Canada. Human Activity and the Environment:  A Statistical Compendium. Figure 6.6.21, page 279. Statistics Canada, Ottawa (1986).

U.S. Department of Transportation
United States Coast Guard

Commander,
Ninth Coast Guard District

1240 E. Ninth St.
Cleveland, Ohio 44199
Staff Symbol: (mpes)
Phone: 216-522-3994

CCGD9INST 16460.1

SEP 22 1993

NINTH DISTRICT INSTRUCTION 16460.1

Subj: ENFORCEMENT OF MARPOL V AND CARGO RESIDUES

1. PURPOSE. This notice sets forth an interim enforcement policy regarding the incidental discharge of cargo residues, what are commonly called "cargo sweepings," from commercial dry cargo carriers on the Great Lakes. The interim enforcement policy applies only to such cargo residues, and does not alter the strict prohibition of any discharge of oily waste, untreated sewage, plastics, dunnage, or other things commonly understood to be "garbage," from vessels on the Great Lakes.

2. DISCUSSION.

a. "MARPOL V" is Annex V to the International Convention for the Prevention of Pollution from Ships. Annex V is a set of Regulations for the Prevention of Pollution by Garbage from Ships which the United States entered into on 31 December 1988. Generally, MARPOL V regulates the disposal of ship-generated "garbage" at sea. The disposal of plastics is prohibited anywhere at sea. Disposal of other specified types of ship-generated waste, including cargo residues, is allowed at distances of more than 25, 12, and 3 nautical miles from the "nearest land," defined as the baseline, depending on the particular characteristics of the waste in question. All discharges, of any type, are prohibited within 3 miles of the baseline.

DISTRIBUTION - SDL No. 131 (Ninth District Only)

| | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | | | | | | | | | | | | | | | | | | | |
| B | * | | * | | | | | | | | | | | | | | | | | | | | | | |
| C | 1 | 1 | | | 1 | | | | 1 | | | | | | | | | | | | | | | | |
| D | | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| E | | | | | | | | | | | | | | | 1 | | | | | | | | | | |
| F | | | | | | | | | | | | | | | | | | | | | | | | | |
| G | | | | | | | | | | | | | | | | | | | | | | | | | |
| H | | | | | | | | | | | | | | | | | | | | | | | | | |

NON-STANDARD DISTRIBUTION: B:c Ninth District (ole), (o), (d), (dcs)
B:a G-TPS (3)

2. (Continued) SEP 22 1993

b. MARPOL V was implemented into United States domestic law by amendments to the Act to Prevent Pollution from Ships, at 33 USC 1902, and by Coast Guard regulations in 33 CFR Part 151. The Act provides that MARPOL V applies to all United States vessels wherever operating, and to all vessels in the navigable waters of the United States. The Act clearly prohibits the disposal of plastics from any United States vessel anywhere on the Great Lakes, and any discharge of plastics anywhere in the internal waters of the United States, including all of the United States portions of the Great Lakes. However, the Act does not specify how the regime of allowable discharges of certain other types of ship-generated wastes at specified distances from the baseline is intended to apply to the Great Lakes (where there are no baselines). For most of the navigable waters of the United States, which are less than six miles across, there is no issue about the application of the MARPOL V regime under a common-sense reading of the prohibition of any discharge within three miles of the "nearest land." But this is a significant issue on the Great Lakes, particularly as applied to cargo residues.

c. "Cargo residues," also called "cargo sweepings," are residues of bulk dry cargo in holds, cargo tunnels, machinery, or on deck, left after either loading or unloading operations. They may include coal, ore, grain, cement, limestone, gypsum, sand, salt, and other dry cargos. Bulk dry cargo vessels on the Great Lakes have traditonally washed down such residues and discharged the residue overboard with the water in low concentrations over long distances. Such discharges may sometimes be necessary to insure the safe operation of the vessel, and it is also quite possible that an absolute prohibition of such discharges would be economically devastating to Great Lakes shipping.

d. The Coast Guard regulations published in 1989 prohibit the discharge of "garbage" in any of the navigable waters. 33 CFR 151.66. As defined in the regulations, "garbage" includes cargo residues. 33 CFR 151.05. When the regulations were published, however, the Coast Guard acknowledged that there is some difficulty with the application of the blanket prohibition of all discharges to cargo residues, particularly in light of Canadian unwillingness to follow such an interpretation on the Great Lakes to date. "Under the revised Great Lakes Water Quality Agreement of 1978, the United States and Canada are obligated to seek compatible regulations for

2.d. (Continued)

the prevention of pollution on those waters." 54 FR 18390. The notice of rulemaking for the current regulations therefore provided that "To resolve the issue of cargo residue discharges on the Great Lakes, the Coast Guard plans to discuss this issue with its Canadian counterparts, toward the goal of achieving compatible U.S.-Canadian pollution prevention regulations." 54 FR 18390.

e. The Canadian Coast Guard is currently engaged in a study intended to provide some evaluation of the environmental effects, if any, of the traditional discharge of cargo residues from commercial vessels on the Great Lakes. In cooperation with this study, the United States Coast Guard is attempting to gather better information about cargo residues from now until the end of the next navigation season in 1994, with the purpose of finding a scientific basis for a revised interpretation of the application of MARPOL V to cargo residue on the Great Lakes which may be acceptable to both nations and consistent with the Great Lakes Water Quality Agreement.

f. During this study period, to last until the end of 1994, the Ninth District is adopting an interim enforcement policy designed to allow for the aggressive enforcement of MARPOL V against any discharges which are likely to be harmful, while avoiding an absolute prohibition of the discharges of all cargo residue which would be inconsistent with our commitment to study the issue in cooperation with Canada and might create impossible requirements for Great Lakes shipping. Under this interim enforcement policy we are adopting a 12-mile rule, subject to amendment in either direction based on the needs of safety and the ecology in a particular area. Although there is some argument in favor of a 3-mile rule for most types of cargo residues under one interpretation of MARPOL V, the 12-mile rule is being adopted as a more conservative line which better reflects the special sensitivity of the Great Lakes freshwater system.

g. During this study period, the Coast Guard will be working with both industry and environmental agencies in the gathering of information on actual effects of discharge of cargo residue beyond the 12 miles from the Great Lakes shorelines. At the same time, the Coast Guard will be actively investigating and citing discharges within 12 miles. As an adjunct to the study program in general, investigations of violations being cited within the enforcement area should gather as much information as

2.g. (Continued)

possible, beyond what might be necessary to merely make a technical case. Also, COTPs are requested to recommend appropriate amendments to the enforcement area, on either side of the 12-mile line, based on all available information relevant to a balancing of the safety and environmental considerations.

3. POLICY. The following policy applies to the enforcement of 33 CFR 151.66 against discharges of cargo residues. This policy applies only to *cargo residues* of the type generated by the customary operations of dry bulk carriers in the Great Lakes, and *does not alter* the current policy of strict and aggressive enforcement action against any discharge of oily waste, untreated sewage, plastics, dunnage, or other things commonly understood to be "garbage," from any United States vessel on the Great Lakes or into any United States waters of the Great Lakes:

a. The "enforcement area" is made up of those parts of the Great Lakes, including Canadian waters in the case of discharges from United States vessels, which are at or within 12 nautical miles from any land, including islands. The enforcement area is subject to amendment in particular, designated locations, based on recommendations by the local COTP and subject to approval by CCGD9(m). The "enforcement area" may vary depending on the particular type of cargo residue in question. In considering requests for relaxation of the enforcement area to less than 12 miles, and in making recommendations for extension of the enforcement area to more than 12 miles in a particular area, COTPs should consider and comment on the following factors:

(1) No cargo residue which is found to be toxic or harmful to the environment may be discharged anywhere.

(2) The enforcement area will not be reduced to less than 3 miles in any area unless necessitated by highly significant and compelling safety considerations.

(3) The enforcement area will not allow discharge within 4 miles of known fish spawning areas.

(4) The enforcement area will not allow discharge of any material which will float or remain in suspension for a sufficient distance that it will be deposited in observable quantities on to (a) any shoreline (b) any fish spawning area, or (c) any water intake.

3. (Continued)

b. When investigating violations within the enforcement area, COTPs should gather all available information on the following factors:

(1) Quantities and concentrations of materials discharged. (What is the estimated total amount, and the estimated concentration in the water being discharged? Does it create any visible scum on the surface or any visible cloud in suspension?)

(2) Characteristics of the migration of the material in the water. (Does it float, or remain in suspension, and for how long?)

(3) Any detectable adverse impact to the environment.

(4) Safety considerations which may have necessitated the discharge.

(5) Possible operational or engineering alterations which may help preclude such discharges in the future consistent with safety.

c. COTPs will cite, under the Federal Water Pollution Control Act, for any discharge of material observed to create any oily sheen, wherever occurring in waters of the United States.

d. COTPs will investigate, cite, and take immediate action to prevent, any discharge or threatened discharge, wherever occurring in waters of the United States, which creates an obvious threat of harm to the environment of the Great Lakes.

4. <u>ACTION</u>.

a. Captains of the Port shall investigate and take enforcement action against violations of MARPOL V on the Great Lakes in accordance with the policy stated above. Also, COTPs are encouraged to provide any information or comments which may improve this policy.

b. Other units observing the discharge of cargo residues or receiving a report of the discharge of cargo residues shall take steps to preserve evidence and make a report to the Captain of the Port for further investigation by the COTP.

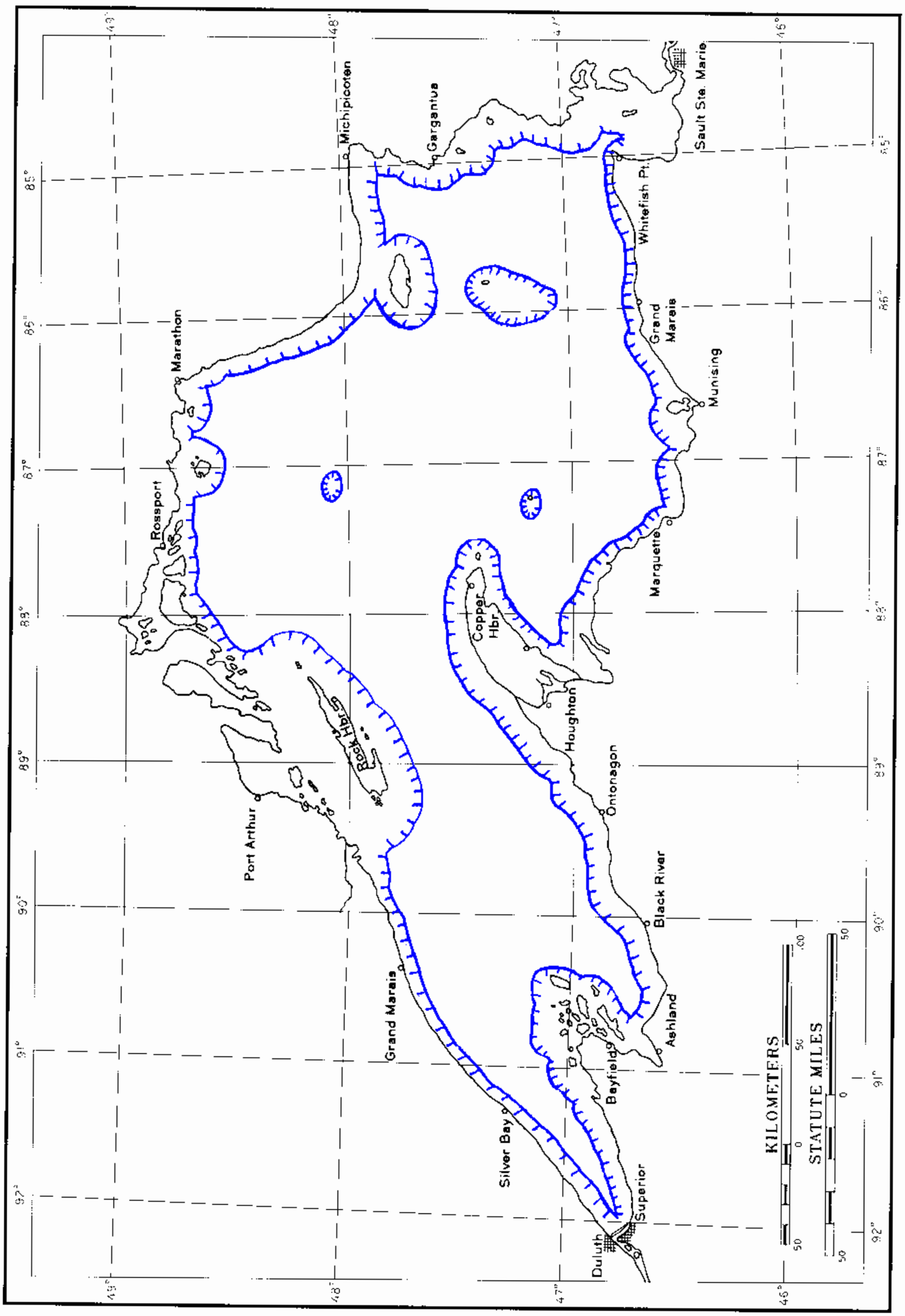
W. R. WILKINS
Chief of Staff

**APPENDIX II: Maps Depicting Recommended Protected Zones (Hatch marks point into areas recommended for protection.**

Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario

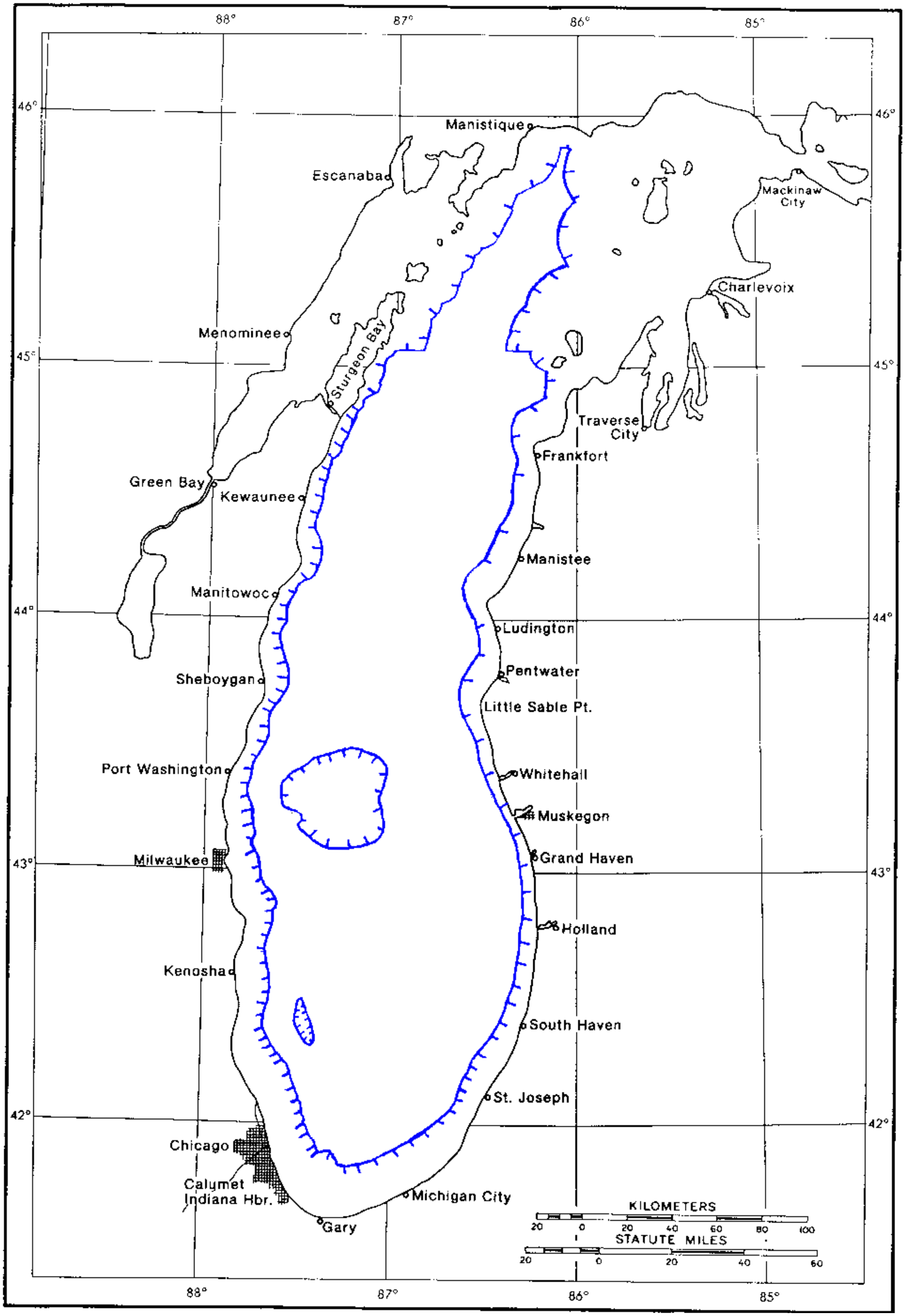
## Lake Superior -- Recommended Protected Zones

(Hatch marks point into areas recommended for protection)



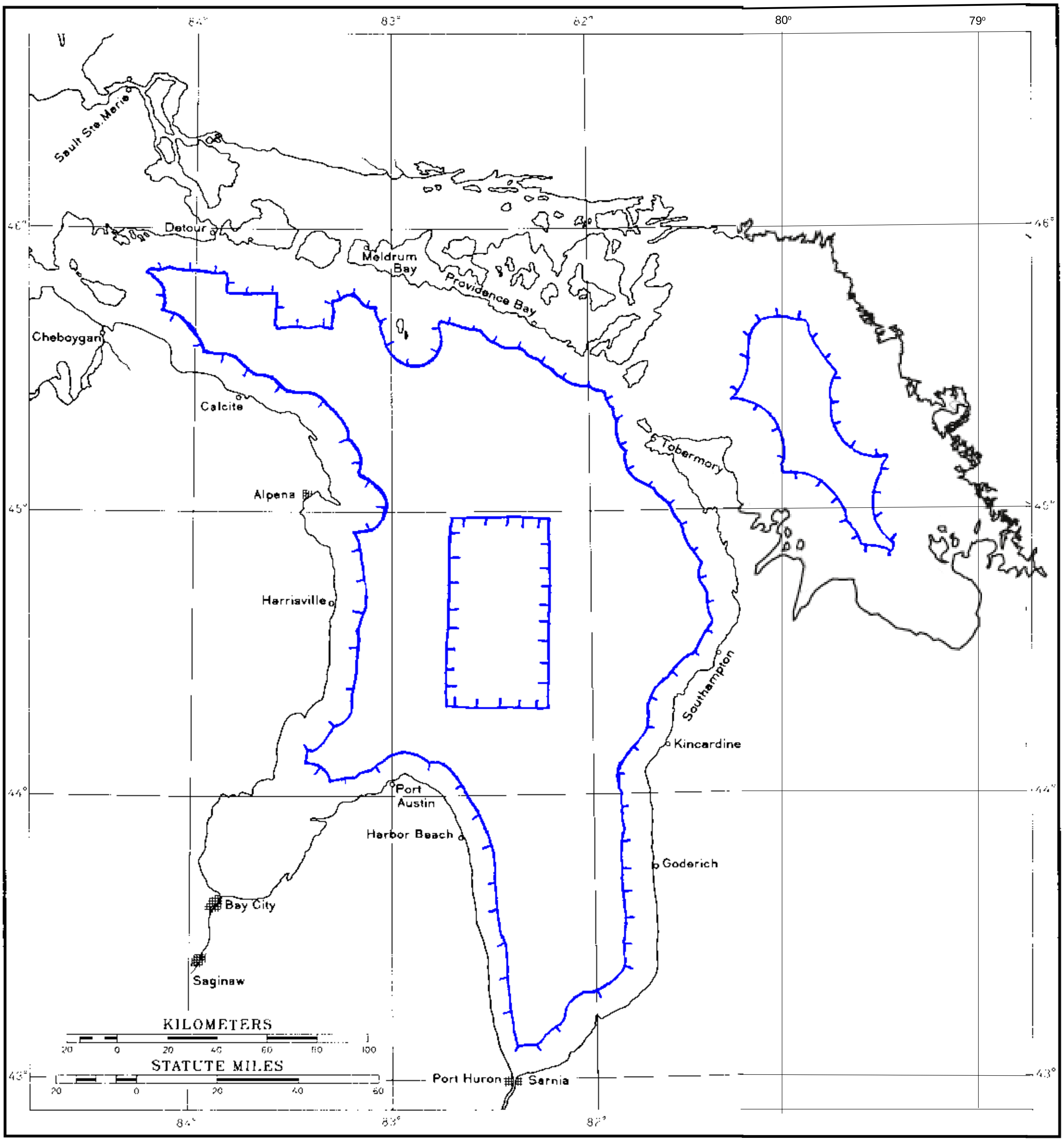
## Lake Michigan -- Recommended Protected Zones

(Hatch marks point into areas recommended for protection)

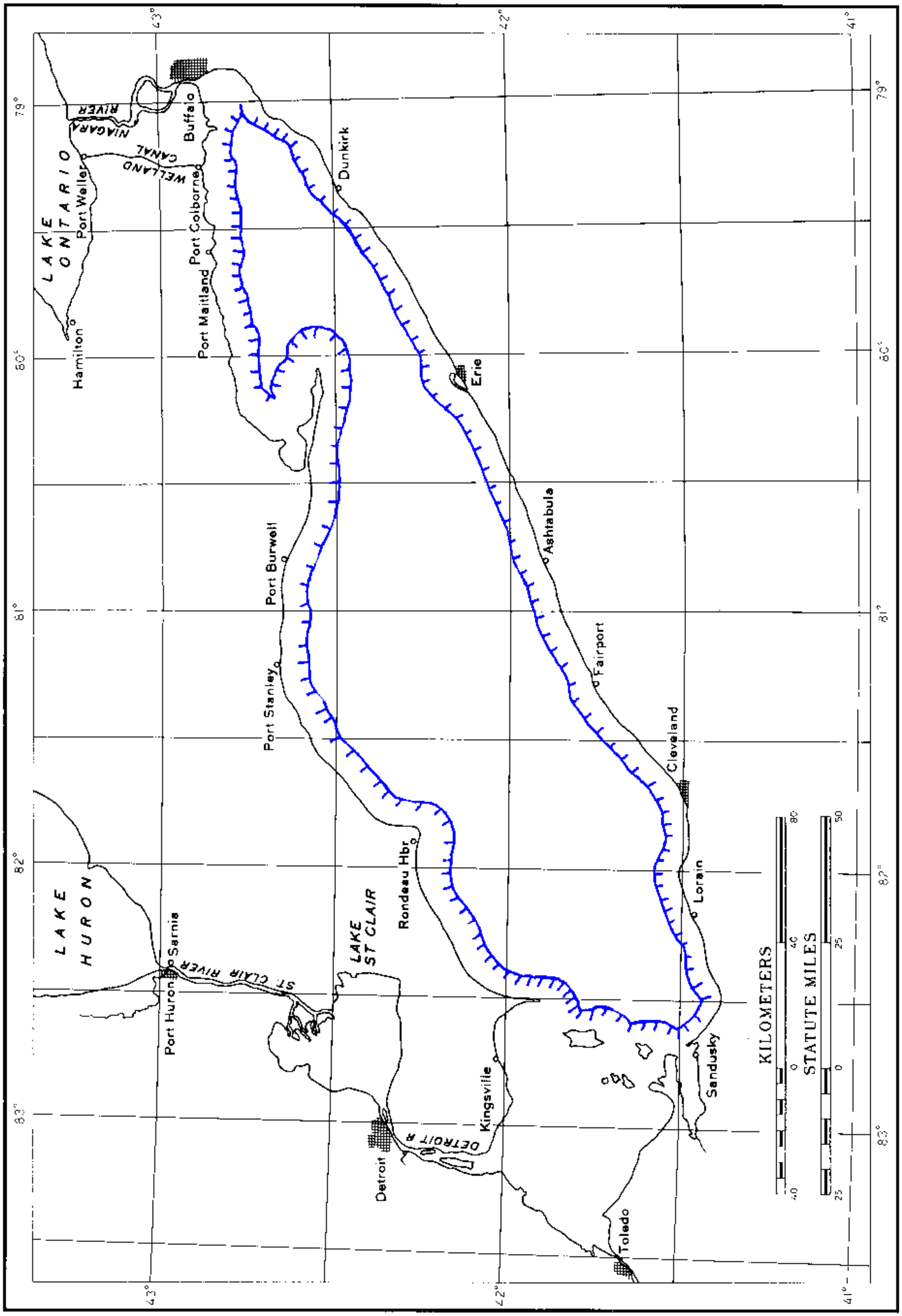


# Lake Huron -- Recommended Protected Zones

(Hatch marks point into areas recommended for protection)

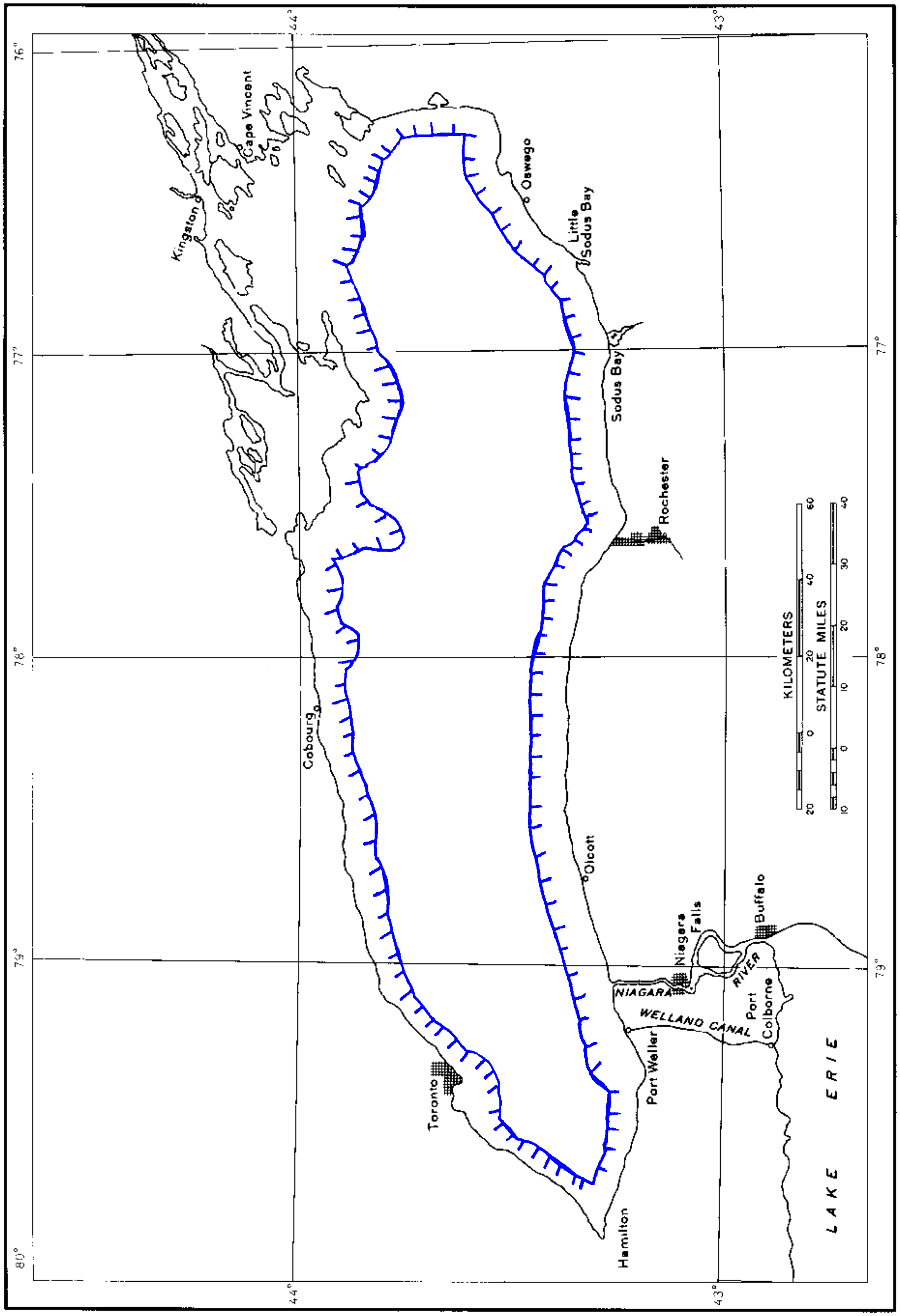


## Lake Erie -- Recommended Protected Zones



## Lake Ontario -- Recommended Protected Zones

(Hatch marks point into areas recommended for protection)



## APPENDIX III: Conversion Factors

1 kilogram = 2.2046 pounds
1 gallon = 3.7853 liters
1 cubic meter = 1000 liters = 264.2 gallons
1 nautical mile = 1.151 statute miles = 1,852 m = 6,076 ft.
1 statute mile = 0.86836 nautical miles = 5,280 ft. = 1,609 m

## APPENDIX IV: U.S. Dry-Bulk Carriage: 1993 Navigation Season

Information in the following table was obtained from the 1993 Annual Report of Lake Carriers' Association, Cleveland, OH.

| Commodity | Net Tons |
|---|---|
| Iron Ore | 57,608,273 |
| Coal & Coke | 19,548,911 |
| Limestone & Gypsum | 22,234,518 |
| Cement & Potash | 3,598,577 |
| Grain | 901,543 |
| Salt | 750,170 |
| Sand | 436,609 |