Recreational Use of the St. Croix Islands and Its Implications for the Integrity of Forest Island Ecosystems

by David G. Pitt, Diane C. Whited, and Michele Hanson

In 1972, Congress designated the Lower St. Croix National Scenic and Recreational Riverway in recognition of the outstanding national significance of the biological, physical, scenic, and recreational resources along the 52-mile corridor that extends from St. Croix Falls to the river’s confluence with the Mississippi River. The riverway is an important corridor for migratory waterfowl and songbird movement between Canada, northern Wisconsin, northern Minnesota, and the Gulf of Mexico. The water quality in the lower St. Croix River is good to excellent, and the river supports a diverse biota. In addition, the riverway contains many scenic landscapes and is prized as a setting for recreational boating.

The value of the Lower St. Croix Riverway is heightened by its proximity to one of the upper Midwest’s largest and most vital metropolitan areas. Located less than 20 miles from the State Capitol in St. Paul, the riverway’s pristine resources have become increasingly attractive and accessible to the region’s 2.97 million residents. Unfortunately, increased recreational use of the riverway threatens to undermine the viability of the biological, physical, scenic, and recreational resources that make the area a source of attraction. Symptoms of environmental degradation, including shoreline erosion and disruption of island ecosystems, have already begun to appear.

In response to anecdotal evidence of degradation resulting from increased recreational use, the National Park Service and the Lower St. Croix Management Commission have considered closing selected islands in the riverway to recreational use. However, the islands are publicly owned and have always been available for public use, so the boating public is not likely to change its perception or use of the islands without sufficient information to justify such regulations. To encourage compliance with such regulations, therefore, the park service and management commission require tangible information about patterns of recreational use of the islands and the consequences of this use for island ecosystems.

Although an interagency task force recently completed studies of the erosive impact of boat wakes and the transformation of island forest ecosystems on selected riverway islands, there have been no comprehensive surveys of island change and its relationship to changing patterns of recreational use of the riverway. The purpose of this study was to develop a better understanding of island change in the Lower St. Croix Riverway and relate these changes to changing patterns of recreational use. The Center for Urban and Regional Affairs provided financial support for this study through its Program for Interactive Research. In addition, the St. Croix National Wild and Scenic Riverway provided in-kind and technical support, and the Minnesota Department of Natural Resources and the Washington County Soil and Water Conservation District both provided technical support for our research.

Our investigation focused on a portion of the riverway located north of Stillwater (see Figure 1). Three sets of questions drove our research:

1. Have the islands in the Lower St. Croix Riverway changed in size? If so, how have the changes in island size affected the structure of vegetative communities on the islands, and how do the patterns of change in size and structure correspond with the location of the islands in the riverway?
2. Have patterns of recreational boating in the waters near the islands changed? Have patterns of island use changed? If so, how do these patterns relate to the location of the islands in the riverway?
3. How are changing patterns of recreational boating and island use related to changes in the size and structure of the islands? How are these relationships affected by the location of the islands in the riverway?
The first section of this article describes in more detail the recreational uses of the Lower St. Croix Riverway. Subsequent sections address in turn each of the research questions listed above, defining the methods used to answer the question as well as the findings that emanated from the investigation. Finally, the article concludes with a series of recommendations for managing the resources of the riverway.

Recreational Uses of the Lower St. Croix Riverway

The Lower St. Croix Riverway extends from the Excel Energy dam at St. Croix Falls to the river’s confluence with the Mississippi River at Prescott, Wisconsin, and includes the river and its associated floodplain and bluff areas. The riverway contains more than 227 islands comprised of sandbars, wetlands, or bottomland forests. Collectively, the islands account for 2,165 of the 44,255 acres of land and water within the riverway. More than 95% of these islands are located north of Stillwater.

The National Park Service and other management agencies currently permit recreational use of the islands by the public. Except where such activity is prohibited, the public can anchor and land boats on the islands, as well as camp overnight. On warm weekend afternoons, it is not unusual to find boats landed or anchored two rows deep at more popular islands. Activities associated with island use include operating boats near island shorelines, landing or anchoring boats at islands, swimming, fishing, picnicking, and camping. Overnight campers often pitch tents along the shoreline and enjoy campfires and other social gatherings. It is not uncommon for island visitors to establish a campsite on an island that will serve as a base of operation in the riverway for several days.

The Apple River is a major tributary of the St. Croix River in Wisconsin. The confluence of these two rivers created the Arcola Sandbar, an extensive area of shallow water. The Arcola Sandbar effectively separates recreational use patterns on the riverway into two zones. Below the sandbar there are few posted speed limits, so travel speeds and the size of boat wakes vary considerably. In addition, many types of vessels—including runabouts, cruisers, fishing boats, and canoes—can navigate this segment of the river. Shoals at the sandbar prevent deeper draft vessels from traveling upstream, where boating is confined primarily to fishing boats, pontoon boats, and canoes. In addition, the National Park Service prohibits travel between the lower and upper reaches of the riverway as a means of preventing the upstream spread of zebra mussels, an exotic species that threatens the stability of native mussel species. In the upper segment of the riverway, travel speeds are restricted by narrower and shallower channels, as well as by the lower propulsion characteristic of smaller boats.
As more and more boaters are attracted to the riverway, the result is a greater number of boats traveling at faster speeds. This produces larger boat wakes close to shoreline environments, which can accelerate shoreline erosion and threaten fragile shoreline ecosystems. Consistent with the type and speed of vessels in use in the upper and lower segments of the riverway, anecdotal evidence suggests that shoreline erosion and changes in island morphology have been greater on islands below the Arcola Sandbar.

Changes in the Size and Structure of the St. Croix Islands

Measuring Changes in Forest Area.
The islands of the St. Croix River (see Figure 1) are comprised of channel bars and point bars whose position and structure are constantly changing. Determining which of these changes are attributable to naturally occurring geologic processes and which are attributable to human disturbance (e.g., recreational use) is difficult.

Island forest vegetation is a reliable measure of island ecosystem structure, particularly in so-called variable-flow systems where the water level changes frequently. The St. Croix River is a variable-flow system because regulated discharges of water from hydroelectric facilities upstream constantly affect the water level. Island forest vegetation is generally tall enough to indicate ecosystem structure regardless of river flow, and is able to persist through a variety of flow regimes. Changes in forest structure, therefore, can be used as indicators of longer term trends in island size and structure. The presence of island forest communities at any point in time is readily detected through aerial photographic reconnaissance. Similarly, changes in island forest structure can be discerned by comparing island forest composition and dispersion at one point in time with composition and dispersion at a subsequent point in time.

Aerial photographs of the area between the Boomsite near Stillwater and the Soo Line Swing Bridge at a scale of 1:12,000 were used to differentiate water and wetland vegetation from forest vegetation on islands in the study area for the years 1969 and 1991. Patches or polygons of forest vegetation in the study area were identified on the aerial photographs and stored in an ArcInfo geographic information system (GIS) database. A GIS database permits the storage, retrieval, analysis, and display of geographic information—such as the location of island forest vegetation—in a computer-assisted mapping system. The locations of forest polygons were linked with specific islands as defined on seven-and-a-half-minute U.S. Geological Survey (USGS) topographic quadrangles of the riverway. Topographic quadrangles, which are available for the entire state, show toposgraphy, land cover, transportation, and other human settlement patterns at a scale where 1 inch on the map equals 2,000 feet in the landscape. Figure 2 illustrates the distribution of island forest-area change that occurred between 1969 and 1991 in the vicinity of Mile Long Island and Pillar Island, immediately upstream of Stillwater.

The forest patches were stratified on the basis of two criteria: (1) their location relative to the Arcola Sandbar (i.e., above or below the sandbar) and (2) the relationship of their area relative to the median area of all forest polygons within the respective location zones (i.e., larger or smaller than the area that divides the distribution of patch area in half). Changes in forest-patch area were tabulated based on location relative to the sandbar as well as relative to median area of forest polygons. These results were also displayed in map format. Such an analysis permits an understanding of forest change on the islands of the riverway in terms of where the changes occurred, as well as the size of forest patches that experienced the greatest amount of change.

Findings. In 1969, there was significantly more total forest area on all of the islands above the Arcola Sandbar than there was on the islands below the sandbar. Table 1 presents change in overall forest area among the St. Croix islands between 1969 and 1991. Forest patches located above the Arcola Sandbar, regardless of their initial size in 1969, gained area. Patches of all sizes located below the sandbar lost area. Mean (average) forest-patch area on islands above the sandbar increased between 1969 and 1991. Mean forest area on islands below the sandbar, regardless of their initial size in 1969, declined. In addition, the number of forest patches located above the sandbar decreased between 1969 and 1991. Below the sandbar, the number of forest patches increased. This is because patches of forest on islands above the sandbar are expanding and becoming connected in such a way that the average area of forest patches is increasing while the total number of individual or isolated patches is decreasing. In contrast, forest area on islands below the sandbar is becoming fragmented into a larger number of patches of smaller size. The rates of forest-patch connection north of the sandbar and forest-patch fragmentation south of the sandbar are higher for smaller forest patches than they are for larger patches. However, south of the sandbar, the rate of fragmentation for smaller patches is almost three times that of larger patches.
Changes in Recreational Boating on the St. Croix River and Islands

Aerial Photographic Reconnaissance of Changes in Recreational Boating. Attempts to associate changes in island size and structure with changes in the pattern of recreational boating on the St. Croix River would ideally use information on these two phenomena gathered during the same time period. For this study, we were unable to obtain data for both of these phenomena from the same time period. However, the Minnesota-Wisconsin Boundary Area Commission (MWBAC) gathered aerial photography of the entire river every two years for the purposes of performing a boat census. This imagery is at a scale of approximately 1:8,000, which permits interpretation of vessel type and activity. The earliest year for which this photography was available was 1980. To gain maximum time interval between years of photography, the 1980 imagery was compared with similar imagery from 1995, the last year for which complete imagery was available at the time this study was undertaken.

The aerial photographs from 1980 were digitized and interpreted to determine the spatial position and characteristics of all vessels on the water surface during 10 days throughout the boating season. Photographs selected for inclusion were taken on both weekdays and weekends in the morning and afternoon. Use characteristics gathered from the photographs included type of vessel; whether the vessel was moving; and characteristics of the mooring, slip, or beaching if the vessel was not moving. The photographs from 1995 were similarly digitized and interpreted to inventory vessels on the water surface during 10 days comparable to those examined for 1980. The boating-use data for both years were digitized and interpreted using the same island base map used to record forest vegetation changes between 1969 and 1991.

Weather has an obvious influence on boaters’ decisions to use the river. Ideally, the weather on days selected for sampling from the 1995 photographs should have matched the weather on days selected for 1980. However, given the relatively small number of days for which photographs were available (19 days for 1980 and 15 days for 1995) and our desire to match the time of day, day of week, and week in season for photographs from these two years, controlling for weather conditions in our photograph sample was not possible.

A near-island buffer zone was defined as a distance of 164 feet (50 meters) from the shoreline of each island. Boats in the buffer zone were counted and characterized in terms of vessel type and vessel activity. A grid with 164-foot-by-164-foot cells was superimposed on the photographs. We tabulated changes in the number of boats that appeared within each 0.62-acre grid cell between 1980 and 1995. This tabulation included moving boats, as well as stationary boats that were not beached on an island. Finally, we tabulated and compared the number of boats beached on each island during the two years.

Findings. Findings related to changes in the nature and distribution of boats observed on the water surface of the lower St. Croix and on the St. Croix islands are reported below.

Changes in the Nature and Distribution of Boats Observed on Water Surface. Table 2 illustrates that the number of boats observed during the 10 days examined in 1980 was 5,896, compared with 5,038 boats observed during a comparable period in 1995. This represents a 15% decrease in the total number of boats observed between 1980 and 1995.

Among the various vessel types observed in the Lower St. Croix Riverway, the greatest decline in use between 1980 and 1995 occurred for...
Table 2. Changes in Vessel Types Observed on Islands and on Water Surface between 1980 and 1995

<table>
<thead>
<tr>
<th>Vessel type</th>
<th>Pct. total vessels on island</th>
<th>Vessels moving on water surface</th>
<th>Pct. total vessels on island</th>
<th>Vessels moving on water surface</th>
<th>Pct. change in vessels 1980–1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canoe</td>
<td>45.05</td>
<td>292</td>
<td>33.45</td>
<td>2263</td>
<td>-14.6</td>
</tr>
<tr>
<td>Fishing</td>
<td>9.91</td>
<td>49</td>
<td>5.61</td>
<td>498</td>
<td>0.0</td>
</tr>
<tr>
<td>Runabout</td>
<td>5.16</td>
<td>119</td>
<td>13.63</td>
<td>259</td>
<td>1.3</td>
</tr>
<tr>
<td>Cruiser</td>
<td>11.55</td>
<td>79</td>
<td>9.05</td>
<td>580</td>
<td>12.8</td>
</tr>
<tr>
<td>Pontoon</td>
<td>26.50</td>
<td>310</td>
<td>35.51</td>
<td>1331</td>
<td>2.4</td>
</tr>
<tr>
<td>Other</td>
<td>1.83</td>
<td>24</td>
<td>2.75</td>
<td>92</td>
<td>4.5</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>873</td>
<td>100.00</td>
<td>5023</td>
<td>-14.6</td>
</tr>
</tbody>
</table>

The decline in canoe and fishing boat use was uniform throughout the riverway. Increased runabout use was most evident in the reaches north of Marine-on-St. Croix, while increased cruiser use was greatest between the Boomsite and Pillar Island and between the Arcola Sandbar and Marine-on-St. Croix. The increase in pontoon boat use was generally restricted to those portions of the riverway above the Arcola Sandbar. Across all vessel types, the number of observed boats increased between 1980 and 1995 only for the reaches between the Arcola Sandbar and Marine-on-St. Croix. The reaches located above Marine-on-St. Croix experienced large declines in the number of boats observed.

Changes in the Nature and Distribution of Boats Observed in Areas Near Islands: There was a corresponding decline between 1980 and 1995 in the number of boats observed in the near-island buffer zone around islands in the study area. This decline was more dramatic for the islands above the Arcola Sandbar than it was for islands below the sandbar. Larger islands also experienced greater reductions in boat numbers than did smaller islands.

Changes in the Nature and Distribution of Boats Observed on Islands: The data in Table 2 also illustrate that the percentage of total vessels beached on an island declined from 15% in 1980 to 10% in 1995. Whereas canoes accounted for 33% of all vessels observed on the islands in 1980, this number declined to 24% in 1995. Similarly, the percentage of pontoon boats declined slightly from 36 to 32% during the same time period. The percentage of runabouts increased from 14% of all beached vessels in 1980 to 20% in 1995, while cruisers increased from 9% in 1980 to 13% in 1995.

Significant declines in the percentage of all beached vessels in the riverway occurred in the lowest reach of the river between the Boomsite at Stillwater and Pillar Island. The percentage of boats beached on islands above Cedar Bend also declined between 1980 and 1995. In contrast, the percentage of beached vessels that were located on islands between Pillar Island and the Wisconsin Central Railroad High Bridge increased significantly, and increases also occurred on islands between the High Bridge and the Arcola Sandbar, between the Science Museum of Minnesota St. Croix Watershed Research Station and Marine-on-St. Croix, and between the Soo Line Swing Bridge and Cedar Bend.

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Island use by canoes declined throughout the riverway except in the reach between the High Bridge and the Arcola Sandbar. Similarly, island use by fishing boats declined throughout the riverway except between the Sool Line Swing Bridge and Osceola. Increases in island use by runabouts occurred in the reach between Pillar Island and the High Bridge, and throughout the riverway above the Arcola Sandbar. Increased use of islands by cruisers occurred from the Boom Site to Pillar Island, and between the High Bridge and Marine-on-St. Croix. Increased island use by pontoon boats occurred throughout the riverway above the Arcola Sandbar.

The decline in the number of boats beached on smaller islands between 1980 and 1995 was significantly less than the change in number of boats beached on the larger islands. However, the decline in the number of boats beached on islands above the Arcola Sandbar was not significantly different than the decline in boats beached on the islands below the sandbar.

Correlation of Forest Changes with Recreational Boating Changes

Methods: Changes in island forest vegetation between 1969 and 1991 were compared with changes in boating use in the 164-foot buffer zone around the islands between 1980 and 1995. Relationships between changes in total forest area and changes in the number of boats, the number of different vessel types, and the incidence of vessel activity were examined using correlation and regression analysis. The islands that contained forest patches in 1969 were divided into two classes: those above the Arcola Sandbar and those below the sandbar. Within these two geographic regions, the islands were further divided between those that had a total forest area in 1969 above the median forest area and those that had a total forest area below the median forest area. Among the islands in these four classes, 21 were randomly selected for analysis.

The following forest polygon variables were included in this analysis for each island studied:

1. the total area of forest in 1969
2. the size of the 1969 total forest area relative to the median forest area of islands of similar size (those larger than or smaller than the median island size)
3. the total area of forest in 1991
4. the change in forest area between 1969 and 1991
5. location relative to the Arcola Sandbar (either above or below the sandbar)
The following variables describing change in recreational boating patterns were included in this analysis:

1. the change between 1980 and 1995 in the number of boats that were beached on each island
2. the change between 1980 and 1995 in the number of moving boats observed within 164 feet (50 meters) of each island
3. the change between 1980 and 1995 in the number of boats observed within 164 feet (50 meters) of each island
4. the change between 1980 and 1995 in the number of boats observed within 164 feet (50 meters) of each island
5. the change between 1980 and 1995 in the number of boats observed within 164 feet (50 meters) of each island
6. the change between 1980 and 1995 in the number of boats observed within 164 feet (50 meters) of each island
7. the change between 1980 and 1995 in the number of boats observed within 164 feet (50 meters) of each island

Pearson correlation coefficients were calculated to examine the relationship between these eight variables. An increase in the magnitude of the coefficients indicates an increase in the strength of the relationship between two variables, while the sign of the coefficient indicates the direction of the relationship between the variables. Coefficients preceded by a minus sign indicate inverse relationships, while a plus sign (implied by the absence of a sign) indicates a direct relationship. Coefficients exceeding 0.20 have a statistical probability of occurring strictly through random chance less than 5 times in 100, while coefficients exceeding 0.25 will occur through random chance less than 1 time in 100.

Multiple regression analysis was also used to gain a better understanding of how the changes in forest area that occurred on the islands between 1969 and 1991 were related to other measures of forest structure and changes in boating-use patterns. The change in island forest area was considered a dependent variable in this analysis, while the other seven variables were considered independent variables. All seven of the independent variables were initially included in the regression equation. A reverse step-wise procedure was used to remove independent variables from consideration until only those variables that contributed significantly to explaining the dependent variable remained. The R² statistic (known as the coefficient of determination) describes the strength of the regression function. The percentage of the variability in the dependent variable (i.e., change in island forest area) that can be explained by variability in the independent variables is indicated by multiplying the R² statistic by 100%. The beta weights of the independent variables provide an indication of the relative importance of each variable in explaining variability in the dependent variable.

**Findings.** Table 3 lists correlation coefficients, which indicate the strength of the relationships among the eight variables. As expected, strong and direct relationships exist between the change in forest area that occurred between 1969 and 1991, the island forest area that existed in 1969, and the island area that existed in 1991. Islands in the upper 50th percentile of island area in 1969 increased in area and islands that were farther north of the equator tended to gain additional island forest area between 1969 and 1991. Similarly, the magnitude of the increase in forest area among islands located above the Arcola Sandbar was significantly larger than the magnitude of the decrease in forest area among islands located below the sandbar. These findings suggest that the increase in area occurring among large forest patches located above the Arcola Sandbar was more significant than were the losses in area occurring among large forest patches below the sandbar.

The change in the number of boats observed on the islands between 1969 and 1991 was not significantly related to changes that occurred in the islands’ forest area. Similarly, the change in the number of boats observed on the islands was not significantly related to the change in the number of boats observed within 50 meters of the islands. However, as the number of boats observed within 50 meters of an island increased, the forest area on the island declined. This finding would suggest that the presence of boaters on the islands per se did not result in forest decline. Rather, forest decline appears to be more directly related to the presence of boat wakes and other disturbances associated with boats traveling near the islands.

The lack of a significant relationship between the number of boats observed on the islands and the number of moving boats near the islands also suggests the location of island use was separate from the location of boats using the water surface. In other words, although island users obviously have to use the water surface to reach their destinations, the location of their on-island experiences did not necessarily coincide with the location of their activities on the water surface. This pattern is further reinforced by the findings that island use increased the further north an island was located, while islands below the Arcola Sandbar and those located further south experienced increasing numbers of boats within 50 meters of their shorelines. The islands receiving most intensive use can be viewed as destinations. Travel from boat slips or launch ramps to the heavily used islands causes boaters to navigate past intervening islands that receive less

### Table 3. Correlation among Forest-Area Change Measures and Boating Change Measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Change foresta</th>
<th>Isl locationb</th>
<th>Isl sizec</th>
<th>Area 1991a</th>
<th>Area 1969a</th>
<th>North posd</th>
<th>Beachinga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in island forest area (Change forest)</td>
<td>-0.26</td>
<td>0.20</td>
<td>0.77</td>
<td>0.63</td>
<td>0.23</td>
<td>-0.11</td>
<td>-0.23</td>
</tr>
<tr>
<td>Island location (Isl location)b</td>
<td>-0.26</td>
<td>0.20</td>
<td>0.77</td>
<td>0.63</td>
<td>0.23</td>
<td>-0.11</td>
<td>-0.23</td>
</tr>
<tr>
<td>Island size (Isl size)c</td>
<td>0.20</td>
<td>0.00</td>
<td>-0.25</td>
<td>-0.22</td>
<td>-0.81</td>
<td>-0.12</td>
<td>0.21</td>
</tr>
<tr>
<td>Island forest area 1991 (Area 1991)</td>
<td>0.77</td>
<td>-0.25</td>
<td>0.39</td>
<td>0.41</td>
<td>-0.18</td>
<td>-0.12</td>
<td>-0.53</td>
</tr>
<tr>
<td>Island forest area 1969 (Area 1969)</td>
<td>0.63</td>
<td>-0.22</td>
<td>0.98</td>
<td>0.34</td>
<td>-0.17</td>
<td>-0.18</td>
<td>-0.58</td>
</tr>
<tr>
<td>Northerly position on river (North pos)d</td>
<td>0.23</td>
<td>-0.81</td>
<td>0.04</td>
<td>0.34</td>
<td>-0.17</td>
<td>-0.18</td>
<td>-0.39</td>
</tr>
<tr>
<td>Change in number of boats moving w/in 30 m. of island (Moving)</td>
<td>-0.11</td>
<td>-0.12</td>
<td>-0.18</td>
<td>-0.53</td>
<td>-0.58</td>
<td>-0.39</td>
<td>0.17</td>
</tr>
</tbody>
</table>

aValues above 0.02 are significant at p < .05; values above 0.25 are significant at p < .01.
ibIslands above the Arcola Sandbar = 1; islands below the Arcola Sandbar = 2.
cIslands smaller than the median = 1; islands larger than the median = 2.
dNortherly position is measured in meters north of the equator.
on-island use but more near-island water surface use. To the extent that the islands boaters traveled past en route to a final destination are smaller islands located south of the Arcola Sandbar, a synthesis of the findings in Table 3 and Table 1 suggests that these islands are more likely to be eroded by wakes from boats traveling within 164 feet of the shoreline.

Table 4 presents results of the multiple regression analysis. The most significant independent variables in terms of explaining changes in island forest area between 1969 and 1991 were total island area in 1969 and the change in the number of moving boats within 164 feet of the islands between 1980 and 1995. Together, these two variables accounted for 41% of the variability in the dependent variable. A comparison of the beta weights for the two independent variables suggests that island area in 1969 was slightly more than three times as important as was change in the number of moving boats in explaining the changes in island forest area.

**Conclusions and Management Implications**

Changes are occurring in the size and structure of islands in the Lower St. Croix National Scenic and Recreational Riverway, but there seem to be two different patterns of change occurring depending on where the island is located in the riverway. Above the Arcola Sandbar, the islands appear to be increasing in size and agglomerating (i.e., merging together). Evidence for these inferences includes an increase in total forest area as well as mean forest polygon area and a decrease in the number of forest polygons. Below the sandbar, the islands appear to be decreasing in size and becoming more fragmented. In both segments of the riverway, the changes are more pronounced for smaller islands. Thus, smaller islands above the sandbar are increasing in size more rapidly than their larger counterparts. In contrast, smaller islands below the sandbar are losing area more rapidly than larger islands.

The recreational boating factor most prominently associated with island forest-area decline between 1969 and 1991 was the change in the number of boats observed within 164 feet of an island, especially when these islands were smaller in size and located below the Arcola Sandbar. Little evidence exists to link island forest decline with actual island use by boaters. Island use on the smaller islands has declined, and there is no statistical relationship between island use and change in the area of island forest patches. Island use tended to move north during the period between 1969 and 1991 into a portion of the river where an increase in island forest area was observed. Intense island use in 1969 in the zone between the Boomsite and Pillar Island moved north into the zone between Pillar Island and the High Bridge. Other relatively large increases in island use occurred between the Science Museum and Marine-on-St. Croix, as well as between the Swing Bridge and Cedar Bend.

These findings and inferences suggest that managing the flow of boats on the water surface rather than restricting island use by recreational boaters will better protect the island forest communities. A potentially useful management tool to stem further fragmentation of island forest area would be to institute policies that prohibit or restrict recreational boating in areas containing small-island forest patches, especially in the portion of the St. Croix River located below the Arcola Sandbar. Given the heritage of the river as a common public resource, it might be most feasible to initiate speed restrictions in areas located near these smaller forest patches rather than attempt outright prohibition of river channel or on-island use. Speed restrictions are currently imposed to manage boat congestion in areas where surface water densities are less than 10 acres of water surface area per moving boat.

Failure to manage boat traffic in the vicinity of smaller islands south of the Arcola Sandbar may lead to the demise of these riverway resources. The presence of boats within 164 feet of these islands is related to accelerated rates of erosion when compared with larger islands in the same location. If existing conditions continue, it is likely that smaller islands in the riverway between Stillwater and the Arcola Sandbar will continue to decrease in size. Larger islands may also become fragmented into smaller islands, which may in turn succumb to further and more accelerated erosion.

Several factors suggest that reductions in boat speed may be difficult to attain through regulatory approaches alone. It would be difficult to bar the public from using the approximately 26 miles of river between Stillwater and Taylor’s Falls. Furthermore, the high propulsion of many contemporary vessels and the natural desire to explore diverse segments of the riverway mean that boaters will disperse themselves throughout the riverway.

Because of these factors, it may be useful to couple the posting of speed limits in narrow channels near smaller islands in the southern reaches of the riverway and increased enforcement efforts with boater education programs. By providing boaters with graphic images of the shoreline damage caused by boat wakes and by identifying the geographic specificity of the problems with respect to smaller islands located south of the Arcola Sandbar, it may be possible to coax boaters into more environmentally friendly behavior. Such educational efforts might include interpretative signage at public boat ramps and private marinas, as well as leaflets distributed in boater registration renewal packets for boaters in the Twin Cities metropolitan area. One survey suggests that 84% of metro area boaters support restricting speeds of travel.1 Targeting educational efforts to specific groups operating boats in specific locales may prove effective in stemming the rate of island erosion in the Lower St. Croix National Scenic and Recreational Riverway.

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### Table 4. Regression of Change in Forest Area (1969–1991) on Island Area (1969) and Change in Moving Boats (1980–1995)

<table>
<thead>
<tr>
<th>Variable entered</th>
<th>Regression coefficient</th>
<th>Beta weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Island area 1969</td>
<td>0.24</td>
<td>0.75</td>
</tr>
<tr>
<td>Change in number of moving boats within 164 feet of island, 1980–1995</td>
<td>600.23</td>
<td>0.2</td>
</tr>
<tr>
<td>Constant</td>
<td>-1402.83</td>
<td></td>
</tr>
</tbody>
</table>

Note: $F = 30.38$, $p < .000$, and adjusted $R^2 = 0.41$. 

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David G. Pitt is a professor in the Department of Landscape Architecture at the University of Minnesota. He has used GIS analysis to examine various dimensions of recreational use of the Lower St. Croix National Scenic and Recreational Riverway and its impact on environmental quality and scenic value. Diane C. Whited is research associate at the Flathead Lake Biological Station at the University of Montana in Polson, Montana. Throughout much of this study, Diane was a research assistant and research fellow in the Department of Landscape Architecture at the University of Minnesota. She is currently applying GIS and remote sensing technologies to the investigation of riverine habitats within the Columbia Basin. Michele Hanson is currently community assistance coordinator for the Metropolitan Region Watershed Initiative at the Minnesota Department of Natural Resources. While working on this project, she was a graduate research assistant in the Department of Landscape Architecture.

CURA’s Web Site Offers Many Useful Resources

The recently redesigned CURA Web site provides a wealth of information about public policy issues and events in Minnesota. In addition to information about current CURA programs and projects, our Web site includes the following handy resources:

- A searchable catalog of more than 1,700 publications available free of charge from CURA. You can use this resource to locate publications by author, title, or keyword, and you can even order publications online.

- A searchable database of nonprofit organizations of color in Minnesota. This Web-based version of one of CURA’s most popular print publications allows visitors to locate organizations that serve people of color by keyword, population served, and major activity areas. Visitors also have the ability to make customized mailing labels based on their search results.

- A calendar of CURA-sponsored and CURA-related events. Each year, CURA sponsors special events on public policy issues of particular concern to the people of Minnesota. In addition, the monthly CURA Housing Forum offers a discussion of housing issues and research in the Twin Cities metropolitan area.

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