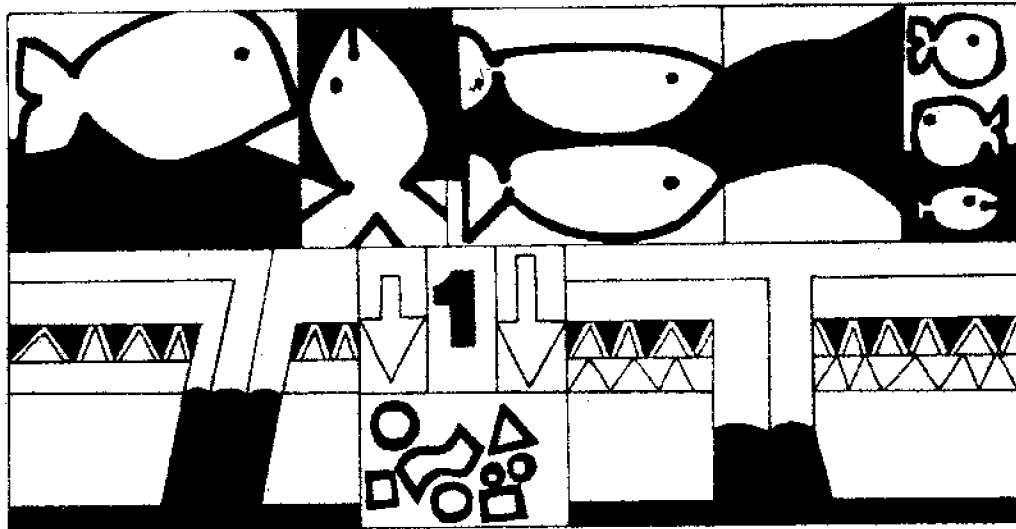


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ANNOTATED BIBLIOGRAPHY OF THE EFFECTS OF WATER
ON THE DESIGN AND MANAGEMENT OF
LAKE AND RIVER MARINAS



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SEA GRANT ADVISORY REPORT NO. 7
UNIVERSITY OF WISCONSIN

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ANNOTATED BIBLIOGRAPHY OF THE EFFECTS OF WATER
ON THE DESIGN AND MANAGEMENT OF LAKE AND RIVER MARINAS

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University of Wisconsin
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ANNOTATED BIBLIOGRAPHY ON THE EFFECTS OF WATER
ON THE DESIGN AND MANAGEMENT OF LAKE AND RIVER MARINAS

ABSTRACT

This bibliography contains 191 literature references on the effects of water on the design and management of lake and river marinas. The references are listed alphabetically by author for the following topics: (1) water quality, (2) flushing-mixing-circulation, (3) harbor improvement, and (4) shoreline modification and coastal zone.

KEYWORDS:

- Water Quality - Eutrophication, nutrients, trace metals, sedimentation, pollution sources, environmental effects, water discharge and disposal, recreation, environmental protection, lakes, estuaries, coastal waters, Great Lakes.
- Flushing-Mixing-Circulation - Nutrients, boundary layers, water temperature, diffusion, flow profile, water movement, currents, wind stress and shear, coastal, Great Lakes.
- Harbor Improvement - Breakwaters, dikes, docks, spoil banks, sediments, silting, shorelines, dredging, channel improvement, wave forces, construction, engineering, recreation demand, costs.
- Shoreline Modification and Coastal Zone - Wave action, wave forces, beach erosion, excavation, sedimentation rates, shore protection, coastal engineering, erosion control, dredging equipment, land reclamation, groins, jetties, piers, coastal zone management, environmental protection, legal actions.

WATER QUALITY

Alabama Code tit. 38, 1971, Discharge of sewage and litter from watercraft: secs. 97 (36) thru 97 (47) (Supp. 1971).

Descriptors: Alabama, legislation, recreation wastes, water pollution sources, boats, administrative agencies, boating, litter, wastes, disposal, environmental sanitation, waste disposal, water pollution, water quality, public health, sewage disposal, recreation, water utilization, water policy, safety, recreation facilities, law enforcement, legal aspects, penalties (legal), ecology.

Identifiers: Marine toilets, hazardous substances (pollution), nuisance (legal aspects).

No person shall deposit or discharge into the waters of this state materials from watercraft detrimental to the public health or to the enjoyment of water for recreational purposes. The Board of Health is authorized to formulate rules and regulations to effectively carry out these provisions. Provisions specifically related to marine toilets, on-shore trash receptacles, and a public education program are included. To enforce rules, regulations and orders of the Board of Health, provisions for prosecution and penalties are provided. Definitions of watercraft, sewage, litter, and marine toilet are listed. (Dunham, Florida).

Allersma, E., DeBruin, M., DeGroot, A. J., and Houtman, J. P., 1970, Cobalt and tantalum tracers measured by activation analysis in sediment transport studies: Interuniversit air reactor instituut, delft (Netherlands). (NTIS N71-33489), 17 p.

Descriptors: Tracers, cobalt, neutron activation analysis, sediment transport, sediments, path of pollutants, adsorption, iron, manganese, chromium, copper, gamma rays, channels, harbors, metals, sedimentation, chelation, estuaries.

Identifiers: Tantalum, Rhine River, Ems River, Chao Phya River, Amazon River, Antimony, Indium, Iridium, Terbium, Eutropium, Zinc, Lead, Arsenic, Lanthanum, Scandium, Samarium, Gamma ray spectrometry, Tantalum radioisotopes, Cobalt radioisotopes, Detection limits.

Certain research principles that can be used in investigating the origin and transport of fine-grained sediments in rivers and sea arms in connection with siltation problems of harbors and navigation channels are proposed. The element, which either does not occur in the sediment or only occurs in minute quantities, is fixed to the mud from the river or sea arm. After the material is marked it is returned to the water course where it mixes with the solids moving naturally. At specified points throughout the water course, sediment samples are taken to determine the marking element by activation

analysis. This gives an insight into the flow path of the suspended matter. The selection and successful application of tracers that can be measured by activation analysis depend on the sensitivity of detection, the natural occurrence of the relevant elements in the sediments under investigation and the fixation capacity of the tracer to the various grain size fractions. Further, the influence of the added element on the sedimentation behavior of the mud in suspension and on the desorption properties must be considered. The irradiation of CO and TA with thermal neutrons gives rise to a very sensitive evaluation of the original elements present. The fixation process of CO is restricted to sediments with special characteristics; TA, however, can adhere tightly to any sediment. Tantalum also has the advantage that its natural content in sediments is very low. Large quantities (several percent by weight) can adhere to the sediment without changing the sedimentation properties to an appreciable extent. Hardly any losses occur during leaching experiments simulating natural conditions. A detailed treatment is given of the chemical aspects of the method, including the behavior of the elements used in the light of the general environmental processes of sediment constituents in deltaic systems, and finally, the scope and limits of the method are discussed. (Holoman-Battelle)

Anonymous, 1972, Chromium in water: A bibliography: U.S. Dept. of the Interior, Water Resources Scientific Information Center, Bibliography Series No. 205, 128 p.

Descriptors: Chromium, water pollution, trace metals.

An annotated bibliography of resources pertaining to chromium in water, drawn from the information base comprising Selected Water Resources Abstracts, is presented. Three indexes classify material by significant descriptors, abstracts with full bibliographic details, and total descriptors. An author index is also provided.

Anonymous, 1972, Engineering design to prevent abuse of the ocean: Engineering Design to Prevent Abuse of the Ocean, Engineering Committee on Oceanic Resources, First General Assembly, Proceedings, Held in London, England, March 16-17, 1972; Engineering Committee on Oceanic Resources, Washington, D.C., 110 p.

Descriptors: Pollution prevention, ocean engineering, marine resources.

Papers are presented on selected facets of engineering design to prevent abuse of the ocean. Oil spills, urban waste water, toxic wastes, and methods of curbing pollution are discussed. Formal proceedings, including discussion and actions concerning the role and proper functioning of the Engineering Committee on Oceanic Resources as a whole and of its working groups, are also presented.

Anonymous, 1971, Great Lakes research: International Association for Great Lakes Research, Fourteenth Conference, Proceedings, (Held in Toronto, Ont. Can. April 19-21, 1971), 844 p.

Descriptors: Pollution, eutrophication, hydrologic data, Great Lakes.

The quality of the Great Lakes is surveyed, with emphasis on the effects of eutrophication, thermal pollution, radioactive effluents, waste disposal, electrical generating plants, and chemical pollutants on the biota, sediments and waters of the lakes. Chemical and physical limnology, geology, meteorology and hydrology are covered.

Anonymous, 1972, Project Hypo: An intensive study of the Lake Erie Central Basin hypolimnion and related surface water phenomena: Canada, Centre for Inland Waters, Paper No. 6, Feb. 1972 and U.S. Environmental Protection Agency, Technical Report No. TS-05-71-208-24, Feb. 1972.

Descriptors: Dissolved oxygen, nutrients, eutrophication.

Identifiers: Great Lakes, Lake Erie Central Basin, Project Hypo.

The causes and effects of oxygen depletion in the hypolimnion of the Central Basin of Lake Erie are studied, and the control of further eutrophication is considered. The physical processes and diffusion characteristics of the lake are discussed, along with sediment oxygen demand, oxygen-nutrient relationships and microbial activity. An automatic underwater camera system and oxygen monitors are described.

Armstrong, John M., 1971, Ecological analysis for management and development of the Great Lakes of North America: See Citation No. 72-3D-0557, 28 p.

Descriptors: Resource management, Great Lakes, Traverse Bay, predictive models.

The development of predictive models for marine resource management is discussed, with emphasis on problems arising from man's use of the Great Lakes. The effects of urbanization, recreational activities, mining, commercial fishing, waste disposal, power production and transportation are incorporated into the models, and the following features of the lakes are surveyed: Depth, circulation; flora and fauna; minerals; climate; sediments; and shoreline configuration.

Army Engineer District, Buffalo, N.Y., 1971, Sandusky harbor, Erie County, Ohio (Draft environmental impact statement): (NTIS #PB-205-795-D) 10 p.

Descriptors: Ohio, dredging, harbors, environmental effects, water pollution effects, operation and maintenance.

Identifiers: Environmental impact statement, Sandusky (Ohio).

The project involves annual channel maintenance dredging of approximately 600,000 cubic yards of spoil in the deep-draft navigation project in Sandusky Harbor, Ohio. Additionally the project involves maintenance and repair of harbor jetties, protection works, and a rock dike as needed. The dredge spoil is dumped in an open, one mile square area of Lake Erie. Adverse environmental effects of this action include the following: noise and dust during structural repair work, short-term turbidity and sedimentation, accelerated algae growth in disposal areas due to increased oxygen availability, possible adverse fish effects from polluted spoil, and further contamination of the already polluted lake from dumping polluted spoil. No quantitative measurements have been made of these effects. The only practical alternative at present is to use other dumping sites. This was considered. A plan is currently being discussed with local officials to construct an enclosed area for permanent confinement of spoil. This would be environmentally beneficial since it would prevent polluted spoil from further contaminating the lake. Also the filled area would ultimately be usable for agriculture or recreation. (Grant - Florida)

Army Engineer District, Chicago, Ill., 1972, Milwaukee diked disposal area, Wisconsin, (Draft environmental impact statement): available from NTIS, Springfield, VA 22151 as PB-208 6550, Feb. 1972, 23 p.

Descriptors: Dredging, harbors, Great Lakes, water pollution control, spoil banks, water pollution sources, sediments, industrial wastes, Wisconsin, engineering structures, runoff, seepage control, retaining walls, environmental effects, data collections.

Identifiers: Dredging disposal, Milwaukee harbor (Wisc.), Port Washington harbor (Wisc.), environmental impact statements.

The Corps of Engineers in dredging the harbor and channel projects at Milwaukee Harbor, Milwaukee County, Wisconsin, and Port Washington Harbor, Ozaukee County, Wisconsin previously disposed of the dredged material in the open waters of Lake Michigan. Proposed action would prevent polluted dredging material from reaching the lake waters by placing this material in a contained area, thereby eliminating the undesirable environmental impact of past disposal procedures. In accordance with an agreement between the Federal Water Pollution Control Administration (now EPA) and the United States Army Corps of Engineers to determine the degree of pollution of bottom sediments in harbors to be dredged, FWPCA sampled representative harbor areas in April 1968. They conclude that (1) the bottom sediments in Port Washington Harbor are not as severely polluted as those found in other Lake Michigan harbors, (2) the disposal of these sediments in Lake Michigan would not add substantial amounts of nutrients to the Lake, and (3) the water quality at Port Washington meets reasonable criteria and does not constitute a serious source of pollution except that the amount of phosphorous should be reduced.

Aubert, M., Aubert, J., Pincemin, J-M., Desirotte, N., and Brettmeyer, J-Ph., 1972, Restructuring of shores and secondary pollution. Study of the eutrophication of harbor zones: Revue Internationale d'Océanographie Médicale, Vol. 26, pp. 53-64.

Descriptors: Harbors, eutrophication, sewage, plankton.

Identifiers: Flagellates, dinoflagellates.

Harbor areas isolated from hydrological exchange with the open sea are localities of the accumulation of substances and wastes, leading to biological imbalance of the marine environment. Investigation of secondary pollution evaluated the degree of eutrophication in seventeen harbors along the coast of France. Microorganisms and plankton were studied along with organic matter, nitrates, phosphates, salinity, temperature, and currents. Conditions for eutrophication were established at the different stations, at the harbor entrances, in the harbors (which received some municipal sewage) at the bottom of the harbor basins and in harbors with no sewage. A proliferation of flagellates and dinoflagellates, particularly at the bottom of the harbor basins, was noted. Samples from the harbor entrances showed

a gradual return to a normal plankton assemblage, but still contained organic matter and bacteria which could pollute adjacent bathing beaches. (Ensign-PAI)

Ayers, John C., and Huang, Joseph C. K., 1967, Studies of Milwaukee Harbor and embayment: Michigan University, Ann Arbor, Great Lakes Res. Div., Institute of Science and Tech. Michigan University Spec. Rep. No. 30 of the Great Lakes Res. Div., pp. 372-394.

Descriptors: Water pollution effects, Lake Michigan, eutrophication.

Identifiers: Water-borne parameters, Milwaukee Harbor.

The quality of water and the biological associations of Milwaukee Harbor water and adjoining Lake Michigan water were studied to learn the mutual effects of the heavily polluted harbor on the lake and of the clean lake on the harbor. Milwaukee harbor is enclosed by a breakwater and heavily polluted by the Milwaukee River and by a sewage outfall just south of the river inside the breakwater. Municipal water intakes are located to the north and south of the harbor entrance and obtain good quality water. The distribution of oligochaetes, sphaerids, and amphipods, as well as of transparency sulfides, and dissolved solids indicate that Milwaukee Harbor is functioning as a sewage lagoon in which settlement and mineralization take place. Currents move generally northward in the area from September through March and southward from April through August. Polluted water from the harbor seldom reaches the intakes to the city water system, and on the few occasions it does it is much diluted by lake water and somewhat purified by its residence in the harbor. (Knapp-USGS)

Bader, Richard G., Ragotzkie, Robert A., 1972, Nonrenewable resources: The Water's Edge: Critical Problems of the Coastal Zone, Coastal Zone Workshop, papers, Ketchum, Bostwick H. (Ed.) (Held in Woods Hole, Mass., May 22-June 3, 1972). Co-sponsored by Institute of Ecology and Woods Hole Oceanographic Institute of Ecology and Woods Hole Oceanographic Institution. MIT Press, Cambridge, Mass., pp. 63-83.

Descriptors: Coastal zones, resource management, dredging, mineral exploitation, oil and gas operations, environmental protection.

Exploitation of coastal and offshore resources is discussed, with emphasis on the environmental impact of dredging and mining operations. Consequences of oil, natural gas, and mineral exploitation are surveyed, along with the effects of sand, gravel, and shell extraction. Current coastal zone mines and mineral resource deposits are described, and recommendations for protecting and utilizing coastal zone resources are proposed.

Blumenthal, I. S., 1971, Positive pollution: Rand Corporation, Santa Monica, Calif. Publication No. P-4613, 37 p. Presented at American Society for Oceanography, National conference (Held in Long Beach, Calif., March 11, 1971).

Descriptors: Pollution, recreation, marine life.

An examination is made of various forms of marine pollution to see if they might in any way enhance man's enjoyment of marine recreation. Thermal pollution, chemicals, oil, organic wastes, organic waste conversion, and solid wastes all have certain positive effects on marine life, fishing, swimming, surfing, and boating.

Born, S. M., and Yanqgen, D. A., 1972, Understanding lakes and lake problems: Wisconsin Univ., Madison. Cooperative Extension Programs. Publication No. G2411, May 1972, 41 p.

Descriptors: Lakes, eutrophication.

Identifiers: Wisconsin Department of Natural Resources.

This article is oriented to the general public. It contains illustrations and discussions of lake processes, problems, and some solutions. The aquatic ecosystem is complex and its components interrelated, life forms depending upon one another for existence. The contrast between natural aging of lakes and man-induced aging is pictured. While the amount of surface water is relatively fixed, human pressures on lakes are sky-rocketing. The principal water quality problems encountered in lakes come from the processes of contamination, sedimentation, and accelerated eutrophication. Careless shoreland usage can increase the amount of eroded material that enters and gradually fills a lake. Pollution from septic tanks and surface runoff can impair water quality. Restricting nutrients to lakes by diverting waste waters improves the lakes, but increasing costs of advance waste treatment must be met. Lake rehabilitation requires solid technical expertise, money, and a "no-guarantee" kind of patience. Citizen interest, understanding, and cooperation are vital to undertaking such programs which must be carried on in conjunction with the appropriate federal and state agencies. (Jones-Wisconsin)

Bowden, K. F., 1972, Application of diffusion processes to the dispersion of pollutants: See citation No. 72-5B-1658, pp. 91-97.

Descriptors: Pollution diffusion, diffusion-advection models, pollutant dispersion.

After referring to various approaches which may be made to obtain estimates of the dispersion of pollutants, some relevant solutions of the diffusion from an instantaneous point source, discharge from a continuous source into a mean flow, and the effects of interaction between a shearing current and diffusion. A brief indication is given of other processes which affect the dispersion of pollutants.

Broenkow, William W., 1971, Hydrographic observations in Monterey Bay, California: See citation No. 72-6B-1877 p. 30.

Descriptors: Monterey Bay, hydrographic observations, nutrients, abstract only.

Measurements of phytoplankton standing stock temperature, salinity, dissolved oxygen, phosphorus, nitrate, nitrite, ammonia and silica in nearshore Monterey Bay are reported. Small-scale variations in distributions occur, reflecting localized sources of nutrient ions. Nutrient sources include 8 sewage outfalls, 3 streams, the Elkhorn Slough and the upwelled deeper waters from Monterey Submarine Canyon. Drift cards have been released at monthly intervals to study surface currents, and net surface drift was found to correspond to changes in the wind field. Short-term variations in hydrographic properties related to tidal and internal wave oscillations were also studied.

Cole, Bruce J., 1973, A report on the second marine recreation conference: Boating in New England, 1973: New England Marine Resources Information Program, Univ. of Rhode Island, Narragansett, NEMRIP P277, 36 p.

Problems facing pleasure boaters, dealers and manufacturers in New England are presented. Boating safety standards and developments, environmental issues, shoreline use and planning, and boating interests organization were discussed. A list of participants and conference program are appended.

Defense Documentation Center, Alexandria, VA., 1971, Water pollution from erosion: Available from the National Technical Information Service as AD-722 960, DDC bibliography - TAS-71-11, 138 p.

Descriptors: Erosion, water pollution, sedimentation, harbors, lakes, inland waterways, industrial wastes, sanitary engineering.

Identifiers: Radioactive fallout.

This bibliography consists of references to reports on the presumably damaging deposition of earth materials in water. Soil sediments are considered to be pollutants if they would seem to interfere with the use of water for navigational, recreational, agricultural, biological, or ecological functions. The entries were selected from references to unclassified and unlimited reports processed into the ad data bank from January 1953 through December 1970. Corporate author-monitoring agency, subject, title, personal author, contract, and report number indexes are provided.

D'Ittri, Frank M., 1971, The environmental mercury problem. Michigan, State University, East Lansing, Institute of Water Research, Technical Report No. 12 303 p. Michigan, House of Representatives, 75th Legislature, Regular Session of 1970, Journal No. 48.

Descriptors: Mercury uptake, environmental surveillance, Great Lakes, Great Lakes mercury contamination.

A comprehensive report is made of the extent of mercury pollution, particularly as it occurs in the Great Lakes. Background mercury concentrations are discussed, along with methods used for determination of mercury. Suggestions are made for the decontamination and restoration of mercury polluted areas.

DeLoach, R. E., Jr., 1972, Oxygen sag and stream self-purification: Water Pollution Control Federation, Wash., D.C. Journal, 44(6): 1198-1204.

Descriptors: Water pollution, estuaries, purification.

A review of 1971 literature is presented. Self-purification models, longitudinal dispersion, reaeration and oxygen transfer, water temperature, benthic deposits and demands, and biochemical oxygen demand kinetics were described for rivers, lakes and estuaries.

Dolan, Robert, Hayden, Bruce P., Hornberger, George M., et al., 1972, Classification of the coastal environments of the world. Part I. The Americas; U.S. National Technical Information Service. Government Reports Announcements, 72(8): 103.

Descriptors: Coastal zones, climatology, topography.

In the Classification of the Coastal Environments of the Americas, each attribute of the coastal environment was independently classified prior to integration into the total system. The atmospheric system was treated using the methodology of air mass climatology, and the marine environment was classified using water mass analysis with modifications appropriate to near-shore conditions. The classification of shoreline interfaces was developed by detailed analysis of coastal landforms.

Dyer, R. C., 1971, Devices for cleaning the bilge water and the like in watercraft; U.S. Patent No. 3,589,608, 2 p. 2 fig. 4 ref. Official Gazette of the United States Patent Office, Vol. 887, No. 6, p. 2016.

Descriptors: Patents, waste water treatment, water pollution control, sewage treatment, microorganisms.

Identifiers: Chemical treatment, bilge water.

A container charged with an antimicrobial compound, as for example, dichlorophen, when inserted into ships bilge water will cause the compound to be dispersed into the water. The container is made of a material having pores through which water may move to contact the antimicrobial agent which is present as a solid and remains within the container.

Federal Water Pollution Control Administration, Washington, D.C., 1969, Second session of the conference on the matter of pollution of Lake Michigan and its tributary basin: Proceedings of the second session, conference on pollution of Lake Michigan and its tributary basin, Illinois, Indiana, Michigan, and Wisconsin, held February 25, 1969 at Chicago, Illinois, Vol 1; 364 p., Vol 2, pp. 365-968.

Descriptors: Conference, Lake Michigan, water pollution sources, phosphorus, water pollution control, ships, harbors, beaches.

Identifiers: Watercraft wastes, alewife, oil spills.

The second session of the 1969 conference on the pollution of Lake Michigan heard representatives from the corps of engineers, Michigan, Indiana, Illinois, Wisconsin, Department of Agriculture, FWPCA, the 5th Army, and Navy on problems and solutions to water pollution, treatment, and elimination, including dredgings, disinfection, chlorine residues, municipal and industrial waste water treatment, soil erosion, flood plain control, economics, storm and waste water sewerage, diversion, interstate transportation of industrial wastes, federal-state concurrent jurisdiction, sampling, monitoring, watercraft and shipping wastes; pollution of marinas and beaches, law formulation and enforcement, shore disposal facilities, insecticides, interstate standards, programs for reducing sediment pollution and erosion damage. Also outlined were waste control and treatment in federal installations and shipboard disposal systems, uniform regulations on watercraft wastes, nuclear plant wastes, and thermal pollution standards, state water quality standards, utilization of thermal water, and alewife die-off. It was concluded that an average 80% reduction of phosphorus loadings into lake Michigan can be achieved by 1972. (Auen-Wisconsin)

Foehrenbach, Jack, 1972, Eutrophication: Water Pollution Control Federation, Washington, D.C. Journal, 44(6), 1150-1159.

Descriptors: Eutrophication, nutrients, toxicity, coastal zones.

The enrichment of natural bodies of water by nutrients continues to prompt studies on several aspects of the entire eutrophication process. Sources of nutrients, ecological factors related to algal blooms, control of eutrophication in lakes and coastal zones, and the removal of nutrients, especially phosphorus and nitrogen, are reviewed from the 1971 literature.

Foess, G. W., 1972, Aquatic sediments: Water Pollution Control Federation, Washington, D.C. Journal, 44(6), pp. 1211-1218.

Descriptors: Sediments, water quality, sampling sediment transport.

Sediments play a predominant role in determining water quality, both as a pollutant and as a transporting or catalytic agent. The 1971 literature on sediments in lakes, rivers, estuaries, and the marine environment is reviewed. Sediment influence on water quality, including nutrients and pesticides in sediments and effects on the growth of organisms, was studied. Several workers considered methods of reducing or eliminating the detrimental impact of sediments. Sampling and analysis methods were also investigated, as well as chemical and biological aspects of sediments (trace element concentrations, phosphorus and nitrogen concentrations as a result of wastewater effluents, bacterial composition, oxygen demand, number and diversity of benthic organisms, and the biological methylation of mercury). Sediment transport studies are also discussed.

Frontier, 1970, Lake Michigan--can it survive?: 30(1), pp. 4-10.

Descriptors: Water pollution, fishes, biological indicators, thermal pollution, Great Lakes.

Extensive studies of the physical, chemical, and biological properties of Lake Michigan have been conducted since about 1955. Evidence of aging, mathematical modeling, fish population, microbiological indicators, dredgings, thermal and mercury pollution, pesticide contamination, federal pollution control action, and progress in pollution control are discussed.

Geinopolos, Anthony, Vilen, Frank I., 1971, Process evaluation - phosphorus removal: Water Pollution Control Federation, Washington, D.C. Journal 43(10), pp. 1975-1990.

Descriptors: Phosphorus, eutrophication, waste effluents, Great Lakes, Wisconsin.

Regulatory enforcement steps are presently being taken to insure the substantial removal of phosphorus from the domestic and industrial wastewaters of those municipalities bordering lakes. The Kenosha, Michigan, Water utility study is described, including methods and techniques used in sampling and phosphorus determinations/removal processes.

General Electric Co., Re-entry and Environmental Systems Div., 1972, Watercraft waste treatment system development and demonstration report: NTIS 72(11), p. 131.

Descriptors: Waste treatment, sewage disposal, shipboard equipment.

A shipboard sewage treatment system designed to process sanitary, culinary and laundry wastes during prolonged sea trials consisted of: comminution of

solids for ease of transport and further treatment, electrocoagulation of sewage for removal of suspended solids, solids separation, soluble biochemical oxygen demand (BOD) reduction with carbon adsorption, coliform bacteria removal, and solids incineration. Advantages of the system are discussed. Waste stream characterization showed the BOD and suspended solids levels of shipboard wastes to be 2-3 times the concentrations common to municipal wastes. The electrochemical system's practicality and economic viability were demonstrated.

Genovese, S., 1970, Eutrophisation: Recentes orientations pour de nouvelles perspectives. *Revue Internationale d'Océanographie Médicale*, 29, pp. 53-61.

Descriptors: Eutrophication, water quality, nutrients.

The concept and the term of eutrophy have undergone an evolution. In the beginning, according to its etymology, it referred to a natural and optimal condition of stretch of water, characterized by its wealth of nutritive substances. Now, the term of eutrophication is employed only to indicate pollution conditions which are due to an excess of organic substances or to the action of man. This had led to a consideration of new studies and experiments on samples of fresh water, marine water of some estuarine areas, and brackish water lagoons in order to use this great potential of nutritive wealths at different levels of the trophic chain.

Goering, John J., 1972, The role of nitrogen in eutrophic processes: See Citation No. 72-40-0587, pp. 43-68.

Descriptors: Water pollution, eutrophication, nitrogen, algae.

Pathways of the nitrogen cycle which appear to be more important when considering so-called nuisance, cultural, or artificial eutrophication are emphasized. Topics discussed include: nitrogen compounds, wastewater, nitrogen transformations induced by freshwater and macroorganisms, nitrification and denitrification in eutrophic processes and dynamics of nutrients and organism growth.

Goodier, J. L., Schiff, D., Stevens, J.L., 1971, The prevention of spills of oil and chemicals into Baltimore Harbor and environs: Litt (Arthur D.) Inc., Cambridge, Mass. Report No. #-72919, 285 p.

Descriptors: Oil spills, chemical pollution, harbors, industrial pollutants.

The spill exposure hazard from the commercial-industrial complex surrounding Baltimore Harbor and the danger areas of potential spills were assessed, and detailed recommendations for their prevention, containment, and cleanup are given. Notes on location and hydrology, analysis of commercial traffic, and an inventory of spill containment and recovery capabilities are discussed. Detailed surveys of area plants including raw materials, finished products, and controls, are provided, and 4 appendixes include a directory of the various business concerns in the area, a survey of the harbor conducted for the Water Quality Office, a paper on environmental conservation from Shell Oil Company and the water pollution control operational plan adopted by Texaco of Baltimore. The possibility of a massive chemical spill is a continual threat as there are no standards, regulations for the storage and/or transport of hazardous chemicals. Most industrial complexes bordering the harbor lack

even basic equipment to warn of, confine, or contend spills. Most of the potential water pollution hazards could be corrected through the institution of appropriate procedures and/or minor modifications of existing equipment of facilities. The majority of existing pollution hazards will not be voluntarily corrected; enactment and enforcement of standards will be necessary.

Grancini, Gianfranco, Cescon, Bruno, 1972, Observations of dispersal processes of pollutants in Venice lagoon and in the Po River coastal area: See Citation No. 72-5B-1658, pp. 99-110.

Descriptors: Adriatic Sea, pollution diffusion, tracers.

Results are presented of the preliminary phase of a long-term study of dispersion of pollutants in coastal waters of the North Adriatic Sea, controlled by physical, chemical and biological processes. Pollutant dispersion was studied in the Venice lagoon and the Po River. Measurements were made of several chemical and physical parameters related to the eutrophic conditions of canals. Nitrate was used as a tracer to monitor the pollution level. Dynamic properties of the plume resulting from the run-off of the Po River were investigated. The process of dilution of freshwater is vertically and laterally reduced by the presence of a horizontal pycnocline and by a front that hinders a continuous mixing with the surrounding seawater, restricting the polluted waters to a thin surface layer.

Hann, Roy W., Jr., Slowey, J. Frank, 1972, Texas Gulf coast sediments and water quality management: See Citation No. 72-4D-0630, pp. 577-597.

Descriptors: Dredging, sediments, Texas Gulf Coast, water quality control.

The role of the dredging industry in environmental modification and as a source of primary and secondary environmental pollution is discussed. A research program being carried out to define and quantify the magnitude of potential secondary environmental pollution in Texas bays and estuaries is described.

Helz, G.R., 1974, Wastewater as a major source of some toxic trace metals in the Chesapeake Bay--an evaluation of the problem: Department of Chemistry, University of Maryland College Park, Maryland, and Huggett, R.J., Virginia Institute of Marine Science, Gloucester Point, Virginia.

It has been estimated that 1.2×10^9 gal. of wastewater per day are dumped into the Chesapeake Bay and its tributaries; this currently represents about 2% of the continental runoff entering the Bay. Analyses of effluents from sewage treatment plants, although strongly dependent upon the nature of the sources and the nature of treatment, reveal orders of magnitude higher concentrations of Cr, Cu, Zn, Cd, and Pb than are found in unpolluted river waters. Thus wastewaters appear to be a dominant source for these metals in the Bay. On the other hand, studies at Back River, Md., and elsewhere near large sewage treatment plants indicate that these metals are rapidly removed from the water column into the sediments. The mechanism of removal appears to be incorporation in organic particles which settle rapidly. As a result, although sediments within a few miles of treatment plants are highly enriched in trace metals, the overlying waters are enriched only near the outfall. The ecological impact of this enrichment is not certain at present, because we have inadequate knowledge of the chemical, physical and biological processes that may remobilize metals from sediments. Field evidence at Back River indicates some remobilization into the water column of Mn, Cd, and possibly Cu.

Hill, D.O., 1973, Adaptation of mathematical modeling techniques to Mobile Bay for water quality management: A review: Journal of Marine Science, 2(2), pp. 19-36.

Descriptors: Mathematical Models, water quality control, marine pollution, bays, Alabama Coast.

The mathematical model is an effective tool in solving problems associated with water resources and pollution within Mobile Bay, Alabama. Models developed for similar water systems minimize duplication of effort in applying this method to Alabama coastal waters. A 2-dimensional (surface) model based on the equations of change for open systems was adopted. This included the analysis of the hydrodynamic (current), thermodynamic (temperature), and material transport (salinity) properties within the water mass.

Holland, R.E., Beeton, A.M., 1972, Significance to eutrophication of spatial differences in nutrients and diatoms in Lake Michigan: Wisconsin University, Milwaukee Center for Great Lakes Studies, Limnology and Oceanography, Vol. 17, No. 1, pp. 88-96.

Descriptors: Sampling, nutrients, diatoms, Lake Michigan, eutrophication, spatial distribution, Great Lakes region, Wisconsin.

Identifiers: Chlorophyll a, Chlorophyll c, Carotenoids.

Water samples were taken from a water-cooling intake at a depth of about 4 m from a railroad ferry between Milwaukee, Wisconsin, and Ludington, Michigan, May 27, 1970 to January 6, 1971 to determine inshore-offshore differences in species and abundance of diatoms, and concentrations of phosphorus, silica, nitrate, and pigments. The various nutrients and pigments were determined, and the diatoms identified by previously described methods. Inshore waters (within 16 km of shore) had greater diatom populations, different species composition within the diatom communities, and different concentrations of major nutrients and pigments than offshore waters (greater than or equal to 16 km from shore). Results indicate that data from water intakes which have been used in the past to document changes in the lake may have represented only local conditions. (Snyder-Battelle)

Hood, Donald W., Kelley, Eleanor, 1972, Contamination and coastal pollution through waste disposal practices: See Citation No. 73-60-00521, pp. 146-186.

Descriptors: Coastal waters, water pollution, environmental protection, waste disposal.

Major concerns about addition of foreign materials to coastal waters are discussed, including concentration of contaminants added to local regions; rates of contaminant mixing and transport; contaminant phase distribution; specific biology and chemistry of pollutant and environment interactions; effect of pollutant on vital life processes; rate of contaminant biodegradation or geochemical removal; food chain concentration factors; prognosis for future pollutant additions; and special factors such as addition pathogens and aesthetic deterrents. Effects of trace metals, plant nutrients, petroleum, PCB and DDT compounds, plastics and other synthetic organic chemicals, solid wastes, radioactivity, pathogens, thermal effluents, dredging, filling, and marine mining are considered. Recommendations for coastal zone management are proposed.

Hopkins, Thomas S., 1972, The effects of physical alteration on water quality in Mulatto Bayou, Escambia Bay: Florida Academy of Sciences, Gainesville, Quarterly Journal, 35(1), 23 p.

Descriptors: Dredging, DO, stratification, water quality, estuaries, Florida coast.

Water quality and flushing were studied for 12 months after recent physical alterations: the construction of Interstate 10 and subsequent real estate development. The most recent alterations of Mulatto Bayou, located on the East side of the bay, also involved maintenance dredging in response to local citizens' protests over loss of access to the bay. In the dredged channel, DO values measured at 3 m depth dropped to below 4.0 mg/l almost immediately. During the summer months stratification develops, and dye studies confirm that excessive engineering has resulted in poor flushing.

Jarkivicz, Thomas P., Jr., Kuzoninski, Lawrence, 1973, A Review of outboard motor effects on the aquatic environment: Journal Water Pollution Control Federation, Vol. 45, No. 8, pp. 1759-1770.

Deals with the compounds of fuel and oil discharged into waters from two-stroke outboard engines. Most notable of these compounds is raw fuel. Disputes the previous findings that the quantity of compounds emitted to receiving waters is not a constant for all engines. Average value for this quantity has been estimated at between 10-20%. Other findings indicate that up to 55% of original fuel can be discharged into receiving waters.

Kardos, L.T., 1972, New approaches for pollution control: Pennsylvania State Univ., University Park, Dept. of Soil Physics. In: "The Shape of Things to Come," Proceedings 26th Annual Meeting, Soil Conservation Society of America, August 15-18, 1972, Columbus, Ohio, pp. 220-226.

Descriptors: Water pollution control, waste water disposal, filtration, sewage effluents.

Soil can be utilized as a "living filter" with the higher plant growth an integral part of the system and complementary to the microbiological and physiochemical components in the soil. By diverting sewage plant effluents from streams to the "living filter," the nutrients which had undesirable effects in water bodies enhance crop and fiber production. The two nutrients, phosphorus and nitrogen, primarily responsible for eutrophication, can be removed from waste water by application of two inches, at weekly intervals, to the land. The biological systems remain in balance and only 129 acres are required for every million gallons of effluent per day which needs to be diverted from the streams or lakes. Data obtained indicate that, in the absence of severe erosion, agriculture does not contribute important amounts of phosphorus toward eutrophication over and above that which normally leaches from the geological substratum. Close controls are necessary to avoid breakthrough of excessive amounts of nitrogen into groundwater supplies. With proper management, agricultural lands can provide a waste disposal system which can minimize pollution of water resources. (Jones-Wisconsin)

Leendertse, J. J., Gritton, E.C., 1971, A water quality simulation model for well mixed estuaries and coastal seas: Vol. III, Jamaica Bay simulation: Rand Corporation, New York City--Rand Institute, report No. 709, 70 p.

Descriptors: Water quality, waste disposal, estuaries, New York.

Progress on a water quality simulation model study of Jamaica Bay, Long Island, New York, is reviewed. Experiments made to adjust the tidal flow in the model are described; these simulations indicated that the tide can generate a circulation in the bay. Presented also is a similarity of the transient movements of constituents in the bay. Distributions of salinity, dissolved oxygen, biochemical oxygen demand, and coliform bacteria were computed simultaneously. The results are presented in charts with isocontours of the concentration of substances. The variations of the concentration are considerable, particularly variations of coliform densities. The approaches used for the design of the simulations are given, as well as an analysis of the applicability of the model.

Lin, K.C., Blum, J.L., 1973, Adaptation to eutrophic conditions by Lake Michigan algae: Wisconsin Univ., Milwaukee Dept. of Botany, NTIS #PB-220-013, 24 p.

Descriptors: Aquatic algae, sessile algae, phosphorus compounds, phosphates, Lake Michigan, Wisconsin.

Identifiers: Milwaukee River, Milwaukee Harbor.

Algae, when supplied with sufficient orthophosphate, can absorb phosphorus in quantities far in excess of the amount needed for optimal growth. This surplus phosphorus is then available for the algae to continue to grow when the external supply of orthophosphate is depleted. Studies were conducted on *Cladophora glomerata* and *Ulothrix* sp. to determine whether algae could utilize polyphosphate. Results showed that the extractable orthophosphate was inversely proportional to the ability of the algae species to hydrolyze either pyrophosphate or tripolyphosphate. Field investigations indicated that algae growing near the Milwaukee Harbor area received a sufficient supply of orthophosphate, whereas the algae located some distance from the harbor did not. It is likely that the algae accumulated the soluble orthophosphate supplied by the waste water effluent and non-point sources discharged by the Milwaukee River. At the same time, the insoluble polyphosphate and organic phosphates dispersed into the open lake. The algae growing furthest from the harbor provided phosphatases to hydrolyze the polyphosphates because of the lack of orthophosphate. This method of phosphorus assimilation by the algal metabolism produced less substantial growth. Field samples were collected in 1971 from four sample sites in the Milwaukee Harbor and five sites in Lake Michigan with a five kilometer radius of the harbor. (Kerrigan-Wisconsin)

Ludwig, H.F., Thoman, J.R., Storrs, P.N., 1972, Trends in marine waste disposal, good and bad: Engineering-Science, Inc. Pasadena, Calif., Coastal Zone Pollution Management, February 21-22, 1972, Clemson University, Clemson, S.C., 1972, pp. 105-130.

Descriptors: Waste disposal, environmental effects, planning, economics.

The overall objective in planning for marine waste disposal is to provide an economical means of disposal with minimum adverse effects on the environment. The first problem is essentially technical in nature: the problem of defining the effects of waste waters and their constituents on the marine environment, and the paucity of scientific parameters available for making such assessments. A second problem is defining "adverse effects" in any given situation. Temperature, DO, pH, suspended solids, floatables, oil grease, nutrients, metals, bacteria and pesticides are considered along with changes in light transmission, benthic organisms and sediment characteristics. The current trend in marine water quality standards appears to shortcut essential investigation and research and to establish the answers by legislative or regulatory fiat. In most cases this will result either in uneconomical utilization of resources or in less than maximal protection of environmental resources.

Mack, W.N., D'Ittri, F.M., 1973, Pollution of a marina area by watercraft use: Michigan State Univ., East Lansing, Dept. of Microbiology, Journal Water Pollution Control Federation, Vol. 45, No. 1, pp. 97-104.

Descriptors: Coliforms, marinas, water quality standards, water pollution sources, Great Lakes, Michigan, Boats.

Samples of water from a marina used by watercraft were tested for the numbers of coliform organisms. The tests indicated a slight increase in coliform organisms in the slips most frequently used by the yachts. However, outside sources of contamination probably added to the total number of organisms in the area. Although the increase in the number of organisms was related to the number of yachts in the marina, the concentration was far below the standard of total body contact established by the Water Quality Standards Committee for Michigan Intrastate Waters. Finally, selected chemical parameters show no indication of human pollution because chemical analyses of water samples taken at the marina were all within normal limits. Bacteriological coliform organism analyses were proven to be a much more sensitive indication of human pollution. Other factors contributing to the presence of the coliform organisms, such as township septic tank discharges and fecal deposits from sea gulls in this largely unpopulated area, were investigated and considered relatively unimportant.

Maritimes, 1971, Harbor dredging presents another waste disposal problem: Vol. 15, No. 4, pp. 11-13.

Descriptors: Bays, harbors, dredging, waste disposal, waste dumps, marine animals, Rhode Island.

Identifiers: Providence (R.I.), Providence River, Narragansett Bay.

Dredged spoil from the dredging of harbors and rivers must be disposed of economically and with minimum damage to the environment. Dredging wastes from Providence Harbor, Rhode Island, which were deposited in the Rhode Island Sound outside Narragansett Bay from December 1967 to September 1970, were studied to determine the resulting physical changes in the dumping area and effects on marine life. Two bathymetric surveys with sonic depth recorders and diver observations were utilized. Small currents and tides appeared incapable of depositing any of the spoil material on or near the area beaches. Direct effects on marine life were limited, with the major fisheries of finfish, lobster and quahogs being disturbed only slightly. Concluding recommendations for ocean dumping were: unpolluted or coarse materials should cover polluted or silty materials; bottom current information should be obtained before dumping fine-grained sediments; permanent records of dumping sites and their surrounding areas should be maintained; and benthic animal colonization should be monitored until permanent communities are established.

Markus, Robert, -- , Removing spilled gasoline from boat bilges: Sergeant, Harrison Township Fire Department, Mount Clemens, Michigan.

Imbiber beads, a pollution control chemical developed for cleaning up hydrocarbon spills and alleviating water pollution is proving useful in removing spilled gasoline from the bilges of pleasure boats.

McGavock, John H., Schworm, William B., 1972, Guarding the Great Lakes: Water and Wastes Engineering, New York, 9(3), pp. 37-39.

Descriptors: Marine pollution, ships, wastewater, Great Lakes.

A new sewage system, designed to handle sanitary and other wastes from ships and shore-based facilities around Lake Michigan is described. The system is expected

to process sewage, solid waste, and the liquid wastes peculiar to ships: Bilge, wash, and ballast water. It will provide secondary treatment for all sanitary waste, as well as other kinds of shipboard waste, and tertiary treatment for phosphate removal.

Mercury Marine Inc., 1973, Analysis of pollution from marine engines and effects on the environment: Boating Industry Assoc., Project No. R801799-02-4, August 31, 1973.

A study, jointly funded by the U.S. Environmental Protection Agency and the Boating Industry Associations, was launched in April, 1971. The study was concluded on August 31, 1973. Major objective of the study was to determine the effects, if any, of two-cycle outboard engine emissions on aquatic environments.

The study involved both laboratory and field investigations. The laboratory phase was conducted by the departments of Civil and Mechanical Engineering at the University of Michigan, Ann Arbor, Mich. The field studies were conducted by Environmental Control Technology Corp., Ann Arbor, Mich., and Environmental Science and Engineering, Inc., Gainesville, Fla.

Objectives of the laboratory studies were to identify and quantify the major components of submerged exhaust emissions from outboard engines. Special studies included the effects of outboard engine exhaust components on representative species of the biota of natural waters.

The field studies were performed in two, one-half acre lakes near Saline, Mich., and in three lakes of 2 to 10 acres near Archer, Fla. No boating activity had occurred on any of the lakes and they received no other pollutional inputs other than the stressing from two-cycle outboard engines. Each of the two Michigan lakes were divided to provide two stress sections and two control sections, and leaded and non-leaded fuels were used. All engines used were "drainless". This allowed for biological and chemical sampling and analyses of resulting data on a "paired" basis. In Florida, one lake was stressed with a "drainless" engine and one with an engine which "drained" unburned fuel into the water. The third lake served as a control. Leaded fuel only was used in the Florida studies. In general all chemical and biological sampling and data analyses were performed by routine standard procedures.

Engines used in the laboratory and field studies were standard production models. Before use in the field, each engine was "aged" by running the engine for approximately 50 hours, the equivalent of one year of normal operation.

Stress rate for the field studies was established by determining, as closely as possible, the number of motorboats that reasonably could be expected to occupy a given surface area of water under optimum (saturation) use conditions. This optimum stress level was tripled for the purposes of this study, resulting in an average stress level of 1 gallon of fuel per million gallons of water per day.

Michigan Water Resources Commission Bureau of Water Management Water Quality Appraisal, 1973, Impact of Outboard Motor Operation on Water Quality: Water Quality protection project, Houghton Lake, Michigan. Technical Bulletin No. 73-1 Department of Natural Resources Lansing, Michigan

The impact of current outboard motor usage on Houghton Lake water quality was investigated during 1972.

Estimates of the total number of two-cycle outboard engines used on Houghton Lake by residents during the June-July and August-September periods were 3122 and 3402, respectively. Approximately 246,469 gallons of outboard motor fuel were consumed on Houghton Lake during May through November, 1972.

Inherent in the operation of two-cycle outboard engines are three sources of chemical pollution: (1) crankcase condensate discharge, (2) fuel vapor discharge and (3) gaseous emissions. Assuming 5 to 10% of the total fuel used by an outboard engine is discharged from the crankcase without being burned, approximately 12,000 to 25,000 gallons of raw fuel, containing short and long chained hydrocarbons, tetraethyl lead, ethylene dibromide or ethylene dichloride, elements such as zinc, sulfur, phosphorus and other unspecified additives, were discharged into Houghton Lake. Exhaust products from burned fuel contribute large quantities of oxides of carbon, nitrogen and sulfur; hydrocarbons; partial oxidation products and complexed particulate lead compounds to lake waters. These emission products are toxic to fish and aquatic life but only at concentrations generally higher than would result from normal outboard engine usage. The fuel consumption rate of 4.4 gallons fuel consumed/million gallons dilution water (lake water) for Houghton Lake was approximately 50% below values reported in the literature that resulted in fish tainting.

Dissolved lead was not detectable (0.01 ppm) in Houghton Lake water. Lead concentrations in lake sediments were within the range found in sediments from Michigan stream background stations. Sediments near marinas did not show elevated lead concentrations as a result of high usage and accidental fuel spillage. Five macroinvertebrates and six species of warm-water fish had average lead concentrations ranging from 1.0 to 1.87 ppm (wet weight) and 0.50 to 1.33 pp. (wet weight), respectively. Lead concentrations in three species of warm-water fish from Michigan background stream stations ranged from 0.1 to 0.5 ppm wet weight. Lead levels appear to be higher in Houghton Lake fishes, but insufficient data prevented statistical analysis.

The snowmobile and car usage of Houghton Lake during the winter 1972-73 was surveyed. These surveys showed that Houghton Lake received substantial usage during the winter months and that these vehicles may contribute significant quantities of exhaust products (hydrocarbons and lead) to Houghton Lake.

Michigan Water Resources Commission Bureau of Water Management and Fisheries Division Cooperating, 1973, Water quality of Houghton Lake: Water quality protection project Houghton Lake, Michigan. Technical Bulletin No. 73-7 Department of Natural Resources Lansing, Michigan.

The water quality of Houghton Lake, Roscommon County, Michigan, was evaluated during the years 1971-1973. The factors investigated were: (1) water chemistry, phytoplankton standing crop and production, nutrient loading and bacteriological status; (2) planktonic diatom and chrysomonad communities; (3) zooplankton communities; (4) benthic macroinvertebrate communities; (5) fish populations and (6) toxic materials in lake sediments and fish. Houghton Lake is Michigan's largest inland lake (31.3 square miles), but it is extremely shallow with a mean and maximum depth of 8.5 and 22 feet, respectively.

During 1972, total phosphorus and inorganic nitrogen concentrations averaged 0.021 and 0.115 mg/l, respectively, resulting in a P/N ratio of 1 to 16. Dissolved oxygen concentrations were near saturation throughout the year. Annual total alkalinity average 96.1 mg/l. Values for conductivity, pH, chloride and iron were within ranges found in uncontaminated surface waters.

Houghton Lake is very productive as indicated by the large phytoplankton standing crop (annual average, 8.8 g chlorophyll a/l) and the high phytoplankton primary productivity (562.98 mg C/m²/day). Winter phytoplankton standing crop was about half the summer standing crops. Aquatic plant production was estimated to be 600 pounds/acre excluding major weedbeds.

Houghton Lake is highly productive with good water quality. The morphometric characteristics and nutrient loading result in a set of environmental conditions extremely favorable for aquatic algae and plant growth. Based on these data Houghton Lake can be classified as eutrophic or possibly meso-eutrophic. However, it does not exhibit the excessive algal and higher aquatic plant growths, chemical stratification and reduced diversity of aquatic biological communities usually associated with advanced eutrophication.

Base-line data were collected for planktonic diatom and chrysomonad, zooplankton and benthic macroinvertebrate communities. All communities exhibited high organism densities and were composed of both tolerant and intolerant species. Fish population data also were collected.

Michigan Water Resources Commission Bureau of Water Management Water Quality Appraisal, 1973, Houghton Lake annual nitrogen and phosphorus budgets, Water quality protection project Houghton Lake, Michigan. Technical Bulletin No. 73-6 Department of Natural Resources Lansing, Michigan.

Partial phosphorus and nitrogen budgets were estimated for Houghton Lake, Roscommon County, Michigan, for the year 1972. The inputs and outputs of water (acre-feet) and nutrients (total phosphorus, and total nitrogen) were determined for this large shallow inland lake.

Houghton Lake received 7,950 and 277,000 pounds of total phosphorus and nitrogen, respectively, while the outlet discharged 5,521 and 153,800 pounds of the corresponding nutrients from the lake. Precipitation was the major contributor of nutrients to the lake during 1972.

The annual phosphorus and nitrogen loadings to Houghton Lake during 1972 did not appear to be excessive. However, based on dangerous loading levels presented in the literature, further increases in the annual phosphorus loading of approximately 5,500 lbs. will result in nuisance growths of aquatic plants or algae.

Concentrations of heavy metals, pesticides, polychlorinated biphenyls (PCB's) and phthalates in sediments and fish were low and within FDA guidelines, with the possible exception of mercury in walleye. The data indicated that walleye longer than 20 inches have mercury concentrations which exceeded the FDA limit of 0.50 mg/kg; however, the average mercury concentration of the 13 walleye analyzed was well below the FDA limit.

Mollo-Christensen, Erik, 1972, The large variability of water quality in coastal waters and suggestions for how we can handle them: See Citation No. 72-6D-0876, pp. 17-26.

Descriptors: Coastal zones, coastal waters, water quality, marine pollution, Massachusetts.

The high variability of chemical and physical properties of coastal waters is discussed, and examples of pollutant variables in Boston Harbor and Massachusetts Bay are given. The physics of the processes that cause this variability is examined. Suggestions for coping with these processes by suitable design of observational programs are described.

Moore, C.A., and Silver, M.L., 1973, Nutrient transport by sediment-water interaction: Illinois Univ., Chicago, Dept. of Materials Engineering, (NTIS PB-72-682, Illinois Water Resources Center, Urbana, Research Report No. 65, 51 p.

Descriptors: Eutrophication, lake beds, phosphates, nutrients, sediment-water interfaces.

Identifiers: P-32 techniques, phosphate-sediment exchange.

This report presents the results of a series of laboratory tests to investigate phosphate transport in sediments subjected to one-dimensional consolidation type loading. P-32 techniques are employed. The results indicate that measurable transport occurs for phosphate concentrations on the order of 2 mg p/100 gm dry soil or more and for loads in excess of the preconsolidated load for the samples. In addition, the report discusses models for the exchange of phosphates between sediment or soil in lakes and lake waters. These models are expressed in a form that allows them to be used to predict the environmental impact of construction operations in aquatic environments. Three modes of interaction are discussed: (1) exchange due to new soil surfaces being exposed, (2) exchange due to the dispersion of soil particles in the water, and (3) release due to forced drainage of water from sediments. The conditions under which each mechanism might be influential are discussed and mathematical models are developed for quantitative predictions.

Neal, V.T., 1972, Physical aspects of the Columbia River and its estuary: Oregon State Univ., Corvallis, Dept. of Oceanography, The Columbia River Estuary and Adjacent Ocean Waters, University of Washington Press, Seattle, Wash., pp. 1-100.

Descriptors: Columbia River, physical properties, estuaries.

Identifiers: Flushing.

Various physical aspects of the Columbia River and its adjacent waters are described. Brief discussions of river flow, navigation, geomorphology, climatic conditions, tides and seawater intrusion are presented. Flushing and pollution distribution in the river estuary (defined as that area of the river subject to salinity intrusion) are examined in greater detail. Some methods used to predict the flushing of contaminants from an estuary are outlined. These include: the classical tidal-prism method, modified tidal-prism method, fraction-of-freshwater method and exponential-decrease method.

Nixon, Scott W., Oviatt, Candace A. and Northby, Sharon L., 1973, Ecology of small boat marinas: Marine Technical Report Series #5, University of Rhode Island, Kingston, Rhode Island.

Two ecological systems, a yacht marina area and a salt marsh cove, are compared and evaluated with regard to biological populations, magnitudes of production and respiration. Marsh grass production, suspended particulate matter, phytoplankton, nutrient concentrations, bacteria, dissolved organic carbon levels, fish and sediments are studied.

Novell, J.P.B., 1971, Control of slope on deposition from small-scale turbidity currents: Experimental results and possible geological significance: Sedimentology, Amsterdam, 17(1-2), pp. 81-88.

Descriptors: Sediment structures, slopes, turbidity currents, turbidites.

The experiments involved pouring aqueous starting suspensions of pumice sand and kaolinite silt into a submerged trough. The steepness of the bottom slope of the trough was varied from run to run. Heights of sand and silt were recorded at 10-cm intervals away from source. The results: Support earlier suggestions that the ratio of sandstone to shale is a sensitive indicator of proximity in ancient turbidites, but do not support clearly the suggestion that the rate of decrease in that ratio away from source may indicate steepness of bottom slope; and suggest that the rate of decrease in sandstone thickness away from source in ancient turbidites may be inversely proportional to steepness of bottom slope. The possible application of the results to the geological record is discussed.

Renfro, Walter D., 1972, A portable land-based dredge for no-man's-land areas: See Citation No. 72-4E-0344, pp. 335-362.

Descriptors: Dredges, eutrophication.

The use of a portable, land-based, highly productive dredge to clean up eutrophic waters is described.

Richey, E.P., 1971, Hydro-ecological marinas in Puget Sound: Washington Univ., Seattle, Dept. of Civil Engineering, Technical Conference on Estuaries of the Pacific Northwest, 1971. Oregon State University, Corvallis, Engineering Experiment Station Circular No. 42, pp. 249-271.

Descriptors: Design standards, design criteria, marinas, Washington.

Identifiers: Puget Sound (Wash.)

Attention is called to the factors of water quality, the accommodation of shellfish and migratory fish, navigation, shoreline equilibrium and management which may influence the planning and hydraulic design of the small harbors and marinas expected to be added during growth of shore facilities resulting from a regional growth forecast in pleasure boating in the Pacific Northwest. New environmental awareness and concerns relating to use of water-related resources will require that designers of these facilities consider features that are not yet a part of conventional practice. Ecological parameters need to be added to those used more traditionally for water-oriented structures. Major points concerning marinas relate to limits on the seaward protrusion of shore-connected structures and the requirement for better wave circulation. The two prediction models for assessing circulations due to tidal effects were developed, the second model showing that neglecting the exit loss would be a permissible assumption in most instances. These new criteria can be woven into the existing planning and design procedures in quite the same way as any other new regulation on navigation, safety, etc., would be handled.

Sager, P.E., 1972, Phosphorous-phytoplankton relationships in Green Bay, Lake Michigan: University of Wisconsin-Green Bay.

On the basis of physical and chemical parameters, the existence of two, rather discrete water masses can be observed in southern Green Bay, one characterized by parameters unique to the Fox River and the other representing Bay water. The diffuse interface between the two masses can be located in the vicinity of Long Tail Point at a distance of approximately five miles from the mouth of the Fox River.

Species composition and phosphorous metabolism of the phytoplankton also reflect the two water masses. River algal species predominate in the extreme lower Bay while species more typical of the Bay can be noted beyond the vicinity of Long Tail Point.

Luxury storage of phosphorous by the phytoplankton community, expressed on a per unit weight chlorophyll a basis, was found to be inversely related to both orthophosphate concentrations in the water and chlorophyll estimates of algal biomass for all samples.

In the extreme lower Bay, the phytoplankton exhibit high biomass and low luxury storage of phosphorous in the presence of high concentrations of orthophosphate. Beyond the vicinity of Long Tail Point, the phytoplankton community is of lower biomass and exhibits higher luxury storage of phosphorous in the presence of lower concentrations of orthophosphate in the water.

Sanger, Clyde, 1972, The Great Lakes clean-up: Marine Pollution Bulletin, London, 3(9), pp. 138-139.

Descriptors: Water quality control, government programs, international cooperation, Great Lakes.

An agreement signed in Canada by President Nixon and Prime Minister Trudeau commits Canada and the U.S. to spend \$3.5 billion over the next 5 years on the task of cleaning up the Great Lakes. Canada is concentrating on removing P, primarily by reducing the amount of phosphate allowed in detergents. The U.S. will build improved sewage treatment plants. The U.S. will spend \$1 billion of federal funds, matched by the same amount from state and municipal governments and an equal amount from private industry. With other newly imposed regulations, including holding-tank requirements for all pleasure craft and stricter rules against Hg and oil discharge, even Lake Erie may once again have game fish in it.

Scarpace, F.L., Green, T., III, 1972, The use of a thermal line scanner in the remote sensing of water pollution: Wisconsin, University, Sea Grant Program, Madison, Technical Report No. 13, 13 p. Presented at Joint Conference on Sensing of Environmental Pollutants, (Held in Palo Alto, Calif., Nov. 8-10, 1971).

Descriptors: Remote sensing, water pollution, temperature data, aerial surveys.

As part of a remote sensing program, the University of Wisconsin conducted aerial surveys using a thermal line scanner to monitor water pollution and surface temperatures at three sites in Michigan. Preliminary analysis of thermal imagery is presented for sewage plant outfalls into the Fox River, power plant thermal discharge into Lake Michigan, and for a section of the western coastal zone of Lake Michigan.

Schaller, Carl L., Scarano, Thomas S., 1971, Shore evaluation of a proprietary 10-20 man waste treatment system designed for shipboard use: U.S. Coast Guard, Office of Research and Development, Washington, D.C. Report No. 714122/100, 1 p.

Descriptors: Waste treatment, shipboard equipment, adsorption, filtration.

A 10-20 man shipboard waste treatment system that uses activated C for filtration, adsorption, and biooxidation of sanitary wastes was tested, and influent and effluent waste properties were determined. Physical modifications were made to convert the operation from aerobic-anaerobic filtration-digestion to aerobic filtration. The system was not capable of treating raw sanitary wastes, the C columns would get plugged by undigested solid material.

Schatzberg, Paul, 1971, Investigation of sorbents for removing oil spills from waters: U.S. Coast Guard, Office of Research and Development, Washington, D.C. Report No. 724110.1/2/1, 1 p.

Descriptors: Oil spill removers, sorbents.

Forty-nine floating sorbent materials were evaluated for their abilities to remove oil from water. Five categories of materials were investigated: inorganic, natural organic, polymeric foam, polymeric hydrocarbon, and miscellaneous products. Oil and water sorption capacity, oil retention, buoyancy retention with and without adsorbed oil, the effect of petroleum product variation, sorbent-oil coherence, and reusability were studied. Polymeric foam and hydrocarbon products were the best of oil removal; of these 2 groups, the resilient polyurethane foams and polypropylene fibers were the choice materials. Inorganic, natural organic, and miscellaneous products had a low capacity for oil and exhibited poor buoyancy retention.

Schelske, C.L., 1972, Nutrient enrichment and eutrophication of Lake Michigan, progress report Nov. 1, 1968 to July 31, 1972: Michigan Univ., Ann Arbor, Great Lakes Research Div. Available from NTIS, Springfield, VA., as C00-2003-17.

Descriptors: Eutrophication, Lake Michigan, on-site investigations, nutrient requirements.

Past work included surveys and experiments with ecological perturbation and nutrient enrichment. Work in progress includes (1) a plastic-bag technique for nutrient experiments, and (2) an environmental study of southern Lake Michigan. A model for prediction and assessment was formulated on the hypothesis that P is the limiting nutrient. The rate of eutrophication is given by the rate of utilization of Si, required by the diatoms, or of N.

Schmeelk, W.G., Knight, E.W., Lue-Hing, C., 1972, Water quality trends in inshore waters of southwestern Lake Michigan: Metropolitan Sanitary District of Greater Chicago, Ill. Presented at the Illinois Institute of Technology Symposium on Water Pollution in Metropolitan Areas, Chicago, Illinois, November 30, 1972., 26 p.

Descriptors: Water quality, Lake Michigan, data collections.

Identifiers: Water quality trends.

The quality of Lake Michigan water is of great concern to public health officials and scientists, especially to the Metropolitan Sanitary District of Greater Chicago. With the establishment of the Sanitary District by State of Illinois Statute, the District was given authority to prevent discharges of any type into the Lake in its geographical area of jurisdiction. Waste discharges flow to the Chicago River, a former tributary of Lake Michigan, but the flow of the River has been reversed to prevent waste discharges to the Lake. An extensive testing program of Lake water quality has been set up by the District to determine water quality deterioration from discharges outside the Districts authority. Over 20 such monitoring stations are in existence and thirty water quality parameters are measured at each station. The data of four such stations are examined in depth with emphasis on plankton and diatom counts. Water quality of Lake Michigan is changing with time. Sulfates and chlorides are increasing, calcium levels are remaining almost constant, and

sodium and potassium levels are declining somewhat. Domestic wastes are occasionally a problem and nitrogen and phosphorus are sufficient to support large algae growths.

Seabloom, Robert W., 1971, Water pollution by sewage from water craft: See Citation No. 72-30-0557, 14 p.

Descriptors: Boating, waste discharge, pollution control, Washington Coast.

The pollution of Meydenbauer Bay (an inlet on the east side of Lake Washington), Wollochet Bay (a sheltered harbor on southern Puget Sound) and San Diego Bay by the discharge of wastes from small pleasure craft was investigated. Bacterial counts were made, and the ecology of the waters was studied; bottom sludge deposits and offensive esthetic conditions are discussed. In addition, pollution control devices (macerator-disinfectors, self-contained recirculating flush toilets, incinerators and holding tanks) are considered.

Smith, Stanford, H., 1972, Destruction of the ecosystem in the Great Lakes and possibilities for its reconstruction; Progress in Fishery and Food Science, fiftieth Anniversary Celebration Symposium, Proceedings, Moore, Remedios W. (ed.), (Held in Seattle, Wash.) University of Washington Press, University of Washington Publications in Fisheries, New Series, Vol. 5, Seattle, pp. 41-46.

Descriptors: Fish stocks, pollution prevention, ecosystems, water quality, Great Lakes.

The sequence of events within the Great Lakes and their drainage provide a basis for interpreting probable cause-and-effect relations between events of settlement and changes in the ecosystem of the Great Lakes. A plan to restore the lakes must include improvement of land uses in the drainage basin; elimination of sources of physical, chemical, and biological pollution entering the lakes; and restoration of favorable and productive fish populations.

Stokes, J.H., Elsan Ltd., 1973, Ship sewage treatment and holding systems: In Symposium on marine pollution, London, Royal Institution of Naval Architects, pp. 60-70.

Descriptors: Sewage treatment, ships, government policies, effluent disposal.

The damaging effects upon harbors, docks, and inland coastways of excessive or continuing pollution loads and the global problem of pollution are discussed. Various marine sewage treatment systems are reviewed, with performance data, and each plant is considered in light of known legislative trends. The relationship of the system to its shipboard environment is outlined, including unskilled handling, variations in hydraulic load, and obligations of the ship's master. Standards of effluent quality and current legislative trends in England, Canada, Japan, and the U.S. are presented. Specific methods of sewage treatment or retention include overboard discharge, extended aeration, anaerobic treatment systems, holding tanks, vacuum transport, evaporation and incineration, and mechanical chemical circulating systems.

Stumm, Werner, 1972, The role of phosphorus in eutrophication: Water Pollution Microbiology, Mitchell, Ralph (Ed.), Wiley-Interscience, New York, pp. 11-42.

Descriptors: Water pollution, nutrients, photosynthesis respiration.

The conflict between resource exploitation and water pollution control is examined. Nutrients and the balance between photosynthesis and respiration in natural waters: oceans, fjords, estuaries, rivers, and lakes, is discussed.

Tabb, R.P., 1972, Activities of the corps of engineers in marine pollution control: Corps of Engineers, Atlanta, Ga., South Atlantic Div. Coastal Zone Pollution Management, Proceedings of the Symposium, Charleston, South Carolina, February 21-22, 1972, Clemson University, Clemson, S.C., 1972, pp. 67-84.

Descriptors: Harbors, coasts, estuaries, treatment facilities, oil spills, cleaning.

The U.S. Army Corps of Engineers is involved in the total concept of water resources management and is concerned with certain aspects of pollution in the coastal zone. The Corps' interest has a twofold aspect: that which is involved in studies, design and construction of Federal Civil Works projects and the regulation responsibilities in navigable waters of the United States. Model studies and investigations on sanitary waste disposal, floating waste treatment facilities, oil spills, harbor cleanup, thermal pollution and ocean dumping are reported. Laws regulating pollution of navigable waters are outlined, including the 1899 River and Harbor Act. One engineering activity of particular concern to the coastal environment is dredging because it modifies the physical hydrology, changes the environment available to organisms and modifies the quality of water to some degree. Refuse discharge permits are also discussed.

Thuessen, Gerlad J., 1971, A study of public attitudes and multiple objective decision criteria for water pollution control projects: Georgia, Institute of Technology, Atlanta, Environmental Resources Center, Report No. 1071, 75 p.

Descriptors: Water quality control, planning methods, multiple objectives.

Methods that would provide the decision-maker more useful and objective information about water quality are investigated. A systematic procedure for developing a multiple objective assessment structure is presented so that water quality can be incorporated into the planning process as a multivariate consideration. Water quality and its impact on society are examined from aspects of recreation, transportation, energy production, industrial heating and cooling, effluent disposal, water supply, and food supply.

Waldichuck, Michael, 1969, Eutrophication studies of a shallow inlet on Vancouver Island: Fisheries research board of Canada, Nanaimo (British Columbia), biological station, Journal Water Pollution Control Federation, Vol. 41, No. 5, part 1, pp. 745-764.

Descriptors: Flushing, eutrophication, water pollution, tides, nutrients, dredging.

While nutrient input into Portage Inlet (British Columbia) is not large, volume of the system is small and flushing mechanism so poor that nutrients tend to concentrate. Phosphates and nitrates are absorbed by plankton and deposited. Provincial government plans for a canal from thetis cove to Portage Inlet with locks for flushing the system rapidly appears a solution. Ecology will be modified and summer temperature in Portage Inlet will be reduced, making it less suitable for bathing--a small price for cleaner water to be regularly replaced by tidal action and for navigation improvement. Dredging might restore the inlet system removing much of the nutrients fixed in the sediments and rooted vegetation, but can be only a palliative if nutrients sources from the drainage system are not eliminated. Effect on ecology is unknown. It is conceivable that removal of rooted aquatics would lead to greater availability of nutrients to plankton resulting in undesirable concentrations of 'red tide' type organisms. (Jones-Wisconsin)

Wege, Peter M., 1972, An environmental organization supports Great Lakes water quality through action and research: Peter M. Wege is President of Center for Environmental Study, Grand Rapids, Michigan.

An action oriented citizens organization in the Grand Rapids area - The Center for Environmental Study (CES) - has been a spark plug in helping achieve improved water quality in the Grand River Basin. Lake Michigan is further improved as a result of the removal of plating wastes by all firms in the Grand Rapids area in 1971. These discharges now meet stringent limits imposed by the Michigan Water Resources Commission. Industry and municipalities have made significant strides in adding treatment facilities to further reduce pollution originating in the Grand River Basin. Not all problems are solved to the satisfaction of the public and/or of control officials. Sediment from erosion is a major problem. High coliform counts, as yet unexplained, still confront officials. Disposal of septic tank wastes took a step backward in 1971 and is unresolved.

CES has urged and assisted the Grand River Watershed Council in a number of ways. The reduction of two years of water monitoring data from about one hundred sampling stations was performed by CES. The data is now computerized such that a monthly water quality index is determined on the basis of nine sampling parameters. Uniform tests by all fourteen testing laboratories was achieved at CES's urging. CES aided in the preparation of an evaluation report of the Watershed Council's accomplishments for improved information to basin residents. A triumvirate research, education and training program for improved water quality management is being coordinated by CES. The Watershed Council, University of Michigan and CES developed a proposal to use computer gaming and computer simulation techniques to improve management procedures.

An eighteen month research program, with nation wide implications, is underway in Wyoming, Michigan. Evidence suggests that chlorine in treated effluents may be toxic to fish. A study to evaluate the effects of chlorinated effluents, de-chlorinated effluents, ozone and chloramines is underway. Grand Valley State College will perform the laboratory analyses associated with the study. New treatment techniques may be indicated as a result of this research.

CES is engaged in a research effort to "put it all together" through its modeling effort. A systems approach employing dynamic simulation is partially developed to aid local citizens and control, officials in improving water quality management practices. Task force groups of citizens and control officials are receiving training in the use of this model. With everyone pulling together in this river basin, we have confidence that better water quality will be achieved and that the concept of the Great Lakes as a clean water reservoir might be enhanced.

FLUSHING - MIXING - CIRCULATION

Birchfield, G.E., 1971 , On the role of topography and turbulent mixing in the dynamics of wind-driven currents in a lake or sea; Departments of Engineering Sciences and Geological Sciences, Northwestern University, Evanston, Illinois.

For sufficiently small vertical and horizontal Ekman numbers, the circulation in a lake may be considered as consisting of a coastal circulation and an interior circulation. The interior geostrophic circulation is determined explicitly for arbitrary topography; it is strongly constrained by the basin topography. The cross contour circulation, however, can be explicitly evaluated and regions of preferred horizontal mass exchange between the interior and coastal regions can be determined for arbitrary topography. Specific examples are for the elliptic basin. It is shown that vertical turbulent mixing can create a broad coastal boundary layer adequate for bringing the total horizontal transport to zero at the coast. The layer is not adequate to produce sufficiently strong upwelling required for global mass balance, in water deeper than the Ekman depth. The necessary upwelling must be produced by either horizontal mixing, convective acceleration or by horizontal divergence in the region of depths less than the Ekman depth. The relative roles are discussed with emphasis on horizontal turbulent mixing.

Brandsma, Maynard G., Lee, Jiin-Jen, Bowerman, Frank R., 1973, Marina del Rey: Computer simulation of pollutant transport in semi-enclosed water body: Sea Grant Publication.

Tidal flushing characteristics of Marina del Rey have been investigated by computer simulation. Because of the special geometry of Marina del Rey which can be approximated by one-dimensional segments; the model developed by Fisher (1970) is used for the simulation process.

Individual elements of fluid are followed as they move along one-dimensional channels in response to flows generated by tidal fluctuations. A mass-conservation equation is used with tidal data to compute tidal flows. Dispersion of pollutants between fluid elements is calculated using a modified Elder's equation for dispersion in wide open-channel flow. (Dispersion coefficients obtained range from 2.3 sq. ft./sec. to 44 sq. ft./sec.) Time proceeds in a series of finite steps, each of which has a convective part and a dispersive part. Data for the program is provided from tide recordings made at various points in the marina.

The results show comparative flushing characteristics for pollutants discharged at various locations in Marina del Rey. The most striking characteristics of the marina is its sensitivity to variations in locations and time of pollutant injections.

Two main conclusions were reached. The main channel has a great deal more flushing activity than the basins. The timing of pollutant injections relative to tidal phases is very important in determining what percentage of material will be flushed out in a given time. Pollutants injected during a high tide experience much more flushing than when injected at low tide.

Brater, E.F., 1972, A hydrological model for estimating the inflows to and outflows from Grand Traverse Bay: Michigan Univ., Ann Arbor, Dept. of Civil Engineering. Technical Report No. 32, August 1972, 22 p.

Descriptors: Hydraulic models, hydrology, bays, Michigan.

Identifiers: Grand Traverse Bay (Mich.).

Estimates of inflow and outflow are provided for any selected portion of Grand Traverse Bay, Michigan. The determination was made first for the 17-year period from 1953 to 1971 for which continuous records are available on the upper Boardman River. For this period it was necessary to find relations between the discharges of the gaged and ungaged portions of the basin. In order to extend inflow and outflow farther into the past or into the future, a deterministic hydrological model was developed for relating runoff to precipitation. This model enables the extension of the estimated inflow and outflow rates with accuracy over as many years as the amount of rainfall is recorded or can be estimated. The inflow to Grand Traverse Bay is the runoff from a drainage area of 973 square miles, of which only that from the Boardman basin above Mayfield (189 square miles) had been gaged. It is estimated that more than 95% of the river discharge is groundwater. The inflows to the bay as well as the outflows to Lake Michigan can be computed for the period starting in 1889 when the first rain gage was established in the area. More than 80 years of hydrologic data could be provided which would supply a dependable basis for predicting future conditions.

Csanady, G.T., 1972, Frictional currents in the mixed layer at the sea surface: Journal of Physical Oceanography, Boston Mass., 2(4), pp. 498-508. Presented at the Conference on the Interaction of the Sea and the Atmosphere. (Held in Ft. Lauderdale Fla., Dec. 1-3, 1971).

Descriptors: Great Lakes, surface layers, friction, currents, turbulent boundary layers.

The wind-driven flow in the mixed layer between the free surface and the top stable sheet of a thermocline is usually turbulent. The frictional component of such a flow may be separated from a depth-independent general current. The turbulent frictional current is governed by a small number of external parameters. Explicit approximate solutions may be obtained with the assumption of constant eddy viscosity and a lower boundary condition of 0 stress at the bottom of the mixed layer; these show a variety of different 'Ekman spirals', depending only on the parameter fh/u_*^2 , where f is the Coriolis parameter, h the mixed layer depth, and u_* the shear velocity. Experimental data collected within the mixed layer on Lake Huron are reported and compared with simple theory. Encouraging agreement between theory and observation is found and some quantitative relationships are tentatively established.

Csanady, G.T., 1972, Response of large stratified lakes to wind: Journal of Physical Oceanography, 2(1), pp. 3-13. Grant: NSF GH55.

Descriptors: Great Lakes, wind stress, theoretical model.

The response of a simple Great Lake model to wind stress is studied theoretically. The model is of constant depth and circular shape and continuously stratified with a thermocline region of linear density distribution. The excitation of natural modes of oscillation is calculated for a suddenly imposed uniform wind stress and for one acting for a finite period. Strong Kelvin-type (shore-bound) waves are generated in the first few baroclinic modes giving rise to "coastal jets" of width of 5 km and less; the combination of several

baroclinic modes results in a complex structure for these jets. In the central portions of the model the response consists of Poincare-type waves of near-inertial frequency. The theoretical results agree quite well with observations made in the Great Lakes.

Csanady, G.T., 1972, The coastal boundary layer in Lake Ontario. Part I: The spring regime: *Journal of Physical Oceanography*, 2(1), pp. 41-53.

Descriptors: Great Lakes, coastal zones, boundary layers, current data.

Results of observations collected in the coastal zone near Oshawa in Lake Ontario during the spring show a current regime different in character from that observed during summer or fall. A nearshore band becomes a unique kind of boundary layer in which mid-lake motions adjust to the presence of the shores. During the spring significant motion is often confined to the vicinity of the coastal boundary layer. Many complex physical factors appear to be involved in determining the current structure in this boundary layer, among them the Coriolis force, inertial accelerations, friction and stratification. The main driving force of these motions is the wind stress at the free surface; the motions also exhibit spatial variability.

Daiber, C., 1972, Flushing pattern of certain tidal streams in Delaware: Delaware Univ., Newark, Coll. of Marine Sciences. Available from the National Technical Information Service as PB-206 795. Completion Report, January 1972, 44 p.

Descriptors: Tidal waters, estuarine environment, water quality, nutrients.

Identifiers: Flushing, Broadkill River (Del.), Murderkill River (Del.).

The flushing characteristics of two tidal streams, the Broadkill and Murderkill Rivers, have been established: (a) Current velocities and volumes of water transported per tidal cycle have been calculated. (b) Each stream can be divided into three segments along the longitudinal axis, a lower estuarine, upper estuarine and fresh water tidal. Each segment has its own salinity distribution, current velocities, tidal characteristics and flushing times. (c) These two streams do not display the two-layer system at all times that is typical of coastal plain estuaries; having a net seaward transport at all depths. Water quality characteristics of biological importance are described for the Broadkill River: (a) There is a longitudinal and seasonal distribution of the various forms of phosphorus and nitrogen, oxygen, pH and chlorophyll pigments. (b) The distribution of these various parameters is determined by the hydrographic features of the stream, the season and the location of one existing sewer outfall.

Hoopes, J.A., Ragotzkie, R.A., Lien, S.L., and Smith, N.P., 1973, Circulation patterns in Lake Superior: Wisconsin Univ., Madison, Dept. of Civil and Environmental Engineering; and Wisconsin Univ., Madison, Dept. of Meteorology. Available from the NTIS as PB-220 244, Wisconsin Water Resources Center, Madison, Technical Report, April 1973, 80 p.

Descriptors: Lake Superior, water circulation, bathythermography, water temperature, currents (water), mathematical models, energy transfer.

Identifiers: Keweenaw Peninsula, Isle Royale.

Lake circulation studies were directed toward Lake Superior for the purpose of broadening the quantitative understanding of large-scale circulation patterns induced by wind and atmospheric pressure variations over lakes under homogeneous and stratified conditions. One phase considers the numerical and physical

modelling of lake circulation under uniform density conditions. The effects of lake geometry and wind stress distributions on the movement of water are considered. Coriolis forces were considered in the models. The second phase involves the analysis and interpretation of field observations of currents and temperatures for the central region of Lake Superior, between the Keweenaw Peninsula and Isle Royale during seasons when lake stratification conditions predominate. Bathythermography data and airborne infrared surface temperature surveys were collected at the same time to permit the investigators to make inferences about the temperature structure of the interior of the lake, given only the surface temperature pattern. By using a diverse approach of combining many sampling techniques and methods of analysis, it was possible to detect and define the nature of the temperature and current patterns for the study area.

Huang, Joseph Chi Kan, 1971, Eddy diffusivity in Lake Michigan: Journal of Geophysical Research, 76(33), Grants: USPHS WP-00311 and WP-01067, Contract: ONR N00014-69-A-0200-6006. Michigan, University, Great Lakes Research Division, Special Report No. 37, pp. 8147-8152.

Descriptors: Great Lakes, turbulent diffusion, eddy diffusion.

A series of experiments on turbulent diffusion were conducted in Lake Michigan by using fluorescent dye as the tracer of water movement. The observed rates of growth of diffusing material under normal conditions agree well with theoretical results concerning relative diffusion in a field of homogeneous turbulence. The effective eddy diffusivity is computed from field measurements of the mean dispersion of the tracers. The lateral (cross stream) eddy diffusivity was found to be of the order of 10^3 cm²/sec and the longitudinal eddy diffusivity was about four to five times greater.

Lee, T.N., 1972, Exchange processes in shallow estuaries: See Citation No. 73-4B-00652, p. 31.

Descriptors: Biscayne Bay, tidal estuaries, flow profile, mixing.

A modular approach to the analysis of mixing and flowing characteristics in shallow tidal estuaries is presented using South Florida's Biscayne Bay estuary as an example. The method depends on isolating relatively simple characteristic flow regimes in different parts of the estuary. These can be considered as building blocks, which when combined in different configurations yield a qualitative model for any scenic estuary. Such models are of immediate value in preliminary documents of estuarine water quality and interaction problems. This method can serve as an effective base for further studies where more precise information is needed.

Lee, T.N., Rooth, C., 1973, Water movements in shallow coastal bays and estuaries: Miami, University of Coral Gables, Fla., Sea Grant Program, Coastal Zone Management Bulletin 3, Jan. 1973, 23 p. Contracts: NOAA 2-35147 and AEC AT(40-1)-3801-4.

Descriptors: Biscayne Bay, coastal currents, water movement, tidal estuaries, wind forces.

A modular approach for understanding estuarine water movements is presented, including data on Biscayne Bay and information on how data from specific estuary studies can be applied to other estuaries. Information is provided on tidal exchange and wind influence. Poorly flushed estuaries cannot be permitted to receive effluents which contain harmful nutrients and viruses, and examination of the residence time of receiving waters in estuaries is an essential part of any preliminary investigations relating to coastal waste water treatment plants.

Lin, Paul C., 1971, Normalized and equilibrium spectra of wind waves in Lake Michigan: *Journal of Physical Oceanography*, 1(4): pp. 249-257.

Descriptors: Great Lakes, wind waves, wave spectra.

An empirical spectral equation for fetch-limited deep-water wind waves was derived by applying similarity analysis to wind and wave data recorded at the Lake Michigan Research Tower during the autumn of 1967. The equation produces reasonably good results in estimating actual wave spectra, provided sufficient duration is achieved in the wind field. The equation also indicates that a full-developed state will not be reached at a steady wind speed as the very low-frequency waves grow continuously with increasing fetch.

Lomax, Claud, C., Orsborn, John F., 1971, Flushing of small shallow lakes: Washington State Univ., Pullman. R.L. Albrook, Hydraulic Lab., Copy available from GPO Sup. Doc. as EPI.16: 16010 DMG, 12/71., Environmental Protection Agency, Water Pollution Control Research Series, 39 p.

Descriptors: Lakes, circulation, laboratory tests, water pollution control.

Identifiers: Flushing, flow characteristics.

Flushing of a lake means reducing the pollution by clean inflow with an equivalent outflow of polluted water, a process by which clean water both displaces and mixes with the polluted water. Parameters influencing the effectiveness of the cleansing stream, most important and manageable under laboratory conditions, were investigated. Parameters studied were: inlet velocity, inlet width, depth, and basin shape. Testing was conducted on two depths, two inlet widths, three inlet velocities, and four elliptical basins. Primary purpose of the project was to evaluate the various parameters to determine their influences on flushing efficiency, and develop prediction equations based on geometric and flow characteristics of the systems tested. Analyses were completed to develop a test program, analyze the system for comparison with experimental results, and develop prediction equations which incorporate analytical and experimental results of the study. Width of basin perpendicular to the axis of flow is an important parameter. Narrower basins have better flushing action and less erratic flow patterns than wider basins. Pollution remaining in a basin after any interval of flushing is primarily dependent on the time of the flushing interval divided by the detention time of the basin.

Ragotzkie, R.A., Hoopes, J.A., 1968, Circulation and mixing processes in lakes: Wisconsin Univ., Madison, Water Research Center, Tech. Comp. Rept. for OWRR Project A-004-Wis., Water Research Center, 1968, 16 p.

Descriptors: Lake Superior, coriolis force, infrared radiometry, wind shear.

Through the combined efforts of this field, laboratory, and theoretical study, quantitative models and data, regarding certain features of the circulation of Lake Superior are known. The most significant result is the tendency for strong and relatively narrow boundary currents to occur along the perimeter of Lake Superior and the other Great Lakes as well. Airborne studies, confirmed by ship and buoy measurements, have shown that the Keweenaw Current (a north-eastward flowing current along the Keweenaw Peninsula) occurs from late June through early October with a velocity of 1 knot. Airborne infrared measurements have also shown the presence of two, large cold cells in the eastern end of the lake. From the theoretical models, the existence of a strong, nearshore, boundary current around the whole Lake is predicted; field observations support this result. Laboratory model studies in a rotating model of the Lake support the field and theoretical observations and provide a physical analog of the Lake circulation.

Ragotzkie, R.A., Ahrnsbrak, W.F., Synowiec, A., 1968, Summer thermal structure and circulation of Chequamegon Bay, Lake Superior--a fluctuating system: Marine Studies Center, University of Wisconsin, Madison, Wisconsin.

An extensive series of measurements of thermal structure, currents and seiches was made during July and August 1968 on Chequamegon Bay, a semi-enclosed bay of Lake Superior. Analysis of these data shows that the circulation of this bay is a fluctuating system in which water movement associated with wind-induced movements of the thermocline is the primary mechanism for water exchange between the Bay and the Lake. Superimposed on this flushing mechanism is a complex pattern of temporally and spatially varying currents associated with seiche activity in the Bay. Current measurements also suggest a weak anti-clockwise general circulation. It is postulated that the physical behavior of Chequamegon Bay and its interaction with Lake Superior may be characteristic of other semi-enclosed bays of the Great Lakes.

Rutkovskiy, V.A., 1971, Wind wave characteristics in deep and shallow parts of a bay: *Oceanology*, 11(1): pp. 28-35.

Descriptors: Baltic Sea, bays, wind waves.

The results of measurements of wind wave elements and of the resulting pressure at subsurface depths in both the deep and shallow parts of a bay are examined. The experimental distribution of wave heights and periods is compared with the generalized probability function. The transformation of the wind wave spectrum with depth and during wave propagation from deep to shallow areas is analyzed. As the waves approach the shore, their heights and periods decrease, regardless of whether their approach is direct or oblique. Shallow water affects the transformation of the spectral composition of surface waves. This is manifested in the filtering out of the long-period spectral components in shallow water

Shemdin, O.H., Dane, K.A., 1971, Laboratory simulation of formation and flushing of sand bars at river mouths: Florida Univ., Gainesville, Dept. of Coastal and Oceanographic Engineering; Hydraulic research and its impact on the environment; Proceedings of 14th Congress of International Association for Hydraulic Research, Paris, August 29-September 3, 1971, Volume 4, pp. 87-94.

Descriptors: Sand bars, sediment transport, silts, estuaries, hydraulic models, deposition (sediments).

Laboratory studies of two rivers, Yaguez and Corazones, in Puerto Rico were conducted to investigate the flushing of sand bars formed at the river mouths. The sand bars form during the dry season when the flow is small, and the continuing wave activity moves sand towards the river mouths. The rate of erosion of the sand bars during the passage of a flood was investigated to determine the maximum water levels in the river. Laboratory simulations were conducted in undistorted movable bed models in which sand and walnut shell were used as movable bed materials. The highest water level in a river occurs when the forward face of the flood arrives at the river mouth. The sand bar then is at its early stages of erosion and behaves like a broad crested weir at the mouth. It, therefore, controls the river flow to the ocean. Rapid erosion of the sand bar takes place thereafter so that a lower water level results in the river even under peak flow conditions. The studies included investigations of remedial measures to reduce water elevation in the rivers. Such measures depend on the relative importance of river flow compared to wave activity which controls the bar formation. Different remedial measures were proposed for the two rivers investigated.

Sholkovitz, Edward S., Gieskes, Joris M., 1971, Limnology and Oceanography: A physical-chemical study of the flushing of the Santa Barbara Basin, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, Vol. XVI, No. 3, pp. 479-489.

Detailed vertical profiles of salinity, temperature, oxygen, nitrate, phosphate, nitrite, and silicate have been taken on 6 cruises over a 14-month period in the Santa Barbara basin. In May 1970, during a period of intense upwelling, the temperature, oxygen, and nitrate content of the basin water from the sill (475 m) to the bottom (580 m) showed significant changes from their normal conditions: the oxygen content increased from 0.05-0.10 ml/liter to 0.35-0.43 ml/liter; the nitrate concentration, which previously decreased markedly below the sill due to nitrate reduction showed little nitrate reduction; and the temperature decreased by 0.14-0.19C. The results from 2 subsequent cruises in June and July 1970 kinetically follow the basin water back to its normal conditions. After 2 months the oxygen content had almost returned to normal with a measured average oxygen consumption rate of $1.3 \text{ ml liter}^{-1} \text{ yr}^{-1}$, while the water temperature rose at a rate of 0.02-0.04C/month. These data indicate that the Santa Barbara basin was flushed of any California basin suggests that its oceanography is dynamic and that it is capable of flushing on a shorter time scale than previously thought.

Viessman, Warren, Jr., 1971, Estimation of lake flushing rates for water quality control planning and management: Maine University, Orono Water Resources Research Center, Proceeding, Workshop-Conference on Reclamation of Maine's Dying Lakes held at the University of Maine, Bangor, Maine, March 24-25, 1971, pp. 50-66.

Descriptors: Lakes, model studies, mathematical models, planning.

Identifiers: Flushing rates.

The water budget of lakes and mathematical water quality models are reviewed. The development of input prediction equations requires monitoring of mixing, thermal conditions, currents, and other factors. Attention is called to the difficulties connected with existing circulation analyses and the development of corresponding mathematical models of practical significance. An emphasis is placed on the value of rough estimates in water quality control planning. An estimate of both the maximum and minimum flushing rates is used as an illustration.

HARBOR IMPROVEMENT

Anonymous, 1973, Concrete tested after 67 years in the sea: Ocean Industry, 8(2), 44 p.

Descriptors: Concrete materials testing, harbors, breakwaters, engineering data, underwater construction, California coast.

Eighteen concrete blocks (5.75 x .75 x 3.5 ft.) were made from various mixes and 6 different commercial brands of cement and were placed on the ocean side of the Los Angeles harbor breakwater in 1905. In 1932, 17 of the blocks were recovered and core tests were conducted. Compressive strengths ranged from 2,180 to 6,010 psi. The 17 blocks were replaced in their original positions. In mid-1972, 6 of the 17 blocks were raised. Identification of the blocks was made by position, based on station grid coordinates set down in 1905. Tumbling seaward was the only apparent movement since 1932. Visual inspection of the blocks showed moderate marine growth on most of the concrete. Original form marks were clearly visible and many edges remained sharp. Compressive strength tests of the cores yielded values of 3,060-6,020 psi. Three blocks increased in strength, 2 remained the same, and 1 had decreased slightly. Concrete appears to be an excellent construction material for underwater structures.

Anonymous, 1972, Richard's Bay harbour project: South African Shipping News and Fishing Industry Review, Cape Town, 27(11), pp. 25,27.

Descriptors: Harbor construction, breakwaters, shipping terminals, South Africa Coast.

The Richard's Bay, South Africa, development is discussed. The shallow Umhlatuzi lagoon at Richard's Bay is a sedimentary basin of some 3,050 ha in area with a narrow mouth to the sea. The selected harbor entrance channel has to be continued in a straight direction into the lagoon and terminated in a ship-turning circle of 500-m radius. This length of channel is required for the stopping distance of a loaded 250,000-dwt bulk carrier entering beyond the S breakwater under adverse sea and wind conditions at a speed of 7 kn. The breakwater system was established in hydraulic model tests.

Army Engineer District, 1971, Alternate disposal area for Grand Haven Harbor, Michigan (Draft environmental impact statement): Available from the national technical information service as PB-202 1830, 13 p.

Descriptors: Michigan, environmental effects, dredging, sediments, water pollution sources, Lake Michigan, channel improvement, harbors, Great Lakes, dikes, spoil banks.

Identifiers: Environmental impact statements, Grand Haven Harbor (Mich.)

This project will remove polluted dredging material from the water of Lake Michigan by disposal in a diked area established to contain the polluted spoil. Channel and harbor improvement in Grand Haven Harbor requires annual maintenance dredging. This project will convert an aquatic/marsh area to a terrestrial condition. The proposed site is not a virgin marsh since it has been used for spoil and trash disposal in the past. Use of the disposal area for the confinement of polluted dredging material will lessen further pollution of Lake Michigan. Use of the containment site will remove or destroy aquatic animal and plant life now inhabiting the area. Construction of a transmission pipeline, a pump-out station and dikes will have an adverse impact on visual aesthetics in the area. Alternatives include no project, which means acceptance of the detrimental environmental impact; discontinuance of the maintenance and dredging operations; removal of the pollutants from the spoil before disposal; or using alternative spoil disposal sites.

Army Engineer District, 1971, Rochester Harbor, Monroe County, New York (maintenance) (Draft Environmental Impact Statement): Available from the NTIS as PB-205 796-D, 11 p.

Descriptors: New York, dredging, channel improvement, harbors.

Identifiers: Environmental impact statement, Rochester Harbor, N.Y.

The work under consideration is the periodic maintenance of completed structures and channels in the deep-draft navigation project for the Rochester, New York Harbor. Project features requiring maintenance are parallel piers at the mouth of the Genesee River and dredged areas. 360,000 cubic yards of material are dredged annually and dumped into Lake Ontario in an area one and a half miles from shore. Environmental impacts resulting from this work include: noise and dust during the construction period, short term turbidity and sedimentation during dredging and dumping, some water quality impairment from sediment, and possible adverse effects to fish from algae and plant growth stimulated by increased oxygenation of spoil material. The only adverse effect is the fact that polluted material from the spoil is placed in Lake Ontario at a faster rate than it would naturally occur. The only feasible alternative is to dispose of spoil in an enclosed area. Funds are available for constructing such an area, and an environmental statement will be prepared. Maps showing alternative disposal sites are included.

Army Engineer District, Philadelphia, Pa., 1971, The navigation project, Bristol Marina, Delaware River, Bucks County, Pennsylvania (Final Environmental Impact Statement): Available from the NTIS as PB-199 452F, 43 p.

Descriptors: Environmental effects, marinas, boating dredging, recreation wastes, recreation, water quality, docks, water pollution sources.

Identifiers: Bristol Marina (Pa.), environmental impact statements.

This project will provide much needed berthing for small craft. The plan includes an entrance channel, an access channel, and two sheet pile breakwaters. The site is within the Philadelphia metropolitan area. At present the area consists of a drainage ditch and small swamp having no useful purpose of recreational value and possessing poor natural and aesthetic qualities. The berthing and service facilities would provide economic stimulus. The project would replace the blighted conditions in an old, historic site by making the area an attractive element of a larger park and recreational development. No adverse effects upon fish and wildlife would result. Oil pollution due to increased boating will be minimized. Dredging will create a temporary increase in turbidity, but dredging will be performed and timed to minimize interference with passage of anadromous and catadromous fish. The chosen site has the lowest construction cost and possesses some historical significance. There were no appreciable differences in the environmental impact of alternative sites. No action would fail to alleviate the unsatisfied needs of small boat owners. The marina would enhance local short-term environmental use. Fifteen acres of swamp and mudflat would be destroyed. Agency responses, two maps, and a photography of the area are included.

Army Engineer District, Chicago, Ill., 1971, Manitowoc Harbor, Wisconsin (Final environmental impact statement): Available from the NTIS as PB-201 843-F, 27 p.

Descriptors: Wisconsin, channel improvement, environmental effects, recreation, boats, dredging, spoil banks, water quality control, dikes, Lake Michigan, disposal.

Identifiers: Environmental impact statements, Manitowoc Harbor (Wis.)

The proposed project, located on the west shore of Lake Michigan, 80 miles north of Milwaukee, involves extending the existing channel upstream in the Manitowoc River for a distance of 720 feet at a depth of 12 feet. The project will require dredging 27,000 cubic yards of bottom material. The channel improvement will be carried out by use of hydraulic dredges, and a land based diked disposal area will be utilized. Environmental impacts include disruption of the present bottom population, which has become increasingly characteristic of polluted waters; some temporary turbidity and sedimentation during construction; dredge spoil overflow into the river with a minimum retention period of 48 hours; and loss of some vegetative cover in the disposal area, although the site will eventually be converted into a park. Adverse impacts include temporary turbidity and destruction of the benthic community in the extended channel. Alternatives considered were limited to varying project dimensions, features, alignments, dredging methods, and disposal sites.

Army Engineer District, Chicago, Ill., 1971, Manitowoc Harbor, Wisconsin (draft environmental impact statement): Available from the National Technical Information Service as PB-201 843-D.

Descriptors: Wisconsin, channel improvement, environmental effects, dredging, hydraulic engineering, aquatic environment.

Identifiers: Environmental impact statements, Manitowoc Harbor (Wis.)

This project provides for the extension of the existing Manitowoc River channel upstream from the river mouth a distance of 720 feet. The extension is considered justified in the interests of light craft commercial and recreational navigation. The dredging operations will disrupt the present bottom populations consisting primarily of pollution worms. Since pollution worms have little value to the aquatic food chain of indigenous fish species, this impact is considered negligible. A temporary increase in turbidity will result from the operation of the hydraulic dredge, which is proposed to remove bottom material. The disposal of the polluted dredgings will affect existing vegetation in the bottom land disposal site. Also the effluent from the disposal site may run directly back into the river. However, requiring an adequate retention period for the effluent before disposal by controlled outflow will minimize this impact. The disposal site has little future value for wildlife with or without the proposed improvement. Due to the nature of the project the only alternatives considered were alternative disposal sites.

Army Engineer District, Anchorage, Alaska, 1972, Small boat harbor project, Bethel, Alaska, (final environmental impact statement): Available from the NTIS as PB-199 620F, 30 p.

Descriptors: Environmental effects, Alaska, harbors, channel improvement.

Identifiers: Environmental impact statements, Bethel (Alaska).

The proposed project involves the dredging of a 5,100 foot long access channel and a 1,700 foot long harbor area in Brown's Slough, in Bethel, Alaska. The project is designed to provide all-tide access to the 1.5 acre small boat beaching and anchorage area from the Kuskokwim River. The width of the access channel will stabilize at 20 feet and will have a usable depth of 6.5 feet at normal river stage. The width of the harbor area will be 40 feet, providing adequate maneuvering space. Channel dredging will eliminate spawning grounds in the existing

channel. Dredging will reduce the carrying capacity of the slough to some extent through reduction of food organisms and spawning habitats. 100 acres of low land will be used for disposal of the spoil and earth embankments. Water turbidity will be temporarily increased during the dredging project and bank erosion will contribute to water turbidity for about three to five years. There will be some alteration of river and terrestrial habitats due to project construction. The biological carrying capacity of the slough will also be impaired. Alternatives included variations in location of the basin and in the location of the channel.

Arnal, Robert E., 1972, A short survey of the environment at the dumping site for Santa Cruz Harbor dredging: Moss Landing Marine Laboratories, Technical Publication No. 72-6, 20 p.

Descriptors: Dredging, currents, bottom topography, benthos, sediments.

A survey of the dumping site prior to dumping of dredge spoil and during dredging is reported. Local surface currents, bottom topography sediments at the dredge and disposal sites, and the benthic environment were studied. Sediments at the dredge site had a very high organic content regardless of sediment particle size, and there was a high biomass value at the disposal site and its surrounding area.

Ashton, P.G., Chubb, M., 1972, A preliminary study for evaluating the capacity of waters for recreational boating: Economic Research Service, Berkeley, Calif., Water Resources Bulletin, Vol. 8, No. 3, pp. 571-577.

Descriptors: Recreation demand, boating, carrying capacity.

Identifiers: Recreational boating, user satisfaction.

The problem investigated was: how many boats can a given body of water accommodate with satisfaction to the majority of users. Data for the study was gathered from boaters on Union, Cass, and Orchard Lakes in southeastern Michigan. Linear regression analysis was used to investigate (1) the relationship between the satisfaction of users and the level of use, and (2) the relationship between the area used by boats and the levels of use. The satisfaction of users was defined in terms of an index calculated by dividing the number of unfavorable boater responses by the total number of responses for a given time and place. The area used by boats was quantified in the form of a 'space consumption index' calculated by dividing the total area consumed by all activities by the total water surface area. The user satisfaction index was found to be directly related to the space consumption index. This result held for both public access boaters and shoreline property owner users. The number of acres per boat was inversely related to space consumption. From these two relationships, the carrying capacity of surface waters for recreational boating can be predicted.

Bassi, D.E., Basco, D.R., 1974, Dredging: "Field Study of an Unconfined Spoil Disposal Area of the Gulf, Intracoastal Waterway in Galveston Bay, Texas." Texas A & M University, College Station, Texas, January 1974.

Bhattacharya, S.K., Biswas, A.N, 1973, Evaluation of harbor deepening projects: American Society of Civil Engineers, Waterways, Harbors and Coastal Engineering Division, Journal 99(W1): pp. 11-123.

Descriptors: Harbors, dredging, channels, costs, economics, India Coast.

World shipping trends show that large vessels are being progressively commissioned for the transport of commodities such as petroleum, ores, and fertilizers, due to the low transportation cost in such carriers. Approach channels to ports are

being deepened to accommodate such vessels. A subsidiary deep-dock system at Haldia, 57 miles seaward of Calcutta in West Bengal, India, was designed to provide access to carriers with a 40-ft. draft, principally for the cargoes of crude petroleum and ore. The navigation channel from the sea to the dock system must be deepened, necessitating a large investment. General equations are developed to determine the costs and benefits involved with a channel deepening project, and the methodology is applied to the Haldia project.

Bowerman, Frank R., Chen, Kenneth Y., 1971, Marina del Rey: A study of environmental variables in a semi-enclosed coastal water: Los Angeles, University of Southern California Sea Grant Program, Publication No. 4-71, 65 p. Grants; USDC GH-89 and 2-35227.

Descriptors: Environmental surveillance, water pollution, marinas, harbors, pesticide residues, California coast.

The physical, chemical, and biological properties of the water body and sediment of the Marina del Rey boat harbor on the southern California coast are examined. Dissolved oxygen, pH, alkalinity, turbidity, and salinity show that environmental variables of the marina are satisfactory. Biological indexes, such as diversity and density of benthic life, are low. The quality of storm water is relatively harmless to the water quality. Chlorinated hydrocarbons are largely absent in storm water and in water samples of the marina, but chlorinated pesticides were detected in some sediments. Higher than normal concentrations of Pb in both the marina and storm water samples probably stem from automobile and marine exhausts. Concentrations of heavy metals, such as Hg and Cd, are generally low in water samples, but significant accumulations in sediments were detected.

Bruun, R., 1973, Port engineering: Houston, Texas: Gulf Publishing Company, 443 p.

Descriptors: Port development port installations, engineering, sediment transport.

The planning and layout of ports are discussed. Specific topics include: modern trends in port engineering; port navigation and hydraulics; breakwaters, jetties, and piers; wharves, quays, fenders, dolphins, and mooring devices; transportation systems; littoral drift and sedimentation problems; coastal geomorphology in port engineering; tidal inlets on alluvial shores; dredging technology small craft harbors; tracing and bypassing; pile foundations; anchored bulkheads; berthing maneuvers; and the use of tracers in harbor, coastal, and ocean engineering.

Cross, Ralph H., Sollitt, Charles K., 1972, Wave transmission by overtopping: American Society of Civil Engineers, Waterways, Harbors and Coastal Engineering Division, Journal, WW, 98(WW3), pp. 295-309, Contract, AEC DACW-72-68-0032.

Descriptors: Breakwaters, harbors, wave transmission, hydraulic models.

A semi-empirical theory for ocean wave transmission past breakwaters by overtopping is presented, based on an evaluation of the energy content of the overtopping water. Comparisons are made with large-scale model tests. An envelope curve for the transmission coefficient, based on all available data, gives a simple tool for preliminary design estimates of the transmission coefficient.

Dearstyne, S. Charles, and others, 1969, Report on small craft harbors: American Society of Civil Engineers, New York, 1969.

This manual is made up of five parts. Planning includes a procedure of master planning and provides certain criteria dealing with the protection that may be necessary to provide safe and useful moorage of small craft within a harbour area. Harbour structures describes in detail the development of facilities within the harbour and their construction. Economics and finance, covers financing possibilities particularly where public agencies are involved, and some sources of Federal and other financial aid that may be available.

Delaune, Kathryn M. (Ed.), 1972, Proceedings of the Marina Management and Operations Seminar: TAMU-SG-72-105; Texas Engineering Experiment Station and Sea Grant Program, Texas A & M University, College Station, Texas.

This conference was held March 28, 1972, in Arlington, Texas as part of the effort to bring specialized and current information in the areas of management and operations of boat facilities to the marina operator. Included in the proceedings are presentations on the Sea Grant Program, marine insurance, facilities, sanitation, safety and anti-pollution: laws and regulations.

Department of Natural Resources, Bureau of Commercial Recreation, 1968, A program for our recreational waters:

Wisconsin's small-craft harbors and facility needs: The following report summarizes intensive research into the small pleasure craft situation in Wisconsin. This work was started after routine comparisons had shown radical differences between the makeup of our boating fleet and that of our neighbor states. Their marina and large-craft business was booming - ours, by comparison, was near death. Why? What factors influence boat ownership, and how was this affecting Wisconsin's non-trailerable boat business?

To get sound data on the situation, it was necessary to investigate the national picture, the industry itself, and our neighboring states. The following outline covers the main aims of this investigation:

Study Plan Outline

- I. Wisconsin's Pleasure Craft Fleet
Size - Types - Ownership
- II. How Does This Fleet Compare With:
Neighboring States? - National Averages?
- III. Gaps - What is Our Potential? Big-Boat Shortage?
- IV. Why Do People Buy Big Boats? Four Factors
- V. What is Holding Down Big-Boat Use Here (Wisconsin)?
Family Incomes OK? Enough Boating Waters Nearby?
How About Facilities
- VI. Conclusions
- VII. Recommendations
- VIII. How Can This Be Accomplished?

Dietz, A.L., 1973, Computer simulation of recreational boating activities: Army Engineer District, Chicago, Ill., Economics Branch, Water Resources Bulletin, Vol. 9, No. 3, pp. 494-498.

Descriptors: Simulation analysis, computer models, Lake Michigan, boating, recreation demand.

Identifiers: Harbor improvement, travel behavior, transient.

Lake Michigan provides the necessary conditions for reducing the region's outdoor recreational boating supply deficiency. However, the presence of the Lake itself is not sufficient to solve the deficiency problem because use is strictly controlled by a limited number of access points. A solution is selected site expansion to not only provide access but also service the refuge and transient needs. Harbor improvement planning which identifies the refuge and transient service needs at points along Lake Michigan is considered. The travel behavior model developed to predict this use is sensitive to five criteria: boater characteristics which influence travel behavior; entry rates into the Lake from each access site; site characteristics; weather conditions; and planning parameters. The model estimates: the number of boaters demanding a given access point at a given time; length of stay at that point; probability of travel to specific access sites in given amounts of time; and those facilities used during a specified time period. The simulation modelling boat movement consists of two parts: a traffic generation routine and an activity simulation. The former schedules the entry of boats into the Lake from each site and the latter establishes the probabilistic movement of boats on the Lake. This simulation of interport movements and port activities enables the planner to investigate some impacts of alternative small boat harbor development plans.

Donoghue, J.L., President, Burke, Ralph H., Inc. Engineers - Architects, - Park Consultants, Chicago, Ill., 1973, Planning the Modern Marina: Presented to Dock and Marina Design Seminar conducted by the University of Wisconsin-Extension in cooperation with the UW Sea Grant Program, May 10 - 11, 1973, The Wisconsin Center, Madison, Wis.,

Dunham, James W., 1962, Design considerations for California marinas: American Society of Civil Engineers, Paper No. 3309, Vol. 127, part IV.

Considerations and criteria for the functional layout and structural design of marinas for small craft, as proposed by the California State Division of Small Craft Harbors, are presented. Examples of successful design practice are given, and recommendations are made for use of various types of material and design under different conditions of exposure.

Frye, John, 1972, Marinas causing Va. oyster bars to be closed: National Fisherman, Camden, Me., 52(12), pp. 24A.

Descriptors: Pollution, oyster beds, marinas, legal actions, Virginia.

A public hearing between a marina operator and oyster lease holders is reported, and a plan by the state of Virginia to condemn all oyster beds near marinas is discussed. Twenty areas have already been restricted because of pollution from boats. The marina owner maintains that concern over possible pollution is unwarranted.

Gole, C.V., Tarapore, C.S., Brahme, S.B., 1972, Prediction of siltation in harbour basins and channels: Central Water and Power Research Station, Poona (India), In: Hydraulic research and its impact on the environment; Proceedings of 14th Congress of International Association for Hydraulic Research, Paris, August 29 - September 3, 1971, Vol. 4, pp. 33-40.

Descriptors: Silting, harbors, suspended load, model studies, dredging.

Identifiers: India.

A method has been developed for the prediction of siltation in harbor basins and channels. This method is based on the analysis of prototype and model data and on theoretical and analytical studies. A coefficient which indicates the ratio of actual siltation to the effective silt load entering the area of development is first evaluated from the known dredging and other data of existing ports and the same value is then utilized for other ports under similar situations.

Goodale, Thomas L., Ditton, Robert B., 1971, The marine recreational uses of Green Bay: Leisure Sciences Collateral, University of Wisconsin-Green Bay.

Substantial increments of time, income, and mobility available to larger numbers of people within the Lake Michigan watershed have placed a heavy burden on all recreation resources. Rapidly increasing pressure on resources for water-based recreation has been well documented. Yet, frequently, multiple-use management schemes have not adequately reflected the recreation component and have fallen short of optimizing the recreation potentials of our water resources.

Some of this deficiency can be attributed to lack of data and to problems of quantifying primary and secondary benefits accruing from recreational use. Of equal importance, perhaps, is lack of understanding of those water quality criteria and requirements perceived as important by the recreational user. Acting on their perceptions, recreational users (and non-users) make daily decisions about water and other resources. Understanding the type and amount of recreational use of a water body; how people perceive the water body's biological, chemical, and physical properties; and how use and perception interact, will enable us to improve policy and management activities and to better understand concerns of the citizenry, accommodate their needs and interests, and enlist their support.

In seeking to rectify some of the present inadequacies, a survey of heads of households was conducted throughout the five Wisconsin counties with shoreline on Green Bay (Brown, Door, Kewaunee, Marinette, and Oconto). Water-based recreation participation frequency data, with emphasis on fishing, boating, and swimming, was gathered along with data on water quality perception, restraints on further participation, location of activity, and standard data on characteristics of the sample.

Field work conducted in August and early September, 1971, yielded 2,174 complete and usable interviews from a random sample of 300 clusters (ten households each) throughout the five-county area. In that over 400 households were not contacted due to time constraints, the response rate was better than 80 percent. The sample, being representative, is fully generalizable for the five-county area, and the N is large enough to enable detailed analysis, only a small portion of which is related here.

Of all respondents, over 70 percent rated Green Bay waters as "dirty" or "somewhat dirty," 20 percent replied "clean" or "reasonably clean," while 9 percent volunteered that it "depends on the location." About one-third of the heads of households did no fishing, boating, or swimming over the twelve-month period preceding the interview. Advanced age is among the major determinants of non-participation. Of the participants, less than half used Green Bay waters for their fishing, boating, or swimming.

Among determinants of selecting the location of the water-based activity, quality of support facilities and proximity (closeness) were most frequently mentioned, although over 20 percent of the respondents preferred locations that were "not too crowded." The major problem for bay users, according to the respondents was, "unpleasant smell," followed by poor bottom quality and weeds. The characteristic most disliked about the bay was dead fish according to 45 percent of the respondents. Harmful bacteria was mentioned by 16 percent.

Of the many hypotheses being tested, only three can be included in this report. Using Chi square tests, participants and non-participants were found to differ significantly on 27 of 30 variables (14 predictor and 16 criterion) at the .001 significance level and 29 of 30 at the .01 level. Participants grouped on the basis of the primary activity type differed significantly from each other on 20 of 30 variables at .001 and 22 of 30 at .01. Our hypothesis that among participants in fishing, boating, or swimming, bay users and those not using Green Bay differed significantly was partially supported. Significant (.01) differences on fourteen variables, including nine at the .001 level were found between these groups.

The full paper will focus on analysis and implications of the findings reported here.

Gullidge, Ellsworth J., Urabeck, Frank J., 1970, Planning for Pleasure Boating on Regional Basis: Journal of the Waterways, Harbors and Coastal Engineering Division, ASCE, Vol. 96, No. WW3, Proc. Paper 7453, pp. 583-600.

A regional study of Puget Sound and adjacent waters, in Washington State, provided comprehensive information for use in planning of small boat harbors and other facilities required by pleasure boaters. This study included: an inventory of existing facilities and shoreline; measurement of marine facility demand by a questionnaire survey; comparison of demand with existing facilities to determine needs for additional facilities and projections of needs to 1980, 2000 or 2020. The paper displays a systematic approach towards the measurement of boater demand, both of quality and quantity, thus providing techniques for use by planners seeking to plan and develop facilities for pleasure boating.

Hansen, Ray S., 1971, Dredging: problems and remedies: Corps of Engineers, Buffalo, N.Y., Limnos, Vol. 4, No. 1, pp. 3-12.

Descriptors: Dredging, Great Lakes, harbors, water pollution sources, water pollution control, rivers and harbors act.

Identifiers: Dredgings disposal, mercury, corps of engineers.

This is an examination of the ecological ramifications of dredging and disposal in the Great Lakes. Water and sediments in harbors, open-lake dumping areas,

and newly constructed disposal sites were sampled as well as material from sources related to dredges, dikes, barriers, etc, for analysis of physical and chemical properties possibly affecting biota and water quality. Relation of dredging to pollutants, especially mercury, was considered. Several processes and combinations of processes for treatment of dredged material were studied. Most "treatment" processes are not very effective for removal of many pollutants, such as heavy metals. Disposal behind enclosed dikes is expensive, but generally is less costly than other means of handling dredging except lake disposal. Factors of design, composition, and location of diked areas vary widely in different localities (disposition of dredged material on land or in marshy areas may harm wildlife and the environment; filled-in areas might be used beneficially). "Benefits" of halting open-lake disposal include improvements in the ecological environment where polluted dredgings are deposited, removal of some undesirable sediment material which could penetrate the ecosystem, and the advantage of reducing turbidity, odor, and oil slicks which appear during open-lake disposal.

Higgs, K.G., McLean, W.A., 1972, Creative waterfront development: *Journal of Soil and Water Conservation*, 27(2), pp. 62-65.

Descriptors: Harbor construction, shorelines, Great Lakes, Canada.

The waterfront plan for the Metropolitan Toronto area is a major attempt at creative waterfront development over a significant stretch of the Lake Ontario shoreline. The design includes development of public recreational facilities at the shoreline, more extensive drainage systems, improved water quality controls and regulation of future shoreline uses.

Krauss, Frederick E., Plude, George H., 1972, 1,200-ft. graving dock: *American Society of Civil Engineers, Waterways, Harbors and Coastal Engineering Division, Ann Arbor, Mich., Journal, WW, 98(WW4)*, pp. 549-560. Presented at: ASCE, Conference on Structural Engineering, (held in Cleveland, Ohio, April 24-28, 1972).

Descriptors: Dry docks, Great Lakes.

Design and construction of the largest dry dock on the Great Lakes is described, and special attention is given to walls, floor, gate, and pumping systems. The floor, which is founded directly on natural shale, supports keel block loads of 180 in each. The dock, which is located in Erie, Pennsylvania, is 1250 ft. x 130 ft. x 25 ft.

Leebeek, H.J., 1972, Ergonomie in een havenmond: *TNO Nieuws*, 27(6), pp. 254-259.

Descriptors: Harbors, breakwaters, lighting, Netherlands.

Ergonomic optimization of the surroundings for the man on a ship bridge resulted in recommendations to the Ministry of Transport, Hydraulics and Public Works about the visual impression of the new harbor entrance near Hook of Holland. A scale model (1:500) was used for the investigations. Recommendations were given about the shape of breakwaters and banks, leading lines of light and annoying background lighting.

LeMehaute, Bernard, Hwang, Li-San, 1972, Harbor design: Scale model or computer?: See citation no. 73-3E-00174, 23 p. Contract: AEC AT(26-1) 289. Also in: *Topics in Ocean Engineering, Vol. 11, Bretschneider, Charles I.*

Descriptors: Hydrodynamic models, wave forces, numerical analysis.

Engineers have relied almost entirely on scale model investigation in dealing with the problem of wave agitation in a harbor of complex shape; in the case of incident long waves the practical difficulties in reproducing satisfactory boundary conditions on scale model require careful interpretation of results. One can theoretically reproduce satisfactory boundary conditions on a scale model; compromises have to be made for economic and practical considerations. A brief review of numerical methods of solution and a critical discussion on the limit of validity of these methods is given, together with a technical and an economical comparison between the experimental and numerical methods. It appears that theoretical studies leading to numerical schemes and computerization with their attendant advantages should replace scale model studies of seiche.

LeMehaute, Bernard, 1972, Wave agitation in a harbor of arbitrary shape: See citation no. 73-3E-00174, 7 p. Advances in Hydroscience, Vol. 7.

Descriptors: Wave forces, harbors, mathematical analysis.

The response of arbitrary shape and constant depth to periodic incident waves is analyzed mathematically. Hwang and Tuck's classical formulation for linear periodic motion, Laplace's equation, Weber's equation, Green's function, Bessel's function, and Hankel's function are utilized in the analysis. Considering the theoretical aspects of explosion-generated waves as an approach to defining harbor boundaries, at least 8 boundary segments/wavelength are required for a satisfactory representation of a harbor boundary. The computing problem is that of a matrix inversion, so computing time increases with the cube of the number of points. Nevertheless, this method allows the treatment of practical problems far more complex than other well-known methods based on relaxation techniques, for example. An example for an irregular harbor shape (Port Hueneme, California) is shown giving the amplification factor A_p for a range of incident frequencies at the location indicated.

LeMehaute, Bernard, 1972, Harbor paradox: See citation no. 73-3E-00174, 14 p.

Descriptors: Harbors, wave forces, coastal engineering, hydrodynamics.

Solutions to the problem of wave agitation in a harbor are examined in 2 parts. First, a comment is made on the conclusions presented by Miles and Munk (1961) on harbor response to outside wave agitation, and on their proposed solutions to the problem of long wave agitation in a harbor. This part is approached from an engineering rather than a theoretical point of view. Secondly, the theoretical approaches to this problem as they have been studied to date (1962) are discussed. An attempt to synthesize these approaches and a brief mention of what could be done in the future are also presented. The principle of the method of approach presented by Miles and Munk, which is practical for simple shaped harbors, could probably be extended by the use of computers, with some modifications, to apply to actual complex harbor basins.

Mass Ann Laws Ch 91, 1967, Surveys and improvements of harbors - establishment of harbor lines - great ponds defined: secs, 31-36.

Descriptors: Massachusetts, harbors, great ponds, damages, banks, coasts, docks, piers.

The Department of Public works of the Commonwealth of Massachusetts may make surveys and improvements for the preservation of harbors and may repair damages caused by storms along the coast line or river banks of the commonwealth. The department may take by eminent domain or purchase any land necessary for the

improvements. The department is also instructed to survey that portion of the Connecticut River lying within the commonwealth. The department may also sell, at such prices and conditions as it prescribes, maps prepared by it in connection with waterways and public lands. The department may, after hearings with interested parties, prescribe lines in any harbor of the commonwealth. The general court must approve these lines. If the lines are approved, no wharf, pier, or other structure may extend into the harbor beyond the lines. The department may also apply to Congress for appropriations for the protection and improvement of any harbor in the commonwealth. Great ponds are defined as ponds containing in their natural state more than ten acres of land.

Moore, Jon T., 1972, A case history of Santa Cruz Harbor, California: California, University, College of Engineering, Hydraulic Engineering Laboratory, Berkeley, Technical Report No. HEL 24-14, 43 p.

Descriptors: harbor construction, sand transport, shoaling, littoral drift, California coast.

Maintenance problems that developed since construction of Santa Cruz Harbor, a small craft harbor located 80 mi. S. of San Francisco, are described. The harbor consists of an entrance channel which is 100 ft. wide, 900 ft. long, and 20 ft. deep. The channel continues an additional 370 ft. at a 15 ft. depth to an inner channel and basin, and it is flanked by 2 rubble-mound breakwaters; the E jetty is 810 ft. long and the W, dog-legged jetty is 1,200 ft. long. The channel has experienced severe shoaling problems and may be responsible for beach erosion in the neighboring community of Capitola. Large littoral transport from upcoast and storm wave attack during winter have occurred, and the littoral compartment upcoast of the W jetty appears to be completely full, with littoral drift moving past the jetty tip. A proposed sand trap may intercept sand transport, but storm conditions may cause problems. If the dredged trap is unsatisfactory, a detached breakwater may be necessary to keep the harbor in use throughout the year.

Rood, Marsha V., Warren, Robert, 1974, Marinas: The Urban Marina: Managing and Developing Marina del Rey. USC-SG-5-74, Sea Grant Program, University of Southern California, January 1974.

Schultz, George P., McCoy, Margarita P., et al., 1972, Marina del Rey study. Working paper 1B: The development of Marina del Rey: Los Angeles, University of Southern California, Sea Grant Program, Publication No. USC-SG-5-72, 113 p. Grant: NOAA 2-35227.

Descriptors: Marinas, harbor construction, economics, California coast.

The development of Marina del Rey boat harbor on the southern California coast is reviewed, including the predevelopment era, initial development (1956-62), and later development (1962-71). This marina is one of the largest man-made small craft harbors in the world, containing 375 a of land and 405 a of water, with 6,000 boats in slips and hundreds more in dry storage. It has a resident population of 10,000 and a seasonal daytime population of about 30,000. Extensive commercial facilities include a shopping center, office buildings, and restaurants. The site of the marina is totally owned by Los Angeles County, but most of the land and some of the water areas are leased to private developers. Funding is from both public and private investment; the project is a financial success.

Skidmore, Owings and Merrill, Portland, Oreg., 1972, Yaquina Bay marine development plan: available from NTIS, Springfield, Va. as COM-72 11305. Report to Economic Development Administration, Department of Commerce, August 15, 1972, 249 p.

Descriptors: Water resources development, marinas, water sports, commercial fishing, Oregon.

Identifiers: Yaquina Bay area (Oreg).

This report is Phase III of a continuing action program which is dedicated to promote sound, environmentally compatible economic development of the Yaquina Bay area, Oregon, while preserving and enhancing its natural resources and life style. Its purpose is to establish the feasibility of expanding the marine-oriented economic base to provide a new and more stable employment opportunities. The scope of the study includes the examination of specific interrelated activities: commercial fishing, fish processing, warehousing and storage, moorage and transportation; recreational and sport fishing; supporting commercial-retail facilities, including marine repair and supply; marine-oriented industrial development, including activities related to the Marine Science Center; and transportation bearing directly upon marine-oriented facilities. The culmination of Phase III of this program has resulted: (a) in the recommendation of specific policies to guide the future marine and recreational development of the Yaquina Bay area, and (b) in the citing of specific projects as potential candidates for Federal financial assistance. This material sets a comprehensive framework for healthy, environmentally compatible economic growth, and will allow the Task Force to seek a "pre-application" interview with Federal authorities for implementative support.

Soule, Dorothy F., Soule, John D., 1971, Preliminary report on techniques for marine monitoring systems: Los Angeles, University of Southern California, Sea Grant Program, Technical Note No. 1T-71, 8 p.

Descriptors: Pollution, harbor surveillance, marine organisms, California.

A monitoring system used to assess the impact of pollution on marine biotic communities is described. The system, which uses settling racks attached to docks, floats and buoys, was tested in California harbor areas where the bottom had a thick layer of mud, organic debris and reducing bacteria or where dredge and grab sampling indicated that the area was dead. Settling racks suspended well above the bottom indicated that many organisms can survive if provided with adequate substrate.

Stair, Bill, 1972, How Baltimore copes with harbor wastes: Work Boat, New Orleans, 29(5), pp. 14-15.

Descriptors: Barges, waste disposal, oil spills, harbors, Maryland.

The efficient recovery and disposal of harbor wastes in Baltimore is handled by several unique barge type vessels. Two barges were designed for the removal of solid debris, and one designed specifically for the recovery of oil spills. Barges and recovery operations are described. Performance of the oil recovery barge proved satisfactory with 11 types of oil including soybean, diesel, linseed, gasoline, diluted molasses, crude oil and bitumastics.

Texas A & M University, College of Agriculture & Environmental Design, Architecture Research Center, 1971, Port and harbor development system. Phase I - design guidelines work report: Texas A & M University, Sea Grant Program, Sea Grant Publication No. 71-216, 144 p. Grant: NSF GH-101.

Descriptors: Ports, harbors.

Future ports and harbors must be planned and designed to accommodate change. As an aid to marine facilities planners, the following areas are reviewed: Analysis of present harbor design features step-by-step requirements in port design and construction; trends of marine and transportation technology; and planning and design concern for ports in different stages of development. A glossary of nautical terms is included.

SHORELINE MODIFICATION AND COASTAL ZONE

American Society of Civil Engineers, 1970, Coastal engineering: proceedings of the twelfth coastal engineering conference, September 13-18, 1970, Washington, D.C., New York, N.Y., 3 Vol., 2, 286 p.

Descriptors: Coastal engineering, water management (applied), engineering structures, shore protection, harbors.

Identifiers: Coastal research council (ASCE), wave theory, storm characteristics, erosion process.

The proceedings of the twelfth conference on coastal engineering are presented in three volumes containing a total of 138 papers. The purpose of the conference is to improve the art and science related to design and planning of coastal works worldwide. This conference was sponsored jointly by the coastal engineering research council of the American Society of Civil Engineers and the American Shore and Beach Preservation Association. The International Association for hydraulic research cooperated with the ASCE groups in carrying out the conference. A short history is given of previous conferences beginning with the first held at Long Beach, California in October 1950 and includes the names of the research councils which sponsored them. Papers presented in the proceedings lean heavily on the sciences of oceanography, meteorology, fluid mechanics, electronics, structural mechanics, and hydraulics generally as applied to shoreline problems. Emphasis is on the dynamic behavior of water as it influences structural design.

Anonymous, 1972, Buyers guide to suppliers of dredge components: Work Boat, New Orleans, 29(10): pp. 17, 19-20, 23-24, 29-30.

Descriptors: Dredging equipment, directories, U.S.

The names and addresses of U.S. firms supplying dredge components are listed by the component produced. Components include bearings, brakes, buckets of various types, clutches, cranes, derricks, and hoists, cutters, cutter shafts, density control units, dippers, dredge maintenance systems, dredge pipe connections, dredge pipe, hose, and sleeves, dynamic positioning systems, explosive systems, fairleaders, gears, ladders, pontoons, power units, pumps, sheaves, spuds, subbottom profiling units, teeth, valves, water-jet boosters; and wire rope.

Anonymous, 1972, Botany Bay first stage underway: Hydrospace, London, 5(3); pp. 35-36.

Descriptors: Port development, dredging, breakwaters, coastal engineering, Australia, botany bay project.

One of the largest dredging projects ever undertaken in Australia is underway as part of a program of port development in Botany Bay. The main entrance channel will be deepened to 63 ft. and the port basin to 73 ft. A 6000 linear ft. 45 ft. armored breakwater embankment will be built to form the eastern boundary of the port works to protect the reclamation of some 300 a of port and industrial land. Large scale configuration dredging will be used to control the waves. Dredging patterns are designed to turn the waves away from the port basin entrance and to direct them primarily to the armored embankment where the wave action can be safely absorbed. A layer of precast concrete tribar armor units will be placed on the seaward face of the embankment to form an interlocking system to resist the force of the waves.

Anonymous, 1972, OD methods used in underwater blasting: World Dredging and Marine Construction, 8(8), pp. 30-32.

Descriptors: Harbors, port development, dredging, drilling platforms, excavation.

In harbor and channel deepening projects around the world, Atlas Copco's OD (overburden drilling) rigs have proved they can handle the job. Conditions encountered in Istanbul, Turkey, and at Milford Haven are described. Considerations in the design of a drilling platform and from a floating raft. Drilling equipment used in the OD method is also described.

Anonymous, 1972, Land from the sea: Engineering, London, 212(9), pp. 844-848.

Descriptors: Coastal zones, land reclamation, harbors, England, Portsmouth.

Reclamation and use of tidal lands in Portsmouth Harbor is described. A motorway is being constructed on this land, and silt is removed by dredgers after parts of the site are flooded. Fill is transported by belt conveyers, and imported fill consisting of dredged marine sand is transported and placed by hydraulic methods. The construction of offices, refuse disposal plants, and a yacht basin is discussed, and the effects of such construction on the seabed and coastal land are considered.

Anonymous, 1972, Ocean utilization and coastal zone development: Massachusetts Institute of Technology, Sea Grant Project Office, Cambridge, Report No. MITSG 73-3, 29 p.

Descriptors: Coastal zones, resource management, ocean engineering education, MIT.

Sea grant activities of the Massachusetts Institute of Technology from June 1, 1970 to June 30, 1972 are summarized. Research projects include: new dimensions of U.S. marine policy, estuary modeling, ocean transportation, the future of Atlantic ports, squid protein concentrate, and oil oxidation by marine bacteria. Education and training projects encompass the following subjects: power, pollution, and public policy; ocean engineering, marine transportation, and evolution and utilization of marine mineral resources.

Anonymous, 1972, Proceedings of seminar on planning and engineering in the coastal zone: Planning and Engineering in the Coastal Zone, Coastal Plains Center for Marine Development Services, Seminar Series No. 2, Wilmington, North Carolina, 139 p.

Descriptors: Coastal zones, beach erosion, environmental conditions, remote sensing, government regulations, legislation, conferences.

Papers are presented which highlight planning and engineering problems and solutions applicable to the coasts of the Carolinas and Georgia. Physical processes, erosion, and protection of the coast are discussed, including storm characteristics and effects, the National Shoreline Study, erosion processes and protection, and a case study of Hunting Island Beach in South Carolina. Environmental characteristics of the southeastern Atlantic coastal zone, mechanics of dredging and filling, environmental aspects of dredging and filling, estuaries as a limited resource, and developmental planning and management are also discussed. Legal aspects and legislation in the coastal zone are reviewed: status of coastal zone legislation, Georgia responses to problems of natural resource allocation, legal aspects and problems of the North Carolina coast, and the tidelands law of South Carolina. Aerial surveillance techniques applied to the coastal zone are also examined.

Anonymous, 1972, Beach erosion: Can mankind help nature regain delicate balance?: National Fisherman, Camden, ME., 52(13): pp. 82-83, 90.

Descriptors: Beach erosion, coast protection, erosion control.

After decades of thoughtless land development along the shore and ignorant placement of rock groins, jetties, and other devices meant to combat beach erosion, those who live and make their living by the sea are beginning to see their errors. Anything that obstructs the natural movement of sand along the beaches (including houses and even natural inlets) threatens the life of a beach. Attention is focused on beach erosion problems and how people plan to react to them in the 1970's. Not much is being done to control beach erosion, but some plans include beach restoration using dredged fill and restrictions on the placement of jetties, groins, or houses at the shore.

Armstrong, J.M., Ryner, P., Bradley, E., 1971, Development of planning and management concepts for the Great Lakes coastal zone; Sea Grant Program, the University of Michigan, Ann Arbor, Michigan.

The Coastal Zone and Shorelands Management Project of the University of Michigan Sea Grant Program has completed a first level Great Lakes shorelands planning guide. Designed for use by local shoreland communities and regional associations, this guide is the first step in preparing a shorelands and coastal zone management guide for the state of Michigan.

The first step in preparing this guide consisted of a review and analysis of the coastal zone management systems of all relevant states in the nation. The second phase involved a pilot planning and management project in Traverse Bay, Michigan. As a result of this pilot project, carried out in cooperation with the Michigan Water Resources Commission, a conceptual approach to shorelands planning was developed for this specific area. Then management and institutional analyses of various concepts were carried out in relationship to other proposed or existing coastal zone programs. The third phase involved participation in the writing of a comprehensive plan for the Traverse City area of Grand Traverse Bay. Working with professional planners of the Traverse Bay Regional Planning Commission, Sea Grant contributed a section on the management of shorelands. As a fourth part of the preparation of the shorelands planning guide, Sea Grant cooperated with the Water Resources Commission in preparing an instructional booklet for the implementation of Michigan's Shorelands Protection and Management Act of 1970. This booklet is being sent to every Great Lakes shoreland governmental unit in the state of Michigan.

This project also worked with the U.S. Army Corps of Engineers in the preparation of their Great Lakes shoreland management guide, and is currently continuing work on a series of conflict matrices, 'best use' principles, and a coastal zone inventory and management information system, which also will be described in this paper.

Armstrong, John M., Bradley, Earl H., Jr., 1972, Status of state coastal zone management programs: Marine Technology Society, Washington, D.C., Journal, 6(5), pp. 7-16.

Descriptors: Coastal zones, wetlands, environmental management, state programs.

The present status of U.S. coastal zone and shoreland management programs at the state level is reviewed to assist persons working in the field by exposing them to the various possible alternative approaches and to the strengths and weaknesses of those approaches, as they are being pursued. Pending congressional legislation would provide increased impetus for states to develop coastal zone

management programs. These programs include those dealing with estuarine and wetland preservation measures including significant acquisition programs; controls over dredging and filling to protect environment quality; industrial, residential, and power plant location controls; and measures to increase beach access.

Army Engineer District, Buffalo, N.Y., 1971, Lorain Harbor, Ohio (maintenance) (draft environmental impact statement): (NTIS #PB-205 787-D, 10 p.)

Descriptors: Channel, environmental effects, breakwaters, coastal engineering, water pollution sources, harbors, water pollution.

Identifiers: Environmental impact statement, Lorain Harbor (Ohio).

The work under consideration is the maintenance of completed channels and structures in the deep-draft navigation project for Lorain Harbor, Ohio. The project calls for the maintenance of breakwaters and the dredging of about 300,000 cubic yards of sediment annually and dumping in Lake Erie. Dredging will cause short-term increases in turbidity and sedimentation, both in dredging and disposal areas. The disposal of dredged material will cause adverse effects to the extent that polluted material is placed in Lake Erie at a more rapid rate than would result from natural processes. Alternatives are either discontinuance of maintenance or provisions for an enclosed disposal area. Dredging and maintenance are continuing activities with both short-term and long-term aspects which are not in conflict. No irretrievable commitment of resources is involved.

Bader, Richard G., Regotzkie, Robert A., Teal, John M., 1972, Transportation and coastline modifications: See Citation No. 73-6D-00521, pp. 125-145.

Descriptors: Coastal zones, environmental protection, shipping industry, port development, dredging.

The impact of shipping, commerce, and construction activities on the coastline is discussed. Commerce and shipping have encouraged establishment of cities and industrial centers in the coastal zone, causing environmental modifications. Port site selection and development, navigation channels, and dredge spoil disposal are examined, along with the effects of dams drainage systems, and increased land use. Consequences of flood control, river diversion, and landscaping are also explored, and coastal zone management procedures are proposed.

Balsillie, J.H., Bruno, R.O., 1972, Groins: U.S. Coastal Engineering Research Center, Washington, D.C., Miscellaneous Paper No. 1-72, 255 p.

Descriptors: Coastal engineering, groins, shore protection.

A groin is a shore protective structure built (usually perpendicular to the shore) to trap littoral drift or to retard erosion of the shore. The groin is one of the most controversial and most difficult to design. Because the functional and structural guidelines for design are incomplete, many groin installations fail to fulfill their intended purpose. The Coastal Engineering Research Center supports a continuing research program devoted to gaining a better understanding of groins. About 460 articles published since 1900 on groins and groin-type structures are presented. Annotations accompany each bibliographic entry where possible. Indexes of authors, titles and subjects are included. Unavailable literature such as foreign articles, although not annotated, are included as entries.

Beers, Gary D., 1972, The role of dredging in the ecosystem management program proposed for the Los Angeles Harbor: Environmental Engineering and Science Conference, Second annual, summaries (Held in Louisville, KY., April 20-21, 1972), University of Louisville, Kentucky, pp. 14-16.

Descriptors: Harbors, dredging, ecosystems, California coast.

In an ecological study of the dredging of Los Angeles Harbor, surface and subsurface sediment samples were analyzed for particle-size distribution, total N, oil and grease, COD, total sulfides and phosphates, benthic animal diversity, and dry wt. The degree of dredging was associated with the degree of potential improvement in the quality of the sediments. Dredging to a depth of 10 ft. would restore conditions for desirable benthic communities.

Bella, David A., McCauley, James E., 1972, Environmental considerations for estuarine dredging operations: World Dredging Conference, IV, proceedings (held in New Orleans, La., Dec. 1-3, 1971). pp. 457-482.

Descriptors: Dredging, estuaries, benthos.

A conceptual model of estuarine benthic systems is presented, and the influence of dredging and spoil disposal operations on estuarine waters is considered.

Berg, Dennis W., Watts, George M., 1971, Groins and groin systems: A review of research: Shore and Beach, 39(2), pp. 34-36.

Descriptors: Shore protection, groins, research review.

Research on groins for shore stabilization purposes is summarized.

Bissell, Harold D., 1972, Coastal zone planning in California: Shore and Beach, 40(1), pp. 24-25.

Descriptors: Coastal zones, resource management, California.

California's Comprehensive Ocean Area Plan (COAP) is briefly discussed. A summary is given of some of the work already done, particularly on the preparation of a coastal zone inventory and the establishment of concepts, criteria and guidelines which will enable planners to allocate coastal zone uses on an orderly basis for the long term benefit of society.

Bosselman, Fred, Callies, David, 1971, The quiet revolution in land use control: Report, Council on Environmental Quality, Washington, D.C., 377 p.

Descriptors: Coast protection, environmental management, shorelines, state policies, legislation.

Nine recent innovative land regulatory systems are considered in great detail, based primarily on a review of the key statutes, regulations and decisions and on interviews with the administering officials and other groups affected by the legislation. These nine land regulatory systems include: Hawaiian Land Use Law, Vermont Environmental Control Law, San Francisco Bay Conservation and Development Commission, Twin Cities Metropolitan Council, Massachusetts Zoning Appeals Law, Maine Site Location Law, Massachusetts Wetlands Protection Program, Wisconsin Shoreland Protection Program, and New England River Basins Commission. A number of other recent laws are summarized and some of the key issues that exist in all of the attempts to revolutionize land regulatory systems are synthesized.

Bowen, Anthony J., Inman, Douglas L., 1971, Edge waves and crescentic bars: Journal of Geophysical Research, 76(36), pp. 8662-8671.

Descriptors: Coastal waters, shorelines, wave velocity, longshore currents.

The velocity fields associated with edge waves on a sloping beach are examined as possible causes of sedimentary features which have a regular, rhythmic pattern in the longshore direction. It is shown that standing edge waves provide a satisfactory explanation for the formation of crescentic bars in regions of small tidal range, the bars having a longshore wavelength of one-half that of the edge waves. In the absence of large, incoming surface waves, the edge waves may also form cusped features on the beach face, with the points of the cusps directly opposite to the horns of the crescentic bars. This situation is commonly observed in nature. The results suggest that standing edge waves with periods of 30-60 secs and significant amplitudes must occur extensively on real beaches.

Dean, R.G., 1972, Storm characteristics and effects: Planning and Engineering in the Coastal Zone, seminar, proceedings, held in Charleston, S.C., June 8-9, 1972), Coastal Plains Center for Marine Development Services, Seminar Series No. 2, Wilmington, North Carolina, pp. 1-15.

Descriptors: Coastal zones, littoral processes, beach erosion, storms, equilibrium.

The major natural forces exerted on the outer coastal zone includes waves, tides, winds, and currents. These agents are responsible for the molding of the shoreline and cause the short-and long-term variations in the nearshore region. Important features of coastal processes are reviewed, including the sand budget, littoral processes of short and long term, characteristics and effects of normal and extreme storm wave and current activity, and effects of man's activities on the equilibrium of the coastal zone.

Dubois, Roger N., 1972, Inverse relation between foreshore slope and mean grain size as a function of the heavy mineral content: Geological Society of America; bulletin, 83(3), pp. 871-875.

Descriptors: Great Lakes, grain size, beach profiles, sedimentology, heavy minerals.

Along the sandy beach of Terry Andrae State Park on Lake Michigan, Wisconsin, an inverse relationship exists between foreshore slope angle and mean grain size. Mean grain size decreases as the heavy mineral content increases. Grain size, wave steepness, and wave length have been reported as variables affecting the foreshore slope angle. It is here suggested that the heavy mineral content in the mid-foreshore be accepted as an active variable that influences the foreshore slope angle.

Ducsik, Dennis W., 1971, The crisis in shoreline recreation: Power, Pollution and Public Policy: Issues in Electric Power Production, Shoreline Recreation, and Air and Water Pollution Facing New England and the Nation. Interdepartmental Student Project, Papers, Ducsik, Dennis W. (Ed.), in Massachusetts Institute of Technology, Sea Grant Program Office, Cambridge, Report No. 24, The MIT Press Cambridge, Massachusetts, pp. 90-186.

Descriptors: Coastal zones, recreation beaches, legal actions, pollution prevention, New England.

The economic, political and sociological aspects of coastal land use for outdoor recreation are discussed, with emphasis on the New England shoreline. A new framework for long-term coastal zone management that places prime responsibility for regulation in the hands of the state is proposed. Legislation and pollution problems are also considered.

Galvin, Cyril, J., Jr., 1972, Wave breaking in shallow water: See citation no. 73-58-00926, pp. 413-456.

Descriptors: Breaking waves, shallow water equations, beaches, wave action.

Deepwater steepness (H_0/L_0) and beach slope (m) determine breaker type and breaker depth-to-height ratio. High initial H_0/L_0 induces breaking in deeper water since steepness grows faster than height. Slope determines the extent of nonlinear changes in wave shape, which occur at a slow rate relative to wave speed. Slow shape changes accompanying soliton development significantly affect the breaking of oscillatory waves and provide plausible explanations for data on the breaking of solitary waves. An empirically and theoretically derived parameter of the form $H/(m^2L_0)$ describes breaker type and predicts the transition between waves which reflect and waves which break on a beach.

Griffin, Owen, M., 1972, Recent designs for transportable wave barriers and breakwaters: Marine Technology Society, Journal, 6(2), pp. 6-16.

Descriptors: Breakwaters, floating breakwaters, transportable wave barrier designs.

The present status of transportable breakwaters and wave barriers is considered, with emphasis placed on recent designs that hold promise for continued development. Basic performance studies for several types of breakwaters are reviewed and the important operating parameters are described on the basis of past theoretical work. Several feasibility studies of recent designs are discussed and the important experimental results are outlined. It is concluded that considerable research and development work remains to be done, particularly in the characterization and measurement of breakwater mooring forces. While technical feasibility has been shown for many concepts in the model stage, both the economic and technical feasibility of most proposed systems remains to be demonstrated in full scale.

Groat, C.G., Brown, L.F., Jr., 1972, Environmental geologic atlas of the Texas coast: Basic data for coastal zone management: See citation no. 72-6D-0876, pp. 1-15.

Descriptors: Coastal zones, geophysical mapping, environmental management, atlases, Texas.

The atlas is aimed at decision-makers and can be used by any educated person. Types of maps included in the atlas are: environmental geology map, physical properties map, environments and biologic assemblages map, current land use map, mineral and energy resource map, active processes map, man-made features and water systems map, rainfall, discharge, and surface salinity map, and topography and bathymetry map. Applications of environmental maps and data are discussed.

Hansen, Ray S., 1971, Great Lakes dredging--problems and remedies: World Dredging and Marine Construction, 7(14), pp. 16-17, 19-20.

Descriptors: Dredging industry, pollution distribution, sediment concentrations, water quality, Great Lakes.

In all the Great Lakes some 115 harbors must be dredged more or less regularly. In the past, virtually all dredged-up material was deposited out in the open lakes. In the mid-60's the Corps of Engineers and the Department of Interior began to make a concerted effort to examine the ecological ramifications of the dredging and disposal. They found many questions but few answers. The Chief of Engineers concluded that a ten-year program to place polluted dredging in diked areas is desirable.

Hayes, Miles, O., Goldsmith, Victor, Hobbs, Carl H., III, 1972, Offset coastal inlets. Forms of sediment accumulation in the beach zone; NTIS 72(16): 82 p.

Descriptors: Gulf of Alaska, New England coast, inlets, sedimentation, beach erosion, wave forces.

Offset coastal inlets on the coasts of New England and the northern Gulf of Alaska are described. In both areas, dominant waves approach the shore at an oblique angle, resulting in strong net littoral drift. The most common type of offset on these coasts is a downdrift offset (i.e., the downdrift side of the inlet protrudes further seaward than the updrift side). Wave refraction around ebb-tidal deltas at the inlets is an important process in formation of downdrift offsets because it creates a local reversal in drift direction just downdrift of the inlet, allowing sediment to accumulate there. Forms of sediment accumulation in the beach zone include ridge-and-runnel systems, berms, several types of nearshore bars, cusp-type sand waves (or rhythmic topography); complex sand bodies affiliated with ebb-tidal deltas, and an ordered system of minor features (bedforms) that correlate with flow-regime conditions. Most sand beaches undergo a simple cycle of erosion and deposition in response to passage of coastal storms.

Hearing-Subcommittee on Rivers and Harbors--Comm. on Public Works, 1969, Shoreline protection: U.S. House of Representatives, November 20, 1969, 65 p.

Descriptors: Sedimentation rates, beach erosion, shore protection, legislation, Great Lakes, recreation.

This hearing took testimony on bills designed to amend 33 U.S.C., Sec. 426 (e), relating to federal participation in the cost of protecting the shores of the United States, its territories, and possessions, so as to include privately owned property within the purview of the act. The question of the basic authority for beach erosion control projects, authorized by Congress to be undertaken by the Corps of Engineers when the shore is privately owned and there is no public use involved was central to the testimony received. Congressmen testifying in behalf of the bills stressed the necessity of immediate action to preserve shorelines from erosion in their home states. Shoreline studies and reports from the Army Corps of Engineers are also included. The financial degree of federal participation would be limited to a certain percentage of the total cost once the private property owners shoreline was approved for preservation. (Tolle-Florida)

Hughes, T.H., Birchfield, G.E., Matthies, M.T., 1972, A compilation of the average depths of Lake Michigan and Lake Ontario on a two-minute grid: Argonne National Laboratory, Environmental Sciences, Argonne, Ill., report no. ES-10, 92 p.

Descriptors: Great Lakes, depth measurements, Lake Michigan, Lake Ontario.

Average depths of Lake Michigan and Lake Ontario were estimated by sounding at two minutes of latitude and two minutes of longitude. The average at a point is the arithmetic mean of all soundings appearing in a circle with a radius of one

minute of latitude centered at the point without consideration of the sounding's position relative to the point. Final tabulation of the averages with contours is in blocks of thirty minutes latitude by thirty minutes longitude.

Jameson, David L., Ragotzkie, Robert A., Bader, Richard G., Teal, John M., 1972, Recreation and aesthetics: See citation no. 73-6D-0521, pp. 84-102.

Descriptors: Coastal zones, recreation, environmental protection.

Natural constraints on the use of coastal areas for recreation are discussed, including limitations of space and access, climate, water quality, marine resources, pollution, and ecosystem management. Regional planning for recreational use and tourism in the coastal area is discussed, and U.S. coastal zone preserves are delineated. Recommendations for preserving the coastal zone are proposed.

Jordaan, J.M., Jr., 1970, Study of Durban Harbor silting and beach erosion: National Mechanical Engineering Research Inst., Durban (South Africa), in proceedings of the twelfth coastal engineering conference, September 13-18, 1970, Washington, D.C., Vol. 2, American Society of Civil Engineers, New York, NY, pp. 1097-1116.

Descriptors: Hydraulic models, beach erosion, harbors, dredging, sediment.

Identifiers: Durban (South Africa)

A scale model of seven miles of the coastline of Durban, South Africa, port limits and the inner harbor, was constructed to study combined wave, tide and wind action on transport of sand along the coast. The accumulation and dredging of sand near the harbor entrance was reproduced and various dredging and storage proposals were studied. The cause of beach erosion is attributed to the existence of an offshore shoal produced by the localized dumping of sand dredged from the harbor approaches. This shoal caused selective wave action along the coastline. Wind and tidal action had a major effect on the redistribution of sand on the beaches by a minor effect on the permanence of the harbor entrance channel. The northern beach, downdrift of the harbor entrance, was starved of littoral supply, due to maintenance of the harbor entrance by dredging and offshore dumping.

Ketchum, Bostwick, H. (Ed.), 1972, The water's edge: Critical problems of the coastal zone: Coastal Zone Workshop, papers, (Held in Woods Hole, Mass., May 22- June 3, 1972). Co-sponsored by Institute of Ecology and Woods Hole Oceanographic Institution, MIT Press, Cambridge, Massachusetts, 408 p.

Descriptors: Coastal zones, resource management, environmental protection, pollution, legal actions, conferences, books.

Characteristics of the coastal zone are described, and the environmental impact of man's uses of the coastal zone and its living and nonliving resources is considered. The effects of fisheries development; petroleum, mineral, and gas exploitation, urbanization, industrial development, and transportation are explored, along with those of waste disposal, dredging, thermal effluents, nutrients, trace metals, various contaminants and pathogens, and radioactivity. Allocation of coastal resources, coastal zone management strategies, and legal aspects of coastal zone protection are also surveyed.

Lacouture, John M. Colonell, Joseph M. Carver, Charles, F., Jr., 1972, Attenuation of wind-generated deep water waves by vertical jet breakwaters: U.S. National Technical Information Service, Government Reports Announcements, 72(21), 111 p.

Descriptors: Breakwaters, hydraulic structures, pneumatic barriers, wind generated waves, wave attenuation, computer analysis.

An investigation was undertaken to study the effects of vertical jet hydraulic and pneumatic breakwaters on wind-generated deepwater waves. Experimental data were collected for each breakwater operating separately and in various combinations. Water surface elevations, recorded in analog form on magnetic tape, were then digitized and subsequently analyzed with the aid of a digital computer. The pneumatic breakwater is slightly more effective in attenuating deepwater wind waves than the hydraulic breakwater. Also the effectiveness of both breakwaters operating in series was not as great as either breakwater operating alone. Furthermore, the breakwaters, whether operating separately or in combination, were found to attenuate random waves over the same frequency band.

Macchemehl, Jerry L., 1972, Mechanics of dredging and filling: See citation no. 73-3E-00216, pp. 49-51.

Descriptors: Coastal zones, dredges, dredge spoil, waste disposal, ocean dumping.

Dredging techniques, equipment employed, and disposal techniques are reviewed. The various types of mechanical dredges (dipper, ladder, and bucket) and hydraulic dredges (pipeline and hopper) are described. The hydraulic dredge is probably the most versatile excavator. It excavates subaqueous material and transports it without rehandling to almost any location. When sufficient water is available, the hydraulic dredge has no economic or productive competitor. Offshore and on-shore disposal technique provides the maximum retention of dredged material with minimum impact on the area being dredged.

McHugh, J.L., Bertrand, Gerard A., Ragotzkie, Robert A., 1972, Strategies and research needs for coastal zone management: See citation no. 73-60-00521, pp. 189-211.

Descriptors: Coastal zones, environmental management, research needs, strategies.

Effective coastal zone management is discussed. Compatible, displaceable, and exclusive uses of the coastal zone are summarized, and their impact on the environment is reviewed. Information needs for allocation of coastal resources, coastal zone management strategies, and legal aspects of coastal zone protection are also surveyed.

Noble, Ronald, M., 1971, Shoreline changes, Humboldt Bay, California: Shore and Beach, 39(2), pp. 11-18.

Descriptors: Jetties, shorelines, California coast, Humboldt Bay, changes.

The construction of jetties at the entrance of Humboldt Bay is discussed, with emphasis on the environmental changes brought about by the littoral barriers. Tidal currents became concentrated, and the entrance channel was deepened by bottom scour; the shallower bottom contours were moved seaward. Littoral drift was predominantly from north to south. Severe wave action has seriously damaged the jetties.

Noble, R.M., 1971, Shoreline changes, Humboldt Bay, California: Dames and Moore, San Francisco, Calif., Shore and Beach, Vol. 39, No. 2, pp. 11-18.

Descriptors: Littoral drift, coastal engineering, bays, jetties, harbors, California.

Identifiers: Humboldt Bay (Calif.)

A history of the shoreline changes in the vicinity of the Humboldt Bay entrance is presented. The Bay is described, and the details of its wave conditions, winds, currents, tides, beach face, and tidal inlets are provided. The Humboldt entrance in its natural state, before jetty construction in 1888, was a typical migrating bar channel, shifting radially through a regular cyclical period from the north to the south. Due to heavy storms which changed the channel and low water depths, ships were often trapped in the harbor. Congress, by Act of 1884, adopted an Army Corps of Engineers proposal to improve the entrance to the harbor. By 1899 construction, consisting of two riprap jetties built by the trestle method, was completed. This construction helped to deepen the entrance channel and move the shallower bottom contours seaward. The jetties were given no maintenance until their rebuilding in 1912, with the effect that the outer one-third of both jetties were badly battered by severe storms and eroded. By 1940 the bar and channel entrance became relatively stable, being maintained in equilibrium. Annual dredging of the entrance channel is now required to maintain the south shoreline.

Omholt, Thore, 1974, Erosion: "Effects of Small Groins on Shoreline Changes on the North Shore of Suffolk County, New York." New York Ocean Science Laboratory Technical Report #0028, April 1974.

O'Neal, Gary, Sceva, Jack, 1971, The effects of dredging on water quality: World Dredging and Marine Construction, 7(14), pp. 24-28, 30-31.

Descriptors: Dredging industry, water quality control, toxicity, Pacific coast, Great Lakes.

Dredging and spoil disposal problems and methods as related to the Pacific Northwest are outlined and recommendations given. A review of the literature is presented on environmental problems associated with dredging, including results of individual studies in: Chesapeake Bay; Author Kill, New Jersey; New York Harbor; a Canadian estuary; Bellingham Bay, Washington; and the Great Lakes.

Papp, Remig R., 1972, New pier in Jamaica Bay: Civil Engineering, 42(8), pp. 52-54.

Descriptors: Piers, materials, concrete, fenders, New York, Jamaica Bay.

The design and construction of a new pier in Jamaica Bay, New York, is described. To meet the design criteria, prestressed concrete was chosen as the building material for the piles and pier deck. In addition to the 367 ft. long pier, the superstructure of the 399 ft. long approach trestle is also composed of precast prestressed channel slabs. Entirely separated from the pier deck structure, the fender system consists of a retractable fender panel strip in front of the face of the pier, Raykin fenders at the corners, and flat winged rubber tube fenders around the mooring platforms.

Quellet, Yvon, 1972, Effects of irregular wave trains on rubble-mound breakwaters: American Society of Civil Engineers, Waterways, Harbors, and Coastal Engineering Division, Journal, WW, 98(WW1), pp. 1-14.

Descriptors: Wave height, breakwaters, harbors, rubble mounds, coastal engineering.

Results of model tests on a typical cross section of rubble-mound breakwater are presented. The structure was protected against wave attack by a cover layer consisting of a double layer of dolos armor units of 43 g. These units were intended to represent 0.19 ton prototype units to a scale of 1/16. All tests were carried out on a slope of 1:1.5. The armor units were first submitted to attack by nonbreaking waves of the regular type and then by nonbreaking waves of the irregular type. Two kinds of irregular waves simulating a narrow-band spectrum and a wide-band spectrum were used. Wave heights and periods were measured with the help of resistance type wave gages. Two types of damage were identified: The stable and the unstable damage. Test results are presented showing the significant wave height and the damage coefficient versus the stable and unstable damage.

Ragotzkie, Robert A., Teal, John M., Bader, Richard G., 1972, Urbanization and Industrial development: See citation no. 73-6D-00521, pp. 103-124.

Descriptors: Coastal zones, resource management, industrial pollutants, environmental protection, urbanization.

The effects of dredging and filling for housing and industrial development on marine resources and coastal zones are discussed. Land use, shore erosion, and pollution from industry and residential development are considered, and energy needs are examined. Problems caused by waste heat from nuclear power plants are surveyed, along with government use of coastal zones and the impact of petroleum production on the coastal environment. Recommendations for coastal zone management are presented.

Saylor, James H., Upchurch, Sam B., 1970, Bottom stability and sedimentary processes at Little Lake Harbor, Lake Superior, United States lake survey, Detroit, Michigan: Available from NTIS as AD-712 300, research report no. 2-1, August 1970, 60 p.

Identifiers: Harbors, construction, engineering, Great Lakes, mass transfer, shore protection.

The report discusses the relationship of littoral drift to sediment texture and fluctuations in offshore and strandline topography at Little Lake in southeastern Lake Superior. Offshore bars and troughs oscillate about a mean position, depending on the direction and intensity of wave attack. In contrast to the offshore bars and troughs, shallow-water topographic features migrate normal to and along shore with changes in lake level and wave attack. Sediment consists of two distinct populations: pebble-cobble and sand. The pebble-cobble population is relatively immobile and serves as an armor for the beach and nearshore. The sand population is highly mobile and its distribution reveals the effect of the harbor breakwaters on littoral drift. Littoral drift causes harbor maintenance problems, including shoaling in the harbor mouth and beach deterioration adjacent to the breakwaters. A primary cause of the shoaling is entrapment of a portion of the sand fraction bypassing the harbor structures by circulation patterns induced by harbor design.

Scholl, R., 1971, Breakwater: U.S. Patent No. 3,595,026, Official Gazette of the United States Patent Office, Vol. 888, No. 4, 1113 p.

Descriptors: Patents, shore protection breakwaters, waves (water), beach erosion.

This breakwater has elements arranged side by side with a lateral space between so that part of an oncoming wave can pass between them. These elements may have a

U-shaped horizontal cross section. The elements may have an arcuately curved vertical cross section to divert the oncoming wave upward and back upon itself.

Sorensen, Alf. H., 1972, Clean water through dredging: Water & Sewage Works Including Industrial Wastes, Chicago, Reference No. R149-R150.

Descriptors: Dredging, pollution control equipment.

Identification of dredging with water pollution is refuted, and the beneficial aspects of dredging estuaries, wetlands, rivers, oceans, and lakes are discussed. A dredge does not generate BOD, but picks up material that generates BOD, restoring clean water. A dredge can be used to improve a channel by increasing the cross-section of the water body, slowing down flow; this minimizes turbidity which, in turn, minimizes scour and erosion. A dredge can take out killing bottom sludge, rid water bodies of dirt, and restore clean water. A dredge can also create drainage and make land out of marshes, destroying mosquito breeding grounds. A dredge can clean out a stagnant estuary, enabling water to flow freely.

Spangler, Miller B., 1972, Projections of socioeconomic trends in the coastal zone: Marine Technology Society, Journal, 6(4), pp. 21-24.

Descriptors: Coastal zones, resource management, socioeconomic trends.

Increases in both population and per capita income result in growing demands for recreational use of coastal zone resources and at the same time they often intensify problems of pollution and environmental quality degradation. Uses of the coastal zones and the planning and development of marine resources are strongly influenced by changing population patterns, industrial growth, and regional characteristics. The socioeconomic trends affecting the 12 coastal regions of the United States are discussed and projected to the year 1980. Forecasts of population, employment, and per capita income are provided for each region and interregional comparisons are made.

Stiassnie, Michael, Dagan, Gedeon, 1972, Wave diffraction by detached breakwater: American Society of Civil Engineers, Waterways, Harbors and Coastal Engineering Division Journal, WW, 98(WW2), pp. 209-224.

Descriptors: Breakwaters, coastal engineering, gravity waves, harbors, wave energy.

A thin barrier of finite length in water of finite depth and infinite extent is considered. An incident gravity wave, attacking the obstacle from infinity, is diffracted and scattered by the thin barrier, which is a satisfactory representation of a detached breakwater of large length to thickness ratio. Computations are carried out for a monochromatic incident wave and an impervious obstacle. The solution is extended afterwards to the cases of a previous barrier and a random incident wave. Comparisons are made with other studies.

Teleki, P.G., 1972, Wave boundary layers and their relation to sediment transport: See citation no. 73-68-01124, pp. 21-59.

Descriptors: Sediment transport, boundary layers, wave motion, shear stress.

Sediment transport is examined from the viewpoint of oscillating flows. Principles of both steady and unsteady boundary layers are reviewed. In the potential flow region the forcing function is represented by the combined effect of waves

and currents. A unifying theory for energy dissipation and sediment transport under shoaling, breaking, and transformed waves does not exist because the non-linearity present in wave motion and in turbulence has not been appraised. Study of the response function (sediment motion) can be conducted more efficiently through research on boundary layers in oscillating flows, enabling the confirmation of universal relationships for the distribution of velocity and shear stress in periodic flows. These relationships are dependent on the characteristic frequency and amplitude of oscillation. As bottom friction is a measure of viscous dissipation in the boundary layer, the principle of energy conservation prior to wave breaking based on this evidence becomes unacceptable.

Thomsen, Arvid, L., Wohlt, Paul E., Harrison, Alfred S., 1972, Riprap stability on earth embankments tested in large- and small-scale wave tanks: U.S. Army, Corps of Engineers, Technical memorandum no. 37.

Tests of models in wave tanks were made to determine the effectiveness of several riprap designs in protecting embankment slopes from wave action.

Models ranging from about 1:20 scale to almost full scale were tested with waves up to about 6 feet high. A range of wave periods were tested, embankment slopes varied from 1 on 2 to 1 on 5, and armor layers were composed of quarried stone, glacial boulders and tribars.

Relationships that define the effect of wave height, wave period, embankment slopes and Reynolds number on size of stable armor units were experimentally determined and are given in graphs and tables.

Significant conclusions are:

1. The median weight of graded armor material is a satisfactory "effective size" with respect to stability.
2. Small-scale models are less stable than larger scale models. The difference in stability is a function of Reynolds number apparently caused by viscous effects. Consequently, there is a "scale effect" that produces conservative results when the stability determined in a small model is scaled up to prototype size on the basis of Froude number alone when equivalent viscous fluids exist in both prototype and model.
3. Stability is a function of wave period. For longer periods that produced wave steepness less than 0.03, stability is little affected by period. For wave steepness greater than 0.03, stability increases with shorter period.

Section VI of this report presents a detailed summary and conclusions.

Titzler, Karl, 1972, Betrachtungen zum Stand des Kuestenschutzes in der DDR: Wasserwirtschaft-Wassertechnik, Berlin, 22(1), pp. 25-28.

Descriptors: Coastal protection, storm damages, Baltic Sea, German democratic republic.

The problems and methods of protecting the coastal regions of the German Democratic Republic from flooding, and prevent land loss and damage by storm floods of the Baltic Sea are discussed. Coastal surveillance and the maintenance of natural and artificial protective structures are described. The state plan for the protection of the Baltic coast from storm flooding between 1964 and 1970 is reviewed.

Vanoni, Vito A., 1969, Sediment control methods, introduction and watershed area, American chemical society, New York, Hydraulics Div.; ASCE Proc., J. Hydraul. Div., Vol. 95, No. NY2, pp. 649-673.

Descriptors: Sediment control, erosion, sedimentation, erosion control, water supply, harbors.

Identifiers: Sediment control methods.

The varying implications regarding the control of sediments to individuals working in different fields are discussed. The subject is considered in 2 general areas, the land surface and the fluvial channels and associated water bodies. Sediment control on land is discussed in terms of watershed areas, and includes considerations of sheet erosion and rills, gullies, or other small fluvial channels. Larger channels are discussed separately in terms of natural and artificial channels, since control of the former is restricted generally by its existing form and the design of the latter is permitted many more degrees of freedom. Controls in reservoirs and harbors are treated separately, since the concepts or purposes differ measurably. The prevention of the erosion of sediment particles from the land or from fluvial channels and the controls applicable in fluvial channels or in the lakes, reservoirs, estuaries, or bays into which they flow are also explored.

Varadachari, V.V.R., 1972, Beach erosion and sedimentation: Mahasagar, Bulletin, 5(2), pp. 85-87.

Descriptors: India coast, beach sands, beach erosion, beach portection.

A beach is the zone of unconsolidated material extending from the low water line to the extreme upper limit of wave action along the coastline. Changes in beaches are partly due to nature and partly manmade. Waves and currents are the chief agencies in beach erosion and accretion. Construction of sea walls and groins is detrimental to beach formation; jetties and groins cause sand to pile up on the side from which the current is moving while the other side is starved for material. The 1st requirement for coastal planning in GOA is adequate scientific knowledge of the shore processes for different coastal areas.

Wagner, H.D., 1970, Notes on beach erosion in the Charleston Harbor Area, Citadel, Charleston, S.C. Dept. of Chemistry: South Carolina Division of Geology, Environmental geology series 1, 1970, 11 p.

Descriptors: Beach erosion, erosion control, recreation.

Identifiers: Charleston Harbor (S.C.)

Barrier Islands, such as the Isle of Palms, Sullivan's Island and Folly Island, all near Charleston Harbor, South Carolina, change significantly in configuration over periods of several decades. Retreat of the island as a result of beach erosion causes loss of land and property damage almost immediately. Erosion arrestment structures such as the Folly Island Groins, the Isle of Palms Groin, and the emergency seawall of the Isle of Palms have generally accomplished the purposes for which they intended. Beach erosion and outbuilding of beaches are directly related to the supply and distribution of sand by waves, longshore and other offshore currents, and tidal currents. South Carolina coastal waters are sufficiently shallow that changes in positions of currents, scour channels, offshore bars, etc., could be monitored by use of conventional black and white stereoscopic aerial photography. Photograph studies could be backed up by in situ measurement of current velocities, rates of sand transport etc.

Weggel, J. Richard, 1972, Maximum breaker height: American Society of Civil Engineers, Waterways, Harbors and Coastal Engineering Division, Ann Arbor, Mich. Journal, WW, 98(WW4), pp. 529-548.

Descriptors: Wave height, breakwaters, maximum height estimation.

The relationship between breaker height/breaker depth ratio, incident wave steepness, and beach slope is studied. This relationship, when combined with experimental observations of breaker travel, permits an estimate of the maximum breaking wave height a coastal structure might experience given a design wave period and a design depth at the structure site. Existing breaker-type classification according to inshore and offshore parameters cannot be reconciled to observations of the relationship, and revised criteria for breaker classification are presented.

Wilder, Carl R., Koller, Earl R., 1971, Modular systems for shore protection: Civil Engineering, 41(10), pp. 60-63.

Descriptors: Shore protection, engineering, construction methods, modular systems.

During the past decade, structural systems have been put to use in a variety of shore protection projects. Machine-produced, pre-cast units have proved economical and effective in applications around the world. Such devices as interlocking revetments, permeable groins, and polypods are discussed.

Williams, A.T., 1971, An analysis of some factors involved in the depth of disturbance of beach sand by waves: Marine Geology, Amsterdam, 11(3), pp. 145-158.

Descriptors: Wave action, beach sands, wave height, tides, depth of disturbance.

A study of the depth of disturbance of beach sand by waves indicates that breaker height is the dominant factor in the mid- and probably low-tide zone; slope in the higher high-tide zone. Newly deposited sand found on top of the coloured sand in the sedimentation stations was mainly uniform in structure, dual sedimentation units, if occurring at all, being more common at mid-tide stations and on beaches where there was a greater range of sediment. Experimental areas were marked with an oscillator-detectable plate buried in the beach face. Skewness values were typically negative, kurtosis values tended to indicate a difference in modality between the sedimentation units obtained, and bottom units were moderately sorted while upper and uniform units were moderately well sorted. Contribution of breaker height, slope, and wave period to depth of disturbance was 82% at mid-tide and 61% at high-water mark.

Wilson, Howard B., 1966, Design for optimum wave conditions, Dana Point Harbor, Dana Point, California, hydraulic model investigation: Army Engineer Waterways Experiment Station, Vicksburg, Miss. (NTIS #AD-720 190) June 1966, 55 p.

Descriptors: Breakwaters, harbors, model studies, shore protection.

Identifiers: Hydraulic models, Dana Point Harbor, Dana Point (Calif.)

The entire Dana Point area that will be enclosed by Dana Point Harbor and sufficient adjacent coastline and offshore bathymetry to permit accurate simulation of storm-wave action were reproduced in a 1:100-scale hydraulic model equipped with wave-generating and wave-height-measuring devices. The purpose of the model study was to determine the effectiveness of the proposed breakwater system and inner-harbor basin in providing protection from storm action for pleasure craft and fishing boats berthed within the harbor. It was concluded that the proposed breakwater system, which consists of a 5500-ft.-long west breakwater and a companion 2250-ft.-long east breakwater with a 600-ft.-wide navigation entrance at

the southeast corner of the harbor, will provide the degree of protection required for small boats to berth safely in the partially enclosed inner-harbor basin. Investigation of the wave-transmission problem, concerning the degree of wave energy that can reach the inner harbor through the interstices of the proposed rubble-mound breakwaters, showed that the wave energy transmitted to the inner basins of the harbor through the outer breakwater structures is not critical. Wave energy transmitted into the fairway by overtopping of the proposed west breakwater by near-maximum storm waves, which have a low frequency of occurrence, was found to cause conditions in the fairway that would be dangerous to small craft. However, it was determined that modification of the mole slope flanking the fairway to include a berm will reduce the wave-reflecting characteristics of this structure, and thereby reduce wave action in the fairway considerably during severe storms.

Wright, L.D., Coleman, J.M., 1971, Effluent expansion and interfacial mixing in the presence of a salt wedge, Mississippi River delta: *Journal of Geophysical Research*, 76(36), pp. 8649-8661.

Descriptors: Mississippi Delta, saline wedges, river discharges, sediment transport, vertical mixing.

Ground observations and remote-sensing imagery indicate that efflux from the mouth of South Pass, Mississippi River, expands as a laterally homogeneous layer above underlying salt water. Flow deceleration and effluent deconcentration are primarily the result of vertical rather than lateral mixing. Field and imagery data correspond closely to theoretical expansion rates predicted as functions of lateral hydrostatic pressure gradient created by the density contrasts between the river water and sea water. The expansion rate is shown to depend solely upon the density ratio given by $r = (p_s - p_f)/p_s$ (where p_s and p_f are the densities of sea water and river water, respectively) and upon densimetric Froude number at the outlet $F_2 = U^2/rg_h$ where U is the mean velocity of the upper layer, g is the acceleration of gravity, and h is the interfacial depth. Flow velocity data agree with predictions based on deceleration caused by salt water entrainment.

Wu, Jin, 1972, Physical and dynamical scales for generation of wind waves: *American Society of Civil Engineers, Waterways, Harbors and Coastal Engineering Division, Journal*, WW, 98(WW2), pp. 163-175.

Descriptors: Wind waves, coastal engineering, wave energy, air-sea interactions.

An analysis is given of relevant physical scales on which coupling takes place between long and short waves, and dynamic scales for coupling of wind and waves, in the generation of wind waves. Based on these scales and on a separation criterion, it is argued that the airflow separates from dominant waves in the laboratory and from ripples superimposed on dominant waves in the field. This difference may account for the discrepancy between the laboratory-determined growth rate and that observed in the field. Finally, some consideration is given to observational evidence and critical scales relating to the nonlinear mechanism for wave generation.