



PARK SCIENCE

A RESOURCE MANAGEMENT BULLETIN

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR

VOLUME 9 – NUMBER 1

FALL 1988



Cover: Shoreline beaches at Glen Canyon National
Recreation Area. (Story on pages 3 and 4).

Study Provides Dynamic Picture of Lake Powell's Boater Use Capacity

By Charles W. Wood and Mike Snyder

Glen Canyon National Recreation Area (NRA) is a developing unit of the National Park System in Utah and Arizona whose major recreational resource is Lake Powell. Five permanent developed marinas, plus a temporary marina on the San Juan arm, operate on its 1900-mile shoreline. Plans for two new marinas and expansion of several existing facilities recently were approved.

Because it is difficult to gauge the cumulative effect of these new developments and expansions, an assessment of the lake's capacity to absorb increased boater use was undertaken to determine development sizes consistent with preservation of park resources and recreation quality.

A study by the Denver Service Center (DSC) in 1982 had identified physical and operational factors affecting boat distribution and boater carrying capacity and had produced models illustrating how boater carrying capacity might be arrived at under varying scenarios. In 1985, Supt. John O. Lancaster decided to quantify boater use limits through a park field study, and to include resource and recreational quality factors. This study, recently completed, appears in a document titled *The Carrying Capacity of Lake Powell, A Management Analysis of Capacity for Boater Use*, (76 pp., available from Glen Canyon NRA, P.O. Box 1507, Page, AZ 86040).

Potentially limiting factors were chosen for evaluation based on information from the 1982 DSC work, park resource monitoring data, and the need to incorporate recreational quality. The factors selected were physical capacity, water quality, shoreline impact, safety, and a three-level spectrum of potential recreational experiences based on density of boaters staying overnight onshore. These levels were termed "semi-primitive," "rural/natural," and "urban/natural."

Data-gathering began with a survey of boaters at the park in 1985 to update information on boater recreational activities, boater distribution on the lake, and length of stay and size of groups. Prior to survey and

monitoring, the lake was divided into 13 geographic zones. Nearly 300 boater groups were interviewed after their trips and asked to complete a trip diary. Questions related to their activities and the impact factors that affected their trip.

Results were coded into a Lotus 1-2-3 spreadsheet for analysis, yielding a table of boater distribution for each of the zones by marina of origin. Field monitoring of lake resource impacts resulting from boater use was completed in 1985 and 1986, concentrating on shoreline water quality and shoreline campsite impact (trash, human waste, fire rings.)

To arrive at capacity estimates, maximum "limits" for each factor were set, based on documented criteria and beyond which the visitor experience and/or resource could be presumed to deteriorate. For example, the limit for physical capacity was the number of adequate shoreline campsites in each zone. These were counted. For water quality, the limit set was the health standard for bacterial content of water used for swimming. For shoreline impact, the limit was based on the amount of trash and human waste around campsites beyond which an increase was noted in complaints from the visitors surveyed.

User density limits corresponding to the recreational opportunity types were derived from the size of each zone in relation to the length of its shoreline (giving a measure of the opportunity for isolation), and user density factors for differing experiences obtained from the literature (Moe and Underhill; USDA Forest Service). These results were translated into the desirable size and development facilities for launching boats – the management control – using a two-step process.

Step I. A limiting factor matrix was prepared using the distribution of boaters to each zone found in the survey. Knowing the number of boats launched during impact studies (from visitor use statistics) it was possible to calculate how many boats it would take to cause each factor to reach its limit in every zone. A matrix of this information is shown in Table 1.

Step II. Identification of the boat launch rates from marinas that would result in a distribution of boaters



Escalante Arm, Lake Powell NRA, has low physical capacity and is deemed a "semi-private" recreational opportunity.

matching the lake's carrying capacity was next. After identifying the "most limiting" factor in each zone, by reference in Table 1 (expressed as boats-at-one-time in the zone), and using the distribution factors from marinas with lengths-of-stay observed during the visitor survey, it was possible to estimate the daily launch rate at each marina that would produce a distribution of boats on the lake equaling the carrying capacity of each zone as gauged by the most limiting factor in each of the zones. This procedure is illustrated in Table 2. (Note: the ROS category used was determined by management objectives for each area as stated in planning documents. It is not only the lowest-density category.)

Table 2 yields a boat launching rate for each of the marina areas that matches carrying capacity. This information affords park management a development planning tool for judging the maximum boat launching capability for each marina consistent with park objectives. Planners are thus able to allocate the number of boat launches among the various facilities – public launch ramps, rental boats, and private slips or moorings.

The study also provides management with the conditions under which the lake's boater use capacity may be increased: Mitigation of the most limiting factor at



Memorial Day recreationists crowd Lone Rock beach, an "urban/natural" recreation opportunity area.

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Lake Powell Study

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a given lake zone permits the number of allowable boats-at-one-time in the zone to increase to the level indicated by the next-most limiting factor. This increase can be traced back to an increase in maximum allowable marina launch rates using methods outlined in the study. In this way, guidance may be obtained on which alternative management actions would be most useful for mitigating capacity constraints and where on the lake they could be most effectively applied.

As an illustrative exercise one can ask, for example, what effect mitigation of water quality and shoreline impact lakewide would have on the limits to boater use. When water and shoreline impacts were not considered as limiting factors and a new table of marina launch rates calculated, it was found that instituting programs to maintain water quality and clean shorelines would double the lake's effective carrying capacity.

The same exercise can be repeated, assuming mitigation only in specific zones, to document where on the lake mitigation would most efficiently alleviate constraints on additional use. This type of analysis is useful in situations where mitigation is a feasible course of action and excess user demand exists. (If the limits to capacity are physical or safety constraints, mitigation usually would not be feasible. The management action would be to keep development to a level consistent with those constraints.)

At Glenn Canyon, the capacity estimates have been directly useful in evaluating planned marina expansion. In Table 3, the results from Table 2 are expressed as "carrying capacity launch rates," and are compared with "existing and approved marina launch capacities." (Marina launch capacities are the physical ability of marinas to launch boats based on the number of lanes at the ramp, number of mooring buoys and slips, etc.) The comparison of projected expansion of marina launch capacities with known carrying capacity led to adoption of a recommendation that marina expansions be accompanied by programs to maintain water quality and clean shorelines.

Although many carrying capacity studies have been done for land and river recreation, few flatwater area studies consider the physical, resource, and recreational limits important to park management. Fewer still offer a means of quantifying capacity. The method used in the present analysis is a way of organizing information to document a management problem, and could be applied to other areas of the National Park System concerned with carrying capacity. The principal requirements are a system for examining the distribution of use, and sufficient resource monitoring data to correlate user impacts with use intensity.

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REFERENCES CITED

- Moe, T.M. and A.H. Underhill, 1982. *A Manual to Determine Recreational Carrying Capacity*. Park Studies Unit at University of Arizona. Special Report No. 1. Tucson, AZ.
- U.S. Department of Agriculture. Forest Service. *User Guide to the Recreational Opportunity Spectrum*. Updated. (Internal guide for forest planning. No further publication information available at presstime.)

Table 1. Limiting Factor Matrix (Number of Boats-At-One-Time)

Zone	Physical	Safety	Water Quality	Shore Impacts	Recreational Opportunity Spectrum (ROS)		
					Semi-Primitive	Rural/Natural	Urban/Natural
1	1088	1054	467	NL	N/A	527	1054
2	951	903	233	444	N/A	903	903
3	2090	1415	NL	1950	102	809	N/A
4	1431	2094	621	NL	151	1047	N/A
5	1770	2950	ND	830	385	2212	N/A
6	729	1529	1722	262	1147	1529	N/A
7	751	1236	ND	560	927	1236	N/A
8	1443	1002	ND	250	725	1002	N/A
9	1341	885	253	736	664	N/A	N/A
10	714	1355	2015	232	1016	1355	N/A
11	1588	1997	1217	NL	N/A	998	1997
12	327	1085	183	585	814	1085	N/A
13	2149	2270	95	689	1702	2270	N/A

N/A = Not Applicable; ND = No Data; NL = Not Limited.

Table 2. Carrying Capacity Launch Rates – Existing Management Scenario

BAOT (Boats-At-One-Time)

Dist % (Distribution %, see Table 10)

LOS (Length-Of-Stay, see Table 9)

CCLR (Carrying Capacity Launch Rate)

Zone	Limiting Factor BAOT	Wahweap/Lone Rock/Antelope Pt.			Bullfrog Basin/Halls Crossing			Hite		
		Dist %	LOS	CCLR	Dist %	LOS	CCLR	Dist %	LOS	CCLR
1	467	97	4.3	105.3	3	4.3	3.3	0	4.3	0
2	233	100	3.8	61.3	0	3.8	0	0	3.8	0
3	809	97	4.6	170.6	3	4.6	5.3	0	4.6	0
4	621	94	4.7	124.2	6	4.7	7.9	0	4.7	0
5	830	91	5.6	134.9	9	5.6	13.3	0	5.6	0
6	262	45	5.5	21.4	55	5.5	26.2	0	5.5	0
7	560	26	5.9	24.7	74	5.9	70.2	0	5.9	0
8	250	60	7.0	21.4	40	7.0	14.3	0	7.0	0
9	253	15	5.6	6.8	83	5.6	37.5	2	5.6	0.9
10	252	4	5.1	2.0	85	5.1	42.0	11	5.1	5.4
11	998	5	4.5	11.1	88	4.5	195.2	7	4.5	15.5
12	183	3	5.1	1.1	62	5.1	22.2	35	5.1	12.6
13	95	0	5.0	0	16	5.0	3.0	84	5.0	16.0
		total CCLR 684.8			total CCLR 440.4			total CCLR 50.4		

total lakewide CCLR 1,175 boats/day

Table 3. Comparison of Marina Launch Capacity with Carrying Capacity Launch Rate (launches/day)

marina	marina launch capacity		carrying capacity launch rate	
	existing	approved*	existing	additional mgmt.**
Wahweap/Lone Rock	644	870	685	1,358
Antelope Point	0	240	0	0
Bullfrog Basin	220	420	440	800
Halls Crossing	145	206	0	0
Hite	114	(114)	50	414
total	1,123	1,850	1,175	2,572

*Launch rates from proposed facilities in current plans.

**Additional management – applying management actions to a particular limiting factor to increase BAOT capacity.