Purpose
As part of its stewardship and operational responsibilities, the Tennessee Valley Authority (TVA) administers the 26a (under the TVA Act) permitting process and inventories recreational developments along Tennessee Valley streams, rivers, and reservoirs. TVA operates the Tennessee River system based on an integrated method that balances recreation with other demands on the system. TVA does not regulate boating. The U.S. Coast Guard and the Valley states have established recreational boating regulations for public waterways located within their borders. The purposes of this report are (1) to compare approaches and findings of recreational boating capacity studies completed by TVA, federal and state agencies, and investor-owned utilities and (2) to describe an inexpensive, quick assessment method for estimating cumulative impacts to recreational boating.

Introduction
Increasingly, shoreline managers/owners, permitting agencies, and state boating law administrators are asked to provide carrying capacity and cumulative impact analyses of recreational boating densities. The densities are not only those seen under current conditions, but also densities predicted when boat storage and boat access are added to current conditions. Reservoir users and residents often express concern that TVA reservoirs are becoming overcrowded. TVA seeks to address perceived overcrowding by using the assessment method, or tool, described in this document. Depending on the action that TVA is considering approving or taking—such as the approval of boat ramps, marinas, and community docks that have multiple parking spaces or boat slips—understanding potential cumulative boating impacts in more detail may be desirable. This paper provides a methodology for doing this.

Landmark Research
Four sources are universally referenced to support boating density and recreational boat carrying capacity analyses concerning waterway and shoreline management. These include:

- Guidelines for Understanding and Determining Optimum Recreation Carrying Capacity (U.S. Department of the Interior, Bureau of Outdoor Recreation [BOR], 1977)
• Parks, Recreation, and Open Space Guidelines (National Recreation and Parks Association [NRPA] 1981)

• Management of Aquatic Recreation Resources (Warren and Rea 1989)


A common term used in boat carrying capacity studies is “surface acres.” This term refers to the surface area (or acres of a water body) that is available to boaters. The total surface area of a water body is usually not available to boaters. Boating capacity analysts review the layout of the water body and deduct land that is not available to users, such as islands or restricted areas. That estimate of water body surface area available to boaters becomes the “acres,” “surface acres,” “effective boating area,” or “usable surface acres” value in calculations of boat carrying capacity. The surface acres available to boaters are never greater than the total surface acres of the water body. Table 1 shows the standard boating density (acres/boat) from these four sources. WROS is the most recent of the recreational carrying capacity management methodologies.

<table>
<thead>
<tr>
<th>Source</th>
<th>Standard (Acres per Boat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bureau of Outdoor Recreation (BOR)</td>
<td>3-18</td>
</tr>
<tr>
<td>National Recreation and Parks Association (NRPA)</td>
<td>4</td>
</tr>
<tr>
<td>Warren and Rea</td>
<td>1.3-12</td>
</tr>
<tr>
<td>Bureau of Reclamation (WROS)</td>
<td>1-3,200</td>
</tr>
</tbody>
</table>

Table 1. Recreational Boat Carrying Capacity Standards and References

Table 2 lists the WROS classification system and each setting’s associated summary of recreation experiences and boating density standards. WROS provides the framework for inventorying water-based recreational activities in order to classify waterways into six zones or management compartments. WROS is a planning tool (methodology), based on the standard of quality for the overall biophysical and social inventory of the waterway and/or zone, and aids in managing recreation experiences compatible in defined zones. Zones may be combined/blended to more accurately define the overall character and nature of the waterway being assessed and classified (e.g., Urban-Suburban or Suburban-Rural Developed), thus creating five additional combined/blended zones for a total of 11 zones. The WROS approach provides a means to define transitional areas as they become more developed and/or use increases. Most TVA reservoirs are currently in the “Rural Developed” to “Urban” classifications and are shifting toward the “Suburban” to “Urban” classifications as development increases.

Results from carrying capacity and boating density assessments are dependent on a number of parameters, including the following:

• Usable surface acres
• Numbers of boats stored and vehicle-trailer parking spaces at boat ramps
• Numbers of watercraft in use on the water at one time
• Spatial requirements of each type of boating activity
• Spatial distributions of each type of watercraft
• Percentage of watercraft (by type) in the boating mix
• Social perceptions and tolerances of perceived crowding
### Table 2. Water Recreation Opportunity Spectrum Classification Summary and Associated Boating Density Standards

<table>
<thead>
<tr>
<th>Setting (Classification)</th>
<th>Generalized Description Summary of the Recreation Experiences by WROS Class</th>
<th>Standard (Acres per Boat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>Limited opportunities to see, hear, or smell the natural resources exist due to the extensive level of development, human activity, and natural resource modification. Meeting other visitors is expected, and socializing with family and friends is important. There is probability for a diverse range of visitors and activities, including groups and special events. Convenience is central and dominant.</td>
<td>1-10</td>
</tr>
<tr>
<td>Suburban</td>
<td>Limited or rare opportunities to see, hear, or smell the natural resources exist due to the widespread and prevalent level of development, human activity, and natural resource modification. Meeting other visitors is expected, and socializing with family and friends is important. There is probability for a diverse range of visitors and activities. Convenience is central and dominant.</td>
<td>10-20</td>
</tr>
<tr>
<td>Rural Developed</td>
<td>Occasional or periodic opportunities to see, hear, or smell the natural resources exist due to the common and frequent level of development, human activity, and natural resource modification. Brief periods of solitude are likely, although the presence of other visitors is expected. There is probability for a diverse range of visitors and activities. Moderate levels of comfort and convenience are expected.</td>
<td>20-50</td>
</tr>
<tr>
<td>Rural Natural</td>
<td>Frequent opportunities exist to see, hear, or smell the natural resources due to an occasional or periodic level of development, human activity, and natural resource modification. Independence and freedom with a moderate level of management presence are important. There is probability for a diverse range of visitors and activities, although experiences tend to be more resource-dependent. Comfort and convenience are not important or expected.</td>
<td>50-110</td>
</tr>
<tr>
<td>Semiprimitive</td>
<td>Widespread and prevalent opportunities exist to see, hear, or smell the natural resources due to a rare or minor level of development, human activity, and natural resource modification. Solitude through the lack of contact with other visitors and managers is important. Opportunities exist for more adventure-based enthusiasts and overnight visitors. Sensations of challenge, adventure, risk, and self-reliance are important.</td>
<td>110-480</td>
</tr>
<tr>
<td>Primitive</td>
<td>Extensive opportunities abound to see, hear, or smell the natural resources due to the rare and very minor level of development, human activity, and natural resource modification. Solitude and lack of the site, sound, and smells of others are important. Opportunities are plentiful for human-powered activities (e.g., canoeing, fly-fishing, backpacking, etc.). Sensations of solitude, peacefulness, tranquility, challenge, adventure, risk, testing skills, orienteering, and self-reliance are important.</td>
<td>480-3,200</td>
</tr>
</tbody>
</table>

Source: WROS 2004
The TFBCS had two additional purposes as well:

(1) To examine methodological approaches for determining boating density and water-based carrying capacity for lakes/reservoirs

(2) To analyze current boat storage, boat access, and boating use data as surrogate measures for determining the on-water boating densities and recreational boat carrying capacity for Tims Ford Reservoir

The TFLP, reviewed by staff from TVA, Tennessee Department of Environment and Conservation, and TWRA, determined that boating densities on TFR would range from 6.1 to 7.8 surface acres per boat at build-out. Recent reports on the following reservoirs provided boating density data for comparison with TFR: Lucky Peak Reservoir near Boise, Idaho (U.S. Army Corps of Engineers [USACE] 1988); Deep Creek Reservoir in western Maryland (Environmental Resources Management [ERM] 2004); and Jocassee and Keowee reservoirs in the northwest area of South Carolina, Keowee-Toxaway Project (Duke Energy 2008). The results of these studies provide representative thresholds for surface acres per boat and are shown in Table 3.
Table 3. Optimum Recreation Carrying Capacity Thresholds: Boat

<table>
<thead>
<tr>
<th>Reservoir Name</th>
<th>Usable Surface Acres</th>
<th>Optimum Boat Capacity</th>
<th>Acres per Boat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucky Peak</td>
<td>2,787</td>
<td>463</td>
<td>6.0</td>
</tr>
<tr>
<td>Jocassee</td>
<td>6,555</td>
<td>1,026</td>
<td>6.4</td>
</tr>
<tr>
<td>Tims Ford</td>
<td>10,560</td>
<td>1,641</td>
<td>6.4</td>
</tr>
<tr>
<td>Deep Creek</td>
<td>2,939</td>
<td>452</td>
<td>6.5</td>
</tr>
<tr>
<td>Keowee</td>
<td>13,641</td>
<td>1,804</td>
<td>7.6</td>
</tr>
</tbody>
</table>

The thresholds shown in Table 3 reflect boating densities from 6.0 to 7.6 surface acres per boat. This density is characterized as “at capacity” (Duke Energy 2008, page 109) and “actual carrying capacity” (ERM 2004, pages 56-58). Recreation professionals recognize that recreation areas have a theoretical capacity, however, the correct way to characterize that capacity is defined by BOR 1977, pages I-3 and 4, and Warren and Rea 1989, pages 116-118. When assessing the recreational boating capacity of waterways, additional characteristics such as location and movement of boats (i.e., density, clustering, and staging) should be analyzed. This typically occurs from boating use associated with public recreation areas (Duke Energy 2008, page 104). The Lucky Peak Master Plan was completed by the USACE in 1988. Phil Benge, USACE lead natural resource specialist on the Lucky Peak plan, discussed the plan’s success as a management tool and indicated that managing to a boating capacity of 6.0 surface acres per boat appeared to be appropriate. By comparing boating capacity estimates for TFR to the estimates of other reservoirs of similar size, or to other reservoirs in the southeastern United States, or to both, the surface acres per boat on TFR, or on any other reservoir, can be verified as an acceptable threshold to the general boating public.

Based on the pilot TFBCS and the other referenced studies, TVA recreation planners developed a rapid assessment planning tool to assist in developing baseline numbers for “in-use” recreational boats. The tool is called the Boating Density Worksheet and is shown in Table 4. The worksheet then was refined after examining current literature and technical reports on the Lucky Peak, Jocassee, Deep Creek, and Keowee reservoirs.

Conclusion
The Boating Density Worksheet uses information already available in existing databases to estimate boat usage on reservoirs. Because worksheet estimates compare favorably to estimates of other agencies’ boat carrying capacity studies, the worksheet can be used to estimate the following:

- Carrying capacity for any TVA reservoir
- Cumulative impacts of a proposed action on TVA reservoirs

For confirmation or rejection of the worksheet’s validity, carrying capacity data from other reservoirs of similar size and dimensions can be used to place the reservoir in context, in the manner of Table 3.
### Table 4. TVA Boating Density Worksheet

<table>
<thead>
<tr>
<th>Total Permits From 26a Records *</th>
<th>Estimated Private Access Boating Units</th>
<th>Private Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Slips (+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community Slips (+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial Marinas (-)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Adjusted Private Access Total</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adjusted Private Access Boating Units</th>
<th>Estimated Boating Units - Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Commercial Wet Slips</td>
</tr>
<tr>
<td></td>
<td>Commercial Dry Slips</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal Boating Units</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Public Ramp Parking</th>
<th>Estimated Parking Spaces for Boating Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Private Community Ramp Parking</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal Parking Spaces</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated % Boating Units In Use</th>
<th>Ave. Summer</th>
<th>Ave. Summer</th>
<th>Peak Holiday</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weekday %</td>
<td>Weekend Day %</td>
<td>Summer %</td>
</tr>
<tr>
<td>Commercial Wet &amp; Dry Slips</td>
<td>15%</td>
<td>25%</td>
<td>35%</td>
</tr>
<tr>
<td>Public/Private Ramp Parking</td>
<td>20%</td>
<td>60%</td>
<td>75%</td>
</tr>
</tbody>
</table>

| Full Pool Surface Acres          | **0**       |
| Full Pool Surface Acres minus barge tow w/safety zone (2x104.5) ** |       |

<table>
<thead>
<tr>
<th>Ave. Summer</th>
<th>Ave. Summer</th>
<th>Peak Holiday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Weekend Day</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Summer</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Surface Acres Per Boating Unit

* **NOTE:** Use stored boat counts to calculate average for 26-a; private docks, piers and boathouses

** **NOTE:** Where appropriate apply recommended Coast Guard Safety Zone for Commercial Boat Traffic
Summary
The Boating Density Worksheet captures a rapid, objective, and inexpensive means of assessing the density of recreational boats on TVA reservoirs. The Appendix A worksheet estimated boating density for TFR, using boat storage numbers from the preferred alternative B1 in the TFLP. Available literature provides standards that can be used to judge the acceptability of boating capacity levels on reservoirs. These standards are based on the assumption that the measure of surface acre per boat provides a suitable metric for measuring acceptability. Further assumptions are that the mix of recreational boating types and activities are similar and range from human-powered and wind-powered craft to motorized boats of various horsepower and size. If boating capacity estimates exceed a relevant standard, a more detailed analysis may be necessary.

References


Appendix A. Tims Ford Boating Density Worksheet at Build-Out

<table>
<thead>
<tr>
<th>Estimated Private Access Boating Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Permits Possible From 26a Records *</td>
</tr>
<tr>
<td>Multiple Slips (+)</td>
</tr>
<tr>
<td>Community Slips (+)</td>
</tr>
<tr>
<td>Commercial Marinas (-)</td>
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<tr>
<td><strong>Adjusted Private Access Total</strong></td>
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</tbody>
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<tr>
<th>Estimated Boating Units - Total</th>
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<tbody>
<tr>
<td>Adjusted Private Access Boating Units</td>
</tr>
<tr>
<td>Commercial Wet Slips</td>
</tr>
<tr>
<td>Commercial Dry Slips</td>
</tr>
<tr>
<td><strong>Subtotal Boating Units</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated Parking Spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Ramp Parking</td>
</tr>
<tr>
<td>Private Community Ramp Parking</td>
</tr>
<tr>
<td><strong>Subtotal Parking Spaces</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated % Boating Units In Use</th>
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<tbody>
<tr>
<td>Ave. Summer</td>
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<tr>
<td>Weekday %</td>
</tr>
<tr>
<td>Commercial Wet &amp; Dry Slips</td>
</tr>
<tr>
<td>Public/Private Ramp Parking</td>
</tr>
</tbody>
</table>

| Full Pool Surface Acres | 10,560 |
| Full Pool Surface Acres minus barge tow w/safety zone (2x104.5) ** | 0 |

<table>
<thead>
<tr>
<th>Ave. Summer</th>
<th>Ave. Summer</th>
<th>Peak Holiday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est Boating Units in Use</td>
<td>Weekday 762</td>
<td>Weekend 1641</td>
</tr>
<tr>
<td>Surface Acres Per Boating Unit</td>
<td>13.9</td>
<td>6.4</td>
</tr>
</tbody>
</table>

* NOTE: Use stored boat counts to calculate average for 26-a; private docks, piers and boathouses

** NOTE: Where appropriate apply recommended Coast Guard Safety Zone for Commercial Boat Traffic