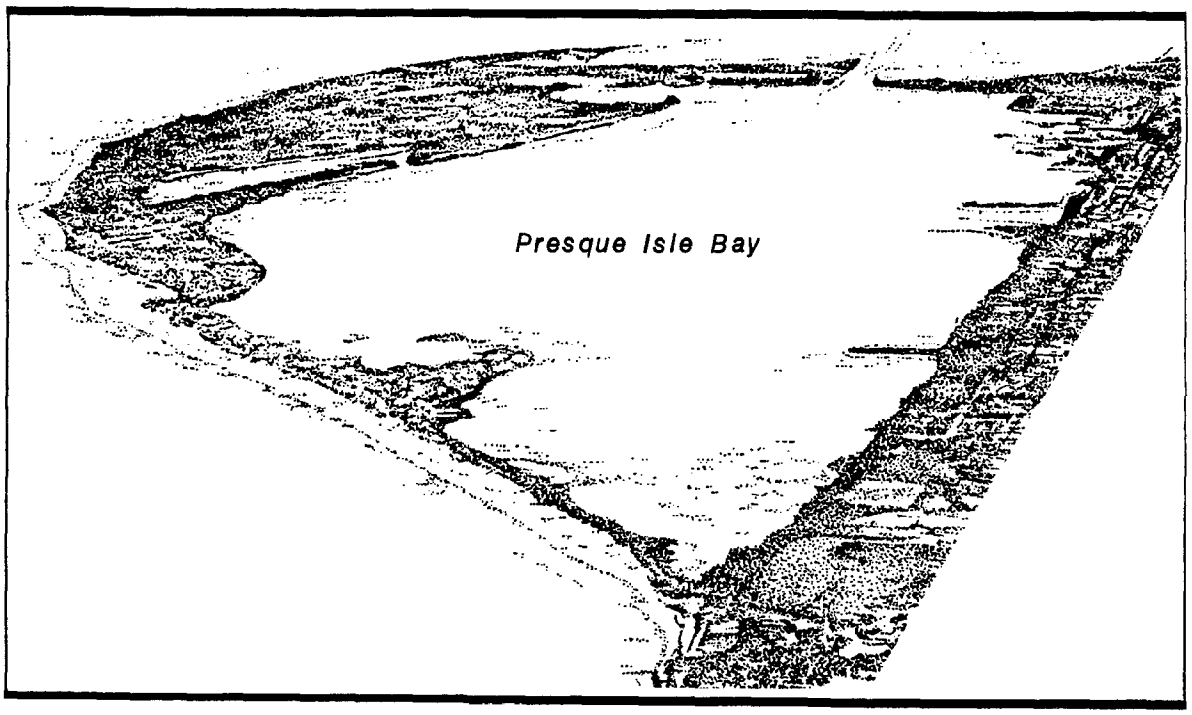
Presque Isle Bay Recreational Boating Study

MARCH 1994



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PRESQUE ISLE BAY RECREATIONAL BOATING STUDY

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and

Pennsylvania State University

A REPORT OF THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES TO THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION PURSUANT TO NOAA AWARD NO. NA270Z0335-01

DER GRANT/CONTRACT NO. - CZ1:92.01PE
GRANT TASK NO. - CZ1:92-EG.04
ME.NO. - 92269

GV776 .P7 P74 1993 c.2

This project was financed in part through a federal Coastal Zone Management Grant from the Pennsylvania Department of Environmental Resources, with funds provided by NOAA. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its subagencies.

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EXECUTIVE SUMMARY

Presque Isle Bay is an approximately 3,700 acre embayment sheltered from Lake Erie by a six-mile long peninsula. This peninsula, which is known as Presque Isle State Park, is managed by the State of Pennsylvania for recreational and conservation purposes. Over the years, as a result of coastal growth and development, Presque Isle Bay has become a popular boating and recreational area. With the anticipated increase in boating pressure and proposed marina expansions, it is important at this time to ascertain what impact recreational boating is having on the Bay and may have on the Bay in the future if recreational boating pressures increase. After assessing the current situation, projections of future recreational boating impacts were made. Management recommendations are proposed to address both existing environmental and social impacts and future impacts from recreational boating pressures.

This study documents the current and potential future environmental and social impacts of recreational and commercial boating on Presque Isle Bay. It evaluates carrying capacity issues related to the sustainable uses which the Bay can support and what restrictions, if any, need to be placed on boating in order to protect the environment and avoid user conflicts. The study evaluates regulatory authorities at the local, State and Federal levels relating to recreational boating activities and recommends management approaches appropriate to the various regulatory authorities.

The report has been organized to present the background, historical and physical setting of the Bay in Section 1.0. Existing recreational boating and port facilities, as well as proposed new or expanded facilities, and potential facilities are presented in Section 2.0. Results of the water quality assessment are included in Section 3.0. A discussion of potential future impacts related to recreational boating and port activities is included in Section 4.0. Carrying capacity concepts as they relate to recreational boating and the development of management recommendations, are examined in Section 5.0. The results of the boater surveys are discussed in Section 6.0, and an analysis of carrying capacity related to existing and future conditions is presented in Section 7.0. The regulatory authority of various local, state and federal agencies is described in Section 8.0. Management recommendations are offered in Section 9.0, and references are included in Section 10.0. More detailed information regarding the boater surveys and water quality sampling data is included in the appendices.

Study findings revealed relatively weak relationships between use levels and the quality of the boating experience on Presque Isle Bay. The most noticeable impact of higher boating densities was a higher degree of perceived crowding. Crowding in turn seemed to influence other impact measures, including displacement, safety, and conflict. All of these types of impacts, however, occurred relatively infrequently and few boaters reported that the number of boats encountered negatively affected their experience, even under the highest congestion conditions. Thus it appears boating levels on Presque Isle Bay have not yet approached capacity limits based on evaluation of the quality of the boater experience.

The results of the sampling study and the estimates of annual loads (and concentrations) due to recreational boating suggests that recreational boating may impact water quality in Presque Isle Bay. The potential impacts include the following:

- **Total petroleum hydrocarbon and PAH loads from engine releases.**
- **Copper from anti-fouling boat paints.**

This study has also assessed the concepts of recreational and resource carrying capacity. Evaluating the capacity of a given area for recreation involves a wide range of variables that may influence the quality of the outdoor recreation experience. One of the major conclusions that can be derived from previous relevant research is that there is no single predictable response of visitors to varying use levels. Rather, visitors are affected by a series of interrelated impacts which result from recreational use of a given area. Recreational use leads most directly to tangible outcomes like contacts between visitors and impacts on the natural environment. These social and environmental impacts in turn can lead to a variety of perceptual and behavioral responses by visitors. In sum, the relationships between use levels and various impacts to the experience are neither simple nor uniform. Yet understanding these relationships is fundamental for managing the recreation experience.

Resource carrying capacity as it relates to the recreation experience has been defined as "The capability of natural resources to withstand use for a desired quality of recreation experience" (Gold 1980). In a broader definition, resource carrying capacity is the level of use a resource can sustain without irreversible degradation. Some of the natural resources in the Presque Isle Bay area, particularly in the State Park, are sensitive to the potential impact of the user. Therefore, even though the resource manager must consider both goals, it is expected that the resource capacity will be the most constraining to use.

Resource capacity is a function of the ecological character of the resource, whether a site or a larger system like the Bay. When trying to determine resource capacity, the interrelations among systems which make up the natural environment must be reflected. Given the complexity of environmental systems, environmental effects (which determine capacity) tend to occur in complex webs. Sometimes several effects can result from a single disturbance, in other instances, a number of separate activities may result in a single effect. The complexity of this web is the greatest limitation to determining a resource capacity (MD DNR 1977).

While this study has considered the potential impacts of recreational boating on Presque Isle Bay, there are numerous other contributors that were not studied. What is known is that the recreational (social) carrying capacity of the Bay has not been reached. For some pollutants it appears that boating is a notable contributor to the Bay, however, overall the relative impact of recreational boating on the Bay is minor. There are also numerous other activities which have an impact on the resource capacity, such as land development, port operations (eg. maintenance dredging), road construction, sewer outfalls, and industrial operations. These activities, and there relative impact to the resources of the Presque

Isle Bay area are unknown, and would require extensive testing to be determined.

The resource carrying capacity issue is complex and may be most approximately viewed as a management concept or tool, a means toward the end of providing a certain type or quality of experience. The concern with "finding the carrying capacity" is being replaced with an emphasis on identifying and maintaining the conditions that will produce the desired outcome. Current management frameworks like the Limits of Acceptable Change (Stankey et al. 1985) and Visitor Impact Management (Graefe et al. 1990) (which is the overall framework for this study) address the concerns that originated in the carrying capacity concept, yet barely mention the term, carrying capacity.

Part of the recreational boating study effort involved identifying proposed marina expansion projects, those projects anticipated to be constructed in the near future. These proposed marinas, described in Section 2.2, are all redevelopment projects to be located along the industrial waterfront of the Port of Erie. Although the final marina design for each of these expansion projects have not yet been developed or approved by permitting agencies, an estimate of the total number of proposed marina slips is approximately 900 new boat slips.

The findings of this study effort (both the boating survey and the water quality study) indicate that the Bay can support increases in recreational boating activity and infrastructure. This belief is based upon the fact that the current level of boating activity has not negatively impacted the boating experience and that the relative contribution of pollutants by boating activities and infrastructure is minor.

Therefore, accepting the limitations of determining a definitive numerical recreational boating carrying capacity for presque Isle Bay, based on the information collected through the boater questionnaires and the water quality sampling, and based upon the level of analysis conducted for this study, we feel 900 additional boat slips along the existing Erie waterfront would not have an irreversible detrimental effect on Presque Isle Bay. Therefore, 3200 boat slips could be viewed as the present capacity of the Bay. This assumes that all new marina facilities are located, designed, and constructed using appropriate water facility guidelines which are available in the literature, a portion of which are discussed elsewhere in this report. This capacity also assumes all other parameters are held constant. This would include the number of boat launch ramps and the number of boaters using them, which is typically managed through the number of parking spaces available, and that the number of transient boaters remains constant. It also assumes no improvement or degradation in the contribution of pollutants through point and non-point sources.

Once the expansion of recreational boating facilities approaches the addition of 900 new boat slips (which will total 3178 boat slips in the study area), the study team recommends that the question of carrying capacity be revisited to determine if additional capacity can be provided at that time. A detailed water quality assessment should be conducted to evaluate whether additional recreational boating pressures would be

detrimental to the Bay. The progress made in implementing the recommendations of the Remedial Action Plan regarding the land-side contribution of point and non-point source pollutants can be incorporated into the evaluation of pollutant loadings from future recreational boating activities in the Bay. Also, the recreational carrying capacity analysis developed in this study effort provides an excellent foundation for reevaluating recreational boating concerns.

This is an opportune time, from a planning perspective, to address recreational boating issues on Presque Isle Bay. There is the opportunity to be proactive instead of responding to crisis situations. Recommendations have been proposed to preserve the natural resources of the Bay and to address areas of concern regarding the contribution of pollutant loadings from recreational boating before significant adverse impacts are detected. The findings do not suggest that there is a preservation versus utilization issue present. Current levels and incremental increases in recreational boating on Presque Isle Bay can coexist with a management approach that has the protection of the natural resources as its primary objective.

The recommendations in this report address both the current situation and future conditions as boating pressure on the Bay increases. The recommendations need to be tailored to the appropriate management or regulatory authority that can most effectively address the issue. Some of the recommendations can be implemented by resource managers and by local jurisdictions; others suggest actions that can be taken by the boating industry or by government at the state and national level. An increase in public education, as well as suggestions for future monitoring are also included.

Summary of Management Recommendations

- When expansion of recreational facilities approaches 900 new boat slips, a detailed assessment should be conducted to address availability of additional capacity, water quality, and carrying capacity.

- There does not appear to be a need to restrict or limit public access to Presque Isle Bay currently or in the near future. Monitoring of the boating conditions should be conducted over time as use levels increase (see Section 9.1).

- Resource managers should consider a balanced approach to maximizing the uses of the Bay and preserving environmental quality.

- One-fifth of the boaters sampled reported that other boats had come too close to them while boating. Such incidents were one of the greatest safety concerns among Presque Isle Bay boaters. All pertinent organizations should consider methods of strengthening their educational efforts to create more boating safety awareness on the Bay.

- While it appears that crowding is not an existing problem on Presque Isle Bay, areas that were identified as having the potential for congestion should be closely monitored by resource management personnel to identify safety concerns or environmental factors before they become problems in the future.

- A "no wake" zone should be considered for the area depicted on Exhibit 9-1 as the Head of Bay Resource Management Area. The restricted area should fall within the area where water depth is 6' or less. Natural resource managers should conduct additional investigations of all ramifications associated with the establishment of such an area. Criteria should be developed for monitoring this and other environmentally sensitive areas in Presque Isle Bay.

- Educational displays should be developed and placed at key locations to educate users about the sensitivity of the Bay's resources and ways to minimize potential use conflicts.

- The inventory of existing recreational boating facilities indicates that four marina pump-out facilities are located within the Study Area. A Clean Vessels Act survey of Presque Isle Bay should be conducted to determine the adequacy of marina pump-out facilities. If found adequate, a petition should be forwarded to the Environmental Protection Agency (EPA) to prohibit the use of Flow Through Type I and II Marine Sanitation Devices (MSDs) in Presque Isle Bay.

- The EPA, with the support of and in coordination with the boating industry, should promote the development of technologies to reduce total petroleum hydrocarbons (TPH) from two-stroke outboard marine engines. The development of an efficient four-stroke outboard marine engine would significantly reduce both TPH and polycyclic aromatic hydrocarbons (PAH) from entering aquatic systems.

- EPA should support increased research funding to determine a viable alternative to the use of copper-based anti-fouling paint. State resource managers should closely monitor the fate of copper released into Presque Isle Bay from wood, steel, and fiberglass boats painted with copper-based paints.

- Millcreek Township should consider a Lake Bluff and Shoreline Land Preservation Program utilizing zoning amendments together with land preservation techniques such as donation, acquisition of easements, and voluntary conservation agreements, to preserve the unique natural resources present along the shoreline. Marinas, which are currently permitted in the zoning district fronting the Head of the Bay, should be prohibited due to the environmental sensitivity of the area.

- The Pennsylvania Department of Environmental Resources, especially through the consistency review process, together with other State reviewing agencies and the U.S. Army Corps of

Engineers, should carefully review joint permit applications for waterfront development in areas outside the proposed and potential marina sites identified in this study.

- Almost eight years have passed since the Erie Waterfront Comprehensive Plan was prepared. Some of the proposed projects have changed, such as the marina development planned near the Erie International Marine Terminal, east of the Turning Basin. The Comprehensive Plan assumed wrongly that the drydock facility was not a viable option and the success of Erie Marine Enterprise is welcomed. However, many of the recommendations prepared at that time are still valid today. The City of Erie and the Erie Western Pennsylvania Port Authority should continue to be proactive in encouraging public/private sector initiatives to take advantage of the waterfront opportunities for redevelopment.

- The City of Erie, or the Erie-Western Pennsylvania Port Authority, should consider providing slips for transient boats along the Presque Isle Bay waterfront. There is a known demand for such facilities and the City could benefit economically by encouraging more visitation from recreational boaters cruising Lake Erie. The area near Dobbins Landing appears to be a viable location.

1.0 INTRODUCTION AND BACKGROUND INFORMATION

This section of the report describes the purpose of the study effort, provides the historical setting of Presque Isle Bay and the Port of Erie, and describes the importance of the landforms and geologic processes in shaping the terrestrial and aquatic resources present in the Study Area.

1.1 Purpose of the Study

Presque Isle Bay is an approximately 3,700 acre embayment sheltered from Lake Erie by a six-mile long peninsula. This peninsula, which is known as Presque Isle State Park, is managed by the State of Pennsylvania for recreational and conservation purposes. Over the years, as a result of coastal growth and development, Presque Isle Bay has become a popular boating and recreational area. With the anticipated increase in boating pressure and proposed marina expansions, it is important at this time to ascertain what impact recreational boating is having on the Bay and may have on the Bay in the future if recreational boating pressures increase. After assessing the current situation, projections of future recreational boating impacts were made. Management recommendations are proposed to address both existing environmental and social impacts and future impacts from recreational boating pressures.

This study documents the current and future environmental and social impacts of recreational and commercial boating on Presque Isle Bay. It evaluates carrying capacity issues related to the sustainable uses which the Bay can support and what restrictions, if any, need to be placed on boating in order to protect the environment and avoid user conflicts. The study evaluates regulatory authorities at the local, State and Federal levels relating to recreational boating activities and recommends management approaches appropriate to the various regulatory authorities.

1.2 Historical Setting of Presque Isle Bay and the Port of Erie

Presque Isle Bay is the oldest U.S. harbor on the Great Lakes. The history of Erie is intimately connected to its industries which grew up along the waterfront and established it as an important link between Lake Erie and the inland transportation systems. This natural port is well sheltered by the Presque Isle peninsula, making this area an ideal spot for settlement. The development of the port, canal, and rail and road transportation corridors encouraged the growth of a strong industrial base for the City during the 19th century. The importance of the historical aspect of the waterfront is reinforced by the recent decision of local officials to locate the Niagara Maritime Museum and Erie County Library at the waterfront.

The first Europeans to arrive in the area were the French, who arrived in 1753 and built a fort on the bank of Mill Creek (Land Design/Research 1986). Their arrival in northwestern Pennsylvania was not for the purpose of settlement, but to establish a series of military outposts to resist the encroachment of the English. To the French, the peninsula had strategic value as it afforded natural protection for the harbor and against attack from the water. They were later defeated by the British in 1758, who built

Fort Presque Isle in the late 1760s. Indian rebellions in the late 18th century slowed settlement of this region.

Americans began to settle in Erie in 1795 along the mouth of Mill Creek in order to have access to the water. The area developed and grew westward towards a ravine which demarcated the extent of the town for many years. Use of the waterway for trade purposes was hampered by a sand bar which extended towards the eastern tip of the peninsula which allowed only shallow-draft boats access to the harbor. Often, the cargo of sailing vessels was off-loaded to a lighter vessel at the mouth of the harbor.

Before the waterfront could be further developed, the War of 1812 intervened. Presque Isle harbored a naval base during the War of 1812. Commodore Perry built his ships and trained his men for the coming battle which culminated in his naval victory on September 10, 1813. Perry's fleet returned to Presque Isle Bay and they suffered during the cold winter that followed. Misery Bay, where his ships were sheltered, received its name for the hardships his men endured.

The residents of Erie, supported by the Commonwealth of Pennsylvania, were able to convince Congress in 1824 to provide funds to develop adequate harbor facilities. The improvements consisted of a series of dikes and piers, designed to eliminate the sand bars and deepen the harbor. The stage was now set for a major increase in commerce and a number of shipbuilding yards were constructed along the waterfront.

The economic development of the City progressed after 1812 with port-related commerce dominating the growing local economy. Steamships serving the Great Lakes used Erie as their home port and began daily steamship service between Erie and other Great Lakes ports. The construction and opening of a canal linking Lake Erie and the Ohio River provided a more direct route for raw materials and finished goods from the Great Lakes to the south. This gave a tremendous boost and importance to Erie, as it became one of the liveliest ports along the Lake.

The importance of the Erie Canal was short-lived, flourishing for approximately twenty-five years, until the first railroad was introduced in 1852 and passenger traffic was diverted from the canal. The transport of cargo by rail came later and reinforced the importance of the Port of Erie as a transportation and industrial center. Ore shipments from the Upper Michigan Peninsula were shipped to Erie for use in the expanding foundries or transshipment by rail to Pittsburgh. Return shipments took coal to the Upper Great Lakes ports.

Although Erie was developing as a railroad and shipping port, other ports such as Buffalo had superior facilities or a more strategic location and they increased in importance. Erie began to industrialize around 1860 (Wellejus 1980) with metalworking the leading manufacturing sector. Erie manufactured freight cars, steam engines, and boilers. Paper and chemicals were also important industrial sectors. The 1880s and the 1890s were the most spectacular decades of industrial growth in Erie. With the rapid expansion of the industrial economy, construction flourished and the brick industry also became important. The business district expanded and urban areas began expanding into areas which were once considered rural.

With the increase in manufacturing, trade in and out of Erie increased and waterfront industrial facilities were greatly expanded.

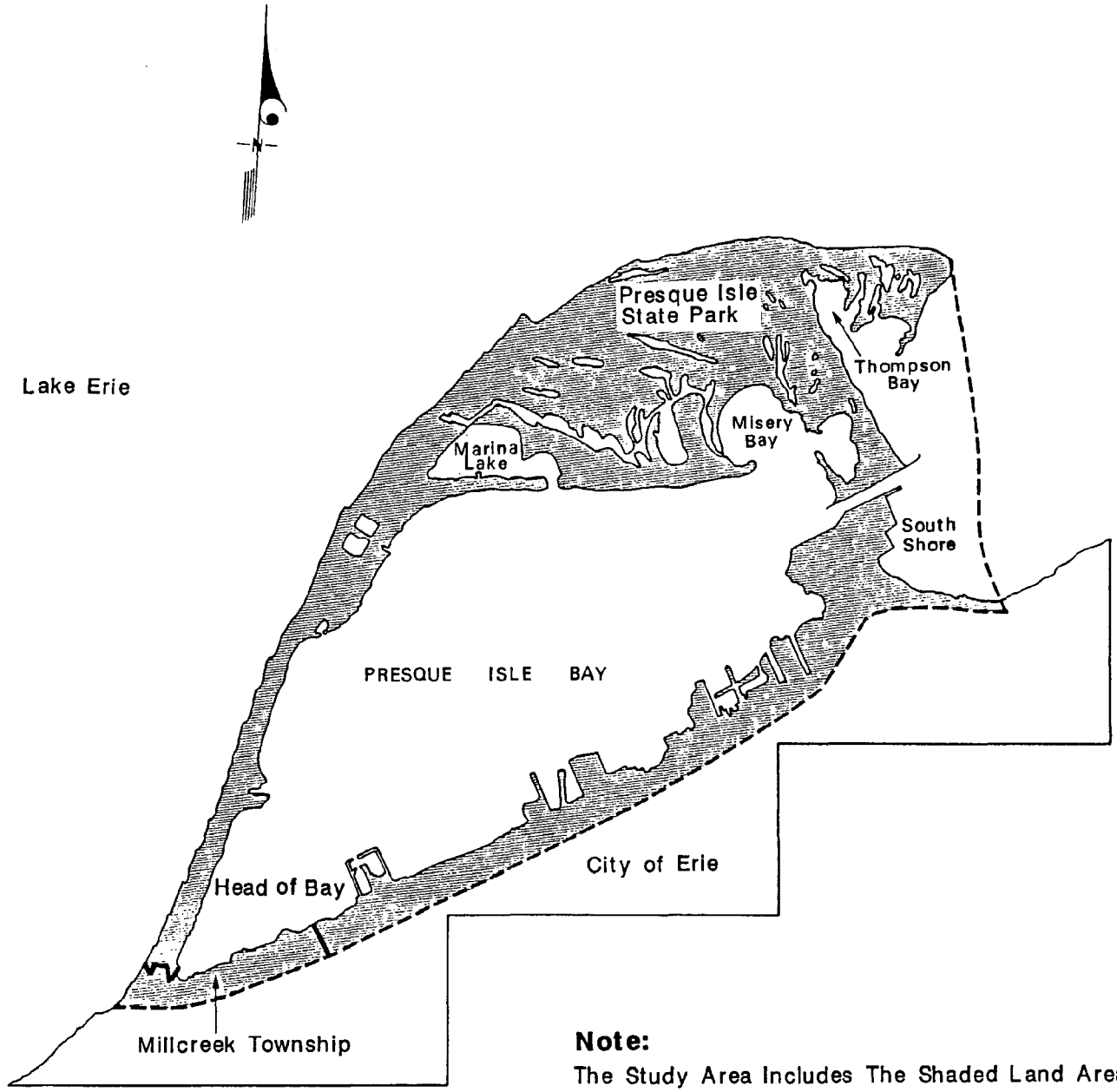
With the introduction of steamships, the railroads, and improvements in fishing methods, commercial fishing grew into a flourishing industry. In 1882 there was only one sizable processing plant; however, by 1906 six large plants were needed to process the catch. "By 1913 the capital invested in fishery had increased to a million dollars with 110 boats and 600 men engaged. The annual harvest included 10 million pounds of lake herring, eight million pounds of pike and perch and 600,000 pounds of white fish" (Land Design/Research 1986). Erie's commercial fishery flourished so well that for a while it was the largest commercial fishing port in the world. Sport fishing also became popular with pleasure boating becoming a favorite pastime of well-to-do residents. The Erie Yacht Club was organized and the club house was built in 1895.

The early 1900s marked the height of Erie's success and importance as a port. The City of Erie became noted for the diversity of its manufacturing base and its industrial enterprises flourished. Steam engines and boilers became the mainstay of Erie's biggest industry and foundries played a large role in the economy (G&O 1993). Markets for products manufactured in Erie had grown nationwide, based largely on a highly efficient transportation network both on land and on the lakes. By 1938, activity on the Lake was brisk and often numerous freighters would have to wait to unload their heavy cargo, which included lumber, coal, petroleum, iron ore, grain and fish (G&O 1993). On a normal work day, over 2,000 rail cars were moved through the Port, carrying ore from the Mesabi Range in Upper Michigan. Other important exports included cars, locomotives, and stoves. World War II changed the direction of the manufacturing industry to focus on munitions and other items for the war effort.

Following the War, many companies returned to manufacturing of consumer goods and other industrial endeavors, However, not all of the former manufacturers were successful and some redirected their operations in new directions. The City retains a sizable portion of its industrial base owing to its well-established transportation routes, work force, and diversity of products. However, economic dislocations in the 1970s and 1980s have had an effect on the regional economy. Port-related commerce has been severely curtailed in the second half of this century. The strategic position of the port has been eroded by major changes to the U.S. economy and more cost-effective freight transportation corridors.

1.3 Environmental Setting of Presque Isle Bay

This Section provides a brief discussion of the environmental setting of the Presque Isle Bay Study Area. The Study Area includes 3,200 acres of Presque Isle State Park, the shoreline of the City of Erie, and the portion of Millcreek Township's shoreline from the neck of Presque Isle to the City of Erie's western boundary (Exhibit 1-1). The water portion of the study area includes the surface area of Presque Isle Bay (3,718 acres) and a portion of Lake Erie along the Eastern side of Presque Isle.



Note:
The Study Area Includes The Shaded Land Area and Water Area Enclosed by Dashed Line

Not To Scale

Presque Isle Bay Recreational Boating Study

ENGINEERS • ARCHITECTS • PLANNERS • SCIENTISTS • SURVEYORS • PHOTOGRAMMETRISTS
GREENHORNE & O'MARA, INC.
9001 EDMONSTON ROAD, GREENBELT, MARYLAND 20770

Study Area

EXHIBIT 1-1

Source: Mariners Atlas, 1990

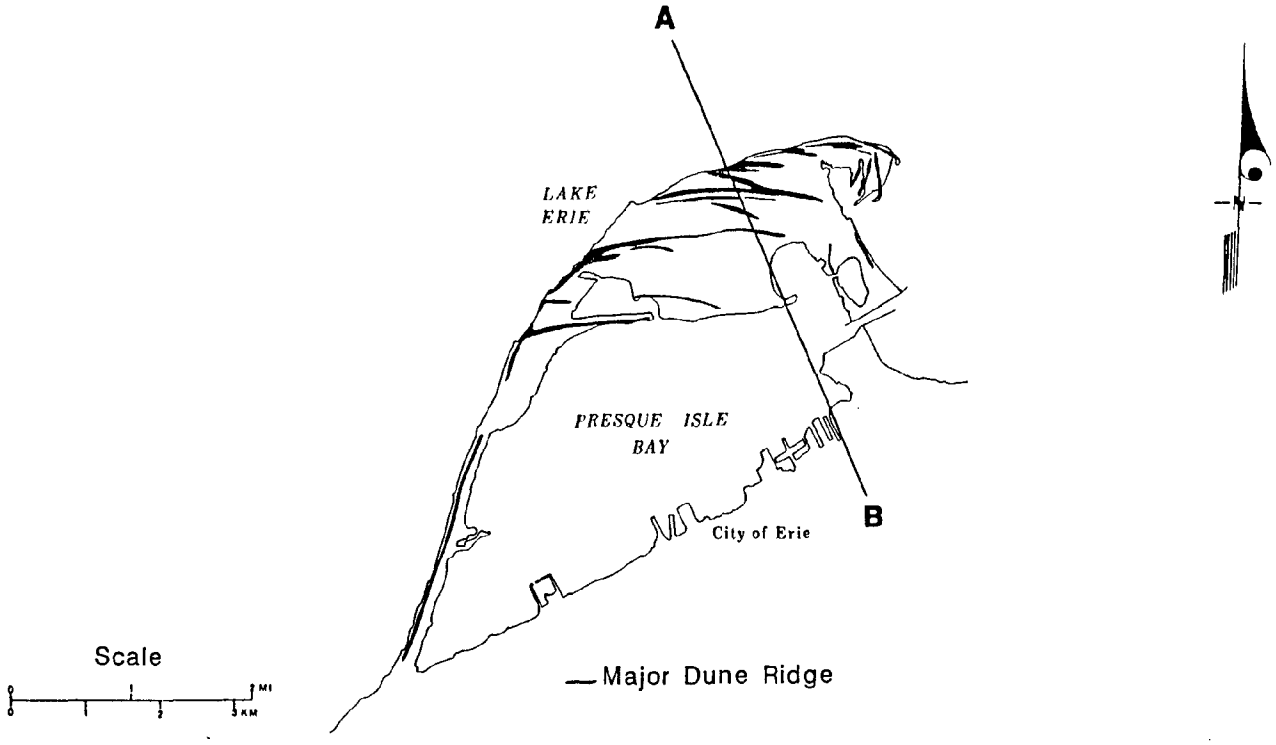
Presque Isle visually dominates the Study Area. Named by French explorers in the 1720s, the translation of Presque Isle is "almost an island" which is certainly appropriate for this peninsula. Approximately six miles in length, Presque Isle is a hook-shaped sandspit with the eastern point curved inward toward the Erie shoreline. Width at the neck is less than a thousand feet while towards the easternmost (distal) end, the width exceeds one mile. The sandspit forms a shallow embayment, Presque Isle Bay, with a channel maintained at the eastern end of the bay by dredging to permit ship access to the harbor.

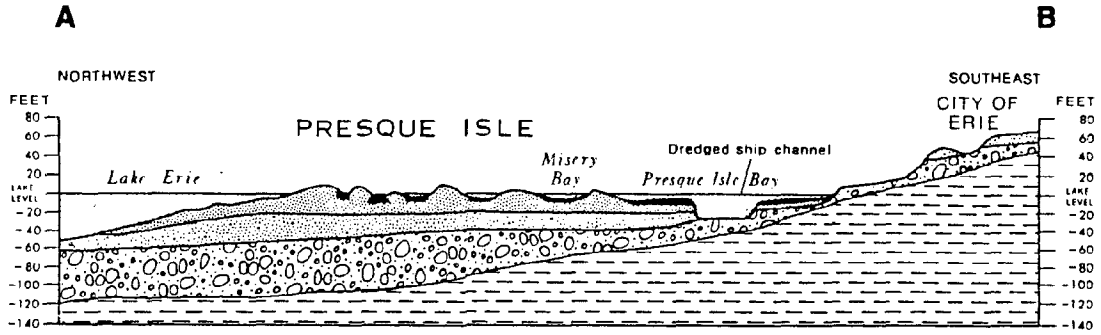
1.3.1 Geological Setting

Presque Isle's existence is related to the presence of a ridge of sediments, known as a moraine, that crosses Lake Erie. Moraines consist of clay, sand and gravel that are deposited at the boundaries of a retreating glacier. The glacier which created this moraine was a minor advance of the last major ice sheet that covered much of northern Pennsylvania approximately 13,000 to 14,000 years ago. Today this moraine is approximately 30 to 50 feet below the level of the lake. Following the retreat of the glacier, lake elevations were lower and the moraine was a ridge of dry land. A channel, offshore of Presque Isle, was cut through the ridge by stream erosion creating a shelf or platform along the southern edge of the lake. As the lake level rose over the last 12,000 years, the shoreline migrated across this platform. Waves and currents shaped the loose sand deposits into sand bars and beaches. As the lake level rose, eroding bluffs along the shore contributed additional materials that led to the creation of the Presque Isle sandspit (Pennsylvania Geological Survey 1991).

Under the thin veneer (approximately 100 feet) of sand and other glacially derived sediments which make up Presque Isle, there is almost 6,000 feet of sedimentary rock. The sediments comprising these rock formations were deposited from 600 to 350 million years ago when this area was below sea level. The rock formations are nearly horizontal (slight southerly downdip) layers of shale, limestone, dolostone, claystone, sandstone, and salt (Pennsylvania DER, Bureau of State Parks 1993). The uppermost bedrock formation is the Northeast Shale, of Devonian age, and is often exposed along the shoreline bluffs in Erie County. This bedrock unit is a gray silty shale with thin layers of fine-grained sandstone and calcareous layers or lenses. Underlying the layers of sedimentary rock are older metamorphic rocks (PBSP 1993).

A schematic geologic cross-section of the Study Area running from the Erie waterfront to the northwest through Presque Isle shows the arrangement of beach, dune, and mud/organic deposits (found in swamps, lagoons, and the bottom sediments of the bay) over the glacial deposits and shale bedrock in the Study Area, from the bluffs along the Erie shoreline through the shallow bay and deeper dredged ship channel to the dune ridges and inter-dune ponds and marshes of Presque Isle (Exhibit 1-2). Where not altered by urbanization, the bluffs along the Erie waterfront range from 30 to 70 feet in elevation. The mean depth of Presque Isle Bay is 13.1 feet with a maximum depth in the dredged channel of 31.2 feet (Pennsylvania Department of Environmental Resources (PADER) 1992).





0 TO 5,000 YEARS OLD
PONDS, SWAMPS, AND LAGOONS—*mud and peat*

BEACHES AND DUNES—*sand and gravel*

12,000 TO 15,000 YEARS OLD
GLACIAL LAKE DEPOSITS—*silt and sand*

13,000 TO 20,000 YEARS OLD
GLACIAL DEPOSITS—*clay, silt, sand, cobbles, and boulders*

370 MILLION YEARS OLD
BEDROCK—*shale*

Scale
0 0.5 1 MI
0 0.5 1 1.5 KM

Presque Isle Bay Recreational Boating Study

ENGINEERS • ARCHITECTS • PLANNERS • SCIENTISTS • SURVEYORS • PHOTOGRAMMETRISTS
GREENHORNE & O'MARA, INC.
9001 EDMONSTON ROAD, GREENBELT, MARYLAND 20770

Geologic Cross-Section

EXHIBIT 1-2

Source: Pennsylvania Geological Survey, 1991

Exhibit 1-2 also illustrates the dynamic nature of Presque Isle in the pattern of dune ridges and the ponds and lagoons that commonly occupy the low areas between them. New ridges form parallel to the shoreline and the older ridges show the locations of earlier shorelines. Littoral drift (also known as longshore sediment transport) predominates in the changing landforms of Presque Isle. Littoral drift is a current that operates along the shore, carrying sediments from actively eroding areas and depositing sediments in zones of slack water. At Presque Isle the littoral drift system generally operates in a southwest to northeast direction, reflecting the prevailing winds in the region. The leading edge of the migrating spit is spilling sand carried along the length of the spit. Gull Point, at the leading edge, has grown appreciably in this century.

It appears that the entire peninsula has been migrating eastward over time (Zagorski and Sampson 1982). Although Presque Isle is a recent landform, in geomorphic terms, it can be considered "old" in the sense that the original sources of sediment have significantly diminished. The fact that the sandspit is migrating with a net annual loss of sediments is an indication of advancing age (PBSP 1993). Since 1828, Presque Isle has been breached at the neck of the peninsula by severe storms at least four times (Zagorski and Sampson 1982). The State and Federal governments have attempted many different ways to control erosion at Presque Isle and to stabilize the beaches. Groins, seawalls, and detached breakwaters have been constructed and an extensive beach nourishment program has been implemented to slow the erosional process of the exposed western shoreline of Presque Isle.

1.3.2 Soils

The soils found within the Study Area are part of the Rimer-Wauseon-Berrien Soils Association and can be characterized as sandy soils associated with the lake plain. The soils have formed in deep, sandy lake sediments. The soils in the Study Area are all of recent origin and are currently in the process of erosion, formation, and change. The most extensive soil type is Beach Sand, Stabilized. This type consists of deep, sandy beach material that has been stabilized by vegetative cover. The material has not been in place long enough for a true soil profile to form. Other soil types most commonly found on Presque Isle include Beach, Dune Sand and Fresh Water Marsh. The latter consists of six to twelve inches of partly decomposed organic material that is underlain by deep lacustrine sand and gravel (Soil Conservation Service 1991).

The bluff areas along the shoreline are identified in the Soil Survey as either Escarpment, characterized by steeply eroding slopes, or as one of the Ottawa soil series, characterized by acidic, well-drained sandy soils with a gray, calcareous layer between four and eight feet in depth. The calcareous layer, locally called quicksand, is very hard when dry but flows when saturated with water. This characteristic can be a significant development constraint presenting unstable conditions for building foundations. The majority of the soils along the City of Erie waterfront are classified as Made Land. Much of this type is filled land and may include disturbed soils or rubble/debris as fill material (SCS 1991).

1.3.3 Terrestrial Resources

The Presque Isle Bay Study Area encompasses a portion of Erie County and the State of Pennsylvania that has a high diversity of vegetative communities. This is due, in large part, to the diverse physiography found in the Study Area. Bluffs, slumps, beaches, dunes, sandplains, and interdune depressions provide varied habitats for the establishment of a number of vegetational communities. The dynamic processes shaping the landscape along Lake Erie's shoreline have created many transitional communities which often have unique, rare, or threatened and endangered species present.

South of the Lake Erie shoreline, the original vegetation was primarily forest. The climax forest is thought to have been sugar maple-beech forest; however, essentially all the forests in Erie County have been logged at least once and the species composition has changed dramatically (Western Pennsylvania Conservancy 1993). The second growth forests in the County are dominated by either red or sugar maple. Secondary members of the forest community include cherry, ash, yellow poplar, and sometimes northern red oak. Beech is now a minor component of the forest canopy (WPC 1993).

The portion of the Study Area along the City of Erie shoreline has been significantly altered by the waterfront commercial, industrial, and residential development. Other than in some restricted or unsuitable sites, the forest cover has been cleared and the remaining shrub and woodland habitat has low value.

The Erie County Natural Heritage Inventory describes the Lake Shore Land Conservation Area (LCA) which includes the entire Presque Isle Bay Study Area and in fact extends along the entire shoreline in Erie County (WPC 1993). The LCA focuses on the importance of the lake bluff system which has been recognized by County, State and Federal agencies (U.S. Department of Commerce 1980). The lake bluff system includes such unique habitat types as lake bluffs, lake sediment slumps, sandspits, beaches, dunes, and sand plains. Natural shoreline erosion and bluff recession make the bluff habitat a dynamic landform. Vegetative communities represent a continuum of ecological successional states, ranging from unvegetated substrate on recently undercut slopes, to mature forest. Lake sediment slumps are a unique shoreline habitat, formed when bluff sediments become over-saturated and move down the bluff slope. These areas provide habitat for several plant species of special state concern.

The Erie County Natural Heritage Inventory identifies a community/ecosystem conservation area along a section of the bluff in the Study Area contiguous to the neck of Presque Isle (WPC 1993). This, area which includes approximately 1,900 feet of the bay shoreline, is characterized as a mesic central forest community (NC001) and includes a 14 acre mature forest on the bluff slope and toe and is bordered on the bluff crest by 50 acres of a younger, relatively undisturbed woodland. The mature forest community is dominated by beech and sugar maple. This community is the only area of naturally vegetated bay shoreline lake bluff in the County that retains its ecological integrity. The Natural Heritage Inventory recommends that the 64 acre forest, bluff, and shoreline area be preserved

because it represents a natural community considered to be imperiled in the State (WPC 1993).

In 1985, the forest types on Presque Isle State Park were mapped by the Pennsylvania Bureau of Forestry and the Bureau of State Parks (PBSP 1993). Four major forest types encompassing approximately 1,400 acres were identified: mixed oak, northern hardwoods, pine plantation, and cottonwood. The northern hardwood type is dominated by black cherry and red maple in the overstory. The major forest type is eastern cottonwood covering approximately 690 acres. Cottonwood, together with willows, is important in creating and stabilizing dunes. This short-lived species has the remarkable attribute of generating additional roots above the original root zone as sand accumulates (PBSP 1993).

The sand dunes and marshes of Presque Isle State Park are recognized as a unique ecosystem complex and the park is registered as a National Natural Landmark. The process of plant community succession on ponds, dunes, and sand plains can be studied in ecosystems ranging from one year to several hundred years old, all within the State Park boundaries. Presque Isle is classified as a Biological Diversity Area (BDA) by the Natural Heritage Inventory. BDA's support special species habitats and relatively large numbers and kinds of species. Presque Isle BDA contains ecological resources that are unique within the State, rare within the Great Lakes Basin, and uncommon on the North American continent.

Only a brief description of the terrestrial plant communities and ecological resources of Presque Isle can be included in this report. Any extensive discussion of these resources would unnecessarily encumber this report and is not crucial to addressing recreational boating issues in Presque Isle Bay. The Presque Isle State Park Management Plan, the Erie County Natural Heritage Inventory (both cited above), and the primary resources used in these documents, should be reviewed if more detailed information is sought by the reader.

Palustrine natural communities on Presque Isle include: sandspit pond and bay community (NC002), Great Lakes palustrine sandplain (NC003), robust/graminoid emergent marsh (NC004), and circumneutral shrub swamp (NC005). The Eastern Great Lakes beach-dune (NC006) and dry-mesic Great Lakes sandplain are the terrestrial communities (WPC 1993). Over 130 species of special concern have been confirmed on Presque Isle, including 63 species of vascular plant species. Many of the natural communities within the BDA provide habitat for migratory shorebirds and raptors, making Presque Isle a critical staging area for migratory birds. One shorebird and two raptors which have historically inhabited Presque Isle are Federally endangered species (WPC 1993). The portion of Presque Isle closest to the mainland was built-up around 1956-1957 by the placement of dredged material from the Bay. With this exception, the natural communities on Presque Isle are progressively older towards the bay side and on the western end of the sandspit. The result of the geomorphic processes is a mosaic of habitats that support a diverse assemblage of flora representing a continuum of successional stages, tending from palustrine ponds and bays to terrestrial climatic climax communities.

Presque Isle State Park, the most frequented State park in Pennsylvania, is vital to the tourist industry in Erie. Its four million annual visitors use the seven miles of sandy beaches for public bathing, hike on its extensive trail system, and utilize its marina and boat ramps for access to Presque Isle Bay and Lake Erie (The Brandow Company 1992). As an important recreational resource, conflicts arise between the need for resource protection and substantial visitor use. Stewardship of Presque Isle State Park is necessary considering the uniqueness of the natural resource and its contribution to the quality of the recreational experience. The mission statement, prepared by the Pennsylvania Bureau of State Parks, for the management of state parklands, addresses this issue:

> ... to provide opportunities for enjoying healthful outdoor recreation and to serve as outdoor classrooms for environmental education. In meeting these purposes, the conservation of the natural science, aesthetic, and historical values of the parks should be given first consideration. Stewardship responsibilities should be carried out in a way that protects the natural outdoor experience for the enjoyment of current and future generations (PBSP 1993).

These goals and objectives are also relevant when addressing the aquatic resources present in Presque Isle Bay.

1.3.4 Aquatic Resources

The aquatic resources in Presque Isle Bay are greatly affected by the overall water quality of the bay and watershed which drains to the bay. The overall water quality of the bay, pollutant loading, and impairment of beneficial uses are discussed in the Presque Isle Remedial Action Plan (PADER 1992). Recreational boating impacts to water quality are discussed in Section 3.0 of this report.

Presque Isle Bay is considered an important part of the Presque Isle Biological Diversity Area and is classified as imperiled in the State due to its rarity (WPC 1993). The bay contains several aquatic resources that have ecological significance because of exceptional aquatic biotic assemblages, partially intact shoreline habitats, and special species habitats. The littoral zone of the bay contains extensive beds of floating, submerged, and emergent vegetation.

The western end of Presque Isle Bay, locally known as the Head of the Bay, has been identified as having an extensive and diverse littoral zone (WPC 1993). The Head of the Bay contains several large stands of emergent vegetation including cattail and bur-reed. Big duckweed, water milfoil, a pondweed (*Potamogeton crispus*), a leafy pondweed (*P. epihydrus* var. *ramosa*), and bullhead-lily (*Nuphar variegatum*) were identified in aquatic beds in this area. Along the shoreline is an emergent zone dominated by arrowhead, a bur-reed (*Sparganium eurycarpum*), and softstem bulrush (*Scirpus validus*). Five special plant species occur within this community including one species classified as critically imperiled in the State, two imperiled in the State, one rare or uncommon species, and one plant species of special concern (WPC 1993).

Significant aquatic habitats in Presque Isle Bay that are considered environmentally sensitive have been identified during a recent study of Presque Isle and the surrounding waters (PADER 1989). This study identified environmentally sensitive areas on the basis of eight criteria. The aquatic species in the bay and ponds or lagoons on Presque Isle that were identified as environmentally sensitive include:

- Eastern Sand Darter (review candidate for listing as a Federally endangered species)
- Juvenile Lake Sturgeon (State level significance)
- Iowa Darter (Park level significance)
- Spotted Gar, or Bowfin (Park level significance)
- Fragile paper-shell, eastern pond, pink heel-splitter, and maple-leaf mussel (Four mollusk species considered to be rare/endangered at the State level)
- Blandings Turtle (State level significance)

The habitats for many of these aquatic species are located in ponds or other water bodies within the park. The significant habitat areas identified on Presque Isle Bay include: navigation channel south of the Coast Guard Station (habitat for Lake Sturgeon); along the west shore of the central portion of Misery Bay (habitat for rare/endangered mollusks); along the south shore of Crystal Point ending at the Perry monument (habitat for rare/endangered mollusks).

Presque Isle Bay provides important aquatic habitat for both sport fish species and for the forage fish species which support the sport fisheries. The shallow-water habitat provides spawning and nursery areas for 16 species of fish (PADER 1992). Creel surveys (interviews with fishermen), fish netting, and electroshocking have been conducted by the Pennsylvania Fish and Boat Commission (PAFBC) over the past ten years to assess the quality and vitality of the sport fisheries resources of Presque Isle Bay. Fishery assessments were conducted in 1981-1982, 1986-1987, and another assessment is currently underway. A 1987 survey reported over 40 different fish species taken from the bay (PAFBC 1988). Of these species, over 20 are being caught by anglers (PADER 1992, Murray, Pers. Comm. 1993). They include:

yellow perch	black crappie
white bass	smallmouth bass
bluegill	largemouth bass
rock bass	salmon
rainbow trout	white crappie
northern pike	channel catfish
bullhead catfish	muskellunge
white perch	walleye
brown trout	bowfin
sunfish	sheepshead

These surveys revealed that Presque Isle Bay is an exceptional and very diverse fishery which sustains a high level of fishing pressure (PAFBC 1983). For example, the 1981 creel census reported 625,000 hours of fishing consisting of about equal amounts of shore and boat fishing and more limited ice fishing. The total recreational fishing catch was estimated at close to a million fish (PADER 1992). The major warm water species sought by anglers are yellow perch, northern pike, muskellunge, largemouth and smallmouth bass. The cold water (salmonid) species sought include chinook salmon and trout.

PFBC has managed the sport fishery in Presque Isle Bay by establishing creel limits, size limits, and seasonal restrictions for many years. The Commission has also supported the sport fishery by stocking sport fish. Over 2.7 million game or sport fish were stocked in the eleven-year period from 1971 to 1981 (PADER 1992). The major success of this stocking activity was the establishment of a significant coho fishery, indicating that the bay has in the past, and may in the future, provide habitat for coho salmon production. However, despite significant walleye stocking, it appears that the bay is not an optimal habitat for a walleye fishery (PADER 1992).

The 1988 fishery assessment examined the status of the walleye fishery and evaluated the fishery management practices in place between the 1983 and 1988 reports. The assessment found that the bay continues to be an exceptional fishery for both panfish and game species. It found that the salmonid fishery had become more significant since the initiation of direct stocking of steelhead smolts into the bay. The report also noted occurrences of "redspot" (a bacterial skin disorder) on northern pike, and skin lesions on bass and brown bullheads (PADER 1992).

2.0 INVENTORY OF RECREATIONAL BOATING AND PORT FACILITIES

An examination of the existing, proposed, and potential recreational boating facilities in Presque Isle Bay is essential to evaluate current and projected environmental and social impacts associated with boating activities. The assessment of future water quality and boat congestion was prepared from the inventory of existing facilities and projections of new or expanded facilities. The future of Erie's port facilities is also important in determining opportunities for redevelopment and potential conflict with recreational boating in Presque Isle Bay.

2.1 Existing Recreational Boating Facilities

An inventory of the existing boating facilities, including marinas, yacht clubs, and boat ramps, was conducted. After examining the needs of the study, the project team devised an approach to define those aspects of boat use which most directly relate to its impact on Presque Isle Bay. Phone interviews and mailed surveys were used to quantify the information needed to describe the existing conditions. A summary of the inventory of existing boating facilities is provided in Exhibit 2-1.

The most important objective of the existing facilities inventory was to obtain the most accurate count of the number of boat slips in the Study Area. However, many other factors such as the frequency of boat use, the extent of boat repair done, parking availability, and marina support services such as gas docks and pump-out facilities, were important components of the inventory. In order to provide the most accurate inventory, the project team decided to contact each of the boating facilities directly. Greenhorne and O'Mara worked with the Erie County Department of Planning to develop a questionnaire for the facility operators that would address these areas of concern. Phone surveys were completed with 11 of the facilities and the remainder were mailed questionnaires with stamped addressed return envelopes. Not all of the 20 recreational boating facilities responded to the phone or mailed survey questions.

The most unambiguous information gathered was that confirming the number of slips and presence or absence of support facilities such as boat ramps, fuel docks, or sewage pumpout facilities. In the case of fuel docks, however, there is one marina which has a fully functional fuel dock but did not operate it during the 1993 boating season. Since it is capable of selling fuel at any time, this marina is shown in the matrix as having fuel available.

Boat ramps are also considered a very important component of the inventory since they are the primary means of access to the bay for many of the smaller boats and jet skis (Exhibit 2-2). Exhibit 2-3 shows the locations of the existing marina and boat launch facilities.

A previous inventory of facilities, prepared in 1992 by Erie County, the Chamber of Commerce, and Port Authority, supported by PADER and the State Coastal Zone Management Program, provided a starting point for the study's more extensive inventory. The pamphlet entitled "Lake Erie Boating Facilities and Related Services, Erie County, Pennsylvania," documented

Exhibit 2-1

Inventory of Existing Boating Facilities

Marinas

NAME OF FACILITY	FACILITY CHARACTERIZATION							
	NUMBER OF SLIPS AVAILABLE	PREDOMINANT BOAT TYPE	BOAT RAMP PRESENT	FUEL AVAILABLE	SEWAGE PUMP OUT FACILITY	REPAIRS ARE DONE ON SITE	TRANSIENT SLIP AVAILABILITY	PARKING SPACES AVAILABLE
Bay Harbor Marina	220	power	✔			✔	✔	100
Bayshore Marina	17[1]	power				✔	✔	50
Cherry Street Marina	220	power				✔	✔	130
Commodore Perry Yacht Club[2]	135	power		✔			✔	125
Divell Marina[4]	10	power						0
Erie Angler	31	power				✔	✔	40
Port Author. Canal Bank Marinas[4]	32	power						0
Erie Yacht Club[2,3]	372	equal	✔	✔	✔	✔	✔	500
Gem City Marina	53	power					✔	20
Hamot Marina[4]	19	power						0
Jolly Roger Marina	30	power						10
Lampe Marina	252	power	✔	✔	✔			100
Lund Boat Works	32	sail				✔	✔	20
McAllister's Marina	40	power		✔		✔	✔	75
Perry's Landing Marina	200	power		✔	✔	✔	✔	180
Presque Isle Yacht Club[2]	101	power				✔	✔	85
Presque Isle State Park	473	power	✔	✔	✔		✔	390
Surf and Turf Marina	21	power				✔		40
Walnut Street Marina	20	power					✔	15
Total Boat Slips	2278							

[1] *50 boats in rack storage.*
[2] *Serves members and guests only.*
[3] *Includes 32 floating moorings.*
[4] *No parking on premises; patrons use public parking.*

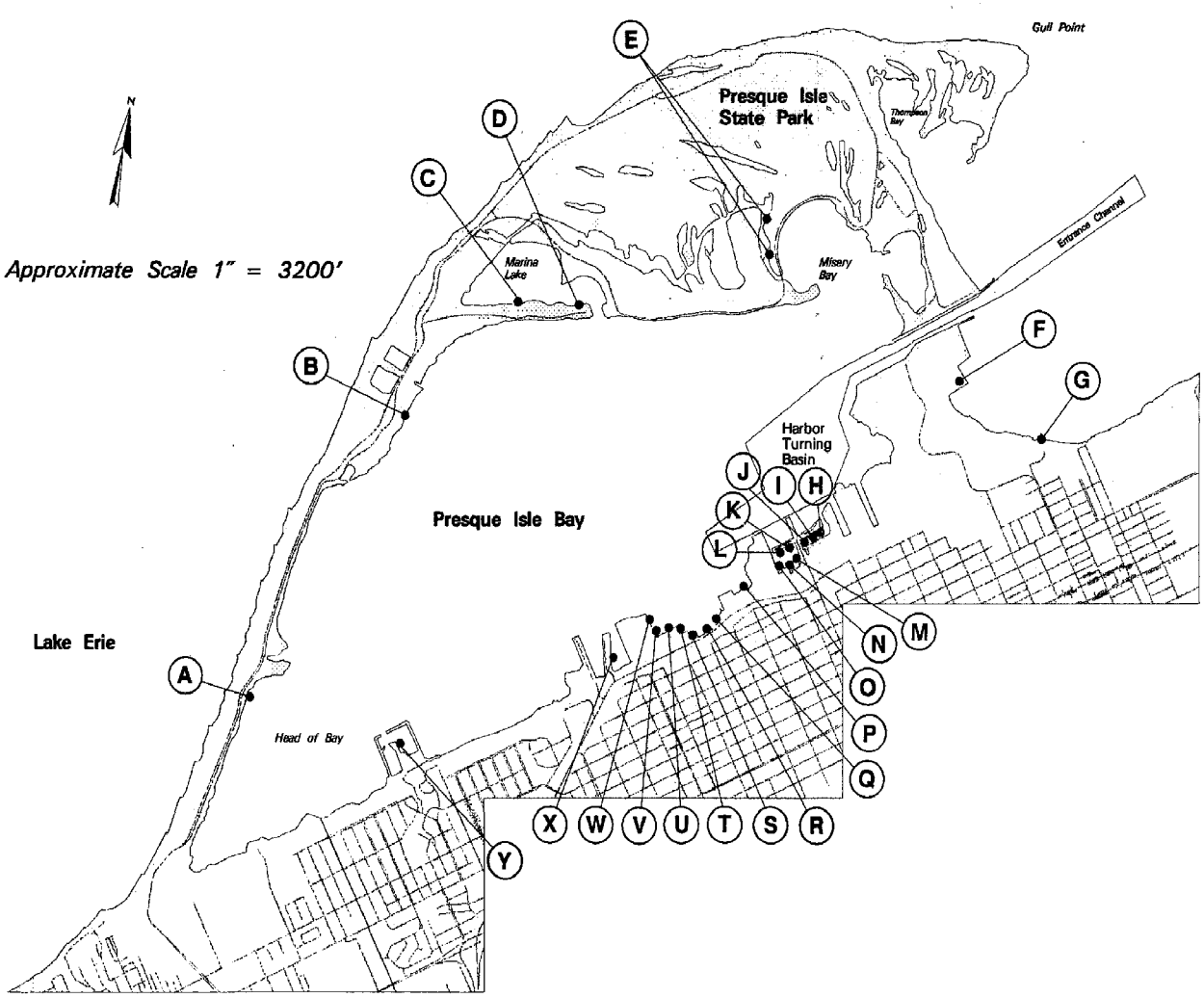
Exhibit 2-2

Inventory of Existing Boating Facilities

Boat Ramps

NAME OF FACILITY	LOCATION	CAPABILITY	PARKING
Chestnut Park	Foot of Chestnut Street, City of Erie	small boats only	30
East Avenue Boat Ramp	Foot of East Avenue, City of Erie	small to medium	50
Erie Outboard Motor Club	Foot of Myrtle Street, City of Erie	small to medium	35
Lagoons Boat Ramps	Presque Isle State Park	small to medium	50
Lampe Marina	Port Access Road, City of Erie	large boats	*
Marina Boat Ramp	Presque Isle State Park	large boats	40
Niagara Boat Ramp	Presque Isle State Park	small to medium	50
Poplar Street Boat Ramp	Foot of Poplar Street, City of Erie	small boats only	15
Vista Boat Ramp	Presque Isle State Park	small boats only	50

**Parking combined with general marina parking, 100 spaces.*



Legend

A. Vista Boat Ramp
B. Niagara Boat Ramp
C. Presque Isle State Park Marina
D. Presque Isle State Park Marina Boat Ramp
E. Lagoons Boat Ramps
F. Lampe Marina and Boat Ramp
G. East Avenue Boat Ramp
H. Bayshore Marina
I. Lund Boat Works
J. McAllister's Marina
K. Surf and Turf Marina
L. Erie Angler
M. Port Authority Marinas (Includes Divell, Erie-Western Port Authority Canal Basin, and Hamot Marinas)
N. Gem City Marina
O. Presque Isle Yacht Club
P. Erie Outboard Motor Club
Q. Chestnut Park Boat Ramp
R. Jolly Roger Marina
S. Walnut Street Marina
T. Cherry Street Marina
U. Commodore Perry Yacht Club
V. Poplar Street Marina
W. Bay Harbor Marina
X. Perry's Landing Marina
Y. Erie Yacht Club

Greenhorne & O'Mara, Inc.

Existing Marinas and Boat Ramps

Exhibit 2-3

boating facilities and support services. Of the marinas and yacht clubs listed in that pamphlet, 19 were determined to be within the Study Area. No new marinas have been constructed. The Chestnut Street Marina, listed in the previous inventory, did not operate during the 1993 boating season. Located adjacent to the Waterworks facility (City of Erie Water Authority), the marina slips were vacant and the future plans for this facility are unclear. In the past, there have been discussions about expanding the Chestnut Street Marina. Slips at the Chestnut Street Marina are not counted in the matrix.

Improvements to the adjacent Chestnut Park boat ramp facility are in progress and expected to be completed in 1994. These improvements include the construction of two new ramps east of the existing ramps, repair of the existing ramps, removal of waterway obstructions, and construction of a floating pier adjacent to the ramps. Additional planned improvements to the park will include construction of a parking lot with capacity for 20 cars with trailers, and 16 spaces for cars alone. A 12' wide concrete public walkway around the perimeter of the parking lot connecting on either side to the future Bay Front Bikeway.

In addition to improvements at the Chestnut Park boat launching facilities, improvements are also planned for launch ramps at Presque Isle State Park. Proposed improvements are expected to be completed in 1995 and include.:

- Niagara Launch Ramp Renovation: Renovating existing concrete ramps and headwalls, constructing a new concrete headwall and cap, constructing two new 16' wide launch ramps on both sides of the headwall, and adding three new floating docks and a fully accessible catwalk.

- West Pier Launch Ramp Renovation: Constructing four new floating docks and two catwalks to be attached to the two existing headwalls, and cutting groves into the concrete launch ramp to provide traction for users.

- Old Lagoon Launch Ramp: Replacing missing and damaged pilings, installing a headwall, and constructing a catwalk and one 20' section of floating dock.

- New Lagoon Launch Ramp: Constructing two new floating docks to replace existing docks, replacing the existing steel grate launch ramp with a concrete ramp and extending it to the north side of the headwall to provide an additional launch lane. Railings will also be installed on the gangways.

In many cases it was found that the number of slips did not agree with the previously published information. To some degree this can be attributed to differences in how undivided mooring space, such as sea walls and landings are counted. The matrix reflects the most recent data available. In those cases where input was not available from a facility's operator, slip numbers from the earlier inventory were used.

Attempts to accurately categorize slips by size were not consistently successful. While some facilities such as Perry's Landing had slip size information to a very detailed level, most of the other marinas did not. Coupled with the reality that slip sizes place only an upper limit to the size of boat which can be moored, it was determined that slip size data would not be included in the results matrix. The relative proportion of sail to power boats was included as a survey question. It became readily apparent that the overwhelmingly predominant boat type for all but two facilities was power boats.

While confirming the presence of repair facilities was straightforward, categorizing those facilities proved more difficult. Most of the larger facilities have lifts or some other means of removing boats from the water and several have paid mechanics or associated repair businesses on site. In the survey, facility operators were asked to categorize the nature of repairs done on site. However, since most facilities will allow individual boat owners to work on their boats or employ outside personnel, it was not possible to narrowly define the types of repairs done at each facility. The summary matrix reflects all facilities where repairs can be performed (see Exhibit 2-1).

Parking was another area where accurate data could not be generated by questioning the facility operators. In general, the facilities interviewed did not have delineated parking spaces; rather parking is usually in the form of loosely organized rows on unmarked, gravel lots. Therefore, for those facilities where no parking capacity was declared by the operator, parking capacity was estimated through interpretation of the aerial photography commissioned for the survey. The boundaries for parking areas were delineated for each facility and transferred on to base maps using Stereo Zoom Transfer Scopes. These base maps were then used for the computation of the acreage devoted to parking at each facility. The known parking counts available for some facilities allowed for the computation of a ratio for use in estimating parking capacity for other facilities. In the case of the Presque Isle Bay area these ratios were assessed at 120 parking spaces per acre for marinas, except for those in the Canal Basin area where parking is more dense at 150 spaces per acre. At boat ramps the average parking to area ratio was 70 spaces per acre, which includes a combination of car/trailer parking and single car parking. The number of estimated parking spaces for each facility is shown on Exhibits 2-1 and 2-2.

2.2 Proposed Recreational Boating Facilities

Proposed recreational boating facilities are defined as: (1) planned expansions or new facilities that have received all necessary approvals but have not initiated or completed the proposed development; (2) projects that have entered into the development review process by submitting permit applications or development plans to local, State or Federal review agencies; or (3) projects that have not formally entered the permit review process but for which there is a high degree of certainty that the project will move forward in the near future.

Five planned expansions of existing facilities or new facilities have been identified as proposed recreational boating facilities in the Presque

Isle Bay Study Area (Exhibit 2-4). These proposed facilities, if all completed, would add 792 boat slips to the current inventory of 2,278 slips in the Study Area. A brief description of each of the proposed facilities follows.

Bay Front Center (Grain Elevator Pier)

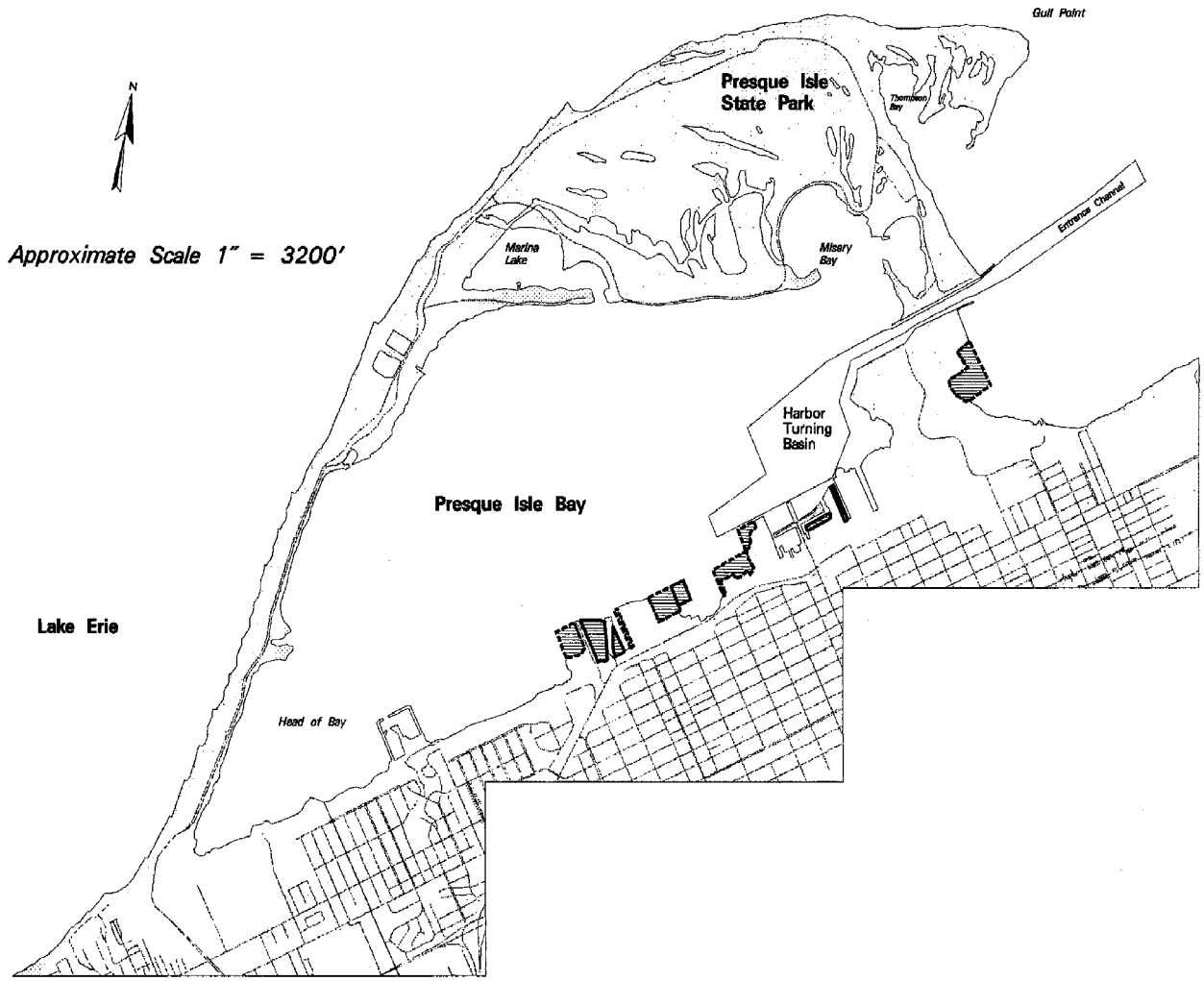
The Bay Front Center is a proposed mixed-use redevelopment project that will include residential uses, a permanent home for the Niagara, historical museum and library, and two marinas. The concept for the Bay Front Center is a public-private sector initiative which is being promoted by the Erie Western Pennsylvania Port Authority, Penelec, the Pennsylvania Historical and Museum Commission, and the County of Erie. The Port Authority has obtained plans for a proposed marina at the Grain Elevator pier from the original marina developer (Pomorski, pers. comm., 1993). The marina concept for this site proceeded as far as obtaining joint PADER and U.S. Army Corps of Engineers approval before the project was shelved. There is some controversy concerning this proposed marina because of the need to temporarily dock lake freighters along the east side of the grain elevator pier for repair by Erie Marine Enterprise's. There have been discussions about temporary piers and finger slips which could be removed following the boating season and perhaps during emergency repair situations. The total number of slips anticipated for this marina is approximately 100.

Bay Front Center (south shore of East Canal Basin)

Another proposed marina which is anticipated to be part of the Bay Front Center will be located on the south shore of the East Canal Basin, adjacent to the former Penelec power plant. The proposed site contained covered slips that have been razed in anticipation of this development. Although no final permits have been granted for this proposed marina, the Port Authority is waiting for approval for dredging of the Canal Basin to initiate the actual marina design process. It is the opinion of the Port Authority that permit approval for dredging is forthcoming and that the proposed marina will be a reality in the near future (Pomorski, pers. comm., 1993). Hence, we are considering this a proposed marina site. The total number of slips anticipated for this marina is approximately 100. Exhibit 2-4 Map of Proposed and Potential Facilities

Cherry Street Marina

The existing Cherry Street Marina has 220 slips (pers. comm. with marina operator, 1993). The marina owner requested and has received joint PADER and U.S. Army Corps of Engineers permit approval and received zoning approval from the City of Erie to expand the facility to 425 slips. The owner has expanded the breakwaters to accommodate the additional slips. However, the reduced demand for these slips over the past several boating seasons has slowed the expansion project. The marina operator reported that this marina had 60-80 vacant slips during the 1993 boating season. If conditions improve and the proposed expansion is completed, 205 additional slips would be added to the total number of boat slips in the Study Area.



Legend

- Proposed and Potential Marinas
- Proposed Marina Boundary
- Potential Marina Boundary
- Harbor Entrance and Turning Basin

Greenhorne & O'Mara, Inc.

Proposed and Potential Boating Facilities

Exhibit 2-4

Perry's Landing (Existing Marina)

The existing marina at Perry's Landing accommodates 200 slips. All the necessary approvals for an additional 37 slips have been obtained. This expansion would extend new floating docks from the existing main piers. Staff of Perry's Landing Marina contacted during this study indicated that this minor expansion will be constructed between the 1993 and 1994 boating seasons. The staff also noted that there have been no slip vacancies during the past three boating seasons.

Perry's Landing (New Marina Proposed Between Piers 1 and 2)

The original Perry's Landing mixed-use project, developed by West Bay Properties, included residential, commercial, and marina development on Piers 1, 2, and 3. The project faltered in 1989 due to financial shortages, and the primary lender, Integra Bank, assumed ownership of West Bay Properties. The project site plan received joint PADER and U.S. Army Corps of Engineers permit approval for the water-related development in October 1987. The original permit for the uncompleted portion of Perry's Landing lapsed because a permit extension request was not made prior to October 1990.

Recently, plans for the completion of Perry's Landing Marina have resurfaced. The revised plans for the marina expansion will use a patented floating breakwater system, tradenamed "Waveshield." The proposed expansion would add approximately 350 slips to Erie's waterfront over a 5-year period. Assuming that permit approval is granted in early 1994, installation of the floating breakwater might begin as early as the fall of 1994.

2.3 Potential Recreational Boating Facilities

The objective of developing an inventory of existing, proposed, and potential recreational boating facilities is to develop a realistic scenario of the ultimate build-out potential of Presque Isle Bay. The estimate of the future build-out is not intended to be a worst-case scenario but one that recognizes the economic feasibility and the environmental constraints of future facilities.

The time frame associated with the future build-out projection is much more difficult to arrive at. Several years ago, it seemed that if a slip was available for rental in the Study Area, it was occupied. Although the weekend weather during the 1993 boating season was very conducive to recreational boating, the previous boating season was very inclement (Mong, pers. comm., 1993). Several of the marinas reported vacant slips during the 1993 boating season, although most of the marinas appeared full during field visits to Presque Isle Bay during the 1993 boating season. The sluggish economic conditions over the past two years have certainly affected demand for additional slips and recreational boater usage patterns. The long-term trends in recreational boating indicate that with improved economic conditions, the demand for additional recreational boating facilities will increase.

A comprehensive approach to evaluating potential sites for marina development was undertaken for this study. Aerial photointerpretation was used to identify potential sites. Local comprehensive plans and zoning ordinances were reviewed to determine where marinas or other recreational boating facilities were permitted by right or by conditional approval. Field visits to potential development sites were made. Physical constraints, such as steep slopes and water depth, that increase development costs or make permit approval unlikely (i.e., any required federal permits with PACZMP consistency review; see Section 8.0) were identified. Boating criteria, such as accessibility to channels and prevailing currents and waves, were determined. Impacts to natural resources were found to be major constraints for potential marina sites. Environmentally sensitive habitats such as shallow-water habitats, supporting fish spawning and nursery areas, were identified and mapped for this analysis. Land use criteria such as the availability of parking, which proved to be an important site consideration, were identified and incorporated into the analysis.

The following set of criteria were incorporated into the analysis to predict the size and location of potential recreational boating facilities:

- presence of shallow-water habitat;
- steep slopes;
- known high quality fish spawning and nursery areas;
- areas of significant emergent or submergent wetlands;
- economic feasibility of potential marina site. Most important factors identified were extent of dredging required or prohibitively high cost of breakwater construction due to water depth;
- areas of poor circulation and flushing;
- adequate, level, fastland for parking and other marina support facilities;
- access to primary road and access to major road network;
- habitat for rare, threatened or endangered species;
- potential for impacts to intact lake bluff habitat;
- availability of infrastructure (sewer, water, solid waste, electricity);
- prevailing currents and waves;
- accessibility to channel.

In addition to developing these criteria, interviews were conducted with members of the Presque Isle Bay Recreational Boating Task Force to assist in identifying sites where new facilities or expansions of existing facilities were conceptually proposed in the past but no significant action has occurred to justify placing these sites into the Proposed Recreational Boating Facility category. Each of the potential sites, where conceptual plans were developed at some time in the past, was specifically evaluated against the criteria described above.

The results of the analysis of potential recreational boating facilities identified seven expansion sites that could conceivably add 1,911 boat slips to the Study Area if all potential projects were completed (Exhibit 2-4). The number of additional potential slips was calculated by determining the water area in acres for each potential site and multiplying

acreage by an average number of slips per acre. The actual number of slips per acre of water area available is dependent upon a number of factors including slip size, type of boats (sail versus power), and configuration of marina (determines location of fairways and main piers). Without any conceptual designs for the potential marinas, the average number of slips per water acre was determined by aerial photointerpretation of several recently constructed marinas in the Study Area and determining the number of slips per acre. The average number of slips per water acre was estimated to be 35 slips.

A brief description of the six potential recreational boating facilities follows:

Perry's Landing (West of Pier 1). The western side of Perry's Landing Pier 1 has been shown with marina piers in some of the early conceptual schemes for the overall development. Dredging and protection from prevailing northwesterly winds are two constraints for this site. The area designated for this potential marina site could conceivably support 280 slips.

Perry's Landing (Existing Marina). The marina is planning to eventually add approximately 88 slips to their existing operation by extending short finger piers from the western edge of Pier 3. No detailed design for this marina expansion has been developed (Perry's Landing staff, pers. comm., 1993).

Commodore Perry Yacht Club. Members of the Yacht Club have stated that no expansion of their facilities is planned; however, this portion of the Erie waterfront is clearly a logical place for marina expansion. The recent improvements to the Cherry Street Marina extended the breakwater, making any expansion of the Yacht Club economically feasible because the area is now protected on both sides. Although current members have expressed that they are strongly against any planned expansion, the suitability of this site for expansion argues for placing this site in the Potential Recreational Boating Facilities category.

The Waterworks. There have been conceptual plans developed at one time for a 400-slip marina which would wrap around the Waterworks Facility operated by the City of Erie Water Authority (Kissel, pers. comm., 1993). The recent placement of a settling basin on the site may restrict the availability of parking, requiring some redesign of water filtration operations for any future marina expansion. The potential facility analysis estimated that 392 slips could be constructed at this site.

Erie Sand and Gravel Site. Current Erie Sand and Gravel operations on the pier west of Dobbins Landing are expected to be relocated to another industrial location on the Erie waterfront, opening up this pier for redevelopment opportunities. Conceptual plans have shown residential development (condominium townhomes) with marina slips for the future residents. Dredging and prevailing winds are two constraints for this potential site. The potential facility analysis estimated that 182 slips could be constructed at this site.

Lampe Marina. This existing marina, located south of the channel entrance (outside of Presque Isle Bay), is owned and operated by the Port Authority. Although there have been discussions about using a portion of the dredged-material spoils area for an expansion of Lampe Marina, this option was not included in the potential marina analysis. Current state water quality requirements do not permit using the spoils area for its original purpose because of the degree of contamination of harbor bottom sediments. The adaptive reuse of this area, protected by breakwaters, is an attractive possibility but one fraught with many hurdles to its implementation. Instead, the potential marina analysis proposed an expansion of Lampe Marina towards the shoreline, providing an additional 574 boat slips.

Several other potential marina locations in the Study Area that were once considered as viable marina locations were not included in this evaluation because of prohibitive cost implications or significant environmental constraints. The Erie Waterfront Comprehensive Plan, prepared in 1986, showed a large marina proposed on filled land to the southwest of the Erie International Marine Terminal (Land Design/Research 1986). This marina concept progressed to the design phase where it was found that cost projections for the marina breakwater were prohibitive (Kissel, pers. comm., 1993).

A marina proposed in the waterfront area between Cherry Street Marina and the Waterworks Facility was denied in the permit process because of potential impacts to productive fish spawning and nursery habitat (Kissel, pers. comm., 1993). This portion of the Erie shoreline is also severely constrained by a lack of adequate space for parking.

The potential expansion of Presque Isle State Park Marina was considered to be a Potential Recreation Boating Facility site. However, expansion of this area will most likely not result in any significant increase in number of slips. Discussions with State Park staff indicate that currently no expansions are planned, and that any expansion of main piers would be used to reconfigure the existing marina operation, providing more amenities for the boaters and not adding significantly to the total number of slips available. No other significant recreational boating facility improvements are planned at Presque Isle State Park, other than minor improvements to the boat ramps.

No new marina facility sites were considered between Perry's Landing and the Erie Yacht Club and continuing westward to the Head of the Bay because of significant physical and environmental constraints. The Lakeshore Bluff is very steep along the shoreline and very limited fastland is available for marina support facilities. There is extensive shallow-water habitat, productive fish spawning and nursery areas, wetlands, and threatened terrestrial and aquatic habitats.

2.4 Commercial Port Facilities Inventory

An inventory of commercial port facilities and an evaluation of the future of Erie's port is important in determining the potential for future conflicts between port-related activities and opportunities for

redevelopment along Erie's waterfront. The existing commercial/industrial operations located within the waterfront Study Area were identified and phone interviews were conducted with representatives of the waterfront industries. Interviews were also conducted with Erie Western Pennsylvania Port Authority staff to discuss the overall health of Erie's waterfront industries and projections for the future.

2.4.1 Waterfront Industrial Facility Descriptions

Descriptions of the major waterfront industrial uses within the Study Area are described below. Current operations are described and the future plans of these industries are discussed, where information was available.

Erie Sand and Gravel

Erie Sand and Gravel is the most active port user and provides sand and stone aggregates for the surrounding region. Dredges which are operated out of the Port of Erie by Erie Sand and Gravel dredge sand and gravel from the bottom of Lake Erie. The dredging operation takes place six days per week, weather permitting, and the boats come into port twice a day to discharge the dredged material. Aggregate stone from Canada is also brought in two to three times a month by lake freighters (Miley, pers. comm., 1993). The average annual bulk tonnage moved through Erie Sand and Gravel operations is 800,000 tons; the 1992 amount was 810,000 tons.

As stated elsewhere in this report, Erie Sand and Gravel will most likely consolidate its operations (now in two locations) in the near future. One possible site for relocation of its operations is at the Erie International Marine Terminal. Erie Sand and Gravel operations are anticipated to continue in the same general tonnage range in the future.

CODAN

CODAN is located at the Erie International Marine Terminal and is a warehousing company. The recent down-turn in the economic climate for the region has reduced import-export shipments from the CODAN facility over the past several years. Historically, between 40 and 45 ships a year docked at the CODAN facility, shipping between 120,000 and 170,000 tons of material and goods (Morosky, pers. comm., 1993). In more recent years, 20 to 30 ships per year dock to load and unload metal alloys, scrap steel, steel slab, boilers, locomotives, and general cargo. Large ore shipments occur more sporadically. More current data indicates that CODAN moves 80,000 to 100,000 tons of materials and goods annually (Frawley, pers. comm., 1993). The company is being sold and will be out of business by the beginning of December 1993. However, it is envisioned that the new owners will continue existing import-export operations (Frawley, pers. comm., 1993).

GAF Corporation

The GAF Corporation is a manufacturer of roofing materials. The plant has been in operation for over a century and was first operated by the H.W. Watson Company, followed by Rubberiod and was later taken over by GAF Corporation (Adams, pers. comm., 1993). GAF produces roofing materials and serves an area of 500 to 600 miles surrounding Erie. The GAF Corporation

facility at Erie is not dependent on port-related facilities. Raw materials come to the plant via rail and trucks and the finished product is sent out via trucks only. Over the last two years, GAF invested over $1.4 million on plant improvements, indicating a long-term investment in this facility.

Erie Coke Company

The Erie Coke Company is located in the South Shore portion of the Study Area. Since the turn of the century this site has been occupied by an industrial use. Originally, the Perry Ship Building Company operated from this site and produced pig iron. It was later taken over by Interlake and Koppers and is now operated by Erie Coke Company. This plant manufactures foundry coke. The raw material is coal, which comes to the plant via the Conrail railroad. The coal is processed into coke, which is then sent out to customers by rail and trucks. None of the raw materials or finished products is transported through the port. No expansion of this plant is envisioned at this time (Babay, pers. comm., 1993).

Erie Marine Enterprises

Erie Marine Enterprises has operated a 1,250 foot drydock at this location since 1991. The previous operation included both ship construction and repair. The main operation of this facility is to repair ships and lake freighters ranging from 900 feet to 1,000 feet in length. Erie Marine Enterprises' operation also includes the production of boilers which are shipped out by barge.

When the Erie Waterfront Comprehensive Plan was being prepared in 1986, the future of the drydock facility was in doubt. In fact, the waterfront development plan identified the site for mixed-use redevelopment. As one of only two drydocks on the Great Lakes that can accommodate the newer 1,000 foot freighters, it is anticipated that Erie Marine Enterprises will continue to be a viable operation in the future. Certainly, the work force and drydock activities will fluctuate significantly over time. No expansion of this facility is anticipated.

Erie Manufacturing Export Complex

The Greater Erie Industrial Development Corporation (GEIDC) has acquired a site from the Erie-Western Pennsylvania Port Authority and is constructing a 36,000 square foot multi-tenant manufacturing facility at the Port of Erie. Plans are to lease the complex to a minimum of two manufacturing companies requiring a heavy duty (20 ton crane/26 feet under hook) facility to produce large products. The new facility will offer the Erie area its first opportunity to capitalize on a Port of Erie location to induce value-added manufacturing activities (CZM 306A Grant Application, 1993).

2.4.2 Port Facilities Summary

As chronicled in the Historical Setting (Section 1.2), the Port of Erie has one of the finest natural harbors on the Great Lakes. This was essential to the City's development as an industrial and manufacturing

center. The harbor supported an extensive commercial fishery, and the port was an important spoke in a transportation hub that also included rail and highways. For many years, the port was able to adjust to changing times because of the diversity of its water-dependent activities. However, its importance as a shipping port has declined over the years due to a number of factors:

- Changes in the vessel and cargo handling capacity have made the port's facilities obsolete and modern port facilities a necessity;
- The port lacks adequate access to the interstate highway system;
- There is a lack of market growth in the region, and the Port of Erie is not strategically placed to capture inter-regional and international growth opportunities.

All of these factors are applicable to a decline in the movement of coal, and other bulk commodities such as grain and ore through the Port of Erie. The projections for future tonnage handled by the Port of Erie are anticipated to stabilize at current levels of approximately one million tons per year (Morosky, pers. comm., 1993). As a result of the historical decline in industrial and commercial port activities, and the increasing growth of recreational boating and fishing, the Erie waterfront is now poised to enter into a new era of redevelopment.

It is projected that the industrial and port-related commercial uses will be consolidated towards the eastern portion of the Erie waterfront in the vicinity of the Erie International Marine Terminal. This projection follows a historical trend. This will then allow areas vacated, such as the Erie Sand and Gravel pier to the west of Dobbins Landing, to be redeveloped for other uses. In the near future, the only major port-related facility on the older portion of Erie's waterfront may be the Erie Marine Enterprises.

There are tremendous opportunities for the creative redevelopment of the waterfront to include residential, commercial, public open space, and increased opportunities for recreational boating facilities. Lessons learned from other waterfront redevelopment projects across the country, stress the importance of encouraging public spaces to draw residents and visitors to the waterfront. It is encouraging that the Bayfront Center, the most visible waterfront redevelopment project on the planning horizon, includes many features which will bring people to the waterfront.

3.0 RECREATIONAL BOATING WATER QUALITY ASSESSMENT

The purpose of the water quality assessment was to identify and evaluate the potential impact of recreational boating on water quality conditions in Presque Isle Bay. This study focused on identifying potential water quality impacts of recreational boating. The assessment results will be used to identify areas for further investigation with respect to the actual magnitude and severity of water quality impacts attributable to recreational boating activity on Presque Isle Bay.

The analysis was limited to assessing the impacts to the water column and does not include investigation of the bottom sediments (The source of bottom sediment pollution cannot be readily determined). A variety of data sources were examined including the Presque Isle Bay Remedial Action Plan (RAP), recreational boating literature, and the results of a limited sampling program which was conducted as part of this study.

The RAP was reviewed to assess existing water quality conditions in Presque Isle Bay (PADER, 1992). The RAP identified the most significant sources of pollution to the Bay including combined sewer overflows, nonpoint source pollution, wastewater treatment plants, and industrial sources. Recreational boating impacts were not discussed in detail. Annual loads were computed for pollutants generated by these sources. The RAP also identified water quality problems in the Bay and impairments to specified beneficial uses.

The potential for significant water quality impacts associated with recreational boating, and the methods for computing annual loads for the associated pollutants, were identified through a literature review. Using the results of the boater survey and boat counts conducted at Presque Isle Bay during the 1993 boating season (Section 5.0), annual loads (or concentrations) for select pollutants associated with boating activity were estimated. The estimated loads were then compared to the annual loads presented in the RAP in order to assess the relative impact of boating activity on water quality conditions in Presque Isle Bay in comparison to other pollutant sources.

A limited water quality sampling program was conducted in two marinas in Presque Isle Bay throughout the 1993 boating season. The results of the sampling program were compared to Pennsylvania Department of Environmental Resources (PADER) water quality standards and criteria and were used to identify potential water quality problems in Presque Isle Bay. Potential causes for the observed water quality problems were identified including combined sewer overflow (CSO) discharges and industrial point sources, as well as recreational boating activity.

The impact of boat wakes on the Presque Isle Bay shoreline was also evaluated. This analysis focused on erosion in narrow channels and speed restriction areas due to recreational boating.

3.1 Water Resources Background

Presque Isle Bay is a shallow, nearly fully enclosed bay located on the southern shore of Lake Erie. The most significant sources of flow to Presque Isle Bay are from Scotts Run and Mill and Cascade Creeks. Virtually all of the City of Erie drains to Presque Isle Bay. The majority (57 percent) of the 25 square mile Presque Isle Bay watershed is characterized by residential development (PADER, 1992). Commercial and industrial land uses account for slightly less than 20 percent of the total drainage area. Approximately 16 percent of the watershed is undeveloped. The most significant undeveloped area is the 3,200 acre Presque Isle State Park.

Presque Isle Bay is a nearly enclosed body of water. Pollutants which do not degrade quickly tend to settle in the Bay sediments (PADER, 1992). In addition, the exchange of water between Presque Isle Bay and Lake Erie is relatively limited and water quality conditions within Presque Isle Bay are not significantly affected by conditions in Lake Erie (PADER, 1992).

Aquatic habitat conditions in the Bay are relatively good based on the diversity of freshwater habitats observed including shallow water habitat, marshes, ponds, and other types of wetlands (PADER, 1992). Presque Isle Bay also supports a variety of fisheries.

3.1.1 Review of the Remedial Action Plan

Results presented in the Remedial Action Plan were used to assess the relative significance of annual pollution loads from recreational boating activity in comparison to annual loads from other sources. Pollution contributions from a variety of land-based sources were quantified in the RAP. Pollution associated with recreational boating activity, however, was not considered.

As outlined in the RAP, the water quality problems in the Bay were identified with respect to impairments of 3 of 14 specified beneficial uses including:

- Fishery impacts as evidenced by fish tumors. These tumors may be due, in part, to elevated levels of polycyclic aromatic hydrocarbons (PAHs) in the bay;

- Dredging restrictions due to high metals, nutrients, cyanide, oil and grease, volatile solids, and potentially high PAH concentrations in Bay sediments;

- Potential for beach closings due to high fecal coliforms near storm sewer discharge points.

The impairments were linked to pollutants which were identified as pollutants of concern (POCs). Some POCs were monitored during the RAP study period and, despite observed impairments, the monitoring results indicated that State water quality standards and criteria in the Bay as listed in the Pennsylvania Code, Titles 16 and 25, were not violated. Impairments were, therefore, attributed to probable sediment releases and

re-suspension of POCs. The long hydraulic detention time in the Bay promotes the settling of pollutants from the water column to the sediment layer.

Annual loads for the POCs for three land-based sources (point sources, nonpoint sources, and CSOs) were presented in the RAP. In addition, the total volume of pollutants in place in the Bay sediments was estimated. The point sources include permitted industrial and sanitary discharges in the Presque Isle Bay watershed. The nonpoint source loads considered include surface runoff, groundwater infiltration, and air deposition. The annual loads are used in Section 3.4 of this report to determine the relative significance of the recreational boating contribution.

3.2 Impact of Recreational Boating Activity Based on Literature Review

Activities related to recreational boating may impact water quality conditions. The activities which are likely to be the most significant sources of boating-related pollution include the discharge of sanitary waste from boats, boat paints and boat cleaning, and the release of hydrocarbons and fuel additives from boat engines.

3.2.1 Sanitary Waste Discharges

Sanitary waste discharges from boating activities, sewerage overflows, or other sources impact water quality conditions by increasing biochemical oxygen demand (BOD) (Milliken, 1990). BOD is a measure of the amount of dissolved oxygen (DO) required for decomposition of organic matter. In general, as BOD increases, DO levels decrease, and less oxygen is available for aquatic organisms. In extreme cases, this may lead to fish kills. Sanitary wastes may also introduce into the water potentially harmful pathogens which can cause diseases such as hepatitis, typhoid, and cholera (Milliken, 1990).

Sanitary waste discharges are evaluated through measurement of fecal coliforms, a bacteria present in the intestines and feces of all warm-blooded animals. Fecal coliforms are removed from the water column through dilution, die-off, and sedimentation. Dilution depends upon the volume of available water, flushing characteristics, and background concentrations. Die-off of the bacteria is a function of several factors including water temperature and toxicity. Finally, some fecal coliforms will sink to the bottom. These coliforms tend to exhibit longer survival times than those in the overlying water column.

Sewage discharges from boats introduce concentrated, small volumes of waste into the water. Impacts from these wastes tend to be most significant in localized areas where boating activity or mooring occurs. Boat sanitary waste discharges in Presque Isle Bay are regulated under the Federal Water Pollution Control Act, Section 312, and the Commonwealth of Pennsylvania Fishing and Boating Regulations, Section 97.9 and 99.5. These regulations require recreational boats with toilet (or head) facilities to be equipped with approved marine sanitation devices (MSDs). Sanitary waste discharges from boats equipped with flow-through Type I and II MSDs are permitted. Type I and II MSDs chemically disinfect sanitary waste prior to discharge. Discharges from toilets equipped with other types of MSDs and

portable toilets are prohibited. Illegal sanitary waste discharges, however, still may occur.

3.2.2 Boat Painting and Boat Cleaning

Boat painting and boat cleaning are potential sources of metals, solvents, nutrients, and other toxins. Painting is usually conducted in dry storage areas. Topside painting, however, can be performed while the boat is in the water. Cleaning can be conducted both when the boat is in dry-storage or while in the water. Surface water conditions may be impaired when runoff from upland areas, paint releases, and wash water from boats enter the Bay.

Boats are usually painted with anti-fouling paints containing biocides which prevent the growth of fouling organisms on boat bottoms. The most common type of biocide used is copper. Anti- fouling paints are designed to release these chemicals into the surrounding water through ablative action and leaching. Leaching is the release of low levels of biocides over time. Ablative paints are designed to shear off of the boat as it travels, releasing biocides along with the paint.

Both copper and tributlytin (TBT) have been found in some marina waters at levels that are toxic to aquatic organisms other than fouling species (Young, 1974). Dissolved copper was detected at toxic levels in several states, including Maryland (USEPA, 1993) and California (Young, 1974). Toxic levels of TBT have also been observed across the country including Maryland, Washington state, California, and North Carolina (Grovhoug, 1986; NCDEHNR, 1991; USEPA, 1993). Previously, TBT was used in bottom paints. TBT, which is highly toxic, is now regulated by the EPA under the Organotin Antifouling Paint Control Act of 1988. This act prohibits the use of paints containing TBT on non-aluminum boats under 25 meters in length (USEPA, 1993). In addition, all TBT paints must be certified by the U.S. EPA as releasing no more than 4 ug/cm2/day into water (Milliken, 1990). Therefore, it is assumed that TBT is not currently used on recreational boats.

Cleaning activities include boat washing and hull scrubbing. According to the boater survey, 67 percent of the boat cleaning is performed in locations other than the bay (e.g., at home). Most of the boaters surveyed use soap and water although cleaners such as teak cleaner and fiberglass polisher may also be used. Cleaning products may contain ammonia nitrogen, sodium hypo-chlorite, chlorinated solvents, petroleum distillates, and lye, which are toxic to aquatic organisms in high concentrations. Detergents containing phosphates can be a source of phosphorus. Phosphorus and ammonia nitrogen are nutrients and can impact water quality conditions by promoting the growth of algae.

3.2.3 Engine Releases

Most studies on pollution due to engine releases focused on two-stroke outboard engines. Two-stroke engines accomplish fuel intake and exhaust in the same cycle and therefore tend to release unburned gas along with exhaust gases. Outboard engines, which are typically two-stroke engines, release approximately 25 percent of their total petroleum intake to the air

and water. The petroleum intake includes both gasoline and the lubricating oils which are mixed in with the fuel. Inboard engines, which are typically four-stroke engines, are estimated to release approximately 2 percent of their total petroleum intake and are, therefore, considered to be a less significant source of petroleum pollutants (Mele, 1993). However, inboard motors contribute an additional petroleum source which is the discharge of oily water from the bilge.

Approximately 37.5 percent of the petroleum discharged to the air and water by boat engines will remain waterbound (Mele, 1993). The waterbound petroleum will collect at the water surface, dissolve into the water column, or settle to the bottom. Much of the petroleum breaks down into simpler carbon chains and is taken up by aquatic organism and plants. However, the petroleum and the additives in the gasoline that settle to the bottom can persist for several years and potentially become a long-term water quality problem.

Impacts associated with petroleum pollution include odor, off taste in fish, and toxic effects on marine organisms. In urban watersheds, petroleum inputs from boating activity may increase the toxicity of background petroleum concentrations from land-based sources, increasing long-term effects.

3.3 Sampling Study

A limited water quality sampling program was conducted at two marinas in Presque Isle Bay during the 1993 boating season. Sampling was performed to determine concentrations of specific pollutants which are associated with recreational boating activities. The sampling was performed in the marinas where potential water quality impacts from recreational boating may be worse than in open water areas. The results of the sampling effort are presented in Appendix A. The laboratory results and the field sheets which include personnel performing the sampling, calibration records, and other pertinent sampling information are available for review at the Erie County Department of Planning. A map showing the sampling locations is also included with the field sheets.

3.3.1 Methodology

Preliminary sampling locations were selected by Greenhorne & O'Mara and reviewed and approved by the Erie County Department of Planning. Sampling was conducted by personnel from the Pennsylvania State University. The majority of the sampling was conducted at the Bay Harbor Marina and the Presque Isle State Park Marina. However, the first set of samples was collected from the Commodore Perry Yacht Club and Presque Isle State Park Marina. (The Commodore Perry Yacht Club declined to participate in the remainder of the sampling program).

Seven sets of samples were collected through the boating season. The first set of samples was collected on May 17, 1993, prior to the start of the boating season. This sample set was used to assess baseline water quality conditions. The remaining samples were collected on June 14; July 2, 6, and 30; August 2; and September 7, 1993. These samples were collected immediately before and after weekends and holiday weekends and

coincided with the dates of the boater surveys and the boat counts (Section 6.0). These samples were used to assess the relative impact of weekend and holiday boating activity on water quality conditions in Presque Isle Bay.

A variety of field parameters including dissolved oxygen and water temperature were measured at each marina at one foot below the surface (surface measurement) and from one-two feet above the bottom (depth measurement). The dissolved oxygen and temperature measurements were made with a YSI Model 57 oxygen meter which was calibrated in the field. Grab samples were collected at the surface and at depth using an at-depth sampler. A portion of the sample water was poured into polyethylene wide-mouthed jars and tested for pH and conductivity. A Cole-Parmer Model 5941-00 pH meter and a Fisher Model 09-325-360 conductivity meter were used. The pH meter was calibrated each time in the field. However, there were problems with the conductivity meter and therefore, the conductivity measurements are suspect. Secchi depth was also measured at each station with a secchi disk. Observations regarding weather, air temperature, number of docked boats, and water depth were also recorded. The remaining portion of the sample was poured into polyethylene, glass, and amber bottles, as appropriate, and transported to the laboratory for analysis. Preservatives were added to the samples in the field as appropriate. Trip and field blanks were also submitted to the laboratory for analysis. No duplicate samples were used for this analysis.

Laboratory tests were performed by Microbac Laboratory using EPA certified methodologies. The samples were analyzed for a variety of parameters which correspond to pollutants associated with sanitary waste discharges, engine and bilge releases, and boat painting and cleaning. The parameters which were analyzed included:

- fecal coliform (most probable number);
- diesel and gasoline range organics;
- ethylene glycol;
- lead;
- copper;
- tin; and
- surfactants (detergents).

The laboratory results are included in Appendix A. Copies of the original laboratory results are included with the water quality work calculation sheets and are available for review at the Erie County Department of Planning.

3.3.2 Additional Data Sources

Precipitation records for the 72 hours preceding each sampling event were obtained from the National Weather Service report for Erie, Pennsylvania (NWS, 1993). This information is presented in Exhibit 3-1. Sustained periods of rain can lead to the discharge of diluted sanitary wastes from CSOs to surface waters. Runoff from rainfall events may also contain urban nonpoint source pollutants such as oil and sediment. Bay Harbor Marina is located near a CSO discharge point and, therefore, water quality conditions (especially fecal coliform and dissolved oxygen concentrations) may be impacted.

EXHIBIT 3-1

CLIMATE DATA

Date	Rainfall During Preceding 72 Hours (IN)	Rainfall During Sampling Date (IN)
5/17/93	0.02	0.00
6/14/93	0.00	0.00
7/02/93	<0.01	<0.01
7/06/93	0.00	0.00
7/30/93	0.77	0.15
8/02/93	0.15	0.30
9/07/93	0.65	0.00

Source: National Weather Service, 1993

3.3.3 Sampling Results

The sampling results as well as the climate data and the boater survey results were used to draw conclusions about the potential impact of recreational boating activity on water quality in Presque Isle Bay. The sampling data results for selected parameters (i.e., fecal coliform, dissolved oxygen, temperature, surfactants, pH, copper, and lead) were compared to PADER water quality standards and criteria and the percent of samples outside the standards or criteria was calculated for each parameter. The results of this comparison are presented in Exhibit 3-2.

Measured parameters that have no corresponding PADER standard include diesel and gasoline range organics, ethylene glycol, tin, conductivity, and secchi depth. However, the diesel and gasoline range organics, ethylene glycol, and tin measurements were all below detection limits. Therefore, these substances were either not present in the water column or present at concentrations below the detection limit.

Conductivity was not examined due to suspected erroneous readings. The secchi depth readings, which are a measurement of water clarity, indicate that water at the Bay Harbor and Presque Isle State Park marinas was clearer during the early part of the boating season than during the latter part. Decreased clarity may be due to algae, sediment resuspension, storm sewer discharges (Bay Harbor Marina), or boat engine releases. Organic suspended solids (e.g., algal cells) in the water column impact water clarity (NALMS, 1990).

Surfactant concentrations did not violate the PADER water quality standard. In addition, water temperatures were within PADER limits as were lead and copper concentrations.

Exhibit 3-2

Comparison of Sampling Results to Pennsylvania Water Quality Standards and Criteria[1,2]

Parameter	Sampling Results Range of Values	Sampling Results % of Samples Outside Standard	Standard	Notes
fecal coliform	<10 - 5000 MPN/100 ml[5]	46%	<200 MPN/100 ml[3] <5,000 MPN/100 ml[4]	1 or more violations during each sampling event. Most violations occurred at Bay Harbor Marina.
dissolved oxygen	2.4 - 12.3 mg/l	8%	>5 mg/l >4 mg/l	Minimum daily average Minimum Violations (2 events) occurred at PIB State Park Marina, bottom measurements.
MBAS (surfactants)	<0.025 - 0.110 mg/l	0%	<0.5 mg/l	Maximum
water temperature	67.1 - 71.6 ^{0}F 70.7 - 78.4 ^{0}F 73.4 - 75.0 ^{0}F 69.8 - 72.5 ^{0}F	0% 0% 0% 0%	80 ^{0}F 87 ^{0}F 87 ^{0}F 84 ^{0}F	June 1 - 15 July 1 - 31 August 1 - 31 September 1 - 15
pH	6.3 - 8.2 units	19%	7.0 - 9.0 units	Most violations occurred after a weekend or holiday.
copper	<0.002 - 0.012 mg/l	0%	<1 mg/l	Human health criteria
lead	<1 - 14 µg/l	0%	<50 µg/l	Human health criteria

1 Fecal coliform, dissolved oxygen, surfactants, pH, and water temperature standards from Pennsylvania Code, Title 25, Chapter 93.
2 Copper and lead standards from Pennsylvania Code, Title 16.
3 Maximum geometric mean for fecal coliforms based on five consecutive samples, each sample collected on different days, May 1-September 30 (swimming season); Maximum geometric mean for fecal coliforms of 2000 MPN/100 ml for remainder of year.
4 Maximum total coliforms as a monthly average value in central channel as demarcated by U.S. Coast Guard.
5 Fecal coliform sampling results are based on a single count as opposed to a geometric mean.

The PADER limits for copper and lead are based on human health criteria. PADER has also developed aquatic organism health criteria for copper and lead. These criteria are significantly lower than the human health criteria and correspond to pollutant concentrations potentially harmful to aquatic species (PADER, 1992). Some of the observed copper and lead concentrations were above the aquatic organism health criteria, indicating that, although the observed concentrations are not considered harmful to humans, the concentrations are at levels potentially harmful to aquatic organisms. Potential copper and lead sources include resuspension from the sediments, nonpoint source runoff, and CSO discharges. Releases from boat paint are another possible copper source. Lubricating oil mixed in with boat fuel is another possible source of lead. The probable source of the lead and copper in Presque Isle Bay cannot be conclusively identified due to the limitations of the available data.

Fecal coliform, dissolved oxygen, and pH water quality standards were violated in one or both of the marinas during the sampling period. These parameters are discussed in the following sections.

Fecal Coliform

At least one violation of the fecal coliform standard was observed during each sampling event. The majority of the violations were observed at the Bay Harbor Marina and many of these violations occurred after weekends or holidays. It is likely that CSO discharges may also have contributed to fecal coliform levels at the Bay Harbor marina as three of the violations occurred after periods of rainfall. Resuspension of fecal coliforms in the sediment is also a potential cause. Recreational boating activity may have also negatively impacted fecal coliform levels at the Bay Harbor marina.

Fecal coliform does not appear to be a significant problem in the Presque Isle State Park Marina because the fecal coliform standard was exceeded on only two occasions, once during pre-season and once during the early portion of the boating season. The violations are not attributed to CSO discharges because there are no combined sewers into this area. The violations may be from boats. However, violations occurred during periods of low boating activity, and studies conducted by the Erie County Health Department suggest that gull droppings may also contribute to the fecal coliform concentration in the State Park Marina (Wellington, 1993).

According to the RAP, fecal coliform levels in the open bay area do not exceed PADER water quality standards. Therefore, the discharges of sanitary wastes from recreational boats does not appear to be a significant problem in the open Bay. The fecal coliform levels in the open Bay are reduced due to the larger volumes of available dilution water.

Dissolved Oxygen

Dissolved oxygen (DO) is an important indicator of the capability of a body of water to support aquatic life and is used to measure the amount of oxygen available in the water column. PADER water quality standards require DO concentrations to be at or above 4 mg/l at all times. The minimum daily average is 5 mg/l. Bottom DO concentrations at the Presque

Isle State Park marina were below the 4 mg/l limit on two occasions although surface measurements on both occasions were well above the standard. The difference between the surface and bottom measurements is unusual because the marina waters are generally well-mixed and do not usually exhibit stratification (PADER, 1992). The results suggest that DO levels in or near the bottom may have been impacted by either a sediment oxygen demand or a localized BOD source such as decaying vegetation. Sanitary waste discharges were not considered as a potential BOD source because fecal coliform levels were below the detection limit on both occasions.

Based on the sampling data, recreational boating does not appear to significantly impact DO concentrations in Presque Isle Bay.

pH

Minor violations of the pH standard were observed in 19 percent of the sampling events. Most of these violations occurred after periods of sustained rain. All of the violations indicated that the water was slightly acidic. A wide variety of factors can cause low pH measurements including acid rain and industrial pollutants in untreated storm water runoff. The actual cause of the low pH cannot be determined due to the limited data available.

3.4 Pollutant Loads Related to Recreational Boating Activity

Methodologies identified during the literature review and the results of the boat count and boater survey were used to estimate annual load rates (or concentrations) from recreational boating activity for copper, total petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and fecal coliform. Pollutants associated with boat cleaning were not quantified. The boater survey results indicated that most of the boats used at Presque Isle Bay are cleaned at home.

When possible, the estimated annual loads were compared to annual loads in the RAP to assess the relative impact of recreational boating activity on Presque Isle Bay in comparison to the point sources, nonpoint sources, and CSO discharges considered in the RAP. The estimated loads and concentrations are presented in Exhibit 3-3. The Water Quality Work Calculation Sheets which show the load calculations are available for review at the Erie County Department of Planning.

3.4.1 Copper

The annual load was estimated for copper which is used as a biocide in anti-fouling paints. The methodology developed by the Southern California Coastal Water Research Project (Young, 1974) and the results of the boater survey and boat count were used to estimate the annual load.

The annual copper load estimate was based on the following assumptions which were obtained from the boater survey:

- Eight percent of the boats in Presque Isle Bay are painted (including moored and trailered boats);

- The majority of the boats that are painted are painted once a year. The overall percentage of boats painted was prorated to account for the boats that were painted less frequently;

- All of the boats that are painted use anti-fouling paints containing copper;

- The average percent copper by volume was estimated to be 43.1 percent. This value is an average of the percent metallic copper in the antifouling paint brands most commonly reported in the boater survey (e.g., Interlux);

- The average boat length is 20 feet;

- The length of the boating season at Presque Isle Bay is five months.

In addition, because the copper release rate from the paints is not available, it was assumed that all of the copper in the paints was released to the water during the five-month boating season. Anti-fouling paints are specifically designed to release copper (or other biocides) to the surrounding water. A conservative assumption was made that all copper from painted boats is released even though trailered boats (as opposed to moored boats) do not remain in the water throughout the five-month boating season. It is probable that most of the copper in antifouling paints is released during the first few times the boats are placed in the water.

The annual load for copper from recreational boats to Presque Isle Bay was estimated to be 761 lbs/yr. Based on the information in the RAP, recreational boats are the second-most significant source of copper to the Bay. The recreational boat contribution is one third of the nonpoint source contribution (2,500 lbs/yr). However, the estimated copper load is almost three times the CSO contribution (264 lbs/yr).

It is likely that the actual annual copper load from recreational boats to Presque Isle Bay is less than estimated. The estimated copper load was based on the total amount of copper being released in a five-month period. If it is assumed that the release rate of copper is constant and occurs over a twelve-month period (which is the frequency of boat painting), then the estimated copper load would be 5/12's of 761 lbs/year or 316 lbs/yr. Even with this adjustment, recreational boats would remain the second-most significant source of copper to the Bay.

3.4.2 Hydrocarbons

The annual load for petroleum hydrocarbons from recreational boats is based on releases from boat engines. The estimate was based on the following assumptions:

- Two-stroke, outboard engines release approximately 25 percent of their total petroleum intake to the air and water (Mele, 1993);

Exhibit 3-3

Estimated Annual Loads and Concentrations for Pollutants Associated with Recreational Boating

Parameter	Point Sources (lbs/yr)	Combined Sewer Overflows (lbs/yr)	Non-Point Sources (lbs/yr)	Recreational* Boating (lbs/yr)
Copper	<139	264	2,500	761
Total petroleum hydrocarbon	---	---	---	65,100
PAHs	---	<340	---	325

Note: Point source, combined sewer overflow, non-point source, and in-place figures from Remedial Action Plan (PADER 1992).

Parameters	Estimated Concentrations		Standard
Fecal coliform	260 MPN/100 ml	Bay Harbor Marina	<200 MPN/100 ml
	135 MPN/100 ml	Presque Isle State Park Marina	

*These numbers, which are based on the best available data, may vary widely and should not be used to make planning level decisions.

- Two-stroke, inboard engines release approximately 2 percent of their total petroleum intake to the air and water (Mele, 1993);

- Approximately 37.5 percent of the petroleum released from boat engines to the air and water remains waterbound (Mele, 1993);

- Approximately 95 percent of the boats on the Bay are powered (boater survey);

- Powered boats are actively used an average of 23 days per year (boater survey);

- Approximately 70 percent of the boaters operate their boats in the Bay rather than exclusively in Lake Erie; and

- The average fuel consumption during a typical week of boating is 23 gallons.

Using these figures, the annual total petroleum hydrocarbon load from recreational boats to Presque Isle Bay was estimated to be 65,100 lbs/year.

The total petroleum hydrocarbon load was not examined in the RAP. Instead, the RAP focused on a small fraction of hydrocarbons, polycyclic aromatic hydrocarbons (PAHs). PAHs tend to persist in the environment and have been associated with chronic toxic impacts on aquatic organisms (PADER, 1992). PAHs, which are found in refined petroleum products, include compounds such as anthracene and naphthalene and generally account for only a small fraction of the hydrocarbons found in fuel and oils (Mele, 1993).

The PAH content in the fuels and lubricant oils load from recreational boats to Presque Isle Bay was assumed to be 0.5 percent of the total petroleum hydrocarbon load which translates to an annual PAH load of approximately 325 lbs/year (Mele, 1993). This estimate does not take in account fuel consumption patterns related to amount of fuel consumed in the Bay versus amount of fuel consumed in Lake Erie. Therefore, the actual PAH load attributable to recreational boating activity on Presque Isle Bay is probably less than estimated.

In the RAP, only the annual load for PAHs from CSO discharges was developed. Sufficient information was not available to quantify the point and nonpoint source contributions. The CSO discharge rate was estimated to be 340 lbs/year, which is somewhat more than the estimated recreational boating rate. Although the actual PAH load from recreational boating may be less than estimated, in the absence of the point and non-point source rates, recreational boating appears to be a potentially significant contributor of PAHs to the Bay.

3.4.3. Fecal Coliform Concentration

A concentration rather than an annual load was developed for fecal coliform. In comparison to other pollutants, fecal coliform degrades quickly and will not significantly accumulate in the bottom sediments.

Therefore, the concentration of fecal coliform in the water is a more accurate gauge of potential impacts than an annual load.

A daily average fecal coliform concentration was calculated for each of the two marinas monitored during the sampling study using a methodology based on the State of Maryland Marina Assessment Model (Milliken, 1990). The calculations were based on the following:

- the number of slips in each marina;
- an average surface area per boat slip of 900 square feet/slip;
- the average depth in each marina;
- the average number of boats at each marina;
- the average number of occupants per boat (3.2 from boaters survey);
- the average amount of time the boats were occupied each day when in use;
- a sanitary device failure rate of approximately 50 percent;
- a 38 percent occupancy rate; and
- the number of fecal coliforms generated per person per day.

The average surface area per boat slip corresponds to the amount of dilution water available in the boat slip and the marina channels. Using this model, fecal coliform concentration estimates would generally be greatest in small, shallow marinas. Because the channels at Presque Isle State Park Marina are wider than at Bay Harbor Marina, it is likely that more dilution water is available on a per boat slip basis. Therefore, the actual fecal coliform concentration at Presque Isle State Park Marina is probably lower than estimated.

This is a conservative estimate because the total number of boats at the marinas was included in the computations. However, the boater survey results indicated that only 40 percent of the boats at Presque Isle Bay are equipped with marine sanitation devices. Therefore, the assumption that all boats discharge to the water is a worst-case scenario.

The estimated average daily fecal coliform concentrations at Bay Harbor and Presque Isle State Park marinas were estimated to be 260 (MPN)/100 ml and 135 MPN/100 ml, respectively.

The Bay Harbor estimate exceeds the PADER limit of 200 MPN/100 ml. The results suggest that sanitary waste discharges from recreational boats may have an impact on water quality conditions within the Bay Harbor Marina. However, fecal coliform concentrations outside the marinas are probably significantly less. The impact of fecal coliform loads from recreational boats inside a marina rapidly decreases as the distance from the marina increases (Milliken, 1990). In addition, because there is combined sewer outfall at Bay Harbor Marina, CSO discharges probably have a more significant impact on water quality conditions in the Bay Harbor Marina than sanitary waste discharges from recreational boats.

3.5 Summary of Water Quality Impacts Related to Recreational Boating in Presque Isle Bay

The results of the sampling study and the estimates of annual loads (and concentrations) due to recreational boating suggest that recreational boating may impact water quality conditions in Presque Isle Bay. This water quality study is based on available information and cursory water quality sampling. Further investigations should be conducted prior to making planning level decisions. Specifically, the potential impacts include:

- **Total petroleum hydrocarbon and PAH loads from engine releases.** The annual load estimates suggest that recreational boating may be a significant source of PAHs to Presque Isle Bay. Based on the sampling results, however, gasoline and diesel were not detected in the marinas. The total petroleum hydrocarbon and PAHs load may be settling to the bottom of the Bay or evaporating.

- **Fecal coliform from the discharge of sanitary wastes.** The sampling results and the concentration estimates indicated that sanitary discharges from recreational boats may impact fecal coliform concentrations within Bay Harbor Marina. However, CSO discharges probably have a more significant impact at Bay Harbor marina than recreational boats. Fecal coliform levels in the Presque Isle State Park Marina were generally lower than at the Bay Harbor Marina which could be due to the fact that the Presque Isle State Park Marina is larger and deeper and is not adjacent to any CSOs.

- **Copper from anti-fouling boat paints.** During the sampling study, copper was detected at levels which are harmful to some aquatic organisms. Because of the limited amount of water quality data available, recreational boats cannot be identified as the sole source of the observed copper. However, the copper load estimate suggested that recreational boating, specifically releases from anti-fouling paints, may be the second-most significant source of copper to Presque Isle Bay (after the nonpoint source contribution).

3.6 Boat Wake Impact Study

A limited investigation of the effects of boat wakes on the Presque Isle Bay shoreline was performed. This investigation focused on the shoreline in narrow channels and along speed restricted areas. Narrow channels are characterized by high boat frequency and dense boat traffic. Erosion due to boat wakes is common in such areas. In addition, in areas where speed transitions occur due to posted speed limit changes, boats may often operate near their maximum wake energy. This, in turn, may cause shoreline erosion. Shoreline erosion is also impacted by natural wind and wave actions, especially during storm events.

The investigation was conducted by Greenhorne & O'Mara on May 18 and 19, 1993. The investigation included interviews with select individuals familiar with Presque Isle Bay and visual inspection of the Bay shoreline. The persons interviewed included:

- John Mong, Assistant Director, Erie County Department of Planning; and
- Harry Leslie, Park Superintendent, Presque Isle State Park.

Shore erosion due to boat wakes did not appear to be a significant problem in the Bay. This may be attributed to the extensive structural armoring which has been placed along the Bay shoreline including:

- Most of the city-side shoreline (metal bulkhead);
- Shorelines near designated launch facilities in Presque Isle State Park (riprap and metal bulkhead);
- The East and West Piers at the entrance to Marina Lake (metal bulkhead);
- Crystal Point in Misery Bay near Perry's Monument (concrete bulkhead);
- The North and South Pier at the entrance to the Bay (metal bulkhead); and
- The channel wall along the Port of Erie terminal (metal bulkhead);

In addition, "Minimum Wake Within 500 Feet of Shore" signs are posted at most launch sites and at the entrance to Marina Lake. This minimum wake requirement (as opposed to a speed restriction) significantly reduces the potential for shore erosion due to boat wakes.

Only a limited amount of erosion was observed along the Presque Isle Bay shoreline, primarily near the boat dock near Waterworks Park and at Fry's Landing in Misery Bay. These areas are not armored and appeared to have been denuded of protective vegetated cover and may be more susceptible to boat wake erosion. In general, however, areas where heavy or frequent boat traffic occur are protected by a combination of structural and regulatory controls.

4.0 FUTURE ENVIRONMENTAL IMPACTS

An assessment of the potential for adverse environmental impacts related to future recreational boating activities on Presque Isle Bay is a complex task. A set of criteria was used to develop a reasonable build-out scenario for proposed and potential marinas in the Study Area. Numerous assumptions were necessary to estimate a future, high-peak recreational boating day. The anticipated increase in recreational boating needs to be weighed against a historical decline in Erie's industrial base and commerce moving through the Port of Erie. The recommendations for point and nonpoint source pollutant load reductions contained in the RAP, if implemented incrementally over time, would reduce the total loading to the Bay from the Presque Isle Bay watershed and increase the relative impact of pollutant loading associated with recreational boating.

A good understanding of the expected pace of new waterfront development would be useful in evaluating projected recreational boating impacts against the other factors that play an important role in the overall future water quality of Presque Isle Bay. Unfortunately, there is no certain way to predict how long it will take to reach the marina build-out scenario proposed for Presque Isle Bay.

4.1 Assumptions for Projecting Future Impacts

Despite the risks in developing projections for marina build-out and an estimation of future high-peak day usage, it is essential to evaluating carrying capacity issues for Presque Isle Bay. The assessment of future water quality conditions and the evaluation of future boating congestion is based upon these projections. Consideration was given to the boat registration information available from the Pennsylvania Fish and Boat Commission. However, since the data represents registered boats and not the available capacity of facilities on the Bay, and because it doesn't consider the potential for latent demand (people who would boat if more facilities were readily available), a different approach to project future usage was selected. The projections of marina build-out and future high-peak day usage is based on the existing facilities inventory and boater survey information. The inventory shows 2,278 boat slips available for use during the 1993 boating season. Aerial photointerpretation was used to accurately count boats on the Bay during the 1993 boating season, including the 4th of July weekend which represented the high-peak usage day. The aerial boat count identified 668 boats, including 54 special category boats, on Presque Isle Bay during the peak day of this holiday weekend. The weekend was a "special event" weekend during which the Port of Erie hosted a flotilla of "tall ships."

Sections 2.2 and 2.3 describe the methodology and results of the inventory of proposed and potential marinas. The estimate of the future build-out scenario for the Study Area is an additional 2,703 slips of which 574 new slips could be constructed outside of the Presque Isle Bay.

The estimate of the future high-peak usage day was prepared by considering the following sources of additional boats (above the current high peak day): additional trailered boats; proposed marinas in the Bay;

potential marinas in the Bay; potential marinas outside of the Bay (expansion of Lampe Marina); and additional transient boats.

Exhibit 4-1 illustrates how the future high peak usage day was calculated. The calculation assumed a high marina usage rate of 30 percent, which is generous. Marinas during high usage periods generally have usage rates of between 20 and 30 percent. The number of future slips was multiplied by 0.3 to estimate the number of boats that would be on the water. The number of boats was further reduced by a factor of 0.7 to reflect the boats which only transit the Bay to Lake Erie. This factor was determined by results obtained from the boater survey. The anticipated increase in trailered boats was relatively small (55 boats) and reflected minor improvements to the boat ramps around Presque Isle Bay. There did not appear to be a strong likelihood of additional boat ramps with large parking capacity being constructed within the planning period. Increased availability of slips for transient boats was incorporated into the build-out scenario, leading to an additional 50 boats visiting Presque Isle Bay during a future high peak event. Boats leaving Lampe Marina either enter Presque Isle Bay or head directly out to the Lake. The assumption that 50 percent spent a portion of their time in Presque Isle Bay was supported by the boater survey data.

The future high peak day usage calculation shows an additional 622 boats using Presque Isle Bay following completion of the build-out scenario. This addition represents about a doubling of the recreational boating density from the current high peak usage day (Exhibit 4-1). Low usage days would also most likely show about a doubling of the boats using Presque Isle Bay for recreational activities.

4.2 Future Water Quality Conditions

The potential impacts on water quality due to future predicted increases in boating activity were evaluated. Based on the analysis outlined in the previous Section, it is estimated that on peak usage days, the number of boats using Presque Isle Bay for recreation will double. The number of slips in the Study Area could increase by 2,700 or an increase of 133 percent over existing conditions. Future pollutant loads (or concentrations) were estimated for copper, hydrocarbons, and fecal coliforms. A summary of existing versus future conditions loads is included in Exhibit 4-2.

Copper

By doubling the amount of recreational boats, the estimated annual load for copper will also double. As discussed in Section 3.4, recreational boats are predicted to be the second most significant source of copper in the bay for existing conditions due to the leaching of anti-fouling paints into the water. If the number of recreational boaters doubles, over 50 percent of the total predicted copper load to the bay would be generated by recreational boats. This amount of copper may have an impact on the water quality of the bay.

Exhibit 4-1

Future High Peak Day Usage Calculation

	Number of Slips	Number of Boats	High Marina Usage Rate (30%)	Boats Remaining in Bay (70%)
Current Slips				
Presque Isle Bay	2026			
Adjacent Lake Erie Waters	252			
Subtotal	**2278**			
Future Slips				
Presque Isle Bay				
Proposed	792		238	166
Potential	1337		401	281
Subtotal	**2129**		**639**	**447**[2]
Adjacent Lake Erie Waters				
Potential	574		172	86[1,2]
Total Future Slips	**2703**			
Boat Ramps (Trailered Boats)				
Existing		350		245
Future Addition		55		39[2]
Transient Boats				50[2]
Future High Peak Usage				
Current High Peak (July 4, 1993)		614		
Future Contribution		622		
Total High Peak Usage Day		**1236**		

[1]Assume 50 percent of boats from South Shore expansion visit Bay.
[2]Future contribution is sum of numbers shown with Footnote.

Exhibit 4-2

Estimated Annual Loads and Concentrations for Existing and Future Conditions

Parameter	Existing Conditions (lbs/yr)	Future Conditions (lbs/yr)
Copper	761	1540
Total petroleum hydrocarbon	65,100	133,129
PAHs	325	666

Parameter	Existing Concentration	Future Concentration	Location
fecal coliform	260 MPN/100 ml	293 MPN/100 ml	Bay Harbor Marina
	135 MPN/100 ml	175 MPN/100 ml	Presque Isle State Park Marina

However, the sampling results indicate that copper levels in the water column are very low. This observation may be partly attributed to the settlement of copper to the Bay sediments. In addition, the sampling results also indicate that the contribution of copper from recreational boats may not be as significant as the literature suggests. Furthermore, because new anti-fouling paints which do not contain copper are being developed, the estimated annual load for copper from recreational boats will probably be less than indicated by the load computations. Use of new paints which do not contain copper is likely to become more common in the future.

Hydrocarbons

The annual loading estimates for existing conditions indicate that recreational boating is a significant source of PAHs to Presque Isle Bay. Based on future conditions, the predicted contribution of PAHs to the Bay will double. It is likely that these loads will impact aquatic organisms in the Bay. However, a more detailed study of the impacts of hydrocarbons due to recreational boating should be performed to quantify the impacts of hydrocarbons, specifically PAHs which are very toxic, on organisms and on human health.

The majority of the PAH load from recreational boating will probably settle to the bottom of the Bay. As discussed in Section 3.1.1, previous water quality studies conducted in the Bay indicate that PAHs in the water column are not a problem. Instead, it is the PAHs in the bottom sediments which are of concern. When the sediments are disturbed, PAHs are re-introduced into the water column and becomes available for ingestion by aquatic organisms.

Fecal Coliforms

The fecal coliform concentration estimates for existing conditions were computed based on the actual number of boat slips being utilized at Bay Harbor and Presque Isle State Marina. Because there are no expansion plans for these marinas, the estimates for proposed conditions are based on the total number of existing slips at the marinas. The predicted fecal coliform values are 293 MPN/100 ml and 175 MPN/100 ml at Bay Harbor Marina and the Presque Isle State Park Marina, respectively. The value for Presque Isle State Marina is still under the state standards of 200 MPN/100 ml.

However, based on the sampling results, the fecal concentrations were higher than the predicted values. The higher values are due in part to the CSOs, particularly in Bay Harbor. Based on the limited study data, it is not certain whether there will be a large increase in fecal coliform concentrations with an increase in boating activity.

4.3 Projected Shoreline Impacts Associated With Future Boating Activities

The projected shoreline impacts associated with future boating activities will depend, to a great extent, on where the proposed "landside" improvements are located. The shoreline improvements include marinas,

yacht clubs, gas docks, dry-storage, parking facilities, and other recreational boating support services. If the future shoreline improvements follow the build-out scenario developed in this study, the potential adverse environmental impacts associated with shoreline development will be minimized.

There are several reasons for this statement. Many of the criteria utilized in determining potential locations for new recreational boating facilities reflected a sensitivity to the potential adverse environmental impacts associated with constructing and operating marinas. Although not intentional, the analysis lead to a "redevelopment" thrust to future marina siting. The demise of Erie's industrial and commerce based waterfront provides great opportunities for redevelopment which includes increased recreational boating facilities.

Locating future recreational boating facilities elsewhere in the Study Area would have the potential for significant adverse environmental impacts. Much of the undeveloped shoreline west of the Erie waterfront and along the bay shore of Presque Isle is constrained by environmentally sensitive areas. Along much of the shoreline, particularly in areas with steep bluff slopes, new facilities would not be practical. In the easternmost portion of the Bay, new recreational boating facilities would conflict with on-going port-related commerce and industry.

5.0 CARRYING CAPACITY CONCEPTS

This study is one of many that have been concerned with the general issue of maintaining a quality recreation experience in the face of increasing numbers of visitors. Much of this research has focused on the notion of recreational carrying capacity. In 1964, Wagar defined carrying capacity as "the level of recreational use an area can withstand while providing a sustained quality of recreation." Since that time, the concept has evolved considerably and the term carrying capacity has different connotations today than it did 10 or 20 years ago.

5.1 Review of Carrying Capacity Concepts

The evolution of carrying capacity research came about during a period of burgeoning recreational use of natural areas. Literally hundreds of studies have addressed various aspects of carrying capacity in a wide variety of outdoor recreation environments. A number of recent publications provide synopses of this literature (Graefe et al. 1984; Manning 1985; Stankey and Schreyer 1987). The following discussion summarizes the major principles derived from previous research, with particular emphasis on the findings that were instrumental in the design of the current study.

5.1.1 Resource Carrying Capacity

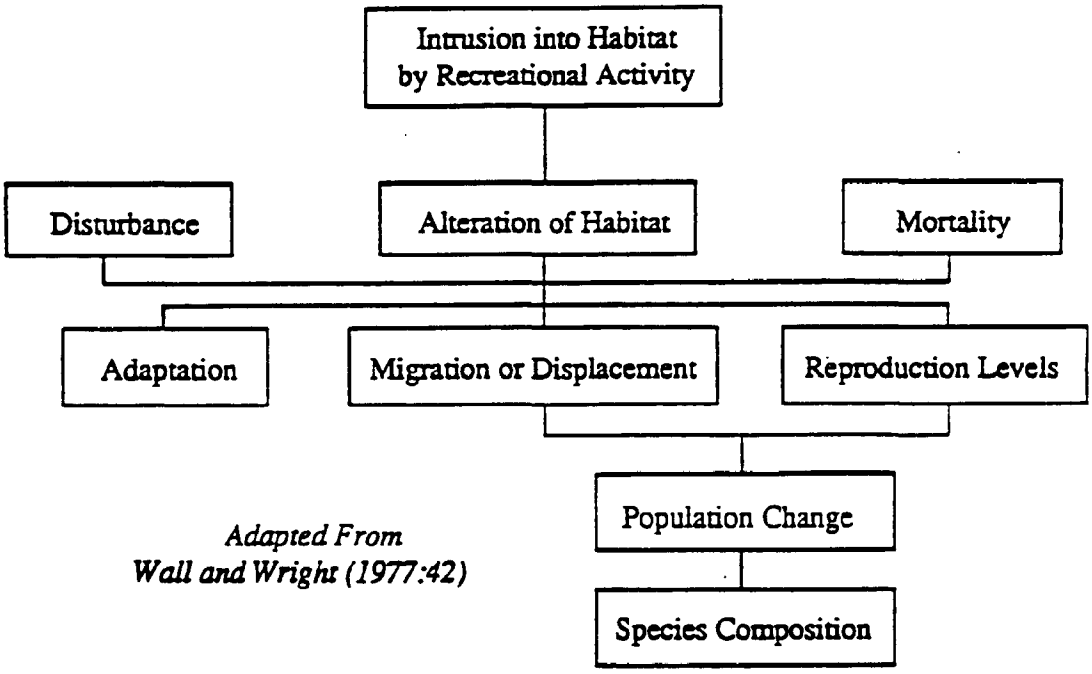
Resource carrying capacity as it relates to the recreation experience has been defined as "The capability of natural resources to withstand use for a desired quality of recreation experience" (Gold 1980). In a broader definition, resource carrying capacity is the level of use a resource can sustain without irreversible degradation. Recreational resource managers are tasked with two goals; 1) to provide a recreational experience that meets the needs of the user, and 2) to protect the resources in a manner that does not allow degradation. Some of the natural resources in the Presque Isle Bay area, particularly in the State Park, are sensitive to the potential impact of the user. Therefore, even though the resource manager must consider both goals, it is expected that the resource capacity will be the most constraining to use.

Resource capacity is a function of the ecological character of the resource, whether a site or a larger system like the Bay. When trying to determine resource capacity, the interrelations among systems which make up the natural environment must be reflected (Exhibit 5-1). Given the complexity of environmental systems, environmental effects (which determine capacity) tend to occur in complex webs. Sometimes several effects can result from a single disturbance; in other instances, a number of separate activities may result in a single effect. The complexity of this web is the greatest limitation to determining a resource capacity (Rogers & Golden 1977).

While this study has considered the potential impacts of recreational boating on Presque Isle Bay, there are numerous other contributors that were not studied. What is known is that the recreational (social) carrying capacity of the Bay has not been reached. For some pollutants it appears

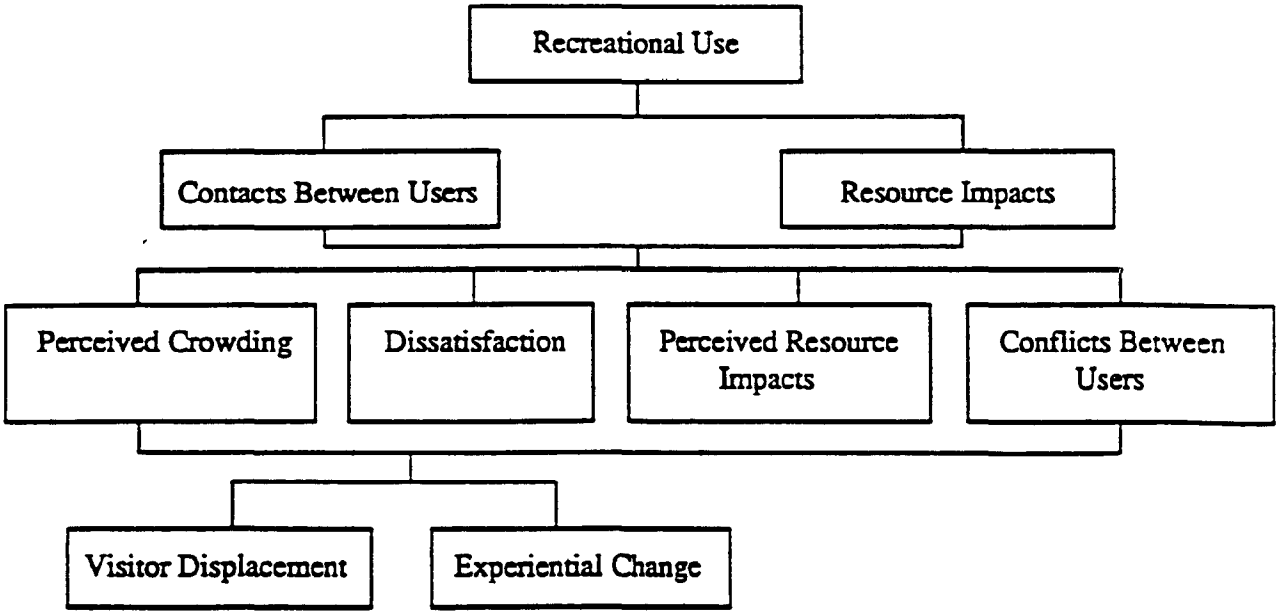
Exhibit 5-1

Ecological Impacts of Recreation



Adapted From Wall and Wright (1977:42)

Social Impacts of Increasing Recreational Use



that boating is a notable contributor to the Bay, however, overall the relative impact of recreational boating on the Bay is minor. There are also numerous other activities which have an impact on the resource capacity, such as land development, port operations (eg. maintenance dredging), road construction, sewer outfalls, and industrial operations. These activities, and there relative impact to the resources of the Presque Isle Bay area are unknown, and would require extensive testing to be determined.

Given the complexity of the resource carrying capacity issue, carrying capacity is most appropriately viewed as a management concept or tool, a means toward the end of providing a certain type or quality of experience. The concern with "finding the carrying capacity" is being replaced with an emphasis on identifying and maintaining the conditions that will produce the desired outcome (see Section 5.2).

5.1.2 Impacts to the Recreation Experience

Evaluating the capacity of a given area for recreation involves a wide range of variables that may influence the quality of the outdoor recreation experience. One of the major conclusions that can be derived from previous relevant research is that there is no single predictable response of visitors to varying use levels. Rather, visitors are affected by a series of interrelated impacts which result from recreational use of a given area (Exhibit 5-1). Recreational use leads most directly to tangible outcomes like contacts between visitors and impacts on the natural environment. These social and environmental impacts in turn can lead to a variety of perceptual and behavioral responses by visitors.

It is helpful to view the various items shown in Exhibit 5-1 as potential impacts to the recreation experience, and to recognize that several sequential levels of impacts may occur. First order impacts (contacts between users and resource impacts) may contribute to any combination of impacts within the next level (i.e., perceived crowding, dissatisfaction, perceived resource impacts, and conflicts between users). But not all of these impacts will necessarily occur in all situations. When they do occur, the various impacts may tend to reinforce each other. For example, a person may feel more crowded if he/she perceives the environment to be degraded or experiences conflicts with other visitors (Stankey and Schreyer 1987). On the other hand, some forms of impact may act to offset or cancel out other impacts. The perception of crowding may be reduced, for example, if a person responds by moving to a different environment (displacement) or by changing his or her perceptions of the experience (experiential change).

Capacity-related studies like this investigation of Presque Isle Bay need to consider all of these potential impacts to the recreation experience. Accordingly, indicators were developed to measure each type of impact. The indicators used represent state-of-the-art measures developed from previous studies.

Satisfaction

Researchers and managers alike have often maintained that the goal of recreation management is to maximize user satisfaction (Lucas and Stankey 1974). Studies of visitor satisfaction have consistently reaffirmed several major conclusions: (1) Most visitors to outdoor recreation areas report relatively high satisfaction levels (Heberlein and Shelby 1977). Schreyer (1979) suggests that recreationists are basically out to have a good time and are often able to achieve a satisfying experience by shifting their perceptions, priorities or behaviors. (2) Satisfaction is influenced by a variety of situational and subjective factors (Hendee 1974; Graefe and Fedler 1986). It typically is not strongly related to visitor density levels (Graefe et al. 1984). (3) Overall satisfaction can be measured in various ways. Recent studies suggest that multiple-item indices provide more sensitive and reliable measures than single item indicators (Vaske et al., 1986; Graefe and Fedler, 1986).

Crowding

It is widely recognized that there is a distinct difference between density and crowding (Stokols, 1972). Density refers to the number or concentration of people in a given area, while crowding is the negative evaluation of a certain density, a value judgment that there are too many people. Thus, whether or not an area is crowded is a subjective judgment of an individual, not an objective fact. Numerous studies lend support to a traditional crowding model in which use levels influence the numbers of contacts between individuals, which in turn lead to perceptions of crowding (Graefe et al. 1984). These same investigations found that the relationship between density and crowding is mediated by a variety of variables, such as visitors' expectations, preferences and prior experience. Most importantly, crowding perceptions vary depending on the types of behaviors encountered and the location of encounters with other visitors. Thus, questions about crowding need to be phrased with reference to particular points during the overall experience.

Conflict

Recreational conflict has been defined as a special case of user dissatisfaction in which visitors attribute the cause of goal interference to the behavior of other individuals (Jacob and Schreyer 1980). Most previous studies of conflict have focused on asymmetrical relationships between different activity groups, especially between participants using motorized and non-motorized means of transportation (Adelman et al., 1982). Conflicts within a given activity like boating can also arise when visitors with different expectations and norms interact with each other. Conflict was represented in this study with several questions probing boaters' reactions to certain behaviors practiced by other boaters.

Displacement

A shift in behavior patterns in response to changes occurring in the environment has been called recreational displacement (Becker, 1981; Schreyer 1979). Behavioral changes may involve simply revising the pattern of participation within a given area. In the most extreme form of

displacement, people who are most sensitive to user density may stop visiting an area entirely as a result of conditions they have encountered there. These displaced visitors presumably seek out an alternate setting with lower use levels. It is difficult to document this latter type of displacement because most studies take place in the field and include only the current users of a given area. This study was no exception, but several indicators of various types of displacement were incorporated into the study questionnaire. These included modifications in the time, place and activity participation of Presque Isle Bay boaters. In addition, a hypothetical question asked boaters if they would have come to the lake if they knew what the conditions would be like that day.

5.1.3 Use/Impact Relationships

Shelby and Heberlein (1987) stated that carrying capacities can be determined only when the relationships between use levels and relevant indicators of experiential quality are known. This principle is the major premise underlying the overall study design used in this investigation. Meeting this condition required a sampling design that would allow visitor perceptions to be examined in relation to boat use levels and patterns. Thus, the measurement of use levels and the visitor survey were both implemented on the same sampling schedule.

Previous studies demonstrate that the relationships between visitor use levels and impacts to the experience are complex and mediated by a variety of background and situational factors. Impacts to the outdoor recreation experience are, by definition, a consequence of recreational use, but the strength and nature of the relationship vary widely for different types of impacts. For example, numerous studies have challenged the fundamental hypothesis that increased density would reduce visitors' overall satisfaction (Graefe et al. 1984). Instead, studies have shown that the amount of use affects the quality of the experience differently for different people. In this particular study, satisfaction levels were highest on the highest use holiday weekend, suggesting that factors other than density levels are more important determinants of satisfaction at Presque Isle Bay.

One of the most important factors affecting use/impact relationships is the inherent variation in tolerance among individuals and user groups. Put simply, all people do not respond the same way to encounters with other visitors. How people respond to other visitors varies for participants in different activities and depends on many different background characteristics, such as previous experience, motivations, and attitudes (Stankey and McCool, 1984; Wagar, 1964). Manning (1985) suggests, for example, that experience affects crowding perceptions and norms either through refinement of tastes or by virtue of exposure to lower density conditions during earlier participation.

In sum, the relationships between use levels and various impacts to the experience are neither simple nor uniform. Yet understanding these relationships is fundamental for managing the recreation experience. This study includes a full examination of such relationships at Presque Isle Bay.

5.2 Evolving Frameworks for Management

There is generally consensus in the literature that carrying capacity is most appropriately viewed as a management concept or tool, a means toward the end of providing a certain type or quality of experience. The initial concern with "finding the carrying capacity" is gradually being replaced with an emphasis on identifying and maintaining the conditions that will produce the desired quality experiences. Current management frameworks like the Limits of Acceptable Change (Stankey et al. 1985) and Visitor Impact Management (Graefe et al. 1990) address the concerns that originated in the carrying capacity concept, yet barely mention the term, carrying capacity.

Current management models are built on the recognition that any effective management strategy involves both scientific and evaluative (judgmental) components (Shelby and Heberlein 1987). The scientific component focuses on documenting the relationships within the system and thereby provides the data needed to predict the impacts of different planning/development alternatives. The evaluative component is concerned with the desirability or acceptability of the impacts associated with various alternatives.

Exhibit 5-2 presents one framework that has been developed for managing the impacts associated with increasing recreational use (Visitor Impact Management). This framework was derived from an extensive review of the literature and is conceptually similar to the Limits of Acceptable Change process that was developed for the U.S. Forest Service. The VIM process includes an eight-step sequence for assessing and managing recreation impacts. The steps in this process are designed to facilitate dealing with three basic issues inherent to impact management: (1) the identification of problem conditions or unacceptable impacts (steps 1 through 5); (2) the determination of potential causal factors influencing the occurrence and severity of the current impacts; and (3) the selection of potential management strategies for ameliorating unacceptable impact conditions. The data collected in this study were designed to provide inputs at various decision points in this type of management framework.

An important outcome of this study, then, is the documentation of existing conditions at Presque Isle Bay and the relationships between these conditions and peak use boat densities. This information provides a basis for: (1) evaluation of the acceptability of current conditions, (2) identification of management actions designed to improve current conditions, (3) evaluation of the probable impacts of various potential options for further facility development and expansion, and (4) development of procedures for monitoring the quality of boating at Presque Isle Bay in the future.

Exhibit 5-2

VISITOR IMPACT MANAGEMENT/PLANNING PROCESS

BASIC APPROACH–Systematic process for identification of impact problems, their causes, and effective management strategies for reduction of visitor impacts

CONDITIONS FOR USE–Integrated with other planning frameworks or as management tool for localized impact problems.

STEPS IN PROCESS

1 Preassessment Data Base Review

Review of legislative and policy direction, previous research and area data base.

Product: Summary of existing situation

2 Review of Management Objectives

Review existing objectives for consistency with legislative mandate and policy direction. Specify visitor experience and resource management objectives.

Product: Clear statement of specific area objectives

e.g., maintain natural vegetation in riparian zones.

3 Selection of Key Impact Indicators

Identify measurable social and ecological variables. Select for examination those most pertinent to area management objectives.

Product: List of indicators and units of measurement.

e.g., loss of vegatation/% of ground cover

4 Selection of Standards for Key Impact Indicators

Restatement of management objectives in terms of desired conditions for selected impact indicators.

Product: Quantitative statements of desired conditions

e.g., no more than 30% vegetation loss at specified site

5 Comparison of Standards and Existing Conditions

Field assessment of social and ecological impact indicators.

Product: Determination of consistency or discrepancy with selected standards

Discrepancy

No Discrepancy

Monitoring

6 Identify Probable Causes of Impacts

Examine use patterns and other potential factors affecting occurrence and severity of unacceptable impacts.

Product: Description of causal factors for management attention.

7 Identify Management Strategies

Examine full range of direct and indirect management strategies dealing with probable causes of visitor impacts.

Product: Matrix of alternative management strategies

8 Implementation

Monitoring

6.0 BOATER SURVEY RESULTS

This component of the study focused on documenting peak boating use patterns and their effects on boating quality at Presque Isle Bay during the summer 1993 boating season. Emphasis was placed on developing indicators of boating use levels and boaters' perceptions of and reactions to the boat densities they encountered.

The boater survey was designed to examine the relationships between boating densities during peak use periods and boaters' evaluations of the conditions resulting from these density levels. User surveys were conducted to obtain a description of bay users, including their characteristics, activities, and perceptions of the boating experience. The boater survey also obtained measures of boating use levels and patterns which were needed for the examination of the relationships described above.

6.1 Methodology

Several types of data were collected to meet the objectives of this study. Boat use levels were measured through aerial photography, counts of boating traffic at two locations (the channel to Lake Erie and the channel to Marina Lake), and counts of the numbers of vehicles and boat trailers parked at selected access points on the bay. User perceptions of their experiences were obtained through exit interviews with 479 boaters sampled at major boat ramps and marinas on the bay. Both the measurement of boat density and the visitor surveys were implemented on ten sampling days during the summer of 1993 (aerial photography was conducted on only four of these sampling days).

6.1.1 Sampling Design

The overall goal of the sampling design was to represent the varying levels of peak use and patterns of activity that occur on Presque Isle Bay throughout the summer. Four weekends were selected as sampling periods, including two holiday weekends (June 12 & 13, July 3 & 4, July 31 & August 1, and September 5 & 6). Boater surveys were implemented on both Saturday and Sunday during each of these sampled weekends (Sunday and Monday for the Labor Day holiday weekend). In addition, two weekdays were sampled to provide a base of comparison to weekend peak use levels. One of the sampled weekdays resulted in zero interviews completed due to inclement weather. Exhibit 6-1 shows the locations for the Boater Survey Sample.

6.1.2 Parking Lot Counts

On each sampling day, personnel stationed at selected access points made periodic counts of the numbers of vehicles, boat trailers, and vehicle/trailer combinations parked at the site (Exhibit 6-1). Counts were made at approximate two-hour intervals throughout each sampling day. The counts were made at eight specified locations surrounding the bay (four along the Erie Bayfront and four within the State Park). Thus, they do not represent measures of total boat use, but rather should be viewed as indicators of boating density levels. Boaters gaining access to the lake at other private marinas and other smaller boat ramps and those entering the Bay from Lake Erie are not represented in these counts.

Exhibit 6-1 SUMMARY OF BOATER SURVEY SAMPLE

STUDY LOCATION	PERCENT OF INTERVIEWS	PERCENT OF PEAK USE COUNTS
Erie Bayfront Sites		
Lampe Ramp/Marina	16%	28%
East Avenue Ramp	12%	9%
Perry's Landing	16%	0%
Erie Yacht Club	3%	0%
Dobbin's Landing	3%	0%
Chestnut Street Ramp	0%	5%
Bay Harbor Ramp	0%	3%
Erie Bayfront Subtotal	50%	45%
State Park Sites		
West Pier (Marina) Ramp	17%	16%
Marina	14%	28%
Niagara Ramp	15%	8%
Lagoon Ramp	3%	0%
Beach 9	1%	0%
Vista Ramp	0%	3%
State Park Subtotal	50%	55%

6.1.3 Boat Channel Counts

On these same sampling days, field personnel counted the number of boats passing through the main channel between Presque Isle Bay and Lake Erie as well as the channel from Presque Isle Bay to Marina Lake within Presque Isle State Park. The number of boats passing in each direction was tabulated in fifteen-minute intervals. At the main channel to Lake Erie, these counts were made continuously throughout the day for eight to ten hours with varying starting and stopping times. At the Marina Lake channel, selected fifteen-minute intervals were sampled throughout each day. Beginning with the July 4th sampling, separate counts were made for the following categories of boats passing in either direction: power boats, sail boats, personal watercraft, and "other" boats.

6.1.4 Aerial Photography

Aerial photographs were an integral component of the visitor survey and provided a measure of the actual numbers of boats on the bay and at selected locations at certain points in time. Aerial photographs of the bay surface were taken on one day within each of the four sampling weekends. The day selected was intended to represent the peak day of that weekend based on weather forecasts. The overflights were flown between 1:00 to 2:00 P.M.

Photo missions were flown on June 12, July 4, July 31, and September 5. The photography was taken at a flying height of approximately 6000 feet, which yielded a photo scale of one inch to one thousand feet. This scale of photography is appropriate for identifying different types of boats. Bausch and Lomb Stereo Zoom Transfer Scopes (ZTS) were used to complete the transfer of interpreted data, a process which results in a highly accurate cartographic product. The ZTS facilitates the transfer process by superimposing the imagery onto the basemap optically, thus allowing for an accurate plot of the boats' position and type on to the 200-scale and 400- scale orthophoto basemaps.

The boats were identified and counted into six different categories: (1) moving power boats, (2) stationary power boats, (3) sailboats, (4) boats moored along the shoreline, (5) waterskiers (identifying waterskiers by photointerpretation was not successful and this category was dropped to avoid any undercounting), (6) special category boats (e.g., jet skis, canoes). The boat's position and direction of travel were plotted onto the working basemaps, with a different symbol representing each different category.

The number of boats and types of boats which were docked at all of the marinas and boat launch facilities in the Presque Isle Bay were also counted. Exhibit 6-2 presents the results of the photointerpretation boat counts for the four weekends sampled. The table illustrates the seasonal progression very well: early in the season, the total number of boats is lowest and many boats are drydocked; and, as the season progresses the total number of boats identified increases steadily and then begins to taper off towards Labor Day. The July 4th weekend was clearly the high peak usage day for the 1993 boating season.

EXHIBIT 6-2 AERIAL PHOTOINTERPRETATION BOAT COUNTS IN PRESQUE ISLE BAY

Boats in Presque Isle Bay	June 12	July 4	July 31	Sept 5
Moving Power Boats	107	200	84	101
Stationary Power Boats	132	314	158	191
Sailboats	43	68	51	67
Moored Boats	42	32	15	3
Special Category Boats*	9	54**	20	23
Total Boats in Presque Isle Bay	**333**	**668**	**328**	**385**
Boats in Marina Slips or Docked (in Water)				
Power Boats	1175	1237	1490	1451
Sail Boats	301	298	344	350
Special Category Boats	16	24	12	10
Total Boats Docked	**1492**	**1559**	**1846**	**1811**
Dry Storage at Marina/Yacht Club/Boat Ramp				
Power Boats	88	52	46	17
Sailboats	49	37	32	13
Total Boats in Dry Storage	**137**	**89**	**78**	**30**
Grand Total of Boats Identified	**1962**	**2316**	**2252**	**2226**

* includes canoes, jet skis, pontoon boats
** does not include 6 Tall Ships

6.1.5 Personal Interviews

User characteristics, perceptions, and opinions were measured through on-site interviews conducted at major access points surrounding Presque Isle Bay. Interviews were conducted by a team of trained interviewers, all of whom were graduate students at Penn State University. Interviews were completed on nine of the ten sampled days (no interviews were conducted on July 30 because no boaters were available due to very inclement weather). Sites sampled included twelve different locations surrounding the bay (see Exhibit 6-1). Sampling at each of these sites was rotated throughout the survey season; not all sites were sampled each day. The number of interviewers working each day ranged from five to seven. Half of the interviews were completed at sites within Presque Isle State Park and the other half were conducted at sites along the Erie Bayfront.

The on-site survey questionnaire was patterned after similar previous studies and was designed to measure a complete set of potential impacts to the quality of the recreational boating experience, as well as boaters' general characteristics and activity patterns. Boaters were interviewed as they were exiting the bay or lake (in some cases boaters sampled at marinas may not have completed their boating for the day, but all had been out on the water prior to the interview). One of the persons within the boating party was randomly selected (if willing) to answer the survey questions. People contacted later in the summer who had already completed the survey on a previous occasion were not asked to respond to the survey more than one time.

6.2 Survey Results

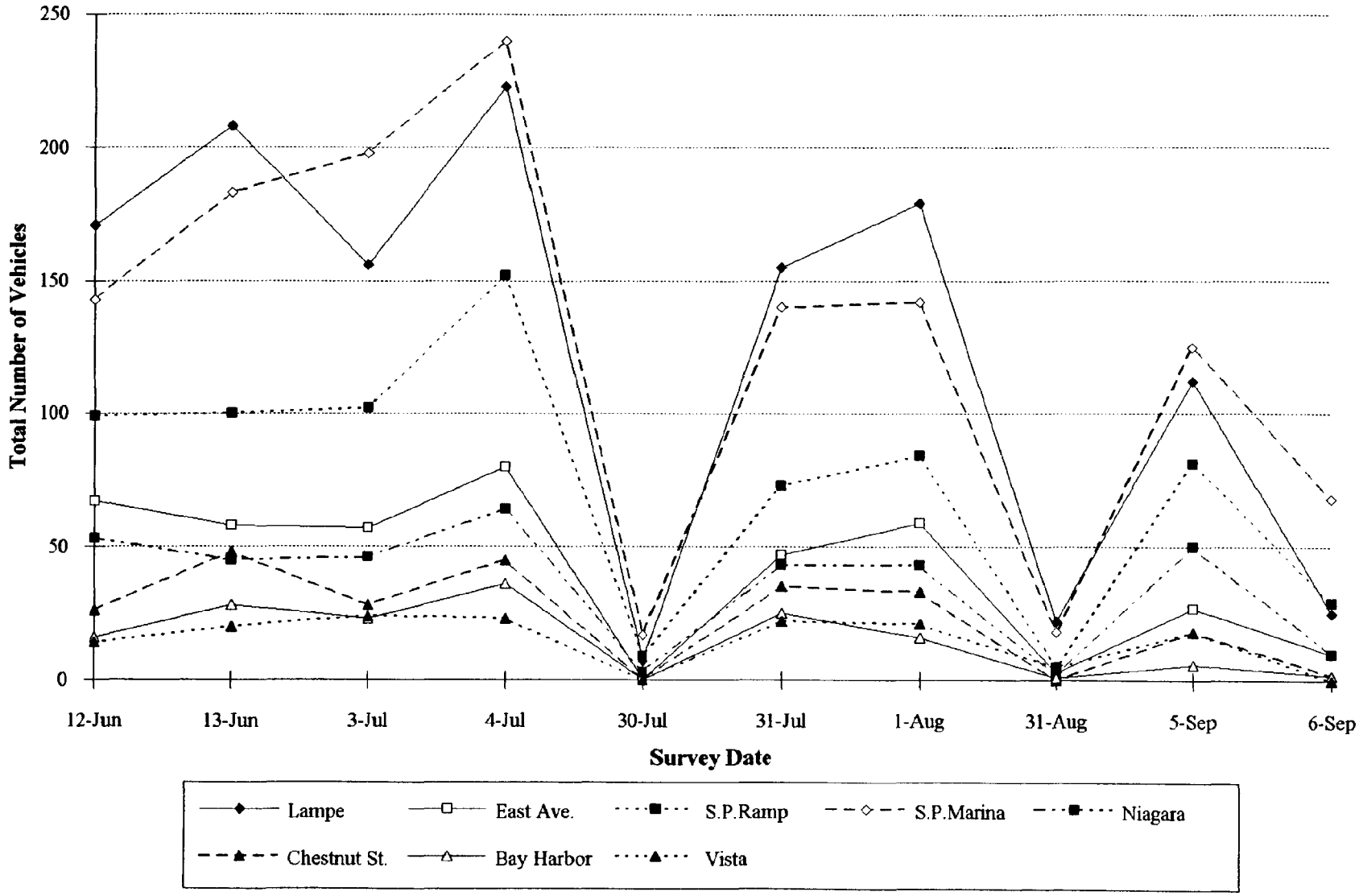
6.2.1 Boat Use Patterns

Boat density levels followed a consistent pattern for the ten days they were observed (Exhibit 6-3). The highest vehicle counts were made at the two large marinas included among the sampling sites (Lampe and Presque Isle State Park) and reflect the large vehicle parking lots available at these sites. Each of these sites accounted for 28 percent of the total number of vehicles counted at all eight sites.

For each of the sampled weekends, Sunday peak use levels were higher than the numbers counted for the corresponding Saturday. The boat densities observed on July 4th probably represent the peak use level occurring during 1993, since this day was the stereotypical holiday Sunday with ideal boating weather conditions. Likewise, the low counts recorded on July 30 probably represent the lowest boating density for the entire summer since this day was particularly cold, windy, and rainy. The lower use levels recorded for the final sampling weekend probably reflect the beginning of a normal tailing off of boating activity toward the end of the boating season, coupled with less favorable weather conditions over the Labor Day weekend.

Peak use levels during the day were typically recorded between 2:00 and 4:00 P.M., and then declined as the day went on (Exhibits 6-4 and 6-5). The 7:00 to 8:00 P.M counts were relatively similar to the counts made at noon on any given day. The pattern observed on July 4th showed more

Exhibit 6-3
Summary of Peak Parking Lot Counts- 2:00PM



**Note: Diamonds are high use areas, squares are medium use areas, and triangles are low use areas.*

consistency across all sampling sites (see Exhibit 6-3), whereas the pattern on June 12th revealed a notable difference in boating activity at the East Avenue ramp (Exhibit 6-4). At the East Avenue ramp on June 12th, the peak number of vehicles counted was during the earliest count (9:30 A.M.), which is probably a reflection of the popularity of this particular ramp among Lake Erie anglers who were more likely to be out on the water at this time of day.

Exhibits 6-6 and 6-7 demonstrate the daily pattern of boating activity across sampling days for two particular access areas, Lampe Ramp/Marina and the Presque Isle State Park Ramp. These figures further illustrate the popularity of boating on Sundays as well as the wide range of boating densities found even within summer weekends. The pattern throughout the day remained quite consistent with patterns at other locations in that the density levels varied widely. One notable exception (the drop-off in numbers between 11:00 and 12:00 at both locations on September 6) was due to a change in weather conditions, which started partly cloudy and changed to rain around 11:00 which continued for the rest of the day and curtailed the expected boating activity on this Labor Day holiday this year.

Results of the counts of boat traffic through the main channel between Presque Isle Bay and Lake Erie show a similar pattern across sampling days (Exhibit 6-8). Traffic on the 4th of July was noticeably higher than traffic on other weekend days. Peak traffic levels are slightly earlier than they appear because data shown in the figure are the average for each one-hour increment and are assigned to the endpoint of that sampling period.

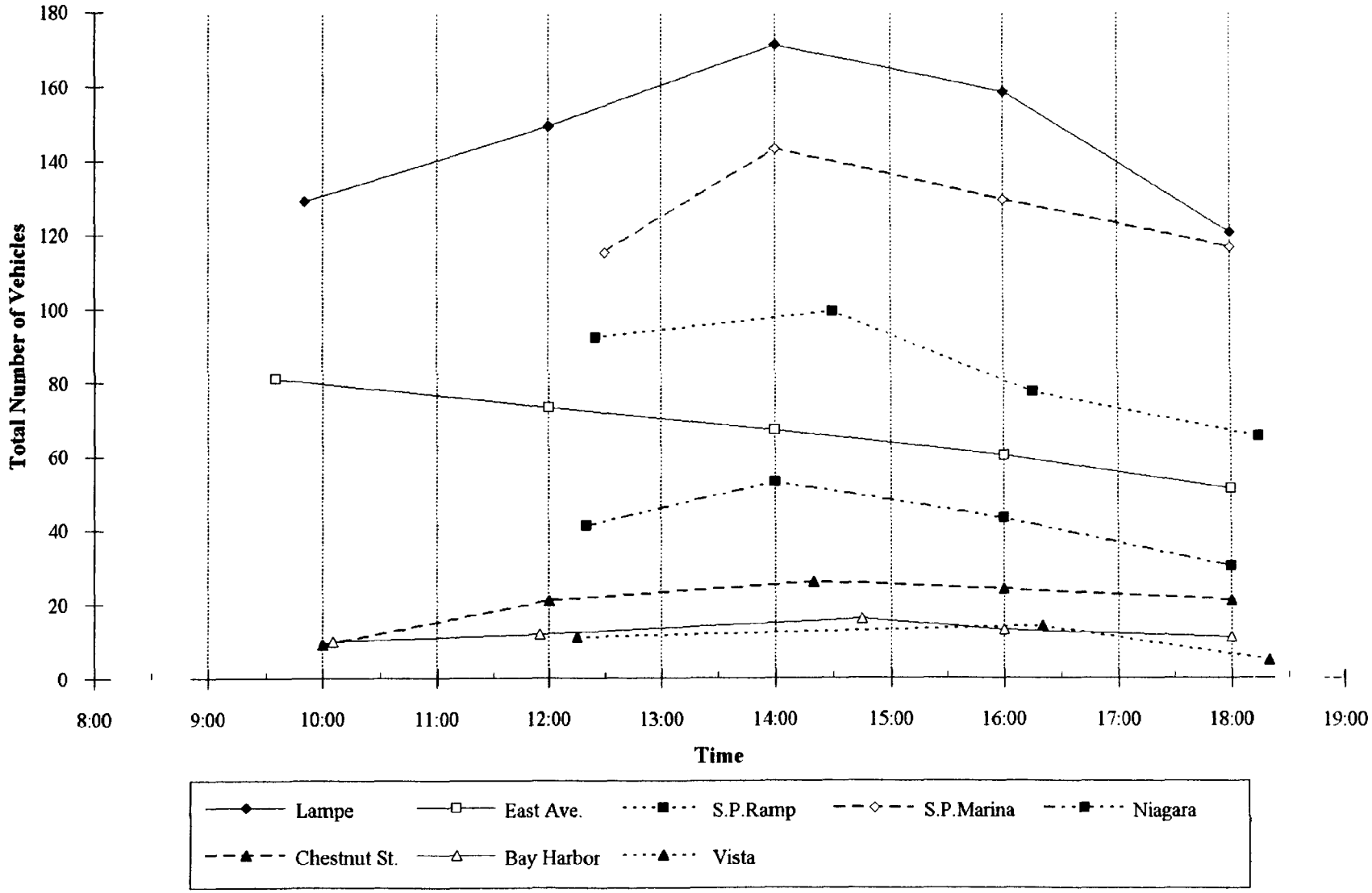
Exhibits 6-9 and 6-10 depict the daily pattern of boat traffic in the main channel on two sampling days, July 3rd and 4th. As one would expect, traffic on July 3rd was light prior to 10:00 A.M., reached a peak level around noon, and remained at that level until late afternoon. Boat traffic earlier in the day was more likely to be going from the bay out to the lake, and in the evening this pattern shifted such that more boats were coming in off the lake. During the middle part of the day, the number of boats traveling in either direction was roughly equivalent.

Channel boat traffic patterns on July 4th showed a similar pattern (Exhibit 6-10), although the numbers of boats counted per fifteen-minute interval were much higher. Exhibit 6-10 also graphically depicts the dominance of power boats versus sail boats, personal watercraft (jet skis), and other boat types within the channel.

Exhibit 6-11 presents a summary of the four methods used in this study for measuring boating use levels on Presque Isle Bay. The four methods showed a high degree of consistency across the sampling days. The total numbers of vehicles counted across all eight counting locations in the middle of the afternoon ranged from a low of 56 on August 31 (a Tuesday) to 863 on the 4th of July. The number of vehicles counted on other weekend days was relatively consistent throughout the summer. Likewise, aerial photography found a peak of 668 boats on the bay on July 4th versus between 300 and 400 on each of the other sampled weekends. Similarly, boat counts in the main channel showed a peak of about 300 boats per hour (converted from fifteen-minute intervals in order to show up more clearly on the scale

Exhibit 6-4

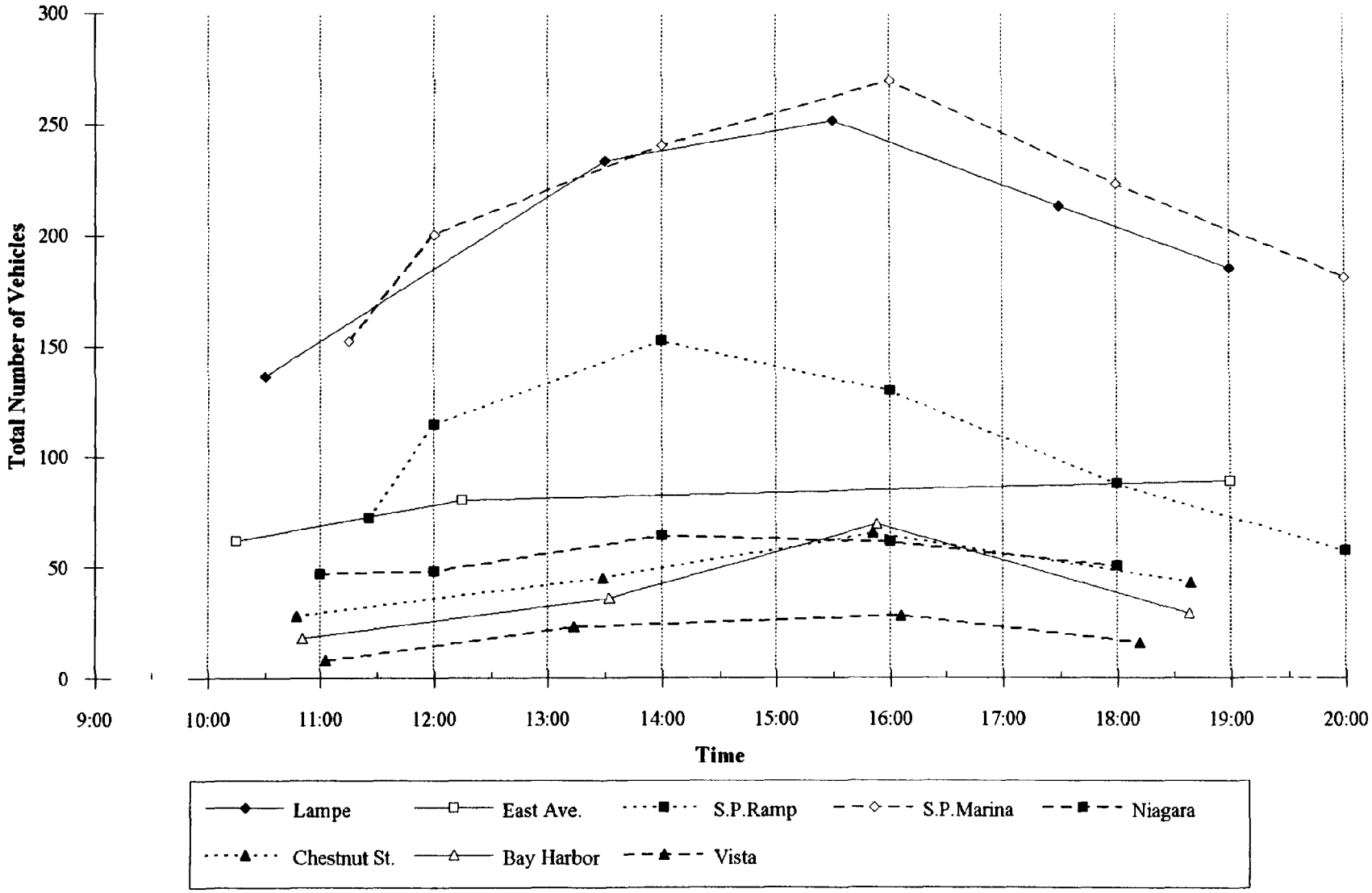
Daily Parking Lot Counts - June 12, 1993 (Sat)



**Note: Diamonds are high use areas, squares are medium use areas and triangle are low use areas*

Exhibit 6-5

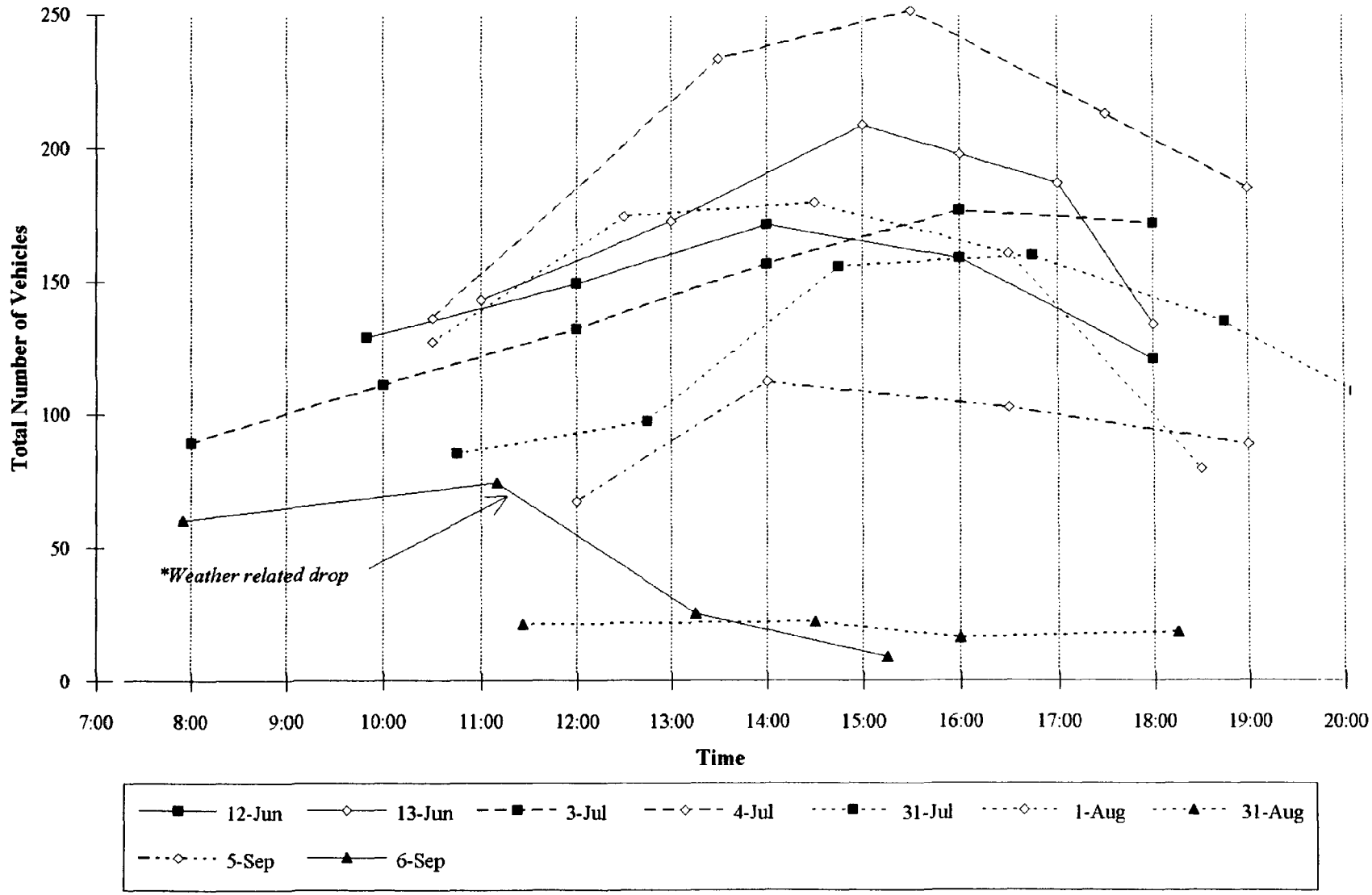
Daily Parking Lot Counts - July 4, 1993 (Sun)



**Note: Diamonds are high use areas, squares are medium use areas and triangles are low use areas*

Exhibit 6-6

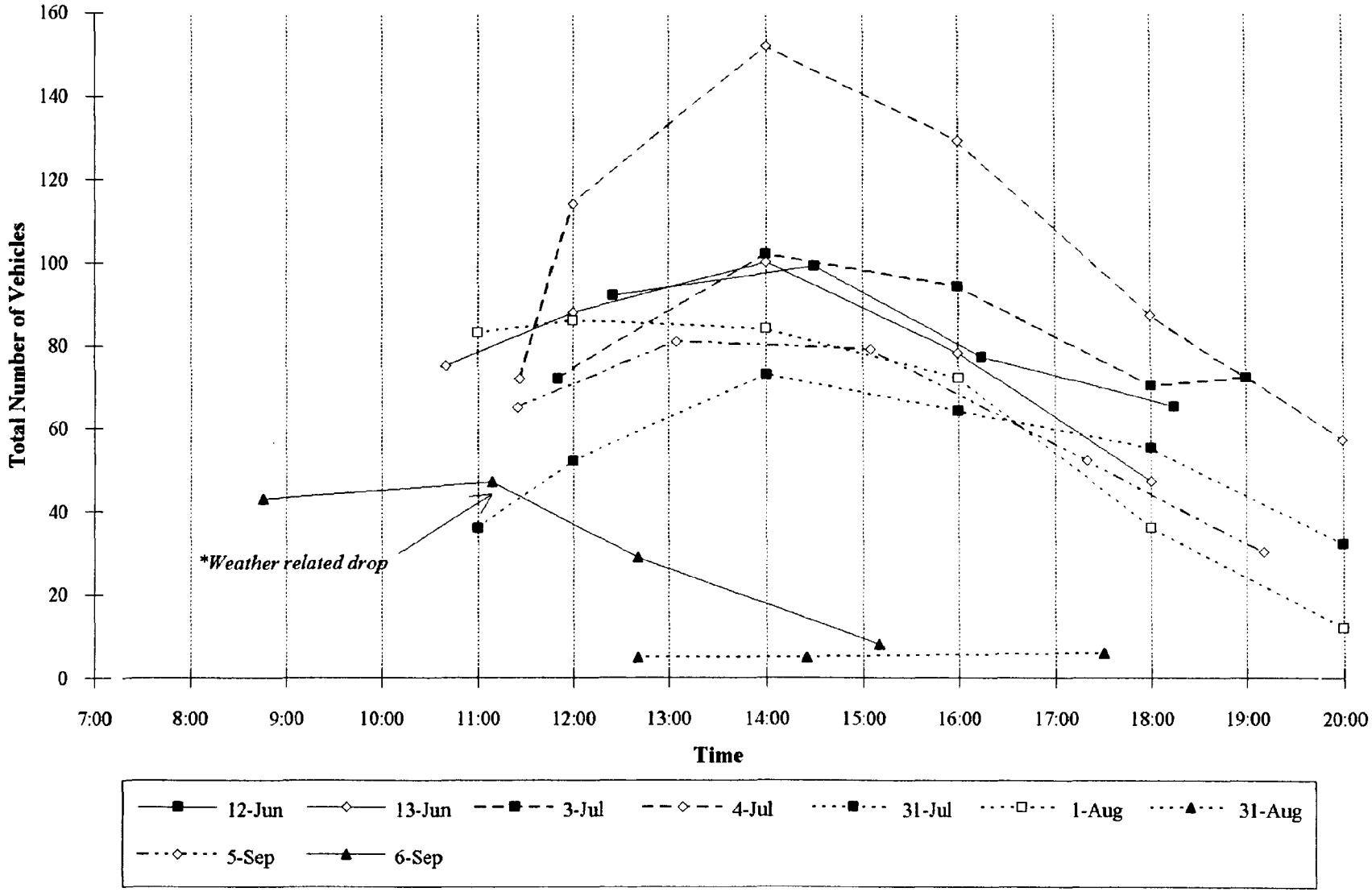
Parking Lot Counts - Lampe Ramp & Marina



**Note: Squares are Saturdays, diamonds are Sundays, and triangles are weekdays.*

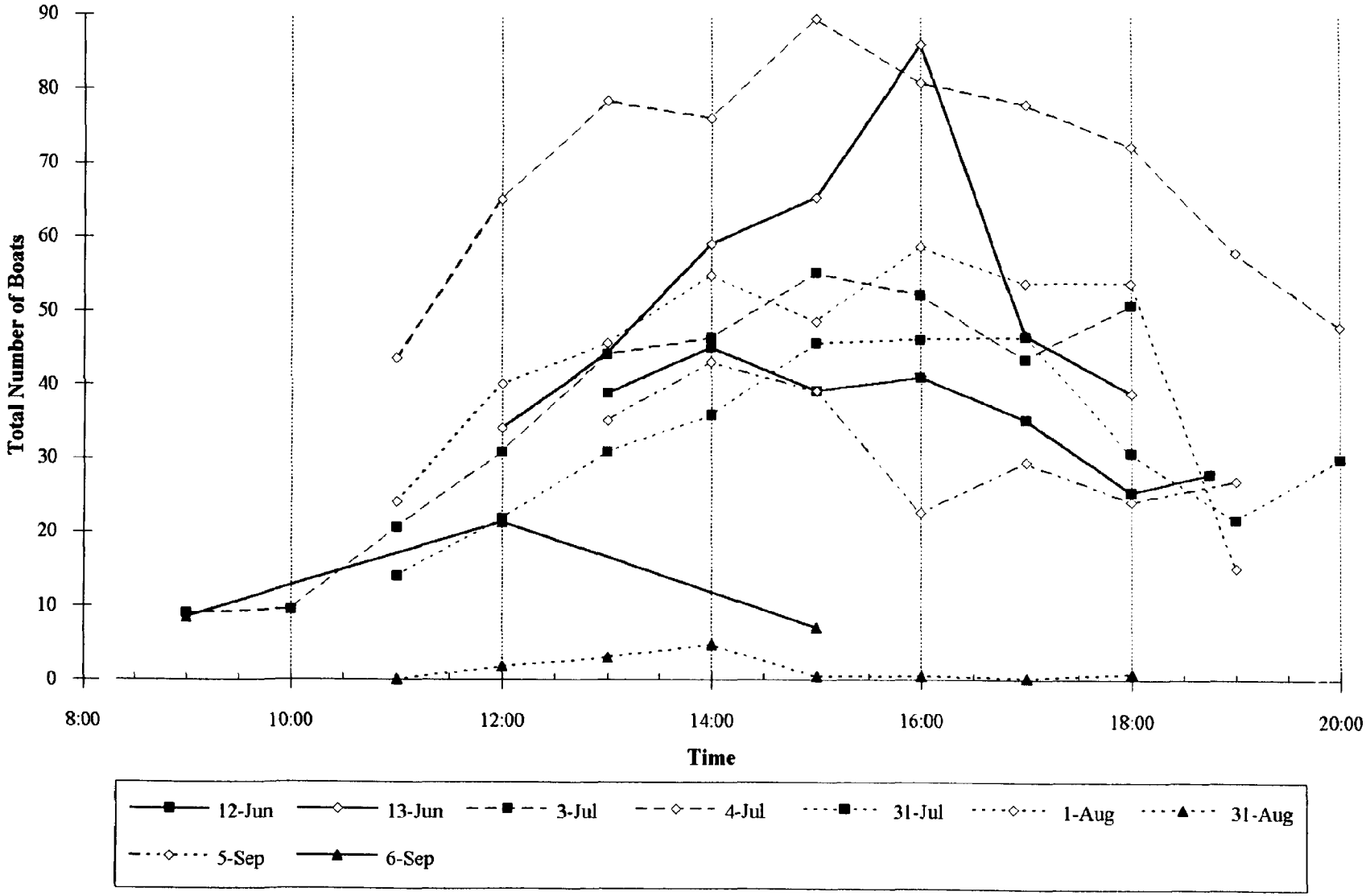
Exhibit 6-7

Parking Lot Counts - Presque Isle State Park Ramp



**Note: Squares are Saturdays, diamonds are Sundays, and triangles are weekdays.*

Exhibit 6-8
Summary of Daily Boat Counts - Main Channel



**Note: Squares are Saturdays, diamonds are Sundays and triangles are weekdays.*

Exhibit 6-9
Boat Counts at Presque Isle Bay Main Channel - July 3, 1993

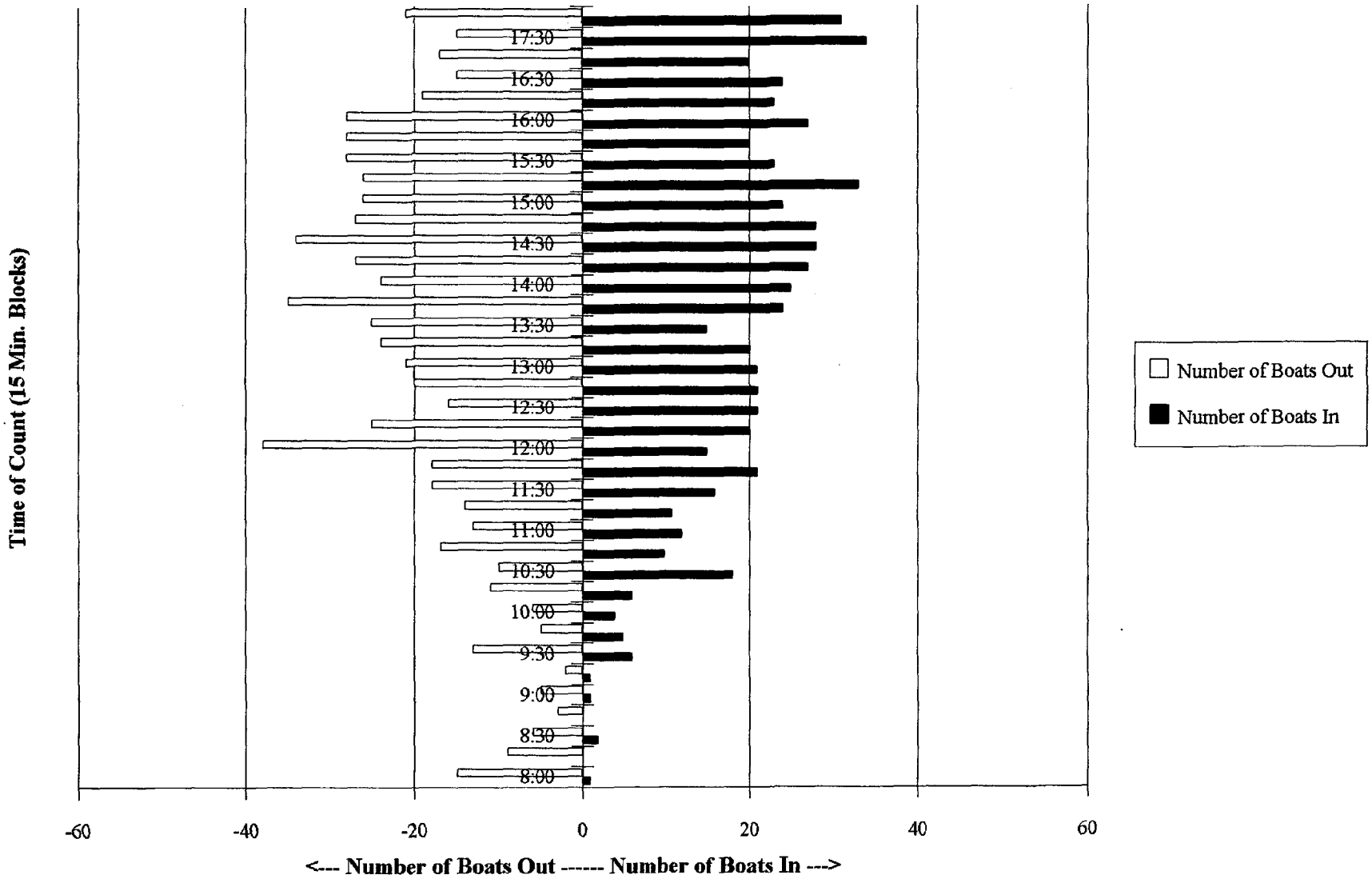


Exhibit 6-10

Boat Counts at Presque Isle Bay Main Channel - July 4, 1993

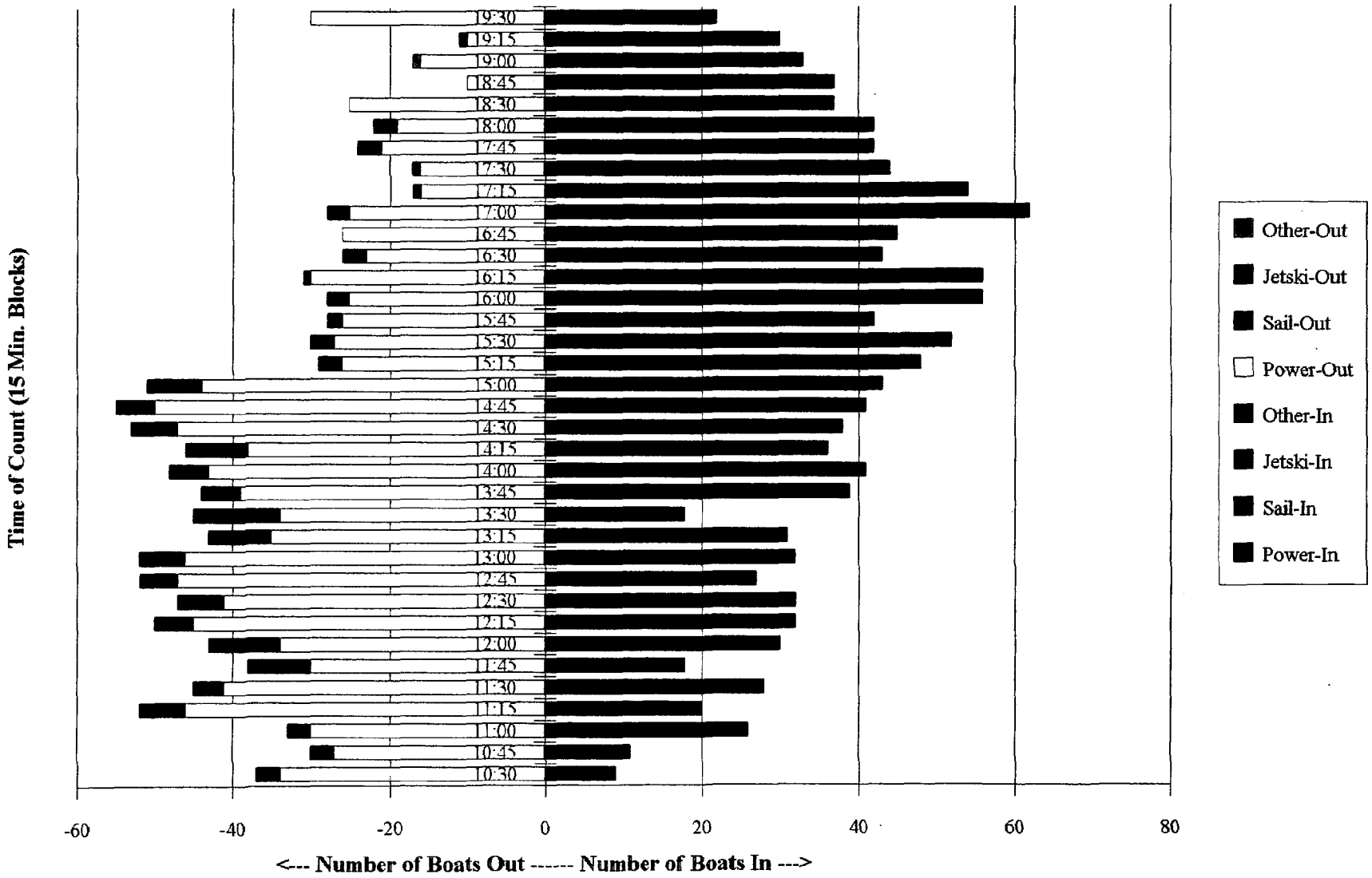
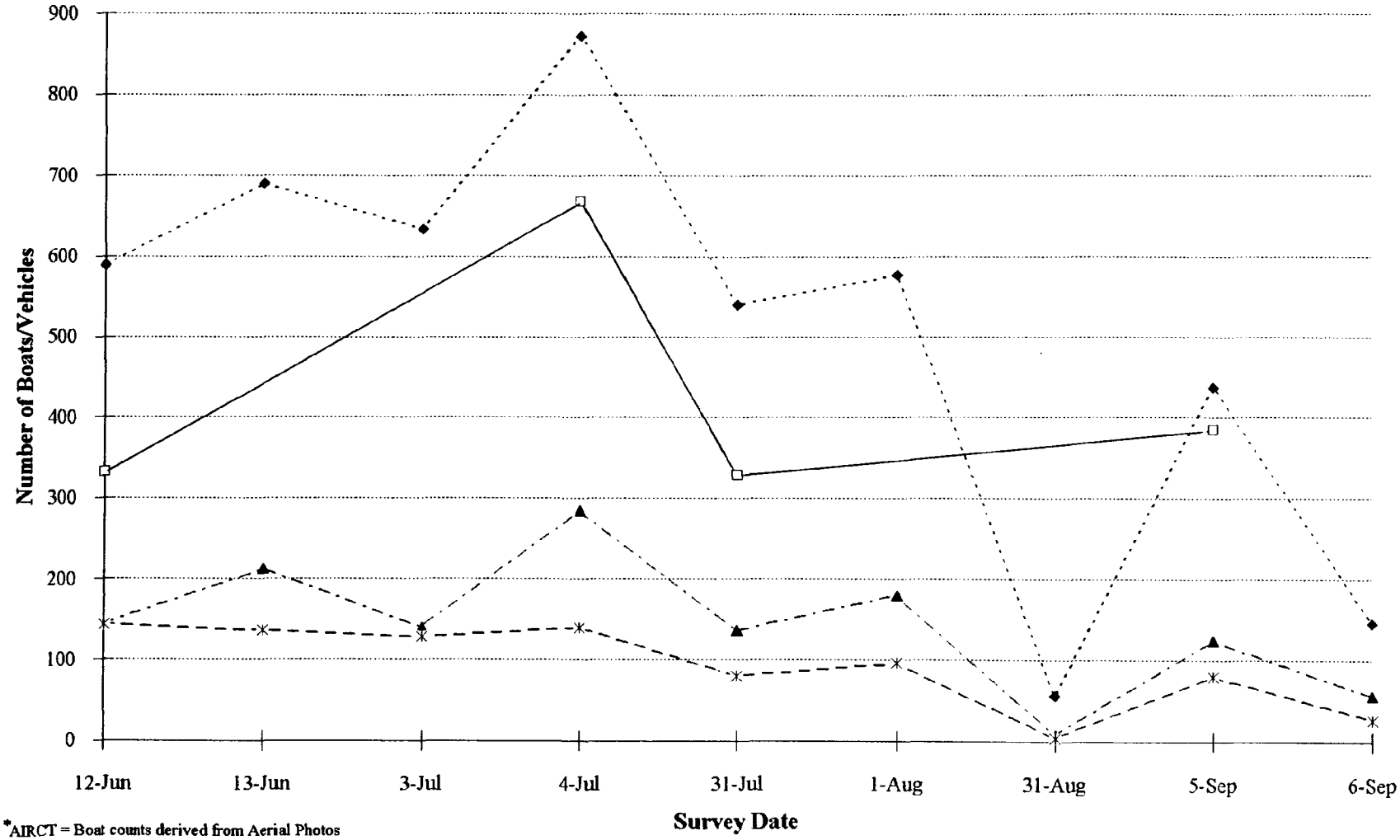


Exhibit 6-11

Summary of Use Level Indicators



*AIRCT = Boat counts derived from Aerial Photos

BTCT1 = Boat counts from main channel

BTCT2 = Boat counts from State Park Marina Channel

PLOTCT = Parking Lot Counts of Vehicles, Trailers & Combinations

used in the figure) on July 4th but closer to 200 per hour on other summer weekend days. The counts made at the other channel (from Presque Isle Bay to Marina Lake) were more constant and less consistent with the other three indicators; thus no further analyses of these boat counts were pursued.

A statistical correlation analysis was also conducted to measure the relationships between the four methods of measuring boating use (Exhibit 6-12). The resulting correlation coefficients showed that the boat counts made at the main channel (Boat Count 1) were strongly correlated with both the counts from aerial photographs (r=.966) and the parking lot counts of vehicles and boat trailers (r=.957). As noted above, the correlations with the boat counts at the Marina Lake channel (Boat Count 2) were not as strong, suggesting those counts are a less effective indicator of overall use levels on Presque Isle Bay. Based on the strong correlations for the main channel boat counts, it is concluded that these counts can serve as a highly accurate indicator of overall boating activity on Presque Isle Bay.

6.2.2 Descriptive Profile of Presque Isle Bay Boaters

One of the purposes of the survey of boaters was to collect background information on the population of bay users. A summary of this information is presented in Exhibit 6-13 and in the copy of the survey instrument shown in Appendix A. Before examining this data, however, it is important to consider a key study variable that was used to group the overall sample of Presque Isle Bay boaters into three groups: those that boated only on Presque Isle Bay during their trip that day, those that boated only on Lake Erie (although they may have crossed through the bay to reach the lake), and those that boated on both the bay and Lake Erie. The largest group (49%) included those that boated on both the bay and the lake (Exhibit 6-14). An additional 21 percent reported boating only on the bay while 30 percent reported boating only on the lake. This user group classification is important because the responses to many of the questions included in the survey can be better understood when viewed in relation to this breakdown of what areas people had experienced.

The thirty percent of respondents who had boated only on Lake Erie tended to be more local in origin (56% from Erie versus 42-47% of the other groups), more active (50 days boating during the past year versus only 30 for those who stayed only on the bay and 40 for those who used both the lake and bay), and more experienced and skilled (see Exhibit 6-13). In contrast, those who stayed on the bay exclusively tended to have the smallest boats and greatest diversity in types of boats used. Family boating groups were most likely to stay on the bay, while those with larger and more powerful boats were more likely to use both the bay and the lake. Finally, those staying on the bay reported shorter amounts of time spent on the water, and longer trips were reported by those who went out on the lake, either exclusively or in combination with boating on the bay.

Some of these differences can be better understood in terms of the boating activities reported by survey respondents. As shown in Exhibit 6-15, fishing was the most popular activity among sampled respondents, with 52 percent reporting some fishing activity and 45% of all time spent on the

Exhibit 6-12 CORRELATIONS BETWEEN USE LEVEL DENSITY MEASURES.

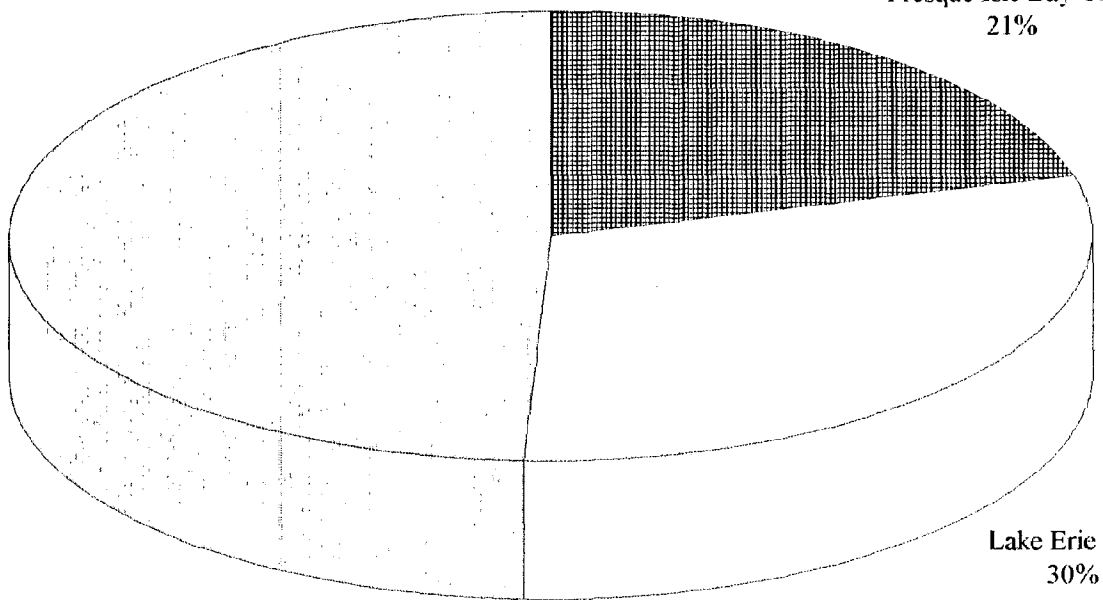
	Air Count	Boat Count #1 (Main Channel)	Boat Count #2 (Marina Channel)	Parking Lot Count
Air Count	1.000			
Boat Count #1	0.966	1.000		
Boat Count #2	0.475	0.815	1.000	
Parking Lot Count	0.879	0.957	0.919	1.000

Exhibit 6-13 DESCRIPTIVE PROFILE OF PRESQUE ISLE BAY BOATERS, BOATS, AND CHARACTERISTICS OF SAMPLED TRIPS BY USER GROUP.

	USER GROUP			
	Total Sample (n=478)	Boated Only on Bay (n=98)	Boated Only on Lake (n=142)	Boated on Bay & Lake (n=233)
Principal Home Residence: State = Pennsylvania	93%	93%	96%	94%
Principal Home Residence: Town = Erie	48%	42%	56%	47%
= Pittsburgh	10%	12%	8%	12%
Average Miles from Principal Residence to P.I.Bay	55.0	67.6	47.5	52.2
Average 1993 Total Boating Participation (days)	41.2	30.2	50.4	39.7
Average 1993 Boating Participation on P.I. Bay (days)	24.0	15.1	29.1	24.2
Average Years Boating Experience	17.0	15.6	19.2	15.8
Average Perceived Boating Skill Level (1-4)	2.7	2.4	2.7	2.7
1 - Novice (%)	9%	11%	7%	10%
2 - Intermediate (%)	34%	49%	32%	28%
3 - Advanced (%)	38%	26%	45%	40%
4 - Expert (%)	19%	13%	16%	22%
Boater Safety Course Completed (%)	46%	44%	41%	50%
Type of Boat Owned (%)				
Runabout	48%	42%	57%	44%
Cabin Cruiser	32%	17%	29%	40%
Bass Boat	7%	16%	7%	4%
Sailboat	5%	11%	1%	5%
Jetski	3%	4%	1%	5%
Other	5%	9%	6%	3%
Average Boat Length (feet)	20.2	17.8	19.9	21.4
Average Engine Horsepower	164	107	146	196
Type of Boating Group (%)				
Family	46%	64%	40%	44%
Friends	26%	14%	36%	23%
Family and Friends	20%	10%	14%	29%
Alone	7%	10%	9%	4%
Average Group Size	3.2	2.9	2.7	3.7
Average Length of Time Spent Boating (Hrs.)	6.1	4.8	6.4	6.5
Boating Activities - % of Time Spent				
Anchored	6%	5%	3%	9%
Fishing	45%	30%	81%	29%
Swimming	4%	2%	1%	5%
Waterskiing	3%	3%	0%	4%
Pleasure Cruising	29%	34%	10%	39%
Sailing	5%	13%	1%	4%
Jet Skiing	3%	5%	1%	4%
Other	4%	8%	2%	4%

Exhibit 6-14

Categorization of Sampled Boaters by Where they Boated on Day Sampled



water accounted for by fishing. Activity participation varied substantially, however, in relation to where people had gone boating (see Exhibit 6-13). Fishing was especially dominant among those boating only on the Lake (81 percent of time spent on fishing versus 29-30 percent for those who boated on the bay as well). On the other hand, pleasure cruising tended to be a more popular bay boating activity, accounting for 34-39 percent of the time spent by groups boating on the bay versus only 10 percent of those boating exclusively on Lake Erie.

6.2.3 Perceptions of Quality in the Boating Experience

The survey of boaters included a variety of types of questions designed to measure boaters' perceptions of quality and the potential impacts that might reduce the quality of their experience. The indicators measured represent a complete set of potential impacts identified from previous boating studies. As in previous studies, some of these items have been combined into indices measuring the major types of impacts to the quality of the boating experience. These indices provide measures that are more sensitive and reliable than the individual survey items themselves.

Exhibit 6-16 summarizes these various measures of quality and boating impacts for the overall boater sample as well as the three user groups discussed above. Survey respondents generally were relatively satisfied with their boating experiences, although those going out only on the Lake reported lower satisfaction on both the overall trip rating and satisfaction index than the other two groups. The pattern of responses to items included within the satisfaction index suggests that most boaters enjoyed their trips and felt they were worth the money they had spent, although for many the sampled boat trip did not measure up to their ideal or best-ever boating outing. For comparison, Exhibit 6-17 shows the results of similar studies of other nearby waterbodies.

Perceptions of crowding also varied in relation to location of boating (Exhibit 6-16). Those who boated only on Lake Erie tended to report less crowding, especially at the start of their trip and out on the water while boating. Since the Lake-only boaters also tended to be less satisfied than the others, this is the first indication that boaters' overall trip evaluations are not strongly influenced by crowding perceptions. Comments received from boaters and responses to open-ended questions (Appendix B) in fact suggest that weather and wave conditions may be the primary reason why Lake-only boaters tended to be less satisfied than those using the bay.

Among the other boating impact measures, scores on the conflict index and noise item differed significantly across user groups, with bay-only boaters reporting slightly higher levels of noise and conflict. These differences, while slight, perhaps reflect the smaller size and general closeness of the bay compared to Lake Erie, since items related to noise and other boats coming too close seemed to be more sensitive within the confines of the bay. In contrast, displacement tended to be lowest among those who had used both the lake and the bay. Perhaps those boaters willing to use both locations were better able to avoid the types of displacement items shown due to their use of a larger and less restricted environment that the confines of Presque Isle Bay.

Exhibit 6-15

Participation vs Time Spent on Various Boating Related Activities

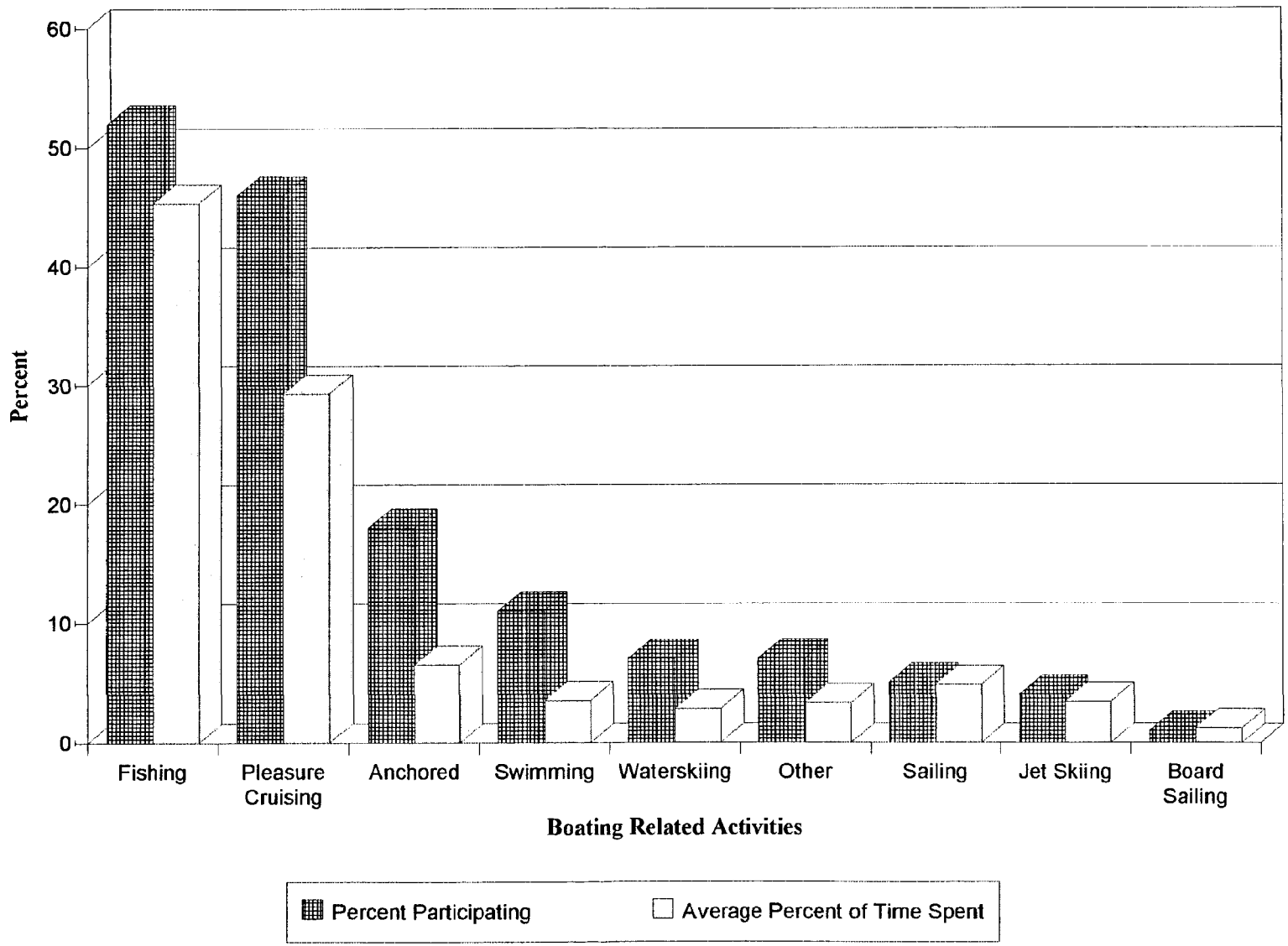


Exhibit 6-16 VALUES FOR SELECTED IMPACT INDICES AND THEIR COMPONENT ITEMS BY WHERE VISITORS BOATED.

	USER GROUP				
	Total Population (n=478)	Boated Only on Bay (n=98)	Boated Only on Lake (n=140)	Boated on Bay & Lake (n=230)	Level of Significance*
Overall Trip Rating[1]	**7.3**	**7.4**	**6.8**	**7.6**	**.004**
Satisfaction Index[2] ($\alpha = 0.88$)	**3.7**	**3.7**	**3.6**	**3.8**	**.007**
Thoroughly Enjoyed Trip	86%	80%	80%	91%	.004
Trip Not as Enjoyable as Expected[3]	20%	20%	25%	16%	ns
Cannot Imagine a Better Trip	32%	38%	30%	31%	.047
Trip Worth the Money Spent	86%	87%	82%	90%	ns
Disappointed in Some Aspects of Trip[3]	30%	33%	37%	25%	ns
Want No More Trips Like This[3]	7%	8%	9%	5%	ns
Crowding Index[4] ($\alpha = 0.74$)	**2.2**	**2.1**	**2.0**	**2.2**	**.057**
Perceived Crowding					
At the access at start of the trip	2.4	2.7	2.0	2.6	.003
Out on the Bay/Lake	3.7	3.5	3.4	3.9	.052
At the channel	4.8	4.5 (n=40)	4.4 (n=102)	5.0	ns
At the access at end of trip	3.2	3.2	3.0	3.3	ns
Influence of Others	21%	29%	14%	20%	.038
Number of Boaters Reduced Enjoyment	10%	14%	8%	9%	ns
Expectation of Use Level	13%	11%	11%	14%	ns
Displacement Index[2] ($\alpha = 0.78$)	**1.9**	**2.0**	**2.0**	**1.8**	**.009**
Avoided Favorite Parts of Bay	11%	15%	13%	9%	ns
Stayed Off Bays Part of Day	8%	8%	8%	9%	ns
Gave Up Activity Due to Crowding	7%	10%	7%	6%	ns
Safety Index[2] ($\alpha = 0.66$)	**4.1**	**4.0**	**4.1**	**4.1**	**ns**
Other Boats Came Too Close[3]	19%	27%	21%	16%	ns
Consider Law Enforcement Adequate	76%	78%	70%	80%	ns
Nearly Had an Accident[3]	2%	3%	0%	1%	ns
Considered Conditions on the Bay Safe	89%	90%	83%	91%	.035
Unsafe Number of Boats on the Bay[3]	6%	7%	5%	7%	ns
Observed an Unsafe Boating Situation[5]	22%	25%	19%	22%	ns
Conflict Index[2] ($\alpha = 0.69$)	**2.0**	**2.2**	**2.0**	**2.0**	**.026**
Other Boats Came Too Close	19%	27%	21%	16%	ns
Bothered by Noise of Other Boats	4%	11%	0%	3%	.000
Observed Inappropriate Behavior	12%	15%	6%	12%	ns
Environmental Quality Index[2] ($\alpha = 0.48$)	**3.3**	**3.3**	**3.1**	**3.3**	**ns**
Bay Water Quality Appeared Good	73%	68%	77%	72%	ns
Would Feel Comfortable Swimming in Bay	42%	54%	33%	42%	.022

[1]Variable scored on 10-point scale, with 10 being the perfect trip; value shown is mean based on responses.
[2]Variable scored on 5-point scale, with 1 = strongly disagree and 5 = strongly agree. Index scores are the mean of the items listed. Values for items listed under each index are the percent who agreed or strongly agreed with each statement.
[3]Item scoring reversed for computation of index due to negative statement wording.
[4]Variable scored on 5-point scale, with 1 = least crowded and 5 = most crowded. Crowding index includes 4 measures of perceived crowding (1 = not at all crowded to 9 = extremely crowded), influence of others (1 = increased enjoyment, 5 = no effect, 9 = decreased enjoyment), number of boaters reduced enjoyment (1 = strongly disagree to 5 = strongly agree) and expectation of use level (1 = a lot less than expected to 5 = a lot more than expected). Index score is the mean of all items listed, standardized to a 5-point scale. Value for influence of others is % reporting reduced enjoyment (6-9); value for expectation is % seeing more than they expected to see (4-5).
[5]Dichotomous variable; values shown are percent who said yes, they observed an unsafe boating situation.
*The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between user groups at the .05 level of probability.

Exhibit 6-17 Comparison of Boating Impact Measures on Presque Isle Bay with Other Nearby Water Resources

	Presque Isle Bay	Raystown Lake (PA)	Delaware Inland Bays	Berlin Lake (OH)
Overall Trip Rating	7.3	7.5	7.5	7.2
Satisfaction Measures				
Thoroughly Enjoyed Trip	86%	85%	90%	84%
Trip Not as Enjoyable as Expected	20%	15%	20%	19%
Cannot Imagine a Better Trip	32%	25%	21%	18%
Trip Worth the Money Spent	86%	91%	92%	89%
Disappointed in Some Aspects of Trip	30%	32%	29%	38%
Want No More Trips Like This	7%	5%	N/A	7%
Crowding Measures				
Perceived Crowding				
..... At the access at start of trip	2.4	3.8	N/A	3.3
..... Out on the Bay/Lake	3.7	5.7	4.9	5.3
..... At the Channel	4.8	N/A	N/A	N/A
..... At the access at end of trip	3.2	4.2	N/A	4.5
Influence of Others	21%	40%	24%	39%
Number of Boaters Reduced Enjoyment	10%	N/A	N/A	32%
Displacement Measures				
Avoided Favorite Parts of Bay/Lake	11%	25%	12%	22%
Stayed Off Parts of Day	8%	27%	14%	27%
Gave Up Activity Due to Crowding	7%	23%	6%	29%
Safety Measures				
Other Boats Came Too Close	19%	34%	32%	36%
Consider Law Enforcement Adequate	76%	N/A	66%	65%
Nearly Had an Accident	2%	N/A	2%	4%
Considered Conditions on the Bay Safe	89%	78%	89%	80%
Unsafe Number of Boats of the Bay	6%	17%	N/A	19%
Observed an Unsafe Boating Situation	22%	N/A	26%	41%
Conflict Measures				
Bothered by Noise of Other Boats	4%	5%	9%	11%
Observed Inappropriate Behavior	12%	22%	17%	28%

Perceptions of safety and the environmental quality of Presque Isle Bay did not differ significantly among the three user groups (bay only, lake only, and bay/Lake boaters). Nor did they differ across those pursuing different boating activities (Exhibit 6-18). Fishermen, however, tended to be the least satisfied boating group, which may account in large part for the lower satisfaction scores associated with boating only on Lake Erie (which is heavily dominated by fishing). A few other activity-specific differences worth noting include the finding that swimmers were somewhat more sensitive to the number of boats on the water and their impacts on safety, while sail boaters were much more likely to object to noise from other boats, although even among sailors, only a small segment (22%) were bothered by the noise of other boats (Exhibit 6-18).

6.2.4 Effects of Boat Density on Boating Quality

Establishing the relationships between the number of boats on the bay and the various measures of quality in the boating experience is a critical element in the evaluation and management of current conditions. Consequently, boaters' responses to the various impact indices and component items were analyzed by boat density level (Exhibit 6-19). The four density levels represent conditions observed on a peak 4th of July holiday (high use), typical summer Sundays (medium/high use), typical summer Saturdays (low/medium use) and normal weekdays and weekend days when bad weather conditions may prevail (low use).

The crowding index and its component items varied to a greater extent by density level than any other impact index. The pattern for crowding was as expected; crowding scores increased as density levels increased. Noteworthy, however, is the fact that only 19% of those sampled on the 4th of July reported that the number of boaters encountered was more than they expected. This may explain why the majority of boaters sampled under the highest density conditions reported no loss of enjoyment as a result of the number of boats on the water.

The satisfaction measures also varied significantly in relation to use level, but the direction of the trend was opposite of what was expected. That is, satisfaction was at its highest among boaters sampled at the highest density level. This finding held true across both the overall trip rating and the satisfaction index and most of its component items. This finding, coupled with the lack of significance found for the other impact indices, suggests that use levels have not become a significant deterrent to satisfaction among Presque Isle Bay boaters. It appears that boating satisfaction depends more on other factors such as wave and weather conditions.

To further explore the determinants of quality in the boating experience, Exhibit 6-20 presents the relationships between the various trip quality and impact measures and the overall level of satisfaction reported by boaters. In this analysis, the sample of boaters was categorized into three levels according to their satisfaction index scores. Consistent with the previous results and discussion, boaters showing the lowest degree of overall satisfaction did not differ significantly in their

Exhibit 6-18 VALUES FOR SELECTED IMPACT INDICES AND COMPONENT ITEMS BY PRIMARY ACTIVITY GROUP.

	ACTIVITY GROUP								
	Anchored (n=38)	Fishing (n=225)	Swim-ming (n=16)	Water-Skiing (n=14)	Pleasure Cruising (n=126)	Sailing (n=23)	Jet Skiing (n=15)	Other (n=18)	Level of Significance*
Overall Trip Rating[1]	**7.5**	**6.8**	**8.2**	**8.1**	**8.0**	**8.3**	**8.0**	**6.5**	**.000**
Satisfaction Index[2]	**3.8**	**3.5**	**4.1**	**4.0**	**3.9**	**4.0**	**4.1**	**3.4**	**.000**
Thoroughly Enjoyed Trip	95%	81%	94%	93%	89%	96%	100%	56%	.007
Trip Not Enjoyable as Expected[3]	23%	28%	6%	0%	12%	9%	0%	24%	.010
Cannot Imagine a Better Trip	41%	28%	62%	29%	33%	35%	47%	22%	.015
Trip Worth the Money Spent	95%	82%	94%	100%	90%	96%	100%	67%	.000
Disappointed in Aspects of Trip[3]	33%	42%	12%	21%	14%	30%	13%	33%	.000
No More Trips Like This[3]	3%	10%	7%	0%	5%	0%	0%	7%	.023
Crowding Index[4]	**2.0**	**2.1**	**2.3**	**2.0**	**2.2**	**2.4**	**2.1**	**2.1**	**ns**
Perceived Crowding									
Access at Start of the Trip	2.3	2.1	3.2	2.1	2.8	3.5	2.9	2.6	.003
Out on the Bay/Lake	3.5	3.5	4.3	3.3	4.0	4.2	3.3	3.8	ns
At the Channel	4.5	4.6	4.9	4.0	5.0	5.7	4.2	5.8	ns
At the Access at End of Trip	3.0	3.2	3.6	2.8	3.3	3.4	3.3	2.6	ns
Influence of Others	18%	19%	17%	22%	25%	30%	7%	17%	ns
Numbers Reduced Enjoyment	10%	11%	12%	14%	9%	13%	0%	0%	ns
Expectation of Use Level	10%	10%	19%	14%	18%	9%	13%	17%	ns
Displacement Index[2]	**1.9**	**2.1**	**1.9**	**1.7**	**1.8**	**1.9**	**1.8**	**1.9**	**.011**
Avoided Favorite Parts of Bay	8%	16%	6%	7%	8%	9%	7%	11%	ns
Stayed Off Bays Part of Day	5%	12%	6%	0%	7%	9%	0%	0%	ns
Gave Up Activity Due to Crowds	16%	10%	12%	0%	2%	4%	0%	0%	.024
Safety Index[2]	**4.1**	**4.0**	**4.0**	**4.1**	**4.2**	**4.0**	**4.3**	**4.1**	**ns**
Other Boats Too Close[3]	20%	24%	31%	21%	12%	21%	13%	6%	ns
Consider Enforcement Adequate	87%	70%	81%	86%	78%	83%	87%	72%	ns
Nearly Had an Accident[3]	3%	1%	6%	0%	2%	0%	0%	0%	ns
Considered Conditions Safe	85%	85%	97%	93%	91%	96%	87%	94%	ns
Unsafe Number of Boats[3]	5%	7%	19%	7%	6%	0%	0%	0%	.008
Observed an Unsafe Situation[5]	24%	20%	31%	29%	21%	35%	7%	28%	ns
Conflict Index[2]	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.2**	**1.8**	**1.8**	**ns**
Other Boats Too Close	20%	24%	31%	21%	12%	21%	13%	6%	ns
Bothered by Noise of Boats	5%	2%	0%	0%	4%	22%	0%	0%	.002
Observed Inappropriate Behavior	13%	11%	12%	7%	15%	13%	0%	0%	ns
Environmental Quality Index[2]	**3.3**	**3.2**	**3.2**	**3.5**	**3.2**	**3.5**	**3.6**	**3.2**	**ns**
Water Quality Appeared Good	72%	81%	69%	57%	70%	78%	27%	50%	.001
Feel Comfortable Swimming	54%	39%	37%	64%	37%	56%	33%	61%	ns

[1] Variable scored on 10-point scale, with 10 being the perfect trip; value shown is mean based on responses.
[2] Variable scored on 5-point scale, with 1 = strongly disagree and 5 = strongly agree. Index scores are the mean of the items listed. Values for items listed under each index are the percent who agreed or strongly agreed with each statement.
[3] Item scoring reversed for computation of index due to negative statement wording.
[4] Variable scored on 5-point scale, with 1 = least crowded and 5 = most crowded. Crowding index includes 4 measures of perceived crowding (1 = not at all crowded to 9 = extremely crowded), influence of others (1 = increased enjoyment, 5 = no effect, 9 = decreased enjoyment), number of boaters reduced enjoyment (1 = strongly disagree to 5 = strongly agree) and expectation of use level (1 = a lot less than expected to 5 = a lot more than expected). Index score is the mean of all items listed, standardized to a 5-point scale. Value for influence of others is % reporting reduced enjoyment (6-9); value for expectation is % seeing more than they expected to see (4-5).
[5] Dichotomous variable; values shown are percent who said yes, they observed an unsafe boating situation.
*The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between user groups at the .05 level of probability.

Exhibit 6-19 VALUES FOR SELECTED IMPACT INDICES AND THEIR COMPONENT ITEMS BY LEVEL OF USE.

	USE LEVEL				
	Low (n=10)	Low/Medium (n=252)	Medium/High (n=143)	High (n=73)	Level of Significance*
Use Level (Boats/Hour in Channel)	**8-56**	**124-144**	**180-212**	**284**	**.000**
Overall Trip Rating[1]	**5.8**	**7.6**	**7.1**	**8.2**	**.001**
Satisfaction Index[2] (α = 0.88)	**3.3**	**3.8**	**3.6**	**4.1**	**.001**
Thoroughly Enjoyed Trip	50%	86%	82%	94%	.004
Trip Not as Enjoyable as Expected[3]	40%	18%	22%	8%	.025
Cannot Imagine a Better Trip	17%	34%	26%	48%	ns
Trip Worth the Money Spent	67%	88%	82%	94%	.008
Disappointed in Some Aspects of Trip[3]	67%	30%	32%	14%	.035
Want No More Trips Like This[3]	0%	5%	7%	3%	ns
Crowding Index[4] (α = 0.74)	**1.2**	**2.1**	**2.1**	**2.7**	**.000**
Perceived Crowding					
At the Access at Start of the Trip	1.0	2.4	2.3	3.1	.004
Out on the Bay/Lake	1.0	3.5	3.5	5.6	.000
At the Channel	1.0	4.4	5.0	6.9	.000
At the Access at End of the Trip	1.0	3.2	3.1	4.2	.000
Influence of Others	11%	18%	18%	36%	.021
Number of Boaters Reduced Enjoyment	0%	10%	11%	16%	ns
Expectation of Use Level	0%	12%	11%	19%	.059
Displacement Index[2] (α = 0.78)	**1.8**	**1.9**	**2.0**	**1.9**	**ns**
Avoided Favorite Parts of Bay	0%	10%	11%	18%	ns
Stayed Off Bays Part of Day	0%	9%	7%	12%	ns
Gave Up Activity Due to Crowding	0%	8%	6%	10%	ns
Safety Index[2] (α = 0.66)	**4.0**	**4.1**	**4.0**	**3.9**	**ns**
Other Boats Came Too Close[3]	0%	20%	21%	22%	ns
Consider Law Enforcement Adequate	50%	76%	75%	72%	ns
Nearly Had an Accident[3]	0%	1%	3%	0%	.027
Considered Conditions on the Bay Safe	67%	91%	87%	85%	.006
Unsafe Number of Boats on the Bay[3]	0%	5%	7%	15%	.038
Observed an Unsafe Boating Situation[5]	10%	19%	24%	29%	ns
Conflict Index[2] (α = 0.69)	**1.8**	**2.0**	**2.0**	**2.0**	**ns**
Other Boats Came Too Close	0%	20%	21%	22%	ns
Bothered by Noise of Other Boats	0%	5%	3%	3%	ns
Observed Inappropriate Behavior	0%	10%	14%	16%	ns
Environmental Quality Index[2] (α = 0.48)	**2.9**	**3.2**	**3.2**	**3.2**	**ns**
Bay Water Quality Appeared Good	33%	76%	72%	69%	ns
Feel Comfortable Swimming in Bay	67%	39%	46%	40%	ns

[1] Variable scored on 10-point scale, with 10 being the perfect trip; value shown is mean based on responses.
[2] Variable scored on 5-point scale, with 1 = strongly disagree and 5 = strongly agree. Index scores are the mean of the items listed. Values for items listed under each index are the percent who agreed or strongly agreed with each statement.
[3] Item scoring reversed for computation of index due to negative statement wording.
[4] Variable scored on 5-point scale, with 1 = least crowded and 5 = most crowded. Crowding index includes 4 measures of perceived crowding (1 = not at all crowded to 9 = extremely crowded), influence of others (1 = increased enjoyment, 5 = no effect, 9 = decreased enjoyment), number of boaters reduced enjoyment (1 = strongly disagree to 5 = strongly agree) and expectation of use level (1 = a lot less than expected to 5 = a lot more than expected). Index score is the mean of all items listed, standardized to a 5-point scale. Value for influence of others is % reporting reduced enjoyment (6-9); value for expectation is % seeing more than they expected to see (4-5).
[5] Dichotomous variable; values shown are percent who said yes, they observed an unsafe boating situation.
*The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between user groups at the .05 level of probability.

Exhibit 6-20 VALUES FOR SELECTED IMPACT INDICES AND THEIR COMPONENT ITEMS BY THE LEVEL OF SATISFACTION.

	USER SATISFACTION LEVEL			
	High Satisfaction (n=152)	Medium Satisfaction (n=105)	Low Satisfaction (n=218)	Level of Significance*
Overall Trip Rating[1]	**8.9**	**7.9**	**6.0**	**.000**
Satisfaction Index[2] (α = 0.88)	**4.5**	**3.9**	**3.1**	**.000**
Thoroughly Enjoyed Trip	100%	98%	68%	.000
Trip Not as Enjoyable as Expected[3]	1%	2%	42%	.000
Cannot Imagine a Better Trip	75%	23%	6%	.000
Trip Worth the Money Spent	99%	100%	72%	.000
Disappointed in Some Aspects of Trip[3]	5%	7%	60%	.000
Want No More Trips Like This[3]	0%	0%	15%	.000
Crowding Index[4] (α = 0.74)	**2.1**	**2.1**	**2.2**	**ns**
At the access at start of the trip	2.5	2.5	2.4	ns
Out on the Bay	4.0	3.8	3.4	ns
At the channel	5.2	4.8	4.5	ns
At the access at end of trip	3.2	3.4	3.1	ns
Influence of Others	17%	16%	24%	ns
Number of Boaters Reduced Enjoyment	4%	6%	16%	.002
Expectation of Use Level	9%	12%	16%	ns
Displacement Index[2] (α = 0.78)	**1.8**	**2.2**	**2.5**	**.000**
Avoided Favorite Parts of Bay	7%	9%	16%	.001
Stayed Off Bays Part of Day	5%	9%	11%	.027
Gave Up Activity Due to Crowding	1%	6%	12%	.000
Safety Index[2] (α = 0.66)	**4.2**	**3.9**	**4.0**	**.000**
Other Boats Came Too Close[3]	15%	14%	25%	.052
Consider Law Enforcement Adequate	80%	75%	73%	ns
Nearly Had an Accident[3]	0%	0%	3%	.049
Considered Conditions on the Bay Safe	95%	88%	84%	.041
Unsafe Number of Boats on the Bay	6%	3%	8%	ns
Observed an Unsafe Boating Situation[5]	24%	24%	19%	ns
Conflict Index[2] (α = 0.69)	**1.9**	**2.2**	**2.0**	**.001**
Other Boats Came Too Close	15%	14%	25%	.052
Bothered by Noise of Other Boats	3%	3%	4%	ns
Observed Inappropriate Behavior	10%	7%	14%	.036
Environmental Quality Index[2] (α = 0.48)	**3.3**	**3.2**	**3.0**	**ns**
Bay Water Quality Appeared Good	78%	71%	71%	ns
Would Feel Comfortable Swimming in Bay	45%	46%	37%	ns

[1] Variable scored on 10-point scale, with 10 being the perfect trip; value shown is mean based on responses.
[2] Variable scored on 5-point scale, with 1 = strongly disagree and 5 = strongly agree. Index scores are the mean of the items listed. Values for items listed under each index are the percent who agreed or strongly agreed with each statement.
[3] Item scoring reversed for computation of index due to negative statement wording.
[4] Variable scored on 5-point scale, with 1 = least crowded and 5 = most crowded. Crowding index includes 4 measures of perceived crowding (1 = not at all crowded to 9 = extremely crowded), influence of others (1 = increased enjoyment, 5 = no effect, 9 = decreased enjoyment), number of boaters reduced enjoyment (1 = strongly disagree to 5 = strongly agree) and expectation of use level (1 = a lot less than expected to 5 = a lot more than expected). Index score is the mean of all items listed, standardized to a 5-point scale. Value for influence of others is % reporting reduced enjoyment (6-9); value for expectation is % seeing more than they expected to see (4-5).
[5] Dichotomous variable; values shown are percent who said yes, they observed an unsafe boating situation.
*The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between user groups at the .05 level of probability.

responses to the crowding questions, suggesting that crowding has little to do with boater satisfaction on Presque Isle Bay. The displacement, safety, and conflict indices were related to overall satisfaction, however. Boaters who were most satisfied also reported the highest levels of perceived safety and the lowest levels of displacement and conflict.

Consideration of the characteristics of boaters in relation to their satisfaction scores sheds further light on who was satisfied and who was not among the overall population of boaters (Exhibit 6-21). The most noteworthy characteristic of the least satisfied boater group was the proportion of fishermen within this group. Fifty-six percent of the least satisfied boaters were anglers, compared with only 34 to 38 percent of the more satisfied groups of boaters.

A similar analysis was conducted with the 9-point influence of others scale in a final attempt to identify factors contributing to loss of satisfaction among boaters (Exhibit 6-22). In this case, boaters were classified in terms of their responses to the question, "How did the number of boaters at the bay today affect your overall boating experience?" (a measure of crowding and a component of the crowding index). The three categories of boaters compared include those whose experience was enhanced by the densities they encountered (values 1-4 on the 9 point scale), those who reported no effect (value 5 on the scale; by far the most common response), and those reporting decreased enjoyment (values 6-9 on the 9-point scale). The latter group can be interpreted as those boaters who felt some degree of crowding, since crowding is usually defined as a negative reaction to a given density level. This latter group included about 23 percent of the study respondents.

As can be seen in Exhibit 6-22, virtually all of the impact measures showed significant differences across the three groups of boaters. In most cases, there was little or no difference between the first two groups (those reporting either increased enjoyment or no effect from the influence of others). The decreased enjoyment (or crowded) group stood out with the highest levels of displacement and conflict. Thirty-six percent of these boaters avoided favorite parts of the bay and 26 percent gave up some activity due to crowding (compared to negligible percentages of the other groups). Forty percent of the "decreased enjoyment" group observed an unsafe boating situation (compared to 2-4 percent), underscoring the importance of safety as a determinant of satisfaction. Forty-five percent said other boats came too close and 38 percent reported observing some inappropriate behavior. These findings imply that those boaters who are experiencing unpleasant impacts resulting from other boaters are most likely responding to certain inappropriate behavior patterns rather than simply the number of boaters encountered. In many cases, these behavior patterns are amenable to management through enforcement and educational practices.

Looking at the characteristics of these same boater segments, it appears that those most sensitive to the influence of others are more likely to be the more active, experienced, and skilled boaters, as well as those who travelled greater distances to boat at Presque Isle Bay (Exhibit 6-23).

Exhibit 6-21 DESCRIPTIVE PROFILE OF PRESQUE ISLE BAY BOATERS, BOATS, AND CHARACTERISTICS OF SAMPLED TRIPS BY USER SATISFACTION RATING.

	USER SATISFACTION LEVEL		
	High Satisfaction (n=152)	Medium Satisfaction (n=105)	Low Satisfaction (n=218)
Principal Home Residence: State = Pennsylvania	95%	97%	91%
Principal Home Residence: Town = Erie	51%	56%	43%
= Pittsburgh	11%	12%	10%
Average Miles from Principal Home Residence to P.I.Bay	49.5	46.9	62.9
Average 1993 Total Boating Participation (days)	37.8	34.9	46.2
Average 1993 Boating Participation on P.I. Bay (days)	26.3	24.0	22.2
Average Years Boating Experience	16.7	16.5	17.3
Average Perceived Boating Skill Level (1-4)	2.7	2.6	2.7
1 - Novice (%)	9%	10%	9%
2 - Intermediate (%)	33%	37%	33%
3 - Advanced (%)	39%	33%	39%
4 - Expert (%)	19%	19%	19%
Boater Safety Course Completed (%)	54%	44%	42%
Type of Boat Owned (%)			
Runabout	43%	42%	53%
Cabin Cruiser	36%	41%	25%
Bass Boat	4%	8%	9%
Sailboat	8%	3%	4%
Jetski	4%	2%	4%
Other	9%	6%	3%
Average Boat Length (feet)	21.2	20.9	19.2
Average Engine Horsepower	182	188	138
Type of Boating Group (%)			
Family	46%	49%	46%
Friends	24%	18%	31%
Family and Friends	27%	22%	14%
Alone	2%	8%	9%
Average Group Size	3.7	3.4	2.8
Average Length of Time Spent Boating (Hrs.)	6.4	6.6	5.6
Boating Activities - Average % of Time Spent			
Anchored	7%	7%	5%
Fishing	34%	38%	56%
Swimming	7%	2%	2%
Waterskiing	3%	3%	2%
Pleasure Cruising	33%	38%	22%
Sailing	8%	3%	3%
Jet Skiing	4%	2%	3%
Other	4%	6%	5%

Exhibit 6-22 VALUES FOR SELECTED IMPACT INDICES AND THEIR COMPONENT ITEMS BY INFLUENCE OF OTHERS ON THE BOATING EXPERIENCE.

	INFLUENCE OF OTHERS			
	Increased Enjoyment (n=53)	No Effect on Enjoyment (n=255)	Decreased Enjoyment (n=98)	Level of Significance*
Overall Trip Rating[1]	7.7	7.0	7.5	ns
Satisfaction Index[2] (α = 0.88)	**4.0**	**3.7**	**3.6**	**.046**
Thoroughly Enjoyed Trip	92%	84%	85%	ns
Trip Not as Enjoyable as Expected[3]	15%	23%	20%	ns
Cannot Imagine a Better Trip	50%	32%	25%	ns
Trip Worth the Money Spent	91%	85%	89%	ns
Disappointed in Some Aspects of Trip[3]	24%	33%	45%	.013
Want No More Trips Like This[3]	8%	7%	8%	ns
Crowding Index[4] (α = 0.74)	**1.7**	**2.0**	**2.8**	**.000**
Perceived Crowding				
At the Access at Start of the Trip	2.1	2.2	2.9	.008
Out on the Bay/Lake	2.9	3.2	4.7	.000
At the Channel	4.0	4.5	5.8	.001
At the Access at End of Trip	2.6	2.8	4.0	.000
Influence of Others	0%	0%	100%	.000
Number of Boaters Reduced Enjoyment	2%	4%	40%	.000
Expectation of Use Level	12%	8%	30%	.000
Displacement Index[2] (α = 0.78)	**1.8**	**1.9**	**2.5**	**.000**
Avoided Favorite Parts of Bay	8%	8%	36%	.000
Stayed Off Bays Part of Day	6%	5%	11%	.000
Gave Up Activity Due to Crowding	2%	5%	26%	.000
Safety Index[2] (α = 0.66)	**4.2**	**4.1**	**3.6**	**.000**
Other Boats Came Too Close[3]	17%	15%	45%	.000
Consider Law Enforcement Adequate	83%	73%	77%	ns
Nearly Had an Accident[3]	0%	1%	5%	.023
Considered Conditions on the Bay Safe	93%	89%	80%	ns
Unsafe Number of Boats on the Bay[3]	4%	3%	22%	.000
Observed an Unsafe Boating Situation[5]	16%	18%	40%	.000
Conflict Index[2] (α = 0.69)	**1.8**	**1.9**	**2.6**	**.000**
Other Boats Came Too Close	17%	15%	45%	.000
Bothered by Noise of Other Boats	2%	3%	12%	.002
Observed Inappropriate Behavior	9%	6%	38%	.000
Environmental Quality Index[2] (α = 0.48)	**3.3**	**3.2**	**3.2**	**ns**
Bay Water Quality Appeared Good	66%	70%	77%	ns
Would Feel Comfortable Swimming in Bay	47%	43%	49%	ns

[1] Variable scored on 10-point scale, with 10 being the perfect trip; value shown is mean based on responses.
[2] Variable scored on 5-point scale, with 1 = strongly disagree and 5 = strongly agree. Index scores are the mean of the items listed. Values for items listed under each index are the percent who agreed or strongly agreed with each statement.
[3] Item scoring reversed for computation of index due to negative statement wording.
[4] Variable scored on 5-point scale, with 1 = least crowded and 5 = most crowded. Crowding index includes 4 measures of perceived crowding (1 = not at all crowded to 9 = extremely crowded), influence of others (1 = increased enjoyment, 5 = no effect, 9 = decreased enjoyment), number of boaters reduced enjoyment (1 = strongly disagree to 5 = strongly agree) and expectation of use level (1 = a lot less than expected to 5 = a lot more than expected). Index score is the mean of all items listed, standardized to a 5-point scale. Value for influence of others is % reporting reduced enjoyment (6-9); value for expectation is % seeing more than they expected to see (4-5).
[5] Dichotomous variable; values shown are percent who said yes, they observed an unsafe boating situation.
*The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between user groups at the .05 level of probability.

Exhibit 6-23 DESCRIPTIVE PROFILE OF PRESQUE ISLE BAY BOATERS, BOATS, AND CHARACTERISTICS OF SAMPLED TRIPS BY THE REPORTED INFLUENCE OF OTHERS ON THE BOATING EXPERIENCE.

	INFLUENCE OF OTHERS		
	Increased Enjoyment (n=53)	No Effect on Enjoyment (n=256)	Decreased Enjoyment (n=78)
Principal Home Residence: State = Pennsylvania	96%	94%	95%
Principal Home Residence: Town = Erie	49%	49%	49%
= Pittsburgh	15%	10%	10%
Average Miles from Principal Home Residence to P.I.Bay	38.3	51.6	70.6
Average 1993 Total Boating Participation (days)	37.0	38.4	46.8
Average 1993 Boating Participation on P.I. Bay (days)	21.9	18.2	31.5
Average Years Boating Experience	18.8	17.3	17.1
Average Perceived Boating Skill Level (1-4)	2.4	2.6	2.7
1 - Novice (%)	17%	9%	8%
2 - Intermediate (%)	34%	34%	30%
3 - Advanced (%)	36%	40%	41%
4 - Expert (%)	13%	17%	22%
Boater Safety Course Completed (%)	34%	40%	53%
Type of Boat Owned (%)			
Runabout	47%	53%	58%
Cabin Cruiser	19%	27%	18%
Bass Boat	9%	8%	10%
Sailboat	13%	3%	6%
Jetski	6%	4%	1%
Other	6%	5%	5%
Average Boat Length (feet)	18.1	19.3	18.7
Average Engine Horsepower	151	136	130
Type of Boating Group (%)			
Family	40%	44%	54%
Friends	29%	28%	22%
Family and Friends	19%	19%	18%
Alone	12%	8%	5%
Average Group Size	2.9	3.0	3.2
Average Length of Time Spent Boating (Hrs.)	4.8	5.8	6.2
Boating Activities - % of Time Spent			
Anchored	8%	8%	6%
Fishing	31%	55%	47%
Swimming	8%	3%	2%
Waterskiing	2%	2%	3%
Pleasure Cruising	32%	21%	27%
Sailing	10%	3%	8%
Jet Skiing	6%	4%	1%
Other	3%	4%	3%

7.0 CARRYING CAPACITY ANALYSIS

7.1 Evaluation of Existing Conditions

As described in Section 5.0, current recreational planning models clearly identify the management process of problem identification and selection of indicators and standards for measuring impacts, as the role of management rather than of research. Those responsible for the management of Presque Isle Bay ultimately must decide whether or not current conditions are acceptable. Thus, while this study can demonstrate, for example, that the average satisfaction of weekend boaters during 1993 was 7.3 on a 10-point scale, or that the average perceived crowding score in the channel was 4.8 on a 9-point crowding scale, area planners and managers must decide if these values are consistent with their objectives for the area.

Study results can aid managers with such decisions in two ways. First, it provides data on how the visitors perceive current conditions. Agency personnel may have their own opinions about existing conditions, but prior to this study had no concrete data regarding the visitors' perceptions. Other studies have shown that the perceptions of managers and visitors often differ (Hendee et al. 1970; Merriam et al. 1972; Peterson 1974; Graefe et al. 1984; Stankey 1987). Thus, while managers may base their decisions on any criteria they consider relevant, data on visitor perceptions provide one additional source of information for decision making.

Secondly, study results can be used as a basis for establishing quantitative standards of acceptability. Current management approaches like the Visitor Impact Management framework rely on standards to make the evaluation process objective and systematic. Standards provide a means of describing the type of experience that is to be provided in measurable terms. Problem identification then is based on the comparison of existing conditions and corresponding standards. In this case, there are no pre-existing standards for the boating experience at Presque Isle Bay. Thus, knowledge of the current levels of various impact indicators provide a baseline against which an initial set of standards can be determined.

For example, various segments of the population of Presque Isle Bay boaters rated the overall quality of their boat trip between 6.5 and 8.3 on a ten-point scale (Exhibits 6-13 and 6-16). About one-fifth of those sampled reported that their enjoyment was reduced because of the number of other boaters they encountered. The vast majority (89%) considered conditions on the bay safe on the day they were interviewed, while 22 percent reported that they had observed an unsafe boating situation. If local resource managers consider such conditions acceptable, then these statistics can be used to set standards against which future measurements can be compared.

After the acceptability of current conditions has been assessed, a second type of information needed to examine the question of capacity involves identifying the relationship between visitor use patterns and the impacts one is trying to control. It is necessary to demonstrate a link between cause (visitor use) and effect (impacts on either the environment

or the visitor experience). The stronger this relationship is, the more precise one can be in estimating carrying capacities. If there is no significant relationship, it is not possible to determine a capacity because the impact remains constant regardless of the use level. In such a case, a capacity limit would serve no purpose.

Study findings revealed relatively weak relationships between use levels and the quality of the boating experience on Presque Isle Bay. The most noticeable impact of higher boating densities was a higher degree of perceived crowding. Crowding in turn seemed to influence other impact measures, including displacement, safety, and conflict. All of these types of impacts, however, occurred relatively infrequently and few boaters reported that the number of boats encountered negatively affected their experience, even under the highest conditions. Thus it appears boating levels on Presque Isle Bay have not yet approached capacity limits based on evaluation of the quality of the boater experience.

7.2 Evaluation of Future Conditions

While the documented relationships between boating use levels and resulting impacts were insufficient for determining an overall capacity, study results can be used to evaluate the potential effects of future conditions resulting from various management or facility development options. The likely effects of new or expanded facilities on Presque Isle Bay would naturally depend to some degree on the type, size, and location of the proposed facility. There are three basic findings of this study, however, that should be kept in mind when considering any type of further facility development.

Range of Peak-Use Density Levels

The density of boats using the bay at one time on summer 1993 weekend days varied widely. The number of boats counted from aerial photos of the bay surface was twice as high on July 4th as it was on three other sampled weekends. Access areas were used to their full capacity only occasionally (possibly only on the 4th of July) this summer. This variation in use intensity results largely from the influence of weather conditions. It is reasonable to expect that the use patterns of any new facilities would mirror those of the existing facilities on the bay. Thus, additional facilities would be used to their full capacity relatively infrequently (mainly on holiday weekends with good weather conditions). On these peak days, the additional access provided could lead to total use levels above the maximum recorded in this study. For the remaining non-peak weekends and weekdays, the total number of boats on Presque Isle Bay would remain within the range observed during 1993.

General Acceptance of Existing Conditions

Most boaters surveyed were quite satisfied with their boating experiences and relatively few reported impacts of displacement, conflict, or safety problems. While these results do not guarantee that Presque Isle Bay boaters will accept higher boat densities, they do document that most current users do not feel that the bay is already overused. Further in-

creases in boating facilities would be more questionable if current users perceived there was already a greater problem with existing conditions.

Weak Relationships Between Boat Densities and Boating Quality

As noted earlier, most measures of boating quality and the impacts that might interfere with boating quality showed little or no variation in relation to different boat densities. Thus, within the range of densities represented in this study, management actions that change the number of boats using the bay should have little impact on the experience of boaters. There is greater uncertainty in predicting the effects of actions that could greatly increase boating densities beyond the range included in the study. The weak association between use levels and quality/impact variables, however, coupled with the tendency for maximum use to occur only infrequently, implies that modest or incremental increases in boating densities will have little impact. Of course, one cannot rule out the possibility of a non-linear relationship between boat density and boating quality. Such a relationship would be characterized by a threshold use level above which large portions of the boating public become disturbed. Clearly, no such threshold was reached during the 1993 boating season. The safest way to avoid reaching such an unacceptable use level in the future would be to consider facility development proposals incrementally, allowing only relatively small expansions in boating access at any one time, and monitoring the responses of boaters to the resulting new conditions.

Applying these considerations to the projections for future development at and around Presque Isle Bay (Sections 2.2, 2.3 and 4.1), it is necessary to consider the potential impacts that could occur if the peak number of boats using the bay doubles, as suggested in the maximum build-out scenario. Because boater perceptions were not strongly correlated with the use levels observed in this study, we cannot project how boaters would respond to boat densities twice as high as current peak levels. We can state, however, that such conditions would occur only rarely, if at all, since boaters might pursue various self-selection behaviors, such as boating at off peak times or leaving the Bay to cruise or fish on Lake Erie, which would reduce the total densities below that assumed in the build-out scenario. The more typical densities found on ordinary summer weekends would probably be comparable to the current maximum density level, which is a condition that we can evaluate. Boaters sampled on the 1993 4th of July holiday reported the highest satisfaction levels recorded during the entire summer. We can only assume that boaters would not object if such conditions became more common on Presque Isle Bay.

Of course, a doubling of current peak use levels would not occur overnight and, in fact, is based on a series of proposed and potential development alternatives that might or might not be implemented, and certainly will not all be implemented at one time. Considering only the currently proposed (not potential) marina development, along with an assumed increase in trailered and transient boats results in an increase of only 255 additional boats under peak conditions (42 percent increase over the current peak). In addition, 367 boats are projected to come from potential marina expansion projects (see Section 4.1). Accepting the limitations of determining a definitive recreational boating carrying capacity for Presque Isle Bay, based on the data collected for this study,

we feel 900 additional boat slips along the existing Erie waterfront would not have an irreversible detrimental effect. Once the expansion of new slips approaches 900, an evaluation of additional available capacity water quality and recreational carrying capacity should be conducted.

8.0 REVIEW OF LOCAL, STATE AND FEDERAL REGULATORY AUTHORITIES

Millcreek Township Comprehensive Plan

The Millcreek Township Comprehensive Plan (August 1980), includes an analysis, summary, and recommendations for development in Millcreek Township. The westernmost end of Presque Isle Bay is located on the northeastern tip of Millcreek Township. This area possess some development potential and could be incorporated into the waterfront development of the City of Erie. The land use analysis shows the area along the bay as being a flood hazard and having wetlands and steep slopes along the bluffs. The Plan recommends that development in these areas be restricted, or the land be retained in its present state. The General Development Plan also shows the shore area abutting Presque Isle Bay for parkland or restricted development.

Millcreek Township Zoning Ordinance

The Zoning Ordinance of Millcreek Township, enacted December 30, 1974 with amendments through January 8, 1991, is designed to achieve the development objectives of the Comprehensive Plan.

Presque Isle Bay is adjacent to four zoning categories in Millcreek Township.

- "A" Residence District permits parks not operated as business for profit (Section 402).
- "B" Business District permits parks.
- Light Industrial
- The Resort/Business District is intended to provide space for facilities serving the recreation and vacation oriented population in the Presque Isle area. The purpose of the Resort/Business District is to provide standards for specific types of land uses and to control the intensity of development in order to reduce or eliminate adverse environmental impacts in areas near the entrance to Presque Isle State Park. This District promotes and enhances the many recreational and commercial uses of land adjacent to the entrance of Presque Isle State Park, and do so in a manner that protects the people's right to natural, scenic and aesthetic values of this unique natural resource which is part of the common property of all the people.

Boating facilities, marina, and rentals and sales of boats are permitted uses in the Resort/Business District.

City of Erie, Waterfront Comprehensive Plan

The Waterfront Comprehensive Plan for the City of Erie, (May 1986), was transmitted to the Mayor via a letter dated August 29, 1986, for implementation.

The Comprehensive Plan was designed to guide development of the Lake Erie waterfront toward a balanced mix of existing and proposed uses to safeguard the viability of water-dependent commerce and industry while encouraging an expanded range of people-oriented activities. The Plan is the official planning guide for development and serves to guide zoning revisions.

The Comprehensive Plan provides a framework to guide revitalization of the waterfront area by focusing on the following objectives:

- Encourage residential development to build a downtown population that will support commercial activity and create a 24-hour cycle of pedestrian use.
- Consolidate existing waterfront-oriented industrial uses at the Marine Terminal, and relocate non-waterfront industry to more appropriate areas.
- Capitalize on the current demand for marina facilities with new port development.
- Adjust current plans for Niagara Place to be more compatible with the scale of the Erie community and reflect a maritime commercial theme.
- Recognize the prime commercial opportunity at the end of State Street and develop it as a focal point of the revitalized waterfront.
- Retain the historic ship Niagara in its current location to take advantage of its visibility and reinforce the importance of the State Street area.
- Establish a unifying urban character for the revitalized waterfront with a density and scale that are compatible with the existing community.

The Comprehensive Plan acknowledges that the Presque Isle Bay Bluff, the Port of Erie and Waterfront Area, and Presque Isle Bay are identified as an Overlap Geographic Area of Particular Concern (GAPC) by the Coastal Zone Management Program (CZMP) and therefore special attention has to be given to their development. The CZMP recognizes the area as being unique, offering a climate conducive to the development of both port and recreational activities. Uses to be highly encouraged include:

- Increasing the port's import and export grain handling capacity.
- Increasing the warehouse capacity and capability.
- Providing better road access between the port and the interstate highway system.
- Improving port facilities used in support of the commercial fishing fleet.
- Expanding the marina capacity of the harbor.
- Providing better recreational access to the harbor via the development of access roads, parking lots, and service docks.

The bluffs along the shoreline act as an environmental buffer zone and support many species of wildlife and vegetation. Urban development pressures within the City's bayfront have eliminated much of the ecological significance of the bluffs. It is therefore important that these areas be monitored.

Presque Isle Bay is also significant because it is a socioeconomic resource. The Bay is used year-round as a recreational area and Presque Isle is Pennsylvania's only Great Lakes harbor. The Comprehensive Plan further recommends an expanded variety of uses which draw people to the waterfront. This is seen as the key that will unlock the potential of the area, spur economic growth, provide a variety of recreational opportunities, and enhance the image and identity of the community. A broad range of new waterfront uses which are appropriate and potentially marketable include: specialty retail, restaurants, hotel and entertainment uses, cultural/historical attractions, parks and plazas, offices, and housing.

By using a mixed land use planning approach which emphasizes integration of diverse but compatible functions, the potential for economic development is significant. The goal is to establish an activity mix which draws substantial numbers of persons for a variety of reasons throughout the day and evenings to create a functional focus and lively atmosphere. This will enable the waterfront to maximize its economic development potential and capitalize on the opportunity to create mutually beneficial relationships between the waterfront area and the surrounding areas.

The Comprehensive Plan states that over the years the numbers of boat registrations have increased significantly and there is an unmet demand for boat slips. Therefore, the potential for expanding marina facilities exists. The Plan recommends that the waterfront would be able to accommodate an additional 700-1,000 slips between 1985-1990 with the potential for an additional 600-800 slips between 1990-2000.

In order to implement its recommendations and guide development on the waterfront, the Comprehensive Plan made recommendations for amending the City's zoning map in addition to site plan and design review requirements.

City of Erie Zoning Ordinance

The City of Erie's Zoning Ordinance, effective August 1, 1968 and revised July 1, 1992, incorporated the zoning amendments recommended by the Waterfront Comprehensive Plan and set the stage for development along the waterfront to take place.

The Waterfront Districts (Section 202.50) provide a framework to guide and control the development of the Erie Bayfront. This district is intended to coordinate future public and private improvements in a mixed land use concept. The waterfront districts are as follows (Exhibit 8-1):

1. Waterfront Commercial District (W-C), designed for residential, commercial, recreational and historical uses.

2. Waterfront Commercial District No. 2 (W-C-2), designed for residential, commercial, recreational and historical uses. The zones are differentiated by the requirements for lot, yard and height requirements.

3. Waterfront Industrial District (W-M), designed for industries that require waterfront or waterfront related uses.

4. Waterfront Residential Districts (W-R), designed for high density residential areas on valuable properties or properties where good access, public utilities, and common facilities warrant a higher density population.

All uses permitted within the Waterfront Districts are categorized as conditional uses in order to properly regulate the development along the waterfront. Marinas are permitted as a conditional use in the Waterfront Commercial (W-C) District (Section 204.20).

Additional requirements are as follows:

- Developments which access the bayfront water's edge in a Waterfront District must provide free public accessway.

- Off-street parking (Section 302) shall be provided for all developments and any enlargements to existing facilities. Marinas require 1 parking space per 2 boat stalls.

- Any proposed development located within the Waterfront District shall have all necessary permits from the various governmental agencies such as the U.S Army Corps of Engineers, the U.S. Environmental Protection Agency and the Pennsylvania Department of Environmental Resources (Section 306). Additionally, an Environmental Assessment for impacts on the air, water, and land to provide a general picture of the total development impact on the harbor and shoreline is to be submitted for review.

Erie County Regulations

According to John Mong of the Erie County Department of Planning (ECDP), Erie County has no specific regulations which deal with development within Presque Isle Bay. However, the ECDP is responsible for reviewing all subdivisions and land developments within the project area. The ECDP also reviews all zoning changes which are proposed by the local municipalities. In accordance with the provisions of Pennsylvania Act 14, Erie County government is notified of any developments within the City of Erie and Millcreek Township. The ECDP is also responsible for administering the PCZMP on behalf of PADER.

State Regulations

Fishing and Boating Regulations

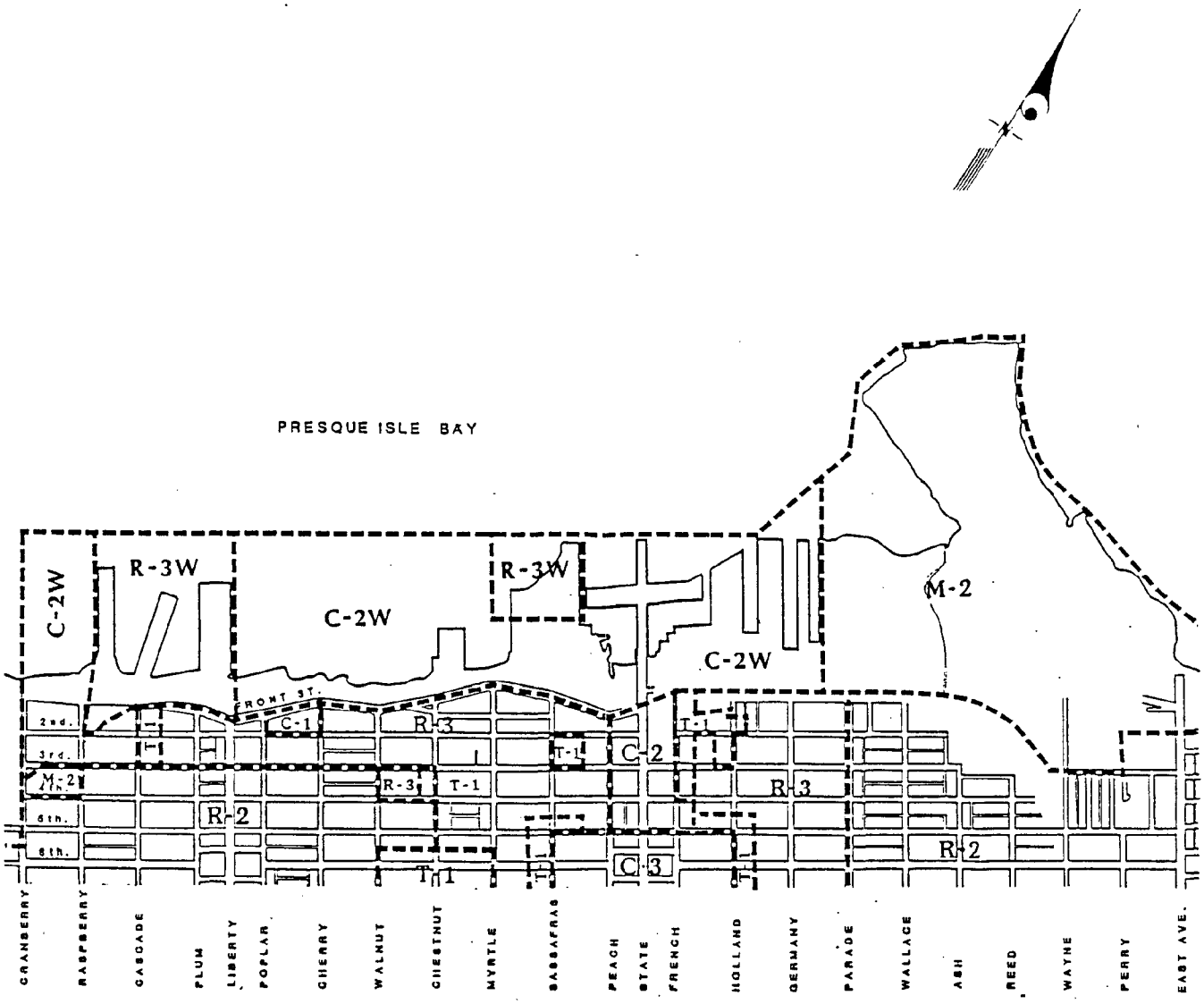
The Commonwealth of Pennsylvania, Fishing and Boating Regulations are administered by the Pennsylvania Fish and Boat Commission which regulates permits for the disturbance of waterways or watersheds. The Pennsylvania Fish and Boat Commission is charged with administering and enforcing laws and regulations relating to fishing and boating on all waters of the Commonwealth. These responsibilities extend to Presque Isle Bay and there are no special or additional responsibilities which pertain to fishing and boating in Presque Isle Bay (Moore, pers. comm., 1993). The main responsibilities of the Fish and Boat Commission are:

1. The encouragement, promotion and development of the fishery interest.
2. The protection, propagation and distribution of fish.
3. The management of boating and operation of boats.
4. The encouragement, promotion and development of recreational boating.

The Commission institutes general and special rules and regulations concerning fish and fishing including the regulations concerning protection, preservation and management of fish and fish habitat, in addition to fish restoration and management. The Commission is also charged to supervise and administer regulations concerning the operation of boats through the establishment of educational programs and improvement of waterway facilities including aids to navigation (PAFBC, 1993).

Permits required for Fishing and Boating include the following:

Activity and Permits Required	Agency
Marina Development/Expansion (includes dredge and fill process)	
Dam Safety and Encroachment	PADER
Penn. Clean Streams Law	PADER
Pennsylvania CZM	PADER
Section 404 Permits	Corps of Engineers
Section 404(b)(1)	EPA
Section 10	USFWS
Water Obstruction, Section 105	PADER



Not To Scale

Presque Isle Bay Recreational Boating Study

ENGINEERS • ARCHITECTS • PLANNERS • SCIENTISTS • SURVEYORS • PHOTOGRAMMETRISTS
GREENHORNE & O'MARA, INC.
9001 EDMONSTON ROAD, GREENBELT, MARYLAND 20770

City of Erie Waterfront Zoning

EXHIBIT 8-1

Source: Erie Waterfront Comprehensive Plan, 1986

Building Permit	City of Erie
Water Resource Regulations	PADER
Construction of Piers and Bulkheads	PADER
Landside Improvements	
Parking Facilities:	
Building Permit	City of Erie
Boat Ramp and Parking	
Building Permit	City of Erie
Dam Safety and Encroachment	PADER
Clean Streams Law	PADER
Pennsylvania CZM	PADER
Section 404	Corps of Engineers
Section 404(b)(1)	EPA
Recreational Boating and Fishing	
Fishing and Boating Regulations	Fish and Boat Commission
NPDES Permit	PADER

Dam Safety and Waterway Management

The Dam Safety and Encroachments Act gives the State authority to protect wetlands. Dams, water obstructions, and encroachments proposed in or otherwise affecting any important wetland will have to meet performance standards as stated in Chapter 105 of the Pennsylvania Code of Regulations. These standards require that the maintenance of the character and function of coastal wetlands be a primary consideration for the permitting of any action in those wetlands. Permits are issued by PADER's Division of Dams and Waterways Management. PADER's jurisdiction in and along Lake Erie is defined by the highwater elevation of 572.8 feet International Great Lakes Datum (IGLD) and low water elevation of 568.6 IGLD.

The Pennsylvania Department of Environmental Resources may by written agreement, delegate to a County Conservation District or other County agency one or more of its regulatory functions, including enforcement, permitting, inspection, and monitoring of specified categories of water obstructions and encroachments. However, this does not apply a to public utility, a political subdivision, or a water obstruction or encroachment constructed by the Commonwealth of Pennsylvania. A permit issued to a delegated agency is subject to review by the Department.

Clean Streams Law

The Pennsylvania Clean Streams Law prohibits the discharge of pollutants into the waters of the Commonwealth and is regulated by the Department of Environmental Resources. Chapter 102 provides the authority

for PADER to implement erosion and sedimentation control programs. This is regulated by the Bureau of Soil and Water Conservation in PADER.

Presque Isle State Park

Presque Isle State Park is important to the Erie Harbor, not only because it protects the harbor but it is also important as a research, educational, and recreational area. The PADER Bureau of State Parks, which regulates the operation of Presque State Park, is responsible for supervising, maintaining, improving, policing, protecting, and the overall stewardship of the park (Houghton, pers. comm., 1993). Presque Isle State Park promotes outdoor recreation and education and is an area of natural and unusual scenic beauty. In order to meet the responsibility of maintaining this park, properties are acquired from time to time as they become available. Because of its popularity, there is a desire for transportation, shelter, comfort and educational facilities. However, in making available these facilities, design and construction have to be carefully considered so as to preserve the natural features of the of the park (PBSP, 1993).

The authority for the enforcement of laws, rules, and regulations in Presque Isle State Park is delineated in the Pennsylvania Administrative Code of 1929 which gives park officers the same authority to enforce the law as a police officer of a First Class City. The area under park jurisdiction includes all areas on land, lakes, and lagoons within the park, Misery Bay, Marina Lake, and extends 500 feet from the shoreline into the surrounding waters. Though Park Officers are empowered to enforce all laws which apply within the park, enforcement of game and fish regulations are most often left to the officers of the Pennsylvania Fish and Boat Commission. The Park Officers are responsible for the enforcement of park regulations such as those which regulate activity in the Gull Point Management Area (Houghton, Pers. Comm. 1993).

Federal Regulations

Coastal Zone Management Program (CZMP)

Federal CZMP guidance documents stress the need to protect and wisely use the important national resources contained in the coastal zone. The Coastal Zone Management Act was signed into Law by the Congress of the United States on October 27, 1972. The Act authorized a Federal grant-in-aid program to be administered by the Secretary of Commerce, who in turn delegated this responsibility to the National Oceanic and Atmospheric Administration's (NOAA) Office of Coastal Zone Management (OCZM). The grants-in-aid were to facilitate the establishment of State Coastal Zone Authorities empowered to manage their coastal waters and adjacent lands.

The Coastal Zone Management Act, amended July 20, 1976, empowered the States to exercise full authority over their coastal areas. Federal agencies and local government agencies were required to participate in the development of management programs, and state governments were given the central role and responsibility of the process. Financial assistance was granted to the states to help in achieving the stated objectives and policies. States with coastal areas are eligible for grants from NOAA for

up to 80 percent of the cost for developing coastal zone management programs. The states are required to address specific issues, consult with local governments and relevant Federal agencies, and involve the general public. The Management Program is then submitted to the Secretary of Commerce for approval, and if it is approved the state is then eligible for annual grants to administer the management program.

The Commonwealth of Pennsylvania Coastal Zone Management Program was approved by the Federal Government and addresses major coastal resource management issues of State, Federal, and local concerns and has developed policies to guide State decision making in the coastal zones. These areas of concern are:

1. Coastal Hazards
2. Dredging and Spoil Disposal
3. Fisheries Management
4. Wetlands
5. Public Access for Recreation
6. Historic Sites and Structures
7. Port Activities
8. Energy Facility Siting
9. Intergovernmental Coordination
10. Public Involvement

A State statute, the Bluff Recession and Setback Act (BRSA) requires municipalities within the Bluff Recession Hazard Areas along the Lake Erie shoreline to enact setback ordinances affecting stationary structures.

The CZMP has a "consistency" element which helps with policy implementation. Under the PACZMP Act of 1972, as amended, Pennsylvania's CZM program is required to review federal activities for consistency with its policies. The federal activities reviewed are divided into four categories: 1) federal assistance; 2) federal permit; 3) direct federal development project; and 4) Outer Continental Shelf activities.

On the state level, the CZM program reviews certain state permit applications and state activities for consistency. Those state permit applications selected for review are solid waste, encroachment, air and water quality. The program also reviews state funded projects or state development projects for consistency. These reviews are accomplished through a Governor's Executive Order, or interagency agreements.

Presque Isle Bay, which is managed under the authorities of the Dam Safety and Encroachment Act and the Clean Streams Law, is a unique area offering a climate conducive to the development of both port and recreational facilities. High priority uses include development of coal loading and off loading facilities, increasing the port's import and export grain handling capacity, increasing the port's warehousing capacity and capability, providing better road access between the port and the local interstate highway system, improving port facilities used in support of the growing commercial fishing fleet, expanding the marina capacity of the harbor, providing better recreational access to the harbor, and providing better recreational access roads, parking lots, and service docks. Low

priority uses are any uses which exclude or conflict with high priority uses.

Most of the authorities which are responsible for implementing the PCZMP are in the Department of Environmental Resources, the leading agency for administering the CZMP.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers is responsible for wetland delineation. Section 404 of the Clean Water Act gives the U.S. Army Corps of Engineers the power to issue permits for the discharge of dredge or fill materials in the "waters of the United States." A Section 404 permit is required for disposal of dredge of fill materials in:

- Territorial seas of the United States.
- Coastal and inland waters, lakes, rivers, streams, that are navigable waters of the United States.
- The tributaries of navigable waters of the United States, including adjacent wetlands, even if separated by a dike, berms, or dunes.
- Interstate waters and their tributaries, including adjacent wetlands.
- All other water bodies not included in the above categories.

If an area is within the Corps' jurisdiction, an individual dredge and fill permit may be required for certain activities, or approval under a "Nationwide" permit can be issued for other specific categories of activities. The Corps determines whether a wetland is within its jurisdiction by using specific criteria as contained in 40 CFR Part 230, and more recently in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands published in January 1989. These criteria include various factors such as adequacy, areal extent, type of vegetation, tidal or flood water heights, and soil and hydraulic characteristics.

Environmental Protection Agency

The Environmental Protection Agency (EPA), in conjunction with the Secretary of the Army, has responsibility for developing and ensuring compliance with the 404(b)(1) Guidelines, effective March 23, 1981, which are the substantive environmental criteria used in evaluating discharges of dredged or fill material under Section 404.

U.S. Coast Guard

The primary responsibility of the U.S. Coast Guard (USCG) operations in Presque Isle Bay is to undertake search and rescue missions (Carter, pers. comm., 1993). The USCG responds to emergencies such as boat fires, collisions, sinkings or rescuing persons who are experiencing difficulties in the water. The USCG is also responsible for the maintenance of Aids to Navigation such as buoys which guide barges into docking areas. They

monitor the buoys to make sure they are in place and in good condition. In addition, the USCG will respond to any oil, chemical or other type of spills which occur on the Bay. They are responsible for containment of the spill and investigation as to the cause of the spill. The decision as to who will undertake the clean-up of the spill is made in conjunction with DER.

Nonpoint Source Pollution

National Pollution Discharge Elimination System (NPDES) permits are required for stormwater discharge. The objective of the NPDES stormwater program is to target control efforts at the greatest source of nonpoint source pollution.

9.0 RECREATIONAL BOATING MANAGEMENT RECOMMENDATIONS

9.1 Presque Isle Bay Recreational Boating Management Recommendations

The findings of this study (both the boater survey and the water quality study) indicate that Presque Isle Bay can support increases in recreational boating activities and infrastructure. This belief is based upon the fact that current levels of boating activity have not had a negative impact on the boating experience and that the relative contribution of pollutants by boating activities and infrastructure is minor. This is not to suggest recreational boating activities, both on the water and associated with support facilities on the shoreline, do not have adverse environmental impacts. Several of the management recommendations included in this section address areas where environmental impacts associated with recreational boating can be minimized.

Therefore, accepting the limitations of determining a definitive numerical recreational boating carrying capacity for presque Isle Bay, based on the information collected through the boater questionnaires and the water quality sampling, and based upon the level of analysis conducted for this study, we feel 900 additional boat slips along the existing Erie waterfront would not have an irreversible detrimental effect on Presque Isle Bay. Therefore, 3200 boat slips could be viewed as the present capacity of the Bay. This assumes that all new marina facilities are located, designed, and constructed using appropriate water facility guidelines which are available in the literature, a portion of which are discussed elsewhere in this report. This capacity also assumes all other parameters are held constant. This would include the number of boat launch ramps and the number of boaters using them, which is typically managed through the number of parking spaces available, and that the number of transient boaters remains constant. It also assumes no improvement or degradation in the contribution of pollutants through point and non-point sources.

Once the expansion of recreational boating facilities approaches the addition of 900 new boat slips (which will total 3178 boat slips in the study area), the study team recommends that the question of carrying capacity be revisited to determine if additional capacity can be provided at that time. A detailed water quality assessment should be conducted to evaluate whether additional recreational boating pressures would be detrimental to the Bay. The progress made in implementing the recommendations of the Remedial Action Plan regarding the land-side contribution of point and non-point source pollutants can be incorporated into the evaluation of pollutant loadings from future recreational boating activities in the Bay. Also, the recreational carrying capacity analysis developed in this study effort provides an excellent foundation for reevaluating recreational boating concerns.

This is an opportune time, from a planning perspective, to address recreational boating issues on Presque Isle Bay. There is the opportunity to be proactive instead of responding to crisis situations. Recommendations can be developed to preserve the natural resources of the Bay and to address areas of concern regarding the contribution of pollutant loadings from recreational boating before significant adverse impacts are detected.

The findings do not suggest that there is a preservation versus utilization issue present. Current levels and incremental increases in recreational boating on Presque Isle Bay can coexist with a management approach that has the protection of the natural resources as its primary objective.

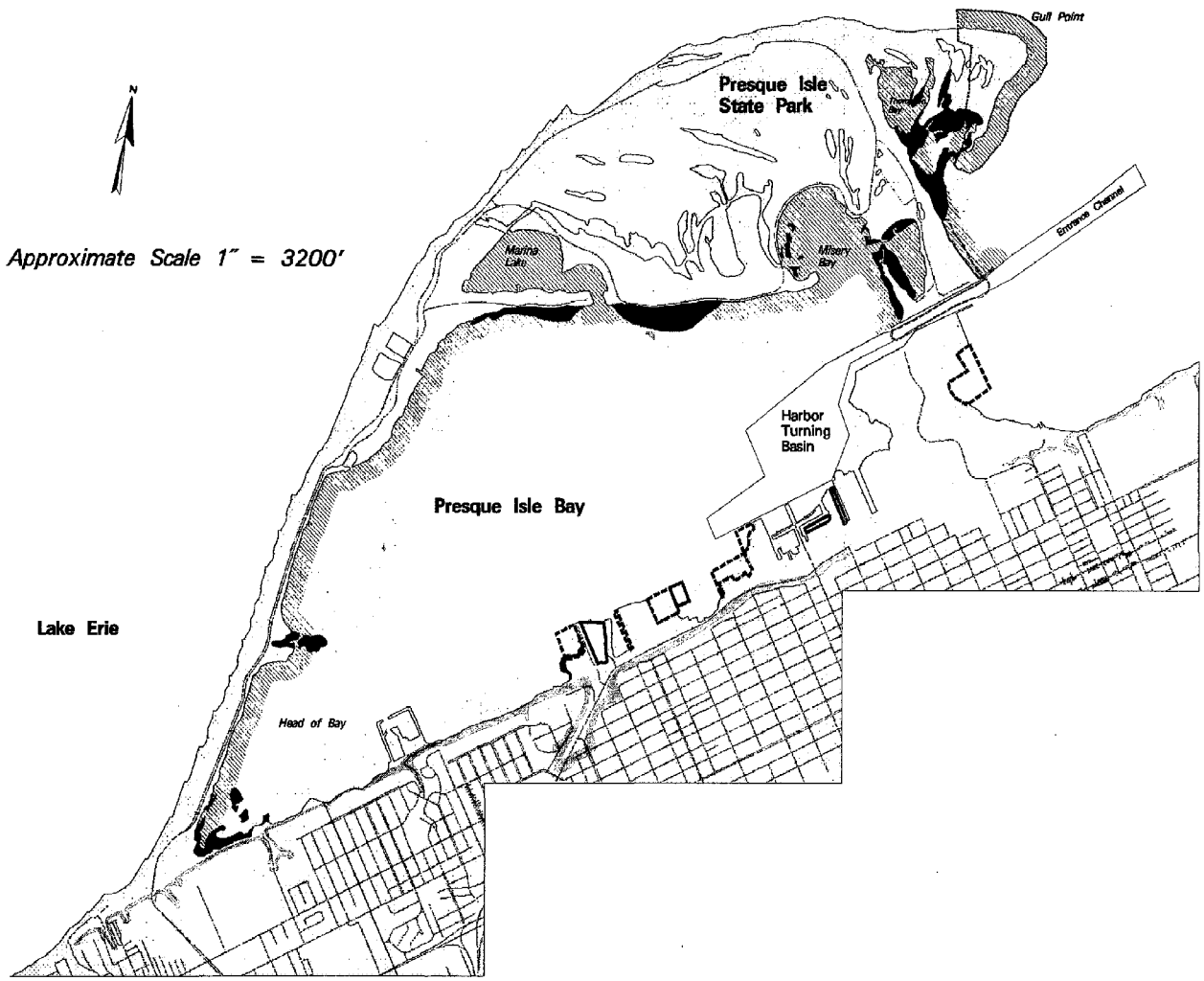
The recommendations in this section of the report address both the current situation and future conditions as boating pressure on the Bay increases. The recommendations need to be tailored to the appropriate management or regulatory authority that can most effectively address the issue. Some of the recommendations can be implemented by resource managers and by local jurisdictions, others suggest actions that can be taken by the boating industry or by government at the state and national level.

Exhibit 9-1 depicts the opportunities and constraints to recreational boating on Presque Isle Bay. The map identifies opportunities for expansion of recreational boating facilities along the Erie waterfront and on the South Shore of Presque Isle. If done properly, the redevelopment of the waterfront will provide an economic development opportunity for the City of Erie. As has occurred in many waterfront redevelopment projects, most notably in the example of Baltimore, attracting residents and visitors to the waterfront has also focused attention on water quality and protecting the natural resources present.

Exhibit 9-1 also identifies environmentally sensitive areas and constraints to expanding marinas, yacht clubs and other boating facilities on the shoreline. Information on shallow-water habitat, defined as waters less than six feet in depth, was obtained from marine charts and National Wetlands Inventory Maps prepared by U.S. Fish and Wildlife Service. Shallow-water areas in Presque Isle Bay provide important habitat for fish spawning and nursery. Aquatic vegetation was mapped by aerial photointerpretation and includes emergent, submergent, and floating aquatic vegetation. The Lake shore bluffs are identified as the steep slope areas; they are a significant physical and environmental constraint to shoreline development along the City of Erie and Millcreek Township waterfront.

Several existing management zones implemented by Presque Isle State Park resource managers, and which affect recreational boating, are identified on the constraints and opportunities map. An interconnected set of ponds and lagoons with access to the Bay have been designated by the state park as a non-motorized boating area. These ponds and lagoons support a diverse set of wetland plant communities and provide a wide-array of wildlife habitat. Canoes and rowboats are allowed for fishing and paddling. A five hundred foot "no-wake" zone is in effect along the entire bayshore of Presque Isle.

The Gull Point Special Management Area is depicted on the easternmost point of Presque Isle and encompasses an area of approximately 67 acres. Although this area has been identified as a unique and fragile natural area for some time, additional special management area restrictions will go into effect on April 1, 1994. The management area is closed to all public use from April 1 through November 30. All land and water access, including hiking and beaching of boats, is prohibited. Boats are not permitted to moor within 100 feet of the shoreline.



Legend

- Shallow Water Habitat
- Aquatic Vegetation
- Presque Isle State Park Prohibition of Motorized Boats
- Presque Isle State Park No Wake Zone
- Steep Slopes
- Proposed Marina
- Potential Marina
- Boat Concentration Areas
- Presque Isle State Park Gull Point Management Area
- Harbor Entrance and Turning Basin

Head of Bay: Proposed Resource Management Area

Greenhorne & O'Mara, Inc.

Recreational Boating Constraints and Opportunities

Exhibit 9-1

The eastern tip of Gull Point is an area of shifting sandspits which provide critical habitat for nesting and migrating shorebirds. It has also been popular with recreational boaters and provided a place where boaters could beach their boats or moor just offshore in a relatively protected setting. This restriction has generated controversy over its merits among some boaters and resource managers, and provides a good example of natural resource use conflicts. This restriction will also increase boat congestion along Beach Number 11 (identified on Exhibit 9-1 as a boat concentration area), one of the few remaining areas where boats can moor offshore.

The Head of the Bay is identified in this study as a portion of the Bay which should be managed to protect the aquatic resources present and adjacent undisturbed Lake Bluff and shoreline plant communities. Sections 1.3.3 and 1.3.4 describe the significance of aquatic and terrestrial communities that are present in the proposed management area. They include a variety of habitats which are imperiled; contain rare, threatened or endangered species; and provide important fish spawning habitat and fish nursery grounds. This study recommends that a "no-wake" policy be implemented within the limits depicted as a Resource Management Area. Fishing and low-impact boating activities would be permissible; water skiing and power cruising should be strictly prohibited.

A public information effort should be undertaken to inform recreational boaters of their responsibility in protecting the natural resources of Presque Isle Bay. Resource managers should encourage boaters to play a stronger role in the bay's protection and enhancement efforts.

Summary of Management Recommendations

- When expansion of recreational facilities approaches 900 new boat slips, a detailed assessment should be conducted to address availability of additional capacity, water quality, and carrying capacity.

- There does not appear to be a need to restrict or limit public access to Presque Isle Bay currently or in the near future. Monitoring of the boating conditions should be conducted over time if use levels increase (see Section 9.1).

- Resource managers should consider a balanced approach to maximizing the uses of the Bay and preserving environmental quality.

- One-fifth of the boaters sampled reported that other boats had come too close to them while boating. Such incidents were one of the greatest safety concerns among Presque Isle Bay boaters. All pertinent organizations should consider methods of strengthening their educational efforts to create more boating safety awareness on the Bay.

- While it appears that crowding is not an existing problem on Presque Isle Bay, areas that were identified as having the potential for congestion should be closely monitored by resource management personnel to identify safety concerns or environmental factors before they become problems in the future.

- A "no wake" zone should be considered for the area depicted on Exhibit 9-1 as the Head of Bay Resource Management Area. The restricted area should fall within the area where water depth is 6' or less. Natural resource managers should conduct additional investigations of all ramifications associated with the establishment of such an area. Criteria should be developed for monitoring this and other environmentally sensitive areas in Presque Isle Bay.

- Educational displays should be developed and placed at key locations to educate users about the sensitivity of the Bay's resources and ways to minimize potential use conflicts.

- The inventory of existing recreational boating facilities indicates that four marina pump-out facilities are located within the Study Area. A Clean Vessels Act survey of Presque Isle Bay should be conducted to determine the adequacy of marina pump-out facilities. If found adequate, a petition should be forwarded to the Environmental Protection Agency (EPA) to prohibit the use of Flow Through Type I and II Marine Sanitation Devices (MSDs) in Presque Isle Bay.

- The EPA, with the support of and in coordination with the boating industry, should promote the development of technologies to reduce total petroleum hydrocarbons (TPH) from two-stroke outboard marine engines. The development of an efficient four-stroke outboard marine engine would significantly reduce both TPH and polycyclic aromatic hydrocarbons (PAH) from entering aquatic systems.

- EPA should support increased research funding to determine a viable alternative to the use of copper-based anti-fouling paint. State resource managers should closely monitor the fate of copper released into Presque Isle Bay from wood and steel boats painted with copper-based paints.

- Millcreek Township should consider a Lake Bluff and Shoreline Land Preservation Program utilizing zoning amendments together with land preservation techniques such as donation, acquisition of easements, and voluntary conservation agreements, to preserve the unique natural resources present along the shoreline. Marinas, which are currently permitted in the zoning district fronting the Head of the Bay, should be prohibited due to the environmental sensitivity of the area.

- The Pennsylvania Department of Environmental Resources, especially through the consistency review process, together with other State reviewing agencies and the U.S. Army Corps of

Engineers, should carefully review joint permit applications for waterfront development in areas outside the proposed and potential marina sites identified in this study.

- Almost eight years have passed since the Erie Waterfront Comprehensive Plan was prepared. Some of the proposed projects have changed, such as the marina development planned near the Erie International Marine Terminal, east of the Turning Basin. The Comprehensive Plan assumed wrongly that the drydock facility was not a viable option and the success of Erie Marine Enterprise is welcomed. However, many of the recommendations prepared at that time are still valid today. The City of Erie and the Erie Western Pennsylvania Port Authority should continue to be proactive in encouraging public/private sector initiatives to take advantage of the waterfront opportunities for redevelopment.

- The City of Erie, or the Erie-Western Pennsylvania Port Authority, should consider providing slips for transient boats along the Presque Isle Bay waterfront. There is a known demand for such facilities and the City could benefit economically by encouraging more visitation from recreational boaters cruising Lake Erie. The area near Dobbins Landing appears to be a viable location.

9.2 Recommendations for Future Monitoring

Regardless of what carrying capacity is assumed for the Bay, or which management and facility development alternatives are implemented in the future, the effects on boating quality can ultimately only be determined through a monitoring program. Results of this study can be used to suggest what variables can be monitored most effectively as well as what variables may be most important as potential limiting factors in the future.

Any future monitoring program should include measures of boat density and use patterns as well as data on critical indicators of boating quality and impacts. The strong correlations between the various use level indicators included in this study imply that those indicators that can be obtained in the most cost-effective manner could be used as surrogate measures of overall boating use levels. Thus, periodic counts of boat traffic through the main channel to Lake Erie should be made on a regular sampling schedule, although it probably is not necessary to maintain continuous counts throughout the day as was done in this study. At a minimum, the numbers of boats traveling in either direction should be counted for several 15-minute intervals within a constant time period (say between 2:00 and 4:00 P.M. to capture the peak use) to reduce the possibility of distortion due to peaks and outliers. In addition, parking lot counts could be made at a few selected locations to provide a base of comparison to the boat channel counts. The relatively large parking lots at Lampe Marina and the State Park (West Pier) would provide good locations representing the larger number of locations monitored during this study.

Boating quality/impact indicators that should be monitored include those occurring most frequently in the present study as well as those most strongly associated with use levels and/or overall boating satisfaction.

Boater satisfaction is an important variable because it indicates boaters' overall reaction to their boating experience. Although satisfaction at Presque Isle Bay was relatively high and was not negatively associated with use levels, it should still be monitored in the future to detect changes that may occur in response to changing boating conditions.

Of the various satisfaction measures included in this study, the 10-point overall trip rating, while less sensitive and precise, can be obtained and analyzed more easily and thus has a practical advantage over the satisfaction index comprised of six separate items. Because of the strong correlation between the overall trip rating and the satisfaction index, use of the 10-point scale should provide an adequate means of detecting unacceptable changes in the overall quality of boating at Presque Isle Bay. If monitoring does reveal a drop in this score in the future, it would be useful to conduct an in-depth investigation similar to the current study which would include the more complete satisfaction index.

Of all the impact indicators measured, the various crowding measures tended to be most strongly correlated with the boat density measures. Perceived crowding in the channel appears to be the most serious crowding-related concern and should definitely be monitored if more facilities are developed on Presque Isle Bay.

10.0 REFERENCES

Adelman, B. J., T. A. Heberlein and T. M. Bonnicksen. 1982. "Social psychological explanations for the persistence of a conflict between paddling canoeists and motorcraft users in the Boundary Waters Canoe Area." Leisure Sciences 5 (1): 45-62.

Becker, R. H. 1981. "Displacement of recreational users between the Lower St. Croix and Upper Mississippi Rivers." Journal of Environmental Management 13: 259-267.

The Brandow Company. December 1, 1992. "The Erie County Economic Adjustment Strategy and Implementation Plan."

City of Erie. 1992 (latest revision). Zoning Ordinance, City of Erie, PA. Effective date August 1, 1968.

Ditton, R. B., A. R. Graefe, and A. J. Fedler. 1981. "Recreational satisfaction at Buffalo National River: some measurement concerns." In Some Recent Products of River Recreation Research. USDA Forest Service General Technical Report NC-63, North Central Forest Experiment Station, St. Paul, MN, p. 9-17.

Erie County, Department of Planning et al. Undated. Lake Erie Boating Facilities and Related Services, Erie County, Pennsylvania.

Fisher, John S. et al. 1987. A Comparison of Water Quality at Two Recreational Marinas During a Peak-Use Period. Raleigh, North Carolina: U.N.C. Sea Grant College Program, North Carolina State University.

Gold, Seymour M. 1980. Recreation Planning and Design. New York: McGraw-Hill Book Company.

Graefe, A. R., F. R. Kuss and J. J. Vaske. 1990. Visitor impact management: the planning framework. Washington, D.C.: National Parks and Conservation Association.

Graefe, A. R. and A. J. Fedler. 1986. "Situational and subjective determinants of satisfaction in marine recreational fishing." Leisure Sciences 8 (3): 275-295.

Graefe, A. R., J. J. Vaske and F. R. Kuss. 1984. "Social carrying capacity: an integration and synthesis of twenty years of research." Leisure Sciences 6 (4): 395-431.

Greenhorne & O'Mara, Inc. 1993. City of Erie - Foundries and Machine Shops. Data Analysis Report, Erie County Industrial Resources Survey Phase I. Prepared for Erie County. Erie, Pennsylvania.

Grovhoug, J.G. et al. 1986. "Baseline Measurements of Butyltin in U.S. Harbors and Estuaries." Paper presented at the Oceans 86 Conference, September 23-25, 1986, at Washington D.C.

Heberlein, T. A. and B. Shelby. 1977. "Carrying capacity, values and the satisfaction model: a reply to Greist." Journal of Leisure Research 9 (2): 142-148.

Hendee, J.C. and R.W. Harris. 1970. "Foresters' Perception of Wilderness User Attitudes and Preferences." Journal of Forestry, 68(12) 759-762.

Hendee, J. C. 1974. "A multiple-satisfaction approach to game management." Wildlife Society Bulletin 2 (3): 104-113.

Jacob. G. R. and R. Schreyer. 1980. "Conflict in outdoor recreation: a theoretical perspective." Journal of Leisure Research 12 (4): 368-380.

Land Design/Research, Inc. 1986. Waterfront Comprehensive Plan. Prepared for the City of Erie, Pennsylvania.

Lucas, R. C. and G. H. Stankey. 1974. "Social carrying capacity for backcountry recreation." In Outdoor Recreation Research: Applying the Results. USDA Forest Service General Technical Report NC-9, North Central Forest Experiment Station, St. Paul MN, p. 14-23.

Maguire, R. James. 1986. "Review of the Occurrence, Persistence, and Degradation of Tributyltin in Fresh Water Ecosystems in Canada." Paper presented at the Oceans 86 Conference, September 23-25, 1986, at Washington D.C.

Manning, R. E. 1985. "Crowding norms in backcountry settings: a review and synthesis." Journal of Leisure Research 17 (2): 75-89.

Mele, Andre. 1993. Polluting for Pleasure. New York: W.W. Norton and Company.

Merriam, L.C., Jr., K.D. Wald, and C.E. Ramsey. 1972. "Public and Professional Definitions of the State Park: A Minnesota Case." Journal of Leisure Research, (4) Fall: 259-274.

Milcreek Township. 1980. Comprehensive Plan for Millcreek Township, Erie County, Pennsylvania.

Millcreek Township. 1991. Zoning Ordinance, Millcreek Township, Erie County, PA. Enacted December 30, 1974.

Milliken, Andrew S. and Virginia Lee. 1990. Pollution Impacts from Recreational Boating: A Bibliography and Summary Review. Narragansett, Rhode Island: Rhode Island Sea Grant Publications, University of Rhode Island.

North American Lake Management Society (NALMS). 1990. Lake and Reservoir Restoration Guide. Prepared for the U.S. Environmental Protection Agency. Washington, D.C.

Nixon, Scott W. et al. 1973. Ecology of Small Boat Marinas. Marine Technical Report Series No. 5. Kingston, Rhode Island: University of Rhode Island.

North Carolina Department of Environment, Health, and Natural Resources. 1990. North Carolina Coastal Marinas: Water Quality Assessment. Report No. 90-01.

North Carolina Department of Environment, Health, and Natural Resources. 1991. Coastal Marinas: Field Survey of Contaminants and Literature Review. Report No. 91-03.

Pennsylvania Code, Title 25, Environmental Resources, Chapter 105, Dam Safety and Waterway Management. Department of Environmental Resources.

Pennsylvania Fish and Boat Commission (PAFBC). 1983. Presque Isle Bay Fisheries Assessment. Fisheries Management Section.

Pennsylvania Fish and Boat Commission (PAFBC). 1993. Fishing and Boating Regulations.

Pennsylvania Bureau of State Parks (PBSP). 1993. Resource Management Plan Presque Isle State Park. Erie, PA.

Pennsylvania Department of Environmental Resources (PADER) and the Presque Isle Bay Public Advisory Committee. 1992. Presque Isle Bay Remedial Action Plan.

Pennsylvania Department of Environmental Resources (PADER). 1989. Environmentally Sensitive Areas Study - Presque Isle State Park. Prepared by RBA Group.

Pennsylvania Geological Survey. 1991. Presque Isle State Park, A Dynamic Interface of Water and Land. Pennsylvania Trail of Geology, Park Guide 21. Harrisburg, PA.

Pennsylvania Fish and Boat Commission (PAFBC). 1987. Presque Isle Bay Fisheries Assessment. Fisheries Management Section.

Peterson, G.L. 1974. "A Comparison of the Sentiments and Perceptions of Wilderness Managers and Canoeists in the Boundary Waters Canoe Area." Journal of Leisure Research, (6) Summer 194-206.

Rogers & Golden, Inc. and Alan Mallach/Associates. 1977. Maryland Major Facilities Study, Volume 4: Environmental Assessment Handbook. Maryland Department of Natural Resources, Annapolis, MD.

Schreyer, R. 1979. "Succession and displacement in river recreation." Paper prepared for River Recreation Project, USDA Forest Service, North Central Forest Experiment Station, St. Paul, MN, 45 pp.

Shelby, B. and T. Heberlein. 1987. Carrying Capacities in Recreational Settings. Corvallis, OR: Oregon State University Press.

Stankey, G. H. and S McCool. 1984. "Carrying capacity in recreational settings: evolution, appraisal and application." Leisure Sciences 6 (4): 453-474.

Stankey, G. H., D. N. Cole, R. C. Lucas, M. E. Petersen and S. S. Frissell. 1985. The Limits of Acceptable Change (LAC) System for Wilderness Planning. USDA Forest Service General Technical Report INT-176. Intermountain Forest and Range Experiment Station. Ogden, Utah, 37 pp.

Stankey, G. H. and R. Schreyer. 1987. "Attitudes toward wilderness and factors affecting visitor behavior: a state-of-knowledge review." In Proceedings - National Wilderness Research Conference: Issues, State-of Knowledge, Future Directions. USDA Forest Service General Technical Report INT-220. Intermountain Research Station. Ogden, Utah, p. 246-293.

Stokols, D. 1972. "On the distinction between density and crowding: some implications for future research." Psychological Review 79: 275-277.

U. S. Department of Agriculture, Soil Conservation Service. 1991. Erie County Pennsylvania Soil Survey.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1980. Commonwealth of Pennsylvania Coastal Zone Management Program and Final Environmental Impact Statement.

United States Environmental Protection Agency, Office of Water. 1993. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. Washington, D.C.

Vaske, J. J., A. J. Fedler and A. R. Graefe. 1986. "Multiple determinants of satisfaction from a specific waterfowl hunting trip." Leisure Sciences 8 (2): 149-166.

Wagar, J. A. 1964. The carrying capacity of wildlands for recreation. Society of American Foresters, Forest Science Monograph,23 pp.

Wellejus, E. 1980. Erie - Chronicle of a Great Lakes City. Winsor Publications Woodland Hills, CA.

Western Pennsylvania Conservancy (WPC). 1993. Draft Erie County Natural Heritage Inventory. Pittsburgh, PA.

Young, David R. et al. 1974. Marine Inputs of Polychlorinated Biphenyls and Copper from Anti-Fouling Paints. El Segundo, California: Southern California Coastal Water Research Project.

Yousef, Yousef A. 1974. Assessing Effects on Water Quality by Boating Activity. Prepared for the National Environmental Research Center. Orlando, Florida: Florida Technical University.

Zagorski, S. J. and M. Sampson. 1982. "The Changing Configuration of Presque Isle State Park Peninsula." The Journal of Erie Studies. Vol. 11, No.1.

Personal Communications

Adams, David. Plant Manager, GAF Corporation, Erie, Pennsylvania. November 3, 1993.

Babay, Jim. Plant Controller, Erie Coke Company, Erie, Pennsylvania. November 2, 1993.

Boffoet, Larry. Assistant Director, Economic Development Corporation, Erie, Pennsylvania. November 3, 1993.

Carter, Craig. Chief Officer, U.S. Coast Guard. Erie, Pennsylvania. November 22, 1993.

Frawley, Art. Controller, CODAN, Erie, Pennsylvania. November 3, 1993.

Hickey, Jack. May 1993. International Paints. Personal Communication with Robin Potter.

Houghton, Pete. Chief, Presque Isle State Park. Erie, Pennsylvania. November 22, 1993 and December 14, 1993.

Kissel, Edward. S.O.N.S of Lake Erie representative. Presque Isle Bay Recreational Boating Task Force. November 1, 1993 and December 16, 1993.

Miley, Steve. General Manager, Erie Marine Enterprise, Erie, Pennsylvania. November 2, 1993.

Mong, John. Project Manager, Erie County Department of Planning. Erie County, Pennsylvania. October 22, 1993.

Morosky, Larry. Executive Director, Erie-Western Pennsylvania Port Authority. July 23, 1993 and October 28, 1993.

Murray, Charles. Pennsylvania Fish and Boat Commission. December 16, 1993.

Pomorski, Doug. Erie-Western Pennsylvania Port Authority. July 23, 1993.

Simmons, John. Recreational Boating Bureau Chief. Pennsylvania Fish and Boat Commission. October 27, 1993.

Wellington, Bob. Erie County Health Department. October 13, 1993.

APPENDIX A

WATER QUALITY SAMPLING DATA

Presque Isle Bay Recreational Boating Impacts

Water Quality Sampling Results

	5/17/1993 (PRE-SEASON)				6/14/1993 (POST-WEEKEND)			
PARAMETERS	COMMODORE PERRY SURFACE	COMMODORE PERRY DEPTH	PIB STATE PARK SURFACE	PIB STATE PARK DEPTH	BAY HARBOR SURFACE	BAY HARBOR DEPTH	PIB STATE PARK SURFACE	PIB STATE PARK DEPTH
DIESEL RANGE ORGANICS (mg/l)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
GASOLINE RANGE ORGANICS (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SURFACTANTS (mg/l)	0.046	< 0.025	0.025	0.033	0.025	0.032	< 0.025	< 0.025
ETHYLENE GLYCOL (mg/l)	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
FECAL COLIFORM (MPN)	800	1200	3600	1800	200	60	1500	200
LEAD (ug/l)	2	2	2	2	4	4	< 1	< 1
COPPER (mg/l)	0.007	0.006	0.005	0.004	< 0.002	< 0.002	< 0.002	< 0.002
TIN (mg/l)	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
DISSOLVED OXYGEN (mg/l)	9.2	9.3	11.3	9.8	8.6*	10.3*	12.2*	10.5*
CONDUCTIVITY (umhos)	494	441	471	458	521	495	507	531
WATER TEMP. (degrees Celsius)	15.0	14.5	15.5	15.0	21.0	19.5	22.0	20.0
pH (units)	7.2	7.0	7.1	7.0	7.4	7.4	7.0	7.2
TOTAL DEPTH (ft)	6.0		13.0		8.0		13.5	
SECCHI DEPTH (ft)	CLEAR TO BOTTOM		4.5		4.5		9.0	
# OF BOATS IN DOCK	35		144		195		344	
AIR TEMP (degrees Celsius)	13.0		13.0		31.0		31.0	

NOTE: Field conductivity readings are suspect.

* Dissolved oxygen meter calibration suspect.

Presque Isle Bay Recreational Boating Impacts

Water Quality Sampling Results

PARAMETERS	7/2/1993 (PRE-HOLIDAY)				7/6/1993 (POST-HOLIDAY)			
	BAY HARBOR SURFACE	BAY HARBOR DEPTH	PIB STATE PARK SURFACE	PIB STATE PARK DEPTH	BAY HARBOR SURFACE	BAY HARBOR DEPTH	PIB STATE PARK SURFACE	PIB STATE PARK DEPTH
DIESEL RANGE ORGANICS (mg/l)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
GASOLINE RANGE ORGANICS (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SURFACTANTS (mg/l)	0.027	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
ETHYLENE GLYCOL (mg/l)	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
FECAL COLIFORM (MPN)	220	230	10	80	840	60	50	60
LEAD (ug/l)	5	6	2	1	5	5	2	< 1
COPPER (mg/l)	0.006	0.007	0.003	0.004	0.012	0.008	0.008	0.008
TIN (mg/l)	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
DISSOLVED OXYGEN (mg/l)	5.6	5.3	6.3	5.8	6.7	6.4	10.0	4.3
CONDUCTIVITY (umhos)	503	576	496	488	538	536	506	512
WATER TEMP. (degrees Celsius)	21.8	21.5	22.8	22.0	24.5	24.0	25.8	23.0
pH (units)	6.8	7.3	7.8	7.7	7.4	7.6	7.6	7.5
TOTAL DEPTH (ft)	8.0		14.0		8.0		14.0	
SECCHI DEPTH (ft)	4.5		5.5		4.5		8.0	
# OF BOATS IN DOCK	205		402		209		411	
AIR TEMP (degrees Celsius)	24.0		24.0		27.0		27.0	

NOTE: Field conductivity readings are suspect.

Presque Isle Bay Recreational Boating Impacts

Water Quality Sampling Results

PARAMETERS	7/30/1993 (PRE-WEEKEND)				8/2/1993 (POST-WEEKEND)			
	BAY HARBOR SURFACE	BAY HARBOR DEPTH	PIB STATE PARK SURFACE	PIB STATE PARK DEPTH	BAY HARBOR SURFACE	BAY HARBOR DEPTH	PIB STATE PARK SURFACE	PIB STATE PARK DEPTH
DIESEL RANGE ORGANICS (mg/l)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
GASOLINE RANGE ORGANICS (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SURFACTANTS (mg/l)	0.035	0.057	0.034	< 0.025	0.033	0.037	< 0.025	< 0.025
ETHYLENE GLYCOL (mg/l)	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
FECAL COLIFORM (MPN)	3800	5000	20	< 10	530	850	< 10	< 10
LEAD (ug/l)	8	9	3	2	7	14	< 1	< 1
COPPER (mg/l)	0.007	0.007	< 0.002	< 0.002	0.007	0.011	< 0.002	< 0.002
TIN (mg/l)	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
DISSOLVED OXYGEN (mg/l)	5.7	5.6	7.0	6.9	5.5	5.5	8.8	2.4
CONDUCTIVITY (umhos)	442	463	450	402	494	500	457	469*
WATER TEMP. (degrees Celsius)	23.2	23.2	24.0	24.2	23.0	23.0	23.9	23.0
pH (units)	7.2	7.4	8.2	8.1	6.3	6.3	8.0	7.6
TOTAL DEPTH (ft)	8.5		14.0		8.0		14.0	
SECCHI DEPTH (ft)	2.0		3.0		3.5		3.5	
# OF BOATS IN DOCK	204		418		204		416	
AIR TEMP (degrees Celsius)	18.5		18.5		21.5		21.5	

NOTE: Field conductivity readings are suspect.

* Laboratory conductivity reading for this site (at depth) was 269 umhos.

Presque Isle Bay Recreational Boating Impacts

Water Quality Sampling Results

	9/7/1993 (POST-HOLIDAY)			
PARAMETERS	BAY HARBOR SURFACE	BAY HARBOR DEPTH	PIB STATE PARK SURFACE	PIB STATE PARK DEPTH
DIESEL RANGE ORGANICS (mg/l)	< 0.1	< 0.1	< 0.1	< 0.1
GASOLINE RANGE ORGANICS (mg/l)	< 0.01	< 0.01	< 0.01	< 0.01
SURFACTANTS (mg/l)	0.037	0.038	0.055	0.110
ETHYLENE GLYCOL (mg/l)	< 2	< 2	< 2	< 2
FECAL COLIFORM (MPN)	1400	1300	20	< 20
LEAD (ug/l)	3	5	1	< 1
COPPER (mg/l)	0.008	0.011	0.007	0.004
TIN (mg/l)	< 0.04	< 0.04	< 0.04	< 0.04
DISSOLVED OXYGEN (mg/l)	5.3	5.8	6.2	5.9
CONDUCTIVITY (umhos)	N/A	N/A	N/A	N/A
WATER TEMP. (degrees Celsius)	21.0	21.0	22.0	22.5
pH (units)	7.2	7.3	6.8	6.9
TOTAL DEPTH (ft)	7.5		12.5	
SECCHI DEPTH (ft)	5.0		3.5	
# OF BOATS IN DOCK	213		422	
AIR TEMP (degrees Celsius)	16.5		16.5	

APPENDIX B

BOATER SURVEY RESULTS

1993 PRESQUE ISLE BAY RECREATIONAL BOATING STUDY

SUMMARY OF BOATER SURVEYS

NUMBER OF INTERVIEWS COMPLETED: 479

DATE OF INTERVIEWS:		
	JUNE 12	74
	JUNE 13	71
	JULY 3	72
	JULY 4	74
	JULY 31	47
	AUGUST 1	72
	AUGUST 31	6
	SEPT. 5	59
	SEPT. 6	4

LOCATION OF INTERVIEWS:		
	LAMPE RAMP/MARINA	77
	EAST AVENUE RAMP	58
	PERRY'S LANDING	76
	ERIE YACHT CLUB	12
	DOBBINS LANDING	16
	PRESQUE ISLE STATE PARK	
	WEST PIER RAMP	82
	MARINA	68
	NIAGARA RAMP	74
	LAGOON RAMP	13
	BEACH 9	3

1. Where is your principal home residence?

PA-93% OH-3% (state) ERIE-48% PITTSBURGH-10% (town)

2. About how many miles is it from your residence to Presque Isle Bay one-way?

RANGE=0-750 MILES MEAN=55 MILES[1] MEDIAN=5 MILES[2]

3. How many people were in your boating group today? Include all the people who used the boat today?

RANGE=0-15 PEOPLE MEAN=3.2 PEOPLE MEDIAN=2 PEOPLE

4. Which of the following best describes the people in your group?

7% Alone	20% Family & Friends
26% Friends	.4% Business Associates
46% Family	.4% Other

4a. How many children under age 12 are in your group?

21% OF GROUPS HAD AN AVERAGE OF 1.9 CHILDREN WITH THEM

[1] The mean value is the arithmetic average, or the sum of all responses divided by the number of cases.

[2] The median is the middle value, or the value having the same number of scores with smaller values as there are with larger values.

5. What time did you start boating today?

RANGE=4:00 AM TO 7:00 PM

6. Have you finished boating for the day?

30% No 70% Yes

IF NO When do you plan to go out on the water again?

RANGE=11:00 AM TO 8:00 PM

When do you plan to stop boating for the day?

RANGE=12:00 NOON TO 12:00 MIDNIGHT

Next, I would like to ask some questions about your boat.

7. What kind of boat do you have at the lake today?

32% Cabin Cruiser	1% Row Boat
48% Runabout	1% Canoe or kayak
<1% House Boat	0% Pontoon Boat
5% Sailboat	7% Bass Boat
3% Waverunner/jetski	2% Sailboard
	1% Other

8.. What kind of power, if any, does your boat use?

33% Outboard	4% Sail only
18% Inboard	1% Paddle/oar only
44% Inboard/Outboard	<1% Other

9. What is the total horsepower of your engine(s)?

RANGE=0-1000 HP MEAN=164 HP MEDIAN=130 HP

10. How many feet long is your boat?

RANGE=6-50 FEET MEAN=20 FEET MEDIAN=19 FEET

My next questions are about your boating experience.

11. How many years have you been a boater?

RANGE=0-65 YEARS MEAN=17 YEARS MEDIAN=15 YEARS

12. How would you rate yourself as a boater?

9% Novice 34% Intermediate 38% Advanced 19% Expert

13. Have you ever taken a boater safety training course?

54% No 46% Yes

14. How many days did you boat on Presque Isle Bay last year?

RANGE=0-200 DAYS MEAN=24 DAYS MEDIAN=14 DAYS

15. Including your boating at Presque Isle Bay, how many days did you boat in total last year?

RANGE=0-365 DAYS MEAN=41 DAYS MEDIAN=30 DAYS

16. Here is a list of boating activities you might have participated in today. Please tell me which of these activites your boating group did. What percent of time did you spend on each of the following activities?

Percent Participating	Average Percent of Time Spent	
18%	6.5%	Anchored
52%	45.3%	Fishing
11%	3.5%	Swimming from Boat
7%	2.8%	Waterskiing
46%	29.3%	Pleasure Cruising
5%	4.8%	Sailing
1%	1.2%	Board Sailing
4%	3.4%	Jet Skiing
7%	3.3%	Other

17. While boating today, did you:

21% Boat only within Presque Isle Bay
30% Boat outside of the Bay on Lake Erie
49% Boat both within the bay and on Lake Erie

18. On a scale of 1 to 10 (with 10 being the perfect trip), how would you rate the quality of your boating experience today?

RANGE=1-10 MEAN=7.3 MEDIAN=8.0

19. What were the most enjoyable aspects of your boat trip today?

NICE WEATHER, CATCHING FISH, RELAXATION, SCENERY (MOST COMMON ANSWERS)

20. What were the least enjoyable aspects of your boat trip today?

ROUGH WEATHER, NOTHING, NO FISH (MOST COMMON ANSWERS)

21. Using the enjoyment scale on the card, how did the number of boaters at the lake today affect your overall boating experience?

2%	4%	5%	3%	66%	5%	10%	3%	3%
1	2	3	4	5	6	7	8	9

Increased my enjoyment No effect Reduced my enjoyment

22. Next I am going to read some statements about boating here at Presque Isle Bay. Based on your experience here today, please rate your level of agreement or disagreement with each statement I read, using the agreement scale on the card.

	STRONGLY AGREE	AGREE	UNDECIDED	DISAGREE	STRONGLY DISAGREE
I avoided my favorite parts of the bay because there were too many boats there	3%	9%	8%	50%	30%
I thoroughly enjoyed my boat trip today	31%	55%	6%	7%	2%
I stayed off the bay during parts of the day today because there were too many boats on the bay	2%	6%	7%	54%	30%
My boating trip was <u>not</u> as enjoyable as I expected it to be	4%	16%	4%	51%	25%
There was an unsafe number of boats on the water today	1%	5%	5%	61%	28%
I cannot imagine a better boating trip	8%	24%	14%	44%	10%
Other boats came closer to my boat than I like	5%	14%	2%	55%	24%
The bay water quality appeared good	11%	62%	9%	13%	5%
I do not want to go on any more boat trips like this one	2%	5%	3%	45%	44%
The noise of other boats reduced my enjoyment on the bay today	1%	3%	3%	63%	31%
My boat trip today was well worth the money I spent to take it	21%	65%	5%	7%	2%
There are adequate law enforcement patrols at Presque Isle Bay	27%	49%	14%	9%	2%
If I had known what it was going to be like here today, I would not have come on this visit	3%	7%	2%	47%	41%
I was disappointed with some aspects of my boat trip	4%	26%	3%	49%	18%
I would feel comfortable swimming in the bay	8%	34%	10%	33%	15%
The number of boats on the bay reduced my enjoyment of the bay today	1%	9%	7%	61%	23%
I nearly had an accident on the bay today because of crowded conditions	1%	1%	1%	41%	56%

	STRONGLY AGREE	AGREE	UNDECIDED	DISAGREE	STRONGLY DISAGREE
The behavior of other boaters interfered with the quality of my boating experience	2%	10%	4%	56%	29%
IF AGREE WITH THIS STATEMENT Can you describe how:					
I did not like the amount of time I had to wait to get on the water today	1%	2%	3%	50%	44%

IF AGREE How much time did you have to wait?

AVERAGE=25 MINUTES

How long are you willing to wait?

AVERAGE=18 MINUTES

Boating conditions on the bay today were safe	21%	68%	5%	7%	<1%
I did not participate in some boating activities today because of crowded conditions on the bay	1%	6%	3%	60%	30%

IF AGREE Which activities?

23. Did you observe any unsafe boating situations on the bay today?

78% No 22% Yes

IF YES, could you describe them?

Where did they occur? COMMENTS LISTED IN SEPARATE DATA REPORT

24. Using the crowding scale on the card, how would you describe the boating conditions at each of the following areas today?

1	2	3	4	5	6	7	8	9
Not at all Crowded		Slightly Crowded			Moderately Crowded			Extremely Crowded

2.4 At the access area at the start of your trip (mean rating)
3.7 Out on the bay while boating
4.8 At the channel
3.2 At the access area when you stopped boating

25. How did the number of people you saw at the bay today compare with what you expected to see?

18% A lot less than you expected
22% A little less than you expected
44% About what you expected
10% A little more than you expected
3% A lot more than you expected
2% You didn't really have any expectations

26. Were there any specific locations on the bay or lake that you felt were especially crowded?

COMMENTS LISTED IN SEPARATE DATA REPORT

The last few questions are about how you handle the maintenance and upkeep of your boat.

27. What material is your boat made of (the hull)?

78% Fiberglass 2% Wood 20% Metal

28. How often is your boat painted? 77% NEVER 7% EVERY YEAR 6% EVERY 5 YEARS

29. What are the brand names of the paints and other products used on your boat?

INTERLUX (most common answer)

30. How soon after painting is your boat returned to the water?

5% < 1 week 5% 1 week 9% > 1 week 83% Not applicable

31. What other types of maintenance are performed on your boat while it is in the water? (Be as specific as possible)

11% Engine repair 11% Oil change 21% Other (mostly minor tune-ups)

32. How many times a year do you clean the outside of your boat?

7% AFTER EACH USE 5% EACH WEEK 9% ONCE/YEAR 15% TWICE/YEAR

33. What cleaning solutions do you use? (List the brand and product names)

SOAP AND WATER (most common answer)

34. Where do you clean your boat?

18% Marina 3% Dry dock 67% At home 11% Other

35. How old is your boat and engine?

age of boat RANGE=0-52 YEARS MEAN=10 YEARS MEDIAN=7 YEARS

age of engine RANGE=0-36 YEARS MEAN=9 YEARS MEDIAN=6 YEARS

36. How large is your gas tank?

RANGE=0-400 GALLONS MEAN=47 GALLONS MEDIAN=28 GALLONS

37. Where do you fill your gas tank? 77% GAS STATION 20% MARINA/GAS DOCK

38. During a typical week of boating on Presque Isle Bay, how much gasoline do you use?

RANGE=0-360 GALLONS MEAN=24 GALLONS MEDIAN=15 GALLONS

39. Does your boat have a marine toilet or porta potty? 60% No 40% Yes

ASK IF YES What type is it?

18% Built-in head with holding tank
21% Portable unit (Porta Potty)
1% Other

40. Finally, do you have any suggestions for improved management of Presque Isle Bay?

COMMENTS LISTED IN SEPARATE DATA REPORT

ADDITIONAL COMMENTS:

COMMENTS LISTED IN SEPARATE DATA REPORT

APPENDIX C

BOATER COMMENTS ABOUT RECREATIONAL BOATING ON PRESQUE ISLE BAY

Table AA. Open-ended responses for most enjoyable aspects of the trip.

Value Label	Frequency	Valid Percent
WEATHER/WIND CONDITIONS	137	23.1
FISH/FISHING	104	17.6
BEING W/ FAMILY/FRIENDS	58	9.8
REST/RELAXATION	41	6.9
WATER/WAVE CONDITIONS	31	5.2
ENJOYING NATURE/SCENERY	29	4.9
BOATING/PLEASURE CRUISING	27	4.6
BEING OUT ON LAKE/BAY	19	3.2
ESCAPE/GETTING AWAY	14	2.4
OTHER/MISC	14	2.4
COMING IN/GETTING OFF LAKE/BAY	13	2.2
TALL SHIPS	13	2.2
SWIMMING	12	2.0
EATING/DRINKING	10	1.7
EVERYTHING	10	1.7
WATERSKIING	10	1.7
NOTHING/NONE	8	1.4
ACCESS/GETTING HERE	6	1.0
GIRLS/WOMEN	6	1.0
BEING INTERVIEWED	5	0.8
SAILING	5	0.8
GETTING WET	4	0.7
SIGHTSEEING	4	0.7
LACK OF CROWDS/CROWD	2	0.3
RECREATION/LEISURE/FUN	2	0.3
BEACH/BEACHES	1	0.2
BOAT RAN WELL	1	0.2
CHANNEL	1	0.2
JET SKIING	1	0.2
LISTENING TO RADIO	1	0.2
LONG POINT	1	0.2
NICE FACILITIES	1	0.2
SUNBATHING	1	0.2
Total	**592**	**100.0%**

Table BB. Open-ended responses for least enjoyable aspects of boat trip.

Value Label	Frequency	Valid Percent
WATER/WAVE CONDITIONS	105	21.0
NOTHING/NONE/NO	71	14.2
WEATHER/WIND CONDITIONS	64	12.8
FISH/FISHING	53	10.6
BROKE DOWN/MECHANICAL PROBLEMS	31	6.2
CROWDING/TOO MANY BOATS/PEOPLE	28	5.6
ACCESS AREA/MARINA/DOCKS	21	4.2
OTHER/MISC	18	3.6
INJURY/SICKNESS	13	2.6
BUGS/FLIES/INSECTS	11	2.2
WEEDS/SEAWEED	11	2.2
COMING IN/HOME	7	1.4
SWAMPED/FALLING/GETTING WET	7	1.4
OTHER BOATERS	6	1.2
LOST SOMETHING	5	1.0
UNSAFE BOATING	5	1.0
ACCIDENT/COLLISION	4	0.8
CLEANING BOAT	4	0.8
LAUNCHING/RETRIEVING	4	0.8
RESTROOMS	4	0.8
CHANNEL	3	0.6
COST	2	0.4
EATING/DRINKING	2	0.4
GETTING HERE/DRIVING	2	0.4
JET SKIERS	2	0.4
NOISE	2	0.4
SAILING/SAILORS	2	0.4
SMELL	2	0.4
WATER QUALITY/POLLUTION	2	0.4
BEACH/SHORE CONDITIONS	1	0.2
EVERYTHING	1	0.2
GULL POINT	1	0.2
LACK OF TIME	1	0.2
PACKING/PREPARATION	1	0.2
PARKING	1	0.2
POLICE/LAW ENFORCEMENT	1	0.2
THE BAY (IN GENERAL)	1	0.2
WAITING	1	0.2
Total	**500**	**100.0%**

Table CC. Open-ended responses describing the behavior of other boaters that interfered with the boating experience.

Value Label	Frequency	Valid Percent
CARELESS/INCONSIDERATE BOATERS	7	15.2
JET SKIERS	7	15.2
FAILURE TO OBSERVE RULES (R.O.W.)	6	13.0
SPEED-TOO FAST/SLOW	6	13.0
TOO CLOSE	6	13.0
CUT OFF/GOT IN WAY	3	6.5
LOUD MUSIC/NOISE	3	6.5
WAKE VIOLATIONS/BIG WAKES/WAVES	3	6.5
CROWDS/CROWDING	1	2.2
FISHERMEN	1	2.2
NONE/NOT TODAY	1	2.2
OTHER/MISC	1	2.2
SAILBOATS/SAILORS	1	2.2
Total	**46**	**100.0%**

Table DD. Open-ended responses for activities displaced due to crowded conditions.

Value Label	Frequency	Valid Percent
FISHING/FISHED MORE	8	36.4
WATERSKIING/TUBING/KNEE BOARDING	6	27.3
PLACE DISPLACEMENT (GENERAL)	3	13.6
BOATING/BOATED MORE	2	9.1
TALL SHIPS (VIEWING/SIGHTSEEING)	2	9.1
SWIMMING	1	4.5
Total	**22**	**100.0%**

Table EE. Open-ended responses for unsafe boating situations observed by respondent.

Value Label	Frequency	Valid Percent
JET SKIERS	16	13.7
SPEEDING/TOO FAST	15	12.8
TOO CLOSE	12	10.3
CUT OFF/IN FRONT	11	9.4
BOATSIZE-TOO BIG/SMALL	7	6.0
SAILBOATS	7	6.0
ARMS/LEGS IN WATER WHILE MOVING	5	4.3
WAKE VIOLATIONS	5	4.3
OTHER/MISC	4	3.4
ALCOHOL/DRINKING & DRIVING	3	2.6
BOATING LANE VIOLATIONS	3	2.6
GENERAL RULE VIOLATIONS	3	2.6
CARELESSNESS	2	1.7
COLLISION/ACCIDENT	2	1.7
RECKLESS DRIVING	2	1.7
STANDING/ROCKING BOAT	2	1.7
WATERSKIING	2	1.7
BOATING ALONE	1	0.9
CANOE/KAYAKS	1	0.9
CAPSIZING/SWAMPING	1	0.9
CROWDING/HEAVY TRAFFIC	1	0.9
HANDICAP DECK STICKS OUT TOO FAR	1	0.9
INJURY/ILLNESS	1	0.9
NAVIGATION PROBLEMS	1	0.9
NOT PAYING ATTENTION	1	0.9
OVERLOADED BOAT	1	0.9
PFD/LIFE JACKET VIOLATIONS	1	0.9
POLICE/LAW ENFORCEMENT	1	0.9
ROCKS	1	0.9
SMOKING ON BOAT	1	0.9
TOO CLOSE TO SHORE	1	0.9
UNSAFE RE-FUELING	1	0.9
WAVE/WATER CONDITIONS	1	0.9
Total	**117**	**100.0%**

Table FF. Open-ended responses for location of unsafe boating situations observed by respondent.

Value Label	Frequency	Valid Percent
ALL OVER BAY/EVERYWHERE	21	24.1
CHANNEL	19	21.8
LAKE ERIE	9	10.3
MARINA CHANNEL/ENTRANCE	6	6.9
DOCKS/ACCESS AREAS/MARINAS	5	5.7
BAY & LAKE	4	4.6
BEACH 11	4	4.6
MIDDLE OF BAY	3	3.4
OTHER/MISC	2	2.3
FISHING AREAS	1	1.1
FUEL DOCKS	1	1.1
GRAVE YARD POINT	1	1.1
GULL POINT	1	1.1
HAMMERMILL	1	1.1
MISERY BAY	1	1.1
NEAR LAMPE	1	1.1
NORTHEAST AREA	1	1.1
RUM RUNNERS	1	1.1
SHADES BEACH	1	1.1
STATE PARK MARINA/RAMP	1	1.1
THOMPSON BAY	1	1.1
WATERSKIING AREAS	1	1.1
WEST SIDE	1	1.1
Total	**87**	**100.0%**

Table GG. Open-ended responses for specific location on Bay/Lake that respondents felt were especially crowded.

Value Label	Frequency	Valid Percent
NONE/NO	250	61.6
CHANNEL	54	13.3
ACCESS AREAS/LAUNCH	34	8.4
BEACH #11	15	3.7
BAY-IN GENERAL	9	2.2
NEAR TALL SHIPS	9	2.2
GULL POINT	4	1.0
SHADES BEACH	4	1.0
BEACHES-IN GENERAL	3	0.7
DOBBINS LANDING	2	0.5
FISHING AREAS	2	0.5
HAMMER MILL	2	0.5
HEAD OF BAY	2	0.5
PARKING LOTS	2	0.5
WATERSKI RAMPS/AREA	2	0.5
BARS	1	0.2
BEACH #6	1	0.2
HARBOR	1	0.2
LAGOON	1	0.2
NO WAKE AREAS	1	0.2
PRESQUE ISLE MARINA	1	0.2
RUM RUNNERS	1	0.2
SNO-CO CRISTA AREA	1	0.2
THE WALL	1	0.2
THOMPSON BAY	1	0.2
TYPICAL PLACES	1	0.2
YACHT CLUB	1	0.2
Total	**406**	**100.0%**

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