

**APPENDIX G**  
**BOATING CAPACITY STUDY**

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## I. Introduction

Balancing outdoor recreational use with natural resource protection is a core tenet of Colorado State Parks' mission. Considering carrying capacities for park resources is also an important element of Goal Two of Colorado State Parks' 2010 Strategic Plan, and will help ensure that park resources can be enjoyed by the maximum number of visitors in perpetuity.

The Stagecoach Planning Team evaluated boating capacity at Stagecoach State Park to help park management prevent issues from arising and respond to potential conflicts associated with reservoir use. Two specific looming issues at Stagecoach that may affect boating capacity include: 1) the potential moving of the bouy line to expand the wake boating zone; and 2) future implementation of a private marina planned along the south shore. Implementation of one or both of these actions have the potential to significantly alter boating use and the overall boating experience at Stagecoach. In the absence of documentation or evaluation of existing boating use levels, park staff have not been provided enough information to guide decisions on these matters.

This document includes five main sections. Following the *Introduction* is Section II entitled *Background on Visitor Capacity*. This section highlights the goals of such a study, and describes how it will be used to achieve a balance of boater satisfaction and safety, fiscal constraints, and natural resource protection. Section III, *Boating Capacity at Stagecoach State Park Methodology*, describes the process and methodology of this study that looks specifically at boating capacity through four separate categories at Stagecoach State Park. Next, Section IV, *Existing Boating Levels* will analyze the number of boats that were in use at one time during three days of the 2010 season (the busiest day, the average high-use day, and average day during the peak season). Section V, *Boating Capacity Indicators* describes four important elements directly tied to boating capacity: ecological capacity, facility capacity, spatial capacity, and social capacity. Section VI, *Overall Recreational Boating Capacity Conclusion* qualitatively evaluates each of the four capacity categories to suggest an overall boating capacity for Stagecoach.

There are numerous methodologies for evaluating boating use and overall boating capacity. The Stagecoach Planning Team ultimately settled on a methodology that would account for a variety of factors that are directly tied to boating use: 1) sensitive shoreline conditions following the four-foot dam level raise (which included significant wetland mitigation, revegetation, and changes to the shoreline; 2) available parking for boat trailers; 3) boater safety; and 4) the desired type of boater experience. The rationale for this approach was that while it provided a range of flexibility from which to evaluate overall boating capacity, it also considered the implications of boating beyond simply safety concerns or facility constraints (e.g., available parking) considerations.

### Stagecoach Boating Capacity Summary

This boating capacity study serves as a management tool to help balance boating use alongside safety, visitor experience, and other important natural resource considerations. Conserving these resources, and maintaining a high quality visitor experience is essential if Colorado’s State Parks are to be sustained into the future.

- Goals**
- Maintain visitor satisfaction and retention
  - Maintain safety
  - Enhancement of the natural resource
  - Efficient use of scarce capital

**Ecological Capacity:** Capacity in regards to the ecosystem’s ability to cope with human impacts associated with recreation.

**Facility Capacity:** Capacity in regards to the facilities’ ability to handle a number of users, such as number of parking spaces for boat trailers and boat launch wait times

**Spatial Capacity:** Capacity in regards to the physical constraints that determine the number of boats that can comfortably use the reservoir at one time

**Social Capacity:** Capacity in regards to visitors’ perception of crowding that impact the users’ enjoyment of the resource.

**At Capacity\*  
Limiting Factor**

**Approaching Capacity  
Not a Limiting Factor**

**At Capacity  
Limiting Factor**

**Approaching Capacity  
Limiting Factor**



**During Peak Visitation Stagecoach Reservoir is near or at Boating Capacity with a moderate level of concern**

\*Considered at capacity largely due to dam construction

## II. Background on Visitor Capacity

Visitor capacity is the amount of activity and use in a specific location and time, which can be accommodated within acceptable amounts of impact. Use beyond the visitor capacity will begin to degrade the resource and/or the visitor experience. Determination of visitor capacity has become increasingly important for natural resource and outdoor recreation managers. Each of Colorado’s state parks has finite space and limited outdoor recreation and natural resources. Conserving these resources, and maintaining a high quality visitor experience is essential if Colorado State Parks is to continue to connect people to the outdoors through quality recreation. This study gives park staff a tool to help balance boating use alongside safety, visitor experience, and other important natural resource considerations.

There is a multitude of ways to determine visitor capacity. It is also important to note that visitor capacity determination is never purely objective. Capacity decisions are based on a number of factors with the goal of increasing visitor satisfaction, retention, and safety, enhancement of the natural resource, and efficient use of scarce capital. Capacity will vary from site to site, and is dependent on the natural environment and physical constraints; visitor behavior and preferences; infrastructure and facilities; as well as management goals and objectives. In addition, **boating capacities are not to be viewed as a “cap” or limit to boating use, rather they are tools to better understand boating use and preferences on a given reservoir and provide a basis for informed management decisions.**

### III. Boating Capacity at Stagecoach State Park Methodology

This study focuses on the boating capacity of Stagecoach State Park. Subsequent studies may focus on other visitor capacities on land, along the shore, the Tailwater area, and other aspects of recreation at the park.

A wide variety of techniques for establishing boating capacity have been employed in the past, but typically, accepted capacities are based on several sets of standards that coincide with pre-determined levels of acceptable impact. Bo Shelby and Thomas Herberlein (two of the more respected researchers on the subject)<sup>1</sup> outlined four components of recreational carrying capacity: ecological, spatial, facility, and social capacity, which, when considered together, provide a useful basis for determining park visitor carrying capacity. Each of these four indicators can serve as a limiting factor or maximum threshold when dealing with carrying capacity. Boating capacity at Stagecoach has been evaluated for each of these four categories and is determined to be either below, approaching, at, or exceeding capacity. A detailed description of each category is provided below:

- **Ecological Capacity** – Capacity in regards to the ecosystem’s ability to cope with human impacts associated with recreation. For example, impacts to wetlands and riparian communities, soil erosion, loss of ground cover, trash accumulation, etc.
- **Facility Capacity** – Capacity in regards to the facilities’ ability to handle number of users, such as number of parking spaces for boat trailers. Impacts can include increased waiting times to pass through Aquatic Nuisance Species (ANS) inspections and launch a boat. It can be advantageous to use facility capacity as the limiting factor to avoid impacts associated with the other forms of recreational carrying capacity. However, it is possible that current facility capacity either over or under limits use.
- **Spatial Capacity** – Capacity in regards to the physical constraints leading to space-related impacts. In other words, spatial capacity is the number of boats that can comfortably conduct their chosen recreational activity in a specific area of the reservoir. A reservoir’s shape will also affect the physical constraints on use. An irregular shoreline limits the amount of useable boating surface.
- **Social Capacity** – Capacity in regards to visitors’ perception of crowding. Social capacity is defined by the specific user group of each specific lake. Social capacity may but not always impact the users’ enjoyment of the recreational resources. Social Capacity is reached when conflict arises or when users choose not to utilize the resource.

Colorado State Parks Planning staff recommend considering each of these four types of visitor capacity indicators to calculate the overall boating capacity of the park and to make recommendations for future management. For each category, establishment of standards of quality or thresholds creates a mechanism to alert park management when actions may be necessary to protect natural and recreation resources and/or to maintain and enhance the overall visitor experience. A minimum acceptable condition set for each category illuminates when the park is below, approaching, at, or exceeding a given indicator and cumulatively point to whether overall boating use at the park may be at, near, or above capacity. The use of capacity types, along with their associated thresholds, provides a

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<sup>1</sup> Bo Shelby is a Professor in the Department of Resource Recreation Management at Oregon State University. Thomas Heberlein is a Professor in the Departments of Rural Sociology and Sociology at the University of Wisconsin-Madison. They have published extensively in the field of carrying capacity studies, participated in research, and worked as consultants both to professional journals and to such organizations as the National Park Service.

management tool for prescribing a range of potential responses. Reaching capacity in a given category does not necessarily require visitor reduction or site closures, only that management decisions must be carefully evaluated in order to protect the current boating experience and resource in question.

#### **IV. Existing Boating Levels**

The main attraction at Stagecoach State Park is Stagecoach Reservoir. Visitors come to the park to enjoy the many recreational activities associated with the water, including boating, fishing, water skiing, or simply enjoying the scenery. Boating activities have major impacts on all four forms of the aforementioned visitor capacity indicators. Evaluating current boating use is the first step in determining where Stagecoach boating levels fall along the continuum of boating use.

#### **Considerations Regarding Existing Numbers of Boats**

In order to estimate the average number of boats actually in use at one point in time, two factors were considered along with assumptions on use patterns: 1) ANS inspection data of boats entering the reservoir, and 2) boat storage and mooring data.

##### ***ANS Inspections and Moored Boats***

ANS inspections count the number of boats that were inspected before entering the water providing a good estimate of the number of boats that arrive to use the reservoir.<sup>2</sup> The Peak Day, June 20, 2010 saw the most number of ANS inspections, **67**. The average high use day saw **36** inspections. The average day during the peak season saw **24** inspections. Boaters that moor their boats overnight near the campsites do not have to repeat the ANS inspections and are therefore not counted. Park Staff estimate that this practice attributes to an **additional 12-15 boats moored offshore on a peak day**.

However, the total number of inspections plus the moored boats do not give an accurate count of the number of boats using the reservoir because, not all of these boats will be in use at the same time. Some boats will come in the morning and leave before additional boats enter in the afternoon. In addition, some visitors will anchor their boats to picnic, swim, or just relax. **A conservative estimate is that 50% of these boats will be in use at any one point in time.**<sup>3</sup>

##### ***Stored Boats***

In addition to inspections and moorings, boats will also enter the water from the Marina's dry and wet storage facilities. Boats stored in the water obviously are not counted by ANS inspections as they are already in the water and therefore need to be counted in addition to ANS inspections.

- The Marina boat slips: 35 boats slips
- The Marina dry storage: 39 spaces available for boats and RVs
- Haybro Beach: 6 beached sailboats and canoes  
80 total storage spaces

For the purpose of this study, the maximum number of boats that can currently be stored at Stagecoach is 80. However, to avoid double counting boats in dry storage that must go through ANS inspections, stored boats account for 41 boats (80 stored boats minus the 39 dry storage boats). In addition, not all

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<sup>2</sup> Only ANS IN inspections were counted.

<sup>3</sup> Progressive AE (2001). Four Township Recreational Carrying Capacity Study: Pine Lake, Upper Crooked Lake, Gull Lake, Sherman Lake. Four Township Water Resources Council.

spaces are utilized. The occupancy rate of storage is typically 75%; therefore, we expect that at any given time, the **total number of stored boats that avoid ANS inspections is 31** (75% of 41). Obviously not all of these boats will be in use at the same time. A conservative estimate is **that 10% of these boats will be in use at any given time, translating to an additional 3 boats.**<sup>4</sup>

For the 2010 season, estimates were created for the total number of boats that were in use on the reservoir at any one point in time on three separate days:

- **Peak day** occurred on Father’s Day (June 20, 2010) when the reservoir saw the most number of boats.
- **Average High-Use Day** is the average number of boats during the weekends and holidays through the Peak Season (Memorial Day – Labor Day weekends).
- **Average Peak-Season Day** represents a daily boater average during all days in the Peak Season, May 28 – September 6, 2010.

Table 1 illustrates the estimates of existing boat numbers occurring under peak day, average high-use, or average peak-season days.

**Table 1: Existing Boating Levels (Boats in use at a single point in time)**

	ANS INSPECTIONS + MOORED BOATS			STORED BOATS			TOTAL IN USE AT ONE TIME
		Use Rate	In Use		Use Rate	In Use	
<b>Peak Day June 20, 2010</b>	67 inspections <u>15</u> moored boats <b>82 boats</b>	50%	<b>41</b>	31	10%	<b>3</b>	<b>44</b>
<b>Average High-Use Day</b>	36 inspections <u>15</u> moored boats <b>51 boats</b>	50%	<b>26</b>	31	10%	<b>3</b>	<b>29</b>
<b>Average Peak-Season Day</b>	24 inspections <u>12</u> moored boats <b>36 boats</b>	50%	<b>18</b>	31	10%	<b>3</b>	<b>21</b>

### **Peak Day**

Table 1 shows that there were **44 boats in use at the same time on the Peak Day**. This number is derived from 50% of the estimated 82 boats that either entered the water or were moored that day plus 10% of the 31 stored boats (41 plus 3 equals 44). Because we assume that only 50% of the boats that enter the water in one day are in use at the same time, we attribute 41 boats on the water to inspections and moorings. Additionally, there are 31 boats in storage with a use rate of 10%, attributing to 3 boats on the water at any given point in time.

### **Average High-Use Day**

Table 1 shows that there were **29 boats in use at the same time on the Average High-Use Day**. This number is derived from 50% of the estimated 51 boats that either entered the water or were moored that day plus 10% of the 31 stored boats (26 plus 3 equals 29). Because we assume that only 50% of the boats that enter the water in one day are in use at the same time, we attribute 26 boats on the water to inspections and moorings. Additionally, there are 31 boats in storage with a use rate of 10%, attributing to 3 boats on the water at any given point in time.

<sup>4</sup> Ibid.

### ***Average Peak Season Day***

Table 1 shows that there were **21 boats in use at the same time on the Average Peak Season Day**. This number is derived from 50% of the estimated 36 boats that either entered the water or were moored that day plus 10% of the 31 stored boats (18 plus 3 equals 21). Because we assume that only 50% of the boats that enter the water in one day are in use at the same time, we attribute 18 boats on the water to inspections and moorings. Additionally, there are 31 boats in storage with a use rate of 10%, attributing to 3 boats on the water at any given point in time.

### **Vessel Type Considerations**

Because spatial and ecological capacity may be influenced by the type of boating vessel (e.g. a motorboat requires a lot of space to operate safely and may produce more significant wave action), it is important to consider vessel types when determining boating capacity. Currently, there are no vessel type count data for Stagecoach Reservoir. A simple vessel type survey should be conducted continuously at ANS inspection stations to determine more accurate vessel type counts. Park staff estimated the vessel type mix as shown in Table 2:

**Table 2: Vessel Type Mix**

Vessel Type	Peak Day Count	Average High Use Day	Average Day	% of Total
Boat Fishing	21	14	10	48%
Water Skiing	12	8	6	28%
PWC	2	1	1	4%
Non-Motorized	9	6	4	20%
<b>Total</b>	<b>44</b>	<b>29</b>	<b>21</b>	<b>100%</b>

## **V. Boating Capacity Indicators**

Each boating capacity indicator serves as a mechanism to alert park management when actions may be necessary to proactively manage boating numbers. A minimum acceptable condition set for each indicator illuminates when the park is below, approaching, at, or exceeding a given indicator, and cumulatively point to whether overall boating use at the park may be at, near, or above, desired capacity. Associated thresholds for each capacity indicator provides a basis for prescribing a range of potential responses and making clear management decisions. *Reaching carrying capacity in a given category or overall, does not necessitate visitor reductions or site closures, only that management decisions must be carefully evaluated in order to protect the boating experience and resource in question. In addition, some thresholds defined in this study may change over time as the boating use characteristics and visitor preferences at Stagecoach change.*

## **Ecological Capacity**

Simply looking at total number of boats is an inappropriate measure of recreational visitor capacity because the presence of a single boat might be just as disturbing as many.<sup>5</sup> Conversely, some boating activities are less disruptive than others. In other words, ecological impacts are not solely dependent on the number of boats. Therefore, to determine the overall boating capacity of a body of water, ecological consequences of the recreation activity must be looked at separately.

In the year this management plan was written, 2010, the reservoir was under major construction. The Upper Yampa Water Conservancy District (UYWCD) increased the height of the dam spillway's crest elevation by 4 feet. During this process, they lowered the water level by over 15 feet and re-graded the entire shoreline. The contour of the basin was altered by digging up and moving the wetland soils from the old shoreline to the new higher shoreline. Erosion netting was then placed over the moved soil and the area was revegetated. This process altered the topography around the entire shoreline.

Because the entire shoreline was affected, many boating impacts could not be documented. However, boating impacts are expected to be heightened until vegetation is able to reestablish along the shoreline.

After vegetation has reestablished, and through careful monitoring of shoreline erosion and other various ecological impacts, park staff will be able to reassess the ecological capacity of boating activities. To assess boating impacts to the natural setting, major occurrences of ecological damage must be defined and documented.

For the purposes of this study, planning staff defined ecological capacity in terms of the ecosystem's ability to cope with human impacts associated with recreation. Ecological capacity is determined from the observed occurrences of major disturbances. Major disturbances can be but are not limited to:

- Shoreline erosion – qualitative assessment of the extent of erosion likely caused by boating activities
- Significant drop in waterfowl rafting due to boating activity
- Existence of boating within adequate buffer zones surrounding critical wildlife habitat
- The disappearance of a lekking area that was likely caused by boating activity
- Vegetation damage – qualitative assessment of the extent of damage likely caused by boating
- Major change in water quality due to boating
- Other observed disturbances likely caused by boating
- Shoreline damage due to unregulated beaching of boats

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<sup>5</sup> DeLong, A. K. (2002). Managing visitor use & disturbance of waterbirds: A literature review of impacts and mitigation measures. Prepared for Stillwater National Wildlife Refuge. Appendix L (114 pp.) *in* Stillwater National Wildlife Refuge Complex final environmental impact statement for the comprehensive conservation plan and boundary revision (Vol. II) Dept. of the Interior, U.S. Fish and Wildlife Service, Region 1. Portland, OR.

### Ecological Boating Capacity Summary

Capacity in regards to the ecosystem's ability to cope with human impacts associated with recreation. For example, impacts to wetlands and riparian communities, soil erosion, loss of ground cover, trash accumulation, etc.

#### Observed Significant Ecological Impacts:

1. Due to dam construction, entire shoreline has been recontoured (boating is expected to significantly impact the shoreline's ability to stabilize)
2. Major vegetation damage due to dam construction (boating is expected to significantly impact new vegetation's ability to establish)
3. Unregulated beaching of boats is expanding boat pull offs in at least three areas of the reservoir causing shoreline erosion

#### Limiting Factor

With 3 observed significant impacts, Stagecoach Reservoir is considered to be **at ecological capacity** with a **moderate** level of concern

Of major importance is the wave action caused by motorized boats. One of the most potent impacts of waves created by boating occurs when the waves hit the shoreline and contribute to erosion. Boat-generated waves can severely erode the roots of plants growing on the bank and disturb habitat along the shore.<sup>6</sup> To successfully assess the ecological capacity of boating activities at Stagecoach, a careful erosion monitoring plan should be put in place. Care should be taken to monitor the difference of impact within and outside the wakeless zone. *Any decision to move the wakeless zone boundary should take the erosion findings into account.*

Boating and angling activities from the banks have been documented to affect bird distribution and abundance, reproductive success, predation rates, and foraging.<sup>7</sup> Dr. James Rodgers, a Biological Scientist II at the Florida Game and Fresh Water Fish Commission has published extensively on the topic of human disturbance to nesting bird colonies. Stagecoach State Park was known to have multiple sensitive Columbian Sharp-Tailed Grouse Leaks in 2010. Rodgers recommends minimum buffer zones around bird species ranging from 74 to 175 meters.<sup>8</sup>

Other harmful environmental impacts from boats can include increased turbidity, direct boat contact, noise and chemical pollution, as well as the dispersal of aquatic plants and the spread of noxious weeds and invasive species.<sup>9</sup>

Table 3 illustrates how ecological capacity is determined based on the number of observed significant impacts.

<sup>6</sup> Mosisch, T. D., & Arthington, A. H. (1998). The impacts of power boating and water skiing on lakes and reservoirs. *Lakes & Reservoirs: Research and Management*, 1-17.

<sup>7</sup> Ibid.

<sup>8</sup> Rodgers, J.A. (1991). Minimum buffer zone requirements to protect nesting bird colonies from human disturbance. Final Report, study number 7511. Bureau of Wildlife Research, Florida Game and Fresh Water Commission.

<sup>9</sup> EDAAW, Inc. (2004). Ririe Reservoir Recreation Carrying Capacity Study. U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Snake River Area Office.

**Table 3: Ecological Boating Capacity Level Measurements<sup>10</sup>**

Ecological Boating Capacity	Number of Observed Significant Impacts	Level of Concern
Below	0	No significant concerns
Approaching	1 to 2	Low
At	3	Moderate
Exceeding	>3	High

At Stagecoach Reservoir, park staff observed three significant ecological impacts, indicating that the boating is at ecological capacity with a moderate level of concern. These impacts are noted below:

1. Due to dam construction, entire shoreline has been recontoured (boating is expected to significantly impact the shoreline’s ability to stabilize)
2. Major vegetation damage due to dam construction (boating can potentially impact new vegetation’s ability to establish)
3. Unregulated beaching of boats is expanding boat pull offs in at least three areas of the reservoir causing shoreline erosion

At this time, Stagecoach reservoir is at ecological capacity with a moderate level of concern. Ecological capacity is considered a limiting factor to the overall boating capacity, as increased boating activity can exacerbate the observed ecological impacts. *This conclusion is largely due to the changes to the shoreline and vegetation from the dam construction. Ecological capacity should be reevaluated after the vegetation can reestablish and the shoreline is stabilized.*

## **Facility Capacity**

Boating facilities at Stagecoach State Park consist of two ANS inspection sites, parking spaces designated for boats and trailers, storage spaces, and boat ramps. Table 4 illustrates how facility capacity is determined based on the percent parking lots are full on the Peak Day and total wait times to go through ANS inspection and boat launching.

**Table 4: Boating Facility Capacity Level Measurements**

Boating Facility Capacity	Percentage of Parking Lots that are Full and Wait Times	Level of Concern
Below	<60% < 10 minutes	No significant concerns
Approaching	60-90% 10-15 minutes	Low
At	90-110% 15-20 minutes	Moderate
Exceeding	>110% >20 minutes	High

<sup>10</sup> Adapted from EDAW, Inc. (2004). Ririe Reservoir Recreation Carrying Capacity Study. U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Snake River Area Office.

### ***Wait times to Launch Boat***

Park staff estimate boat launching and ANS inspection wait times to be 5 minutes or less, on average. However, on peak days the total wait times may reach 10 minutes. Park staff considers this an acceptable wait time and considers ANS facilities to be below capacity. However, if total wait times reach 20 minutes, staff would consider that ANS inspections stations to have exceeded capacity.

### ***Boat and Trailer Parking Capacity***

There are a total of about 59 designated parking spaces for boats and trailers. This includes 35 spaces in the Marina Lot, 14 spaces in the Morrison Cove Lot, plus 10 designated overflow spaces in the Haybro Day-Use Area Lot. The most boats that have gone through the ANS stations in a single day is **67 boats** (occurred June 20, 2010). However, some of these boats may have come from dry storage, and therefore do not require a parking space. To avoid counting boats from the dry storage area, 10% of stored boats (**3 boats**) are subtracted from the 67 inspections. An additional 10% (**6 boats**) can be discounted because not all boats will be at the reservoir at the same time (i.e. morning boats leave and free up space for afternoon boats). **Therefore, the number of boats requiring trailer parking space on Peak day is 58 (67 – 3 – 6 = 58), or 98% of full capacity (59 designated boat and trailer parking spots):**

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However, there are numerous other parking spaces available throughout the park. If the maximum number of parking spots includes all overflow space in the Arrowhead Group Picnic Area, the Entrance Parking Lot, and at campsites, the total number of spots increases to 80 spaces, bringing the capacity down to 73% on the Peak Day:

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The equation above that takes into account all possible overflow parking spaces illuminates the amount of flexibility that park staff has to accommodate all parking for boating at Stagecoach.

### ***Marina Lot Parking Capacity***

The only single boating facility that has exceeded capacity is the Marina parking lot. Because the Marina parking lot is not striped, visitors do not always park in the most efficient way. For this reason Park staff considers the parking capacity of the marina lot reached at 35 vehicles with boat trailers. Park staff estimate that during the months of June, July, and August, 2010 trailer parking at the marina parking lot surpassed capacity three (3) times and was near or at capacity 2-3 other times. There were 15 days in total when there were 35 or more ANS inspections at the Marina. However, there were fewer days when the facility reached capacity because not all boats were in the water at the same time (i.e. morning boats leave and free up space for afternoon boats).

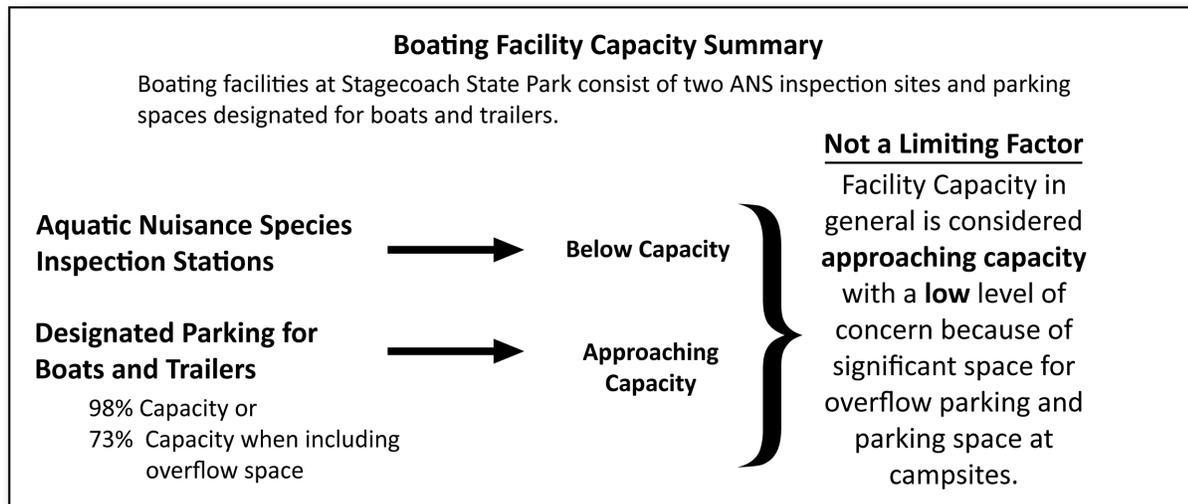
When capacity is reached, it typically does not last very long as people begin to exit the reservoir and free up space. When capacity is reached, staff directs visitors to park their trailers at nearby parking lots (Haybro, Arrowhead, Keystone, etc.). Park staff is looking into ways to make more efficient use of the unmarked space. Although this parking facility reaches capacity, it is not considered a limiting factor, as there are other places to park trailers such as at campsites and at other parking lots.

### **Morrison Cove Parking Capacity**

The Morrison Cove boat ramp parking lot has space for 14 vehicles and trailers. There have been no reports that this lot has surpassed capacity. However, on July 4, 22 boats were inspected at the Morrison ANS station. In addition, there were 10 days during the summer of 2010 when the Morrison ANS station inspected 14 or more boats. Therefore, the Morrison Parking lot is functioning at or near capacity.

### **Overall Boating Facility Capacity at Stagecoach State Park**

Even though use at the Marina and Morrison parking lots are considered at capacity on Peak Day, overall facility capacity is not a limiting factor for the overall boating capacity at Stagecoach State Park. The overall boat parking capacity is at 73% of capacity on Peak Day when including all overflow spaces, **indicating that boating facilities are approaching capacity.**



Facility is a **low level of concern** because park staff is already looking into measures to increase parking efficiency, by restriping the parking lots, and making sure inspections run as efficiently as possible. While during busy weekends parking lots do fill up, this capacity does not serve as a limiting factor. In addition, many campers choose to park their boat trailers at their campsite, effectively increasing capacity. **In conclusion, boat facilities are approaching capacity; however, because of significant room for management intervention, there is a low level of concern.**

Planned future development along the south shore is slated to have its own marina and boat ramp, which will further increase facility capacity at the lake and may lessen the demand at the Stagecoach State Park facilities. This new development will increase impacts associated with the other three capacity types, while decreasing the facility capacity's effectiveness as a limiting factor.

### **Spatial Capacity**

Spatial capacity is often referred to as physical capacity, because it deals with the physical constraints to recreation activities on the reservoir. The usable surface area of the reservoir can comfortably accommodate only a certain number of boats at any one time. In addition, an irregular shoreline with many coves and inlets will effectively decrease the amount of useable boating space and pose greater safety risks as well as ecological consequences.

The first step in calculating the spatial capacity of the reservoir is determining the usable surface area of the reservoir. The usable surface area is the total area of water minus a shoreline buffer zone (100 feet). At the time of writing the Stagecoach State Park Management Plan, the Upper Yampa Water Conservancy District (UYWCD) was in the process of raising maximum pool elevation of Stagecoach Reservoir from 7,200 feet to 7,204 feet. This increase will result in a 48-acre increase in surface area from 771 acres to 819 acres. However, some of this acreage is outside the reservoir and included in inundated wetland areas. The total contiguous surface acreage is 809.5 acres. **The surface acreage at maximum pool elevation and minus the 100' shoreline buffer is 685.3 acres. Not counting the wakeless-zone, the surface acres for speed boats, or wake-zone is 325.4 acres. The wakeless-zone accounts for approximately 359.9 acres.**<sup>11</sup>

In addition to size, the shape and depth of the reservoir also influence the spatial capacity. A more irregular shoreline may increase safety risks. The irregularity of the shore line is measured as a ratio of the actual length of the shoreline to the circumference of the lake if it were a perfect circle. The greater the difference (i.e. the higher the ratio), the more irregular the shoreline is. **Stagecoach has a high shoreline irregularity ratio of 2.76** (please refer to footnote for the calculations).<sup>12</sup>

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**The highly irregular shoreline should be taken into consideration as it can lead to increased safety issues.** Because of the irregular shape of Stagecoach Reservoir, a more conservative optimum density was chosen. Different types of boats have different optimum densities. A number of studies have asserted a wide range of acceptable boating density standards. From the studies reviewed, the range of safe boating densities ranges from 4 acres/boat to 40 acres/boat.

Table 5 is a summary of the optimum boating densities of six different studies that each handled the concept slightly differently.

**Table 5: Summary of Optimum Boating Densities**

Source	Boating Uses	Suggested Density (Acres per boat)
Ashton (1971)	All uses combined in Cass Lake	5 – 9
	All uses combined in Orchard Lake	4 – 9
	All uses combined in Union Lake	6 – 11
Kusler (1972)	Waterskiing - All uses combined	40
	Waterskiing	20
	Coordinated waterskiing	15

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<sup>11</sup> These data were obtained through ArcGIS using available Lidar data.

<sup>12</sup>

Jackson et al. (1989)	Waterskiing and motorboat cruising Fishing Canoeing, kayaking, sailing All uses combined	20 10 8 10
Florida Department of Environmental Protection	Limited Power (<10 HP) Unlimited Power Water-skiing Sailing No Power	5 – 10 10 – 20 20 – 50 5 – 10 5 – 10
Wagner (1991)	All recreational activities	25
Warbach et al. (1994)	All motorized (> 5 HP) uses	30

Even during the Peak Day, the most common boating activity at Stagecoach is fishing. Fishermen tend to stay in one locale for extended periods of time and only intermittently travel at high speeds. However, fishermen need space to cast their line and to be buffered from the wake of other boats. The irregular shape of the reservoir also requires a lower density (higher acres/boat) to allow for safe boating activities. Currently over half the usable water surface at Stagecoach is designated wakeless – giving less space to waterskiing and motorboat cruising. Based on these considerations and past studies, Planning staff recommend a “conservative” optimum boating density for the Stagecoach Reservoir:

- **15 acres/boat for non-motorized and fishing boats combined**
- **25 acres/boat for water skiing**

These optimum spatial densities are calculated specially for Stagecoach State Park and are not meant to be considered as an agency-wide standard. In addition, this threshold density may change over time as the boating use characteristics at Stagecoach change over time. At these densities, fisherman shall be able to fish throughout the whole reservoir, while others can safely water-ski and cruise in the wake zone. These densities are in-between Aukerman’s Water Recreation Opportunity Spectrum’s (WROS) “Suburban” and “Rural Developed” category, where there is a diverse range of visitors and activities, contact with other visitors is expected, and there are limited to occasional opportunities to see, hear, or smell the natural environment.

Stagecoach Reservoir is effectively two different water-bodies, that of the wake-zone and that the wakeless-zone. Water-skiing and motorboat cruising is limited to the wake-zone, while other uses can use the whole reservoir. Where both users are allowed, the optimum density must be adjusted to account for the vessel type mix. The results are shown in Table 6.

**Table 6: Optimum Boating Standards:**

**Based on:**

15 acres/boat for non-motorized and fishing boats combined

25 acres/boat for water skiing

Reservoir Section	# of Acres	Discounted Adjustment <sup>13</sup> 68% of boats are non-motorized 32% of boats are water skiing ant PWC	Adjusted Boating Density (acres/boat)	Recommended Number of Boats in use at one time
Wakeless Zone	359.9	1.00 * 15 acres/boat =	15	359.9/15 = 24
Wake Zone	325.4	68% of boats at 15 acres/boat = 10.2 + 32% of boats at 25 acres/boat = 8.0 =	18.2	325.4/18.2 = 18
<b>Total</b>	<b>685.3</b>			<b>42</b>

Boating at Stagecoach is exceeding capacity on the Peak Day (Father’s Day, June 20) and approaching capacity on the average weekend and holiday. Spatial capacity is considered a limiting factor.

The following calculations show the current spatial capacities during the Peak Day and the Average High-Use Day.

**Spatial Capacity during the Peak Day:**

\_\_\_\_\_

**Spatial Capacity during the Average High-Use Day:**

\_\_\_\_\_

These calculations were figured at maximum pool elevation. The average drawdown of the reservoir during the peak recreational season (i.e. June – August) between the years 1989-1996 was 2.4 feet. However, the drawdown during some years can be as much as 8 to 9 feet.<sup>14</sup> With the increase of the maximum water level to 7,204 feet, it is not possible to know what the average drawdown will be. In conclusion, **overall boating at Stagecoach is at spatial capacity with a moderate level of concern. Spatial capacity is considered a limiting factor at this time.** For the wide majority of the summer, boating use at Stagecoach exists comfortable under the spatial capacity threshold as defined in this study. It is only during the busiest times, when boating use reaches the density optimum. Changes in use patterns in the future may alter the defined threshold and therefore may change the determination of spatial capacity.

Of important interest is the planned future development along the south shore that is slated to have its own marina and boat ramp, which may further increase the number of boats in use at one time on the reservoir. For this reason, spatial capacity is expected to be of increasing concern in the future.

<sup>13</sup> 68% of the boats on the reservoir are non-motorized and/or fishing and therefore follow the denser standard of 15 acres/boat regardless of being in the wake zone. 32% of the boats on the reservoir are for skiing or are person watercrafts therefore require the less dense standard of 25 acres/boat. To adjust for this discrepancy, the standards discounted based the percentage of boats in each category.

<sup>14</sup> Federal Energy Regulatory Commission. (2009). Environmental Assessment: Stagecoach Hydroelectric Project.

### Boating Spatial Capacity Summary

Capacity based on physical constraints and corresponding to space-related impacts. In other words, spatial capacity is the number of boats that can comfortably conduct their chosen recreational activity in a specific area of the reservoir. The shape of the reservoir will also affect the physical constraints on use.

**Surface acreage of useable boating area 685.3 acres**

Wake zone - 325.4 acres  
Wakeless zone - 359.9

**Shoreline Irregularity = 2.76 = highly irregular shoreline**

Based on these considerations and past studies, the moderate recommended **optimum boating density is:**

- **15 acres/boat** for non-motorized and fishing boats
- **25 acres/boat** for water skiing and heavy use boats

The maximum number of boats that can safely use the reservoir at one time is **42 boats**  
Actual use is 44

**Spatial Capacity during the Peak Day:**

$\frac{44 \text{ boats in Use}}{42 \text{ Optimal number}} = 105\% \text{ of Spatial Capacity}$

**Spatial Capacity during the Average High-Use Day:**

$\frac{29 \text{ boats in Use}}{42 \text{ Optimal number}} = 69\% \text{ of Spatial Capacity}$

**Limiting Factor**

Boating at Stagecoach is **at spatial capacity** with a **moderate level** of concern

### **Social Capacity**

Data on visitors' perceptions of the level of crowdedness are not available at this time. However, a 2008/2009 Marketing Assessment Study, conducted by Corona Insight, included visitor surveys from each park, which provide subjective data in which to draw conclusions from. Stagecoach State Park staff gathered 216 surveys, which provided a wealth of visitation data. Some of the key findings related to social capacity outlined in the 2009 Corona Insight Visitor Intercept Survey are provided below:

- 77% of respondents rated "Scenery / Surroundings" as very important in terms of their overall quality of experience while visiting, ranking 28<sup>th</sup> out of 42 state Parks. In addition, 78% of respondents were very satisfied with the "Scenery / Surroundings" feature of Stagecoach State Park, ranking 26<sup>th</sup> out of 42 state Parks.
- 81% of respondents rated "Cleanliness" as very important in terms of their overall quality of experience while visiting, ranking 28<sup>th</sup> out of 42 state Parks. In addition, 75% of respondents were very satisfied with the "Cleanliness" feature of Stagecoach State Park, ranking 28<sup>th</sup> out of 42 state Parks.
- 71% of respondents rated "Recreational Activities" as very important in terms of their overall quality of experience while visiting, ranking 5<sup>th</sup> out of 42 state Parks. In addition, 60% of respondents were very satisfied with the "Recreation Activities" feature of Stagecoach State Park, ranking 19<sup>th</sup> out of 42 state Parks.

Table 7 shows selected answers to question 26 of the Corona Survey, “How would the following feature alter the number of times you visit this state park?”:

**Table 7: How would the following feature alter the number of times you visit this state park?**

Feature	Greatly Increase	Slightly Increase	No Difference	Decrease Visits	Don't Know / NA	Rank among 42 State Parks
More natural / primitive experience	13%	23%	53%	2%	8%	35
Easier / improved boating access	9%	19%	58%	2%	12%	22

Further, while 77% of respondents reported that scenery and surroundings was very important, this only ranked 28<sup>th</sup> among all state parks and an increase in the natural experience does not translate to an increase in visits from the majority of visitors. In addition, there does not seem to be a perceived need for an increase of or improved boating access. The results from the Corona study seem to lead to a conclusion that Stagecoach State Park has not reached its social capacity.

Another more approach to evaluating social capacity is through the use of the Water Recreating Opportunity Spectrum (WROS). The WROS was developed by Aukerman, Haas, and Associates in cooperation with the US Department of the Interior, Bureau of Reclamation. The spectrum offers a tool to understand the type and location of six types of water related recreation opportunities, otherwise known as WROS classes. The six WROS classes range across a spectrum of urban, suburban, rural developed, rural natural, semi-primitive, and primitive classes.

Table 9 describes each of the WROS classes and shows the corresponding recommended boating densities. According to the WROS, the current boating densities at Stagecoach correspond to the suburban level of development during the busiest day. An addition of only five boats during the average weekend would tip the Average High-Use day to the classification of “Suburban.” Considering the remote and natural setting, one might assume that the reservoir should be considered a “Rural Developed” or even a “Rural Natural” setting. Table 8 shows the density of boats in use during the peak day, the average high use day, and the average during the peak season.

**Table 8: Boating Densities at Stagecoach Reservoir**

	Number of Acres	Number of Boats	Boating Density (acres/boat)	WROS Designation
Peak Day (June 20, 2010)	685.3	44	15.6	Suburban (34 – 68 boats)
Average High-Use Day	685.3	29	23.6	Rural Developed (14 – 33 boats)
Average Day	685.3	21	32.6	Rural Developed (14 – 33 boats)

**Table 9: Water Recreation Opportunity Spectrum**

<b>Setting</b>	<b>Description</b>	<b>Acres/ boat</b>	<b>Approx. # of Boats at STG</b>
Urban	<ul style="list-style-type: none"> <li>Limited opportunities to see, hear, or smell the natural resource due to the extensive level of development, human activity, and natural resource modification.</li> <li>Watching and meeting other visitors is expected and socializing with family and friends is important.</li> <li>Diverse range of visitors and activities, including large groups and special events.</li> <li>Convenience is central and dominant.</li> </ul>	1 – 10	More than 68 boats
Suburban	<ul style="list-style-type: none"> <li>Limited or seldom opportunities to see, hear, or smell the natural resources due to the widespread and prevalent level of development, human activity, and natural resource modification.</li> <li>Watching and meeting other visitors is expected and socializing with family and friends is important.</li> <li>Diverse range of visitors and activities.</li> <li>Convenience is central and dominant.</li> </ul>	10 – 20	34 – 68 boats
Rural Developed	<ul style="list-style-type: none"> <li>Occasional or periodic opportunities to see, hear, or smell, the natural resources due to the widespread and prevalent level of development, human activity, and natural resource modification.</li> <li>Brief periods of solitude are important though the presence of other visitors is expected.</li> <li>Diverse range of visitors and activities.</li> <li>A moderate level of comfort and convenience is important.</li> </ul>	20 – 50	14 – 33 boats
Rural natural	<ul style="list-style-type: none"> <li>Frequent opportunities to see, hear, or smell the natural resources due to the common and frequent level of development, human activity, and natural resource modification.</li> <li>A sense of independence and freedom with a moderate level of management presence is important.</li> <li>Diverse range of visitors and activities though experiences tend to be more resource-dependent.</li> <li>Comfort and convenience is not important or expected.</li> </ul>	50 – 110	7 – 13 boats
Semi-Primitive	<ul style="list-style-type: none"> <li>Widespread and very prevalent opportunities to see, hear or smell the natural resources due to the seldom or minor level of development, human activity, and natural resource modification.</li> <li>Solitude and lack of contact with other visitors, managers, and management is important.</li> <li>Opportunities for adventure-based enthusiasts and overnight visitors.</li> <li>A sense of challenge, adventure, risk, and self-reliance is important.</li> </ul>	110 – 480	2 – 6 boats
Primitive	<ul style="list-style-type: none"> <li>Extensive opportunities to see, hear, or smell the natural resources due to the rare and very minor level of development, human activity, and natural resource modification.</li> <li>Solitude and lack the lack of the sight, sound, and smells of others is very important.</li> <li>Opportunities for human powered activities (e.g. canoeing, fly fishing, backpacking, etc.)</li> <li>A sense of solitude, peacefulness, tranquility, challenge, adventure, risk, testing skills, orienteering, and self-reliance is important.</li> </ul>	480 – 3,200	Less than 2 boats

During the average day and average high-use day at Stagecoach, the boating densities are comparable to Aukerman’s WROS boating densities for a “Rural Developed” setting. This setting is characterized as having “occasional or periodic opportunities to see, hear, or smell the natural resources due to widespread and prevalent development, human activity, and natural resource modification.” However, on the high-use days and the peak day, the densities reach the level of a “Suburban” setting where there are “limited or seldom opportunities to see, hear, or smell the natural resources due to the widespread and prevalent level of development, human activity, and natural resource modification.” A “Rural Natural” setting is 4-5 times less dense and offers “frequent opportunities to see, hear, or smell the natural resources due to the occasional or periodic level of development, human activity and natural resource modification.”

In addition, the highly irregular shoreline may increase the number of conflicts among users of the resource. Some visitors have complained that water-skiers come too close to fishing boats, or that fishing boats should not be allowed in the wake-zone. These kinds of conflicts between competing user groups will only increase as density increases.

Combining the desired character of the park and user conflict issues with the Corona study results, leads to the conclusion that **Stagecoach is approaching its social capacity as a part of the overall boating capacity. Social capacity is a limiting factor with a low level of concern.**

**Boating Social Capacity Summary**

Capacity in regards to visitors’ perception of crowding. Social capacity is defined by the specific user group of each specific lake. Social capacity may but not always impact the users’ enjoyment of the recreational resources. Social Capacity is reached when conflict arises or when users choose not to utilize the resource.

- **Increasing boating densities during the peak season is changing the character of the reservoir from a “rural developed” feel to a “suburban” feel.**
- **The majority of park visitors ranked scenery/ surroundings, cleanliness, and recreation activities as very important features.**
- **36% of visitors would increase their visitation if the park offered a more natural/primitive experience.**
- **28% of visitors would increase their visitation if the park offered easier or improved boating access.**
- **The highly irregular shoreline decreases usable surface area and increases chance for conflicts among competing users of the resource.**

**Limiting Factor**

Boating at Stagecoach is **approaching social capacity** with a **low level of concern**

## VI. Overall Recreational Boating Capacity Conclusion

The overall recreational boating capacity is a combination of the four capacity categories, ecological, facility, spatial and social capacity. Visitor capacity determination is never purely objective, but is used as a tool to help balance boating use alongside safety, visitor experience, and other important natural resource considerations. Conserving park resources, and maintaining a high quality visitor experience is essential if Colorado’s state parks are to be sustained into the future.

Looking at four different components of boating capacity at Stagecoach, leads to the conclusion **that the reservoir is near or at boating capacity**. While boater levels have not necessarily exceeded the overall boating capacity at the reservoir, any future management decisions that may potentially affect boating capacity elements should be carefully considered prior to being implemented.

**Ecological Capacity.** As of 2010, this study finds Stagecoach Reservoir to be at ecological capacity with a moderate level of concern. Ecological capacity is considered a limiting factor to the overall boating capacity, as increased boating activity could exacerbate the observed ecological impacts. This conclusion is largely due to the changes to the shoreline and vegetation from the dam construction. Ecological capacity should be reevaluated after vegetation reestablishes and the shoreline is stabilized.

**Facility Capacity.** Stagecoach is approaching facility capacity but this is not a limiting factor to overall use because of significant flexibility in overflow parking and other management interventions. On the busiest day of the 2010 season, the Marina lot was full but the overall facility capacity throughout the park was at 73% capacity when including all overflow lots. While the existing facilities can handle more boats, it is important to note that there are plans for additional boating facilities as a part of future planned development on the south shore.

**Spatial Capacity.** Spatial capacity is determined from an acceptable amount of boating density on the reservoir. While based on a number of studies, spatial capacity is still a subjective process. Based on an acceptance of a fairly low level of density, boating use at the reservoir reached 105% of spatial capacity on the busiest day of the 2010 season. Therefore, this studies finds the Stagecoach Reservoir at spatial capacity with a moderate level of concern. However, during the majority of the summer, boating use at Stagecoach exists comfortable under the spatial capacity threshold as defined in this study.

**Social Capacity.** Social Capacity is based on visitors' perception of crowdedness. It is the tolerance of visitors to share the resource with others. Based on available data, Stagecoach Reservoir is approaching its social capacity. Based on the Water Recreation Opportunity Spectrum (WROS) develop by Auckerman et al. Stagecoach would be considered a "suburban" reservoir during the Peak Day. An addition of only five boats during the average weekend would tip the Average High-Use day to the classification of "Suburban." Considering the remote and natural setting, one might assume that the reservoir should be considered a "Rural Developed" or even a "Rural Natural" setting.

In conclusion, ecological, spatial, and social capacities should be considered limiting factors at this time. In addition, facility capacity is approaching its limit. Management must take into consideration increased risk of ecological impact and diminished safety, and overall visitor experience if boating densities are increased in the future. **Stagecoach Reservoir is at or near boating capacity with a moderate level of concern.** This capacity determination should not be viewed as a "cap" or limit to boating use, but rather as a tool to better understand boating use and preferences at Stagecoach.

*This boating capacity study was developed especially for Stagecoach State Park and many of the standards and thresholds highlighted herein may/may not be applicable to other boating reservoirs. In addition, some thresholds defined in this study may change over time as the boating use characteristics and visitor preferences at Stagecoach change. Finally, reaching carrying capacity in a given category or overall, does not necessitate visitor reductions or site closures, only that management decisions must be carefully evaluated in order to protect the boating experience and resource in question.*

While Stagecoach Reservoir may be able to accommodate more boating use, any such increase may result in ecological impacts; increased wait times and parking congestion; safety risks and user conflicts; and a change in the look and feel of the natural setting. Any additional facilities to accommodate boating (e.g. parking or an additional marina), could result in heightened impacts to shoreline resources, the visitor experience, and the visitors' ability to comfortably partake in their chosen recreational activity. Altering the reservoir's buoy line should also be considered within the context of subsequent impacts to spatial, social, and ecological capacity.

*“Any additional facilities to accommodate boating (e.g. parking or an additional marina), could result in heightened impacts to shoreline resources, the visitor experience, and boater safety. Altering the reservoir's buoy line should also be considered within the context of subsequent impacts to spatial, social, and ecological capacity.”*