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RECREATIONAL BOATING ON DELAWARE'S INLAND BAYS:

IMPLICATIONS FOR SOCIAL AND ENVIRONMENTAL CARRYING CAPACITY

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EXECUTIVE SUMMARY

Background and Methods

This study, entitled *Recreational Boating on Delaware's Inland Bays: Implications for Social and Environmental Carrying Capacity*, provides the first-ever glimpse of recreational boating carrying capacity for a water body in Delaware. It was a cooperative effort of the Inland Bays Estuary Program, under the direction of the Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Water Resources, and the University of Delaware Sea Grant Marine Advisory Service (UDSGMAS). The purpose of the study was to obtain information from recreational users, bay-wide, during the summer of 1991, to determine whether problems existed from a carrying capacity standpoint.

The study had five objectives: (1) establish linkages between recreational uses and impacts on the bays and determine spatial relationships between the uses; (2) identify users' perceptions about specific environmental quality problems; (3) evaluate the potential of a range of management strategies for the Inland Bays; (4) develop recommendations for integrating carrying capacity issues with other land- and water-use planning methods; (5) develop a Geographic Information System (GIS) for display and analysis of recreational use data.

Recreational use data were collected in Rehoboth, Indian River, and Little Assawoman Bays by several integrated methods. Initially, on-site field interviews were conducted at nine sampling locations around the bays during the summer of 1991. A total of 451 recreational users were interviewed. Additionally, 600 mail surveys were sent to shoreline residents living in the Inland Bays area. Two hundred and ninety residents responded to the questionnaires for a 58 percent response rate after adjusting for nondeliverable addresses. On seven days during the month of August, on-water counts of boats were conducted on Rehoboth and Indian River bays to ascertain the density levels of boating activity on the bays. Density levels were examined within distinct zones identified for each bay system. The numbers of vehicles parked at major access points were also counted to help determine density levels.

The collected data were analyzed in various ways. First, boater survey responses were examined by user group classification (permanent resident, seasonal resident, and seasonal visitor). Other analyses were performed by type of facility used by boaters (marina, boat ramp, and shoreline community) and by bay of residence (Rehoboth, Indian River, and Little Assawoman). Since the user group classification represented the greatest differences statistically, and this information is most relevant to resource managers, it forms the basis for most of the study findings which follow.

Study Findings

<u>Profile of Inland Bay Boaters</u>

- Overall, seasonal residents and visitors were most likely to have their permanent homes in Pennsylvania, followed by Delaware and Maryland. Seasonal residents lived, on average, 137 miles from the bays, and visitors lived, on average, 238 miles away.

- Permanent residents reported the highest level of boating participation on the Inland Bays (41 days in 1990), while seasonal visitors reported the lowest frequency (18 days), and seasonal residents reported boating an average of 33 days on the Inland Bays in 1990.

- Permanent residents tended to have the most boating experience (23 years) and rated their boating skills the highest, while seasonal visitors were lowest on both of these measures.

- Boaters sampled at marinas were the least active on the Inland Bays during 1990 (16 days), whereas those sampled at shoreline communities were the most active (44 days). Boat-ramp users interviewed reported that they boated, on average, 18 days on the Inland Bays in 1990.

Profile of Inland Bay Boats

- Most seasonal visitors (84%), seasonal residents (73%), and permanent residents (58%) reported owning powerboats; however, pontoon boats were used by a significant minority of permanent residents (25%) and seasonal residents (21%).

- Seasonal residents had the largest boats (20') and the highest horsepower engines (126 HP). Seasonal visitors had the smallest boats (17'), and permanent residents tended to have the smallest horsepower engines (88 HP).

- Powerboats were used by two-thirds or more of marina-based boaters, boat-ramp users, and boaters in shoreline communities. Pontoon boats were well represented, however, at both marinas (20%) and shoreline communities (34%).

- Shoreline community boaters had the largest boats (23') and highest horsepower engines, on average, (142 HP). Boat-ramp users had the smallest boats (17') and lowest horsepower engines (87 HP).

- Rehoboth Bay boaters tended to have larger boats (20') than either Indian River (18') or Little Assawoman (18') Bay boaters.

Boating-Group Characteristics

- The majority of all three user groups reported that their boating party was made up of family members. Seasonal residents were most likely to report a boating group comprised of both family and friends. Permanent residents were more likely than seasonal residents or visitors to boat alone.

- Seasonal residents reported the largest boating groups (3.2 people), and permanent residents reported the smallest group size (2.7 people).

- Those sampled at marinas were the most likely to boat with family and friends together and were the only case where family groups represented less than the majority. About 60 percent of both boat-ramp users and shoreline community residents reported boating with family members most often.

- Rehoboth Bay residents tended to boat in the smallest groups (2.2 people), while those living on Indian River Bay reported the largest groups (3.0 people).

Boating-Group Activities

- According to survey respondents, fishing was the most popular boating activity overall. Seasonal visitors reported the highest proportion of time devoted to fishing (56%) compared to seasonal residents (42%) and permanent residents (30%).

- Powerboating (pleasure cruising) was significantly more popular among both permanent (24%) and seasonal (20%) residents than seasonal visitors (10%). Little Assawoman Bay boaters (47%) reported twice as much powerboating activity as Rehoboth Bay (22%) or Indian River Bay (25%) boaters.

- Sailors were a small minority, but were significantly better represented among permanent residents (6%) than among seasonal residents (1%) and visitors (2%).

- Clamming activity was greater in Indian River Bay than in the other two bays and was engaged in more often by boat-ramp users (11%) than by marina boaters (3%) or shoreline community residents (2%).

- Little Assawoman Bay (16%) attracted the most crabbing activity by boaters, followed by Rehoboth Bay (8%) and Indian River Bay (6%).

On-Water Observations of Boating Activity (Indian River and Rehoboth Bays)

- About three-quarters of all the activities observed in Indian River Bay were either fishing (40%) or cruising (34%), whereas these same two activities in Rehoboth Bay constituted only 41% of the observed activity (cruising, 21%; fishing, 20%).

- Sailing and sailboarding made up 31% of the total boating activity observed in Rehoboth Bay and only 3% of the activity in Indian River Bay.

- Jetskiing activity was observed more often in Rehoboth Bay (8%) than in Indian River Bay (2%).

- Crabbing and clamming activity in Indian River Bay accounted for 16 percent of the total activity observed. The same two activities in Rehoboth Bay amounted to 12 percent of the total.

- The zone in Indian River Bay between Channel Markers 30 and 31 had the highest boat use intensity by acre of total water surface; the average ratio was 23 acres/boat.

- The least intensely used area, based on observations, was between Channel Markers 28 and 30; the average acre to boat ratio was 58 acres/boat.

- The most intensely used area in Rehoboth Bay was the northeast quadrant where the average ratio was 14 acres/boat.

- The northwest quadrant of Rehoboth Bay (excluding tributaries) was the least intensely used area; the average acre to boat ratio was 125 acres/boat.

- The area between the Indian River Inlet Bridge and Channel Marker 20 was the most heavily used zone when total number of boats were counted. On the average, 186 vessels were observed in this zone on each sampling day (range: 100-311 boats).

Spatial Analysis of Boating Distributions and Patterns

- The area in the bays that boaters reported enjoying the least or avoiding the most was near Indian River Inlet. The reasons mentioned most often were high-use densities, perceived conflicting usages, and shallow water conditions.

- The areas that boaters reported enjoying the most were dispersed throughout the bays. The reasons most often mentioned were good fishing, crabbing or clamming, low use densities, and lack of crowds.

- Analyses of reported boating routes and locations of certain activities suggest areas of potential conflict between cruising boats and fishermen.

Perceptions of Boating Quality and Impacts

- Permanent residents rated the quality of their trip 8.0 (1 to 10 scale), while seasonal residents rated their experience 7.3, and seasonal visitors rated their trip 7.2.

- All user groups reported that they enjoyed their trip and felt it was worth the money that they spent on it; however, many noted that it did not measure up to their ideal or best-ever boating outing.

- All user groups tended to feel that the bays were moderately crowded (4.5-4.9 on a 9-point scale index), but the number of boats on the bays generally had little or no effect on their overall enjoyment levels.

- Permanent residents reported higher levels of displacement (2.3 on a 1 to 5 scale index), for example, avoiding favorite parts of bay due to crowding, staying off the bays during part of the day due to crowding, giving up activities because of water quality than seasonal residents (2.1) and visitors (2.1).

- Most boaters (74-92%) agreed that conditions on the bays the day they boated were safe, and only a minority (21-46%) said that they had observed any unsafe boating situations. Permanent resident responses showed more concern about safety on the bays than either of the other user groups.

- Very few boaters (2-5%) acknowledged that they nearly had an accident on the day they were sampled, while most (42-64%) felt that there were adequate law enforcement patrols on the bays. Permanent residents (42%) were the only group where less than a majority felt that current law enforcement patrols were adequate (64%-seasonal residents; 52%-seasonal visitors).

- Permanent residents (21%) were more sensitive to the noise of other boaters (11%-seasonal residents; 12%-seasonal visitors), and they also observed more inappropriate boater behavior (31%) than seasonal residents (19%) or visitors (14%).

Effects of Boat Density on Boating Quality

- Boaters who were sampled on days with higher boat density levels perceived crowding to be greater (5.6 on a 1 to 9 scale) (3.8-low use; 4.8-medium use) and were more likely to feel that the increased number of boaters on the bays had an impact on their day's trip (5.4 on a 1 to 9 scale) (4.8-low use; 5.1-medium use).

- High-use-day boaters (20%) were also more likely to stay off the bays during parts of the day because there were too many other boats than either low- (13%) or medium-density (12%) boaters.

- Most boaters who were sampled on low- (3.3 on a 1 to 5 scale index), medium- (3.2), or high-use days (3.2) felt that safe boating conditions existed on the bays. However, high-use-day boaters reported observing more unsafe situations (37%) than boaters who boated on less crowded days (24% -low use; 31%-medium use).

- Boaters who felt the number of other boats on the bays decreased their trip enjoyment were less satisfied overall with their boating experience (3.2 on a 1 to 5 scale index) than boaters who felt no effect (3.6) or felt increased enjoyment (3.7) from the presence of others.

- The boating group that reported decreased enjoyment from the presence of others also had a higher level of perceived crowding (6.5 on a 1 to 9 scale) than boaters who felt no effect (4.2) or felt increased enjoyment (3.6).

- Seventy percent of the boaters in the group that felt decreased enjoyment reported that other boats had come too close to them compared to 25% of boaters that felt increased enjoyment from the presence of others and 21% that felt no effect.

<u>Perceptions of Litter and Marine Waste</u>

- Very few boaters reported seeing marine debris or litter during their boating trips. Permanent residents (who are more sensitive to litter and debris) consistently reported a higher frequency of observing marine debris and were significantly more likely to report reduced enjoyment of their trip because of debris (5.1 on a 9-point scale versus 4.3-seasonal residents; 4.1-seasonal visitors).

- Boaters sampled at shoreline communities (3.8 on a 9-point scale) were most likely to report that seeing little or no marine debris enhanced the quality of their boating experience, while marina-based boaters (4.8) were more sensitive to the waste they observed.

<u>Perceived Changes in Environmental Quality and Living Resources</u>

- Permanent residents (57%) were much more likely than seasonal residents (32%) and seasonal visitors (27%) to state that the environmental quality (water quality and clarity) of the bays was deteriorating.

- Seasonal residents (37%) and visitors (34%) had a stronger sense that the environmental quality of the bays was improving than did permanent residents (19%).

- Permanent residents (66%) had a stronger feeling than seasonal residents (48%) and visitors (42%) that the bays' living resources (fish, crabs, clams, etc.) were deteriorating.

- Indian River Bay residents (70%) felt more strongly that the environmental quality of the bays was deteriorating than either Rehoboth (53%) or Little Assawoman Bay (53%) residents.

- A strong majority of the bay residents sampled felt the bays' living resources were deteriorating. However, residents of Indian River Bay (80%) were more likely than residents of Rehoboth Bay (70%) or Little Assawoman Bay (64%) to report this.

Management Options

- The majority of all user groups tended to support most of the management options presented to them. There was overwhelming support for prohibiting all discharges of pollutants into the bay waters, establishing off-limit zones to protect sensitive resources, and restricting building and development.

- Permanent residents (70%) favored restricting the number of marinas more than seasonal residents (49%) or visitors (39%).

- Permanent and seasonal residents (70% each) more strongly supported stricter limits on harvesting the bays' living resources than did seasonal visitors (55%).

- The majority of all groups (53-62%) favored zoning the bay waters for certain activities, with seasonal visitors voicing the strongest support.

- The least-favored options by all groups included limiting the size and power of boats (35-50%), restricting the number of boat ramps (23-39%) and limiting the number of boats on the bays (14-25%). Permanent residents did, however, favor these options to a greater degree than did seasonal residents or visitors.

Management Restrictions Offered by Boaters

- Permanent residents mentioned that jetskiing should be limited or zoned within the bays (18%), boater safety and education programs should be required (15%), boat speeds and wakes should be controlled (10%), and pollution should be controlled and sewer systems developed (10%).

- Seasonal residents indicated that there was a need to require boater safety and education programs (29%), limit or zone jet-skiers (18%), control pollution and develop sewer systems (8%), and limit boat speeds and control wakes (7%).

- Seasonal visitors suggested that boat speed and wakes should be controlled (21%), boater safety and education programs should be required (13%), additional marine patrols should be added to enforce laws (13%), and the size and number of powerboats should be restricted on the bays (13%).

Management Suggestions Offered by Boaters

- Permanent residents favored controlling pollution in the bays (20%), adding additional marine patrols to enforce laws (16%), and undertaking additional dredging in the bays (15%).

- Seasonal residents were most supportive of controlling pollution (26%), seeking additional dredging (21%), and having more marine patrols to enforce the laws (9%).

- Seasonal visitors identified controlling pollution (23%), adding marine patrols (20%), conducting more dredging (11%), controlling development and protecting critical areas (11%), and improving fisheries management in the bays (11%) as their primary suggestions for management.

Management Recommendations

Policy Issues

- The Inland Bays Estuary Program (IBEP) should consider a balanced approach to maximizing the uses of the bays and preserving environmental quality. To reach this goal, clearly defined management objectives should be established.

- The IBEP must decide the relative importance of planning for distinct user groups and what priorities, if any, should be given to the groups.

- Resource managers should encourage boaters to play a stronger role in the bays' enhancement efforts (the majority of respondents support paying additional money for bay improvements).

- While it appears that crowding is not an existing problem on the Inland Bays as a whole, areas in the bays identified as "hot spots" should be closely monitored by resource management personnel to observe whether safety concerns or environmental factors become future problems.

- The majority of respondents support zoning bay waters. Officials should consider zoning options if living resource or user conflicts are evident.

- Based upon user preferences, the current supply of marinas, and the environmental impacts they cause, priorities for further boating access to the bays should be given to additional launch ramps rather than marinas.

- DNREC should incorporate the Geographic Information System GIS study findings related to boating activities and desirability into their Inland Bays data base to maintain baseline data for tracking potential user conflicts.

- Long-term monitoring of boating activity and associated perceptions of users should be conducted periodically to modify these recommendations as growth, development, and use patterns around the bays change.

- Monitoring and site-specific analysis of major tributaries should be examined in the future if use levels increase.

Enforcement

- Many respondents indicated a desire for additional law enforcement on the bays. DNREC should review its current enforcement operations in the bays and decide whether increased patrols are warranted. The role the U.S. Coast Guard can provide, relative to boating safety and added law enforcement in the Inland Bays, should also be reviewed and expanded, if feasible.

- On heavy water-use days, additional law enforcement personnel should patrol the areas identified as "hot spots" to maintain a safe experience for all users.

Boating Safety

- All pertinent organizations should consider methods of strengthening their educational efforts to create more boating safety awareness in the bays.

- Monitoring should occur in areas where high-speed boats create wakes and high waves near anchored vessels or drifting fishing boats.

- Jetskiing problems appear to be caused by those renting the watercraft rather than those owning jetskis. If this is the case, current legislation should hopefully control the concerns voiced by individuals.

- DNREC should review their current policies related to crab-pot usage in the bays and consider establishing off-limit areas near boat navigation channels to insure safe boating.

Environmental

- DNREC should increase its efforts to reduce pollution of the bays.

- If environmental officials determine that larger boats and engines cause greater deterioration of the Inland Bays' environment than smaller vessels, they should consider action to control boat and engine sizes in the bays.

- The IBEP should establish criteria and conduct an assessment of sensitive habitats and resources and establish off-limit zones to protect these areas.

- Restricting boating activity in excessively shallow waters should be considered to protect valuable nearshore habitats.

- Environmental groups, along with state and local officials, should support the creation of greenways around the bays to protect areas from further development and provide additional public access to the bays.

Education and Awareness

- Additional education and awareness should be targeted to individuals about shallow areas in the bays and signs should be erected to mark exact locations of maintained navigation channels.

- Organizations involved in bay-related education should consider the distinct user groups involved and assess whether uniform educational methods are effective in reaching all concerned groups.

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

- Creating a focus on the bays by developing a theme like "Delaware's Inland Bays: A National Estuary" may give the bays more prominence and develop a stronger sense of personal ownership and pride on the part of users.

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RECREATIONAL USES ON DELAWARE'S INLAND BAYS: IMPLICATIONS FOR SOCIAL AND ENVIRONMENTAL CARRYING CAPACITY

INTRODUCTION

Background

Delaware's Inland Bays--Rehoboth, Indian River, and Little Assawoman--are located in the southeastern portion of the state. The bays and their drainage areas comprise about 255 square miles of Delaware's Sussex County. The bays are relatively shallow, five to eight feet deep, and small (average surface area 15 square miles). They are encased by a barrier island complex to the east and fringing marshes on the south, north, and west (Delaware DNREC 1988).

Delaware's Inland Bays are threatened by ever-increasing impacts from anthropogenic sources. Since the late 1950s, multiple-use priorities which endanger these ecosystems have emerged. These uses include industrial water supply, wastewater disposal, commercial propagation and harvesting of fish and shellfish, and various recreational uses and their related support systems. Delaware has recognized the importance of water quality for recreation and has designated the Inland Bays as waters of exceptional recreational and ecological significance (ERES). ERES waters are accorded a level of protection in excess of that provided most other state waters.

The Inland Bays' area has become increasingly attractive to new residents and seasonal visitors over the years. A major portion of this permanent and seasonal population growth comes from the Mid-Atlantic corridor between Washington, DC, and New York City. This corridor is the most densely populated coastal region in the United States (U.S. Department of Commerce 1990). The resulting growth in Sussex County has far exceeded national averages for the past two decades, and its population has increased from about 80,000 in 1970 to more than 113,000 in 1990. It is projected to increase to almost 150,000 by 2011 (Inland Bays Estuary Program 1992). This growth has had and will continue to have significant impacts on the bays and the surrounding area.

Recreational users are attracted to the Inland Bays' region by its expanse of ocean-front and the protected waters of the Inland Bays, which provide excellent opportunities for small-craft sailing and boating, waterskiing, windsurfing, swimming and sunbathing. The waters of the bays are also important recreational clamming, crabbing and fishing areas. Those who use the bays for recreation may be classified into four groups: permanent residents, seasonal residents (who spend and average of nine weeks per year in the area), seasonal visitors or renters (who spend three weeks on the average), and day-trip visitors (Greeley-Polhemus Group 1986).

Recreational boating represents an important activity in its own right as well as a means of participating in other activities like waterskiing and fishing. In 1991 there were an estimated 40,000 boats registered in the state of Delaware (Delaware DNREC 1991). Hollender, Cohen and Associates (1989) reported that 35 percent of Sussex County residents own at least one boat, and 74 percent of these boats are engine powered. In addition, approximately 1,350 boat-ramp use permits were purchased by out-of-state registered boaters to use the public launch ramps managed by the Department of Natural Resources and Environmental Control (DNREC), Division of Fish and Wildlife throughout the state (Delaware DNREC 1991).

Boating access to the Inland Bays is provided by an extensive network of facilities surrounding the resource. These facilities include about 75 marinas which provide over 6,100 boat slips, more than 60 public and privately-operated boat ramps, and in excess of 325 private docks (DNREC 1989). On weekend days during the summer, boats are present over a large percentage of the bay waters. Public opinion appears to be that the bays are too crowded and that more marinas will generate more boat traffic, degrade water quality and negatively impact natural resources (Battelle Memorial Institute 1989b).

Various documents about the Inland Bays mention a wide variety of impacts associated with recreational use of the bays, such as disturbed submerged aquatic vegetation, increased turbidity, fuel and oil spills, increased debris, etc. At present, however, there is very little hard data linking most of these types of impacts to recreational use levels on the bays. It is generally accepted that the environmental impacts resulting from recreational uses of the bays are minor when compared to other environmental problems facing the bays.

Most of the pollution of the bays is attributed to non-point sources, since direct pipeline discharges are relatively few and are stringently regulated. Failing residential septic systems and the poultry industry appear to be the primary nonpoint source polluters, contributing 49 to 69 percent of the total nitrogen load to the Inland Bays (Battelle Memorial Institute 1989b). In contrast, several studies suggest that recreational boating contributes less than 0.1 percent of the nutrient loading of the Inland Bays (Jensen and Weeks 1977; Ritter 1986; Inland Bays Estuary Program 1992).

The environmental impacts of boating remain an important issue, however, because the pollution loading of nutrients in high-use areas like marinas may exceed relevant water-quality standards. Several studies have been conducted to assess the effects of recreational boats in concentrated-use areas. Pingree's (1990) Labor Day Weekend Boating Surveys, for example, were undertaken to provide a basis for policies to determine shellfish harvest closure areas near marinas. In 1992, approximately 1,043 acres of Rehoboth Bay shellfish growing areas and 1,495 acres of Indian River Bay areas were classified as "conditionally approved" or "prohibited" for harvesting by the Delaware Division of Public Health, due to the presence of marinas (Pingree 1992).

Pollutants discharged by boats include toxic substances essential for vessel operation (oil, gas, antifreeze, etc.), trash and litter, and human wastes. Much of this pollution is unintended and is both preventable and controllable (Chesapeake Bay Program 1991). The disposal of human wastes was considered the most significant environmental impact in a recent study of recreational boating pollution on the Chesapeake Bay. Most of the recommendations of this study focused on ways of reducing the discharge of human wastes from boats, including the designation of "no discharge zones," the expansion and enhancement of sewage pumpout facilities, encouragement of municipal plants to accept pumpout wastes and manufacturers to substitute less harmful disinfectants for those currently in use, educational efforts aimed at informing boaters about vessel waste problems, and more research to assess the magnitude and location of pollutant discharges from recreational and commercial boats (Chesapeake Bay Program 1991). It is notable that the recommendations focused on strategies addressing the major causal factors leading to the most visible, unacceptable impact of human waste. There was no mention of the need to restrict the number of boats because of their environmental impacts.

The situation in Delaware appears to be similar to that on the Chesapeake. While 12 sewage pumpout units and four dump stations are currently available on the Inland Bays (Herr 1992), it is estimated that these units are used only occasionally (Pingree 1990). This pattern may reflect the "Catch-22" situation that complicates the issue of vessel waste discharge management, in which marina operators are reluctant to install pumpout facilities without adequate boater demand, while boater demand will not materialize until boaters are adequately informed or required to use pumpout stations and they are conveniently available at a reasonable cost (Chesapeake Bay Program 1991).

The public's perception of environmental impacts on the Inland Bays is an important consideration as well. Various user groups within the Inland Bays region were surveyed during the 1980s to obtain their opinions about environmental concerns. About one-third of the respondents to a recreation use survey conducted by the Greeley-Polhemus Group (1986) said they had perceived a deterioration in the environmental quality of the bays over the previous six years. Over one-half of the property owners surveyed by University of Delaware researchers Hastings and Kuennen (1984) reported that water quality in the Inland Bays' area had declined over the previous five years. Over 80 percent of the property owners considered litter a problem, while 69 percent viewed contamination of shellfish beds and 70 percent considered boat discharges problems. One-fourth of Sussex County residents surveyed by Hollender, Cohen Associates (1989) felt that motorboating was harming the environment.

Boating activity is expected to rise in the future as rapid development of Sussex County continues. Numerous housing development projects are planned for the perimeter of the bays, and many of the plans include the construction of marinas. Because of the complex environmental and socioeconomic issues involved, Delaware officials need to understand more about the impacts on the bays, as well as perceptions of boaters, before allowing further marina development or other boating access to continue.

Previous Studies of Inland Bays' Users and Residents

As noted above, several studies have been conducted in the Inland Bays region to examine individuals and groups who recreate on the bays' waters. However, there has never been a focused study to examine use activity levels and the associated impacts and potential conflicts caused by these activities or to begin assessing the bays' carrying capacity levels. Many of the previous efforts, however, do provide an excellent starting point to begin assessing what is known about bay users.

As early as 1969, when Governor Russell W. Peterson requested that an environmental study be conducted of the Rehoboth, Indian River, and Little Assawoman Bays, it was recognized that the waters were good fishing and shellfishing areas. The report further noted that the calm waters were ideal for pleasure boating and waterskiing. The report was critical of the changes taking place with regard to the quantity and quality of the bays resources, as dredging was undertaken to support the increasing number of recreational watercraft appearing on the waters of the bays (Delaware State Game and Fish Commission, et al. 1969).

Hastings and Kuennen (1984) surveyed 3,000 property owners in the Inland Bays area during the summer of 1983. The primary objective of the study was to determine the views of property owners with respect to various environmental and developmental issues in the Inland Bays area. A 31 percent response rate was achieved. Of the total response, 33 percent indicated that they were full-time residents, and 56 percent indicated that they resided in the Inland Bays' area on a seasonal basis. When asked what the most important reasons were for originally locating in the Inland Bays area, "for recreational opportunities" was mentioned by 45 percent of the full-time residents and 60 percent of the seasonal residents.

During the summer of 1986, the Greeley-Polhemus Group interviewed 423 individuals engaged in various recreational activities on Delaware's Inland Bays. Approximately 54 percent of those interviewed engaged in recreational boating during the season, either as the owner of a boat, as someone who had rented a boat, or as a passenger or crew member. The group also noted that about 74 percent of those interviewed said that they spent time fishing or crabbing in the Inland Bays during the season. The Indian River Inlet area was mentioned as a very popular fishing spot. Twelve percent of those who were interviewed indicated that they engaged in windsurfing, with the majority of windsurfing taking place on Rehoboth Bay.

The Greeley-Polhemus (1986) study observed close to 400 boats on the Inland Bays on a warm, sunny holiday (Saturday, July 5, 1986), but also estimated that an average day may have 150-200 boats in use on the bays at any one time. The study also estimated that about 125,000 boat trips occurred on the bays during a 22-week season from May to October. Estimates of boating activity on the Inland Bays ranged from 284-338 motorboats, 114-363 boat fishermen, 55-71 sailboats, 19-33 water-skiers, and 18 jet-skiers. All forms of boating tended to be concentrated in certain areas of the Inland Bays, and there is considerable overlap in the areas preferred for various activities. For example, motorboating and fishing tended to be done in the same areas of the bays.

Of notable interest is the fact that 76 percent of those interviewed said that they would favor "area use restrictions on boating," and another 85 percent mentioned that they would support policy measures to impose speed limits on boats using the Inland Bays. Only 38 percent, however, felt that they could support limiting the use of fuel-powered boats in the bay system (Greeley-Polhemus Group 1986).

Hollender, Cohen Associates, Inc. (1989) conducted a telephone survey of 301 Sussex County residents and found that enjoying the scenery was the most popular recreational use of the Inland Bays (reportedly participated in by 74% of those interviewed), followed by swimming/sunbathing (44%), picnicking (41%), shore/dock fishing (39%), boat fishing (38%), other boating (28%), shore crabbing (36%), boat crabbing (25%), clamming (12%), waterskiing (11%), sailing (11%), windsurfing (5%), and jetskiing (1%). The study found that boat ownership was strongly related to the distance between residences and the Inland Bays; 58 percent of those living within a mile of the bays owned a boat compared to only 22 percent of those county residents living more than 15 miles from the bays.

When residents were asked if any bay uses interfered with "their own enjoyment of the inland waters," eight percent said yes for motorboating, five percent said yes for jetskiing, and two percent for waterskiing. In contrast, 51 percent of these same respondents reported that they or members of their household were restricted in the uses they would like to make of the Inland Bays because of crowds and traffic congestion, while 46 percent were restricted due to a concern for personal health and 30 percent due to a concern for personal safety.

The majority of respondents in each of the surveys conducted (Hastings and Kuennen 1984; Greeley-Polhemus Group 1986; Hollender, Cohen Associates, Inc. 1989) tended to support controls aimed at protecting environmental quality. Forty-two percent of property owners surveyed in 1983 were most likely to support the view that stronger enforcement of existing laws and regulations was the most appropriate means of solving the environmental problems in the Inland Bays area (Hastings and Kuennen 1984).

Seventy-one to 82 percent of the recreational users surveyed by the Greeley-Polhemus Group felt the following management actions were very desirable: stricter enforcement of environmental laws (82%), increased monitoring of water quality (80%), increased fines for violators of environmental laws (80%), better communications with the public on beach closings and other water-quality issues (74%), and increased public information and environmental education programs (71%). These Inland Bays users also tended to strongly support the closing of contaminated swimming and shellfishing areas, as well as area restrictions and speed limits for power boats, although they were generally opposed to limiting the use of powerboats and limiting the number of users or charging fees at crowded beaches.

The Sussex County residents surveyed by Hollender, Cohen Associates (1989) were even more likely to favor various restrictions for the Inland Bays. Nearly all (97%) favored prohibiting all discharges of pollutants into the water, 83 percent favored restrictions on building and development, 77 percent favored stricter limits on fish and shellfish, 68 percent favored zoning the waters to provide for specific uses at specific places, and 67 percent supported limiting the size and power of boats using these waters. In contrast to the recreation user survey (Greeley-Polhemus Group 1986), nearly half (48%) of the county residents favored limiting the numbers of boats using the bays, tributaries and canals.

Falk, et al. (1987) conducted a statewide study of Delaware boaters who had their boats registered in the state during the 1985 season. This study examined responses from a random sample of 1,300 boaters. The responses from the 62 percent of the sample who responded to the survey provide additional insight into the importance of Delaware's Inland Bays as a boating resource.

Fishing was by far the dominant use of boats by Delaware boaters. More than 60 percent of all boaters sampled reported that fishing was the primary use of their boat. Boaters residing in Sussex County (where the Inland Bays are located) were the most likely to state that fishing was their primary boating activity (72%).

Delaware's Inland Bays were the most popular boating areas among the study's respondents. Approximately 55 percent of all respondents reported some boating activity on the bays. Seventeen percent of the responding boaters mentioned that they boated in the bays exclusively. The bays were used heavily by Maryland residents (48% of total boating activity), Sussex County residents (46% of total boating activity), New Castle County residents (30% of total boating activity) and Pennsylvania residents (28% of total boating activity).

Water-Use Planning for the Inland Bays

With recreational intensities increasing and competition for space beginning to emerge on the bays, the Battelle Memorial Institute was contracted by the Inland Bays Estuary Program within the Delaware Department of Natural Resources and Environmental Control to develop a water-use plan for the resource in 1989. The purpose of the task was to provide a detailed characterization of existing and projected uses of the bays, which could be used to draft guidelines for managing water uses on the bays.

The challenge of developing a water-use plan, as Battelle envisioned it, "was to untangle the complex interactions of the participants of the water-use groups; determine the environmental and interactivity conflicts and start to alter the participants' behavior to reduce the impact to acceptable levels." The goal was to arrive at a feasible compromise that would be in harmony with the natural environment of the estuary and allow fair access to the bays for a wide range of responsible water users.

Use areas were to be designated to minimize conflicts between user groups to allow for high-quality recreational opportunity and promote a healthy estuarine ecosystem. Where there were user-group conflicts without environmental impacts, the conflict areas were to be divided to separate the user groups. These areas would be divided according to the numbers of constituents associated with each group and according to specified local social, political, and economic factors.

Battelle further stated, "simultaneous management of all water-use activities is the only fair way to begin achieving the goal of successful water-use planning in the Inland Bays. Radical restrictions to only a few high-impact uses such as jetskiing, motorboating, marina operations, and discharges will almost surely bring resentment and strong opposition to a water-use plan. The individuals that appeared to defend their activities were generally open-minded about possible restrictions as long as they could participate in a fair decision-making process where they would not be unfairly penalized."

From a detailed review of Battelle's water use plan report, it was apparent that potential use conflicts and problems associated with carrying capacity in the Inland Bays were nearly all related to recreational boating activity. This activity included personal watercraft (jetskis), windsurfing/sailboarding, and any other bay-related activities which involved the use of a boat or personal watercraft.

Battelle identified the following boating activities and the potential competition and conflict for water-space usage in the Inland Bays (Battelle Memorial Institute 1989b):

Windsurfing/sailboarding--Incompatible with high speed motorized vessels (wakes) and water pollution sources. Greatest potential for conflict is with swimmers, when windsurfers are exiting and entering beach areas.

Jetskiing--A primary water-contact activity that competes for space with all other water-use activities. It is particularly incompatible with other primary water-contact recreation owing to its pollution and accident potential. It demands relatively high water quality because the participants often get wet when boarding, operating, or falling off their craft. Jetskiing can also negatively impact fishing, crabbing, clamming, nature study, and sightseeing (aesthetic) activities.

Waterskiing--A primary water-contact activity. This activity demands a large area and high water quality, and it conflicts with several other open-water uses. The activity is generally restricted to areas of the bays that are relatively calm, because of the high speeds required, the total length of the boat/skier combination, and the difficulty negotiating safely in rough waters. The potential for accidents rises significantly when there are many boats with water-skiers in the same area trying to maneuver around downed skiers. Noise and wakes from the towing boat can also impact swimming, windsurfing, diving, sailing, rowing, hunting, sightseeing, and fishing participants.

Motorboating--Competes directly with all primary and secondary water-contact uses. Congestion of motorboats during holiday weekends affects other recreational activities involving boats, and irresponsible use is a safety threat to swimmers, sailors, divers, and rowers. Large wakes generated by fast motorboating may cause sailboats to take evasive actions. Environmental effects that may result in conflicts with other recreational activities include noise and increased turbidity.

Sailing--Competes for open water space with all other primary and secondary water users, but since sailboats are relatively few and quiet, their only frequent conflicts are with motorized vessels and their wakes. There may also be some ingress/egress conflicts at the shoreline between small-boat sailors and swimmers.

Rowing--A very low-impact activity, with minimal pollution and noise potential. Its primary conflict is with the wakes from motor vessels, particularly jet skis, which can negotiate shallow, sheltered areas that might have previously been used only by rowers.

Fishing from boats--Competes for space with motorboating jetskiing, waterskiing, diving, scuba diving, and sailboating. Excessive noise and wake disturbances from jet- and water-skiers can impose on the required/expected solitude that fishing demands. Motorboats may run over and cut fishing lines. Fishing also conflicts with all users who directly or indirectly degrade fish habitat, including shore development (marinas and private docks) and major polluters (industrial and municipal dischargers).

Crabbing from boats--Competes with jetskiing, waterskiing and motorboating for open water space and is in conflict with habitat degradation from coastal development (marinas and private docks) and major pollution sources (recreational, industrial, and municipal dischargers). There may be occasional territory conflicts between crabbers and fishermen.

Clamming--Clammers do not compete for space with the commercial operators or motorized vessels because they work shallow, harder-bottom areas that are accessible by wading at low tide. All clamming is incompatible with major degraders of water quality in the bays such as coastal development (marinas and private docks) and industrial and municipal dischargers.

The information gathered by Battelle provides an initial picture of the recreational uses and associated impacts in the Inland Bays. However, because there is no analysis of the relationships between recreational uses and associated impacts, their information falls short of providing a basis for estimating carrying capacities for the bays for recreational activities. While their report is a useful compilation of existing data on an activity-specific basis, their attempt to estimate capacities was based on the outdated space standards approach.

This approach assumes that various boating activities require certain amounts of space, and that the capacity of a given area for boating can be determined simply by dividing the total amount of surface area available by the space standards (amount of space required per boat) for all relevant boating activities occurring in the area. While early studies of water-based systems focused on space standards as a means of determining capacities, more recent work suggests that this approach fails to recognize the complexities and numerous factors involved in determining boating capacities (See Appendix A of this report for a more detailed discussion of carrying capacity and related studies).

Current models of carrying capacity suggest that there are no absolute capacities, but rather the carrying capacity for a given area should be viewed as a range of values that depend on the specific management objectives for the area. The initial concern with determining carrying capacities has gradually been replaced with an emphasis on identifying and maintaining the conditions that are defined as acceptable or appropriate for a given area. Current carrying-capacity frameworks recognize that any effective resource management must involve both scientific and judgmental components. The scientific component is needed to document the relationships between use patterns and resulting impacts on resources and recreational experiences. The judgmental component is concerned with evaluating the desirability or acceptability of existing conditions.

Study Objectives

This project examines the issue of recreational carrying capacity on the Inland Bays of Delaware. Previous studies provide some information on the use patterns of the Inland Bays and on the attitudes of residents surrounding the bays, but little attention has been focused on assessing how much recreational use the bays can sustain. The question of how many boats there should be on the Inland Bays, for example, remains largely unanswered. This project addresses this issue through an extensive field survey conducted during the summer of 1991. This field work builds upon previous studies that have been conducted on the Inland Bays and other water-based recreation resources.

The study was designed to examine the relationships between boating densities during peak-use periods and boaters' evaluations of the conditions resulting from these density levels (both social and environmental). User surveys were conducted to obtain a description of bay users, including their characteristics, activities, perceptions and preferences for various management alternatives. Users were asked to provide detailed information on the locations of their recreational activities and their perceptions of use and environmental conditions at specified locations on the bays. The study was designed to obtain information to support the development of a water-use plan for the Inland Bays.

More specifically, the objectives of this study included the following:

1. Establishing the relationships between recreational uses and impacts on the Inland Bays through a field monitoring program that included surveys of recreational users and adjacent landowners, ground counts, and on-water counts of boating activity. The work focused on boating-related activities (e.g., pleasure cruising, waterskiing, jetskiing, sailboarding, fishing, crabbing) and emphasized determination of spatial relationships between these activities. The focus was on social considerations such as congestion, user conflicts, and safety. The ultimate goal of this objective was not to develop actual capacities, but rather to develop capacity-related recommendations relative to these activities.

2. Identifying recreational users' perceptions about specific environmental quality problems (e.g., declining fisheries resources, deteriorating water quality, presence of litter and debris) occurring in the Inland Bays system. Through field surveys, users' reactions to proposed management strategies to protect and restore sensitive resources were also ascertained.

3. Evaluating the potential of a range of management strategies for the Inland Bays. Two major elements of this objective included extending the existing knowledge of the degree to which various publics accept different strategies (via the surveys conducted for Objective 1), and evaluating the applicability of various strategies to the particular circumstances of Delaware's Inland Bays (based on both existing data and data collected during the study).

4. Developing recommendations for integrating carrying-capacity issues with other relevant land-use and water-use planning methods.

5. Developing a Geographic Information System (GIS) data base for display and analysis of data collected in Objective 1. This work builds upon and is expected to be compatible with the GIS that currently exists in DNREC relative to the Inland Bays.

METHODS

A combination of survey procedures was used to measure boating use patterns and user perceptions about the conditions they encountered on Delaware's Inland Bays.

On-Site Surveys

User perceptions and opinions were obtained through on-site personal interviews conducted at major access points surrounding Indian River and Rehoboth Bays on selected days during the summer of 1991 from July 4 to August 25. These days included the peak weekend periods of July 4-5, August 3-4, and August 23-25. Additional interviewing was conducted on selected mid-week days. A total of 451 on-site surveys were completed during the data collection period.

The major access points sampled included both publicly- and privately-operated boat ramps (Rosedale Beach, Massey's Landing, Delaware Seashore State Park) and marinas (Delaware Seashore State Park, Pier Point, White House Beach, West Bay Park, Bayshore, and Pot Nets; Figure 1). Typically, one or two surveyors were stationed at these access points from approximately 11:00 a.m. to 7:00 p.m. on peak-use weekend days. Boaters were approached as they returned from boating on the bays (those who boated only on the ocean were not included in the sample). One of the persons in the boating party was randomly selected (if willing) to answer the survey questions.

The on-site survey questionnaire was patterned after similar, previous studies and was designed to measure boaters' characteristics, activities, and perceptions (Appendix F). A special version of the survey instrument was developed for sailboarders who were sampled at the main sailboarding beach (New Road) within Delaware Seashore State Park (Appendix H).

Measuring Boating Activity

The overall goal of the sampling design was to represent the varying levels of peak use and patterns of activity that occur on the bays throughout the summer. Boating activity was measured by counting vehicles at access points (parking lot counts) and through on-water counts of boating activity on Rehoboth and Indian River bays.

Parking Lot Counts. On each on-site sampling day, interviewers stationed at access areas spent part of their time counting the number of vehicles parked at the sampling site. At the boat ramps, counts were made of automobiles, automobiles with trailers, and unattached trailers. At the marinas and residential community docks, the vehicles in the parking lots were counted. These counts were repeated at approximately two-hour intervals beginning at 12:00 noon and ending at 6:00 p.m. This information proved useful in verifying use intensities on the on-site sampling days.

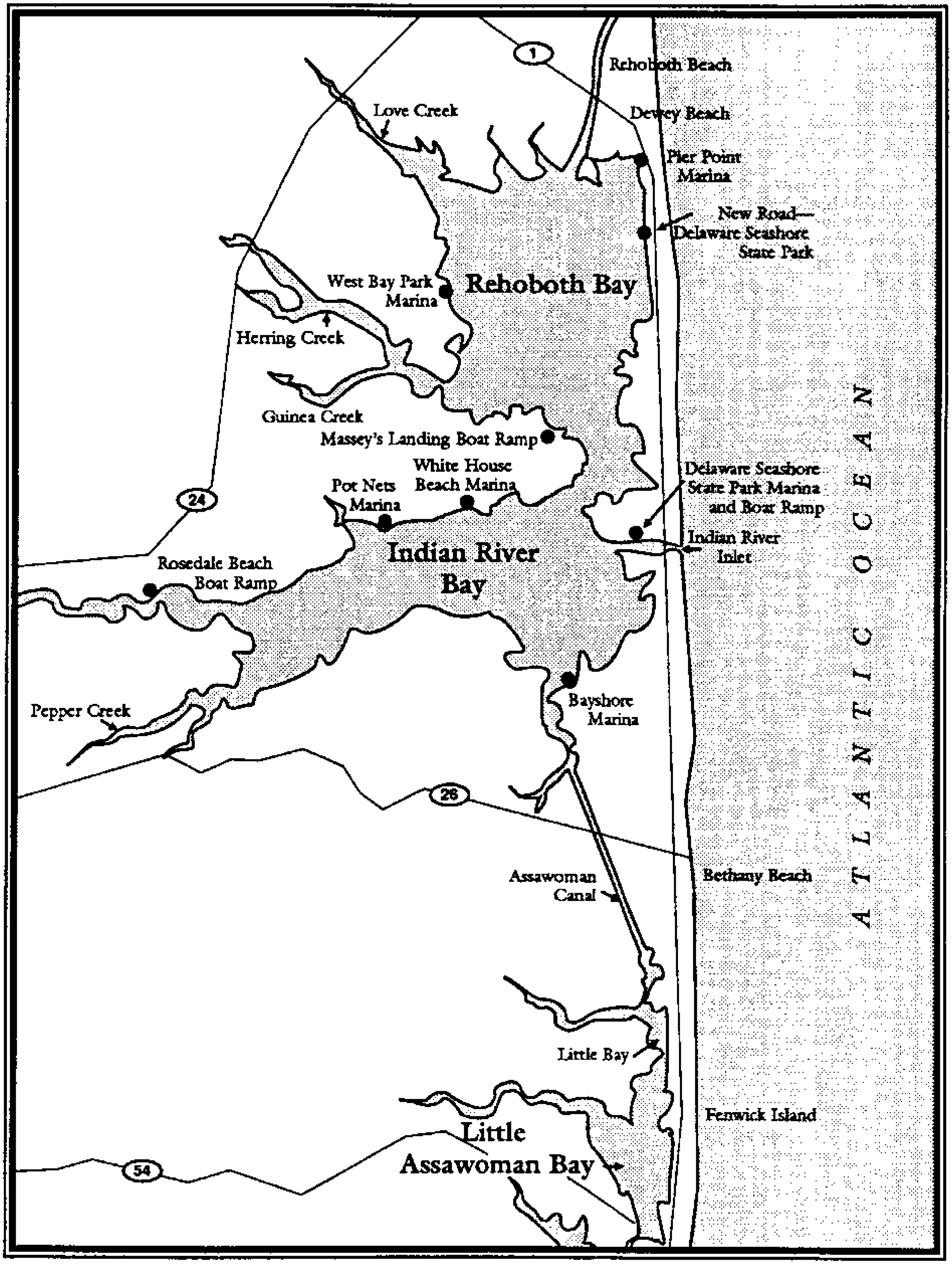


Figure 1. Inland Bays area map and on-site sampling locations.

On-Water Boat Counts. On six dates during August, on-water counts of recreational boating activity were conducted in Rehoboth and Indian River bays (excluding the adjoining tributaries). The sampling procedure was to leave Rosedale Beach public launch ramp (Oak Orchard) in a powerboat and proceed west up Indian River toward the Millsboro Dam. The first zone identified in the Indian River Bay system (between channel markers 31 to 47) was cruised, and counts were made of the boats and various types of boating activities being conducted in the zone. This procedure was repeated in seven additional zones with counts being made throughout the Indian River Bay system (Figure 2).

Zones were based primarily on locations of channel markers situated along the navigational channel in the river and bay (Figure 2). The zones varied in size with Zone Two, between channel markers 31 to 30, being the smallest zone (about 125 water surface acres) and Zone Eight, between the Indian River Inlet Bridge and channel marker 20, being the largest zone (approximately 8,228 water-surface acres). Water surface acre estimates were provided by DNREC using the department's Geographic Information System (GIS).

After sampling was completed in Indian River Bay, the same procedure was undertaken in Rehoboth Bay, beginning with the southeast quadrant of the bay and proceeding clockwise, ending at the northeast quadrant of the bay (Figure 3). The four zones in Rehoboth Bay were more equivalent in size than the zones in Indian River Bay, with the northeast quadrant being the smallest (about 1,082 water-surface acres) and the southwest quadrant being the largest (approximately 2,995 water-surface acres).

Peak-Use Estimates. Because the two methods of determining peak use (on-water boat counts and parking lot counts) were not conducted on every on-site sampling day, a statistical correlation analysis was performed to measure the relationship between the on-water boat and parking lot counts for those days when both counts were made. The degree of this relationship (statistically known as Pearson r) is a value between -1 and +1. The closer the value is to +1, the more highly and directly related are the two variables. For example, as the number of vehicles in parking lots increase, we would expect the number of boats on the water to increase. In fact, the total number of vehicles observed at the Delaware Seashore State Park facility was highly and directly correlated ($r = +.97$) with the total on-water boat counts. Counts of vehicles from other sampling sites were also strongly correlated with both the state park totals and the on-water boat count totals.

Clear differences in boat density levels were observed among Saturdays, Sundays, and weekdays. Saturday counts were much higher than those on corresponding Sundays. The average density level as indicated by the number of vehicles parked at the Delaware Seashore State Park marina and boat ramp was 149 on sampled weekdays (designated low-use level), 258 on Sundays (designated moderate-use level), and 312 on Saturdays (designated high-use level). The parking lot estimates and on-water boat counts made on Saturday, August 24, represented the highest use levels observed while sampling during the 1991 boating season. Use levels on many other weekends, including the 4th of July holiday, were curtailed by inclement weather conditions.

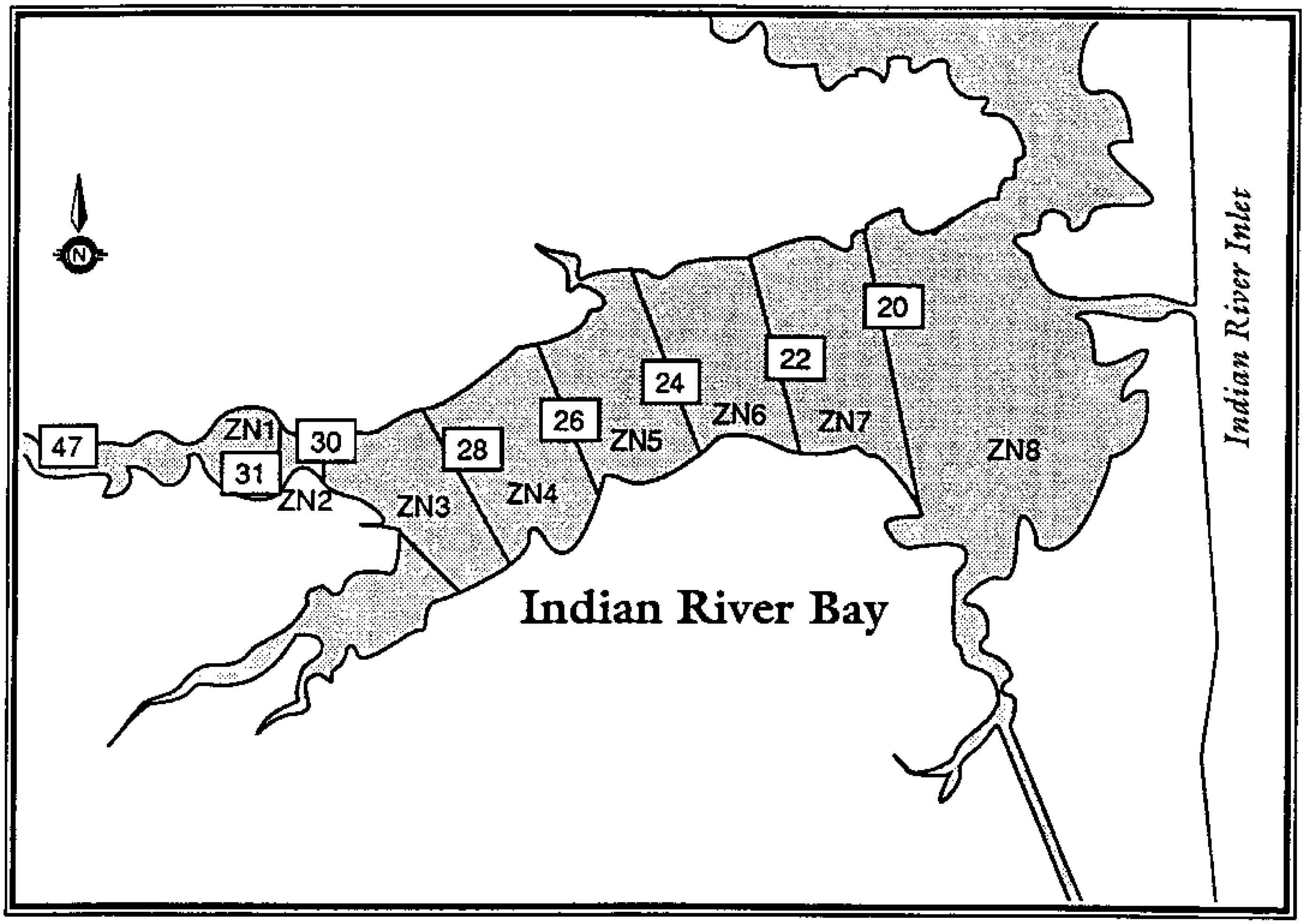


Figure 2. Water-use zones in Indian River Bay.

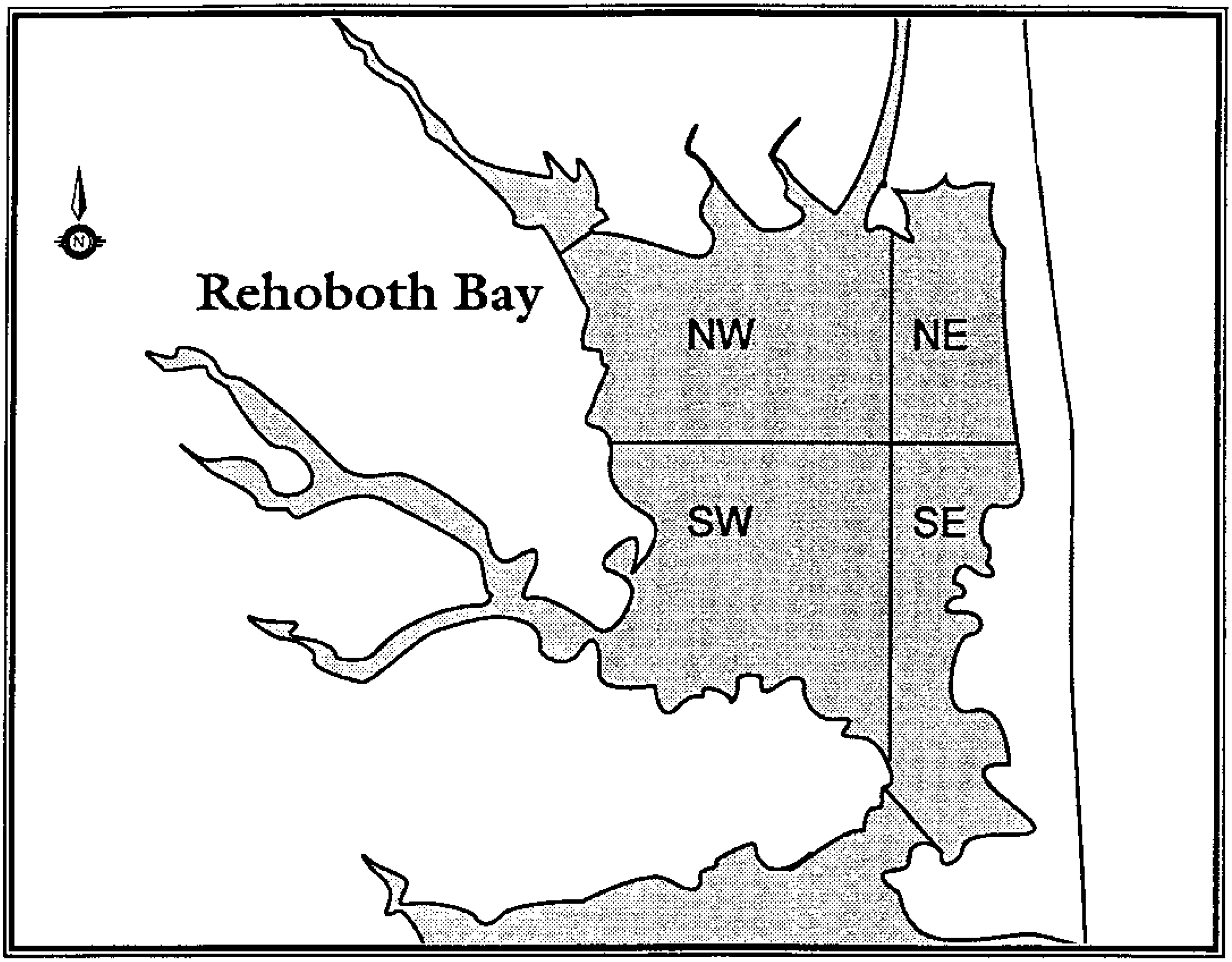


Figure 3. Water-use quadrants in Rehoboth Bay.

Mail Surveys

The names and addresses of approximately 180 bayfront property owners were provided by DNREC based on permit records for docks, bulkheads or piers directly on the Inland Bays or one of its tributaries. To supplement this list, the names and addresses of an additional 420 property owners living adjacent to the bays were selected randomly from a pool determined on the basis of parcel location from Sussex County tax maps. Only those properties directly on the waters of the bays or on one of the tributaries were chosen. If an owner of multiple properties was selected more than once, or if he/she was already represented on the state-provided list, the owner was included only once in the sample.

A total of 200 names and addresses were obtained for each bay system. For example, 200 names were gathered for Rehoboth Bay including some individuals living along Love Creek, Herring Creek, and Guinea Creek. Indian River Bay included Indian River (to the dam in Millsboro), Pepper Creek, Vines Creek, Blackwater Creek, and White's Creek. Little Assawoman Bay included Miller Creek, Little Bay, and Dirickson Creek.

Questionnaires were mailed to 300 property owners (100 from each bay system) on Saturday, August 3, to assure delivery as soon as possible following the on-site sampling weekend of August 3-4. Included with each questionnaire was a cover letter explaining the study and a self-addressed, business-reply envelope (Appendices G and I). Each questionnaire was coded to monitor responses by bay. Once the questionnaire was returned and logged in, association of each questionnaire with a respondent ended.

One week after the initial mailing, postcard reminders were sent to those property owners who had not returned their original questionnaire (Appendix I). Three weeks after the initial mailing, a follow-up cover letter, replacement questionnaire (again coded), and business-reply envelope were mailed to those who had not yet responded. All survey materials were mailed first class.

The same procedure was repeated for the other half of the sample following the on-site sampling weekend of August 24-25. Again, 300 (100 for each bay) coded surveys, cover letters, and business-reply envelopes were mailed on Saturday, August 24. Approximately one week later, the postcard reminders were sent; three weeks after the initial mailing, complete follow-up materials were sent.

A total of 99 questionnaires out of 600 were returned as undeliverable by the U.S. Postal Service due to insufficient or incomplete addresses, lack of forwarding address, or other reasons. As of mid-October 1991, the deadline for receiving responses, 290 completed questionnaires were returned for a 58 percent response rate.

Data Analysis

Data collected through the various sampling efforts were analyzed in several ways. Initially, frequency distributions for all questions were tabulated separately for each of the three versions of the survey (on-site boater survey, on-site sailboarder survey, and mail survey of residents). These frequencies are shown on the copies of the survey instruments included in Appendices F, G, and H. Data from the three surveys were then merged into a single file containing all the variables included in common across the survey efforts. This combining of data enabled more complete comparisons of different segments of the population.

Since various segments of bay users were sampled in different ways, comparisons were made across several population classification variables. First, respondents were classified by user group into three categories--permanent residents, seasonal residents, and seasonal visitors. The mail survey included mainly permanent residents, along with some seasonal residents, while the on-site field surveys represented all three user-group classifications.

Statistical comparisons were made to assess whether the primary user groups were significantly different (i.e., whether differences observed for the samples can be safely generalized to the populations they represent). The statistical test used depended on the type of variable considered. Categorical variables such as boat type, home residence, or boating activities were analyzed using a chi square statistic, while continuous variables, such as number of boating days or distance from bays, were analyzed by using an analysis of variance test. In either case, the level of significance is represented by a value between 0 and +1. The closer the number is to .000, the greater the probability that differences found in the sample are not due to chance and thus can be inferred to the entire population. Following statistical norms, differences significant at the .05 level or less are noted in the tables. Levels of significance above .05 are termed not significant and are indicated using the notation *ns*.

Additional comparisons were made using the same procedures. On-site survey respondents were further categorized by sampling location into three groups representing distinct types of boating access facilities (boat ramp, marina, and shoreline residential community). Mail survey respondents residing on the three bays (Rehoboth, Indian River, and Little Assawoman) were compared to see the extent to which people living around the various bays differed in their characteristics, activities, and attitudes. Further, individuals engaging in different bay-related activities were compared to gain a better perspective on possible conflicts between different user groups. Finally, responses to the various satisfaction measures and impact indicators were compared by boating density levels to determine how boaters encountering different densities felt about their experiences.

Each of these comparisons is presented in tables with either averages or percentages provided, as well as the level of significance value. The "n" values shown in the tables denote the number of cases included in each category. The user-group tables include data merged from all three surveys (on-site, mail, and sailboard), while the comparisons by type of facility include only on-site respondents, and the bay of residence comparison tables include only mail-survey respondents. In certain instances, totals within tables do not equal 100 percent due to rounding.

Geographic Information System (GIS). A final method of data analysis was to map and subsequently examine the spatial distribution of boating activity in the bays using a Geographic Information System (GIS). This included mapping the desirability of sites that boaters reported as being most and least enjoyable during their boating trips, as well as areas that they reported they avoided. Additionally, the locations where boaters participated in selected on-water activities and their actual boating routes were examined for evidence of clustering. The daily boating routes were coded and overlaid with the activity sites to identify areas of potential user conflict.

Of the 422 completed on-site surveys, 318 contained usable spatial information recorded on maps. The map data from completed surveys were manually digitized, analyzed, and displayed using IDRISI, a grid-based, geographical analysis software package. A survey ID number, site code, and desirability or activity code were entered into the computer. The (X,Y) coordinates were then digitized. Additionally, the Inland Bays (Rehoboth, Indian River, Little Assawoman) coastline, Delaware-Maryland state line, major roads, streams, and sampling areas were digitized from a base map to provide a geographic reference.

The reported boating desirability and activity sites were analyzed using measures of dispersion and arrangement to determine if the locations exhibited clustering. Significant clustering could suggest areas that experience crowding or overuse. Subsequently, these clusters were statistically analyzed to determine whether they were significantly different from a pattern of complete spatial randomness. The overall aim of this analysis was to explore and identify environmental and geographic factors that might influence the development of these patterns.

STUDY FINDINGS

On-Water Observations of Boating Activity

An initial way to characterize boating activities in the Inland Bays was through on-water counts of boats and the uses boaters were engaged in while on the water. These field observations were conducted to (1) verify the reported activities that were mentioned by boaters sampled at access points and by mail, (2) estimate peak daily use levels, and (3) ascertain the density levels of boats in identified zones throughout the two bays. Peak daily use levels recorded during on-water boat counts ranged from 251 to 848 boats for the two-bay system (Table 1).

There were notable differences, overall, in the primary activities observed in the two bays through on-water estimates (Table 2). However, direct comparisons between uses in the two bays cannot be made since they are distinct water bodies with different environmental and living-resource features. About three-quarters of all the activities observed in Indian River Bay were either fishing (40%) or cruising boats (34%), whereas these same two activities in Rehoboth Bay constituted only 41 percent of the observed activity (cruising, 21%; fishing, 20%).

Sailing and sailboarding activity probably represented the most distinct activities in the two bays. They made up 31 percent of the total boating activity in Rehoboth Bay and only 3 percent of the activity in Indian River Bay. Jetskiing activity was also observed more often in Rehoboth Bay (8%) than in Indian River Bay (2%).

Crabbing and clamming activity in Indian River Bay accounted for 16 percent of the total activity observed, whereas the same two activities in Rehoboth Bay amounted to 12 percent of the total. However, when the activities were examined alone, crabbing was being engaged in by 10 percent of the boaters observed in Indian River Bay and only 1 percent of the boaters in Rehoboth Bay; whereas 11 percent of the boaters in Rehoboth Bay were clamming versus 6 percent of the boaters in Indian River Bay.

When the two bays were examined for intensity of boating use within the zones, it is apparent that different parts of the bays are used to varying degrees and for different purposes. Zone Two, in Indian River Bay, between channel markers 31 and 30 (Table 3), had the highest use intensity by acre of water surface. The average ratio was 23 acres per boat. The least intensely used area, based on observations, was Zone Three (between channel markers 28 and 30). This zone revealed an average ratio of one boat per 58 surface acres of water.

Rehoboth Bay had similar ratios within its four quadrants (Table 4) that seem to indicate, in general, that there typically is not intensive use by boaters in this bay either. The most intensely used area in Rehoboth Bay was the northeast quadrant, where, on the average, one boat per 14 acres was observed. The northwest quadrant was the least used area in Rehoboth Bay. The average acre-to-boat ratio was 125.

Table 1. On-water boat counts in Indian River and Rehoboth bays by boating activity and sampling date.

SATURDAY, AUGUST 3

	Cruisers	Clammers	Fishers	Crabbers	Sailors	Swimmers	Water-skiers	Jet-skiers	Sail-boarders	Beachers	Total
Indian River	117	10	199	52	12	1	1	7	0	8	407
Rehoboth	56	33	51	0	54	3	3	16	12	10	238
TOTAL	173	43	250	52	66	4	4	23	12	18	645
	(27%)	(7%)	(38%)	(8%)	(5%)	(1%)	(1%)	(3%)	(7%)	(3%)	(100%)

SUNDAY, AUGUST 4

	Cruisers	Clammers	Fishers	Crabbers	Sailors	Swimmers	Water-skiers	Jet-skiers	Sail-boarders	Beachers	Total
Indian River	119	9	116	57	3	0	7	9	2	8	330
Rehoboth	42	13	67	0	12	1	1	14	29	3	182
TOTAL	161	22	183	57	15	1	8	23	31	11	512
	(31%)	(4%)	(36%)	(11%)	(3%)	(1%)	(2%)	(4%)	(6%)	(2%)	(100%)

SATURDAY, AUGUST 17

	Cruisers	Clammers	Fishers	Crabbers	Sailors	Swimmers	Water-skiers	Jet-skiers	Sail-boarders	Beachers	Total
Indian River	121	23	114	22	4	0	0	9	3	14	310
Rehoboth	66	15	35	11	25	1	9	18	22	10	212
TOTAL	187	38	149	33	29	1	9	27	25	24	522
	(36%)	(7%)	(28%)	(6%)	(6%)	(0%)	(2%)	(5%)	(5%)	(5%)	(100%)

FRIDAY, AUGUST 23

	Cruisers	Clammers	Fishers	Crabbers	Sailors	Swimmers	Water-skiers	Jet-skiers	Sail-boarders	Beachers	Total
Indian River	63	10	56	13	2	1	1	2	1	15	164
Rehoboth	22	11	11	0	25	1	2	10	15	5	102
TOTAL	85	21	67	13	27	2	3	12	16	20	266
	(32%)	(8%)	(25%)	(5%)	(10%)	(1%)	(1%)	(4%)	(6%)	(8%)	(100%)

SATURDAY, AUGUST 24

	Cruisers	Clammers	Fishers	Crabbers	Sailors	Swimmers	Water-skiers	Jet-skiers	Sail-boarders	Beachers	Total
Indian River	167	50	199	35	13	1	14	7	0	24	510
Rehoboth	49	57	69	2	71	1	3	23	35	28	338
TOTAL	216	107	268	37	84	2	17	30	35	52	848
	(25%)	(13%)	(32%)	(4%)	(10%)	(0%)	(2%)	(4%)	(4%)	(6%)	(100%)

SUNDAY, AUGUST 25

	Cruisers	Clammers	Fishers	Crabbers	Sailors	Swimmers	Water-skiers	Jet-skiers	Sail-boarders	Beachers	Total
Indian River	48	3	76	17	4	0	1	0	11	1	161
Rehoboth	10	1	6	0	19	0	2	9	43	0	90
TOTAL	58	4	82	17	23	0	3	9	54	1	251
	(23%)	(2%)	(33%)	(7%)	(9%)	(0%)	(1%)	(3%)	(22%)	(0%)	(100%)

Table 2. Percent of boating activity by bays as observed by on-water counts during August 1991.

	Indian River Bay (n = 1882)	Rehoboth Bay (n = 1171)
Fishing	40	20
Cruising*	34	21
Crabbing	10	1
Clamming	6	11
Beaching	4	5
Sailing	2	18
Jetskiing	2	8
Waterskiing	1	2
Sailboarding	1	13
Swimming	<1	1

* Cruising, also referred to as powerboating, includes all powerboats (excluding jet-skiers and water-skiers) that were moving at the time of the count. Some of these boats may have been enroute to pursue another stationary boating activity.

Some additional observations should be made regarding the lack of boating intensity within the identified use zones. For instance, Zone Eight in Indian River Bay (between the Indian River Inlet bridge and channel marker 20) is the most heavily used zone when number of boats are counted. On the average, about 186 vessels were observed in this zone on each sampling day. Although the use intensity ratio in this zone is low (44-acres/boat), this area is considered a "hot spot" since most of the activity takes place within a very tight area in or near the navigational channel, between channel marker 20 and the Indian River Inlet Bridge. Shallow-water areas surrounding the channel force many boaters to compete for this deeper water. Eighty-eight percent of the total activity within the zone was observed as drifting or anchored fishing boats (61%) and cruising boats (27%).

A few zones in Indian River Bay could be considered areas of multiple use, where different activities occur at levels that could create problems. Zone Seven in Indian River Bay (between channel markers 20 and 22) exhibits low use intensity overall (32 ares/boat). However, the uses that occur are diverse--cruising (37%), fishing (27%), beaching (16%), and clamming (13%). Conflicts between these users could occur in this zone if use intensities increased and potential problems were not closely monitored. Zone Six (between channel markers 22 and 24) and Zone Two (between channel markers 30 and 31) are two other zones in Indian River Bay where three or more different activities were observed at levels where future monitoring may be necessary.

Each of the four quadrants in Rehoboth Bay displayed relatively low-use intensity levels; however, each zone had three or more different activities occurring within them at levels where monitoring may be necessary to prevent future user conflicts. For a complete listing of daily use intensities and activities observed through on-water boat counts for both bays (Appendices B and C).

Table 3. Use intensity and activity counts by zone within Indian River Bay. (See Figure 2 on page 14 for a map depicting zones in Indian River Bay.)

INDIAN RIVER BAY				
Zone	Water Acreage	Average No. of Watercraft Observed	Use Intensity Acres/ Boat	Primary Activities (% of Total)
Zone 1--between Channel Markers 31-47	539	21	26	Crabbing (58%), Cruising (30%), Waterskiing (6%), Fishing (2%), Jetskiing (1%), Swimming (1%), Sailing (1%)
Zone 2--between Channel Markers 30-31	125	6	23	Cruising (45%), Crabbing (36%), Waterskiing (12%), Jetskiing (3%), Fishing (3%)
Zone 3--between Channel Markers 28-30	652	11	58	Cruising (57%), Crabbing (30%), Sailing (6%), Jetskiing (4%), Waterskiing (1%), Fishing (1%)
Zone 4--between Channel Markers 26-28	788	15	53	Cruising (51%), Crabbing (31%), Beaching (7%), Jetskiing (3%), Waterskiing (3%), Sailing (2%), Fishing (1%), Swimming (1%)
Zone 5--between Channel Markers 24-26	906	19	47	Cruising (55%), Crabbing (23%), Fishing (5%), Jetskiing (5%), Beaching (3%), Waterskiing (3%), Sailing (2%), Clamming (2%), Swimming (1%)
Zone 6--between Channel Markers 22-24	805	22	37	Cruising (45%), Clamming (14%), Crabbing (11%), Fishing (11%), Sailboarding (6%), Sailing (5%), Jetskiing (3%), Beaching (2%), Waterskiing (2%)
Zone 7--between Channel Markers 20-22	1,095	35	32	Cruising (37%), Fishing (27%), Beaching (16%), Clamming (13%), Crabbing (4%), Sailing (3%), Jetskiing (1%)
Zone 8--between Indian River Inlet Bridge and Channel Marker 20	8,228	186	44	Fishing (61%), Cruising (27%), Clamming (5%), Beaching (2%), Sailing (1%), Sailboarding (1%), Crabbing (1%), Jetskiing (1%), Waterskiing (<1%)

Table 4. Use intensity and activity counts by quadrant within Rehoboth Bay. (See Figure 3 on page 15 for a map depicting quadrants in Rehoboth Bay.)

REHOBOTH BAY				
Quadrant	Water Acreage	Average No. of Watercraft Observed	Use Intensity Acres/ Boat	Primary Activities (% of Total)
Northwest Quadrant	2,554	21	125	Cruising (46%), Sailing (29%), Fishing (11%), Waterskiing (5%), Clamming (4%), Sail-boarding (2%), Jetskiing (1%), Swim-ming (1%)
Northeast Quadrant	1,082	77	14	Sailboarding (41%), Sailing (26%), Jetskiing (16%), Cruising (11%), Waterskiing (2%), Crabbing (2%), Clamming (1%), Swim-ming (<1%), Beaching (<1%)
Southwest Quadrant	2,995	59	51	Fishing (29%), Cruising (28%), Clamming (20%), Beaching (15%), Sailing (3%), Jet-skiing (2%), Swimming (1%), Water-skiing (1%)
Southeast Quadrant	1,297	36	36	Fishing (55%), Clamming (25%), Cruising (16%), Sailing (3%), Jetskiing (2%), Swim-ming (<1%), Beaching (<1%)

Description of Sample

Data on bay-user characteristics, activities, and perceptions were gathered through three integrated survey efforts: mail survey (N = 290, 39% of respondents), on-site survey (N = 422, 57%), and sailboard survey (N = 29, 4%). Respondents were asked to identify themselves as permanent residents (i.e., those residing in the Inland Bays area on a year-round basis); seasonal residents (i.e., persons who lived in the area on a seasonal basis whose primary residence was not in the Inland Bays area); and seasonal visitors (i.e., persons visiting the area on a short-term basis--tourists). Of the mail surveys, the vast majority of respondents (79.6%) were permanent residents, with a smaller percentage (20.4%) being seasonal residents (Table 5). The majority of the on-site respondents (55.8%) were seasonal residents, while permanent residents and seasonal visitors accounted for smaller proportions, 21.2 percent and 23.0 percent, respectively. The sailboard survey was somewhat different from the other surveys in that it was focused on a particular group who did their boating in a particular area of the Inland Bays. Of those responding to the sailboarder survey, a majority (73.9%) were seasonal visitors, 21.7 percent were seasonal residents, and 4.4 percent were permanent residents.

Table 5. Summary of responses by user group.

	Combined (n=741)	Mail Survey (n=290)	On-Site Survey (n=422)	Sailboard Survey (n=29)
Permanent Resident	45.0%	79.6%	21.2%	4.4%
Seasonal Resident	39.9%	20.4%	55.8%	21.7%
Seasonal Visitor	15.1%	0.0%	23.0%	73.9%
Totals	100.0%	100.0%	100.0%	100.0%

Profile of Inland Bay Boaters

This section summarizes the results of both the on-site and mail surveys of bay users. Tables 6 through 8 provide a descriptive profile of survey respondents by user group, type of facility used, and bay where the respondents' live. As previous studies have shown, users of the Inland Bays include a cross section of Delawareans and visitors from other states. Seasonal residents and visitors were most likely to have their permanent homes in Pennsylvania, followed by Delaware and Maryland (Figures 4-6). Boat-ramp users reported traveling the shortest distances to the bays. Individuals with property on Indian River Bay tended to live much closer to the water than those living on either Rehoboth or Little Assawoman Bays.

Since the on-site field survey and mail survey were conducted during the summer of 1991 (and boating activity for the year was still ongoing) respondents were requested to provide estimates for total boating activity and Inland Bays boating activity for the previous year--1990. Inland Bays boaters tend to be relatively active and concentrate most of their boating activity on the bays. Permanent residents reported the highest level of boating participation in 1990 (47 days, 41 of which were on the Inland Bays), while seasonal visitors reported the lowest frequency of boating on the bays (18 days) and seasonal residents tended to report levels of boating participation in between the permanent residents and the visitors.

Permanent residents also tended to have the most boating experience (23 years) and rated their boating skills highest, while seasonal visitors were lowest on these measures. Relative to facility type, boaters sampled at marinas tended to be the least active in 1990 (16 days) and experienced, while those sampled in shoreline communities were most active (50 days), particularly with respect to their frequency of boating on the Inland Bays (44 days). Boat-ramp users reported that more than one-half of their boating participation during 1990 (18 of 30 total trips) was on the Inland Bays. This is consistent with the previous comparison of user groups because most of the respondents interviewed in shoreline communities were permanent or seasonal residents, while those using boat ramps and marinas were more likely to be shorter-term visitors.

Table 6. Descriptive profile of Delaware Inland Bays boaters, boats, and characteristics of sampled trips by user group.

	USER GROUP		
	Permanent Residents (n=312)	Seasonal Residents (n=277)	Seasonal Visitors (n=105)
Average Miles from Principal Home Residence to Inland Bays	33	137	238
Average 1990 Total Boating Participation (days)	47	38	32
Average 1990 Boating Participation on Inland Bays (days)	41	33	18
Average Years Boating Experience	23	19	15
Average Perceived Boating Skill Level (1-4) 1 = novice; 2 = intermediate; 3 = advanced; 4 = expert	2.8	2.6	2.4
Type of Boat Owned (%)			
Powerboat	58	71	70
Pontoon Boat	25	20	4
Sailboat	6	2	2
Rowboat	6	2	2
Jetski	0	2	5
Sailboard	<1	2	16
Other	4	2	<1
Average Boat Length (feet)	19	20	17
Average Engine Horsepower	88	126	98
Type of Boating Group (%)			
Family	55	54	60
Family and Friends	19	29	21
Friends	16	12	16
Alone	10	5	3
Average Group Size	2.7	3.2	3.1
Boating Activities (% of time spent on activity)			
Fishing	29	41	47
Powerboating	24	20	8
Crabbing	13	16	11
Sunbathing/Sightseeing	13	8	3
Clamming	6	3	6
Sailing	6	1	2
Waterskiing	4	3	1
Swimming	2	1	1
Sailboarding	1	2	16
Other	3	5	5
Total*	101	100	100

*Totals may exceed 100% due to rounding.

Table 7. Descriptive profile of Delaware Inland Bays boaters, boats, and characteristics of sampled trips by type of facility.

	TYPE OF FACILITY		
	Marina (n = 69)	Boat Ramp (n = 199)	Shoreline Community (n = 154)
Average Miles from Principal Home Residence to Inland Bays	139	98	123
Average 1990 Total Boating Participation (days)	23	30	50
Average 1990 Boating Participation on Inland Bays (days)	16	18	44
Average Years Boating Experience	15	19	20
Average Perceived Boating Skill Level (1 = novice, 2 = intermediate, 3 = advanced, 4 = expert)	2.3	2.8	2.7
Type of Boat Owned (%)			
Powerboat	70	83	65
Pontoon Boat	20	1	31
Sailboat	5	1	2
Row Boat	<1	4	1
Jetski	3	4	1
Other	2	7	1
Average Boat Length (feet)	20	17	23
Average Engine Horsepower	141	87	142
Type of Boating Group (%)			
Family	33	60	59
Friends	25	20	11
Family and Friends	35	15	23
Alone	7	6	6
Average Group Size	2.7	3.0	3.1
Boating Activities (% of time spent on activity)			
Fishing	42	47	52
Powerboating	25	13	10
Crabbing	14	17	17
Sunbathing/Sightseeing	1	5	10
Clamming	3	11	2
Sailing	5	1	1
Waterskiing	4	3	3
Swimming	2	1	1
Other	4	4	5
Total*	100	102	101

*Totals may exceed 100% due to rounding.

Table 8. Descriptive profile of Delaware Inland Bays boaters, boats, and characteristics of sampled trips by bay of residence.

	BAY OF RESIDENCE		
	Rehoboth (n = 98)	Indian River (n = 83)	Little Assawoman (n = 98)
Average Miles from Principal Home Residence to Inland Bays	35	13	40
Average 1990 Total Boating Participation (days)	27	31	39
Average 1990 Boating Participation on Inland Bays (days)	21	26	36
Average Years Boating Experience	20	25	22
Average Perceived Boating Skill Level (1 = novice, 2 = intermediate, 3 = advanced, 4 = expert)	2.7	2.8	2.7
Type of Boat Owned (%)			
Powerboat	47	62	52
Pontoon Boat	27	21	34
Sailboat	12	7	4
Rowboat	7	7	5
Jet Ski	<1	<1	<1
Other	7	1	5
Average Boat Length (feet)	20	18	18
Average Engine Horsepower	101	87	80
Type of Boating Group (%)			
Family	51	56	54
Friends	16	7	12
Family and Friends	21	27	28
Alone	10	10	6
Average Group Size	2.2	3.0	2.8
Boating Activities (% of time spent on activity)			
Fishing	28	34	11
Powerboating	22	25	47
Crabbing	8	6	16
Sunbathing/Sightseeing	15	12	16
Clamming	4	6	1
Sailing	12	6	3
Waterskiing	5	2	2
Swimming	3	3	1
Other	5	6	3
Total*	102	100	100

*Totals may exceed 100% due to rounding.

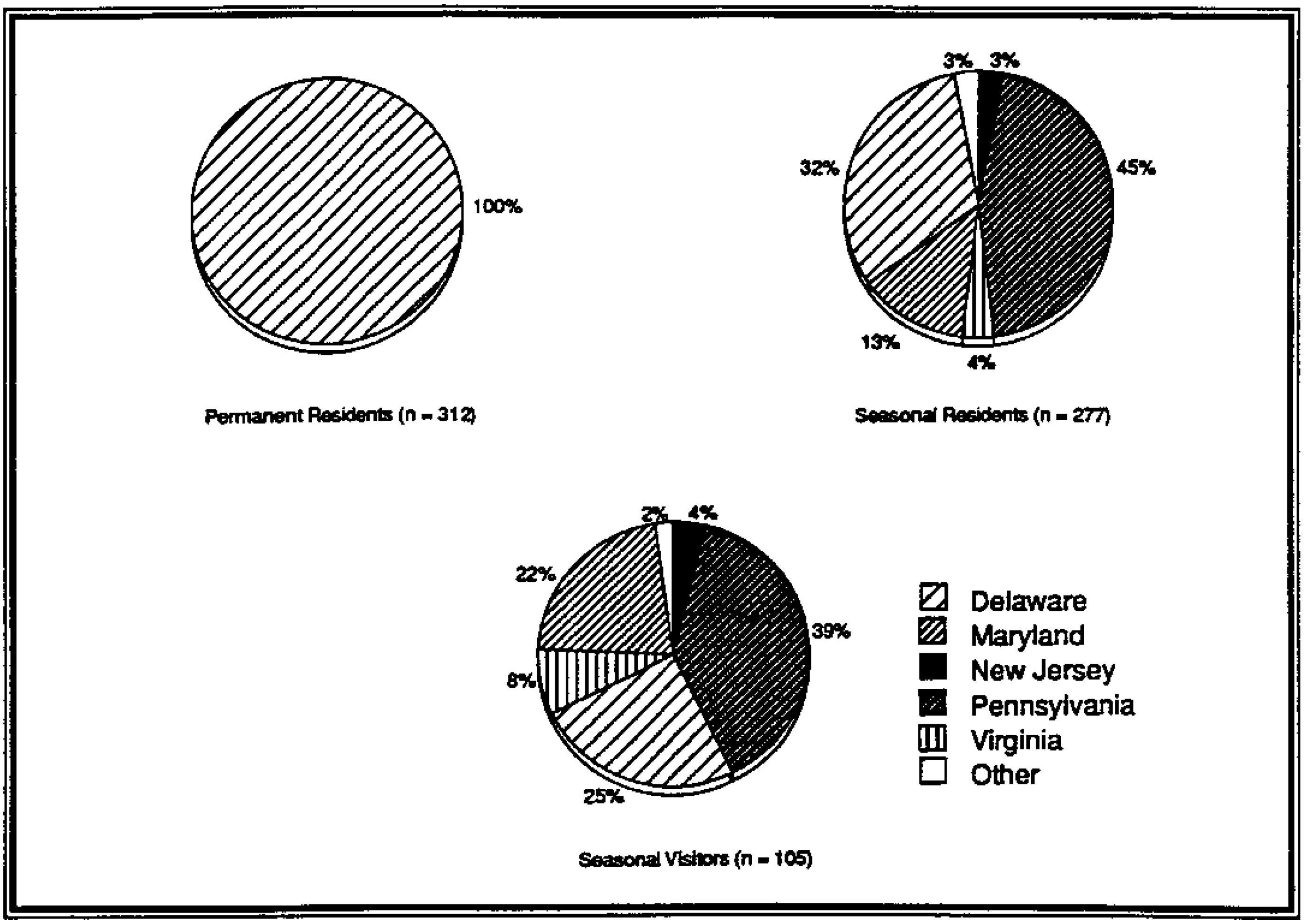


Figure 4. Inland Bays boaters' state of principal home residence by user group.

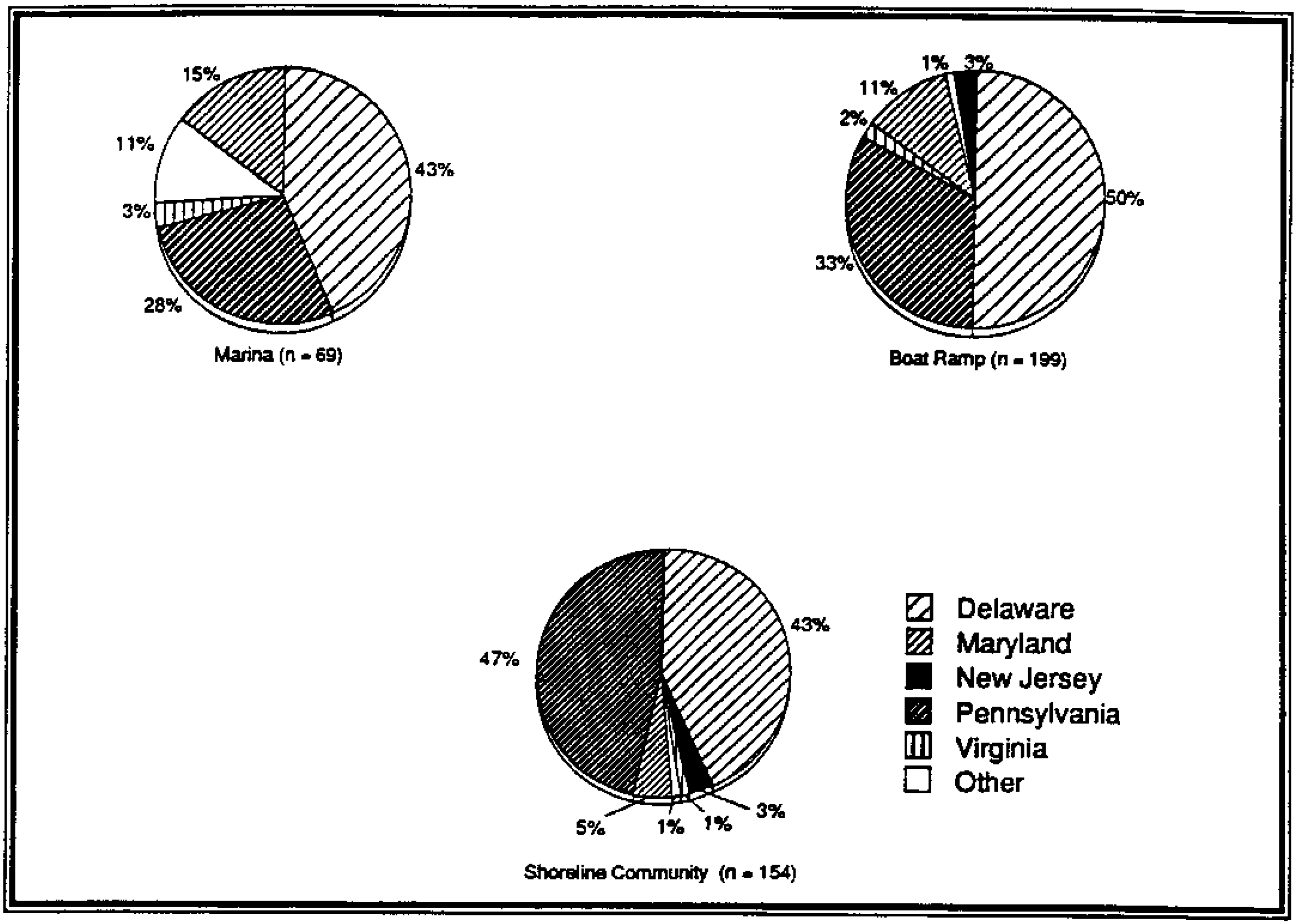


Figure 5. Inland Bays boaters' state of principal home residence by type of facility.

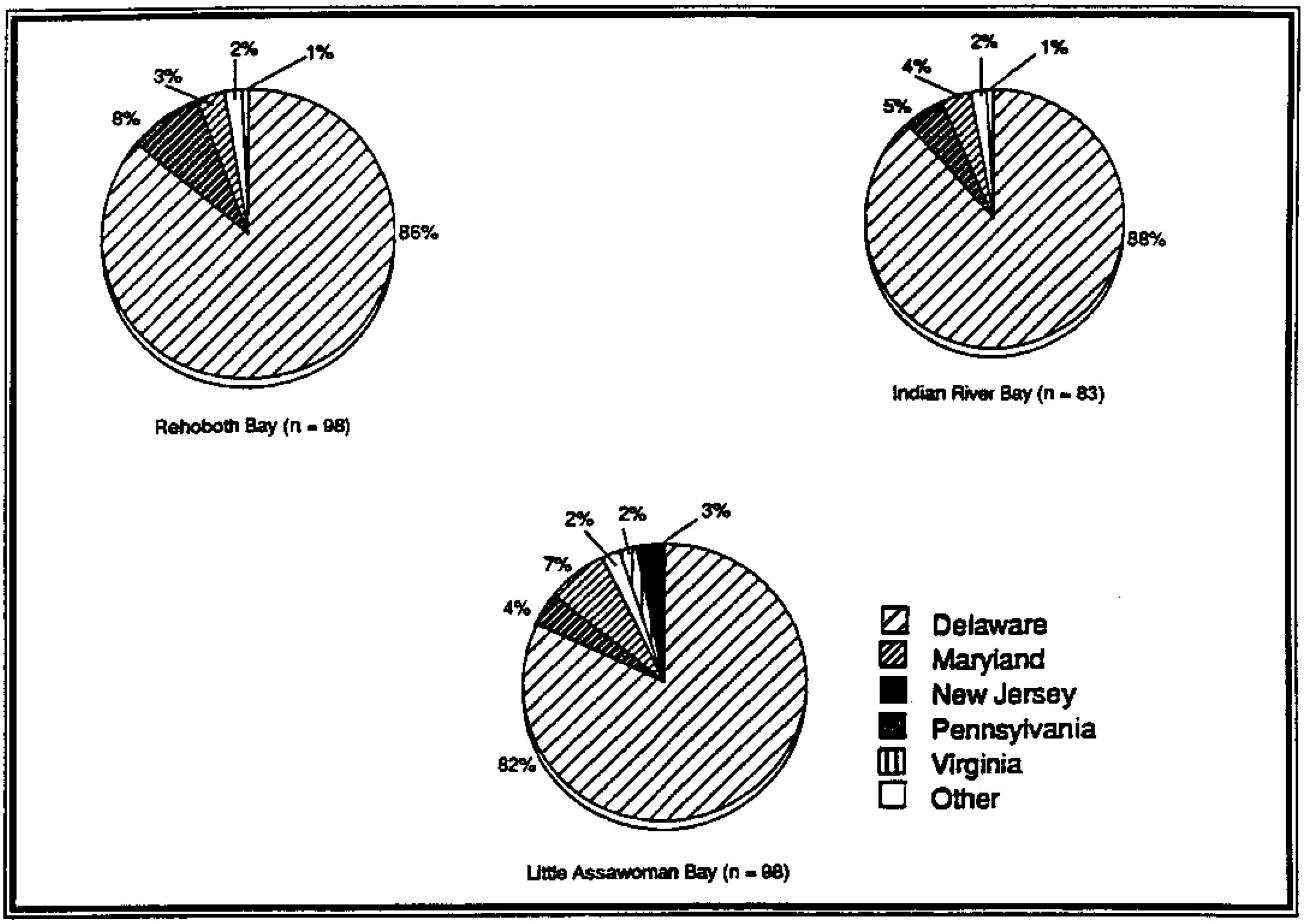


Figure 6. Inland Bays boaters' state of principal home residence by bay of residence.

The comparison of respondents living on the different bays (Table 8) tended to reveal fewer differences than either the comparison of user groups or facility types. One noteworthy difference by bay of residence involved the frequency of boating on the bays. Residents living on Little Assawoman Bay reported the highest level of boating on the bays for 1990 (36 days) while those living on Rehoboth Bay reported the lowest participation (24 days).

Profile of Inland Bay Boats

Boats of all sizes and types are used on the Inland Bays (Tables 6-8). Seasonal visitors (70%) and boaters sampled at boat ramps (83%) were most heavily dominated by powerboats, although powerboats represented the majority boat type even among permanent bay area residents (58%). Pontoon boats were used by a significant minority of permanent (25%) and seasonal (20%) residents and were well represented at both marinas (20%) and shoreline communities (31%). In comparing the three bay systems, pontoon boats were somewhat more common on Little Assawoman Bay, while those individuals living on Rehoboth Bay showed the widest variation in types of boats used and the highest percentage using sailboats and "other" boat types (e.g., canoes and kayaks).

Seasonal residents (20' average) and those sampled in shoreline communities (23' average) tended to have the largest boats and the highest horsepower engines (126 hp and 142 hp, respectively). In contrast, seasonal visitors (17' average) and boat-ramp users (17' average) had the smallest boats. Residents living on Rehoboth Bay reported a significantly greater average boat length (20') than those living on the other two bays (18' average for each bay).

Boating-Group Characteristics and Activities

The majority of all user groups examined reported that their boating party was made up of family members, confirming that boating on Delaware's Inland Bays is largely a family activity. Seasonal residents (3.2 people) reported the largest boating groups and were also most likely to report a boating group comprised of family and friends. Marina-based boaters showed a more even distribution of boating group types (excluding boating alone) than did the boat ramp or shoreline community boaters. There was no significant difference in type of boating group for residents of the different bays, although Rehoboth Bay residents tended to boat in the smallest groups (2.2 people) while those living on Indian River Bay reported the largest groups (3.0 people).

Fishing was the most popular boating activity overall, followed by powerboating, crabbing, and sunbathing/sightseeing. Permanent residents were more likely to divide their boating time between different activities, while seasonal visitors reported the highest proportion of time devoted to fishing (47%). Powerboating was significantly more popular among both permanent (24%) and seasonal (20%) residents than with visitors, while crabbing represented a consistent 11 to 16 percent of the activity of all three user groups. Sailors were a small minority but were significantly better represented among permanent residents (6%) than among seasonal residents (1%) and visitors (2%).

Marina users spent more time powerboating (25%) and sailing (5%), but less time clamming (3%), than users of the other facility types (Table 7). Residents of shoreline communities devoted more time than other facility users to sunbathing and sightseeing (10%). Fishing remained the dominant activity, however, among users of all three types of facilities (42%-marina; 47%-boat ramp; 52%-shoreline community).

Individuals living on the different bay systems showed quite distinct boating activity patterns (Table 6). Those living on Little Assawoman Bay reported the highest percentage of activity for powerboating (47%) and crabbing (16%) and the lowest effort devoted to fishing (11%) and clamming (1%). While the level of powerboating among Little Assawoman respondents may be high considering the size and depth of this bay, survey respondents indicated that much of this powerboating activity is taking place in Maryland waters by boaters traveling outside of Little Assawoman Bay. Additionally, the Little Assawoman Canal, linking this bay to Indian River and Rehoboth bays, is currently not navigable.

Perceptions of Boating Quality and Impacts

Survey respondents were asked a series of questions about the quality of their boating experience and the various types of impacts that might interfere with a satisfactory boating experience. These questions were based on previous boating capacity and related studies. As in the previous studies, some of these items have been combined into indices measuring the major types of impacts to the quality of the boating experience (Table 9). These indices provide measures that are more sensitive and reliable than the individual questionnaire items themselves.

Inland Bay boaters tended to report relatively high levels of satisfaction with their sampled boating trips. When asked to rate their trips on a scale of 1 to 10, with 10 being the perfect boat trip, the average response of the various user groups ranged from 7.2 for seasonal visitors to 8.0 for permanent residents (Table 9). Similarly, responses to five items composing an overall satisfaction index showed that most boaters enjoyed their trip and felt it was worth the money they spent on it. In sum, boaters were generally satisfied, although for many the sampled boat trip did not measure up to their ideal or best-ever boating outing. There were few significant differences in responses to satisfaction indicators among the various segments of the overall sample. Those using different facilities (Table 10) or residing on different bay systems (Table 11) all reported the same high levels of satisfaction.

Perceptions of crowded conditions were assessed through two 9-point scales that were combined into a crowding index. Responses to these items showed that boaters tended to feel the bays were moderately crowded, but the number of boats on the bays had no effect on most people's enjoyment levels. As in the case of the satisfaction measures, the differences in perceptions of crowding between various user segments

Table 9. Values for selected impact indices and their component items by user group.

	USER GROUP			
	Permanent Resident (n = 312)	Seasonal Resident (n = 277)	Seasonal Visitor (n = 105)	Level of Significance*
Overall Trip Rating[1]	8.0	7.3	7.2	.002
Satisfaction Index[2]	3.5	3.5	3.5	*ns*
Thoroughly Enjoyed Trip	85%	90%	89%	*ns*
Trip Not as Enjoyable as Expected[3]	17%	20%	21%	*ns*
Cannot Imagine a Better Trip	30%	24%	17%	.002
Trip Worth the Money Spent	84%	90%	92%	*ns*
Disappointed in Some Aspects of Trip[3]	27%	30%	30%	*ns*
Crowding Index[4]	4.9	4.9	4.8	*ns*
Perceived Crowding	4.5	4.8	4.9	*ns*
Influence of Others	5.4	5.0	5.0	.043
Displacement Index[2]	2.3	2.1	2.1	.000
Avoided Favorite Parts of Bay	22%	12%	11%	.009
Stayed Off Bays Part of Day	25%	14%	13%	.016
Gave Up Activity Due to Crowding	12%	7%	8%	*ns*
Gave Up Activity Due to Water Quality	15%	8%	1%	.001
Safety Index[2]	3.0	3.3	3.3	.000
Other Boats Came Too Close[3]	40%	31%	30%	.030
Consider Law Enforcement Adequate	42%	64%	52%	.000
Nearly Had an Accident[3]	5%	2%	3%	*ns*
Considered Conditions on the Bay Safe	74%	89%	92%	.000
Observed an Unsafe Boating Situation[5]	46%	28%	21%	.000
Conflict Index[2]	2.5	2.2	2.2	.000
Bothered by Noise of Other Boats	21%	11%	12%	.000
Observed Inappropriate Behavior	31%	19%	14%	.000

[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] Crowding index is the mean of perceived crowding (scored on a 9-point scale, with 1 = not at all crowded and 9 = extremely crowded) and influence of others (scored on a 9-point scale with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment).

[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.

Table 10. Values for selected impact indices and their component items by type of facility.

	TYPE OF FACILITY			
	Marina (n = 69)	Boat Ramp (n = 199)	Shoreline Community (n = 154)	Level of Significance*
Overall Trip Rating[1]	7.7	7.7	7.2	*ns*
Satisfaction Index[2]	3.6	3.5	3.5	*ns*
Thoroughly Enjoyed Trip	95%	90%	91%	*ns*
Trip Not as Enjoyable as Expected[3]	14%	23%	20%	*ns*
Cannot Imagine a Better Trip	22%	23%	18%	.006
Trip Worth the Money Spent	88%	93%	91%	*ns*
Disappointed in Some Aspects of Trip[3]	23%	24%	37%	*ns*
Crowding Index[4]	4.8	4.9	5.0	*ns*
Perceived Crowding	4.8	4.9	5.0	*ns*
Influence of Others	4.8	5.0	5.1	*ns*
Displacement Index[2]	2.1	2.2	2.0	.002
Avoided Favorite Parts of Bay	15%	14%	10%	.017
Stayed Off Bays Part of Day	9%	13%	15%	*ns*
Gave Up Activity Due to Crowding	10%	7%	4%	.001
Gave Up Activity Due to Water Quality	3%	7%	4%	.026
Safety Index[2]	3.3	3.3	3.3	*ns*
Other Boats Came Too Close[3]	36%	31%	32%	*ns*
Consider Law Enforcement Adequate	66%	68%	62%	*ns*
Nearly Had an Accident[3]	3%	2%	1%	*ns*
Considered Conditions on the Bay Safe	98%	91%	82%	*ns*
Observed an Unsafe Boating Situation[5]	29%	22%	32%	*ns*
Conflict Index[2]	2.3	2.2	2.1	*ns*
Bothered by Noise of Other Boats	12%	10%	5%	.002
Observed Inappropriate Behavior	28%	12%	20%	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] Crowding index is the mean of perceived crowding (scored on a 9-point scale, with 1 = not at all crowded and 9 = extremely crowded) and influence of others (scored on a 9-point scale with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment).

[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 facility types at the .05 level of probability.

Table 11. Values for selected impact indices and their component items by bay of residence.

	BAY OF RESIDENCE			
	Rehoboth (n = 98)	Indian River (n = 83)	Little Assawoman (n = 98)	Level of Significance*
Overall Trip Rating[1]	7.3	7.7	8.1	*ns*
Satisfaction Index[2]	3.5	3.5	3.8	*ns*
Thoroughly Enjoyed Trip	81%	78%	88%	*ns*
Trip Not as Enjoyable as Expected[3]	18%	22%	15%	*ns*
Cannot Imagine a Better Trip	30%	29%	40%	*ns*
Trip Worth the Money Spent	83%	75%	83%	*ns*
Disappointed in Some Aspects of Trip[3]	30%	27%	26%	*ns*
Crowding Index[4]	5.1	5.0	4.9	*ns*
Perceived Crowding	4.7	4.7	4.3	*ns*
Influence of Others	5.4	5.4	5.5	*ns*
Displacement Index[2]	2.5	2.5	2.2	*ns*
Avoided Favorite Parts of Bay	21%	30%	24%	*ns*
Stayed Off Bays Part of Day	24%	29%	25%	*ns*
Gave Up Activity Due to Crowding	17%	20%	7%	.028
Gave Up Activity Due to Water Quality	25%	16%	15%	*ns*
Safety Index[2]	3.0	2.9	3.0	*ns*
Other Boats Came Too Close[3]	47%	49%	32%	*ns*
Consider Law Enforcement Adequate	38%	37%	22%	*ns*
Nearly Had an Accident[3]	5%	6%	5%	*ns*
Considered Conditions on the Bay Safe	69%	71%	74%	*ns*
Observed an Unsafe Boating Situation[5]	55%	44%	53%	*ns*
Conflict Index[2]	2.6	2.7	2.6	*ns*
Bothered by Noise of Other Boats	25%	25%	27%	*ns*
Observed Inappropriate Behavior	39%	39%	34%	*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] Crowding index is the mean of perceived crowding (scored on a 9-point scale, with 1 = not at all crowded and 9 = extremely crowded) and influence of others (scored on a 9-point scale with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment).
[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 bays of residence at the .05 level of probability.

generally were not significant. These findings are consistent with many other studies that have shown that crowding perceptions are highly subjective and are influenced by people's expectations and preferences, as well as the conditions they encounter.

Displacement refers to various behavioral adjustments boaters might make in response to unacceptably high density levels. In this study, boaters were asked if they avoided certain places, stayed off the bays at certain times, or gave up any planned activities in response to crowded conditions. The majority of each major user group (Table 9) indicated they had not experienced these types of displacement, although they were more likely to have avoided certain places (11-22%) or times (13-25%) than to have foregone any planned activities (7-12%). The permanent residents reported higher levels of displacement for all indicators, perhaps reflecting greater flexibility in their boating activity resulting from their more convenient access to the bays. Among those sampled at different types of facilities, however, the opposite pattern was found. Boaters in shoreline communities tended to report slightly lower levels of displacement (Table 10). Concerning the different bays of residence (Table 11), those living on Little Assawoman Bay reported giving up boating activities due to crowding less frequently (7%) than those living on Rehoboth (17%) and Indian River bays (20%).

Additional insight into displacement on the Inland Bays is provided in responses to some questions asked only of bay area residents in the mail survey. When asked which times they typically use their boats on the bays, 80 percent said weekdays, 61 percent weekends, and 35 percent holidays. (Respondents could check more than one response.) It appears that many of those boaters who live adjacent to the bays routinely adjust their participation towards weekdays to avoid weekend and, especially, holiday crowding.

When asked how their use of the bays might change if they were less crowded, only 19% of the adjacent landowners said that they would boat at different times than they usually do, and even fewer (13%) reported that they would participate more frequently in certain boating activities. Fifty-nine percent indicated, however, that they would spend less time boating on the Inland Bays if they became more crowded. Relatively few reported that they would change the times (17%) or activities they pursued (12%) if crowding increased.

Several questions probed boaters' perceptions of safety on the Inland Bays. Most respondents (74-92%) agreed that conditions on the bays the day they boated were safe, and less than a majority of each group said that they had observed any unsafe boating situations (21-46%). Even fewer boaters (2-5%) acknowledged that they nearly had an accident, while most felt there were adequate law enforcement patrols on the bays. Respondents were more evenly split relative to an item asking whether other boats had come too close to them. The pattern of responses to the safety items, along with the index created from these items, showed that permanent residents were more concerned with safety on the bays than were the other user groups (Table 9). Again, there were no significant differences in perceptions of safety based on type of facility used (Table 10) or bay of residence (Table 11).

Finally, two items focusing on boating noise and inappropriate boater behavior were included to assess possible conflicts between different types of boaters. As was the case for many of the other impact indicators, permanent residents living year-round in the area were more sensitive to these indicators than either seasonal residents or visitors (Table 9). They view the bays in a different way than the other users and are probably more aware of its condition and the effects of users. For example, 21 percent of permanent residents were bothered by noise of other boats compared to 11 percent of seasonal residents and 12 percent of seasonal visitors. Similarly, more permanent residents (31%) observed inappropriate behavior than did seasonal residents (19%) and seasonal visitors (14%). Once again, there was little difference between users of different facilities or residents of different bay systems with respect to these conflict indicators.

Study respondents' reactions to the various boating quality indicators were also examined by the primary activity they were engaged in (Table 12). For this comparison, respondents were included in an activity group if they indicated that they had participated in that activity more than any other during the sampled trip. Thus, individuals were assigned to only one group even if they participated in more than one activity. Those participating equally in more than one activity were omitted from this comparison.

Fishermen, sailors, and sailboarders tended to report the lowest satisfaction scores, while water-skiers were most satisfied. Similarly, anglers and sailors tended to perceive conditions as slightly more crowded. Sailboarders gave the lowest ratings for safety, reflecting a greater concern, particularly for other boats coming too close to them. With respect to indicators of boater conflicts, sailors again stood out as the group most bothered by the noise of other boats and inappropriate boater behavior.

Effects of Boat Density on Boating Quality. Establishing the relationships between the number of boats on the bays and the various measures of the quality of 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 (Table 13). The three density levels compared in the table represent average conditions observed on weekdays (low use), Sundays (medium use), and Saturdays (high use). (See the discussion on peak-use estimates in the Methods section.) This analysis provides a comparison of how boaters encountering different boat density levels on the bays felt about their experiences. Not surprisingly, the crowding, displacement, and conflict indices varied significantly by density level.

The crowding scale (comprised of perceived crowding and the influence of others on enjoyment) varied to a greater extent by density level than any other impact index. The data reflect a consistent pattern in which crowding was felt to be greater on heavier use days (i.e., Saturdays). This same pattern held true for several other impact indices, although the differences were not as pronounced. For example, visitors on peak-use days reported slightly higher degrees of conflict, greater intentions to alter their boating activity and perceptions of less-safe conditions.

Table 12. Values for selected impact indices and component items by primary activity group.

	ACTIVITY GROUP								
	Fishing (n=242)	Power-boating (n=141)	Crabbing (n=77)	Sunbathing/ Sightseeing (n=52)	Clamming (n=32)	Sailing (n=22)	Water-skiing (n=17)	Sail-boarding (n=30)	Level of Significance*
OVERALL TRIP RATING[1]	7.1	8.2	7.5	7.7	8.1	7.5	8.1	6.7	.001
SATISFACTION INDEX[2]	3.4	3.7	3.6	3.5	3.7	3.2	3.7	3.6	.000
Thoroughly Enjoyed Trip	87%	91%	87%	84%	94%	77%	100%	90%	*ns*
Trip Not as Enjoyable as Expected[3]	27%	12%	15%	24%	10%	14%	12%	27%	.019
Cannot Imagine a Better Trip	17%	34%	32%	32%	29%	19%	28%	33%	.015
Trip Worth the Money Spent	89%	88%	92%	86%	84%	60%	94%	93%	.025
Disappointed in Some Aspects of Trip[3]	36%	20%	21%	35%	16%	33%	24%	47%	.004
CROWDING INDEX[4]	5.4	4.7	4.4	5.2	4.4	5.2	4.1	3.6	.000
Perceived Crowding	5.5	4.4	3.9	5.0	4.1	4.7	3.9	3.6	.000
Influence of Others	5.3	5.1	5.0	5.5	4.7	5.7	4.2	4.6	.018
DISPLACEMENT INDEX[2]	2.2	2.1	2.2	2.4	2.3	2.6	2.1	*	.006
Avoided Favorite Parts of Bay	17%	15%	13%	22%	16%	23%	18%	0%	*ns*
Stayed Off Bays Part of Day	16%	17%	22%	20%	19%	25%	12%	*	*ns*
Gave Up Activity Due to Crowding	9%	6%	10%	14%	11%	24%	6%	*	*ns*
Gave Up Activity Due to Water Quality ...	3%	14%	14%	16%	4%	11%	19%	*	.001

Table 12 (continued).

	ACTIVITY GROUP								
	Fishing (n=242)	Power-boating (n=141)	Crabbing (n=77)	Sunbathing/ Sightseeing (n=52)	Clamming (n=32)	Sailing (n=22)	Water-skiing (n=17)	Sail-boarding (n=30)	Level of Significance*
SAFETY INDEX[1]	3.2	3.2	3.4	3.0	3.2	2.7	3.3	3.5	.000
Other Boats Came Too Close[3]	42%	32%	22%	46%	25%	46%	29%	7%	.001
Consider Law Enforcement Adequate	63%	48%	58%	7%	50%	24%	53%	37%	.001
Nearly Had an Accident[3]	4%	2%	1%	0%	3%	10%	6%	7%	*ns*
Considered Conditions on the Bay Safe	85%	82%	87%	73%	80%	76%	94%	100%	*ns*
Observed an Unsafe Boating Situation[4]	36%	39%	22%	41%	30%	50%	29%	3%	.018
CONFLICT INDEX[2]	2.4	2.3	2.1	2.5	2.3	3.0	2.3	1.9	.000
Bothered by Noise of Other Boats . . .	14%	13%	8%	22%	10%	38%	12%	17%	.057
Observed Inappropriate Behavior . .	24%	31%	8%	29%	19%	41%	24%	0%	.001

[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] Crowding index is the mean of perceived crowding (scored on a 9-point scale, with 1 = not at all crowded and 9 = extremely crowded) and influence of others (scored on a 9-point scale with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment).
[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 activity groups at the .05 level of probability.

Table 13. Values for selected impact indices and component items by density levels.

	DENSITY LEVEL			
	Low Use (n = 176)	Medium Use (n = 207)	High Use (n = 261)	Level of Significance*
Overall Trip Rating[1]	7.1	7.6	7.6	*ns*
Satisfaction Index[2]	3.5	3.5	3.5	*ns*
Thoroughly Enjoyed Trip	88%	89%	88%	*ns*
Trip Not as Enjoyable as Expected[3]	21%	20%	20%	*ns*
Cannot Imagine a Better Trip	29%	17%	25%	*ns*
Trip Worth the Money Spent	86%	92%	89%	*ns*
Disappointed in Some Aspects of Trip[3]	32%	26%	29%	*ns*
Crowding Index[4]	4.3	4.9	5.5	.00
Perceived Crowding	3.8	4.8	5.6	.00
Influence of Others	4.8	5.1	5.4	.05
Displacement Index[2]	2.2	2.1	2.2	.04
Avoided Favorite Parts of Bays	13%	15%	15%	*ns*
Stayed Off Bays Part of Day	13%	12%	20%	.03
Gave Up Activity Due to Crowding	8%	9%	9%	*ns*
Gave Up Activity Due to Water Quality	7%	7%	8%	*ns*
Safety Index[2]	3.3	3.3	3.2	.05
Other Boats Came Too Close[3]	29%	37%	37%	*ns*
Consider Law Enforcement Adequate	47%	68%	59%	.00
Nearly Had an Accident[3]	2%	6%	2%	*ns*
Considered Conditions on the Bay Safe	88%	89%	81%	.01
Observed an Unsafe Boating Situation[5]	24%	31%	37%	.04
Conflict Index[2]	2.2	2.2	2.4	.02
Bothered by Noise of Other Boats	13%	10%	15%	.03
Observed Inappropriate Behavior	17%	21%	26%	*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] Crowding index is the mean of perceived crowding (scored on a 9-point scale, with 1 = not at all crowded and 9 = extremely crowded) and influence of others (scored on a 9-point scale with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment).

[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 density levels at the .05 level of probability.

There were, however, no statistically significant differences for the various satisfaction measures in relation to boat density levels. Overall, boater satisfaction was the same regardless of the number of boats using the bays. In fact, the mean response to the 10-point satisfaction rating reached its highest on days with higher use. Similarly, the average score on the satisfaction index did not vary by density level. These findings are consistent with other studies showing that a satisfactory boating experience is influenced by many situational (e.g., weather, visible law enforcement, caught fish) and subjective (e.g., individual perception) factors and therefore is not strongly related to use level. Understanding what contributes to the quality of boating on the Delaware's Inland Bays clearly requires consideration of more than just the number of boats on the bays.

To further explore the determinants of quality in the boating experience, a correlation analysis was performed to measure the strength of the relationships between study variables (Table 14). The degree of correlation between two variables is a value between -1 and +1. The closer the value is to +1, the more highly and directly related are the two variables. For example, the correlation of .40 between the satisfaction and safety indices indicates that as perception of safety increases, overall satisfaction also increases. The closer the value is to -1, the more highly and inversely related are the two variables. For example, the correlation of -.24 between the crowding index and satisfaction index means that as perceived crowding increases, overall satisfaction decreases. However, the influence of crowding on satisfaction is not as strong as that of safety because the coefficient is smaller for crowding (-.24 versus .40). If the value is near zero or not significant, there is no association between the two variables.

Table 14. Correlations of density and impact indices.

	Overall Trip Rating	Satisfaction Index	Crowding Index	Displacement Index	Safety Index	Conflict Index	Average Density Level
Overall Trip Rating	--	.55**	-.10*	-.12**	.12**	-.09*	.08
Satisfaction Index		--	-.24**	-.38**	.40**	-.43**	.01
Crowding Index			--	.39**	-.39**	.39**	.25**
Displacement Index				--	-.57**	.56**	.04
Safety Index					--	-.66**	-.04
Conflict Index						--	.10*
Average Density Level							--

* Significant at the .05 level.
** Significant at the .01 level.

The correlation between the two measures of satisfaction (satisfaction index and 10-point overall trip rating) was relatively high (.55), suggesting that both measures are valid indicators of satisfaction. Both satisfaction measures tended to be associated with nearly all of the impact indices, although the relationships were consistently much stronger between the satisfaction index and the various impact indices.

The variables most strongly related to satisfaction were the perception that the conditions on the bays were safe (.40), the degree of perceived conflict (-.43), and displacement (-.38). Those variables most weakly associated with satisfaction included the number of boats on the bays (.01) and subsequent perceived crowding (-.24).

A wide range of relationships exist between the impact indicators. The degree of conflict (reflecting the behavior of other boaters and effects of noise) showed an extremely strong inverse relationship (-.66) with safety (including adequacy of patrols and other boats coming too close); in other words, the increased perception of conflict between boaters was linked to a decreased perception of safety. As one would expect from the previous analyses, the density level of boats on the bays showed a pattern of weak or insignificant relationships with the various impact indices. The number of boats did contribute, however, to the perceived level of crowding on the bays (.25). Perceived crowding on the bays, in turn, was moderately associated with the displacement (.39), safety (-.39), and conflict (.39) indices. Thus, while boat density had little direct effect on boater satisfaction, it did have some indirect influence on satisfaction through its relationship with perceived crowding and the subsequent relationships between crowding and the other indices.

As a final step in understanding the quality of the Inland Bays boaters' experience, Table 15 presents the various impact indices and component items analyzed by responses to the question, "How did the number of boaters on the bays impact your enjoyment of the day's trip?" (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 9-point 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 impression of a given density level. This group included 26 percent of the study respondents.

As can be seen in Table 15, 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, or those reporting either increased enjoyment or no effect from the influence of others. The decreased enjoyment (or crowded) group stood out as the least-satisfied boaters (3.2 versus 3.6 and 3.7). This group had a much higher average score on the other measure of perceived crowding (6.5 on the 9-point scale versus 3.6 and 4.2 for the other groups). They also showed much higher levels of displacement and conflict and lower levels of perceived safety. Perhaps the most striking difference is the 70 percent of those in the decreased enjoyment group who reported that other boats had come too close (compared to 21 and 25 percent of the other two groups), which is reinforced by the 53 percent reporting that they had observed inappropriate behavior (compared to only 12 and 13 percent of the other groups). 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 numbers of boaters encountered. In many cases, these behavior patterns are amenable to management through enforcement of regulations and education of boaters.

Table 15. Values for selected impact indices and component items by influence of others on the boating experience.

	INFLUENCE OF OTHERS			
	Increased Enjoyment (n = 97)	No Effect on Enjoyment (n = 369)	Decreased Enjoyment (n = 165)	Level of Significance*
Satisfaction Index[1]	3.7	3.6	3.2	.000
Thoroughly Enjoyed Trip	98%	91%	78%	.000
Trip Not as Enjoyable as Expected[2]	17%	16%	29%	.000
Cannot Imagine a Better Trip	33%	27%	18%	.002
Trip Worth the Money Spent	93%	90%	82%	.001
Disappointed in Some Aspects of Trip[2]	22%	22%	49%	.000
Perceived Crowding[3]	3.6	4.2	6.5	.000
Displacement Index[1]	1.9	2.0	2.6	.000
Avoided Favorite Parts of Bays	7%	10%	33%	.000
Stayed Off Bays Part of Day	12%	10%	37%	.000
Gave Up Activity Due to Crowding	7%	3%	23%	.000
Gave Up Activity Due to Water Quality	5%	7%	16%	.002
Safety Index[1]	3.4	3.4	2.8	.000
Other Boats Came Too Close[2]	25%	21%	70%	.000
Consider Law Enforcement Adequate	58%	58%	38%	.000
Nearly Had an Accident[2]	2%	2%	7%	.008
Considered Conditions on the Bay Safe	91%	91%	65%	.000
Observed an Unsafe Boating Situation[4]	28%	22%	62%	.000
Conflict Index[1]	2.0	2.1	3.0	.000
Bothered by Noise of Other Boats	6%	8%	33%	.000
Observed Inappropriate Behavior	12%	13%	53%	.000

[1] 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.
[2] Item scoring reversed for computation of index due to negative statement wording.
[3] Variable scored on a 9-point scale, with 1 = not at all crowded and 9 = extremely crowded.
[4] 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 between categories are due to chance.

Perceptions of Litter and Marine Waste

Study participants were asked how often they had seen various types of litter and marine waste on the day of their sampled trip. Most respondents indicated that they never saw any of the specified types of waste (Table 16). Discarded paper or plastic products (which float) were seen more than discarded glass or metal containers (which typically sink). When asked how the amount of debris had impacted their boating enjoyment, most respondents indicated that it had no effect, while some reported increased enjoyment due to the low levels of waste they encountered.

Table 16. Perceived amounts of marine waste observed by boaters by user group.

	USER GROUP			
	Permanent Resident (n = 312)	Seasonal Resident (n = 277)	Seasonal Visitor (n = 105)	Level of Significance*
Frequency of Observing Marine Waste[1]				
Discarded Plastic Products	1.6	1.4	1.2	.000
Discarded Glass Containers	1.2	1.1	1.0	.000
Discarded Metal Containers	1.3	1.1	1.1	.000
Discarded Paper Products	1.7	1.3	1.2	.000
Floating Algae or Plant Material	1.8	1.6	1.3	.000
Dead Fish, Birds, or Animals	1.2	1.2	1.2	*ns*
Overall Effects of Debris on Enjoyment[2]	5.1	4.3	4.1	.000

[1] Variable measured on 4-point scale, with 1 = never and 4 = all of the time.
[2] Variable measured on 9-point scale, with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment.

* 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.

Permanent residents consistently reported a higher frequency of observing litter and marine waste. They were also significantly more likely to report a reduced level of enjoyment (5.1) on their boating trip because of observing marine waste than either seasonal residents (4.3) or visitors (4.1). It is possible that permanent residents are reporting marine debris that has floated ashore near their property.

Among the on-site survey respondents, boaters sampled at shoreline communities (3.8) were most likely to report that seeing little or no marine waste added to the quality of their boating experience, while marina-based boaters (4.8) were more sensitive to the waste they observed (Table 17). The only difference between respondents from the different bays to the marine debris questions involved the frequency of observing floating algae or plant material. Individuals living on Rehoboth Bay reported the highest frequency of observing floating algae (2.2), while those on Little Assawoman Bay (1.8) reported the lowest incidence (Table 18).

Table 17. Perceived amounts of marine waste observed by boaters by type of facility.

	TYPE OF FACILITY			
	Marina (n = 69)	Boat Ramp (n = 199)	Shoreline Community (n = 154)	Level of Significance*
Frequency of Observing Marine Waste[1]				
Discarded Plastic Products	1.3	1.2	1.3	*ns*
Discarded Glass Containers	1.1	1.0	1.0	*ns*
Discarded Metal Containers	1.1	1.1	1.1	*ns*
Discarded Paper Products	1.3	1.1	1.2	*ns*
Floating Algae or Plant Material	1.8	1.3	1.5	.000
Dead Fish, Birds, or Animals	1.3	1.2	1.1	.02
Overall Effects of Debris on Enjoyment[2]	4.8	4.1	3.8	.002

[1] Variable measured on 4-point scale, with 1 = never and 4 = all of the time.

[2] Variable measured on 9-point scale, with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment.

* The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between facility types at the .05 level of probability.

Table 18. Perceived amounts of marine waste observed by boaters by bay of residence.

	BAY OF RESIDENCE			
	Rehoboth (n = 98)	Indian River (n = 83)	Little Assawoman (n = 98)	Level of Significance*
Frequency of Observing Marine Waste[1]				
Discarded Plastic Products	1.8	1.7	1.8	*ns*
Discarded Glass Containers	1.2	1.3	1.2	*ns*
Discarded Metal Containers	1.5	1.5	1.4	*ns*
Discarded Paper Products	1.9	1.9	2.0	*ns*
Floating Algae or Plant Material	2.2	2.0	1.8	.02
Dead Fish, Birds, or Animals	1.3	1.3	1.3	*ns*
Overall Effects of Debris on Enjoyment[2]	5.5	5.6	5.4	*ns*

[1] Variable measured on 4-point scale, with 1 = never and 4 = all of the time.

[2] Variable measured on 9-point scale, with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment.

* The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between bays of residence at the .05 level of probability.

Respondents' perceptions of and reactions to marine waste also varied in relation to the activities in which they engaged (Table 19). As was the case for many of the impact indicators considered earlier, sailors were most sensitive to the various types of marine waste they observed. They reported seeing it more frequently and were more likely to indicate that it reduced their enjoyment (5.7). Fishermen, on the other hand, tended to notice the least amounts of debris and, accordingly, were more likely to indicate that this relative absence added to the quality of their boating experience.

Table 19. Frequency of observing marine waste by boating activity group.

Marine Waste[1]	ACTIVITY GROUP									
	Fishing	Power-boating	Crabbing	Sunbathing/ Sightseeing	Clamming	Sailing	Water-skiing	Swimming	Sail-boarding	Level of Significance*
	(n = 299)	(n = 223)	(n = 152)	(n = 110)	(n = 55)	(n = 23)	(n = 42)	(n = 33)	(n = 29)	
Plastic	1.4	1.6	1.5	1.6	1.4	1.8	1.5	1.6	1.3	.000
Glass	1.1	1.2	1.1	1.1	1.1	1.4	1.2	1.1	1.2	.000
Metal	1.2	1.3	1.2	1.3	1.2	1.2	1.3	1.2	1.2	.008
Paper	1.4	1.6	1.6	1.7	1.4	1.8	1.5	1.6	1.4	.000
Algae/ Plant Material	1.6	1.7	1.8	1.9	1.6	1.8	2.0	2.0	1.4	.002
Dead Fish or Animals	1.2	1.3	1.2	1.3	1.3	1.3	1.4	1.4	1.4	.007
Effect of Debris on Enjoyment[2]	4.3	5.0	4.7	4.9	4.7	5.7	4.9	5.2	4.7	.000

[1] Variable measured on 4-point scale, with 1 = never and 4 = all of the time.
[2] Variable measured on 9-point scale, with 1 = increased my enjoyment, 5 = no effect on my enjoyment, and 9 = reduced my enjoyment.
* 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.

Perceived Changes in Environmental Quality and Living Resources

The survey instruments used in this study included one question asked by Hollender, Cohen Associates, Inc. (1989) in their report entitled "Inland Bays Survey of Sussex County Residents." This question asked respondents how they felt the *environmental conditions* (e.g., water quality) of the Inland Bays had changed over the past 10 years. A second question devised for this study asked how the *living resources* (e.g., fish, crabs, clams) of the bays had changed over the same time period. Permanent residents (57%) were much more likely than seasonal residents (32%) or visitors (27%) to state that the overall environmental quality of the bays had been deteriorating (Figure 7).

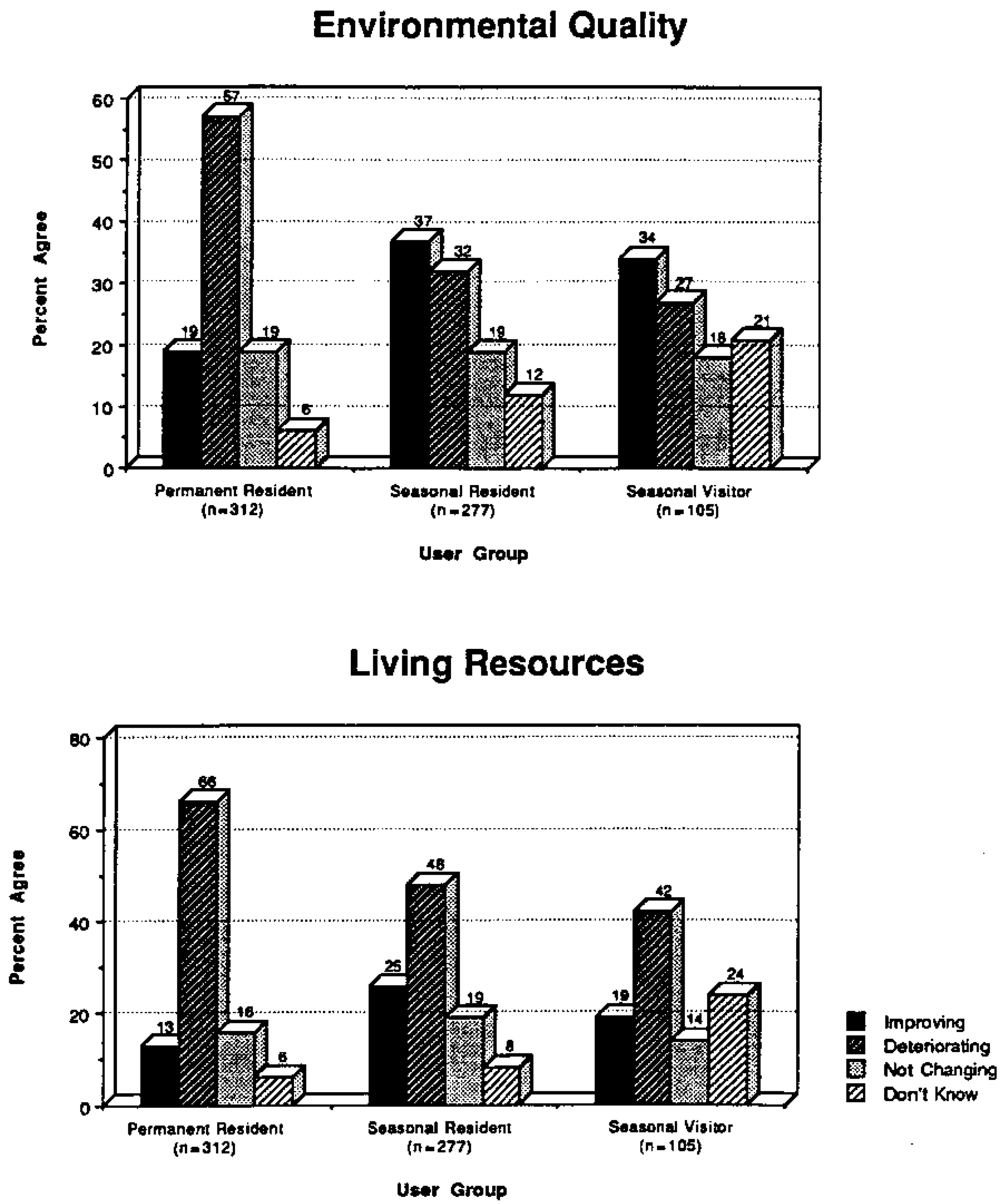


Figure 7. Perceived changes in bays' environmental quality and living resources over the past 10 years by user group.

Likewise, the permanent residents (66%) were also more likely than seasonal residents (48%) and seasonal visitors (42%) to report they felt the bays' living resources were deteriorating (Figure 7). Seasonal residents and visitors were more evenly divided about changes in overall environmental quality, with about one-third seeing improvement and another one-third seeing deteriorating conditions. For comparisons, 54 percent of the residents responding to the Hollender, Cohen Associates, Inc. study reported that the environmental quality of the bays had deteriorated.

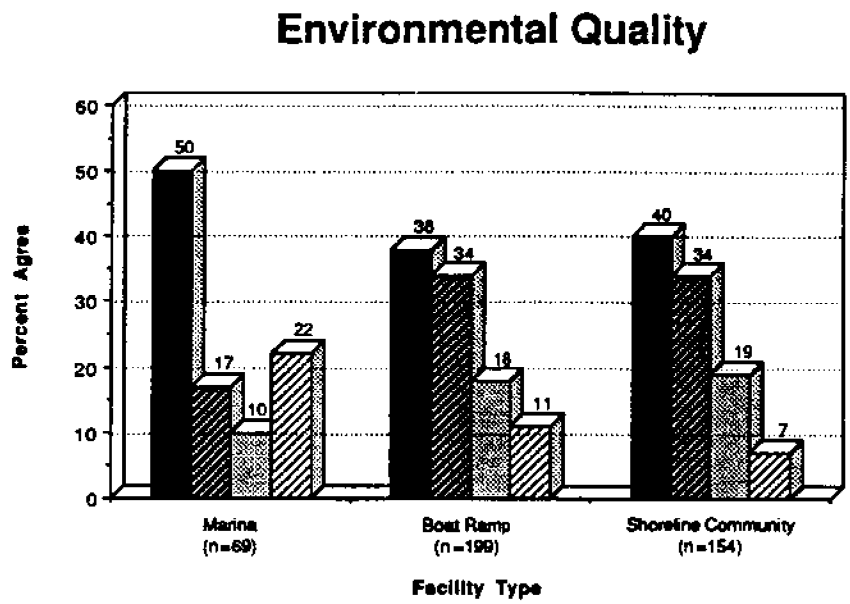
Differences between those using different types of facilities were generally smaller (Figure 8). Those interviewed at marinas were more likely to state that the environmental quality of the bays had been improving (50%) or that they did not know (22%). Those sampled at shoreline communities were most apt to have definite opinions on changes in the bays' living resources. These respondents were least likely to say that they did not know what changes had occurred (7%). They were also most likely to report that they perceived the living resources in the bays to be improving (34%).

Relative to the different bay systems, 70 percent of the respondents living on Indian River Bay felt environmental quality had been deteriorating, compared to 53 percent for the other two bays. Similarly, those living on Indian River Bay (80%) were most likely to feel that the living resources had been deteriorating (Figure 9).

Management Options

Survey respondents were presented with a list of possible management options for the Inland Bays and asked whether they favored, opposed, or were not sure about each option listed. In general, nearly everyone supported certain options, such as prohibiting discharges of pollutants and establishing off-limit zones for sensitive resource areas. Respondents were more evenly divided on alternatives that involved various types of restrictions, and most were opposed to limiting the number of boats allowed to use the bays.

Responses to about half of the alternatives varied significantly by user group (Table 20). Permanent residents generally were more inclined to favor restricting the number of boat ramps (39%) and marinas (70%) than seasonal residents or visitors, and 78 percent favored restrictions on building and development. Half of the permanent residents favored limiting the size and power of boats using the bays, with one-fourth favoring limits on the numbers of boats. Seasonal residents (35%) and visitors (35%) were much less likely than the permanent residents to support limiting the size and power of boats using the bays. Seasonal residents (16%) and visitors (14%) were also less likely to favor limiting the number of boats on the bays. About half of all three groups of respondents favored zoning the waters for specific uses, restricting boat use in shallow areas, and requiring a seasonal boating use permit. More than two-thirds of permanent and seasonal residents favored stricter harvest limits on fish and waterfowl, compared to 55 percent of visitors.



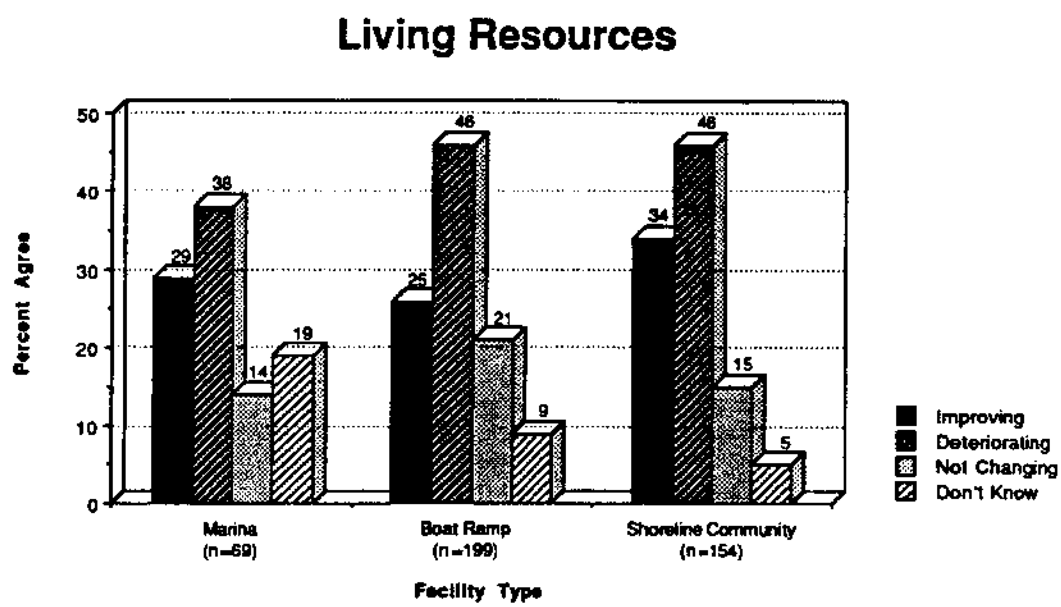


Figure 8. Perceived changes in bays' environmental quality and living resources over the past 10 years by type of facility.

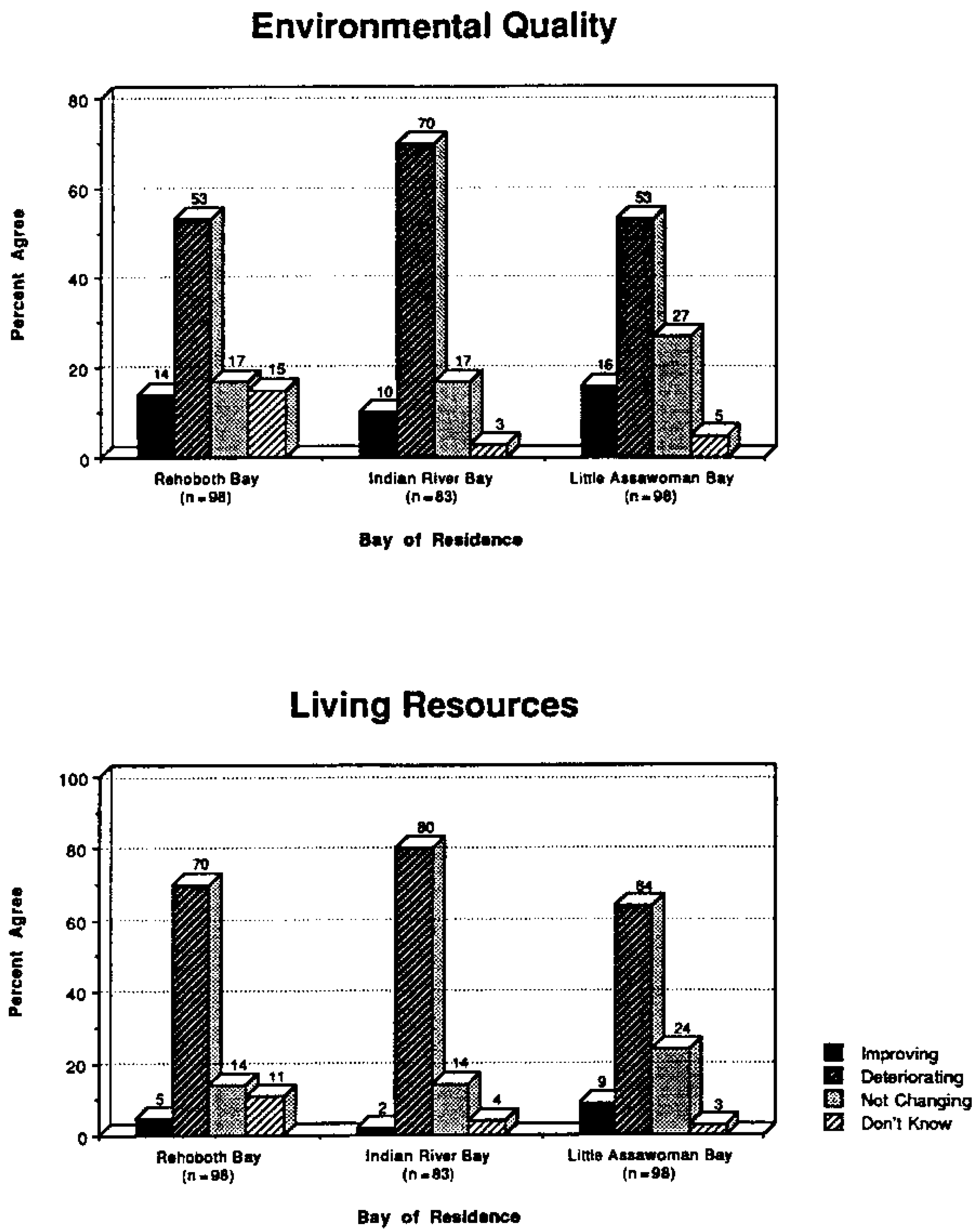


Figure 9. Perceived changes in bays' environmental quality and living resources over the past 10 years by bay of residence.

Table 20. Percent of respondents favoring various management options by user group.

	USER GROUP			
	Permanent Resident (n = 312)	Seasonal Resident (n = 277)	Seasonal Visitor (n = 105)	Level of Significance*
Prohibiting All Discharges of Pollutants into the Water	96%	97%	99%	*ns*
Establish Off-Limit Zones to Protect Sensitive Resources	84%	89%	92%	*ns*
Restrictions on Building and Development	78%	75%	87%	*ns*
Restrict the Number of Marinas	70%	49%	39%	.000
Stricter Limits on the Size and/or Number of Fish, Crabs, Clams, and Waterfowl That Can Be Taken	70%	70%	55%	.02
Zoning the Waters to Provide for Specific Uses at Specific Places	54%	53%	62%	.02
Restrict Boat Use in Excessively Shallow Waters	53%	56%	61%	*ns*
Require Purchasing a Seasonal Boating Use Permit for Bay Use, if the Money Were Used for Bay Improvement	52%	56%	55%	*ns*
Limit the Size and Power of Boats Using these Waters	50%	35%	35%	.001
Restrict the Number of Boat Ramps	39%	34%	23%	.000
Limit the Number of Boats Using the Bays, Tributaries, and Canals	25%	16%	14%	.000

* 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.

Those sampled at marinas (21%) and boat ramps (18%) were less likely than those in shoreline communities (34%) to favor restricting the number of boat ramps around the bays (Table 21). Boaters in shoreline communities (53%) favored restricting marina development more often than marina-based boaters (36%) or boaters using boat ramps (39%). The differences shown in Table 21 probably reflect the user-group differences discussed previously, since most respondents sampled in shoreline communities would be permanent or seasonal residents while those sampled at marinas and boat ramps are more likely to be visitors.

Again, the smallest number of significant differences were found when comparing respondents living on different bays (Table 22). Those living on Rehoboth Bay (77%) were more supportive of restricting marina development than those living on either Indian River (69%) or Little Assawoman (68%) bays. Rehoboth Bay residents (57%) were also more likely to favor restricting boat ramp developments than Indian River Bay (42%) or Little Assawoman Bay (36%) residents.

Management Restrictions and Suggestions Offered by Boaters

Survey respondents (both mail and on-site) were given the opportunity to provide open-ended comments about measures they felt would improve the management of the Inland Bays. In the on-site field survey, after a series of management restrictions were presented, respondents had the opportunity to recommend additional restrictions. In the mail survey, those sampled were asked if there were "any other restrictions or management improvements they would suggest." The mail survey question was worded somewhat differently than the on-site survey question, and, thus, some of the "restrictions" that were offered appeared more like management suggestions. Additionally, some of the responses provided by on-site survey respondents are not actual restrictions either. In each case, however, boaters felt strongly about many issues and concerns facing them and were not hesitant to voice their opinions.

The final question on both survey instruments asked, "Do you have any suggestions for improved management of the Inland Bays?" The mail respondents provided more suggestions, as well as more detailed responses to this question, than the on-site respondents. This was probably due to the fact that they had more time to think about different management suggestions that they felt strongly about. Respondents could offer up to two restrictions or suggestions for management. These two possibilities were combined to arrive at the total number of responses for each group of issues listed. For a complete frequency listing of individual responses see Appendices D and E.

Table 21. Percent of respondents favoring various management options by type of facility.

	TYPE OF FACILITY			
	Marina (n = 69)	Boat Ramp (n = 199)	Shoreline Community (n = 154)	Level of Significance*
Restrict the Number of Boat Ramps	21%	18%	34%	.007
Restrict the Number of Marinas	36%	39%	53%	.003
Limit the Number of Boats Using the Bays, Tributaries, and Canals	14%	10%	17%	.05
Limit the Size and Power of Boats Using These Waters	29%	26%	34%	*ns*
Zoning the Waters to Provide for Specific Uses at Specific Places	48%	55%	58%	*ns*
Stricter Limits on the Size and/or Number of Fish, Crabs, Clams, and Waterfowl That Can Be Taken	60%	57%	69%	.004
Restrictions on Building and Development	69%	77%	78%	*ns*
Establish Off-Limit Zones to Protect Sensitive Resources	88%	90%	89%	*ns*
Prohibiting All Discharges of Pollutants into the Water	96%	97%	99%	*ns*
Restrict Boat Use in Excessively Shallow Waters	57%	55%	62%	*ns*
Require Purchasing a Seasonal Boating Use Permit for Bay Use, If the Money Were Used for Bay Improvement	66%	56%	56%	*ns*

* The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between facility types at the .05 level of probability.

Table 22. Percent of respondents favoring various management options by bay of residence.

	BAY OF RESIDENCE			
	Rehoboth (n = 98)	Indian River (n = 83)	Little Assawoman (n = 98)	Level of Significance*
Restrict the Number of Boat Ramps	57%	42%	36%	.05
Restrict the Number of Marinas	77%	69%	68%	.02
Limit the Number of Boats Using the Bays, Tributaries, and Canals	31%	28%	20%	*ns*
Limit the Size and Power of Boats Using These Waters	59%	42%	57%	*ns*
Zoning the Waters to Provide for Specific Uses at Specific Places	57%	43%	56%	*ns*
Stricter Limits on the Size and/or Number of Fish, Crabs, Clams, and Waterfowl That Can Be Taken	76%	75%	76%	*ns*
Restrictions on Building and Development	80%	79%	77%	*ns*
Establish Off-Limit Zones to Protect Sensitive Resources	87%	79%	83%	*ns*
Prohibiting All Discharges of Pollutants into the Water	96%	92%	96%	*ns*
Restrict Boat Use in Excessively Shallow Waters	57%	46%	51%	*ns*
Require Purchasing a Seasonal Boating Use Permit for Bay Use, If the Money Were Used for Bay Improvement	55%	39%	54%	*ns*

* The level of significance represents the probability that the differences shown are due to chance; *ns* indicates there is no significant difference between bays of residence at the .05 level of probability.

Table 23 provides a grouping of the restrictions mentioned by all of the respondents arranged by user group. Overall, the most often-mentioned restriction was "boater safety/education" (20%). This is not a management restriction, but respondents felt strongly enough about it to mention it as an Inland Bays' concern that should be considered. Restrictions related to "limiting/zoning jetskis" (17%), "limiting boat speed/controlling wakes" (10%), and "controlling pollution/developing sewer systems" (9%) were the next series of most often-mentioned restrictions by all of the respondents.

Eighteen percent of permanent residents felt most strongly about "limit/zoning jetskis," followed by "boater safety/education" (15%), "controlling pollution/developing sewer systems" (10%), and "limiting boat speed/controlling wakes" (10%). Seasonal residents placed "boater safety/education" (28%) at the top of their list of most often-mentioned restrictions. "Limiting/zoning jetskis" was mentioned by 17 percent of seasonal residents. "Controlling pollution/developing sewers" (8%) and "Limiting boat speed/controlling wakes" (7%) were the two next most often-listed restrictions. Very few seasonal visitors responded to this question; however, those who did mentioned that "limiting boat speed/controlling wakes" (21%) was the restriction they favored the most. "Boater safety/education," "more marine patrols/enforce laws," and "restrict the size and number of powerboats" were all mentioned by an equal number of seasonal visitors (13%).

When both mail and on-site respondents were given the opportunity to suggest management improvements for the bays, responses were very similar to those responses mentioned as restrictions (Table 24). Overall, 23 percent of respondents mentioned that pollution of the bays should be better controlled. Seventeen percent felt that more dredging was needed. Fourteen percent of all responding boaters felt that more marine patrols were needed and that current laws should be enforced. "Boater safety/education" (7%) and "controlling development/protecting critical areas" (7%) were the next most-often mentioned management suggestions by the overall sample.

Permanent residents mentioned controlling pollution (20%) as their top management suggestion, followed by "more marine patrols/enforce laws" (16%) and "more dredging" (15%). Seasonal residents mentioned "controlling pollution" (26%), "more dredging" (21%) and "more marine patrols/enforce laws" (9%) as their three top management suggestions. Seasonal visitors also mentioned "controlling pollution" (23%), along with "more marine patrols/enforce the laws" (20%), as their top management suggestions. They also supported controlling development/protecting critical habitat, improved fisheries management, and increased dredging to an equal degree (11%).

Table 23. Percent of respondents offering additional management restrictions for the bays by user group.

Restrictions	Permanent Residents (n = 177)	Seasonal Residents (n = 111)	Seasonal Visitors (n = 24)	Total (n = 312)
Boater safety/education	15%	28%	13%	20%
Limit/zone jetskis	18%	17%	4%	17%
Limit boat speed/control wakes	10%	7%	21%	10%
Control pollution/develop sewer systems	10%	8%	4%	9%
More marine patrols/enforce laws	9%	4%	13%	7%
More dredging	8%	5%	0%	6%
Control/regulate crab pots	5%	6%	8%	6%
Restrict/zone waterskiing and powerboating	5%	4%	4%	4%
Limit fish catches/enforce size limits	3%	4%	4%	4%
Ban jetskis	5%	2%	0%	3%
Control development/protect critical areas	2%	3%	8%	3%
Better channel markings	2%	3%	4%	3%
Limit out-of-staters/increase out-of-stater fees	4%	0%	4%	3%
Restrict size/number of powerboats	1%	1%	13%	2%
Restrict commercial/industrial uses in bay	1%	4%	0%	2%
Restrict federal government/enough restrictions	*	4%	0%	2%
Eliminate boating fees/taxes in bays	2%	0%	0%	1%
TOTAL	100%	100%	100%	100%

* Less than 1% responding.

Table 24. Percent of respondents offering improved management suggestions for the bays by user group.

Suggestions	Permanent Residents (n = 234)	Seasonal Residents (n = 202)	Seasonal Visitors (n = 61)	Total (n = 497)
Control pollution	20%	26%	23%	23%
More dredging	15%	21%	11%	17%
More marine patrols/enforce laws	16%	9%	20%	14%
Boater safety/education	8%	7%	8%	7%
Control development/protect critical areas	9%	5%	11%	7%
Improved fisheries management	3%	7%	11%	6%
Control/regulate crab pots	7%	3%	0%	4%
Limit boat speed/control wakes	6%	1%	3%	4%
Limit/regulate jetskis	4%	3%	2%	3%
Improve boat access	1%	5%	2%	3%
Keep up good work	3%	3%	2%	3%
Restrict size and number of boats	2%	2%	0%	2%
Restrict state government/loosen restrictions	1%	2%	3%	2%
Better channel markings	2%	2%	2%	2%
Prohibit jetskis	2%	1%	0%	1%
Generate and use revenues	1%	2%	2%	1%
Restrict commercial/industrial uses in bays	*	1%	0%	1%
TOTAL	100%	100%	100%	100%

* Less than 1% responding

Spatial Analysis of Boating Distributions and Patterns

Another method of analyzing boating distribution and activity patterns with resource managers in mind is through manual manipulation of hand-drawn maps or in a computer environment using a Geographic Information System (GIS). A GIS is designed for the capture, editing, storage, retrieval, management, update, analysis, output, and display of digital spatial (and non-spatial) data and information for use in a decision-making, management, or planning-process framework. This analysis is presented to provide resource managers with another tool to consider for managing boaters in the Inland Bays. It can be used with much of the other information presented to offer a clearer picture of activity patterns and begin to assess possible conflicting uses between users.

This GIS analysis focused solely on map data collected from the on-site interviews of 422 boaters. The reason that only this data was used is that these respondents were more accurate in answering the map questions than in the mail survey. This was due in part to larger maps being used and the influence of trained interviewers who administered the on-site surveys. The recreational use patterns examined in this spatial analysis included sailing, powerboating, sailboarding, waterskiing, swimming, fishing, crabbing, clamming, and other uses (including jetskiing). A further analysis focused on the areas of the bays that boaters liked most, liked least, and areas that they avoided (desirability features).

Figure 10 depicts a map of the study area that was the focus of the on-site surveys from which the map data were derived. This map shows the water areas and coastline, including Rehoboth Bay, Indian River Bay, and major tributary rivers and streams in blue. Major roads (including Routes 1, 24, and 26) are shown in red, and access areas where the on-site surveys were conducted are marked with black crosses.

Desirability Sites and Clustering. Figure 10 also shows the site desirability areas reported by boaters. The first three colors represent the sites boaters identified as being most and least enjoyable and those sites they intentionally avoided. A total of 382 points were mapped in this desirability analysis as reported in Table 25.

Table 25. Reported point counts by desirability.

Desirability Sites	Number Reported	Percentage
Area Most Enjoyed	172	45
Area Least Enjoyed	109	29
Area Avoided	101	26
Desirability Total	382	100

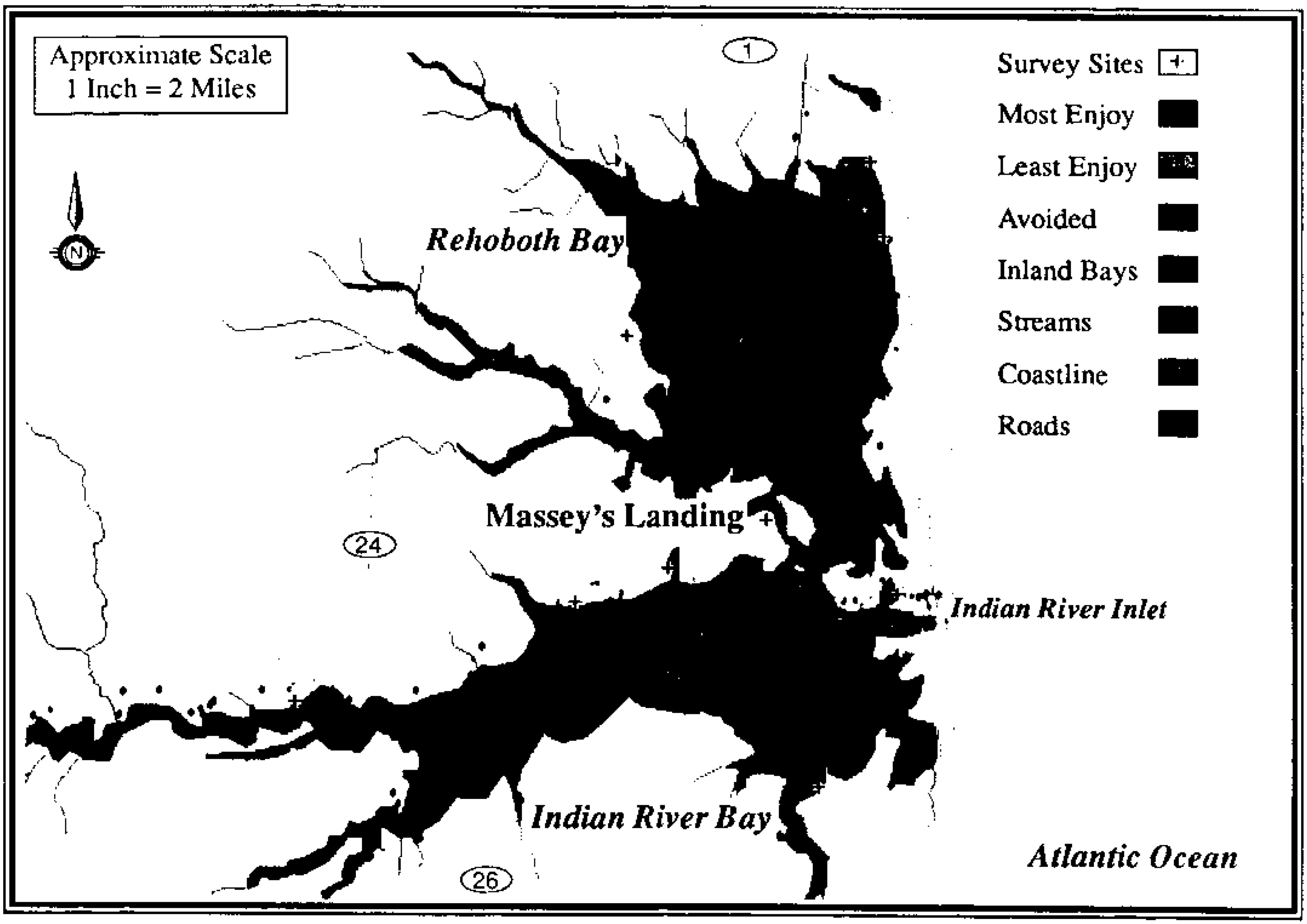


Figure 10. Point-pattern map of reported desirability sites. (Points are not to scale but represent approximate locations.)

The desirability point pattern maps were analyzed using statistical procedures to measure the degree of dispersion and arrangement. To display the results of the statistical point pattern analysis graphically, 50-meter interval buffers were generated,radiating outward from the mapped points. These cluster maps highlight commonalities in the point locations, indicating areas of comparable desirability. The strength of the clusters can be seen by the number of points that intersect at the first black 50-meter buffer. The more points intersecting at a given buffer zone, the more pronounced the clustering at that level; and the shorter the buffer distances, the more statistically significant is the clustering. Therefore, the points that overlap at short buffer distances and display a clumping pattern indicate there is some agreement among users on the desirability of an area. When clusters form at desirability sites, it may indicate areas that produce a common experience for boaters. The fact that the least-enjoyed and avoided areas displayed more clumping suggests that there is more agreement among boaters about these locations than the most enjoyable areas. (See Figures 11-13 for cluster maps.)

The areas that boaters enjoyed most (Figure 11) showed a somewhat lower rate of clustering with a more dispersed point distribution. This may suggest two things. First, what people find as most enjoyable is varied and therefore somewhat dispersed. Also, nearly all of the bay's waters were reported as most enjoyable by someone, suggesting that overall, people find all sections of the bays enjoyable. The minor clustering displayed at certain locations throughout the bays may be due to people participating in the same activities and thus finding the areas enjoyable for the same reasons. The most often reported reason for enjoying these locations was the high quality of the fishing experience. This was followed by a perceived lack of crowding at the sites. Other frequently mentioned reasons for enjoying an area included good crabbing and clamming, as well as favorable water or weather conditions.

The areas most commonly reported as least enjoyed and avoided included the area surrounding the Indian River Inlet and the area around Massey's Landing. These areas did exhibit significant clustering, which suggests that many people find the same areas least enjoyable and that many people avoided these areas. In the cluster map of areas reported as least enjoyed (Figure 12), almost all of the observed clustering occurs just inside the inlet and south of Massey's Landing. This was somewhat predictable given the sometimes diverse and heavy usage this area receives. There are also a few less-significant clusters located in the main channel of Indian River Bay.

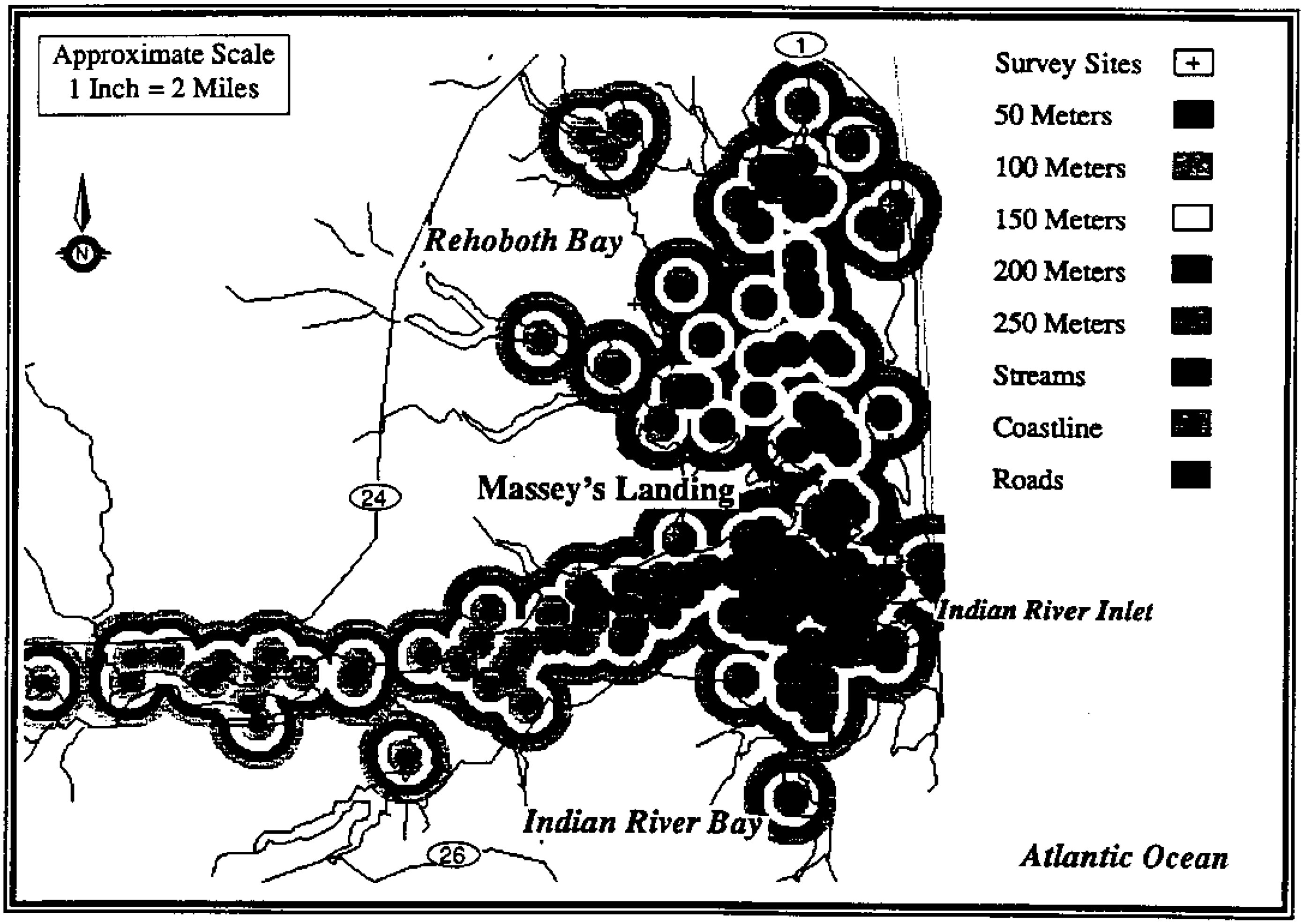


Figure 11. Cluster map of areas most enjoyed by boaters.

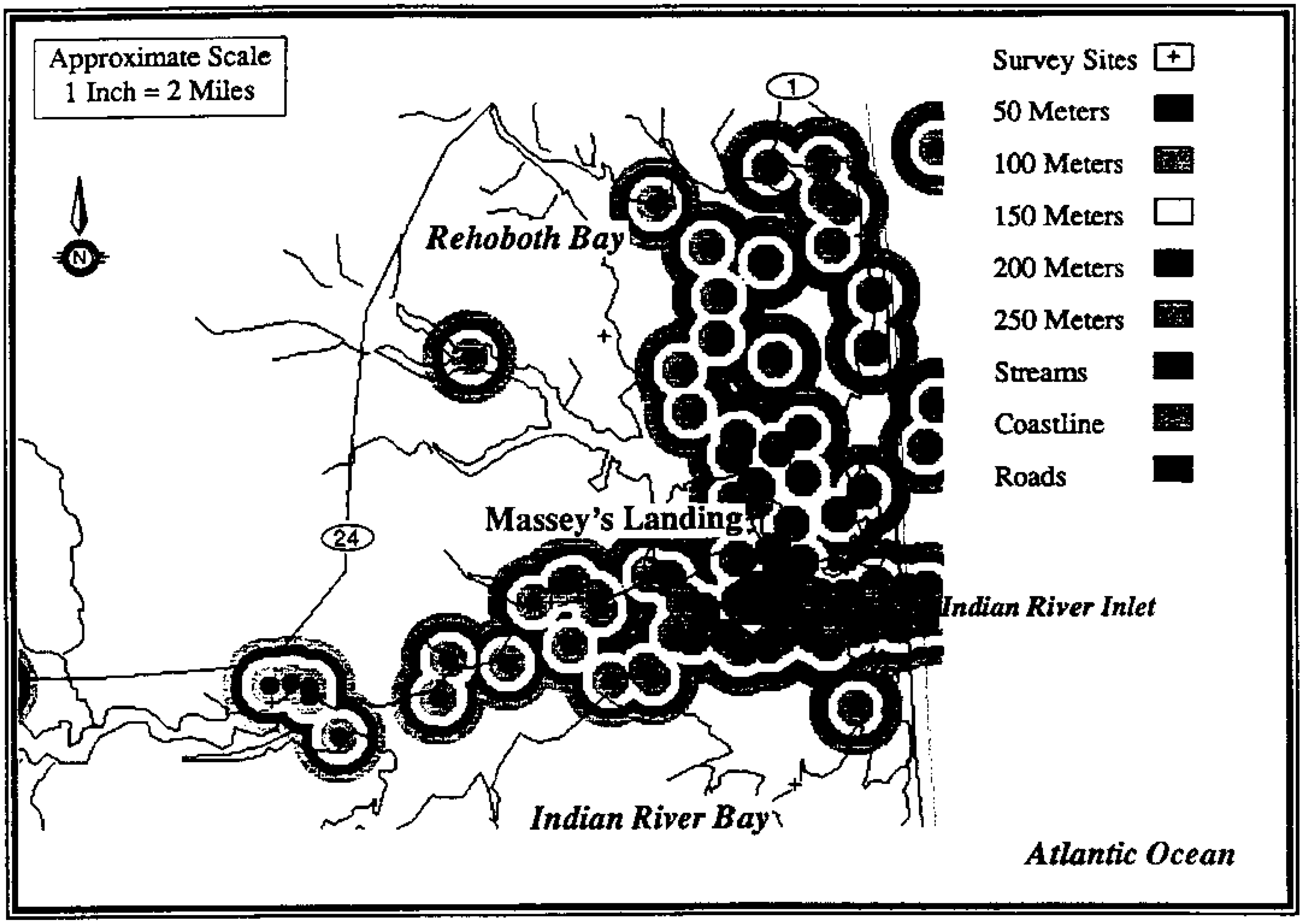


Figure 12. Cluster map of areas least enjoyed by boaters.

In Rehoboth Bay, there is a weak cluster of least-enjoyed areas located just north of Massey's Landing. This is also probably due to increased traffic passing through the confined area of the dredged channel at Massey's. The balance of Rehoboth Bay exhibits no significant clusters, and, in fact, the points are significantly dispersed.

The most-often reported reason for the low desirability of an area was too many people or boats. The next most often-cited reasons for dissatisfaction were unpleasant water and adverse weather conditions. The unfavorable water conditions most often mentioned were high waves or choppy conditions, followed by shallow water. Other reasons included perceived conflicts with jet-skiers, lack of fish, crabs or clams; and observing reckless or unsafe boating practices.

Figure 13 displays the cluster map of areas that boaters reported avoiding. Again there is substantial clustering evident in the Indian River Inlet area. This is probably due to elevated use levels in and around the navigation channels. The most common reason for avoiding an area was shallow water or sandbars. The next most common reason was crowded conditions (too many people or boats). Other reasons included water conditions other than depth (e.g., waves, poor water quality, or dirty water), unsafe area, reckless or inconsiderate boaters, and jet-skiers.

It is important to note that the areas avoided, unlike all of the other points examined, do not represent recreational boaters' activity patterns. They are, in fact, locations from which these users were absent by choice due to various factors. These areas represent a displacement of users to another place, activity or time.

These map results conclude that some minor spatial clustering of points reported as most enjoyable by boaters occurred in the data. Additionally, substantial clustering of points reported as least enjoyable and avoided is evident from the statistical analyses. The causes of this clustering are largely attributable to measurable factors such as use levels and water depth.

Boater Activity Sites and Reported Routes. Figure 14 displays all of the sites (represented by 10 colors) where boaters reported engaging in an activity. There were a total of 403 activity sites located on the maps as reported in Table 26. The most common activities reported were fishing (49%), followed by crabbing (22%), powerboating (10%), and clamming (6%). The remainder accounted for less than 15 percent of the total activity locations reported. Powerboating is probably under-represented since many respondents boated throughout the bays, yet did not specify a particular location for powerboating. Activities such as sailboarding and jetskiing may also be under-represented in this analysis due to sampling methods.

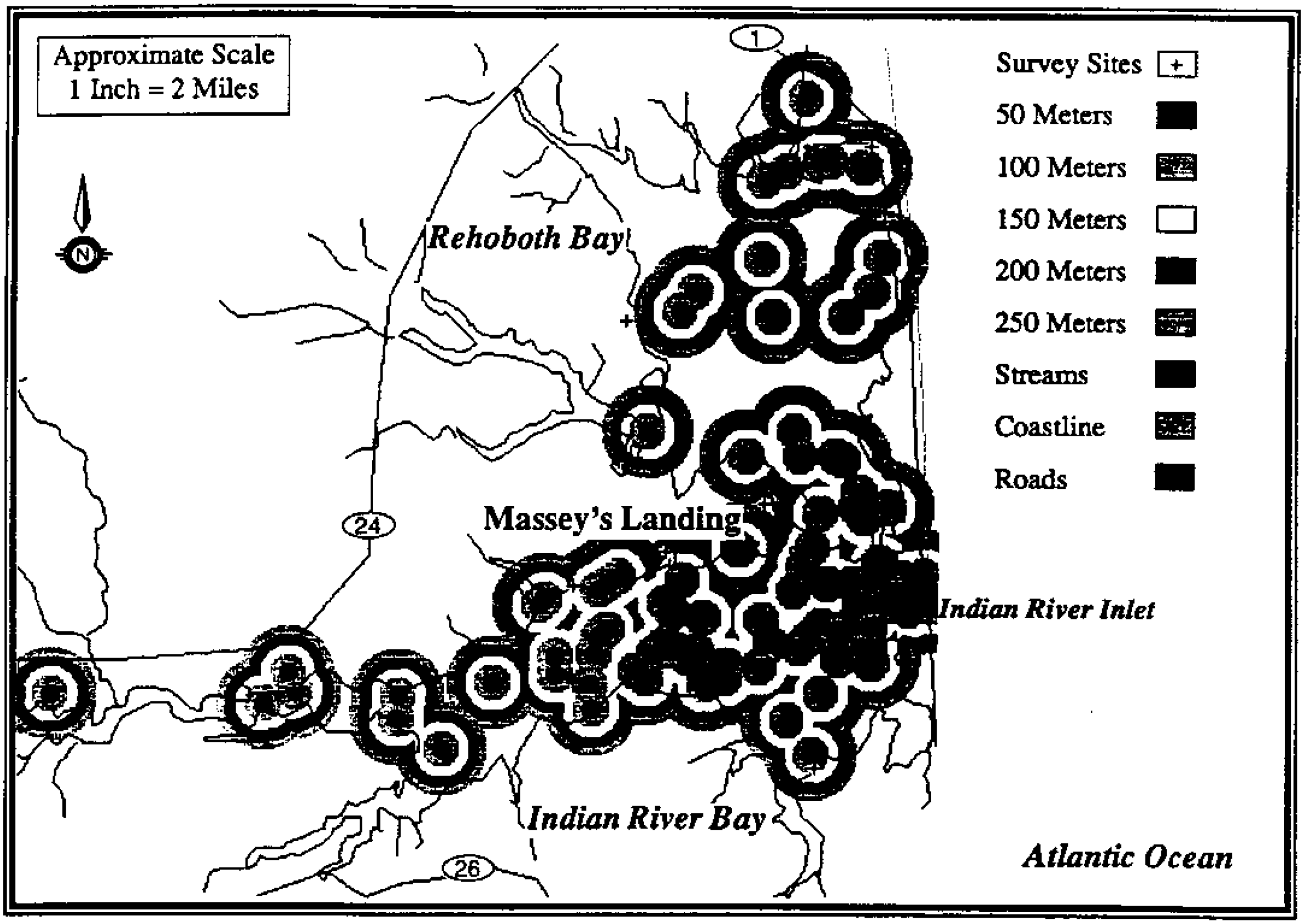


Figure 13. Cluster map of areas avoided by boaters.

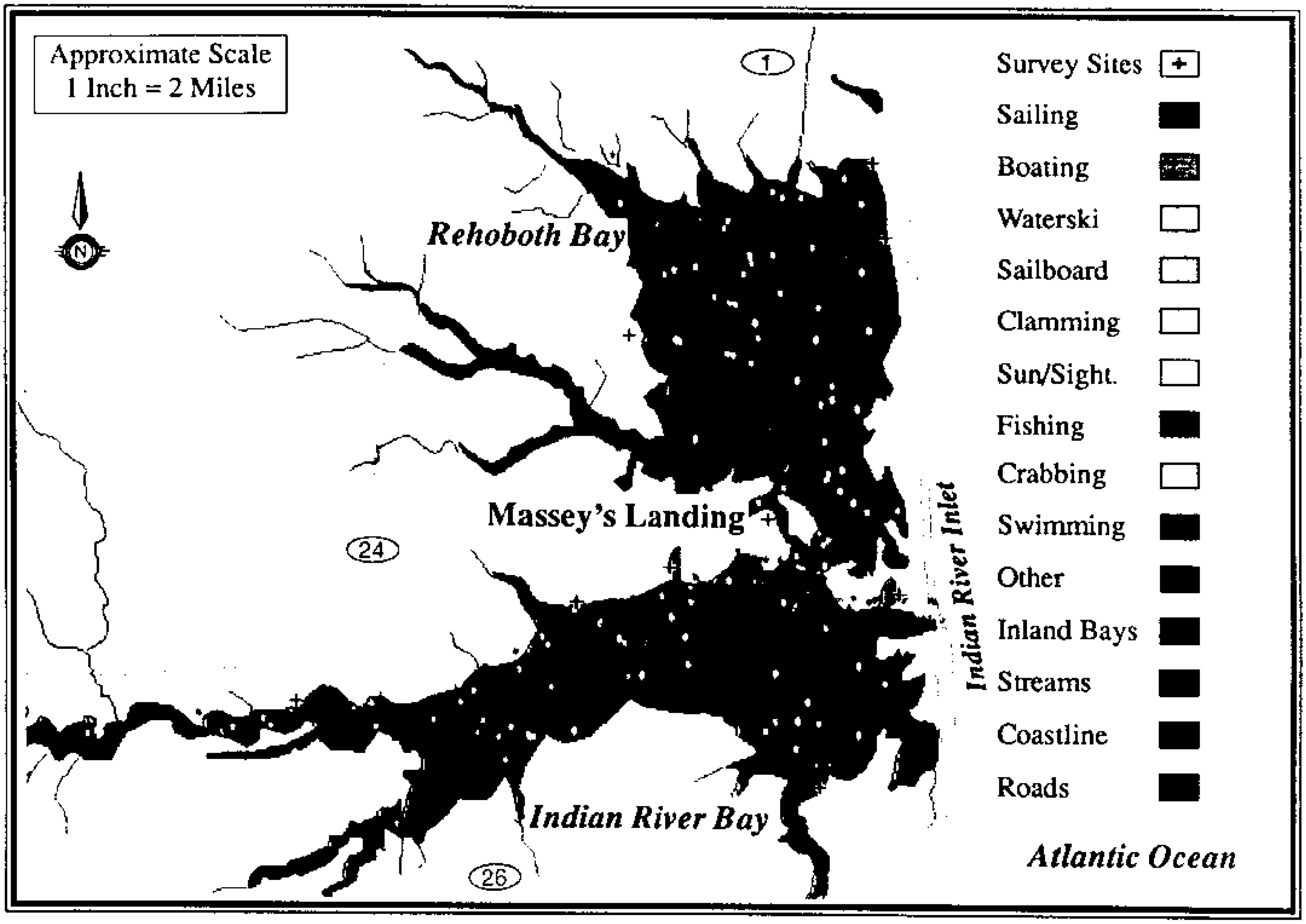


Figure 14. Point-pattern map of reported activity sites. (Points are not to scale, but represent approximate locations of activity sites.)

Table 26. Reported point counts by activity.

Activity Sites	Number Reported	Percentage
Fishing	197	49
Crabbing	86	22
Powerboating	42	10
Clamming	25	6
Sunbathing/Sightseeing	14	4
Swimming	13	3
Waterskiing	13	3
Other	9	2
Sailing	4	1
Activity Total	403	100

Figure 14 shows the use of the bays to be fairly even throughout the entire bay system, with higher concentrations in the area between Massey's Landing, Pot Nets and the Indian River Inlet. This increased density is most apparent in and around the inlet with a second concentration just south of Massey's Landing. This observation is consistent with the on-water counts of boating activity as reported earlier.

Figure 15 is a map showing a random sample of trip routes that boaters reported taking during their day on the bay. A sample was used to represent the entire data set due to the cluttered, uninterpretable maps produced when all the routes were displayed. This sample includes approximately one-quarter of all the reported routes and is representative of the entire data base. The areas that displayed the greatest route densities were the Indian River Inlet area and the area around Massey's Landing. It is also interesting to note that the southern side of Indian River Bay and the center of Rehoboth Bay displayed very low use levels.

Activity Sites and Potential Conflicts. The next series of figures shows the distribution of selected on-water activities and areas of potential conflict due to certain uses. Figure 16 shows areas of fishing activity and powerboat routes. Besides being the most common activity, fishing also appears to be the most highly concentrated. The primary fishing area is Indian River Bay from Pot Nets east to Indian River Inlet and out to the ocean. There is a secondary and much less dense area of reported fishing use in southern Rehoboth Bay extending through Massey's Landing. This area connects with the primary use area discussed earlier. There is another smaller concentration located in the north section of Rehoboth Bay.

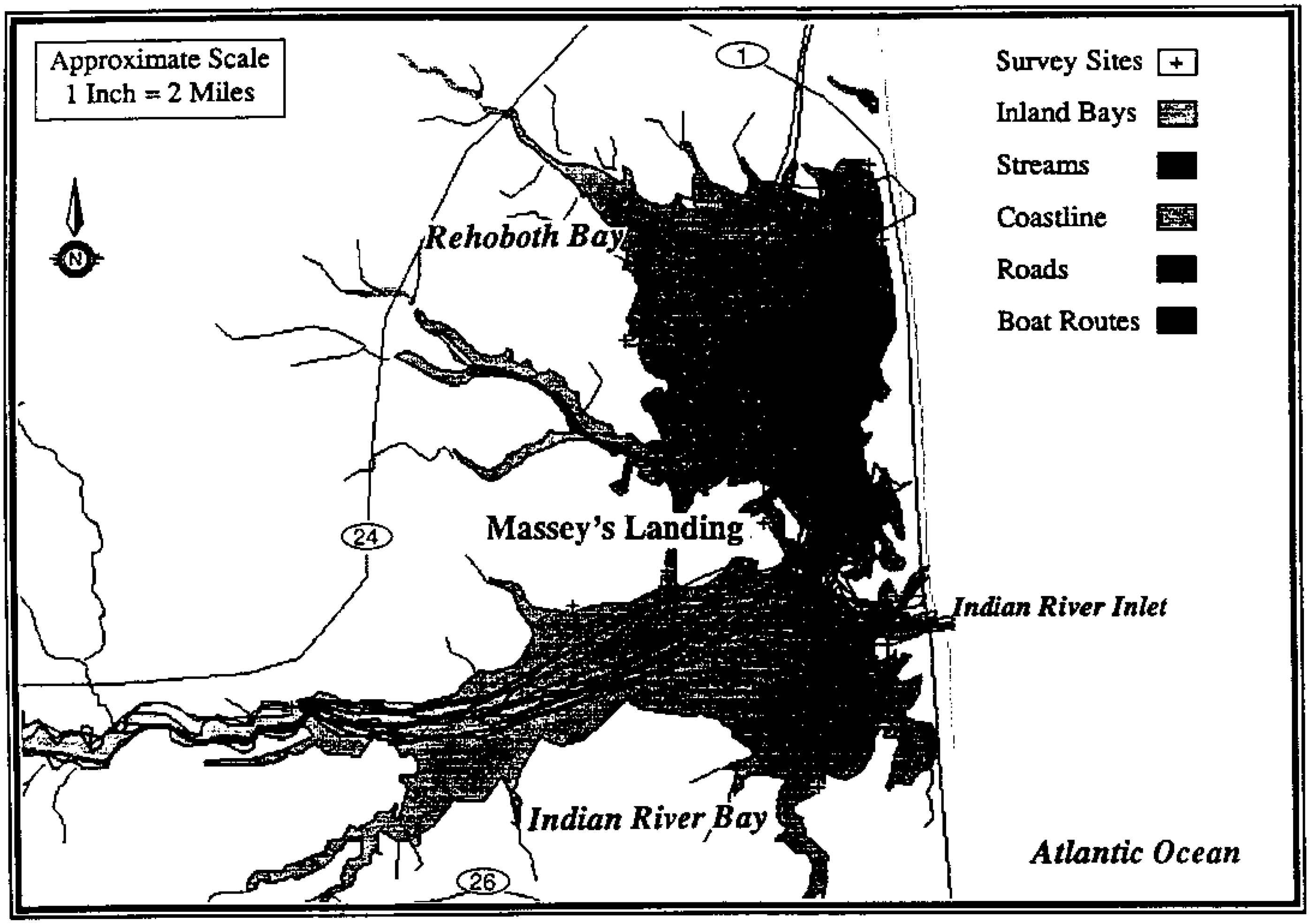


Figure 15. Map of reported boating routes. (Boating routes are not to scale, but represent approximate locations.)

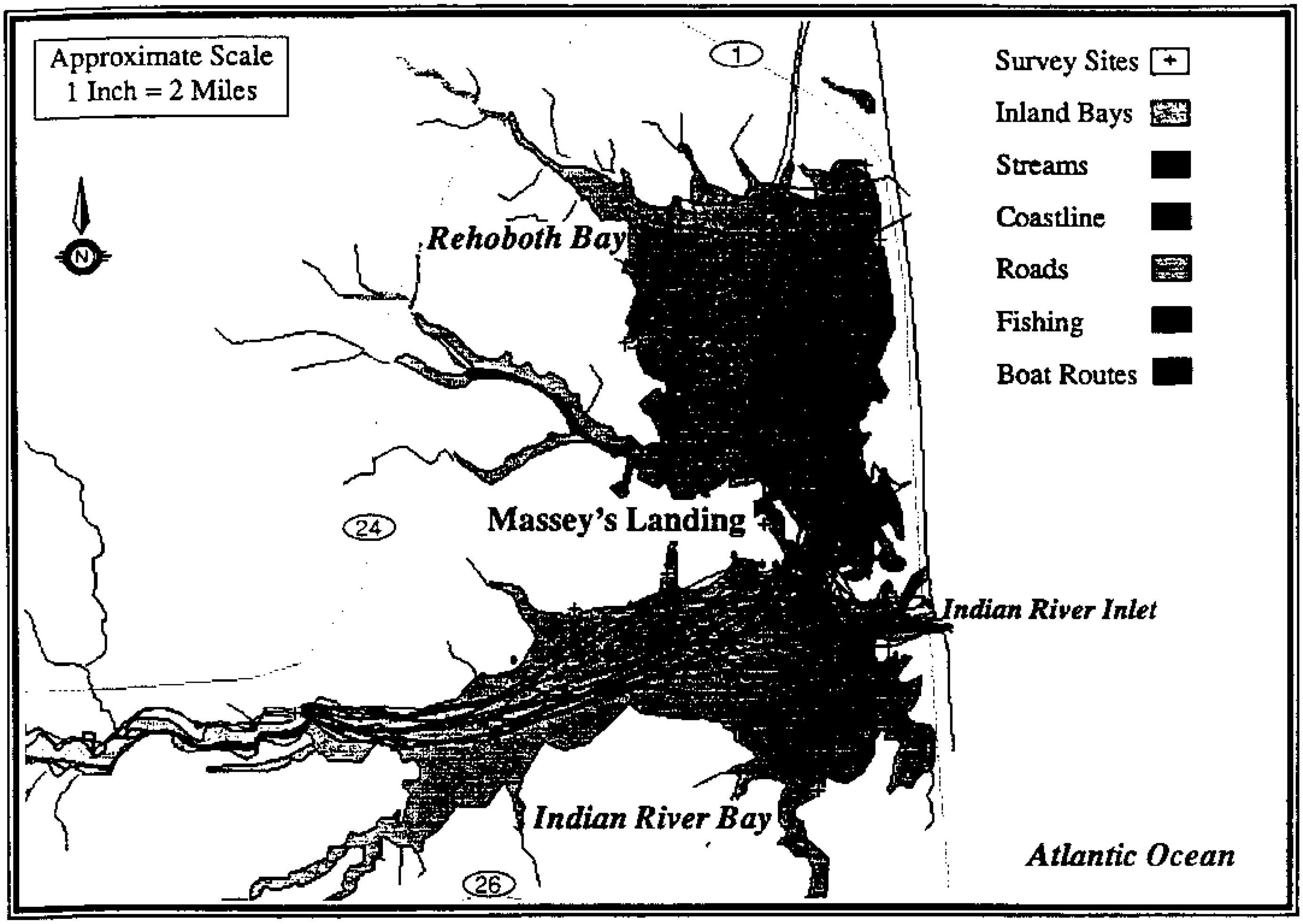


Figure 16. Map of reported locations of fishing activity and reported boating routes. (Points and boating routes are not to scale, but represent approximate locations of activity sites.)

Figure 16 also shows areas of potential conflict between fishermen and power-boaters. Overall, these two activities seem to have the most potential for conflict. Their primary use areas overlap almost completely. Additionally, the type of usage differs, with fishermen reporting primarily anchored or drift fishing, whereas powerboating by nature is mobile. The main area of potential conflict is the area from Indian River Inlet to Massey's Landing. It appears that the major boating channels near the inlet also tend to be the best fishing spots. This is due, in part, to the numerous shallow sandbars that preclude boating and fishing in some parts of the area.

The areas identified as crabbing sites, the second most popular activity, are displayed in Figure 17. This map shows the primary areas of crabbing as the points where Indian River and other tributaries flow into Indian River Bay. There is a second concentration of crabbing in the northwest corner of Rehoboth Bay where numerous tributaries enter the bay. Potential conflicts between crabbers and powerboaters fail to emerge when the boating routes are overlaid (Figure 17). An explanation may be that most crabbing is done in shallow water and in the tributaries, whereas powerboating is limited more to the deep sections and channels. The sites up Indian River do exhibit the possibility for conflict due to the narrow, confined nature of the bay at those points. However, this may be distorted somewhat in that the boating routes displayed may have been the crabbers themselves. A second, minor potential boat/crabbing conflict area is located in the middle of Indian River Bay.

Figure 17 also shows areas of clamming activity reported by boaters (the fourth most popular activity). This plot shows that the primary clamming areas include the east shore of Rehoboth Bay, with the highest concentration just east of Massey's Landing. Additionally, a few areas in Indian River Bay along the north shore and on the east shore south of Indian River Inlet were identified. These areas are fairly shallow and are therefore easily accessible to clammers.

Most of the reported clamming activity is located in the extreme eastern side of both bays with no activity reported in the far northern end of Rehoboth Bay or any of the western reaches of Indian River Bay. This reflects the fact that these areas are closed to clamming during the summer months due to high bacteria levels. This suggests a number of interesting points. First, this analysis lends credibility to the GIS method, implying that clammers know the area where they participated in their activity. It also suggests that clammers respect the shellfish closure designation and refrain from taking clams in the restricted zone.

Figure 17 shows few areas of potential conflict between powerboaters and clammers. By examining this map, it is apparent that the primary areas of clamming activity are not the primary boating routes, due mainly to inadequate water depth required for powerboating. There is one notable exception in the area to the east and south of Massey's Landing, west of Burton Island.

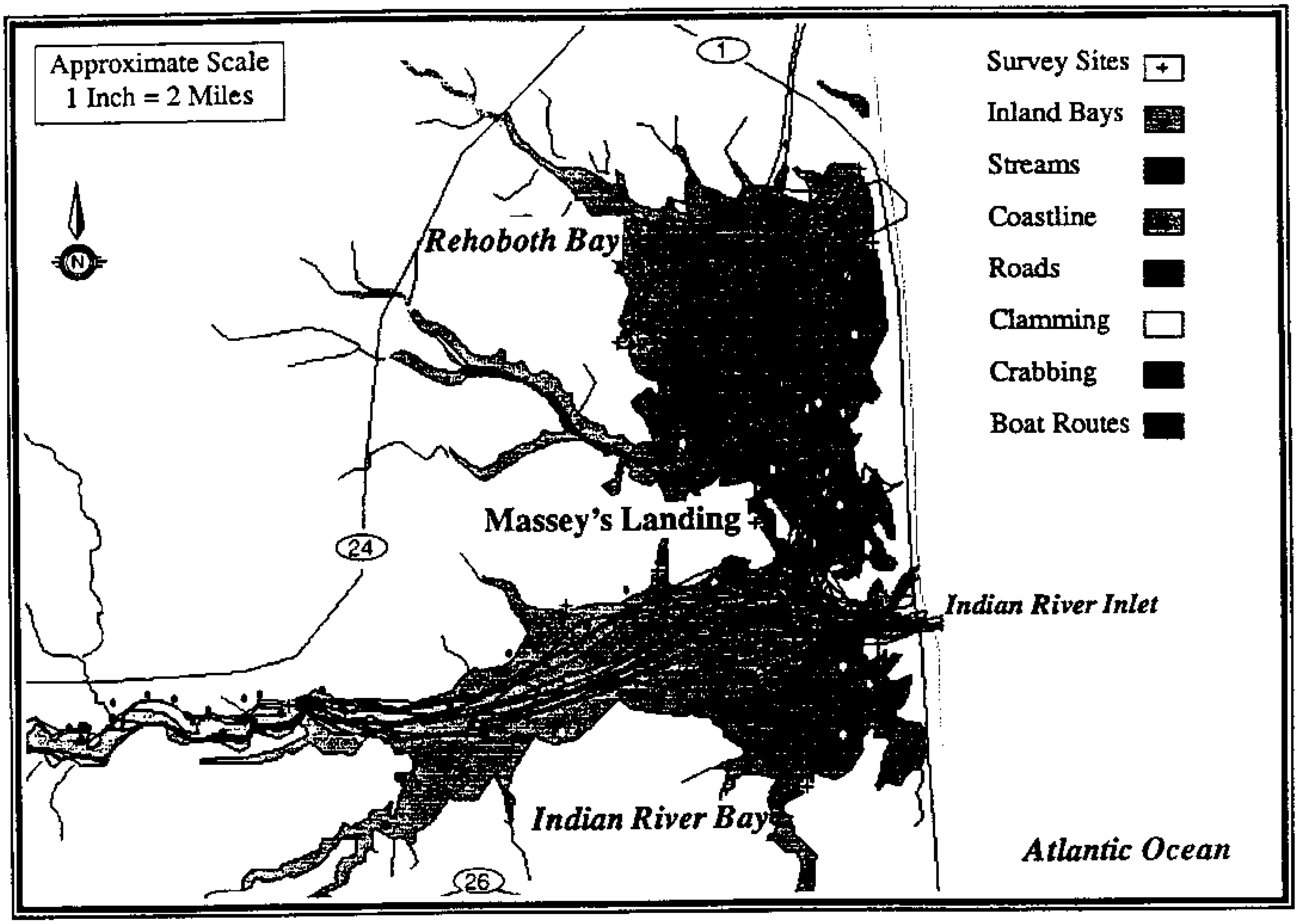


Figure 17. Map of reported locations of crabbing and clamming activity and reported boating routes. (Points and boating routes are not to scale but represent approximate locations.)

From this data, there is not enough evidence to indicate that clamming and powerboating are a common source of use conflict. However, due to the type of conflict and safety issues (i.e., unprotected clammers with just heads and shoulders above water in an area with powerboaters), these two activities should be monitored and/or segregated.

Summary. Based on the results of this spatial analysis of boating distributions and patterns, the Inland Bays do not appear to presently exhibit substantial crowding or major use conflicts. There are, however, a few areas that may experience problems, especially during peak-use periods. The main area of concern appears to be the area from Indian River Inlet to Massey's Landing. This area should be monitored, especially during peak-use periods and if overall use increases. Resource managers should not overlook the value that this GIS analysis can provide in helping to manage the bay's diverse recreational user groups.

CONCLUSIONS

This report provides the first-ever glimpse of recreational boating carrying capacity for a water body in Delaware. Various social and environmental considerations were discussed that can be used to address a variety of management issues and decisions affecting Delaware's Inland Bays. Initially, the data provide a broad overview of the population of boaters using the bays. Information such as group size and composition, activities and locations of use, intensity of use, type of boats, their sizes and engine horsepower, means of access to the bays, and frequency of boating use were described so managers may better understand boater characteristics and the assortment of boats using the resource.

In addition, the data were presented so that managers can examine boaters from various vantage points. For instance, boaters were classified as either permanent residents, seasonal residents, or seasonal visitors. The data are also arranged by the type of facility that boaters use--marina, launch ramp, or shoreline community. Finally, there was a grouping by bay of residence--Rehoboth Bay, Indian River Bay, or Little Assawoman Bay. This level of detail allows managers to take into account boater differences based on these classifications. Managers must decide which segments of the results are most important when developing management strategies for boaters.

A further level of data analysis examined boating densities and use activities in distinct zones within Rehoboth and Indian River bays. This analysis showed where use intensities are the greatest, where boating "hot spots" are located, and where use activities might lead to conflicts. A Geographic Information System (GIS) analysis used map data to suggest potential user group conflicts. These spatial analyses may help resource managers predict where future boating activity will be greatest. In anticipation of these heavier use pressures, managers can impose measures to control boating activity in the areas, post warnings, or provide additional educational messages, and/or employ greater numbers of enforcement personnel to prevent conflicts and safety problems.

Some of the more important data generated from the study relates to attitudes and perceptions of boaters about their boating experiences. Delaware resource managers may have had their own opinions about existing conditions on the bays, but prior to this study they had no reliable data regarding boaters' perceptions. Thus, while managers may base their decisions on any criteria they consider relevant, data on boater perceptions and attitudes provide one additional source of information for decision-making.

If resource managers determine that additional regulations and controls need to be enacted to better manage boating activity in the bays, these study results provide boaters' opinions about certain measures. If regulations are considered that are supported by a majority of boaters, there should be wider acceptance and less likelihood of non-compliance. Conversely, if management measures are considered that do not have widespread support, additional education and stronger enforcement may be necessary.

The survey questions measured attitudes about safety, aspects of crowding, elements of boater displacement, and other behavioral factors. No matter what activity boaters engage in, they are searching for a safe and satisfactory experience. If their expectations are not being met, they may choose to relocate to a different boating environment or pursue other recreational pursuits.

Implications for Carrying Capacity

Resource managers can examine these study findings to help answer the multi-faceted question, "Are there too many boats on Delaware's inland bays?" However, these managers must first ask themselves whether or not current conditions are acceptable. While this study does not answer this question directly, it does provide the data needed to address the question. The data presented can be used as a basis for establishing quantitative standards of acceptability for a wide range of potential social and environmental indicators.

As described more fully in Appendix A, current resource management frameworks 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 their corresponding standards. In this case, there were no pre-existing standards for determining a quality boating experience on the Inland Bays. Therefore, it is difficult to accurately say there are too many boats using Delaware's Inland Bays. Information on the current levels of impacts occurring on the bays, however, can be used as a baseline for the determination of an initial set of standards.

For example, Inland Bays' boaters interviewed during 1991 rated the overall quality of their boat trip between 7.2 and 8.0 (on a 10-point scale). One-fourth (26%) of those sampled reported that their enjoyment was reduced because of the number of other boaters they encountered on the bays. The vast majority (74% to 92%) considered conditions on the bays to be safe on the day they were interviewed. If resource managers consider these conditions acceptable, then such statistics can be used to set a standard against which future measurements can be compared.

Data from other sources can also be integrated into the evaluation of existing conditions. For example, DNREC statistics on boating accidents provide another perspective for evaluating safety on the Inland Bays. The available statistics reveal that the number of accidents reported has been quite stable for the years 1990-1992, although the number of accidents involving jetskis has increased during this brief period (Table 27). The relatively low numbers of accidents reported statewide echo this study's finding that very few study respondents (2-5%) indicated that they nearly had an accident due to crowded conditions. The increasing frequency of accidents involving jetskis (almost all of which occurred on the Inland Bays) is consistent with comments from some study respondents about problems they encountered with jetskis. These data suggested that it is important to maintain and review statistics on boating accidents, especially in the Inland Bays, on a routine basis.

Table 27. Summary of boating accidents reported to DNREC, Division of Fish and Wildlife (1990-1992).

Activity Sites	1990	1991	1992
Number of Accidents Reported	28	28	22
Number of Watercraft Involved	40	43	35
Percent of Accidents on Inland Bays	29%	54%	50%
Number of Accidents Involving Jetskis	4	8	10
Percent of Jetski Accidents on Inland Bays	100%	88%	90%

After assessing the acceptability of current conditions, a second type of information needed to address boating capacity is knowledge of the relationship between boater use patterns and the impacts one is trying to control. It is necessary to demonstrate a link between cause (boater use) and effect (impacts on either the environment or the boating 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 the Inland Bays. The most noticeable impact of higher boating densities was a higher degree of perceived crowding. Crowding, in turn, was accompanied by other impacts, including boater displacement, safety, conflict, and satisfaction. However, the number of boats on the bays seemed to have less of an impact than certain objectionable behaviors engaged in by some boaters. For example, 30 to 40 percent of the boaters interviewed reported that other boats had come too close to them while they were boating. Such incidents were one of the greatest safety concerns among Inland Bays' boaters, but these incidents were also unrelated to boating density levels. This information suggests that managers should consider actions to reduce the frequency of boats coming too close to each other. Limiting the number of boats on the bays would have little effect since the problem is due to behavior patterns rather than the number of boaters encountered. Expanding enforcement of existing regulations and offering educational programs aimed at making offending boaters aware of the impacts of their actions are more likely to bring about improvements in this situation.

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 proposed facility development options. The likely effects of new or expanded facilities on the Inland Bays would naturally depend to some degree on the type, size, and location of the planned facilities. There are three basic findings of this study, however, that should be kept in mind when any future facility developments are considered.

Range of Peak-Use Density Levels. The density of boats using the bays at one time in summer 1991 weekend days varied several orders of magnitude, from a low of 251 to a high of 848 boats counted. Boating activity at access areas sampled (marinas, launch ramps, shoreline community facilities) also varied widely throughout the summer. This variation in peak-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 bays. Thus, additional facilities would be used to their full capacity relatively infrequently (mainly on holiday weekends and Saturdays during the months of July and August). On these peak days, the additional access provided could lead to total use levels above the maximum recorded in this study. However, for the remaining nonpeak weekends and weekdays, the total number of boats on the Inland Bays would remain largely within the range observed during 1991.

Boaters Acceptance of Existing Conditions. Most boaters surveyed were quite satisfied with their boating experiences. Relatively few boaters reported that they had been displaced by crowded conditions on the bays, experienced safety problems, or noticed other boating conflict situations. While these results do not guarantee that inland bays boaters will accept higher boat densities, they do document that most current users do not feel that the bays are already overused. Approvals to increase boating facilities would be more questionable if boaters perceived that 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 associated impacts that might interfere with a quality experience showed little or no variation in relation to different boat densities. Thus, within the range of densities represented in this study, actions that influence the number of boats using the bays 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 boating quality/impact variables, however, coupled with the tendency for maximum use to occur only infrequently, imply that increasing densities will have little impact. Of course, one cannot rule out the possibility of a nonlinear 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 1991 boating season. The safest way to avoid reaching 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.

Future Monitoring Needs

Regardless of what management and development alternatives are implemented in the future, the effects on boating quality can ultimately be determined only through a monitoring program. Future monitoring should focus on those variables that were most critical in this study. The following discussion considers the various indicators measured in this study in light of three criteria. These criteria include frequency of occurrence (to what extent was each indicator prevalent on the Inland Bays), correlation with boat density (to what extent was the indicator associated with changing boat density levels), and correlation with the satisfaction index (to what extent did the indicator contribute to boaters' overall satisfaction levels). It is suggested that future monitoring efforts include those indicators with high values on one or more of these criteria.

Satisfaction. Satisfaction is an important variable because it indicates boaters' overall reactions to their boating experiences. As in many other studies, boater satisfaction was relatively high and did not vary significantly at different boat density levels. In spite of these generally favorable findings, satisfaction should be monitored in the future to detect changes that may occur in response to changing boating conditions.

Of the two satisfaction measures included in the study, the 10-point overall trip rating is less sensitive and precise, but can be obtained and analyzed more easily and thus has a practical advantage over the satisfaction index (comprised of five separate items). The satisfaction index did play an important role in this study by allowing a more complete examination of the factors that influenced boater satisfaction and by providing a validity check for the other satisfaction measure. Because of the relatively strong correlation (r = .55) between the two satisfaction measures, use of the 10-point rating should provide an adequate means of detecting unacceptable changes in the quality of boating on the Inland Bays. If monitoring does reveal lower satisfaction on this scale at some point in the future, it would be useful to conduct an in-depth study similar to the current investigation and then include the more complete, five-item satisfaction index in that study.

Crowding. Of all the impact indicators measured, the crowding index was the variable that was most strongly correlated with boat density (r = .25). Considering the moderate crowding levels recorded during this study and the relationship between crowding and other impact measures, the degree of perceived crowding may be one of the most important limiting factors to future growth of boating on the Inland Bays. Both crowding measures used in this study (perceived crowding and impact of crowding on trip enjoyment) should be monitored regularly in the future.

Other Impact Indicators. The impact of other boats coming too close was the most frequent type of impact cited by Inland Bays' boaters. It is noteworthy that this impact was not related to boat density, but occurred consistently regardless of the number of boats on the bays. Future monitoring of this indicator is important in order to evaluate the effectiveness of changes in enforcement and/or boater education.

The indicators associated with boating time, place, and activity displacement all occurred with similar frequency and showed similar relationships with boat density and satisfaction. Because they directly relate to all three criteria for evaluation, each of these displacement indicators should be included in routine monitoring efforts.

Seventy-four to 92 percent of the boaters surveyed felt that boating conditions on the bays were safe, and the perceived safety index was also relatively strongly correlated with the boater satisfaction index (r = .40). Hence, perceptions of safe conditions should also be monitored. Similarly, asking boaters to report whether they observed an unsafe boating situation would provide a useful indicator of boating safety on the Inland Bays.

In addition to collecting information from boaters, future monitoring should also include measures of boat density and use patterns, as well as other available data, such as the reported accident statistics discussed earlier. Following the procedures used in this study, periodic counts of vehicles at major access points, coupled with on-water counts of the number of boats on the bays at a single time, should be made. This data should be integrated with future surveys of boater perceptions to allow examination of the relationships between boating quality and future peak-use levels.

DNREC resource managers should consider one additional step in their attempts to monitor boating quality and carrying capacity on the Inland Bays. This would involve initiating environmental monitoring in conjunction with future boating quality monitoring. One environmental indicator easily sampled could be water turbidity. This can be measured over the course of a boating season and then compared with boating-use intensities on the same sampling days. Additionally, water samples could be collected and analyzed to determine the composition of the suspended material. Only through an integrated monitoring approach such as this will there ever be a reliable method of associating boating activity with environmental disturbances.

Finally, there are important parts of the Inland Bays that were not included within the scope of this study. These are the major tributaries in the bay system (i.e., Herring Creek, Love Creek, White's Creek, Pepper Creek, and upper Indian River) These areas are subject to intense recreational uses and potential user conflicts. They should especially be monitored in the future to observe whether they might pose problems related to environmental or social carrying capacity.

INLAND BAYS MANAGEMENT RECOMMENDATIONS

Policy

1. In order for the results of this study to have relevance for resource managers, the Inland Bays Estuary Program (IBEP) must develop clearly defined management objectives for the bays. These objectives should identify any applicable standards against which existing conditions can be compared. The IBEP and its committees should consider a balanced approach to maximizing the use of the bays and preserving environmental quality. These objectives should become more apparent as the process of developing an Inland Bays Comprehensive Conservation and Management Plan (CCMP) progresses.

2. Three distinct user groups were identified and analyzed as part of these findings: permanent residents, seasonal residents, and seasonal visitors. The study findings suggest that the three groups are distinct in their perceptions and preference for Inland Bays' management options. The IBEP must decide the relative importance of these distinct user groups and what priorities, if any, should be given to the groups in future planning efforts.

3. Resource managers should encourage boating groups and organizations (as well as individual boaters) to play a stronger role in the bays' enhancement efforts. Fifty-two percent of permanent residents, 56 percent of seasonal residents, and 55 percent of seasonal visitors favored the purchase of a seasonal boating use permit for bay use, if the money were used for bay improvement. Many boaters emphasized that the moneys should be "earmarked" for the bays. This is an indication that the majority of boaters are willing to help finance resource enhancement measures for the bays.

4. There is no substantial evidence, based on this current user perception survey, to suggest that carrying capacity problems exist in the Inland Bays as a whole. There are, however, potential "hot spots" where activity levels and density levels are higher than in other areas. These areas must be closely monitored by DNREC personnel to observe whether safety concerns or environmental factors become critical to users or the resource.

5. More than one-half of all the respondents supported the idea of zoning waters to provide for specific uses at specific places. DNREC should consider zoning the bay waters if living resource or user conflicts appear evident. From current observations, no major conflicts between users have materialized. Certain activities seem to have already "zoned themselves" and are undertaken, almost exclusively, in these areas (e.g., sailboarding in northern Rehoboth Bay, sailing in Rehoboth Bay, fishing in Indian River Bay).

6. Survey respondents had stronger feelings about restricting the development of new marinas in the Inland Bays than they did about restricting boat ramps. Between one-quarter and one-third of permanent residents, seasonal residents, and seasonal visitors felt additional boat-ramp development around the bays should be restricted; however, between 40 percent and 70 percent of each group felt marina development should be restricted. Based upon these user preferences, and in light of the current supply of marinas around the bays and the environmental impacts caused by them, priority for development of further boating access to the bays should be given to additional launch ramps rather than full-service marinas.

7. DNREC should incorporate the GIS study findings related to boating activities and desirability into their Inland Bays data base to maintain baseline data for tracking potential user conflicts and behavior patterns.

8. Evidence suggests that certain use activities occurring in the tributaries of the Inland Bays (e.g., Herring Creek, Love Creek, White's Creek, Pepper Creek, upper Indian River) could lead to future conflicts or resource degradation problems. Since these areas were not examined as a component of this study, future monitoring and site-specific analyses of these areas should be considered by resource managers.

9. As growth, development, and use patterns continue around the bays, further assessments and modifications should be made to these recommendations. Long-term monitoring of boating and other recreational activity in the bays and associated perceptions of users are needed for state and local officials to make these modifications.

Enforcement

1. Twenty-five percent of on-site field survey respondents and 50 percent of mail survey respondents indicated a desire for additional marine police and law enforcement officials on the waters of the Inland Bays. Further, those individuals providing open-ended management suggestions ranked "additional law enforcement" as the third highest management option for IBEP officials to consider. DNREC's Division of Fish and Wildlife Enforcement Section should review its current enforcement operations in the bays and decide whether increased patrols are warranted. The role the U.S. Coast Guard can play, related to boating safety in the Inland Bays, should also be reviewed and expanded, if feasible.

2. On major water-use days (i.e., holiday weekends and Saturdays, primarily) additional law enforcement personnel should patrol the areas identified as "hot spots" to maintain a safe and enjoyable experience for all users.

Boating Safety

1. DNREC, the IBEP, and other organizations should consider methods of strengthening their educational efforts to create more boating safety awareness in the bays. Boater safety education for Inland Bays boaters was the highest rated concern of survey respondents offering open-ended survey comments. Much of this response is directed at boaters who (1) do not follow the "rules of the road," (2) are discourteous when approaching other boaters, or (3) create large wakes and go too fast when passing stationary vessels.

2. Many respondents provided open-ended comments mentioning the problem associated with high-speed boats creating wakes and high waves near stationary or drifting fishing boats. This is a nuisance problem that could become serious if accidents or other safety concerns in the higher use areas become apparent. Courtesy should be adhered to by all moving boaters as they approach stationary boats. DNREC officials should pay particular attention to the popular fishing spots near Massey's Landing, South Shore Marina, Delaware Seashore State Park Marina, and Indian River Inlet. Since the Indian River Bay navigation channel cuts through this major "hot spot," accidents related to boat speed and wakes are possible here.

3. Jetskis have received much media attention as being a major concern in the Inland Bays due to noise, unsafe handling practices, damage to sensitive shallow water areas, etc. Based on on-site field interviews, the major problem with jet-skiers does not appear to be with those owning the personal watercraft, but rather with those who rent the vessels for brief time periods. Many jetski owners are sensitive to the criticism that has been directed at them and realize that they must practice safe, responsible boat handling. The Delaware General Assembly passed jetski legislation in July 1991. The bill outlined restrictions and regulations for personal watercraft (jetski) operators to promote the safe operation of such watercraft. It is hoped that this legislative action is adequate to control the immediate concerns voiced by certain individuals.

4. Open-ended responses by survey respondents indicated a need to control and regulate crab pots in boat channels and other areas of the bays. DNREC should review its current policies related to crab-pot usage in the bays. It should consider establishing off-limit areas in and adjacent to marked navigation channels, and a crab-pot marking system should be instituted to control violators.

Environmental Concerns

1. Less than one-third of each user group indicated that they thought the environmental quality of the bays was improving, and less than 25 percent thought the bays' living resources were improving. Although very few respondents reported that they observed refuse or discarded wastes on the waters of the Inland Bays, there was still a major concern voiced that the bays were not becoming cleaner. This "unseen" pollution is typically thought of in the form of nitrate contamination, sewage plant discharge, septic tank leachate, agricultural runoff, and other point and nonpoint pollution sources. Virtually all survey respondents favored prohibiting all discharge of pollutants into the water. DNREC should consider these findings as solid support to increase its efforts to reduce the total amount of "unseen" pollution being discharged into the bays' waters.

2. There was varied support for limiting the size and power of boats using the bays. Permanent residents (50%) supported this idea more than seasonal residents (35%) and visitors (35%). Given the limited support for this idea, environmental officials should consider action to control boat and engine sizes in the bays only if they determine that larger boats and engines cause greater deterioration of the Inland Bays' environment than smaller vessels.

3. More than 80 percent of all survey respondents supported the establishment of off-limit zones to protect sensitive resources in the bays. The IBEP should conduct an assessment of sensitive habitats and resources in the bays and develop a habitat/living resource management plan. They should also conduct the necessary education to make boaters and other users aware of these sensitive resource zones.

4. More than 50 percent of all respondents favored restricting boat use in excessively shallow waters. Many felt that this would be a common sense rule that boaters would naturally adhere to. From a habitat standpoint these shallow-water areas are considered environmentally sensitive and invaluable nursery grounds. There are additional concerns over boat wakes causing erosion of wetlands and personal property and prop scour disturbing bottom habitat. With these concerns evident, restricting boats in shallow waters should be considered. Adequately marked navigation channels and arteries could also help protect valued shallow-water habitats.

5. More than 75 percent of each user group responded that restrictions on building and development around the bays should be considered. With this support, state and local officials should consider the creation of parks or greenways around the bays for passive and low-intensity recreation and to provide additional public access to the bays. DNREC Division of Parks and Recreation personnel have begun a statewide greenway system that should take into consideration the Inland Bays as a priority location.

Education and Awareness

1. Dredging boat channels and other areas of the bays was an issue mentioned by some survey respondents in open-ended suggestions. DNREC has a state dredging policy in effect for the bays. Additional education and awareness about shallow areas in the bays and the exact location of maintained navigational channels should be targeted to individuals. This may help alleviate some of the concern associated with this issue.

2. Education is a key ingredient in making bay user groups more aware as they use the resource in a safe and environmentally conscious manner. Those organizations involved in provide bay-related education should consider the distinct user groups involved and assess whether they all can be reached in a similar fashion (e.g., permanent residents may respond differently to educational initiatives than seasonal visitors).

3. Educational displays should be developed and placed at key locations (state parks, marinas, tourist information centers) around the bays. These displays will educate various user groups about the sensitivity of the bays' resources and the uniqueness of the watershed, as well as provide information to minimize potential use conflicts with others.

4. Federal, state, and local officials should consider mechanisms to create a more visible focus on the bays. Creating a theme like "Delaware's Inland Bays: A National Estuary" will give the bays a more prominent position, much like national parks and national wildlife refuges. Signs could be placed at key locations throughout the bay watershed giving this "national" designation greater visibility.

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APPENDIX A:
THE CONCEPT OF CARRYING CAPACITY AND RELATED STUDIES

Attempts to establish recreational carrying capacities have puzzled researchers and managers for more than 25 years. Wagar (1964) defined carrying capacity as the "level of recreational use an area can withstand while providing a sustained quality of recreation." Implicit in this definition, as well as other writings of the time, was recognition of at least two components of carrying capacity--a quality natural environment and a quality recreation experience. Subsequent research has produced a large and diverse volume of literature, with environmental studies generally referred to under the rubric, *ecological carrying capacity,* and research related to the recreation experience labeled *social carrying capacity.*

Previous writers have in fact recognized even more types of carrying capacities, including physical, facility, and economic capacity (Pigram 1983, Shelby and Heberlein 1986).

Physical Carrying Capacity is concerned with absolute space requirements and represents the maximum number of people that can be physically accommodated by a given recreational resource (Department of the Army 1989). Physical capacity is exceeded when use levels are greater than those at which recreational activities can occur in a safe and efficient manner.

Facility Capacity focuses on manmade improvements such as parking lots, boat ramps, and so on. Facility capacity is generally relatively easy to measure, but is rarely the most limiting factor in recreational settings.

Social Capacity refers to the impacts of user densities on the quality of the recreational experience. Social impacts involve the number, type, and location of encounters between visitors to a recreation area and the visitors' reactions to these encounters.

Ecological Capacity is concerned with the impacts of recreational use on the natural environment. Pigram (1983) defines ecological capacity as the "maximum level of recreational use in terms of numbers and types of activities that can be accommodated by an area or an ecosystem before an unacceptable or irreversible decline in ecosystem values occurs."

Economic Carrying Capacity refers to the level of activity above which recreation has an unacceptable economic impact on other resource uses (Department of the Army 1989). This concept is most applicable in multiple use situations, such as a water resource that provides water supply and wildlife and fisheries habitat in addition to recreation. Economic capacity is exceeded when the added operation and maintenance costs associated with recreational activities exceed the benefits derived from recreation.

Each of the above types of capacity may impose constraints on the recreational opportunities that can be provided from a given area. Previous studies suggest, however, that the social capacity is most likely to be the limiting factor in most instances (Shelby and Heberlein 1986; Department of the Army 1989).

Most recent research emphasizes that carrying capacity is not an absolute number, but rather represents a range of values that must be related to the specific management objectives for a given area. Nowadays, carrying capacity tends to be defined in terms of levels or types of use beyond which impacts to either the environment or recreational experience exceed acceptable levels. This view of carrying capacity came about in response to a large volume of research that demonstrated how complex recreational impact and capacity issues usually become.

1. **Impact Interrelationships.** There is no single, predictable environmental or behavioral response to increasing recreational use. Instead, an interrelated set of impact indicators can be identified. Some forms of impact are more direct or obvious than others, but any impact indicator or combination of indicators could serve as the basis for estimating capacities or selecting management strategies. Thus, to understand how a given water resource is affected by recreational use, it is necessary to consider a broad range of possible impact variables.

2. **Use-Impact Relationships.** Various impact indicators are related to the amount of recreation use a given area receives, although the strength and nature of the relationships vary widely for different types of impacts. Most impacts do not exhibit a direct linear relationship with visitor density levels. Use-impact relationships vary for different measures of visitor use and are influenced by a variety of situational factors.

3. **Varying Tolerance to Impacts.** One of the most important factors affecting use-impact relationships is the inherent variation in tolerance among environments and user groups. Not all areas respond in the same way to recreational use. Some species may benefit at the expense of others who are negatively impacted or displaced. The same holds true for various recreational user groups. Some groups may enjoy high user densities while others find such use levels unacceptable.

4. **Activity-Specific Influences.** Some types of recreational activity create impacts faster or to a greater degree than other types of activity. The extent of impact resulting from a given activity can vary according to such factors as the type of equipment used and visitor characteristics such as party size and behavior.

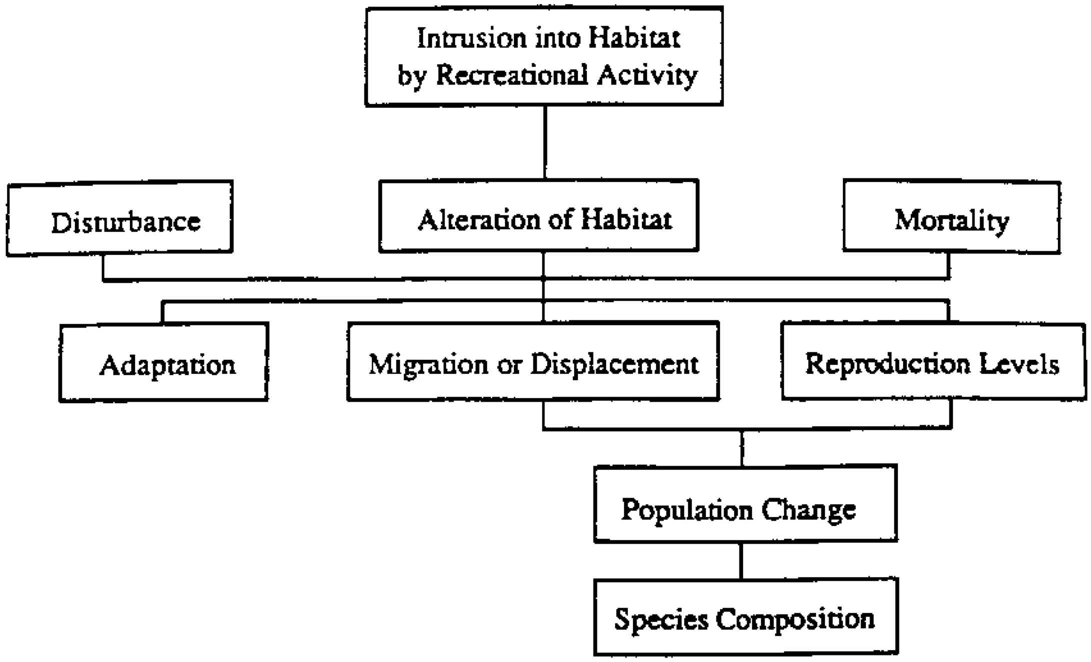
5. **Site-Specific Influences.** The impacts of recreation are influenced by a variety of site-specific and seasonal variables. That is, given a basic tolerance level to a particular type of recreation, the impacts of recreational use may still depend greatly on the time and place of the recreational activity.

One of the important implications of the above considerations is that they seem to be applicable regardless of the type of impact problem one is dealing with. That is, these considerations apply whether one is focusing on ecological, physical, or social impacts. For example, Figure A1 illustrates the impact interrelationships discussed in the first principle for both the ecological and social impacts of increasing recreational use. The upshot of these considerations is that recreational impacts to both the natural environment and recreation experience are complex and mediated by a number of factors besides use levels. Current visitor-management and carrying-capacity frameworks recognize this complexity and therefore emphasize managing for specified ecological and social conditions rather than searching for magic numbers.

Approaches to Estimating Recreational Carrying Capacities

A variety of approaches have been suggested for addressing the question of recreational carrying capacity. These approaches range from formula-based carrying capacity models to more general land-use planning methods that incorporate impact and capacity issues. The initial widespread concern with "finding the carrying capacity" has gradually been replaced with an emphasis on identifying and maintaining the conditions defined as acceptable or appropriate for a given area. Current carrying-capacity frameworks are built on the recognition that any effective management strategy involves both scientific and evaluative (or judgmental) components. The scientific component focuses on documenting use-impact relationships within the system and thereby provides the data needed to predict the impacts of different planning and development alternatives. The evaluative component is concerned with the desirability or acceptability of the impacts associated with various alternatives.

Ecological Impacts of Recreation



Social Impacts of Increasing Recreational Use

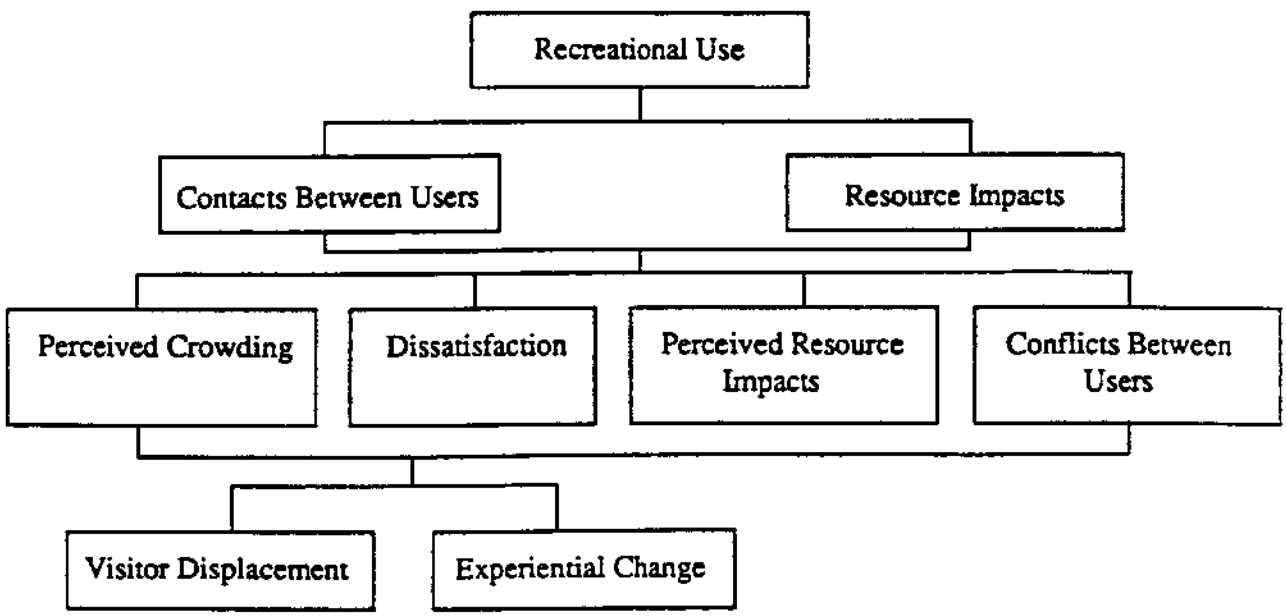


Figure A1. Ecological impacts of recreation and social impacts of increasing recreational use (Wall and Wright 1977:42).

The Limits of Acceptable Change (LAC) Planning Framework. In 1985, the U.S. Forest Service developed the Limits of Acceptable Change system as an alternative for assessing recreational capacities and impacts (Stankey et al. 1985). Designed initially as an approach for planning and managing recreational use of wilderness areas, the LAC built upon the earlier concept of the Recreation Opportunity Spectrum (ROS). The Recreation Opportunity Spectrum, as currently implemented by the U.S. Forest Service and Bureau of Land Management, is basically a zoning concept that offers a means of classifying recreation lands along a continuum designed to ensure provision of a wide range of recreational opportunities. This continuum follows a gradation from unmodified natural areas to those heavily developed and having higher degrees of social interaction and management controls. The LAC approach builds upon the ROS system by providing a means through which different types of areas are managed to provide distinct recreational experiences.

The central element of LAC is a nine-step process for establishing the limits of acceptable change (Figure A2). This process identifies a logical sequence of steps that lead to setting standards for social and environmental settings defined for a range of opportunity classes. The process also incorporates consideration of a range of alternatives for allocation of areas to various opportunity classes and recognition that some user impacts are inevitable and some diversity of conditions is necessary to meet the broad range of user needs.

The LAC approach argues that the carrying-capacity concept is but one choice by which recreation can be managed and provides a means by which management actions can be based on specific standards that recognize both social and environmental dimensions of recreation impacts. While the LAC was developed primarily for use in wilderness settings, its basic concepts and logic could be applied to any type of natural area used for recreational purposes. The LAC approach has become widely known among recreation resource managers and offers several ideas and tools that may be useful in assessing recreational capacities on Delaware's Inland Bays.

Shelby and Heberlein's Carrying-Capacity Assessment Process (C-Cap). Shelby and Heberlein (1986) introduced a general conceptual framework that sorts out many of the difficulties encountered in estimating recreational capacities. A key feature of their approach is the delineation of the DESCRIPTIVE and EVALUATIVE components of carrying capacity (Figure A3). The descriptive component is concerned with the relationships between recreational use patterns and the impacts associated with this use. This component is further broken down into two important types of variables: MANAGEMENT PARAMETERS and IMPACT PARAMETERS. Anything an agency can directly manipulate, such as the type or amount of use, is a management parameter. Examples of management parameters for a water-based resource might include the type and amount of access to the water, the types of uses allowed, and systems for zoning areas for specified uses. Impact parameters, on the other hand, describe what happens to either users or the environment as a result of visitor use patterns and other management parameters. Changes in water quality and the frequency of encounters with other users at boat ramps are examples of impact parameters.

The descriptive component identifies how a recreation system works, but it does not determine the carrying capacity of the area. This determination requires input from the second component of carrying capacity, EVALUATION. The evaluative component defines the management objectives and specifies acceptable levels of social and environmental impacts. For successful implementation, it is important that this evaluation result in a set of standards specifying the type of experience to be provided in terms of appropriate impact parameters.

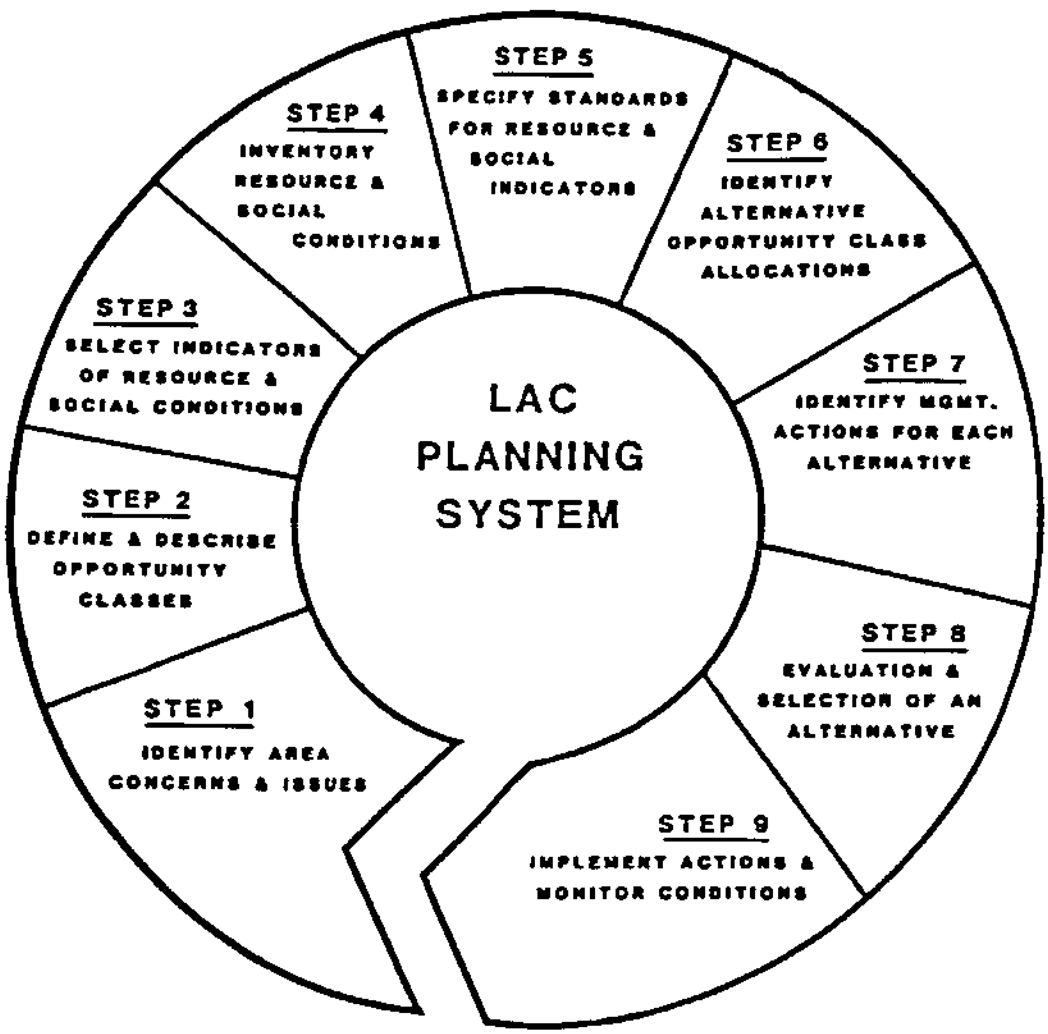


Figure A2. LAC planning system (Stankey et al. 1985).

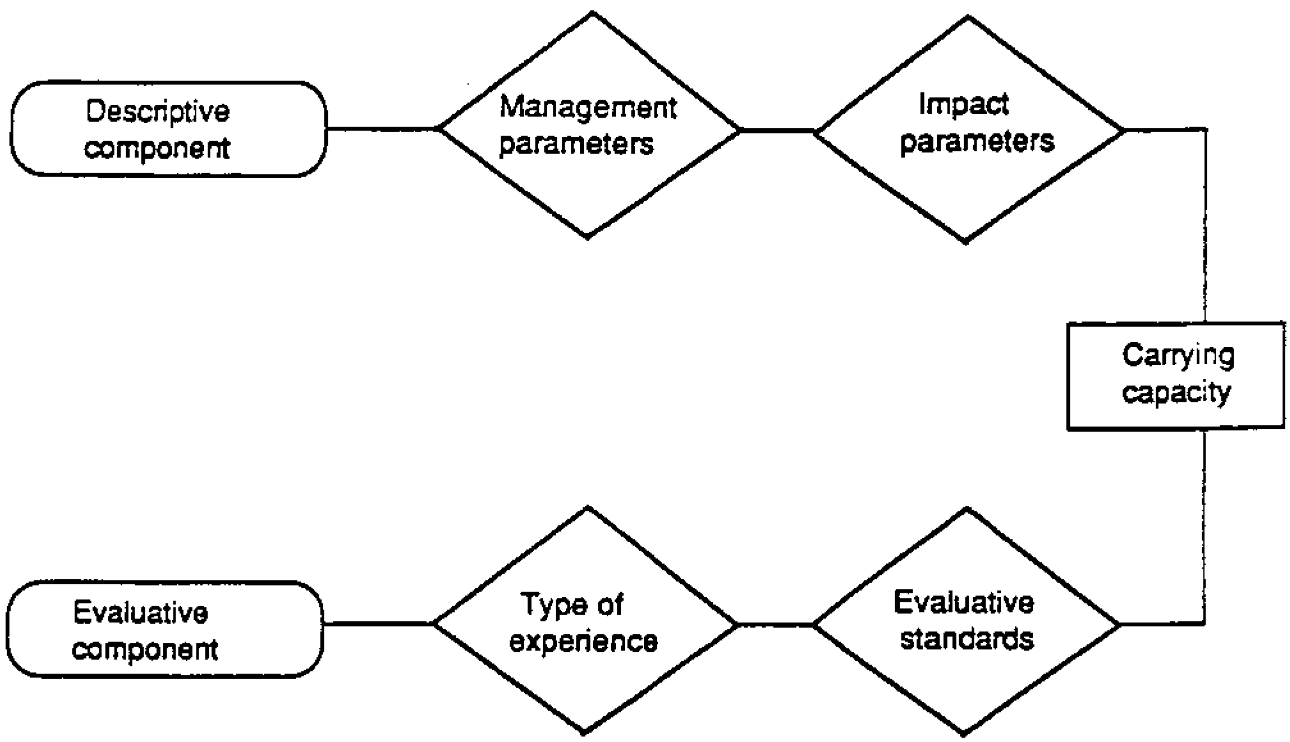


Figure A3. The Shelby and Heberlein (1986) model for carrying-capacity studies.

Shelby and Heberlein (1986) suggest that carrying capacities can be determined only when the following three conditions are met:

1) there is a known relationship between use level, or other management parameters, and relevant impact parameters;

2) there is agreement among relevant groups about the types of recreation experience to be provided; and

3) there is agreement among the relevant groups about the appropriate levels of the relevant impact parameters.

When these conditions are met, their process for determining carrying capacity includes the following steps:

1) Organize and evaluate background information. This process includes compiling existing information on the geographical context, management structures, political climate, use patterns, etc.

2) Identify in general terms the type of experience to be provided. This includes a review of legal mandates, agency guidelines, and management objectives, as well as the spectrum of recreation opportunities within resource capabilities.

3) Identify the important impacts. The task here is to select measurable parameters representing the potentially important ecological, physical, facility and social impacts.

4) Collect detailed information needed to refine study objectives, establish evaluative standards, and document existing conditions.

5) Develop management alternatives that would limit impacts to acceptable levels.

6) Select a management strategy.

7) Monitor impacts to insure that they fall within acceptable limits and adjust management policies if necessary.

The C-Cap approach has been used primarily as a basis for capacity assessments in back-country recreation settings. It has also been used, however, to estimate boating carrying capacity at the Apostle Islands National Seashore on Lake Superior (Heberlein et al. 1986).

The Apostle Islands National Lakeshore: A C-Cap Case Study. Heberlein et al. (1986) conducted a study to determine if the C-Cap carrying-capacity model, which had been developed largely on the basis of linear wilderness systems like trails and rivers, could be used in more complex systems involving nonwilderness types of recreation. This study focused specifically on predicting the effects of additional marina slips on the boating experience at Apostle Islands National Lakeshore.

The study area encompasses 22 islands and a strip of mainland along the south shore of Lake Superior near Bayfield, Wisconsin. At the time of the study (1981), there were five marinas with a total of 584 boat slips in the Bayfield area. Most of these slips are occupied by sailboats which are used primarily to sail around the islands within the national lakeshore. The only other access facility in the area is a single boat ramp with parking for up to 15 trailers.

As described earlier, the C-Cap model includes both descriptive and evaluative components. In this case, the descriptive component focused on documenting the number of boats leaving the existing marinas (a management parameter) and the mooring locations of boats among the islands, or more specifically, the number of boats moored at the two most popular locations in the islands (an impact parameter). Consideration was given to including additional impact parameters, such as the number of boats seen or the number of boat collisions reported, but such indicators were not deemed to be pertinent because of the vast amount of water surface area (600 square miles in the immediate area) and the relatively small number of boats using the area.

The evaluative component focused on the question, how many boats is too many? As is typically the case, the management objectives for the area were too vague (e.g., to provide recreation) to provide any definitive guidance for this question. Consequently, the investigators turned to the boaters for their input. Visitor surveys were used to develop "contact preference curves" which indicated how boaters felt about varying numbers of boats at selected locations.

Methods. Data were collected for 74 days during the summer of 1981. Data collection focused on three key variables, two measured through observational procedures and the third using a questionnaire. The number of empty marina slips was counted daily between 9 and 10 AM to provide an indicator of boat density in the islands. The number of boats moored at the two most popular locations was measured from fly-overs and counts by National Park Service rangers. The contact preference curves were derived from a sample of 323 boaters participating in onsite and mail surveys. Subjects were asked how they would feel about seeing varying numbers of boats at selected locations, using a scale ranging from very pleasant to very unpleasant. The contact preference curves were created by connecting the mean values of visitors' responses. The point crossing the neutral line represents the maximum number of contacts acceptable to boaters, while the highest positive point on the curve depicts the optimum contact level from the boaters' standpoint.

Results. Study results showed that the largest number of boats out of the marinas on any given day was 31 percent of all possible boats. The average weekday use level was 13.4 percent (about 70 boats), while the average weekend use rate was twice as high (27.6%, or about 150 boats). The number of empty slips was a good predictor of the total number of boats moored in the islands, as indicated by a correlation coefficient (Pearson r) between these two variables of $r = .78$.

While the area offers more than 20 potential mooring sites, boaters were concentrated in a few areas. The two most popular sites averaged eight boats (maximum = 33) and 5 boats per night (maximum = 26), respectively. Analysis of the relationships between variables resulted in the prediction that 10 percent of the boats leaving the marinas would use the most popular site, and 6 percent would use the second most popular location.

The user preference data showed that boaters responded most favorably to sharing a site with only one other boat, and the pleasantness rating declined as the number of boats increased. Users were generally positive to seeing between one and five boats, and neutral to between seven and eleven. Their responses became consistently negative at densities of 15 or more boats, suggesting that 15 boats could be viewed as a standard representing the maximum tolerable contact level.

The standard of 15 boats was well above the average numbers of boats using any location, but was exceeded 17 percent of the nights at the most popular area (2% of weekdays and 46% of weekends). Further analysis revealed that adding 100 to 200 more boat slips in the area would cause relatively little change in the percentage of nights where peak use would exceed the standard of 15 boats (58% of weekend nights for 100 more slips; 63% for 200 slips). In contrast, 300 new slips would have a more dramatic effect, with 75 percent of weekend nights and 16 percent of weekday nights above capacity. The authors concluded that 200 new slips is the largest amount that could be accepted before noticeable impacts would be observed.

Conclusions. This study demonstrates how information on use-impact relationships, coupled with an evaluative standard, can be used to assess the capacity of a given area for boating. What is particularly noteworthy about this case is that social capacity became an issue primarily because of spatial concentrations of boaters at certain locations. With a relatively small number of boats using a vast water area, determining the capacity using the space standards approach would have resulted in very different conclusions that would not have reflected the use patterns of the area.

The Visitor Impact Management (VIM) Framework. Visitor Impact Management is an approach to recreational carrying capacity that was developed by the National Parks and Conservation Association (Graefe et al. 1990). Like C-Cap and LAC, the VIM process is built upon the recognition that effective management involves both scientific and judgmental considerations. VIM also stresses that effective management includes more than carrying capacities and use limits. While use quotas represent one potential strategy for reducing the impacts of visitors, it is important to remember the lessons from previous studies that found only weak or indirect relationships between impacts and overall use levels (Graefe et al. 1984; Kuss and Graefe 1985). In such instances, establishing capacities and limits may do little to reduce the impact problems they were intended to solve, whereas other potential management strategies may be quite effective in reducing the impact conditions.

The VIM framework includes an eight-step sequential process for assessing and managing visitor impacts (Figure A4). The steps in this process, however, are essentially designed to facilitate dealing with three basic issues that are inherent to impact management: (1) the identification of problem conditions (or unacceptable visitor impacts); (2) the determination of potential causal factors affecting the occurrence and severity of the unacceptable impacts; and (3) the selection of potential management strategies for ameliorating the unacceptable impacts.

The first five steps in the process are devoted to the important, yet often slighted, task of problem identification. While this may appear to be a simple matter, it has often proved to be a stumbling block to effective resource management and related investigations. Consequently, this first basic issue was separated into several steps to isolate the various decisions that must be made in assessing existing conditions.

Step 1: The Preassessment Data Base Review. The first step in the process involves compiling and reviewing pertinent existing information. The amount of relevant material may vary from situation to situation, but there will always be some background information that can be used to establish an initial perspective on the problem. Policy documents and plans may include useful baseline information on area resources and visitors as well as management guidance and constraints. The real objective of Step 1 is to identify and summarize what is already known about the situation so that existing information can be put to its best use as the process continues.

During the preassessment data base review, it will be necessary to delineate the physical area to be included throughout the visitor impact management process. For localized impact problems, this physical area may be small and have obvious boundaries. For larger scale applications, visitor management areas could be patterned after management zones already in place. It may be desirable to define visitor management subunits within existing management zones. Current visitor use patterns may serve as the basis for defining a visitor management area. In other instances, resource characteristics such as endangered species habitat may provide the basis for defining the management area. What is most important is to identify an area that is workable from a management standpoint and that encompasses the zone of influence over the impact situation under consideration.

Step 2: Review of Management Objectives. The second step in the process is to review the management objectives pertinent to the situation at hand. The importance of clear and specific management objectives has become a dominant theme in the literature on recreational carrying capacity. To be effective, management objectives need to define the type of experience to be provided in terms of appropriate ecological and social conditions (Stankey 1980).

The definition of the type of conditions to be provided in a given area in essence requires a decision selecting one type of experience over competing experiences requiring different types of conditions. While resource managers may be reluctant to make such decisions explicitly, it is important to recognize that this

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.

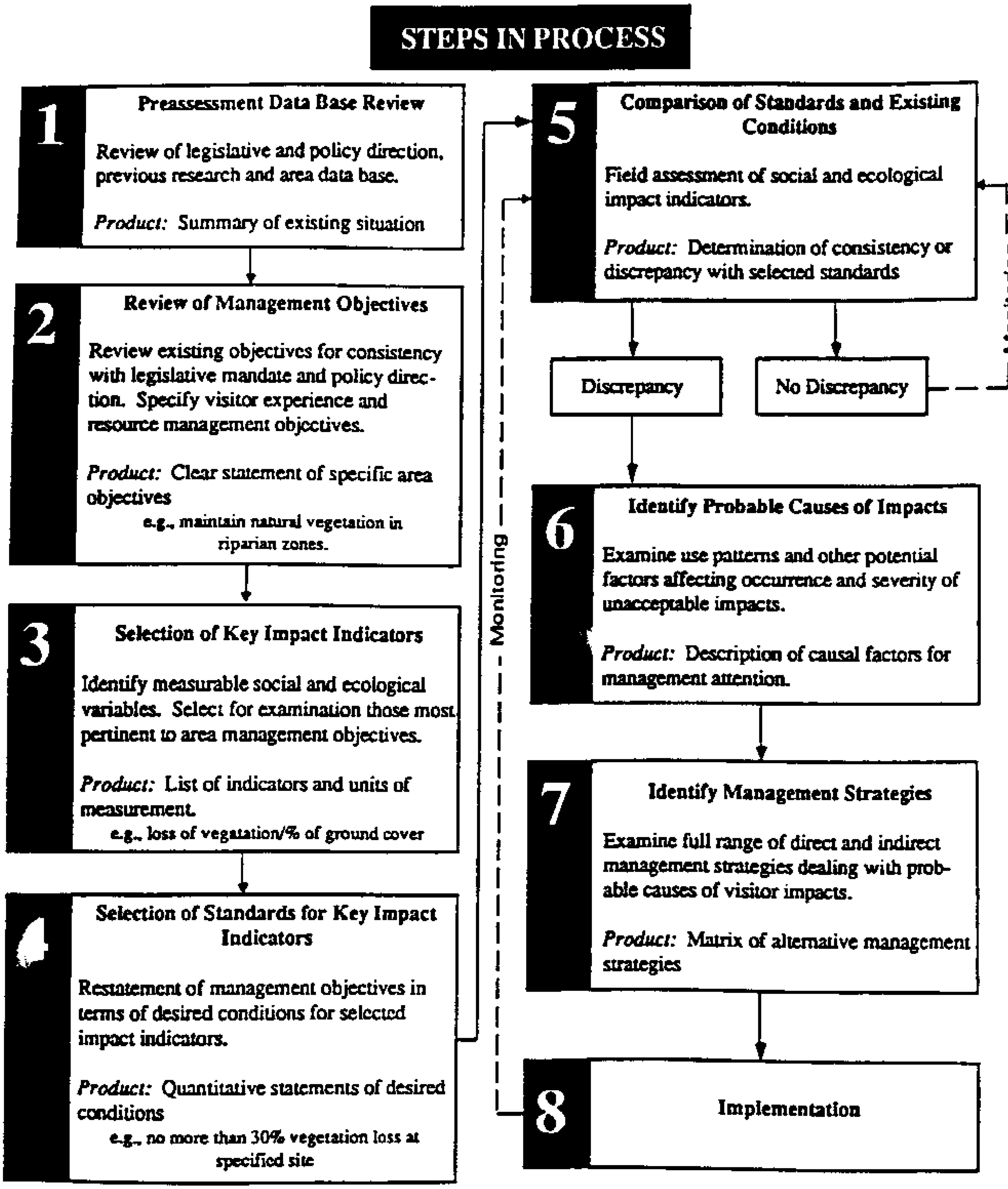


Figure A4. Visitor impact management/planning process.

judgment is inherent to the resource management task and will occur by default if it is not made deliberately. Avoidance of this decision essentially allows those activities that can preempt other opportunities to determine the recreational character of the area (Schreyer 1976).

Step 3: Selection of Key Indicators. The third step in the process involves identifying measurable indicators for the pertinent management objectives. Once objectives have described the type of environmental conditions and visitor experience to be provided, this step serves to identify how the specified conditions and experience will be measured. The specific decision required here is the selection of the most important variables to serve as indicators of the desired conditions.

It is important to recognize that there is no single indicator or set of indicators that is appropriate for all situations. The choice of indicators depends upon the particular type of impact under consideration and the specific characteristics of the site. Several criteria can be used, however, to evaluate the potential usefulness of alternative indicators. The most useful indicators include those that are directly observable, relatively easy to measure, directly related to the objectives for the area, sensitive to changing use conditions, and amenable to management. Examples of both environmental and social impact indicators to consider are included in Table A1.

Step 4: Selection of Standards for Key Impact Indicators. This step adds one further layer of specificity to the VIM process through the selection of standards for the previously selected impact indicators. This step, in essence, calls for a restatement of management objectives in quantitative terms. Standards differ from management objectives by specifying appropriate levels or acceptable limits for the impact indicators designated in Step 3. The standards selected become the basis against which the existing situation is evaluated. Thus, this step serves the important function of describing the environmental conditions and type of experience to be provided in units of measurement which are compatible with available measures of the conditions that currently exist.

Step 5: Comparison of Standards and Existing Conditions. After the first four steps in the process have clarified the conditions one is trying to achieve in a given area, the existing situation can be compared to this desired state of affairs. Step 5 requires some assessment of current conditions for those impact indicators that were selected in Step 3. This assessment does not necessarily require elaborate or costly studies. What is necessary, however, is a level of observation and measurement that provides for a reasonable comparison of existing conditions and their corresponding standards.

If there is no discrepancy between current measures of key impact indicators and their corresponding standards, there is no need for direct management intervention. In this instance, the area is currently providing the environmental conditions and type of experience that have been defined as appropriate for the area (i.e., there is no problem). Monitoring of the selected indicators should be conducted, however, to detect changes that may develop in the future. This monitoring should include both the impact indicators that are most susceptible to change and the use patterns that may lead to changes in the status of these impact indicators.

If measures for certain indicators do not meet the standards for the area, a problem situation is documented. It is then appropriate to move on to the identification of probable causes of the unacceptable impacts.

Step 6: Identification of Probable Causes of Impacts. Because of the many potential factors that may contribute to impact conditions, the challenge of Step 6 is to isolate the most significant cause(s) of the problem. This task can be approached by examining the relationships between visitor use patterns and the impact indicators that have exceeded their respective standards. In examining potential causal factors, it is important to consider all of the specific aspects of visitor use that may influence the situation, including the type of use, length of stay, size of group, time of use, concentration of use, frequency of high-use periods, overall amount of use, and behavior of visitors. It is also important to remember that use-impact relationships may be mediated by site characteristics and consequently may vary for different times and places.

Table A1. Potential environmental and social impact indicators for evaluating recreational capacities.

ENVIRONMENTAL INDICATORS:	Submerged aquatic vegetation (SAV) Dissolved oxygen Phytoplankton concentrations (red tide) Turbidity (propeller wash) Runoff and erosion Human wastes Loss of waterfowl habitat Loss of fish nursery areas Bacterial concentrations (Enterococcus) Litter Trampled benthic life Noise impacts on waterfowl and fisheries Trampled shoreline vegetation/erosion Decreased estuarine production (catches of fish) Loss of wetlands Fuel oil spills Vehicle pollution Disposal of fish cleaning wastes Area of shellfish beds closed
SOCIAL INDICATORS:	Conflicts between activities Percent reporting interference with use Perceived crowding Displacement Percent reporting use limited due to various factors Percent reporting change in activity participation Loss of enjoyment Increase in number of accidents Noise Perceived environmental quality Percent reporting environmental quality deteriorating Percent reporting activity hurts the environment Percent reporting that controls are needed Extent of water-related illnesses

Completion of this step may require some additional studies focusing on the relationships between key impact indicators and visitor use patterns.

Step 7: Identification of Management Strategies. With some understanding of how the amount, type, and distribution of people using a given area affect the pertinent impact indicators, it is possible to identify a range of alternative management strategies. Just as many aspects of use may contribute to the problem, many management alternatives are available for dealing with the problem. It is important at this phase to focus on the probable causes of the visitor impacts rather than on the impact conditions themselves. It is also important to recognize that one may never have a complete understanding of the causes underlying certain visitor impacts, nor can one predict exactly how a given management action will affect a problem situation.

Management techniques aimed at reducing a particular impact may adversely affect other aspects of the situation or may introduce other problems for managers. For this reason, a matrix approach for evaluation of alternative management strategies is recommended (Figure A5). This matrix approach provides a vehicle for evaluating a range of management alternatives against a set of selection criteria. The suggested criteria cover a variety of issues related to the implementation of any management program. A given management option may seem quite desirable according to some of the criteria but less attractive from the perspective of other criteria. A strategy with high odds of producing the desired outcome may be impractical due to the difficulty or cost of implementation, or it may be inadvisable if it causes as many problems in terms of visitor acceptance or other indicators as it solves. There are generally no single right or wrong answers for dealing with visitor impacts. It seems most reasonable to strive for a balance among criteria when selecting a particular management strategy.

Step 8: Implementation. The selected management strategies should be implemented as soon as the necessary resources are available. Because the nature and causes of visitor impacts are highly variable, management programs designed to deal with these impacts should be flexible and quick to respond to changing conditions.

The task of managing visitor impacts is not over when a management program has been implemented. Monitoring of key impact indicators and use patterns is critically important to determine whether the management actions are producing the desired outcomes without creating other undesirable side effects. Future monitoring is needed regardless of the outcome of any particular step in the process. Thus, the process is a continuous framework for the evaluation and management of visitor impacts that builds a data base as it responds to conditions at various points in time.

The Visitor Impact Management framework has been pilot tested in several U.S. National Parks and has also served as the basis for several studies in other areas. Of particular relevance to the current project is an application of VIM to the assessment of boating capacity at Raystown Lake in central Pennsylvania.

Boating Capacity on Raystown Lake: A VIM Case Study. Raystown Lake is an 8,300-acre reservoir located in central Pennsylvania and managed by the U.S. Army Corps of Engineers. The reservoir is unique among corps water projects in that it was constructed primarily to provide recreation opportunities for residents in the region. The lake's geographic location places it within easy driving distance of many boat owners in Pennsylvania and neighboring states. Raystown's physical dimensions make it especially attractive to owners of high-performance and medium-sized to large freshwater boats. The lake does not appear to be desirable for sailing or canoeing. It is very popular among fishermen, who account for most of the boating activity on the lake during the spring and fall seasons.

Recreation use at Raystown Lake increased from 475,000 recreation days in 1975 (the first year of operation) to 1,421,000 visitor days in 1986. This visitation includes a wide variety of recreation activities. Increases in boating activity over the years have led to concerns about congestion and the impacts of the numbers of boats on the quality of the boating experience. Use of the lake is currently limited by the

	Management Strategy	Consistency with Management Objectives	Difficulty to Implement	Probability of Achieving Desired Outcome	Effects on Visitor Freedom	Effects on Other Impact Indicators
Indirect Strategies	Physical Alterations					
	Information Dispersal					
	Economic Constraints					
Direct Strategies	Enforcement					
	Zoning					
	Use Rationing					
	Activity Restrictions					

Figure A5. Matrix for evaluation of alternative management strategies.

capacity of the existing facilities providing access to the lake. It is anticipated, however, that pressures to increase lake access through new construction or expansion of existing facilities will continue to grow.

This study was not a step-by-step application of the VIM framework, but rather was an investigation designed to support certain components of the VIM process (Graefe et al. 1988). The objective of the study was to examine the relationship between boating densities on Raystown Lake during peak-use periods and visitor perceptions of the conditions resulting from these peak-use levels. Emphasis was placed on the identification and measurement of relevant indicators of quality in the recreation experience. The information collected provided a basis for: (1) evaluation of existing peak-use boating conditions, (2) identification of management actions designed to improve current conditions, and (3) prediction of the likely consequences of potential expansions in facility development on the lake. The study also provided recommendations for monitoring boating conditions on Raystown Lake in the future.

Methods. Peak boat use patterns and their effects on boating quality at Raystown Lake were examined during the summer of 1987. A combination of survey procedures was used to measure boating use patterns and visitor perceptions about the conditions they encountered. Peak boat densities were identified through aerial photography of the entire lake surface and ground counts of vehicles at all major access points. Visitor perceptions were obtained through on-site personal interviews conducted at all major access points on the same days as boat use was being measured. Since the study focused on the assessment of peak-use conditions, data collection was conducted on selected weekends during the 1987 boating season. The sampling schedule was designed to represent the varying levels of weekend use and included a total of eight days of data collection, two of which fell during the Memorial Day and Fourth of July holiday weekends. A total of 1,170 boaters were interviewed during the course of the study.

Measurement of Impact Indicators. Overall use levels, determined through aerial photos taken between 1:00 and 3:00 p.m., ranged from 794 boats (10.5 acres per boat) to 1,101 boats (7.5 acres per boat). The lowest boating densities were found on sampling days during August, while the highest use level found in the study occurred during the Fourth of July holiday weekend.

Results of the visitor survey suggest that Raystown Lake boaters were generally satisfied with their boating experiences. On a scale of 1 to 10 (with 10 being the perfect trip), 61 percent rated their experience an eight or higher. Nearly one-fourth of the boaters rated their experience a 10, and the average satisfaction level was 7.5.

Questions related to perceptions of crowding revealed that boaters tended to feel most crowded while out on the lake and least crowded at the access areas at the start of their trips. Very few sampled boaters were dissatisfied with the amount of time they had to wait to get on the water. About one-fourth of the respondents reported being displaced from favorite parts of the lake because of the number of boats there. Similarly, 27 percent stayed off the lake during parts of the day, and 23 percent chose not to participate in some boating activities because of crowded conditions on the lake. Very few boaters were bothered by noise from other boats, but nearly one-fourth reported that the behavior of other boaters interfered with the quality of their experiences. The most frequent types of behavior causing these reactions were boaters coming too close or going too fast and boaters failing to observe no-wake zones. Although one-third of the sampled boaters reported that other boats came closer to them than they would like, only 17 percent felt there was an unsafe number of boats on the water.

Comparing the perceptions of three major user groups on the lake (campers, marina users, and boat ramp users) revealed few significant differences. Thus, although these three types of users were quite distinct in their patterns of boating and the boats they used, all three groups generally perceived their boating experiences very similarly.

Evaluation of Existing Conditions. The VIM process, as well as other current management frameworks, suggests that evaluating the acceptability of current conditions depends on a comparison of existing measures with the standards one is trying to achieve in a given area. Thus, while this study can show, for example, that the average satisfaction of weekend boaters during 1987 was 7.5 on a 10-point scale, lake managers must decide if this satisfaction level is consistent with what they are trying to provide.

In this case, there were no pre-existing standards for the boating experience at Raystown Lake. Knowledge of the current levels of various impact indicators gained through the study can provide a baseline against which an initial set of standards can be determined. If managers decide that current conditions are acceptable and their objective is to prevent conditions from deteriorating in the future, then the existing levels for various impact indicators can set the quantitative standards for future assessments. Thus, the standard for boater satisfaction would be set at 7.5 on the 10-point scale. If, on the other hand, managers feel that current measures for certain indicators are already unacceptable, they may wish to set more stringent standards for such indicators as a goal of their management program. In such a case, the standard for satisfaction might be set at 8.0 rather than 7.5 on the 10-point scale. Standards for other key impact indicators could be established in a similar manner, based on managers' evaluations of the current conditions.

Use/Impact Relationships. Establishing the relationships between the number of boats on the lake and the various measures of experiential quality is a critical element in the evaluation and management of existing conditions. In this case, boaters were generally satisfied with conditions regardless of the number of boats at the lake. Use levels were related, however, to other impact indicators such as perceived crowding on the lake, perceptions of safety, and the various types of displacement behavior.

The perception that conditions on the lake were safe was the indicator that was most strongly associated with overall boating satisfaction ($r = .48$). Many other impact indicators, however, were also strongly correlated with boater satisfaction. The exceptions, or those indicators most weakly associated with satisfaction, included noise from other boats, waiting time to get on the lake, and the actual number of boats on the lake. As noted above, however, the number of boats on the lake did contribute to the level of perceived crowding, which in turn was relatively strongly associated with satisfaction.

These findings are consistent with the results of many other studies and suggest that boating quality is a multifaceted and complex concept. Maintaining boating quality, therefore, will require paying attention to the interrelated set of indicators that are most strongly associated with overall satisfaction.

Consideration of Management Alternatives. Results suggest that current peak-use conditions were acceptable to most Raystown boaters. Conditions could be improved, however, by focusing management on those indicators with the greatest influence on satisfaction. For example, one-third of the boaters sampled reported that other boats had come too close to them while they were boating. Such incidents were one of the greatest safety concerns among Raystown boaters. This information suggests that it would be helpful for management to pursue actions that will reduce the frequency of boats coming too close to each other. Manipulating the number of boats on the lake would have little effect since the problem was due to the behavior, rather than the number, of boaters encountered. Expanding enforcement of existing regulations and offering educational programs aimed at making offending boaters aware of the impacts of their actions are more likely to bring about improvements in this situation.

The probable effects of facility expansion on Raystown Lake vary according to the type and magnitude of expansion considered. Since existing facilities were rarely used to capacity, increasing boating access would only infrequently lead to total use levels above the range observed during 1987. Thus, the potential impacts resulting from new facilities would likely be noticed only on relatively few peak use days during the boating season.

Additional parking spaces at boat ramps (as well as development of a new ramp) would have the most direct influence on peak-use levels because these areas would tend to fill to capacity on peak-use days. Additional marina capacity would increase the number of boats on the lake to a lesser degree, as study results showed that a maximum of one-fourth to one-third of the boats stored in the marinas could be expected to be out on the lake at any one time. Similarly, additional campsites would have relatively little impact on the total number of boats on the water, since many campers do not have boats and those with boats have much flexibility in when they go out on the water.

Monitoring Recommendations. Regardless of what management and development alternatives are implemented in the future, the effects on boating quality can ultimately be determined only through a monitoring program. Results of this study provided a baseline against which future conditions can be compared. Future monitoring should include measures of both boating densities and selected impact indicators. Key indicators for future monitoring should include those variables that played the most important roles in the Raystown study. These indicators could be selected on the basis of frequency of occurrence (to what extent each indicator was prevalent on the lake), correlation with boat density (to what extent the indicator was associated with changing boat density levels), and correlation with satisfaction (to what extent the indicator contributed to boaters' satisfaction).

Monitoring of boating densities could be incorporated into the routine duties of rangers stationed at major access points on weekends. The impact indicators included in this study can be monitored only through direct contact with samples of exiting visitors. Rangers on patrol could also routinely collect this data by administering a brief (2- to 3-minute) interview with selected boaters. On a less frequent basis (perhaps every five years), it would be useful to pursue a more in-depth visitor survey to more fully examine the relationships between boating patterns and the quality of the boating experience.

Conclusions. This study focused on the relationship between boat density levels and visitor perceptions of the conditions encountered at varying use levels. The results of the study can be used to support a variety of visitor-impact management decisions, including the evaluation of existing conditions, identification of management actions aimed at improving these conditions, evaluation of the probable impacts of various potential options for facility development on the lake, and development of procedures for monitoring the quality of boating at the lake in the future.

Study results also demonstrate the scientific principles that underlie the Visitor Impact Management process. The examination of use-impact relationships showed that boating quality is influenced by an interrelated set of impacts with varying degrees of association with use levels.

Summary and Implications. All of the previous approaches to recreational carrying capacity, and particularly the three frameworks described above, offer useful implications for the assessment of visitor impacts and carrying capacities. The C-Cap model, for example, provides a clear conceptual framework for organizing complex impact and capacity-related questions. LAC and VIM both provide systematic processes for identification of problem conditions and selection of management strategies based on area inventories and standards.

The approaches taken together complement weaknesses evident when considering each of them individually. LAC and VIM, for example, are much more explicit than the C-Cap framework in identifying problem conditions and in dealing with the diversity of visitor expectations and preferences. Several LAC steps are devoted to defining opportunity classes and allocating resources accordingly. In contrast, the C-Cap approach makes a clearer distinction between science and value judgements and deals more specifically with how to isolate the use levels and other aspects of recreational use and management that have caused or contributed to the problem conditions.

The VIM and LAC frameworks are really very similar processes that differ from each other primarily in the degree of emphasis placed on various components. For example, VIM includes an explicit step aimed at identifying the probable causes of impact conditions, while LAC places greater emphasis on defining opportunity classes and developing alternative class allocations. Both processes, however, were developed as alternatives to the traditional carrying-capacity concept. Both frameworks rely on the use of indicators and standards as a means to define unacceptable impacts. And both VIM and LAC emphasize consideration of a broad range of management alternatives and require future monitoring.

Water Resource/Boating Capacity Studies

Earlier studies focusing on water-based systems tended to emphasize space standards as a means of determining capacities. This approach was based on the notion that various recreational activities require varying amounts of space to avoid safety problems or conflicts between user groups.

For example, a wide variety of space standards for selected types of recreational boating have been proposed (Table A2). While there appears to be some agreement that certain types of boating, like waterskiing and powerboating, require more space than other boating activities, there is little agreement about the actual amount of space needed for a given type of boating. Published standards for particular types of boating vary by as much as several orders of magnitude; the standards for waterskiing, for example, range from three to 40 acres per boat. As a result, such standards are now considered rather arbitrary and are often treated only as general guidelines for particular types of boating.

The development of uniform space standards for boating is difficult because water resources vary in terms of size, depth, and shoreline development. A lake with many inlets and bays, for example, can accommodate more boats than a circular lake with the same surface area. Space standards also ignore other important factors, including concentrations of boating activity at certain locations and potential conflicts between boating and other recreational activities. Regulations may also influence boating space standards. For example, speed limits could effectively lower the space required for high speed power boating (Department of the Army 1989).

Space standards also exist for swimming beaches, but these standards also vary widely (Fogg 1981, U.S. Bureau of Outdoor Recreation 1970). For example, Fogg (1981) proposed standards of eight and twenty persons per foot of shoreline for low- and high-density beaches, respectively.

Ashton and Chubb (1972) attempted to extend the use of space standards by developing regression models to relate boating use levels to user satisfaction on several heavily used Michigan lakes. Their work obtained measures of satisfaction through surveys of boaters and waterfront property owners as well as detailed estimates of boat use at one-hour intervals via aerial photography. The carrying-capacity estimates that resulted from analyzing relationships between these variables were highly suspect, however, because little of the variability in satisfaction was explained by boat use levels.

A follow-up study by Rittenger (1976) which attempted to refine the methods used by Ashton and Chubb had even less success in estimating a social carrying capacity on another Michigan lake. His work failed to find a significant correlation between use level and user satisfaction, and thus he was not able to estimate the social capacity. Many subsequent studies have found similar results when searching for relationships between density and satisfaction (Graefe et al. 1984). In light of these research findings, it appears that the method proposed by Ashton and Chubb (1972) offers little potential.

Roy Mann Associates Inc. (1974) produced one of the first recreational boating carrying-capacity plans for the Chesapeake and Chincoteague bays. They based their recreational boating carrying-capacity plan on the following criteria: (1) identify the presumed recreational boating carrying capacity of individual sub-areas of the Maryland bays; (2) identify environmental sensitivities and the indicators which reveal the points at which recreational boating may have adverse affects on them; (3) set limits on user numbers, permitted uses, or use intensities at levels safely below thresholds of user dissatisfaction and environmental degradation; (4) provide for new facilities or suitable locations of excess carrying capacity up to the presumed safe limits; (5) encourage and regulate the lessening of use or intensity in areas or at times of deficit carrying capacity or when environmental degradation attributable to recreational boating may occur; (6) be flexible, pragmatic, and adaptable for use by public officials responsible for boating activity and facility construction decisionmaking.

Table A2. Boat space standards (acres per boat).

Source	General Standard	Non-Power	Power (unspecified)	Power (< 10 hp.)	Power (unlimited)	Sailing	Water Skiing	Fishing
Allegheny National Forest		1.0		5.0		1.0	20.0	1.0
Bureau Outdoor Recreation				2.0-10.0	3.0-18.0		7.0-20.0	
California Recreation Comm.	1.0							
Army Corps of Engineers	1.0							
Fogg (1981)		0.5		0.5	3.0	0.25	3.0	0.2-0.5
Great Lakes Basin			10.0					
Jaakson (1984)		0.33				1.25		
Louisiana Park Recreation Comm.			20.0				40.0	8.0
Manitoba	50.0							
Minnesota DNR	10.0							
New York State		1.0	6.0-8.0			6.0-8.0	15.0-20.0	
New Hampshire		1.5			8.8			
Ohio DNR				5.5	7.5			
Ontario	10.0							
Sirles (1968)	0.8-1.8							
Soil Conservation Service			3.0			3.0	5.0	0.2- 0.35
Sowman (1987)			5.0				20.0-40.0	1.2-10.0
Tichacek (1975)		1.0		10.0-20.0		2.0	40.0	8.0
Wisconsin OR Plan			20.0				20.0-40.0	8.0
Wisconsin DNR	20.0							

Roy Mann Associates Inc. suggested an 11-step recreational boating carrying-capacity planning system to meet the above mentioned criteria. It included the following:

1. The delineation of management units within sub-areas of Chesapeake and Chincoteague bays.

2. Classification of the water bodies (sub-bay units and management units) delineated earlier.

3. Detailed shoreline and nearshore analysis.

4. Benthic life analysis, especially those species sensitive to boating impact factors in deeper waters.

5. Existing peaking and congestion determination to determine whether use is approaching capacity.

6. Individual zones within management areas should be established and should be based on general activity, harbor zones, passage zones, special activity zones, and inshore zones.

7. The establishment of use priorities (e.g., low-speed cruising, general activity, waterskiing, etc.) in the delineated use zones will need to be based on departmental policies, recreation needs, environmental sensitivity indicators, community property-owner desires, and other considerations that have been identified through the boating capacity planning system.

8. Development of boating activity models for management units.

9. Modify activity models with data on environmental sensitivity and institute management measures.

10. Determine existence of excess or deficit capacities for each management unit.

11. Develop recommended program for new and expanded boating facilities (Roy Mann Associates Inc. 1974).

In 1980, the Army Corps of Engineers published an alternative method of determining carrying capacities on lakes. This method based social carrying-capacity estimates on "user preference distributions." These preference distributions define the range of distances that individuals prefer to be away from other recreationists. The general preference distributions can be tailored to specific situations by adjusting for various social and environmental factors. Ultimately, the distance distributions selected for a given site are converted into space standards. Thus, while this approach does offer a refinement of the space-standard approach by incorporating user preferences, it still suffers from many of the same problems that render the space standard approach ineffective.

User density standards derived from Corps of Engineers user preference distributions were also used by Klar et al. (1983) in a study designed to aid in the development of a recreation management plan for the Quabbin Reservoir in Massachusetts. What is most noteworthy about this study, however, is the use of a complex model that integrated a variety of economic, environmental, and social factors to determine the optimal mix of recreational activities for the reservoir (Figure A6). In this study, sensitivity to phosphorous loading proved to be the most significant limiting factor to recreational use of the reservoir. This ecological constraint was mitigated, however, by placement of sewage-retaining vaults at recreational sites to eliminate potential phosphorous loading from human wastes.

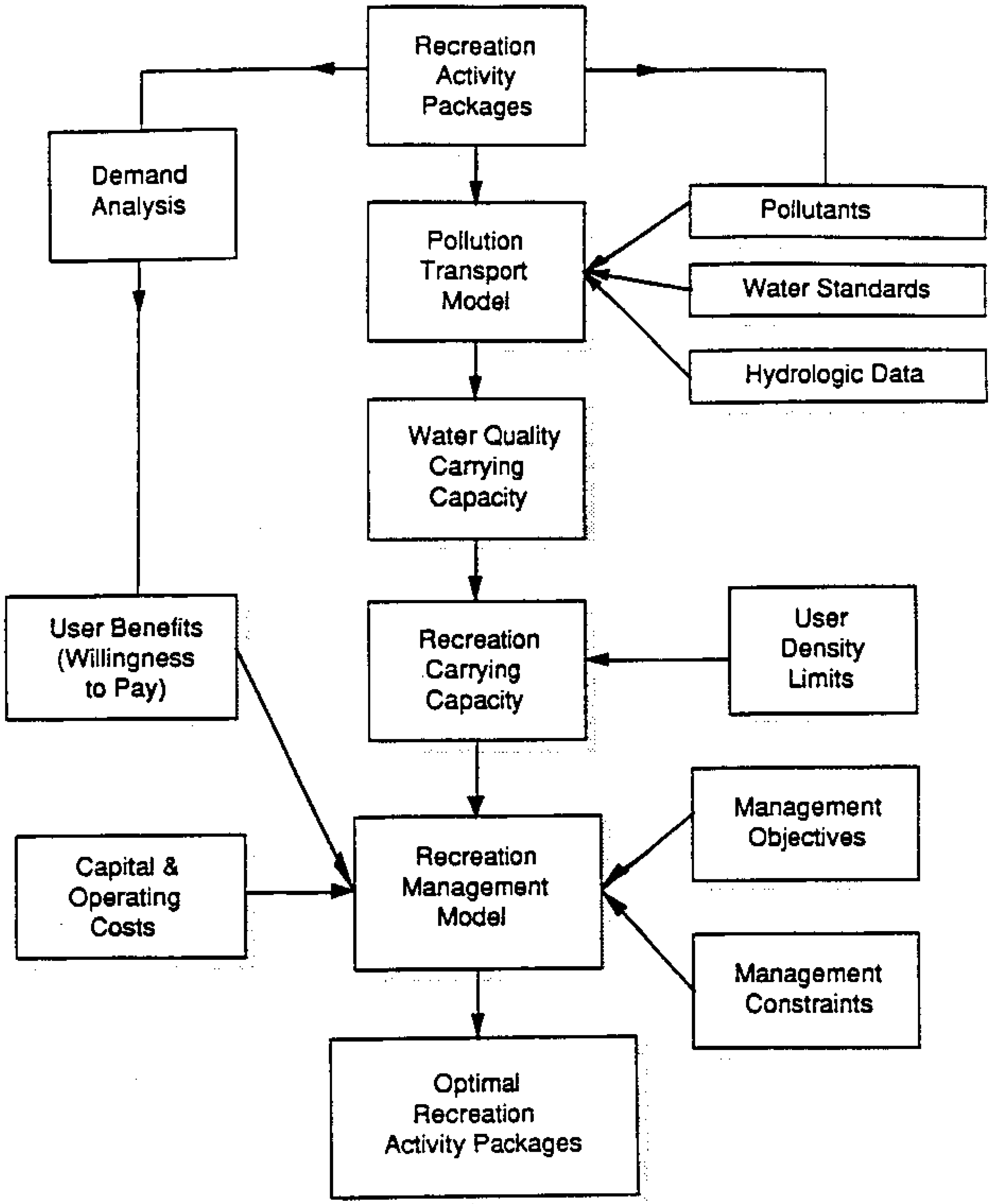


Figure A6. Model for determining the optimal mix of recreational activities on a water-supply reservoir (from Klar et al. 1983).

Anne Arundel County Office of Planning and Zoning (1980) conducted a boating and marina study for Anne Arundel County, Maryland, during 1978. This study analyzed boating activity patterns in the major rivers and tributaries in the county. Aerial photographs were taken and analyzed to determine the intensity of use on the water bodies. The number of boats in the photos were compared to the water acreage being used in each individual waterway, and a figure for boating intensity per water area being used was calculated. For the seven water bodies investigated (Rockhold Creek, Bodkin Creek, Rhode River, Severn River, Magothy River, South River, and West River), the intensity of use ranged from 1.97 acres per boat (Rockhold Creek) to 12.44 acres per boat (West River) on a given day. In order to relate these use intensities to boaters' enjoyment, two questions about crowding and boating enjoyment were asked of registered boaters in the county.

The registered boaters' answers did not support the hypothesis that the enjoyment of boaters is negatively related to the intensity of boating activity. This finding is supported by others who have researched this issue of crowding and boater satisfaction. It is suggested that constrictions in waterways and conflicts between different boating activities may have a greater negative influence on the enjoyment derived from a boating experience than the intensity of activity.

Based on the findings of the Anne Arundel County study, a limit on the number of boats that could use the waters at a given point in time could not be established. At higher intensities of activity or with additional conflicts in activities or additional constrictions in waterways, such as long piers, a saturation level of boating activity could be reached. The report further stated that if such a level is reached, it could be maintained through the voluntary actions of boaters, since those who feel that the density of boats is too high or that the conflicts are too great when they go boating may elect to go at other times or reduce their participation, thus keeping the number of boats present at one time from going any higher.

Sowman (1987) applied a framework that integrates the major physical, ecological, and social constraints to the development of an enclosed estuary in South Africa (Figure A7). This approach relies on information obtained through direct observations, questionnaires, interviews, ecological consultants, and the literature on boating space standards. Recommendations of the study focused on regulating current and projected recreational activities to prevent overcrowding.

A 1988 boating management study of the Rideau Lakes was conducted for the Canada Department of the Environment by Michael Michalski Associates and Anthony Usher Planning Consultant (1988) to provide the agency with recommendations on the optimum levels and types of boating activities which should be permitted in the Rideau Lakes portion of the Rideau Canal. Optimum use referred to the maximum number and mix of watercraft, given the various types of use demands, which can be accommodated safely at any one time so that users can enjoy a safe recreation experience without prejudice to the objectives of the Rideau Canal system.

A major component of the study was to estimate the recreational boating carrying capacity for the lakes. After a comprehensive analysis of boating activity, it was determined that there existed no boating capacity problem on any of the Rideau Lakes taken as a whole. The authors also stated that it was not conceivable that any lake-wide capacity problems would develop in the foreseeable future.

An overall recommendation to the parks agency was that they should not hesitate to consider stringent regulation of user activity--whether through quotas on boat entry to a canal system, broad restrictions on major classes of boats or boating activities, boat operator licensing, broad restrictions on water lot disposition, or other means--if necessary to maintain and enhance environmental and recreational quality on the canals. However, the study indicated there was no need to take any action at the present time. A series of 10 recommendations was presented that focused on limiting development around the lakes and enhancing boating safety and navigation.

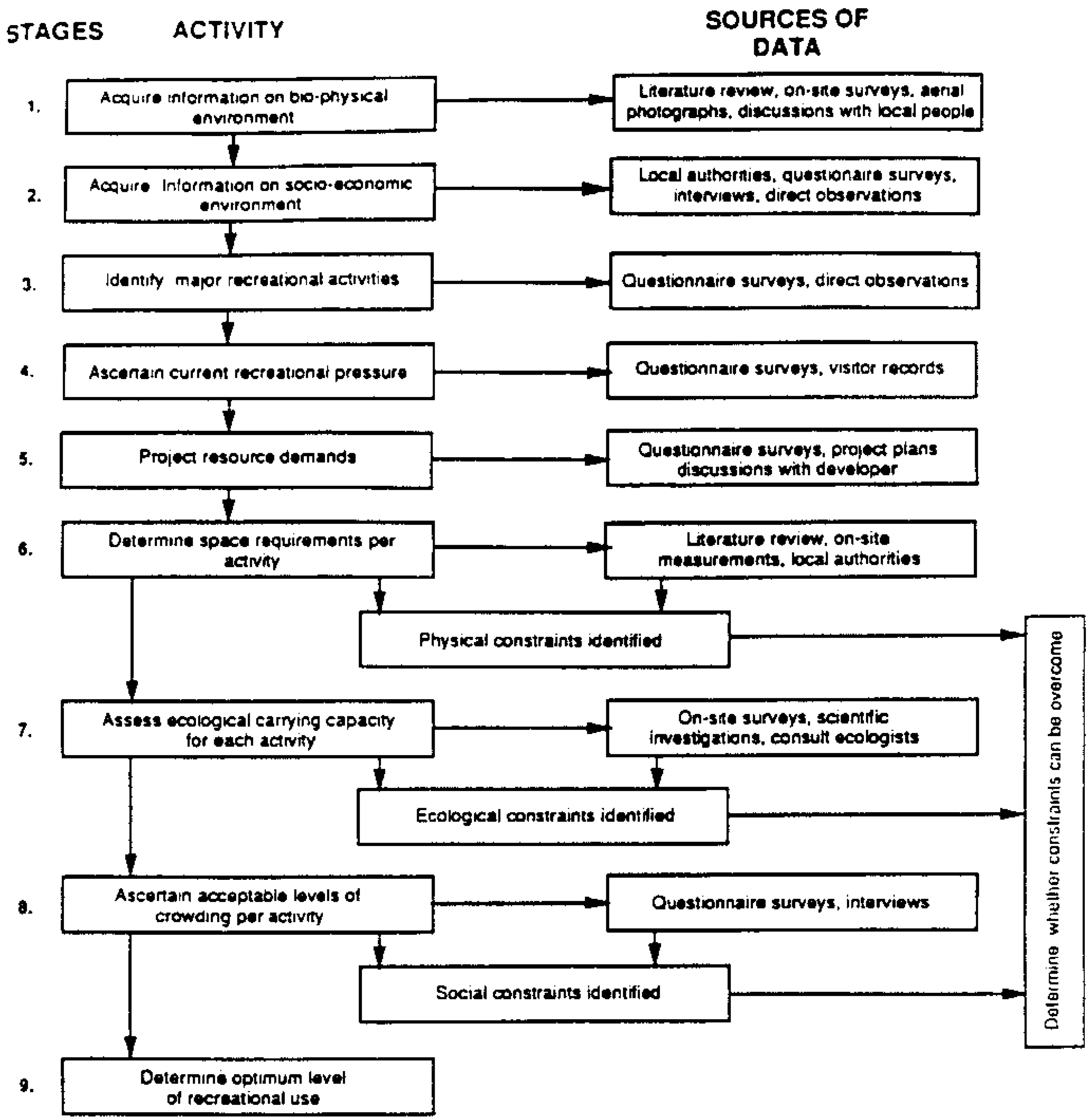


Figure A7. A general procedure for recreational carrying-capacity studies (from Sowman 1987).

Michael Michalski Associates and Anthony Usher Planning Consultant (1989) were also commissioned by the Canada Department of the Environment to assess the present level and type of boater services and provide recommendations on the need for additional facilities to meet the needs of water surface users in the Kars to Black Rapids section of the Rideau Canal. They were also to provide the parks service with recommendations on the appropriate levels and types of water surface and shoreline land-use activities which should be permitted on this section of the canal.

After observing boat use levels and reviewing data from a boater survey conducted in 1986, the authors again concluded that from Kars to Long Island Locks, taken as a whole, there did not appear to be a significant boating capacity problem. There did appear to be frequently high, seasonal capacity problems in one area, and in a few other areas, the problems were only occasional.

The authors noted that they believed that the parks agency should not hesitate to consider stringent regulation of user activity like in the Rideau Canal system. That level of regulation was not needed at the present time however. They stated that there is nothing in the presented situation that warrants any additional restrictions on boater access to the water. The most important capacity issues, the authors explained, in the study area related not to the present situation but to the impacts of future development, particularly in the planned south urban community. The most important control over how much the study area's water surface will be used in future will be how much additional boater access to water is permitted along the shoreline. Twenty-three recommendations were suggested that dealt with marina and boat-ramp development, speed and wake controls, public information and education efforts, and efforts related to shoreline protection.

Rogers, Golden and Halpern, Inc. (1990) conducted an assessment of Barnegat Bay, New Jersey, examining water quality, ecosystem vitality, and human activities that rely on or affect the bay. They examined boating use in the bay and estimated that the capacity of the bay overall is about 6,000 boats at one time. It was noted that this level is well below the reported 53,200 boats using the bay in 1989. However, as in most bay systems, there are several areas, most notably the northern portions where boat use does exceed the local carrying capacity. The authors recommended the following actions to alleviate problems:

1. Impose speed limitations on boats in the bays or in specific areas of the bays.

2. Allocate boat access to the bay such that boat use congestion is not worsened.

3. Develop a data collection program to determine geographic and temporal boat use patterns. Use the results of the data collection to develop a comprehensive boat use management program for the bay.

4. Implement strict enforcement of restrictions on overboard disposal of sewage.

Conclusions and Implications

Previous studies attempting to estimate recreational carrying capacities on lakes and other water resources have demonstrated the complexity and difficulty of pursuing this task. Taken together, these studies lead to several conclusions that should be kept in mind when examining capacity-related issues in any given area:

1. Assessing recreational capacities requires descriptive data on both the use patterns and the impacts associated with this use for the area in question. Many existing studies address only recreational uses or impacts. While such studies can provide some preliminary understanding of capacity-related issues, they offer little direct utility in estimating capacities because they simply lack the necessary data.

2. Carrying capacities can be estimated only when the relationship between use levels and relevant impacts is known. Even those studies that collect data on both uses and impacts often do not examine the relationships between the two. Sometimes these relationships are weak or insignificant, suggesting that there is no capacity problem because the impacts are caused by something other than the number of users.

3. Besides the need for descriptive data, carrying capacity also involves an evaluative or judgmental component that specifies the objectives for the area in question. The management objectives included in most resource management plans are typically too general to be useful in carrying capacity assessment. Hence, it is often necessary to collect data on user preferences to define the conditions one is trying to achieve in a given area.

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APPENDIX B:

DAILY ON-WATER BOAT AND ACTIVITY COUNTS

BY ZONE WITHIN INDIAN RIVER BAY

INDIAN RIVER BAY

Zone 1
(between Channel Markers 31-47)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	539	15	36	Cruising (47%), Crabbing (53%)
August 4	539	19	28	Crabbing (53%), Cruising (32%)
August 17	539	20	27	Crabbing (60%), Cruising (35%)
August 23	539	7	77	Crabbing (100%)
August 24	539	38	14	Crabbing (53%), Cruising (26%), Waterskiing (16%)
August 25	539	26	21	Crabbing (62%), Cruising (27%)
AVERAGE TOTALS		21	26	Crabbing (58%), Cruising (30%), Waterskiing (6%), Fishing (2%), Jetskiing (1%), Swimming (1%), Sailing (1%)

Zone 2
(between Channel Markers 30-31)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	125	9	14	Crabbing (67%), Cruising (33%)
August 4	125	9	14	Crabbing (44%), Cruising (44%)
August 17	125	3	42	Cruising (100%)
August 23	125	2	63	Crabbing (50%), Waterskiing (50%)
August 24	125	7	18	Cruising (43%), Waterskiing (43%)
August 25	125	3	42	Cruising (67%), Crabbing (33%)
AVERAGE TOTALS		6	23	Cruising (45%), Crabbing (36%), Waterskiing (12%), Jetski-ing (3%), Fishing (3%)

INDIAN RIVER BAY

Zone 3
(between Channel Markers 28-30)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	652	28	23	Cruising (43%), Crabbing (36%), Jetskiing (11%)
August 4	652	5	130	Crabbing (60%), Cruising (40%)
August 17	652	6	109	Crabbing (50%), Cruising (50%)
August 23	652	6	109	Crabbing (50%), Cruising (50%)
August 24	652	18	36	Cruising (78%), Sailing (11%)
August 25	652	4	163	Cruising (100%)
AVERAGE TOTALS		11	58	Cruising (57%), Crabbing (30%), Sailing (6%), Jetskiing (4%), Waterskiing (1%), Fishing (1%)

Zone 4
(between Channel Markers 26-28)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	788	34	23	Crabbing (41%), Cruising (38%)
August 4	788	17	46	Cruising (53%), Crabbing (18%), Waterskiing (18%)
August 17	788	11	72	Cruising (73%), Crabbing (27%)
August 23	788	7	113	Cruising (57%), Beaching (29%)
August 24	788	20	39	Cruising (55%), Crabbing (40%)
August 25	788	0	0	–
AVERAGE TOTALS		15	53	Cruising (51%), Crabbing (31%), Beaching (7%), Jetskiing (3%), Waterskiing (3%), Sailing (2%), Fishing (1%), Swimming (1%)

INDIAN RIVER BAY

Zone 5
(between Channel Markers 24-26)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	906	26	35	Cruising (42%), Crabbing (42%)
August 4	906	23	39	Cruising (74%), Crabbing (26%)
August 17	906	19	48	Cruising (53%), Jetskiing (26%), Clamming (11%), Crabbing (11%)
August 23	906	12	76	Cruising (83%), Crabbing (17%)
August 24	906	31	29	Cruising (39%), Crabbing (19%), Fishing (16%), Waterskiing (13%)
August 25	906	4	227	Cruising (75%), Fishing (25%)
AVERAGE TOTALS		19	47	Cruising (55%), Crabbing (23%), Fishing (5%), Jetskiing (5%), Beaching (3%), Waterskiing (3%), Sailing (2%), Clamming (2%), Swimming (1%)

Zone 6
(between Channel Markers 22-24)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	805	33	24	Cruising (39%), Clamming (21%), Fishing (15%)
August 4	805	29	28	Cruising (55%), Crabbing (34%)
August 17	805	31	26	Cruising (52%), Clamming (19%), Fishing (13%)
August 23	805	10	81	Cruising (60%), Sailing (20)
August 24	805	19	42	Cruising (37%), Fishing (26%), Clamming (29%)
August 25	805	9	89	Sailboarding (89%), Cruising (11%)
AVERAGE TOTALS		22	37	Cruising (45%), Clamming (14%), Crabbing (11%), Fishing (11%), Sailboarding (6%), Sailing (5%), Jetskiing (3%), Beaching (2%), Waterskiing (2%)

INDIAN RIVER BAY

Zone 7 (between Channel Markers 20-22)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	1095	38	29	Fishing (58%), Cruising (26%)
August 4	1095	38	29	Cruising (63%), Crabbing (21%), Fishing (16%)
August 17	1095	36	30	Beaching (39%), Cruising (28%), Clamming (22%)
August 23	1095	20	55	Beaching (45%), Cruising (40%), Fishing (15%)
August 24	1095	66	17	Cruising (35%), Fishing (23%), Clamming (21%), Beaching (14%)
August 25	1095	10	110	Fishing (70%), Clamming (20%), Cruising (10%)
AVERAGE TOTALS		35	32	Cruising (37%), Fishing (27%), Beaching (16%), Clamming (13%), Crabbing (4%), Sailing (3%), Jetskiing (1%)

Zone 8 (between Indian River Inlet Bridge and Channel Marker 20)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	8228	224	37	Fishing (77%), Cruising (21%)
August 4	8228	190	43	Fishing (57%), Cruising (21%), Crabbing (7%)
August 17	8228	184	45	Fishing (58%), Cruising (35%)
August 23	8228	100	82	Fishing (52%), Cruising (32%), Clamming (9%)
August 24	8228	311	26	Fishing (55%), Cruising (28%), Clamming (10%)
August 25	8228	105	78	Fishing (64%), Cruising (29%)
AVERAGE TOTALS		186	44	Fishing (61%), Cruising (27%), Clamming (5%), Beaching (2%), Sailing (1%), Sailboarding (1%), Crabbing (1%), Jetskiing (1%), Waterskiing (<1%)

APPENDIX C:

DAILY ON-WATER BOAT AND ACTIVITY COUNTS

BY QUADRANT WITHIN REHOBOTH BAY

REHOBOTH BAY

(Northwest Quadrant)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	2554	45	57	Cruising (53%), Sailing (27%), Clamming (7%), Waterskiing (7%)
August 4	2554	19	134	Cruising (58%), Fishing (21%), Sailing (16%)
August 17	2554	19	134	Cruising (53%), Sailing (37%), Waterskiing (11%)
August 23	2554	13	196	Sailing (54%), Cruising (38%), Sailboarding (8%)
August 24	2554	24	106	Fishing (33%), Sailing (29%), Cruising (21%), Clamming (8%), Sailboarding (8%)
August 25	2554	3	851	Cruising (67%), Waterskiing (33%)
AVERAGE TOTALS		21	125	Cruising (46%), Sailing (29%), Fishing (11%), Waterskiing (5%), Clamming (4%), Sailboarding (2%), Jetskiing (1%), Swimming (1%)

(Northeast Quadrant)

Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	1082	74	15	Sailboarding (65%), Jetskiing (13%), Sailing (8%)
August 4	1082	55	20	Sailboarding (55%), Jetskiing (25%), Sailing (15%)
August 17	1082	94	12	Cruising (32%), Sailboarding (22%), Sailing (18%), Jetskiing (12%),
August 23	1082	43	25	Sailboarding (33%), Sailing (33%), Jetskiing (23%), Cruising (9%)
August 24	1082	124	9	Sailing (46%), Sailboarding (27%), Jetskiing (15%), Cruising (10%)
August 25	1082	72	15	Sailboarding (60%), Sailing (25%), Jetskiing (10%)
AVERAGE TOTALS		77	14	Sailboarding (41%), Sailing (26%), Jetskiing (16%), Cruising (11%), Waterskiing (2%), Crabbing (2%), Clamming (1%), Swimming (<1%), Beaching (<1%)

(Southwest Quadrant)				
Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	2995	65	46	Cruising (35%), Fishing (23%), Clamming (18%), Beaching (15%)
August 4	2995	79	38	Fishing (47%), Cruising (37%), Clamming (13%)
August 17	2995	56	53	Cruising (27%), Clamming (27%), Fishing (20%), Beaching (18%)
August 23	2995	33	91	Cruising (30%), Clamming (18%), Fishing (18%), Beaching (15%) Sailing (12%),
August 24	2995	106	28	Fishing (27%), Beaching (25%), Clamming (24%), Cruising (15%)
August 25	2995	12	250	Fishing (42%), Cruising (42%), Clamming (8%), Sailing (8%)
AVERAGE TOTALS		59	51	Fishing (29%), Cruising (28%), Clamming (20%), Beaching (15%), Sailing (3%), Jetskiing (2%), Swimming (1%), Waterskiing (1%)

(Southeast Quadrant)				
Observation Date	Water Acreage	No. of Watercraft Observed	Use Intensity Acres/Boat	Primary Activities Observed
August 3	1297	54	24	Fishing (52%), Clamming (33%), Cruising (9%)
August 4	1297	29	45	Fishing (90%), Clamming (10%)
August 17	1297	32	41	Fishing (75%), Cruising (25%)
August 23	1297	13	100	Fishing (38%), Clamming (38%), Cruising (23%)
August 24	1297	84	15	Fishing (38%), Clamming (32%), Cruising (21%)
August 25	1297	3	432	Jetskiing (67%), Fishing (33%)
AVERAGE TOTALS		36	36	Fishing (55%), Clamming (25%), Cruising (16%), Sailing (3%), Jetskiing (2%), Swimming (<1%), Beaching (<1%)

APPENDIX D:

FREQUENCY OF MANAGEMENT RESTRICTIONS OFFERED BY SURVEY RESPONDENTS

RESTRICTIONS				
MAJOR TOPICS				
	Permanent Residents (n = 177)	**Seasonal Residents (n = 111)**	**Seasonal Visitors (n = 24)**	**Total (n = 312)**
BOATER SAFETY/EDUCATION				
Boat operator's license	11	10	1	22
Boat safety course	8	12	2	22
Boater minimum age	2	3	0	5
Restrict alcohol use	0	4	0	4
Know rules of the road	3	0	0	3
Renew boater safety course	1	1	0	2
Educate boaters	1	0	0	1
Require license for boat operators	1	0	0	1
Evaluate boater needs	0	1	0	1
Safety at fuel pumps	0	1	0	1
TOTALS	27	32	3	62
LIMIT/ZONE JETSKIS				
TOTALS	32	20	1	53
LIMIT BOAT SPEED/CONTROL WAKES				
Limit boat speed	8	5	4	17
Restrict wakes	8	3	1	12
No wake in Hopkins/Burton's Prong	1	0	0	1
TOTALS	17	8	5	30

RESTRICTIONS				
MAJOR TOPICS				
	Permanent Residents (n = 177)	Seasonal Residents (n = 111)	Seasonal Visitors (n = 24)	Total (n = 312)
CONTROL POLLUTION/DEVELOP SEWER SYSTEMS				
Restrict sewage	1	4	0	5
Stop pollution	2	1	1	4
Require sewers	2	2	0	4
Control farm runoff	3	0	0	3
State-supplied dump-out stations	2	0	0	2
Monitor DP&L discharge	1	1	0	2
Control algae "sea lettuce" problem	0	1	0	1
Companies along bays pollute--make them clean up	1	0	0	1
Stop dumping fish wastes into water	1	0	0	1
Make all conform to sewer regulations	1	0	0	1
Regional sewer system	1	0	0	1
State inspection of boat dumping	1	0	0	1
Control discharge from outboard exhaust	1	0	0	1
Control land-source pollution	1	0	0	1
TOTALS	18	9	1	28
MORE MARINE PATROLS/ENFORCE LAWS				
More law enforcement/marine police	14	3	2	19
More and better patrols	2	0	0	2
Mandatory patrols	0	0	1	1
Tougher enforcement of all laws	0	1	0	1
TOTALS	16	4	3	23
MORE DREDGING				
TOTALS	15	5	0	20

RESTRICTIONS				
MAJOR TOPICS				
	Permanent Residents (n = 177)	Seasonal Residents (n = 111)	Seasonal Visitors (n = 24)	Total (n = 312)
CONTROL/REGULATE CRAB POTS				
Restrict crab pots	6	2	0	8
No crabbing in channel	1	2	2	5
Restrict and regulate crab pots	0	3	0	3
License tags for crab pots	1	0	0	1
Make public areas available for crabbing	1	0	0	1
TOTALS	9	7	2	18
RESTRICT/ZONE WATERSKIING AND POWERBOATING				
Limit/no waterskiing	4	1	0	5
Assign waterski areas	2	0	0	2
Assign powerboating areas	1	0	0	1
Restrict clustering of boats at inlet	0	0	1	1
Keep fishing boats out of channels	0	1	0	1
Restrict/zone waterskiing	0	1	0	1
Separate/zone motorboats	1	0	0	1
Eliminate ski boats	0	1	0	1
TOTALS	8	4	1	13
LIMIT FISH CATCHES/ENFORCE SIZE LIMITS				
Stricter fishing limits	0	3	1	4
Restrict net fishing	1	2	0	3
Limit fish catches	2	0	0	2
Enforce size limits	2	0	0	2
Publicize fish size/quantity limits	1	0	0	1
TOTALS	6	5	1	12

RESTRICTIONS

MAJOR TOPICS

	Permanent Residents (n = 177)	Seasonal Residents (n = 111)	Seasonal Visitors (n = 24)	Total (n = 312)
BAN JETSKIS				
TOTALS	8	2	0	10
CONTROL DEVELOPMENT/PROTECT CRITICAL AREAS				
Protect wetlands/critical areas	0	1	1	2
Restrict building	0	1	1	2
Encourage dry-dock marinas	0	1	0	1
Save our farmland	1	0	0	1
Save wetlands	1	0	0	1
Buffer zones around bays	1	0	0	1
TOTALS	3	3	2	8
LIMIT OUT-OF-STATERS/INCREASE OUT-OF-STATER FEES				
Limit out-of-staters	3	0	1	4
Fees/permits for out-of-state boats	3	0	0	3
Higher registration fees for out-of-staters	1	0	0	1
TOTALS	7	0	1	8
BETTER CHANNEL MARKINGS				
Mark channels better	2	2	0	4
Mark deep areas and channels better	1	1	0	2
Better channel markers	0	0	1	1
TOTALS	3	3	1	7

RESTRICTIONS				
MAJOR TOPICS				
	Permanent Residents (n = 177)	**Seasonal Residents (n = 111)**	**Seasonal Visitors (n = 24)**	**Total (n = 312)**
RESTRICT SIZE/NUMBER OF POWERBOATS				
Restrict cigarette boats and other large boats	1	1	0	2
Restrict boat size from Gull Point to Millsboro	1	0	0	1
Restrict/limit size of boats	0	0	1	1
Limit number and size of boats	0	0	1	1
Restrict excessive boat noise	0	0	1	1
TOTALS	2	1	3	6
RESTRICT COMMERCIAL/INDUSTRIAL USES IN BAYS				
TOTALS	2	4	0	6
RESTRICT FEDERAL GOVERNMENT/ENOUGH RESTRICTIONS				
TOTALS	1	4	0	5
ELIMINATE BOATING FEES/TAXES				
No Coast Guard fees	2	0	0	2
Stop taxing boats	1	0	0	1
TOTALS	3	0	0	3

APPENDIX E:

FREQUENCY OF MANAGEMENT SUGGESTIONS OFFERED BY SURVEY RESPONDENTS

SUGGESTIONS				
MAJOR TOPICS				
	Permanent Residents (n = 234)	Seasonal Residents (n = 202)	Seasonal Visitors (n = 61)	Total (n = 497)
CONTROL POLLUTION				
Install sewer plants	13	16	2	31
Watch pollution	9	13	3	25
Clean up bay pollution	1	5	1	7
Stop sludge dumping	3	3	1	7
Control erosion and storm runoff	1	4	0	5
Improve sediment-control buffers	2	1	1	4
Prohibit sewage-plant discharge into bay	3	1	0	4
Heavy fines for polluters (public and private)	2	1	1	4
Less polluting marine engines	0	1	3	4
Filter DP&L water	1	1	1	3
More water-quality testing	2	1	0	3
Promote clean water	1	2	0	3
Fines for improper sewage disposal	0	2	0	2
Improve water quality	1	0	1	2
Fines for violators	1	1	0	2
Prevent littering/throwing trash overboard	2	0	0	2
Control water quality from land sources	1	0	0	1
Stricter pollution laws	1	0	0	1
Stop all bay dumping	0	1	0	1
Educate people--keep waterways clean	1	0	0	1
Prevent trailer parks from discharging sewage	1	0	0	1
Control use of chicken manure	1	0	0	1
TOTALS	47	53	14	114

SUGGESTIONS				
MAJOR TOPICS				
	Permanent Residents (n = 234)	Seasonal Residents (n = 202)	Seasonal Visitors (n = 61)	Total (n = 497)
MORE DREDGING				
Dredge channel more	13	24	1	38
Dredge Assawoman Canal	13	7	0	20
Mark sand bars	2	4	3	9
Dredge Little Assawoman Bay and tributaries	3	6	0	9
Dredge Herring Creek	1	0	2	3
Dredge ocean outflows to aid in flushing bays	1	0	1	2
Dredge Lewes-Rehoboth Canal	0	1	0	1
Watch for shoaling	0	1	0	1
Dredge Rehoboth Bay	1	0	0	1
TOTALS	34	43	7	84
MORE MARINE PATROLS/ENFORCE LAWS				
More marine police	25	12	7	44
Stricter enforcement of all rules/regulations	1	6	4	11
Enforce laws and regulations	8	1	1	10
Stricter laws	4	0	0	4
TOTALS	38	19	12	69
BOATER SAFETY/EDUCATION				
Boat safety test	13	2	2	17
Boat license	2	7	2	11
Control alcohol	0	4	0	4
Educate boaters	2	1	0	3
Teach boater etiquette	1	0	1	2
TOTALS	18	14	5	37

SUGGESTIONS				
MAJOR TOPICS				
	Permanent Residents (n = 234)	Seasonal Residents (n = 202)	Seasonal Visitors (n = 61)	Total (n = 497)
CONTROL DEVELOPMENT/PROTECT CRITICAL AREAS				
Limit development	9	2	3	14
Environmental restrictions	3	2	1	6
Control marinas	3	2	1	6
Protect wetlands	2	2	1	5
No more marinas/ramps	2	0	1	3
Control building along canals (Fenwick)	1	1	0	2
Purchase more shoreline	0	1	0	1
TOTALS	20	10	7	37
IMPROVED FISHERIES MANAGEMENT				
Fish stocking and management	1	2	5	8
Stop commercial netting	1	6	0	7
Restrict fishing more	1	4	2	7
Check fish sizes	2	1	0	3
Raise fish limits	1	1	0	2
Stop/control fish kills	0	1	0	1
TOTALS	6	15	7	28
CONTROL/REGULATE CRAB POTS				
Restrict crab pots	9	3	0	12
Ban crab traps	4	0	0	4
Ban discarding crab-pot bait into bay	2	1	0	3
Eliminate crab traps	1	1	0	2
Tag crab traps	1	0	0	1
TOTALS	17	5	0	22

SUGGESTIONS

MAJOR TOPICS

	Permanent Residents (n = 234)	Seasonal Residents (n = 202)	Seasonal Visitors (n = 61)	Total (n = 497)
LIMIT BOAT SPEED/CONTROL WAKES				
Control/slow down fast boats	10	1	1	12
Keep wakes to a minimum	2	1	0	3
Eliminate waterskiing in creeks	2	0	0	2
Restrict speeding	0	1	1	2
Control HP of motors used on bays	1	0	0	1
TOTALS	15	3	2	20
LIMIT/REGULATE JETSKIS				
Limit jetskis	9	4	0	13
Regulate jetskis	1	1	1	3
TOTALS	10	5	1	16
IMPROVE BOAT ACCESS				
More boat ramps	2	6	1	9
Need ramp monitor	0	2	0	2
Vending machines at access	0	1	0	1
More fuel areas	0	1	0	1
More parking at ramps	1	0	0	1
TOTALS	3	10	1	14
KEEP UP GOOD WORK				
Doing a good job	4	5	1	10
Keep them safe	1	1	0	2
More study	1	0	0	1
Provide opportunities for people to get involved	1	0	0	1
TOTALS	7	6	1	14

SUGGESTIONS

MAJOR TOPICS

	Permanent Residents (n = 234)	Seasonal Residents (n = 202)	Seasonal Visitors (n = 61)	Total (n = 497)
RESTRICT SIZE AND NUMBER OF BOATS				
Less boats/less people	2	1	0	3
Limit cigarette boats	0	2	0	2
Limit number of boats	2	0	0	2
Odd/even boat days	1	1	0	2
TOTALS	5	4	0	9
RESTRICT STATE GOVERNMENT/LOOSEN RESTRICTIONS				
Do not overregulate	1	0	2	3
Get state government out of bays	1	1	0	2
Do not ban jetskis	0	1	0	1
Limit towing charges	0	1	0	1
No more taxes	0	1	0	1
Paint own pontoons	0	1	0	1
TOTALS	2	5	2	9
BETTER CHANNEL MARKINGS				
TOTALS	4	3	1	8
PROHIBIT JET SKIS				
TOTALS	5	2	0	7

SUGGESTIONS

MAJOR TOPICS

	Permanent Residents (n = 234)	Seasonal Residents (n = 202)	Seasonal Visitors (n = 61)	Total (n = 497)
GENERATE AND USE REVENUES				
More money into bays	0	1	1	2
Fund Coast Guard better	1	0	0	1
Charge at public ramps	0	1	0	1
Use fines, boating fees for water-quality improvements	0	1	0	1
Higher license fees	1	0	0	1
TOTALS	2	3	1	6
RESTRICT COMMERCIAL/INDUSTRIAL USES IN BAYS				
Ban commercial use of waters	0	2	0	2
More control of industries on bay	1	0	0	1
TOTALS	1	2	0	3

APPENDIX F:

SURVEY INSTRUMENT WITH SUMMARY OF RESPONSES

FOR ON-SITE SURVEY OF BOATERS

Delaware Inland Bays Boating Study - 1991

NUMBER ____________
LOCATION ____________
DATE ____________
START TIME ____________
INTERVIEWER ____________
BOAT REGIST. #: ____________

Weather: Skies: Sunny ____ Partly Cloudy ____ Cloudy ____ Rainy ___
Winds: Light (0-7mph)____ Gentle (8-12mph)____ Moderate (13-24mph)____ High (25+) ____
Waves: Calm ____ Light Chop ____ Heavy Chop ____ Whitecaps ____
Temperature: __________ Tide: High ___ Low: ___ Incoming:___ Outgoing: ___

INTRODUCE YOURSELF, SAY

I am with the University of Delaware, College of Marine Studies. We are doing a study of boating on the Inland Bays. Will you answer a few questions about your experience here today?

IF RESPONDENT AGREES, CONTINUE

Thank you. Now I must choose a person in your party who is willing to answer the questions. Who in this party (18 years or older) actually operated the boat today?

SELECT RESPONDENT

BEFORE ASKING QUESTIONS SAY

So that the answers will be reliable, I need to read the questions exactly as they are written.

IF RESPONDENT REFUSES, SAY

My questions will only take 10-15 minutes.
You were selected as part of a representative sample, so your answers are very important. Your answers are confidential and will only be reported as statistics.

IF RESPONDENT REFUSES AGAIN, SAY

Thank you, enjoy your visit

Record the following:

Boat length (app.) $\bar{X}$ = 18.5 feet
Boat type:

1. Cabin cruiser - 8%
2. Runabout - 83%
3. Kayak/Canoe
4. Sailboat
5. Row Boat
6. Jet ski
7. Pontoon boat - 8%
8. Bass boat
9. Sailboard
10. Other ________

in party: $\bar{x}$=2.5 Males $\bar{x}$=2.6 Females # under age 16: $\bar{x}$=1.4

1. Are you staying in the local area? Yes 42 No 47 (If "no, go to #2) Location: —

Are you a:

a. 21% Permanent, year round resident. # of Years $\bar{x}$ = 18 .

b. 56% Seasonal Resident (Property owner)

# of years $\bar{x}$=15. Length of Stay $\bar{x}$ = 17days. # of visits per season $\bar{x}$ = 18 .

c. 23% Seasonal Rental or Visitor (Circle)

Condo, House, Apt., R.V./Camper, Motel etc. (Circle) # of Years $\bar{x}$ = 16. Length of Stay: $\bar{x}$ = 9.5 days

1a. What percentage of time during your stay (your leisure or recreational time) will be devoted to Bay related activities?
$\bar{x}$ = 45%

2. Are you a day trip visitor? Yes 12% No 88%. If "Yes", How many years have you been coming to the Inland Bays? $\bar{x}$ = 18.5 years

3. Where is your principal home residence?
DE-46% PA-38% MD-10% (state) ______ (town) ______ (zip)

4. About how many miles, one way, is it from your residence to this location ?
$\bar{x}$ = 102 miles (CHECK TO SEE THAT MILEAGE IS ONE-WAY)

5. How many people were in your boating group today? (Include all people using the boat today.)
$\bar{x}$ = 2.0 Males $\bar{x}$ = 1.0 Females $\bar{x}$ = .4 # under age 16

6. Which of the following best describes the composition of your group?
1. Family - 56%
2. Friends - 17%
3. Family & friends - 21%
4. Business associates - 0
5. Alone - 6%
6. Other - <1%

7. How many YEARS have you been a boater?
$\bar{x}$ = 20 years

8. How would you rate YOURSELF as a boater?
1. Novice 9%   2. Intermediate 35%   3. Advanced 36%   4. Expert 21%

IF AT RAMP, OBSERVE -- OTHERWISE, ASK:

9. What kind of boat do you have at the bay today?
1. Cabin Cruiser - 13%
2. Runabout - 61%
3. Kayak/Canoe - <1%
4. Sail boat - 2%
5. Row boat - 2%
6. Jet ski - 3%
7. Pontoon boat - 15%
8. Bass boat - 3%
9. Sailboard - 0
10. Other - 3%

10. How many feet long is your boat? (Record to the nearest foot) $\bar{x}$ = 19 feet

a. What is the total horsepower of your engine(s) $\bar{x}$ = 115 hp.

10b. Does your boat have a MARINE HEAD?
71% NONE
1% TYPE II (With Holding Tank)
1% TYPE II (Without Holding Tank)
<1% TYPE III (With "Y" Valve)
<1% TYPE III (Without "Y" Valve)
26% PORTA POTTY

11. Including all the boating you did, how many days did you boat in 1990? $\bar{x}$ = 40 days

12. How many days did you boat in the Inland Bays last year? $\bar{x}$ = 32 days

HAND RESPONDENT INFORMATION CARD

Say : "Now, I would like to ask about today's experiences."

13. What time did you start boating today? MODE = 11:00 A.M

13a. Here is a list of boating activities you might have participated in today. Please tell me which of these activities your boating group did. What percent of time did you spend on each of the following activities?

(% WHO PARTICIPATED) (% of Time Spent)

Activity	%	Activity	%
Sailing (Sa)	1	Sunbathing/Sightseeing (Su)	11
Powerboating (Pb)	25	Fishing (Fi)	53
Water Skiing (Ws)	6	Crabbing (Cr)	24
Sailboarding (Sb)	<1	Swimming (Sw)	4
Clamming (Cl)	9	Other (Ot)	6

Total= 100%

14. On a scale of 1 to 10 (with 10 being the perfect trip), how would you rate the QUALITY of your experience today?
$\bar{x}$=7.5 (rating)

REFER RESPONDENT TO THE MAP

15. On the map, please draw the route that you followed in your boat today.

16. Using the initials from your activity list, please show on your map where you participated in each activity.

17. Which areas of the bays did you MOST ENJOY? (Record these on the map with an "E")

Why did you enjoy these areas? (n=212) CAUGHT FISH-26%; GOOD CRABBING-12%; NOT CROWDED-8%

18. Which areas of the bays did you LEAST ENJOY today? (Record these on the map with an "L")

Why did you not enjoy these areas? (n=137) TOO CROWDED-20%; ROUGH WATER-14%; TOO SHALLOW-11%

19. Were there any parts of the bays you deliberately AVOIDED today? (Record these on the map with an "A")

Why did you avoid these areas? (n=146) TOO SHALLOW-31%; SANDBAR-26%; TOO CROWDED-11%

20. Using the crowding scale (refer to card), how would you describe the BOATING CONDITIONS on the bays today?

12%	9%	11%	11%	11%	16%	14%	10%	6%
1	2	3	4	5	6	7	8	9
Not at all Crowded		Slightly Crowded			Moderately Crowded			Extremely Crowded

$\bar{x}$=4.9

21. Using the following enjoyment scale (refer to card), how did the NUMBER of boaters on the bays impact your enjoyment of the day's trip?

5%	6%	4%	2%	60%	8%	9%	4%	3%
1	2	3	4	5	6	7	8	9
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

$\bar{x}$=5.0

22. While you were on your boat trip, how often did you observe: (%)

	Never	Occasionally	Most of the Time	All of the Time
Discarded whole or pieces of plastic products	1-79	2-20	3-1	4-0
Discarded whole or pieces of glass containers	1-97	2-3	3-0	4-0
Discarded whole or pieces of metal containers	1-93	2-7	3-0	4-0
Discarded whole or pieces of paper products	1-84	2-15	3-1	4-<1
Floating algae or plant material	1-62	2-31	3-6	4-1
Dead fish, birds or animals	1-86	2-13	3-1	4-<1

23. Using the following enjoyment scale (refer to card), how did the AMOUNT OF DEBRIS on the bay and the shore impact your enjoyment of the day's trip?

1-16%	2-8%	3-5%	4-1%	5-63%	6-3%	7-2%	8-1%	9-1%
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

$\bar{x} = 4.$

24. Using the following enjoyment scale (refer to card), how did the WIND AND WAVES on the bay impact your enjoyment of the day's trip?

1-7%	2-8%	3-4%	4-3%	5-49%	6-9%	7-11%	8-6%	9-4%
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

$\bar{x} = 5.1$

I am going to read some statements about boating on the inland bays. Based on your experience here today, please rate your level of agreement or disagreement with each statement I read, using the final scale on the card. (%)

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
25.	I avoided my favorite parts of the bays today because there were too many boats there	SD-11	D-71	U-5	A-10	SA-2
26.	I thoroughly enjoyed my boat trip today	SD-1	D-5	U-4	A-69	SA-22
27.	My boating trip was not as enjoyable as I expected it to be	SD-12	D-64	U-3	A-19	SA-1
28.	I cannot imagine a better boating trip	SD-13	D-57	U-9	A-18	SA-3
29.	Other boats came closer to my boat than I liked	SD-8	D-58	U-2	A-25	SA-7
30.	I stayed off the bays during parts of the day because there were too many boats	SD-10	D-74	U-3	A-12	SA-2
31.	The noise of other boats reduced my enjoyment on the bays	SD-12	D-78	U-2	A-8	SA-<1
32.	My boat trip was well worth the money I spent to take it	SD-1	D-4	U-3	A-76	SA-16

	Statement	SD	D	U	A	SA
33.	There are adequate law enforcement patrols on the Inland Bays	SD - 4	D - 21	U - 11	A - 58	SA - 8
34.	Powerboat activities have negative environmental impacts on the bays	SD - 5	D - 43	U - 16	A - 34	SA - 2
35.	I was disappointed with some aspects of my boat trip today	SD - 6	D - 62	U - 3	A - 28	SA - 1
36.	If I had known what it was going to be like here today, I would have not boated on the Bays	SD - 15	D - 78	U - 1	A - 5	SA - 1
37.	I nearly had an accident on the bays today because of crowded conditions	SD - 18	D - 80	U - 1	A - 1	SA - 1
38.	The behavior of other boaters interfered with the quality of my boating experience	SD - 12	D - 68	U - 2	A - 13	SA - 4

IF RESPONDENT AGREES — Can you describe how the behavior of other boaters interfered? (n=96)

GOING TOO FAST-16%; CAME TOO CLOSE-15%; FAILED TO YIELD RIGHT-OF-WAY-8%

	Statement	SD	D	U	A	SA
39.	Boating conditions on the bays were safe	SD - 0	D - 8	U - 3	A - 81	SA - 8
40.	Amount of public access limits my use of the Inland Bays	SD - 8	D - 65	U - 6	A - 19	SA - 3
41.	A completely unexpected event took place during todays trip	SD - 13	D - 73	U - <1	A - 11	SA - 3

IF RESPONDENT AGREES — Please describe it. (n=60) BOAT BROKE DOWN-16%; CAUGHT FISH-14%; NO FISH CAUGHT-8%

What impact did this event have on your enjoyment?

1 - 14%	2 - 12%	3 - 5%	4 - 0	5 - 32%	6 - 7%	7 - 7%	8 - 9%	9 - 14%
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

x̄ = 5.0

	Statement	SD	D	U	A	SA
42.	I did not participate in some boating activities because of crowded conditions	SD - 13	D - 80	U - 1	A - 6	SA - 0

IF RESPONDENT AGREES Which activities? (n=26)
MORE FISHING-31%; DIDN'T FISH REGULAR SPOT-23%; WATER SKIING-8%

	Statement	SD	D	U	A	SA
43.	I did not participate in some boating activities because of weather conditions	SD - 12	D - 72	U - 1	A - 14	SA - 2

IF RESPONDENT AGREES Which activities? (n=61)
CAME IN EARLY-16%; FISHING-16%; WOULD HAVE GONE TO OCEAN-13%

44. I did not participate in some boating activities because of poor water quality   SD - 13   D - 82   U - 1   A - 5   SA - 1

IF RESPONDENT AGREES — Which activities? (n = 21)
SWIMMING - 43%; CLAMMING - 14%; CRUISING - 10%

45. Did you observe any unsafe boating situations on the bay today?
1. NO - 74%   2. YES - 26%

IF RESPONDENT ANSWERS "YES" — Could you describe the unsafe boating situations you observed?
(n=123) GOING TOO FAST - 17%; CAME TOO CLOSE - 16%; BOAT CUT IN FRONT - 9%

46. Over the past 10 years or since you have been visiting the area, do you think the environmental quality of the Inland Bay, tributaries and canals has been:

40% improving   17% not changing very much
32% deteriorating   11% don't know, not sure

47. Over the past 10 years or since you have been visiting the areado you think the bay's living resources (fish, crabs, clams, etc.) have been:

29% improving   18% not changing very much
45% deteriorating   9% don't know, not sure

48. Would you favor or oppose each of the following restrictions for the Inland Bays, canals and tributaries: (%)

	Favor	Oppose	Not sure
a. Restrict the number of boat ramps	1 - 24	2 - 61	3 - 14
b. Restrict the number of marinas	1 - 44	2 - 46	3 - 10
c. Limit the number of boats using the bays, tributaries and canals	1 - 13	2 - 77	3 - 10
d. Limit the size and power of boats using these waters	1 - 30	2 - 63	3 - 7
e. Zoning the waters to provide for specific uses at specific places	1 - 55	2 - 38	3 - 6
f. Stricter limits on the size and/or number of fish, crabs, clams and waterfowl that can be taken	1 - 62	2 - 32	3 - 6
g. Restrictions on building and development	1 - 76	2 - 16	3 - 8
h. Establish "Off Limits" zones to protect sensitive resources	1 - 89	2 - 6	3 - 4
i. Prohibiting all discharges of pollutants into the water	1 - 98	2 - 1	3 - 2

48 cont'd.

	Favor	Oppose	Not Sure
j. Restrict boat use in excessively shallow waters	1-58	2-32	3-10
k. Require purchasing a seasonal boating use permit for bay use, if the money were used for bay improvement	1-57	2-39	3-4

If you favor boating use permits, how much would you be willing to pay annually? $\bar{X}$ = $26
MODE = $10

49. Are there any other restrictions you would favor? SEE APPENDIX D

50. If boating opportunities were not available on the Inland Bays, would you still (visit/live in) coastal Sussex County?
Yes 57% No 43%

Do you have any suggestions for improved management of the Inland Bays?

SEE APPENDIX E

That concludes our survey, thank you for your time!

PART III. BOATING CONDITIONS LAST WEEKEND

1. Did you boat on the Inland Bays this past Saturday, August 3?

37% Yes — If "Yes", please answer the following questions with regard to your boating experience on that day

63% No — If "No", when is the last time you boated on the bays?
Date:__________
Please answer the following questions with regard to this most recent boating experience.

2. How many people were in your boating group that day?

$\bar{x}$= 1.8 Males $\bar{x}$=1.2 Females $\bar{x}$=.4 Number under age 16

3. Which of the following best describes the composition of your group? (%)
   1. Family - 54
   2. Friends - 12
   3. Family & Friends - 26
   4. Business associates - 0
   5. Alone - 4
   6. Other - 1

4. On a scale of 1 to 10 (with 10 being the perfect trip), how would you rate the ***QUALITY*** of your boating experience? $\bar{x}$ = 7.7 (rating)

5. Using the following scale, how would you describe the ***BOATING CONDITIONS*** on the bays that day? (%)

1-13	2-15	3-12	4-10	5-10	6-14	7-14	8-8	9-5
Not at all crowded		Slightly crowded			Moderately crowded			Extremely crowded

$\bar{x}$=5.0

6. Using the following scale, how did the ***NUMBER OF BOATERS*** on the bays impact your ***ENJOYMENT*** of the day's trip? (%)

1-2	2-4	3-3	4-3	5-56	6-9	7-9	8-8	9-5
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

$\bar{x}$=5.0

7. While you were ***on your boat trip***, how often did you observe: (%)

	Never	Occasionally	Often	Very Often
Discarded whole or pieces of plastic products	1-39	2-50	3-9	4-2
Discarded whole or pieces of glass containers	1-79	2-18	3-2	4-1
Discarded whole or pieces of metal containers	1-63	2-29	3-7	4-1
Discarded whole or pieces of paper products	1-30	2-52	3-12	4-5
Floating algae or plant material	1-34	2-40	3-20	4-6
Dead fish, birds or animals	1-73	2-23	3-3	4-1

8. Using the following scale, how did the amount of ***DEBRIS*** on the bay and the shore impact your ***ENJOYMENT*** of the day's trip? (%)

1-2	2-4	3-2	4-2	5-52	6-14	7-13	8-5	9-6
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

$\bar{x}$=5.0

Listed below are some statements about boating on the Inland Bays. Based on your experience ***ON THE DAY SPECIFIED***, please rate your level of agreement or disagreement with each statement.

(%)

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
9.	I avoided my favorite parts of the bays because there were too many boats there	SD-24	D-40	U-12	A-20	SA-5
10.	I thoroughly enjoyed my boat trip that day	SD-3	D-7	U-8	A-67	SA-16
11.	My boating trip was not as enjoyable as I expected it to be	SD-4	D-14	U-12	A-51	SA-20
12.	I cannot imagine a better boating trip	SD-9	D-35	U-23	A-30	SA-3
13.	Other boats came closer to my boat than I liked	SD-15	D-39	U-4	A-30	SA-12
14.	I stayed off the bays during parts of the day because there were too many boats	SD-25	D-44	U-5	A-18	SA-8
15.	The noise of other boats reduced my enjoyment on the bays	SD-21	D-44	U-9	A-18	SA-9
16.	My boat trip was well worth the money I spent to take it	SD-3	D-4	U-13	A-67	SA-13
17.	There are adequate law enforcement patrols on the Inland Bays	SD-20	D-30	U-19	A-26	SA-6
18.	Powerboat activities have negative environmental impacts on the bays	SD-14	D-27	U-23	A-25	SA-12
19.	I was disappointed with some aspects of my boat trip	SD-3	D-24	U-15	A-46	SA-12
20.	If I had known what it was going to be like that day, I would not have boated on the Bays	SD-23	D-60	U-11	A-4	SA-3
21.	I nearly had an accident on the bays because of crowded conditions	SD-37	D-53	U-4	A-4	SA-1

		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
22.	The behavior of other boaters interfered with the quality of my boating experience	SD - 16	D - 41	U - 6	A - 27	SA - 10

IF YOU AGREE — Can you describe how the behavior of other boaters interfered? (n=106)

GOING TOO FAST-22% JETSKIERS OBEY NO RULES-11% CAME TOO CLOSE-9%
JETSKIERS CUT IN FRONT-9%

23.	Boating conditions on the bays were safe	SD - 3	D - 18	U - 8	A - 66	SA - 5

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

1. NO 49% 2. YES 51%

IF YOU ANSWERED 'YES' — Could you describe the unsafe boating situations you observed? (n=141)

BOATS GOING TOO FAST-19% FISHING IN CHANNEL-13%
BOATS TOO CLOSE-8%

Please refer to the map on the facing page

25. On the map, please draw the route that you followed in your boat on the day specified.

26. Below is a list of boating activities you might have participated in. Please indicate which of these activities your boating group did on this day. What percent of time did you spend on each of the following activities?

(% WHO PARTICIPATED)	(% of Time Spent)		
Sailing (Sa)	7	Sunbathing/Sightseeing (Su)	27
Powerboating (Pb)	50	Fishing (Fi)	33
Water Skiing (Ws)	8	Crabbing (Cr)	21
Sailboarding (Sb)	<1	Swimming (Sw)	8
Clamming (Cl)	7	Other (Ot)	7

Total 100%

27. Using the initials from the activity list above, please show on the map where you participated in each activity.

28. Which areas of the bays did you *MOST ENJOY*? (Record these on the map with an "E") (n=167)

Why did you enjoy these areas? NOT CROWDED-20% QUIET/CALM-13% GOOD FISHING-11%

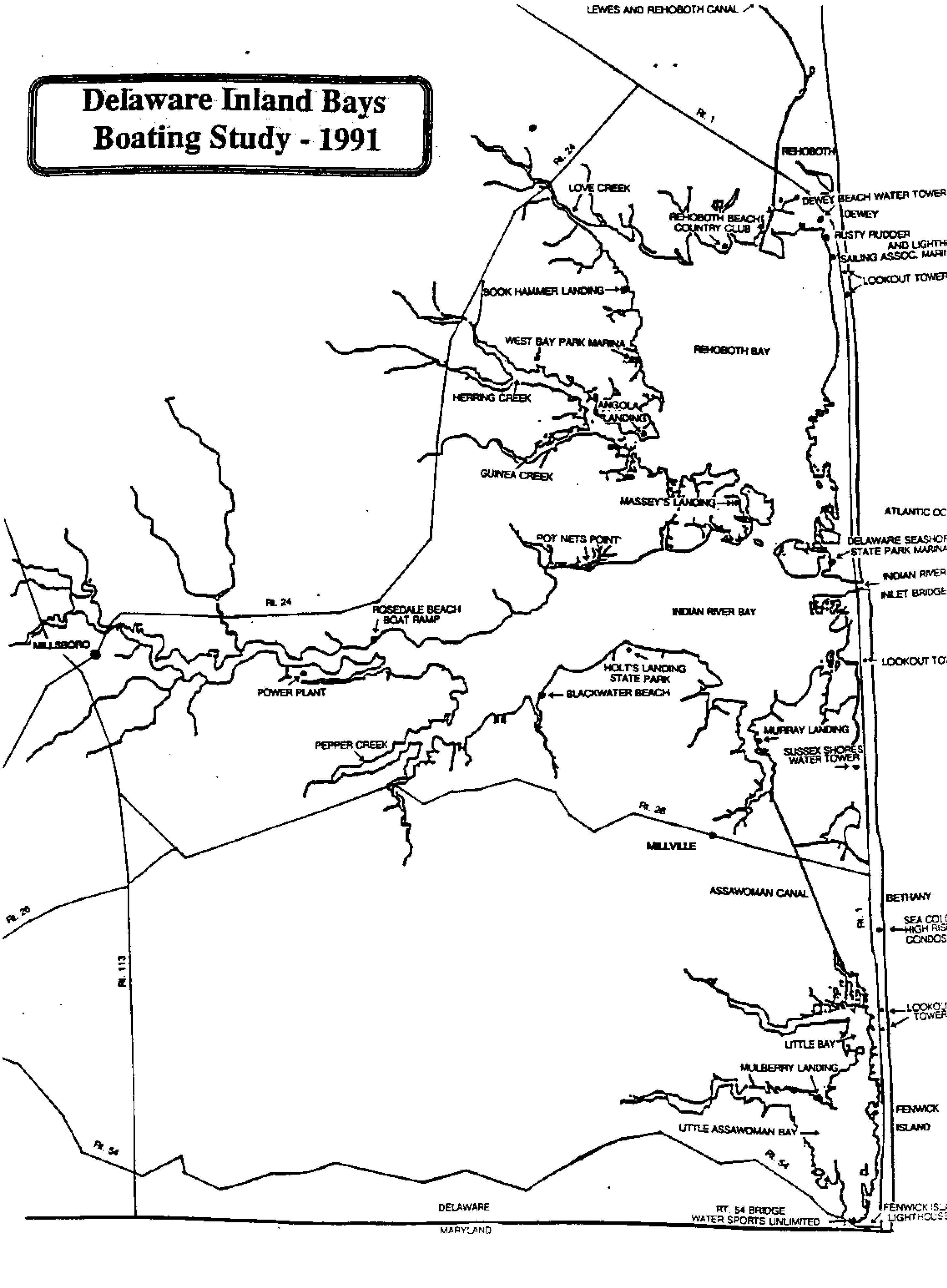
29. Which areas of the bays did you *LEAST ENJOY* ? (Record these on the map with an "L") (n=110)

Why did you not enjoy these areas? TOO SHALLOW-25% CROWDS-15% TOO MANY BOATS-11% JETSKIERS-11%

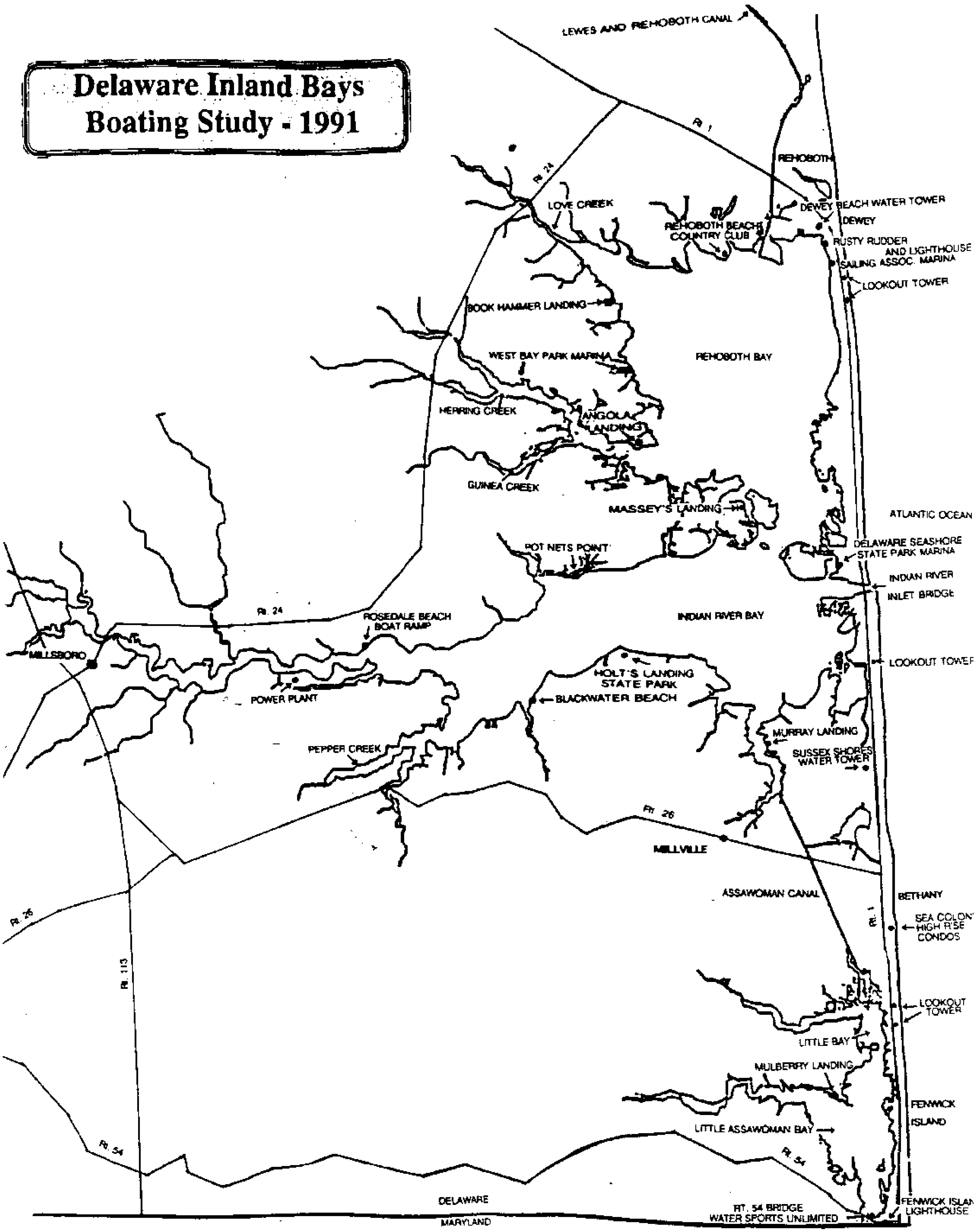
30. Were there any parts of the bays you deliberately *AVOIDED* ? (Record these on the map with an "A") (n=95)

Why did you avoid these areas? TOO SHALLOW-33% CROWDS-24% JETSKIERS-8%

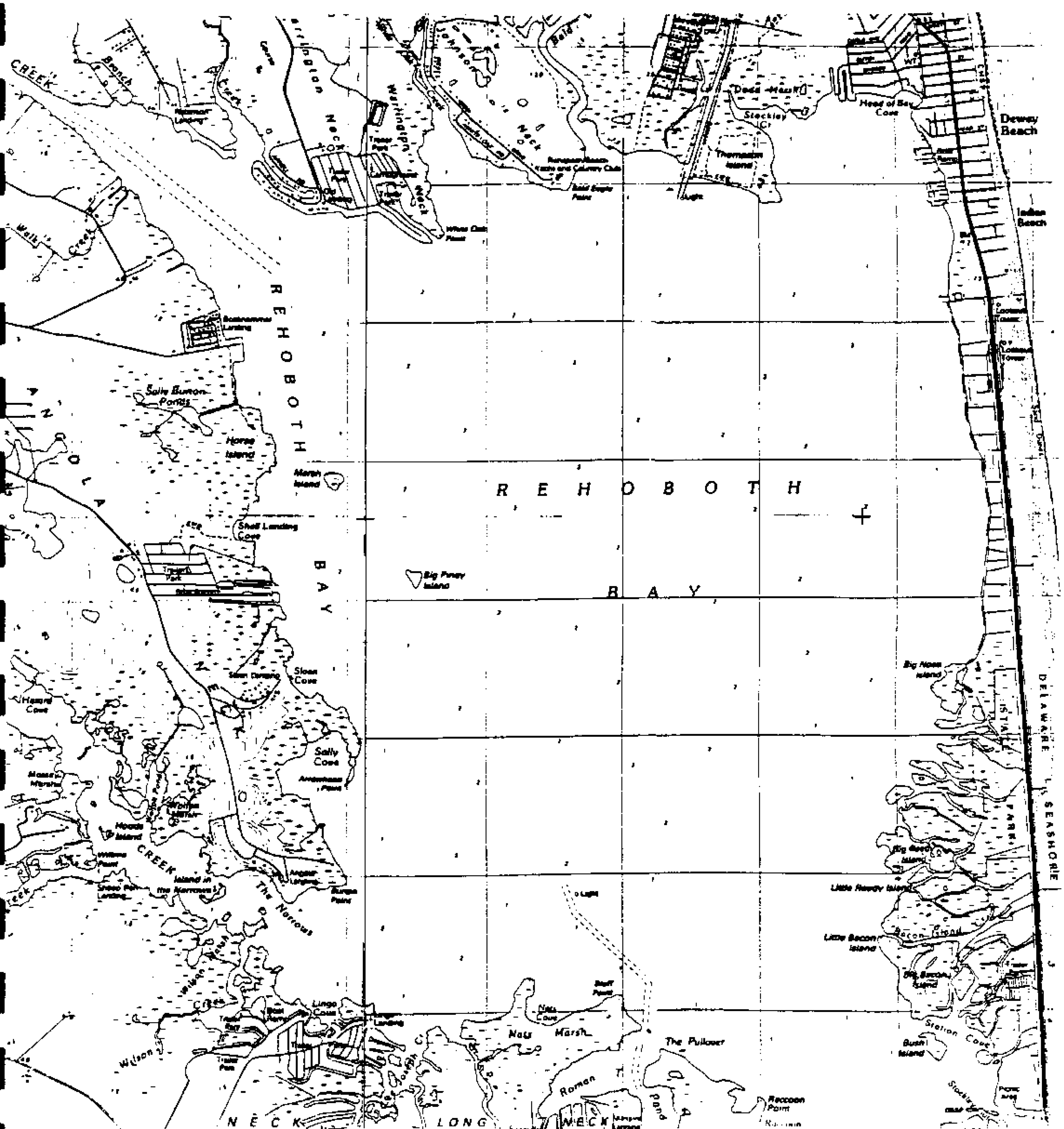
Delaware Inland Bays Boating Study - 1991



Delaware Inland Bays Boating Study - 1991



Delaware Inland Bays
Boating Study - 1991
Sailboarding Version



		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
31.	A completely unexpected event took place during this trip	SD - 31	D - 59	U - 4	A - 5	SA - 2

IF YOU AGREE — Please describe it. (n=17) JETSKIERS DISREGARD FOR OTHERS - 18% BOATS SPEEDING - 12%

How did this event affect your enjoyment of the day's activities? (%)

1 - 5	2 - 7	3 - 2	4 - 5	5 - 55	6 - 2	7 - 2	8 - 7	9 - 14
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

$\bar{x}=5.0$

32.	I did not participate in some boating activities because of crowded conditions	SD - 25	D - 57	U - 4	A - 9	SA - 5

IF YOU AGREE — Which activities? (n=25) MORE FISHING - 36% SIGHTSEEING - 8% WEEKEND FISHING - 8% CRUISING - 8%

33.	I did not participate in some boating activities because of weather conditions	SD - 25	D - 56	U - 4	A - 12	SA - 4

IF YOU AGREE — Which activities? (n=11) FISHING - 36%

34.	I did not participate in some boating activities because of poor water quality	SD - 21	D - 56	U - 5	A - 12	SA - 6

IF YOU AGREE — Which activities? (n=28) SWIMMING - 43% CLAMMING - 36% CRABBING - 7%

35. If boating opportunities were not available on the Inland Bays, would you still live in coastal Sussex County? Yes 57% No 43%

36. Do you have any suggestions for improved management of the Inland Bays?

SEE APPENDIX E

That concludes the survey, thank you for your time!

Please return the completed survey form in the stamped, self addressed envelope provided.

APPENDIX G:

SURVEY INSTRUMENT WITH SUMMARY OF RESPONSES

FOR MAIL SURVEY OF INLAND BAYS' RESIDENTS

University of Delaware
Sea Grant Marine Advisory Service
700 Pilottown Rd.
Lewes, DE 19958-1298

Delaware Inland Bays Boating Study - 1991

The purpose of this survey is to collect information from persons residing on Delaware's Inland Bays, by asking about their boating experiences on the bays and their opinions about how the Inland Bays should be managed.

Some of the questions in this booklet will ask you about boating on the Inland Bays this past weekend. Please refer to your boating on the day indicated when answering these questions. If you did not use your boat on the date specified, please answer the questions with regard to your most recent boating experience.

PART I. YOUR BOATING EXPERIENCE

1. Is your home on the bay your principle residence or do you usually live somewhere else?

80% Permanent Resident

How long have you been a resident of the area? $\bar{X}$ = 18 Years

20% Usually live somewhere else

Where is your principal home residence
PA-35% DE-25%
MD-16% FL-8% State
— City or Town
— Zip Code

How many miles is it from your home residence to the Bays (one-way)?
$\bar{X}$ = 171 Miles

How long have you been visiting the area? $\bar{X}$ = 27 Years

2. How many boats do you keep at the Inland Bays? $\bar{X}$ = 1.4 Boats

3. Do you boat on the Inland Bays? (n=237) 82% Yes (n=53) 18% No

If "Yes", please continue

If "No", please go to Part II and complete that section only.

4. Please answer the following questions with regard to the boat that you use ***most often*** at the Inland Bays.
   a. What is the length of your boat? X̄ = 19 Feet
   b. What is the total horsepower of your engines? X̄ = 88 Hp.
   c. Which of the following best describes your boat? (%)

7 Cabin cruiser	- Jet ski
45 Runabout	28 Pontoon boat
1 Kayak/Canoe	2 Bass boat
7 Sailboat	- Sailboard
6 Row Boat	4 Other ______

5. How many years have you been a boater? X̄ = 26 Years

6. How would you rate yourself as a boater?

   6% Novice 32% Intermediate 46% Advanced 16% Expert

7. Including ***all*** the boating you did, how many days did you boat last year? X̄ = 55 Days

8. How many days did you boat on the Inland Bays last year? X̄ = 52 Days

9. Which of the following times do you ***typically*** use your boat on the Inland Bays? (Please check all that apply) % RESPONDING "YES"

   80 Weekdays 61 Weekends 35 Holidays

10. If the bays were ***less*** crowded, how would it affect your use of the bays? (Please check all that apply) % RESPONDING "YES"
    - 44 I would spend more time boating on the Inland Bays
    - 19 I would boat at different times than I usually do. (When ? Weekends - 62%, Weekdays - 14%)
    - 13 I would participate more frequently in certain boating activities (Please describe what activities) (n = 30) FISHING - 33% CRABBING - 27% WATERSKIING - 23%

11. If the bays were ***more*** crowded, how would it affect your use of the bays? (Please check all that apply) % RESPONDING "YES"
    - 59 I would spend less time boating on the inland bays
    - 17 I would boat at different times than I usually do. (When ? Weekdays - 35%, Weekends, EVENINGS, OFFSEASON - 12%)
    - 12 I would participate less frequently in certain boating activities (Please describe what activities) (n = 27) FISHING - 48% CRABBING - 19% WATERSKIING - 7%

PART II. INLAND BAYS ENVIRONMENTAL CONCERNS

1. During the last 10 years or since you have been visiting the area, do you think the environmental quality of the Inland Bays and tributaries and canals has been: (%)

15 improving	21 not changing very much
58 deteriorating	6 don't know, not sure

2. During the last 10 years or since you have been visiting the area, do you think the bay's living resources (fish, crabs, clams, etc.) have been: (%)

7 improving	18 not changing very much
71 deteriorating	4 don't know, not sure

3. Would you favor or oppose each of the following restrictions for the Inland Bays, canals and tributaries:

(%)

		Favor	Oppose	Not Sure
a.	Restrict the number of boat ramps	1-47	2-30	3-24
b.	Restrict the number of marinas	1-72	2-17	3-11
c.	Limit the number of boats using the bays, tributaries and canals	1-24	2-49	3-27
d.	Limit the size and power of boats using these waters	1-50	2-37	3-13
e.	Zoning the waters to provide for specific uses at specific places	1-50	2-34	3-16
f.	Stricter limits on the size and/or number of fish, crabs, clams and waterfowl that can be taken	1-77	2-16	3-7
g.	Restrictions on building and development	1-80	2-14	3-6
h.	Establish "Off Limits" zones to protect sensitive resources	1-83	2-9	3-8
i.	Prohibiting all discharges of pollutants into the water	1-96	2-2	3-3
j.	Restrict boat use in excessively shallow waters	1-46	2-33	3-21
k.	Require purchasing a seasonal boating use permit for bay use, if the money were used for bay improvement	1-46	2-45	3-9

NOTE: If you favor boating use permits, how much would you be willing to pay annually? $\bar{x}$ = $28 ; MODE: $25

4. Are there any other restrictions or management improvements you would suggest? (n = 159)
LIMIT JETSKIING - 16% INCREASE DREDGING - 12% INCREASE LAW ENFORCEMENT - 6%
BAN JETSKIING - 6%

If you currently boat on the Inland Bays, please continue to Part III.

If you do not, this concludes the survey, Thank you for your input!
Please return the completed form in the stamped, self addressed envelope provided.

APPENDIX H:

SURVEY INSTRUMENT WITH SUMMARY OF RESPONSES

FOR ON-SITE SURVEY OF SAILBOARDERS

Delaware Inland Bays
Boating Study - 1991
Sailboarding Version

Number ________
Location ________
Date ________
Start Time ________
Interviewer ________

Weather:	Skies: Sunny ___ Partly Cloudy ___ Cloudy ___ Rainy ___
	Winds: Light (0-7)___ Gentle (8-12) ___ Moderate (13-24) ___ Heavy(25+)___
	Waves: Calm ___ Light Chop ___ Heavy Chop ___ Whitecaps ___
	Temperature: ______ Tide:______

INTRODUCE YOURSELF, SAY: I am with the University of Delaware, College of Marine Studies. We are doing a study of boating and recreational water uses of the Inland Bays. Will you answer a few questions about your experience here today?

IF RESPONDENT REFUSES, SAY: My questions will take only 10-15 minutes. You were selected as part of a representative sample, so your answers are very important. Your answers are confidential and will only be reported as statistics.

IF RESPONDENT REFUSES AGAIN, SAY: Thank you, enjoy your visit.

IF RESPONDENT AGREES, CONTINUE: Thank you. So that the answers will be reliable, I need to read the questions exactly as they are written.

1. Are you staying in the local area? Yes 82% No 18% (if "no" go to #2) Location: ___—___

Are you a:

a. 4% Permanent, year round resident. # of Years $\bar{x}=2$
b. 22% Season Resident (Property owner)
# of years $\bar{x}=3$. Length of stay $\bar{x}=3$ days # visits per season $\bar{x}=15$
c. 74% Seasonal Renter or Visitor (Circle)
Condo, House, Apt., R.V./Camper, Motel, etc. (Circle)
# of years $\bar{x}=7.3$. Length of Stay $\bar{x}=4$ days

♦ What percentage of time during your stay (leisure time for resident) will be devoted to Bay related activities?
$\bar{x}=51$ %

2. Are you a day trip visitor? Yes 21% No 79%.

3. Where is your principal home residence?
MD-36% VA-25%
PA-18% DE-14%
___—___ (city)________ (state) ___—___ (zip)

4. About how many miles, one way, is it from your residence to this location?
$\bar{x}=119$ miles (check to see that mileage is one way).

5. How many years have you been a sailboarder?
$\bar{x}=4$ years.

6. How would you rate yourself as a sailboarder? (%)
1. Novice - 21 2. Intermediate - 62 3. Advanced - 17 4. Expert - 0

7. Besides sailboarding, do you participate in any other water related activities on the Inland Bays?
Yes 46% No 54% If yes, which activities? (n=13) SAILING-31% FISHING-23%

8. What is the total time you will spend at this sailboarding site today?
X̄ = 5 hours.

9. What time did you start sailboarding today? X̄=11:45 A.M. time.

10. What percentage of time will actually be spent on the water today?
X̄ = 52 %

-- if less than 100% ask-- What other activities will you participate in? (n=35)
RELAXING/RESTING-43% SUNBATHING-31% EATING-9%

11. How many days did you sailboard last year? X̄ = 25 days.

12. Out of those, how many days did you sailboard on the Inland Bays?
X̄ = 11 days.

13. On a scale of 1 to 10 (with 10 being the perfect day), how would you rate the quality of your sailboarding experience here today? X̄=6.7 rating.

REFER RESPONDENT TO THE MAP

14. On the map, please indicate the area in the Bay you sailboarded today.

15. Which areas of the bay did you MOST ENJOY? (Record these on the map with an "E".) (n=21)
Why did you enjoy these areas? BEST WIND-62% NOT CROWDED-24%

16. Which areas of the bay did you LEAST ENJOY today? (Record these on the map with an "L".) (n=8)
Why did you not enjoy these areas? SLUDGE-63% CURRENT TOO STRONG-13% TOO SHALLOW-13%

17. Were there any parts of the bay you deliberately AVOIDED today? (Record these on the map with an "A".) (n=21)
Why did you avoid these areas? SANDBAR-33% TOO MANY BOATS-10% TOO SHALLOW-10%

18. Using the crowding scale (refer to card), how would you describe the overall conditions (including other sailboarders and other watercraft) on the bays today? (%)

1-21	2-17	3-17	4-14	5-17	6-3	7-3	8-7	9-0
Not at all crowded		Slightly crowded			Moderately crowded			Extremely crowded X̄=3.5

19. Using the following enjoyment scale (refer to card), how did the number of other sailboarders impact your enjoyment of the days trip? (%)

1-7	2-14	3-14	4-14	5-48	6-3	7-0	8-0	9-0
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment X̄=3.5

20. Using the following enjoyment scale (refer to card), how did the number of boats/jet skis or other watercraft impact your enjoyment of the days trip? (%)

1-14	2-0	3-3	4-0	5-69	6-7	7-3	8-3	9-0
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

$\bar{x}$=4.6

21. While you were <u>on the bays</u> how often did you observe: (%)

	Never	Occasionally	Often	Very often
Discarded whole or pieces of plastic products	1-72	2-21	3-7	4-0
Discarded whole or pieces of glass containers	1-86	2-10	3-3	4-0
Discarded whole or pieces of metal containers	1-83	2-14	3-3	4-0
Discarded whole or pieces of paper products	1-66	2-28	3-7	4-0
Floating algae or plants	1-72	2-17	3-10	4-0
Dead fish, birds, or animals	1-72	2-14	3-10	4-3

22. Using the following enjoyment scale (refer to card), how did the amount of debris on the bay and the shore impact your enjoyment of the day's trip? (%)

1-10	2-7	3-3	4-0	5-59	6-14	7-3	8-0	9-3
Increased my enjoyment				No effect on my enjoyment				Reduced my enjoyment

$\bar{x}$=4.7

I am going to read some statements about sailboarding on the inland bays. Based on your experience here today, please rate your level of agreement or disagreement with each statement I read, using the final scale on the card.

	(%)				
23. I avoided my favorite parts of the bays because there were too many watercraft there	SD-28	D-66	U-7	A-0	SA-0
24. I thoroughly enjoyed my sailboarding trip today	SD-0	D-3	U-7	A-59	SA-31
25. Sailboarding has not been as enjoyable as I expected it to be today	SD-31	D-45	U-0	A-24	SA-0
26. There were an unsafe number of watercraft on the bays	SD-38	D-59	U-0	A-3	SA-0
27. I cannot imagine a better sailboarding trip	SD-10	D-45	U-10	A-28	SA-7
28. Other watercraft (including other sailboards) came closer to my board than I liked.	SD-17	D-72	U-3	A-7	SA-0
29. The noise of watercraft reduced my enjoyment on the bays	SD-21	D-62	U-0	A-17	SA-0

30. My sailboarding experience here today was well worth the money I spent to do it — SD-0 D-7 U-0 A-62 SA-31

31. There are adequate law enforcement patrols on the Inland Bays — SD-0 D-7 U-59 A-28 SA-7

32. Powerboat activities have negative environmental impacts on the bays — SD-0 D-3 U-10 A-55 SA-31

33. I was disappointed with some aspects of my sailboard trip today — SD-10 D-41 U-0 A-48 SA-0

34. The number of sailboards on the bays reduced my enjoyment — SD-21 D-76 U-0 A-3 SA-0

35. I nearly had an accident on the bays today because of crowded conditions — SD-31 D-62 U-0 A-7 SA-0

36. The behavior of others (all watercraft users) interfered with the quality of my sailboarding experience — SD-28 D-72 U-0 A-0 SA-0

IF RESPONDENT AGREES ------ Can you describe how the behavior of others interfered? ______

37. Sailboarding conditions on the bays were safe — SD-0 D-0 U-0 A-76 SA-24

38. Lack of public access limits my use of the Inland Bays — SD-21 D-48 U-14 A-14 SA-3

39. Did you observe any unsafe sailboarding situations on the bay today?
1. No 2. Yes NO-97% YES-3%

IF RESPONDENT ANSWERS 'YES'------Could you describe the unsafe situations you observed? (n=1)
SAILBOARDER WAS LOST

40. In the last 10 years (or since you've been visiting), do you think the environmental quality of the Inland bays, tributaries and canals has been: (%)

14 improving
17 deteriorating
28 not changing very much
41 don't know, not sure

41. In the last 10 years (or since you've been visiting), do you think the bay's living resources (fish, crabs, clams, etc.) have been: (%)

10 improving
38 deteriorating
0 not changing very much
52 don't know, not sure

42. Would you favor or oppose each of the following restrictions for the Inland Bays, tributaries, and canals?

(%)

	Favor	Oppose	Not sure
Restrict the number of boat ramps	1-66	2-7	3-28
Restrict the number of marinas	1-76	2-7	3-17
Limit the number of boats using the bays tributaries and canals	1-45	2-31	3-24
Limit the size and power of boats using these waters	1-83	2-14	3-3
Zoning the waters to provide for specific uses at specific places	1-79	2-21	3-0
Stricter limits on the size and/or number of fish, crabs, clams and waterfowl that can be taken	1-69	2-3	3-28
Restrictions on building and development	1-97	2-0	3-3
Establish "off-limits" zones to protect sensitive resources	1-100	2-0	3-0
Prohibiting all discharges of pollutants into the water	1-97	2-0	3-3
Require purchasing a seasonal boating/sailboarding use permit for bay use, (in addition to the parking permit at the state parks) if the money were used for bay improvement	1-45	2-45	3-10

If you favor the idea of permits, how much would you be willing to pay? $\bar{x}$ = $19

43. Are there any other restrictions you would favor? (n=8) PROTECT WETLANDS/CRITICAL AREAS SLOW DOWN SPEEDING BOATS

44. If sailboarding opportunities were not available on the Inland Bays, would you still (visit/live in) coastal Sussex county? Yes 52% No 48%

45. Do you have any suggestions for improved management of the Inland Bays? (n=28)
FRESHWATER BATHOUSE AT SAILBOARDING BEACH-11% CONTROL POLLUTION-7% CLEANER BEACHES-7%
PROVIDE RECYCLING BINS AT ACCESS POINTS-7%

THAT CONCLUDES OUR SURVEY, THANK YOU FOR YOUR TIME !

APPENDIX I:

MISCELLANEOUS MAIL SURVEY MATERIALS

University of Delaware

SEA GRANT COLLEGE PROGRAM
Marine Advisory Service
Cannon Laboratory
Marine Studies Complex
Lewes, Delaware 19958-1298

OFFICE: (302) 645-4235
FAX: (302) 645-4007

Summer 1991

Dear Delaware Inland Bays Resident/Visitor:

We are conducting a study of recreational boating on Delaware's Inland Bays. At the present time, little information is available concerning boating and its associated impacts on the Inland Bays. Management decisions need to consider you, the bay user--your experiences, insights, and opinions. Whether you are the owner of this property or a temporary occupant, your views are important. It is vital to the success of this study that we obtain your response to provide us with impressions and observations of activities on the bays this past weekend.

Please place your completed questionnaire in the enclosed postage-paid envelope and return it to us as quickly as possible. Any information you provide will be *strictly confidential*. Only statistical totals will ever be published. Each questionnaire has an identification number for mailing purposes only. When your questionnaire is returned to us, we will use the number to check your name off our mailing list so that you do not receive any further mailings. Your name will never be placed on the questionnaire or reported in any way.

If you would like a copy of a summary report when this study is completed, please write your name and address on a separate sheet of paper and enclose it in the return envelope along with your questionnaire, or send it separately if you wish.

Information from people, like yourself, is needed to determine how to manage the Inland Bays in the best manner possible. For this reason, we greatly appreciate your help and interest in this study.

Sincerely,

James M. Falk
Program Leader

Enclosure

Dear Delaware Inland Bays Resident/Visitor:

Last week a questionnaire seeking information on your use of the Delaware Inland Bays was mailed to you. If you have already completed and returned the questionnaire, please accept our sincere thanks. If not, please do so today.

We are seeking information from persons residing, permanently and seasonally on Delaware's Inland Bays, as well as boaters using the launch ramps and marinas on the Bays. If the results of the study are to accurately represent the views of all Bay users, it is extremely important that your responses be included.

Thanks again for your help and cooperation.

Sincerely,

James M. Falk
Marine Advisory Service Leader

University of Delaware

SEA GRANT COLLEGE PROGRAM
Marine Advisory Service
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Lewes, Delaware 19958-1298

OFFICE: (302) 645-4235
FAX: (302) 645-4007

Summer 1991

Dear Delaware Inland Bays Resident/Visitor:

About three weeks ago, we sent you a questionnaire about your boating experiences on Delaware's Inland Bays. If you have already completed your questionnaire, we thank you for your prompt response. If you have not completed the survey, would you please take the time to do so today? It should only take you about 15 minutes.

At the present time, little information is available concerning boating and its associated impacts on the Inland Bays. Management decisions need to consider you, the bay user--your experiences, insights, and opinions. Whether you are the owner of this property or a temporary occupant, your views are important.

We are writing to you again because if our results are to be as reliable and useful as possible, it is important that each questionnaire be completed and returned. Remember, all responses will be summarized and handled in strict confidentiality.

A copy of the questionnaire and reply envelope are enclosed in case you did not receive, or have misplaced, the original materials we sent to you. Once the survey has been completed, drop the envelope in any mailbox; you need not add any postage.

Your cooperation is greatly appreciated.

Sincerely,

James M. Falk
Program Leader

Enclosure