Carrying Capacity Study of Silver Glen Spring and Run

DEP Contract Number SL 982

Final Report

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By Pandion Systems, Inc.

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Carrying Capacity Study of Silver Glen Spring and Run
(Ocala National Forest, Florida)

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Executive Summary

Introduction and Methods

Silver Glen Spring is a natural hydrologic gem whose beauty rivals any spring in Florida. However, misuse and overuse are degrading its health and beauty. Without proactive management Silver Glen Spring and Run may become permanently damaged and lose its unique values. To address those concerns, the Florida Department of Environmental Protection (DEP) contracted with Pandion Systems, Inc. to conduct a *Carrying Capacity Study of Silver Glen Spring and Run* with the following key tasks:

- Conduct baseline vegetation and recreation impact survey
- Conduct vegetation regrowth research
- Conduct recreation surveys
- Analyze the results of vegetation and recreation research
- Create a bathymetry map of the run
- Develop carrying capacity and management recommendations that include a mooring buoy plan

The field component of the study occurred during January-May of 2003. During that time, the submerged aquatic vegetation (SAV) communities were mapped using GIS technology for the entire length of the run. Information on species composition, percent cover, relative health/condition, substrate type, and approximate depth were collected for the vegetation. In addition, recreation use patterns and impacts from boaters and swimmers/waders were also documented and mapped. The impacts observed included propeller scars, anchor pits, grass chopping and trampling. Exclusion cages and surface buoy quadrats were also installed to study regrowth of the SAV but with limited success because of damage and vandalism.

The majority of the field data was collected using a boat with a laptop computer loaded with ArcPad 6.0 connected to a Trimble Pro XR GPS receiver. This enabled accurate in the field mapping and data transfer into ESRI ArcGIS 8.0 to generate different data layers and/or maps for analysis. Analysis was completed using the data collected by the study team in conjunction with a bathymetry map developed from data collected by the USDA Forest Service (USFS).

Results/Discussion

Rooted submerged aquatic vegetation (SAV) covered 31%, or 6.7 acres of the 21.88 acre Silver Glen Spring and Run. The SAV species observed include: *Vallisneria americana (*eelgrass), *Myriophyllum spp* (water milfoils), *Hydrilla verticillata* (hydrilla), *Eleocharis spp* (spikerushes), *Ceratophyllum spp* (coontails), and *Sagittaria kurziana* (strap-leaf sagittaria).

Non-native hydrilla was present in 20.6% or 4.5 acres of the run. It was noted as the dominant species in 5.2% or 1.1 acres of the run. The hydrilla is a major concern due to its ability to spread rapidly and out-compete native vegetation. If hydrilla continues to

spread, it has the potential to become the dominant species in the run, thereby destroying the native ecosystem. Unrooted algae mats were dominant in 6.8% or 1.5 acres of the run. In some of the areas where algae was dominant, it was found in large, dense mats that were sometimes more than 2 feet thick.

A great diversity of fish and wildlife including mullet (*Mugil cephalus*), jack crevalle (*Caranx hippos*), tilapia (*Oreochromis aureus),* Florida gar (*Lepisosteus platyrhincus*), Florida largemouth bass (*Micropterus salmoides floridanus*), and wildlife including redbelly turtles (*Pseudemys nelsoni*), peninsula cooters (*Pseudemys floridana peninsularis*), common musk turtles (*Sternotherus odoratus*), American alligators (*Alligator mississippiensis*), ospreys (*Pandion haliaetus*), bald eagles (*Haliaeetus leucocephalus*), great blue herons (*Ardea herodias*), great egrets (*Casmerodius albus*), little blue herons (*Egretta caerulea*), green herons (*Butorides striatus*), double-crested cormorants (*Phalacrocorax auritus*), American anhingas (*Anhinga anhinga*), red shouldered hawks (*Buteo lineatus*), mallard ducks (*Anas platyrhynchos*) , purple gallinules (*Porphyrula martinica)*, coopers hawks (*Accipiter cooperii*), river otters (*Lutra Canadensis*), wild boar (*Sus scrofa*), and grey fox (*Urocyon cinereoargenteus*) were also observed. Eleven manatees were seen using the run during January - March 2003.

Despite vandalism and damage to the vegetation exclusion cages, the results showed increases in vegetation growth in all four plots that were able to be used for the research (between 63% and 333% increases). This indicates that when boats and trampling impacts are minimized, the vegetation in the run will regenerate.

The main types of recreation observed were swimming, fishing and boating. Swimmers at Silver Glen have two areas they can use to access the spring and run, 1) from land via the USFS recreation area and 2) from boats. Several types of fishing were observed in the run: rod and reel, bow hunting, and cast netting. All fishing was done from boats and each type utilized different areas of the run and created varying levels of impact. A large range of powerboat types and sizes were seen ranging from small runabouts under 17 feet to houseboats 60 feet in length. Many cabin cruisers and houseboats stayed in the run for several days at a time. Day use boaters utilized the run every day of the year. The use level depended on the time of year, time of week, and weather. Use was heaviest on summer holiday weekends such as Memorial Day, Fourth of July, and Labor Day when as many as 200 boats could be found in the run.

Much of Silver Glen Spring Run showed impacts from recreation. Since the run is only 200 feet wide on average and approximately 3,300 feet long, impacts covered the majority of the area. In most of the run area the eelgrass exhibited some type of direct or indirect mechanical damage due to propeller impacts from boats. Most of the damaged eelgrass showed little or no evidence of successful flowering. Anchors caused scars to the sediment and to the vegetation in the form of drag marks or pits. Although swimming generally caused little impact on vegetation, wading caused trampling of native grasses. Areas near the spring boil where visitors accessed the water from the USFS visitor area were heavily trampled and much of the area was devoid of vegetation. This was also the

case with the open sand area in the western part of the run where boaters preferred to anchor.

In addition to the impacts to vegetation, there are other important considerations for Silver Glen Spring and Run that include direct and indirect impacts to native wildlife, safety for visitors due to large numbers of people and alcohol, and impacts to the recreation experience of the users.

Recommendations

Recommendations for managing Silver Glen Spring Run were based on the mapping analysis and observations made during the research as well as discussions with the DEP. The management recommendations are a framework to begin recovering spring's vegetation while providing continued recreation opportunities. Any management option employed should be done in combination with aggressive hydrilla control in order to prevent the spread of this invasive aquatic plant. Any implemented recommendation will require monitoring and adaptive management to ensure its success. Determining a final and accurate recreation carrying capacity for the area will require time and close attention to the changes in both recreation patterns and the ecology of the area.

Four options were created to address the management needs and carrying capacity of Silver Glen Spring and Run.

Management Option 1: No Action: Current Management Continues

Silver Glen Spring and Run would remain in its current management state. All types of recreation would be allowed. The swimming area would stay the same and boaters would be allowed to anchor and travel throughout the run.

Management Option 2: Mooring Buoy Plan

Option 2 would implement a zoning system to provide recreation opportunities while also protecting and restoring the native aquatic ecosystem. The zones are:

Zone 1: Swimming and Wading
Zone 2: Vegetation Restoration
Zone 3: Mooring Area
Zone 4: Travel and Fishing Area

The mooring zone would be placed in an area that currently contains deeper waters and moderate vegetation impacts. This area is also close enough to the spring and land-based recreation that visitors still have sufficient access to services, facilities, and recreation opportunities. A Bahamian-style mooring system would be employed for much of the mooring area. This allows one mooring for the bow and one for the stern of the boat. Rafting of vessels – where vessels tie up to each other –would be allowed in order to minimize the number of mooring buoys needed for the mooring zone. The maximum number of boats that could be moored using this system is between 78 and 108, depending on the size of the boats. There would be mooring sites for 46 boats under 25 feet in length, and for 31 boats 26-39 feet in length. Higher numbers of boats could be

accommodated (closer to 108) if small boats moored in the large boat slots and rafted to one another.

Management Option 3: Close Silver Glen Spring and Run to Motorized Boats
This study documented that there are ecological impacts from boater and swimmer recreation throughout the run. Under this option swimming would be restricted to the springhead only and would only be accessed from the USFS' current recreation area. All motorized boats would be prohibited from the western two thirds of the run starting immediately to the west of the Juniper Hunt Club boat dock. Anchoring would be prohibited.

Management Option 4: Mooring buoy plan with seasonal closure of Silver Glen Spring and Run
This option is a combination of Option 2 and 3 where the mooring plan would be implemented but Silver Glen Spring and Run would be closed to all motorized traffic from October to March to give the spring and run time to recover.

Conclusions
Silver Glen Spring is a unique recreation area that holds great ecological and recreation value. With increasing visitation to natural areas via water and land, management of the recreation and ecology of the area is needed if the integrity of Silver Glen Spring is to be preserved. Although the spring has endured many changes in human use over time, it has never appeared as threatened as it does now. If the pattern of increased use and hydrilla spread continues without any management intervention, Silver Glen is in serious peril. Active, flexible management combined with ecosystem monitoring is needed in order to restore the ecology of Silver Glen while providing a safe, nature-based recreation experience to the thousands of visitors that come there every year. With continued work and care for the ecosystem a balance can be struck.

Introduction

> "He reached the thick-bedded sand of the Silver Glen road. The tar-flower was in bloom, and fetter-bush and sparkleberry. He slowed to a walk, so that he might pass the changing vegetation tree by tree, bush by bush, each one unique and familiar.
> …The east bank of the road shelved suddenly. It dropped below him twenty feet to a spring. The bank was dense with magnolia and loblolly bay, sweet gum and gray-bearded ash. He went down to the spring in the cool darkness of their shadows. A sharp pleasure came over him. This was a secret and a lovely place.
> A spring as clear as well water bubbled up from nowhere in the sand. It was as though the banks cupped green leafy hands to hold it. There was a whirlpool where the water rose from the earth. Grains of sand boiled in it. Beyond the bank, the parent spring bubbled up at a higher level, cut itself a channel to make a creek. The creek joined Lake George, Lake George was a part of the St. John's River, the great river flowed northward and into the sea. It excited Jody to watch the beginning of the ocean. There were other beginnings, true, but this one was his own. He liked to think that no one came here but himself and the wild animals and the thirsty birds."
>
> - Excerpt from Chapter 1 of *The Yearling* by Marjorie Kinnan Rawlings, 1938

Silver Glen Spring is a natural hydrologic gem whose beauty rivals any spring in Florida. Silver Glen Spring and its run have some of the highest ecological and historic values of any Florida spring including Native American shell middens, abundant native fish, and abundant wildlife. However, misuse and overuse are degrading its health and beauty. Without proactive management Silver Glen Spring and Run may become permanently damaged and lose its unique values.

Silver Glen Spring is a popular recreation site located on the border of Marion and Lake Counties on the eastern edge of the Ocala National Forest, Florida (see photos, Appendix A). It is one of Florida's 33 first magnitude freshwater springs, and flows at a rate of 112 cubic feet of water per second. The springhead bubbles up and forms a semicircular pool 200 feet in diameter that flows eastward for 3,300 feet through an approximately 200 foot wide run bordered with bottomland and floodplain forest. The springhead and run encompass 21.88 acres. The run empties into Lake George, the second largest lake in Florida. The springhead's shoreline is covered with a mesic forest that contains shell

middens, remnants of Native American cultures that once thrived in the region. The spring has had a long history of recreation and human interaction. In 1992 the USDA Forest Service (USFS) purchased the upland and wetland portions to the north of the run because many years of overuse and mismanagement by private landowners that threatened the natural integrity of the area. Today, these northern portions of Silver Glen are still owned by the USFS and are managed by their concessionaire, Recreation Resource Management (RRM). The land to the south of the run is owned and managed privately by the Juniper Hunt Club. The Florida Department of Environmental Protection manages the sovereign submerged lands of the run.

In 2002, Silver Glen received over 39,000 visitors to the USFS recreation area (RRM 2003), indicating it is a very popular destination site within the forest. Most of the 39,000 visitors access the area via land. Silver Glen Spring Run is a favorite boating destination- large numbers of boats use the run throughout the year, accessing it from Lake George. On holiday weekends in the summer as many as 200 boats can be found anchored in its waters (Appendix A). Limited sanitary facilities and the large numbers of people contribute to concerns about the spring area's water quality and ultimately its long-term health. Trampling, anchors, and propellers from the current recreation uses are causing serious damage to the native aquatic plants that are a major component of the natural scenery, ecology and manatee habitat. In addition, motorboats and foot traffic are spreading hydrilla, an invasive exotic aquatic plant, in the spring run.

In October of 2002 DEP contracted with Pandion Systems, Inc. to conduct a Carrying Capacity Study of Silver Glen Spring and Run with the following key tasks:

- Conduct a baseline vegetation and impact survey
- Conduct vegetation regrowth research
- Conduct recreation surveys
- Analyze the results of vegetation and recreation research
- Create a bathymetry map of the run
- Develop carrying capacity and management recommendations that include a mooring buoy plan

The overall objective of the project was to determine the types of uses and intensity of these uses that are compatible with the ecology and aesthetics of the spring and the 3,300 foot run. Two specific objectives were the focus of the Pandion study:

1. To characterize the existing condition of aquatic vegetation in the spring and run
2. To evaluate the specific effects of current recreation use on the vegetation

Based on detailed evaluation of the spring and run and discussions with DEP, Pandion developed carrying capacity criteria and management recommendations.

Project Approach

Data Collection

Baseline Vegetation and Impact Mapping

A baseline vegetation map was created to identify and delineate all submerged aquatic vegetation (SAV) communities within the spring and run. This mapping was completed between January- March 2003. The SAV communities for the entire length of the spring run including native and exotic species were mapped. Information on species composition, percent cover, relative health/condition, substrate type, and approximate depth were collected for the vegetation.

This was done by physically traversing the perimeter of each SAV community with a Trimble Pro-XR GPS receiver mounted on a boat and connected to a laptop computer loaded with ESRI's ArcPad 6.0. This allowed data points and attributes to be spatially linked, collected and immediately transferred to pre-loaded aerial photographs on the laptop. All data were entered directly into attribute tables associated with each individual vegetation polygon. Because of this unique field data collection system, researchers were able to map and digitize with spatial accuracy of less than one meter. Biological/ ecological data were linked into the digital map via customized pull-down screens.

Recreation Use Patterns and Impact Mapping

Recreation use patterns were documented and mapped using the same GPS/GIS technology described above. During the January – March 2003 period when vegetation was being mapped, records were kept of boat visits and boat travel patterns. Major boat routes into and within the run were noted. GPS locations of boat mooring were collected, and boat locations and approximate boat size were noted. Observations were also made on preferred fishing zones within the run. In addition, recreation impacts were recorded using the Trimble Pro-XR GPS unit. Impacts from boats including prop scars, anchor pits, and grass chopping were mapped as points, lines, and areas.

Vegetation Growth Research

Vegetation regrowth was monitored by installing six exclusion cages, which were placed in high, medium, and low impacted areas in the run from February - May 2003. Exclusion cages are a common technique for measuring vegetation regrowth while protecting an area from impacts, in this case trampling, prop scarring, and anchor pits. In this study, the cages consisted of rubber coated metal enclosures with a top that measured 2'x 3' and sides that sat 8" above sediment grade when installed (Appendix A). The cage had openings 3"-4" wide to allow for *Vallisneria americana*, hereafter referred to as eelgrass, (the largest blade width SAV in the run) to grow through without any hindrance. The cages had 5" anchors along their bottom edges that submerged into the substrate to keep them in place. Each corner of the cage was further anchored into the substrate with a 3' section of rebar. Two of the rebar pieces on each cage (set in diagonal corners) had triangle inverted wings that when set into the substrate sat approximately 2' under ground. These were placed to help further secure the cages and discourage their removal. Cages were modified to sit close to the substrate and were intended to protect the roots of the grasses, and allow natural colonization and spreading while protecting the plant from being uprooted by recreation impacts. Typically small areas of grasses or the transitional lines between the vegetative community and the substrate were protected to observe natural growth patterns.

In addition to the exclusion cages, Pandion placed a study plot consisting of a 5'x5' buoyed quadrat exclusion zone in the run in April 2003 to measure grass growth when boats were redirected from the area. The buoys marking the plot made it necessary for boats to avoid the area. The 5'x5' plot stayed in the water for four weeks and after one week the eelgrass within the plot and to the west of the plot showed signs of linear growth and increased flowering.

Because of the small size of the spring run (21.88 acres), the number of people using the area, the clarity of the water, and the displeasure some boaters expressed about the study, the potential for vandalism existed. Measures were taken to conceal the exclusion cages

including giving them a rubberized coating to help them blend into the substrate and designing them to lay only a few inches (6-8) above the substrate. Magnetic points were placed into the substrate at the center of each of the cages subsequent to their placement to assist with relocating the research site if the cage was removed.

Despite efforts to conceal the six cages, all but two were found and vandalized and/or removed from the run. One of the cages was returned to RRM staff. Two of the cages were returned to Pandion by a boater. The other missing cage was not returned although a photo of it was distributed via email by the same boater who returned the other two. The boater did not return this photographed cage to Pandion or to the DEP and it remained "missing" for the duration of the research. By the end of the research, two cages remained in the run (one was replaced following its removal and one was never removed), and one remained in the area buffered from boats near the swim area and springhead until a swimmer removed it 4-6 days prior to research completion. Unfortunately the damage to the removed cages, along with time lost retrieving cages, made it impossible to replace all of them and preserve the integrity of the data collection. Therefore, only three cage sites and the buoyed plot were usable for the study.

Following episodes of vandalism and complaints from boaters in April 2003 regarding the cages, signs were placed on each of the remaining cages that read "DEP research do not touch" and "Removal may prolong research." In addition, orange buoys were placed above the two cages in the run and "DEP research do not touch" was written on each one. The same words were written on the orange buoys at the 5'x 5' buoyed plot (which already had the "Do not touch" signs) after vandalism occurred there. The cages and buoyed plot were left alone following these adjustments, however the buoys marking the cages were pulled out twice and found floating nearby.

Fish and Wildlife

Although the primary focus of the study was a vegetation analysis, the occurrence of fish and wildlife were recorded during vegetation and recreation surveys. General observations on their response to human activity were noted.

Mapping

Vegetation and Recreation Data

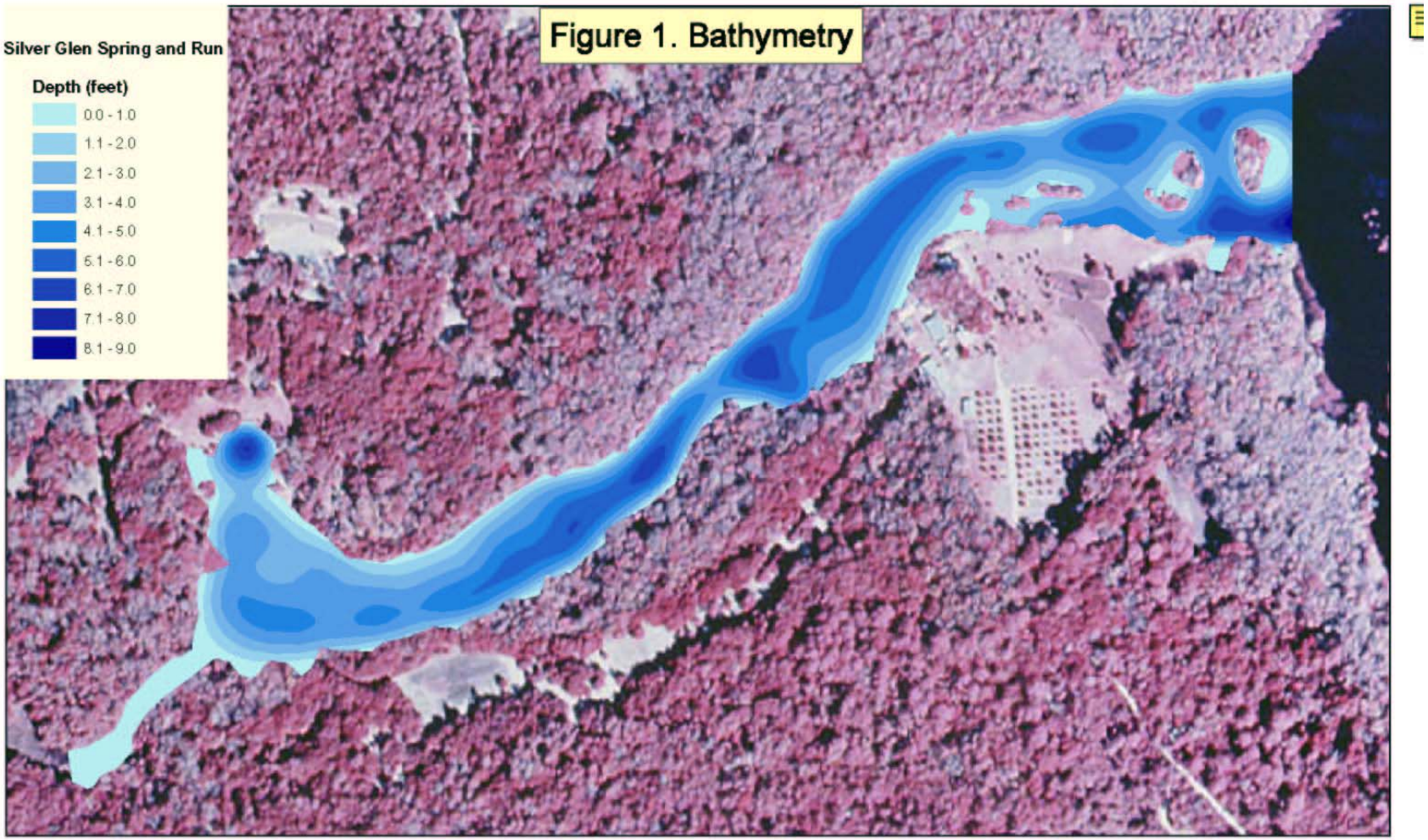
Following the data collection, data from ArcPad 6.0 were exported into ESRI ArcGIS 8.0 to generate different data layers and/or maps for analysis. The layers collected include:

- Submerged aquatic vegetation species composition
    - Percent cover of vegetation, water flow, hydrilla presence
- Recreation impacts to vegetation
- Areas where manatee were observed and their movement patterns
- Areas where recreation activity was observed including boating, swimming, and fishing

Bathymetry

A key component to the study was to create a bathymetry map of the run. This was done using data collected by the USFS. Three hundred data points were collected by the USFS in 2002 and another 300 were collected in April 2003 using a Trimble GPS unit and depth measuring equipment. A bathymetry map was developed from this information using GPS spot depth, shoreline and island data collected by the USFS. The spot depth data layer consisted of point locations, and the shoreline and islands were provided as polygon layers. The shoreline and island polygon vertices were converted to points of zero depth, and combined with the spot depth points. This combined point layer was interpolated into a continuous raster surface of the spring run. This was accomplished with ESRI's Spatial Analyst for ArcGIS using a regularized spline raster interpolation method. The shoreline of the run and the islands were then used as a "Mask", or "Cookie-cutter", not allowing the depth surface to have values outside the run or on an island. This one-meter grid of interpolated depth was then converted to vector "line" contours in six-inch intervals via the Spatial Analyst's Surface Analysis Toolset. Additionally, a "polygon" version of the six-inch contours was created using ESRI's GridPoly command within the Spatial Analyst's Raster Calculator. This enabled a polygon overlay of the bathymetry data with the SAV data.

Figure 1 Bathymetry Map



Results and Discussion

Current Ecological Conditions in the Run

Vegetation

Rooted SAV covers 31%, or 6.7 acres, of Silver Glen Spring Run. The entire run is 21.88 acres. Figures 1 and 2 show the dominant SAV species and percent cover of SAV. The SAV species observed include:

- *Vallisneria americana (*eelgrass)
- *Myriophyllum spp* (water milfoils)
- *Hydrilla verticillata* (hydrilla)
- *Eleocharis spp* (spikerushes)
- *Ceratophyllum spp* (coontails)
- *Sagittaria kurziana* (strap-leaf sagittaria)

The majority of the rooted SAV observed consisted of *Vallisneria americana*. The eelgrass was the dominant species in 46%, or 10 acres, of the run. Table 1 shows the vegetation type and percent cover in acres.

Table 1. Type and percent cover of submerged aquatic vegetation in acres*

	Number of Acres in Each Percent Cover Category				
Species	**>75%**	**50-75%**	**26-50%**	**<5-26%**	**Total**
Vallineriai americana	3.42	2.83	3.77	0.00	10.02
Eleocharis spp.	0.001	0.01	0.03	0.00	0.04
Algae	1.49	0.00	0.00	0.00	1.49
Hydrilla verticillata	0.04	0.01	1.06	0.03	1.14
Myriophyllum spicatum	0.00	0.00	0.00	0.004	0.004
Sand and Loose *Algae*	2.38	0.00	0.00	0.00	2.38

* The acreage is based on areas where the vegetation type was the dominant species. Other species may have occurred in some of these areas, but were not dominant. The remaining acreage consisted of bare ground.

The condition of the eelgrass varied within the run. In most of the run area the grass exhibited some type of direct or indirect mechanical damage due to propeller impacts from boats including chopping, breaking, cutting, and pulling (Appendix A). Eelgrass propagates both by rhizomes extending from the roots underground and by seed dispersal from flowering stalks that extend from the base of the plant upward (Godfrey and Wooten 1979)- typically to the surface of the surrounding water body. The eelgrass was flowering in only a few places in the run. These areas were usually located outside of the main boat traffic area. Most of the eelgrass with high amounts of damage from propeller chop showed little or no evidence of successful flowering. When boat propellers were observed encountering the flowering stalks, the stalks often became wrapped around the propeller and the result was a tearing of the stalk or, often, removal of the entire plant from the substrate (Appendix A). Once the grass was uprooted, the plant was observed floating to the surface (preventing it from re-rooting along the substrate) and frequently getting caught in areas of poor circulation where decaying vegetation settled out and created soft substrate unsuitable for reestablishment of native SAV grasses.

Throughout the run, 21.3% or 4.7 acres, contained non-native *Myriophyllum*, water milfoil, although it was only dominant in <.5 acres of the run.

Non-native hydrilla was present in 20.6%, or 4.5 acres, of the run (Figure 8). It was noted as the dominant species in 5.2%, or 1.1 acres, of the run. The hydrilla is of major concern due to its ability to spread rapidly and out-compete native vegetation. If hydrilla continues to spread, it has the potential to become the dominant species in the run, thereby destroying the native ecosystem.

Algae was present on eelgrass communities to varying degrees throughout the run. A few areas exhibited very low algae cover. These areas were generally in higher-flow areas of the run, which also tended to correlate with greater water depths. Unrooted algae mats were dominant in 6.8%, or 1.5 acres, of the run (Figure 2). In the areas where algae was dominant, it was found in large, dense mats that were sometimes more than 2 feet thick. The algal areas blocked sunlight thus out competing native grasses and other

vegetation. In some areas the algae had smothered all other vegetation to the point where anaerobic conditions existed and hydrogen sulfide bubbled up from the mats when disturbed. Algae was also found occupying bare substrate in 10.9%, or 2.4 acres, of the run; in some areas the density of these algal clusters was greater than 70% of the bare substrate. Significant temperature rises of more than 10 degrees Fahrenheit were measured over areas where the flow was low, the waters shallow, and algae mats were present. Most of the eelgrass in the run showed some growth of algae on the blades.

Fish

Large schools of native fish including striped mullet (*Mugil cephalus*), jack crevalle (*Caranx hippos*), and ladyfish (*Elops saurus*) were commonly seen in the run. Only the mullet were consistently present though, and their numbers varied from day to day. Large schools of the non-native tilapia (*Oreochromis aureus)* were also seen. These fish were seen in schools of 100 or more individuals and created very large (2 foot diameter) nests in the eelgrass. Their preferred nesting area was the same as the bass. There were also several non-native Orinoco sailfin catfish (*Pterygoplichthys multiradiatus)* seen feeding on algae and detritus. Three Florida gar (*Lepisosteus platyrhincus*) were seen regularly near the water's edge in the spring boil area. Four more Florida gar were seen hunting near the Juniper Club's boat ramp. Florida largemouth bass (*Micropterus salmoides floridanus*) were seen as large adults and juveniles throughout the run. Nests were often noticed within the eelgrass throughout the run. A large striped bass (*Morone saxatilis*) was observed deep within the main spring boil on three separate occasions. Three species of sunfish (*Lepomis sp*) were regularly observed along with killifish (*Fundulus sp*), mosquito fish (*Gambusia sp*) and shiners (*Notropis sp*). Rays were also spotted throughout the run. Most of the fish observed were in the native beds of eelgrass, and were very rarely observed on barren sands or in hydrilla beds. Tilapia, however, were observed in both areas of native and exotic SAV.

Wildlife

Reptiles

Turtles including Florida redbelly turtles (*Pseudemys nelsoni*) and Peninsula cooters (*Pseudemys floridana peninsularis*) were often observed in the water and sunning on logs. Common musk turtles (*Sternotherus odoratus*) were seen in the perimeter of the area surrounding the springhead. A large Florida softshell turtle (*Apalone ferox*) was observed burrowing underneath an algal mat. American alligators (*Alligator mississippiensis*) were commonly seen basking on logs and the banks along the spring run. Most observed were under six feet in length with several clutches of individuals under two years old seen in the emergent vegetation and on the small islands and spring run banks near the Juniper Club. These areas are visited less often by boaters and provide more security for the animals. Larger alligators were seen and a couple of rather large individuals (reported by RRM as 13 feet in length) were captured and removed from the swimming area near the boil. Boaters reportedly harassed one large alligator for a period of time while it was attempting to head downstream in the run after being fed by people recreating in the area (RRM 2003).

Birds

Ospreys (*Pandion haliaetus*) were observed every day at Silver Glen during the study. They were seen in the greatest numbers in early morning and late afternoon/evening when hunting for prey such as mullet and other fish species. Approximately six ospreys were observed on a regular basis and several nests were visible from the run. Sightings decreased when the number of people recreating in the run increased. In fact, when visitors were present in high numbers, diversity and abundance of all faunal species declined.

A pair of bald eagles (*Haliaeetus leucocephalus*) was seen regularly at the run. They were most often sighted circling the west end of the run and often perched in pines near the springhead. During times of heavy recreation use the eagles were seen less often.

Great blue herons (*Ardea herodias*) frequented the run as well. Approximately four great blue herons were sighted on a daily basis when traffic was low, and the numbers decreased during days of high boat traffic. They were higher in number when lower numbers of recreational boaters were populating the west end, an area where the great blue herons spent much time foraging near the mouth of the west creek entrance. Great egrets (*Casmerodius albus*), little blue herons (*Egretta caerulea*), green herons (*Butorides striatus*), double-crested cormorants (*Phalacrocorax auritus*), and American anhingas (*Anhinga anhinga*), were also observed throughout the run. Black vultures (*Coragyps atratus*) and turkey vultures (*Cathartes aura*) were common in the trees and in the recreation area near the springhead. Several black vultures were acclimated to people, with at least one individual making a habit out of searching through unattended backpacks and bags in search of food. Redshouldered hawks (*Buteo lineatus*), mallard ducks (*Anas platyrhynchos*), purple gallinules (*Porphyrula martinica)*, and Coopers hawks (*Accipiter cooperii*) were also seen at the run.

Mammals

Twelve different manatees were observed in the spring run during the months of January - March 2003. Seven of these manatees were observed over a period of several weeks within the same two areas presented in Figure 4. Sizes ranged from smaller, approximately 6 feet in length, to several larger manatees that were 10 + feet. Observations on their travel patterns and resting areas were recorded and mapped. The manatees observed spent most of their time in two areas of the run. These two areas represent the deepest areas of the run. Manatees were observed grazing on the eelgrass adjacent to the deep areas of the western most area. There was a report by RRM of a manatee in February 2003 up in the springhead, but the researchers did not actually view the animal there. Highest counts of manatees were observed during the coldest periods of weather when outside air temperatures dropped dramatically. The constant warm temperature of the spring likely provided requisite survival temperatures for the manatee. It is not known if manatees visit the run during warmer months, since research was conducted during mostly cool weather. The manatees observed were very wary of boats

and people and avoided interaction when possible, even drifting small boats changed the location pattern of the manatees within the resting zone.

River otters (*Lutra Canadensis*), wild boar (*Sus scrofa*), and grey fox (*Urocyon cinereoargenteus*) were also seen in and around the spring.

Vegetation Regrowth Research

Despite the difficulties encountered with the vegetation regrowth research, the results showed increases in vegetation growth in all three of the remaining caged plots (between 63% and 333% increases) and also a lengthening and increase in flowering for the area around the 5'x5' buoyed plot (SGSAVBQ-1). These preliminary results are from a small sample size, however they indicate that the recuperative ability of the native vegetation in the run is high. Table 2 shows the results of the research. Eelgrass was the dominant vegetation species in most of the area. When the cages were first placed, the number of plants, or apical meristems, were counted. They were counted again at the end and the percent gain in plants calculated. The exclusion cages were referred to in the research as SGSAVAC-1 through SGSAVAC-6. The 5'x5' buoyed SAV plot was referred to in the research as SGSAVBQ-1.

Researchers suspected that the eelgrass would flower and produce seeds if protected in some of the higher flow areas from boating impacts, due to the observations of a natural plot in front of the sailboat that was semi-permanently moored in the run at the time. Since boats had to go around the sailboat, the sailboat's location protected a small patch of grasses at the bow of the boat, and the grasses here were able to flower and seed unlike any in the nearby areas. The idea to place a protected, non-caged buoy plot in the run emanated from this observation. The idea was to determine if the protection of a similar zone near one of the boat travel routes would result in the flowering and fruiting of the eelgrass.

The number of flowering grasses within the buoyed plot were noted at the beginning of the study (5) but because the plot was vandalized and the plot had to be re-anchored,

researchers were unable to determine the exact amount of increase in grasses and flowering at the end of the study. The length of grass and flowering was distinct when compared to areas in the same part of the run that were not in the immediate vicinity of the plot. This indicates from initial data that protecting certain areas of the run (especially upstream) would allow the eelgrass to extend its length and to flower and reproduce, creating "nursery seed" areas up stream which would naturally carry the grasses throughout the run, allowing natural colonization over time. This may also help with the competition with hydrilla, since the stands may extend to the surface, and give an advantage to the native eelgrass.

There was also a dramatic difference in the growth of the grass protected by the exclusion cage within the swimming area (SGSAVAC-2). The substrate surrounding the cage was generally barren of grasses and had a thick algal covering while the cage-protected area contained 26 eelgrass plants that grew over 2' in length. Twelve weeks prior, the cage had been originally placed on top of 6 small apical meristems of eelgrass that were no taller than 6" at the time. Subsequent observations indicated that the apical meristems increased by approximately 333% by the time the cage was removed. This is important as it appears that protection from trampling and other human impacts of certain zones may allow the healthy redistribution of eelgrass, in a short recovery time. Also, should apical meristems of healthy eelgrass be harvested from genetically similar vegetation in adjacent locations, and transplanted using standard techniques in barren areas, the grasses would likely re-grow, with protection.

The two cages within the run also showed marked differences in the amount of grass found within the protected plot area. SGSAVAC-5 stayed in the run for 4 weeks and showed a 63% increase in vegetation. SGSAVAC-6 was in the run for only 13 weeks and showed a 217% increase in vegetation. Again, this indicates that if these particular grasses can be protected at the root zone, which is required for colonization of natural communities, this would likely be sufficient for the natural regeneration of native SAV eelgrass. It should be noted that this should be combined with an eradication program

for the hydrilla initially and the protection of "flowering and seeding" zones up stream to help with natural recruitment.

Table 2. SAV plot research results

SAV CAGE	DURATION	Number Apical Meristems Start	Number Apical Meristems End	Percent Gain
SGSAVAC-1	Removed/damaged	NA	NA	NA
SGSAVAC-2	12 Weeks	6	26/48*	333 %
SGSAVAC-3	Removed/damaged	NA	NA	NA
SGSAVAC-4	Removed/damaged	NA	NA	NA
SGSAVAC-5	4 Weeks	16	26	63 %
SGSAVAC-6	13 Weeks	18	39	217 %
SGSAVBQ-1	4 Weeks	NA	NA	NA

SGSAVAC-2 –cage was removed approximately 4-6 days before final survey. First number is estimates of the cage area, conservatively, the second number is total in area, as they were only 6 at the beginning in the entire area. Percent is conservative lower number estimate.

Observed Recreation Uses and Patterns in Silver Glen Spring and Run

There are several recreation activities that people participate in at Silver Glen Spring (Figure 5). Each major activity is described here along with user patterns that were observed during January- May 2003. The main types of recreation are swimming, fishing and boating.

Swimming

Swimmers at Silver Glen have two areas they can use to access the spring and run, 1) from land via the USFS recreation area and 2) from boats. Swimmers who access the area from land do so mainly from a "beach" area or nearby wooden stairs located on the east side of the springhead. A secondary access point from land is located at the north end of the springhead via wooden stairs built into the water.

Swimmers who access the water from their boats generally do so in the area of barren substrate southeast of the main spring boil. They gain access to the land and restroom facilities via a wooden stairwell near the bare area. The area in front of the stairwell

contains thick algal mats indicating that although it is used by swimmers, it is not used as regularly as the other two access points near the main spring boil, both of which have no thick algal mats presumably because of human use.

Swimmers using the area generally wade (in shallower water) and swim/snorkel. Near the beach access point in the swimming-only area, people were seen sitting in the water and would often spend extended periods sitting, wading, and playing within an approximately 20 foot distance from the bank. People in the boat area would swim and wade, either walking from boat to boat or remaining in one position next to their boat while eating, drinking, and socializing. Other forms of recreation observed consisted of visitors using inner tubes or rafts, aqua scooters (small motorized handheld devices that pull people along in the water), canoeing, and driving toy boats.

Fishing

Several types of fishing were observed in the run. Each type utilized different areas of the run and created varying levels of impact. The boats used for fishing were generally small (under 20 feet) and those with two or four stroke engines had varying engine sizes. Fishing occurred in most areas of the run, although the eastern areas of the run were utilized more often than others. Fishing, including rod and reel, bow hunting, and cast netting occurred in close proximity to other recreation activities- sometimes within a few feet of boats and people in the water (Appendix A).

Rod and Reel: Rod and reel fisherman were most commonly seen during the study. Many of them came from the Juniper Club, which keeps several fishing boats at its lodge. Other fishing boats access the run via Lake George. Rod and reel fishing was done primarily to catch bass. Fishing for mullet occurred with snatch hooks.

Bow Hunting: Several boats (propeller and air boats) were seen entering the run from Lake George on a regular basis with groups of people that used a bow and arrow to hunt fish. The boats that participated in bow hunting were generally of two types: air boats, and small boats that used a combination of trolling motors and gasoline engines to run the shoreline. The bow hunters most often caught tilapia and mullet, however they also fished for bass and were seen catching large gar as well.

Cast Netting: Airboats would come into the run and fish during both the day and night. Some were observed pursuing schools of tilapia toward the banks of the run and then catching them with cast nets.

Boating

Beside boats associated with fishing, two other types of boating activities occurred in the run: overnight boating and day use boating. Boats that visited the run varied I size from small runabouts to 60 foot houseboats.

Overnight Boaters: Many cabin cruisers and houseboats stayed in the run for several days at a time. They generally anchored in the western end of the run near the buoy line and along the banks next to the springhead. Many of these boaters told researchers that they had been coming to Silver Glen for over a decade. Weekends were the most popular time for overnight stays, with holiday weekends having dozens of boats anchoring overnight. There was one sailboat that was fairly permanently moored in the run. Although it was occasionally removed, the owner had placed buoys around the spot it normally occupied and even painted the stern of the boat to show Silver Glen Spring as the location of origin for the vessel. Some of the boats that stayed overnight in the run were from rental companies located along the St. Johns River. These companies advertised Silver Glen as a destination location for both day and overnight trips.

Day use boaters: Day use boaters utilized the run every day of the year. The use level depended on the time of year, time of week, and weather. Use was heaviest on summer holiday weekends such as Memorial Day, Fourth of July, and Labor Day (RRM 2003). During cool or inclement days in the winter, only one or two boats may have been seen in the run. During warm weekends and holidays, as many as 200 boats could be seen there. This number was derived from hand counting of boats in high-resolution aerial photos taken on Memorial Day, Labor Day, and the 4th of July 1999, 2000, and 2001. Day use boaters generally anchored near the springhead and once these areas filled up they anchored in areas to the east, with most staying on the area of bare ground. They would often “raft up” with other boaters and would stay together in one spot all day. These boaters often swam and waded in the immediate area surrounding their boats. The preferred anchoring areas seemed to be the ones with shallow water and a sandy bottom.

Figure 2. Submerged Aquatic Vegetation Map

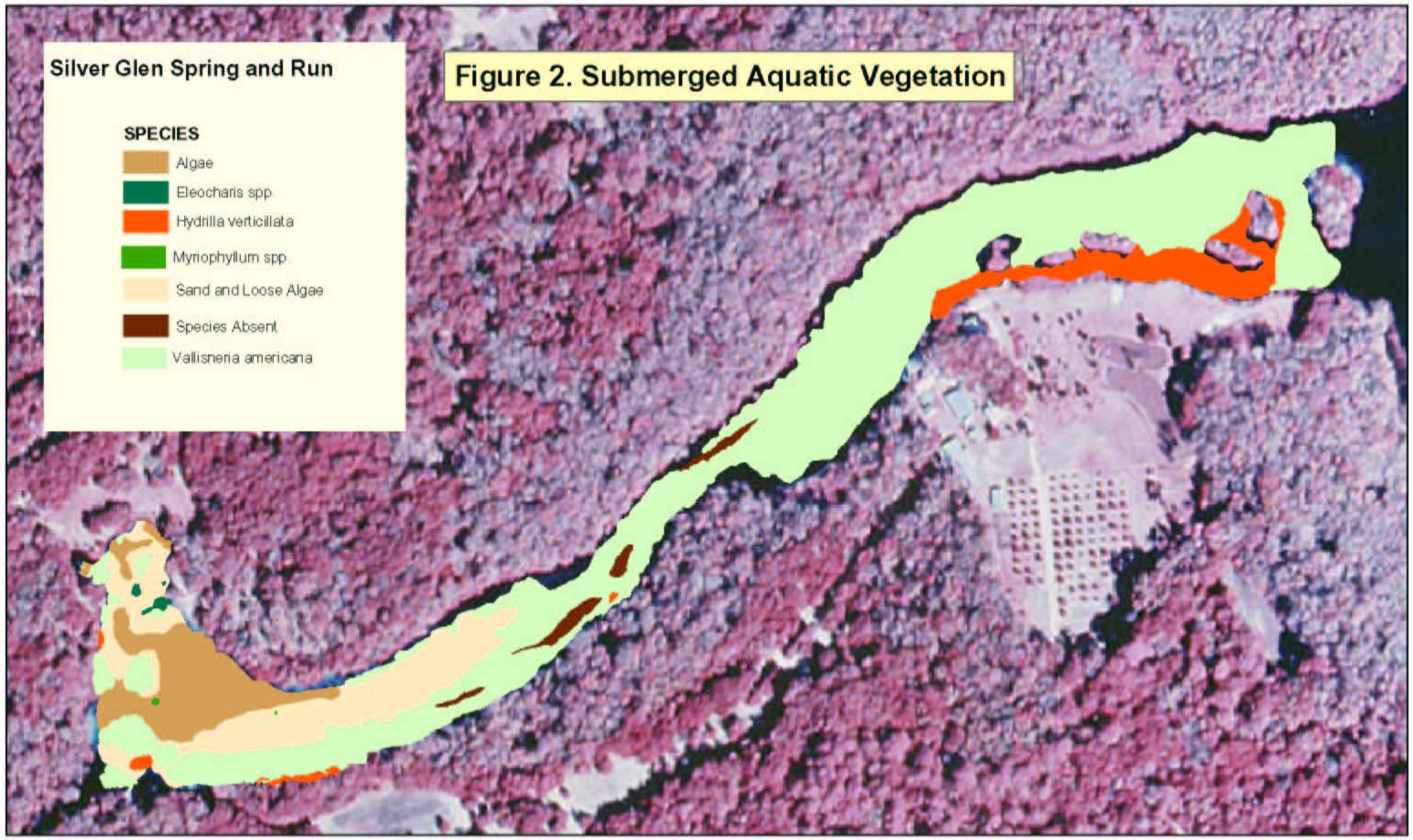


Figure 3. Submerged Aquatic Vegetation Percent Cover Map

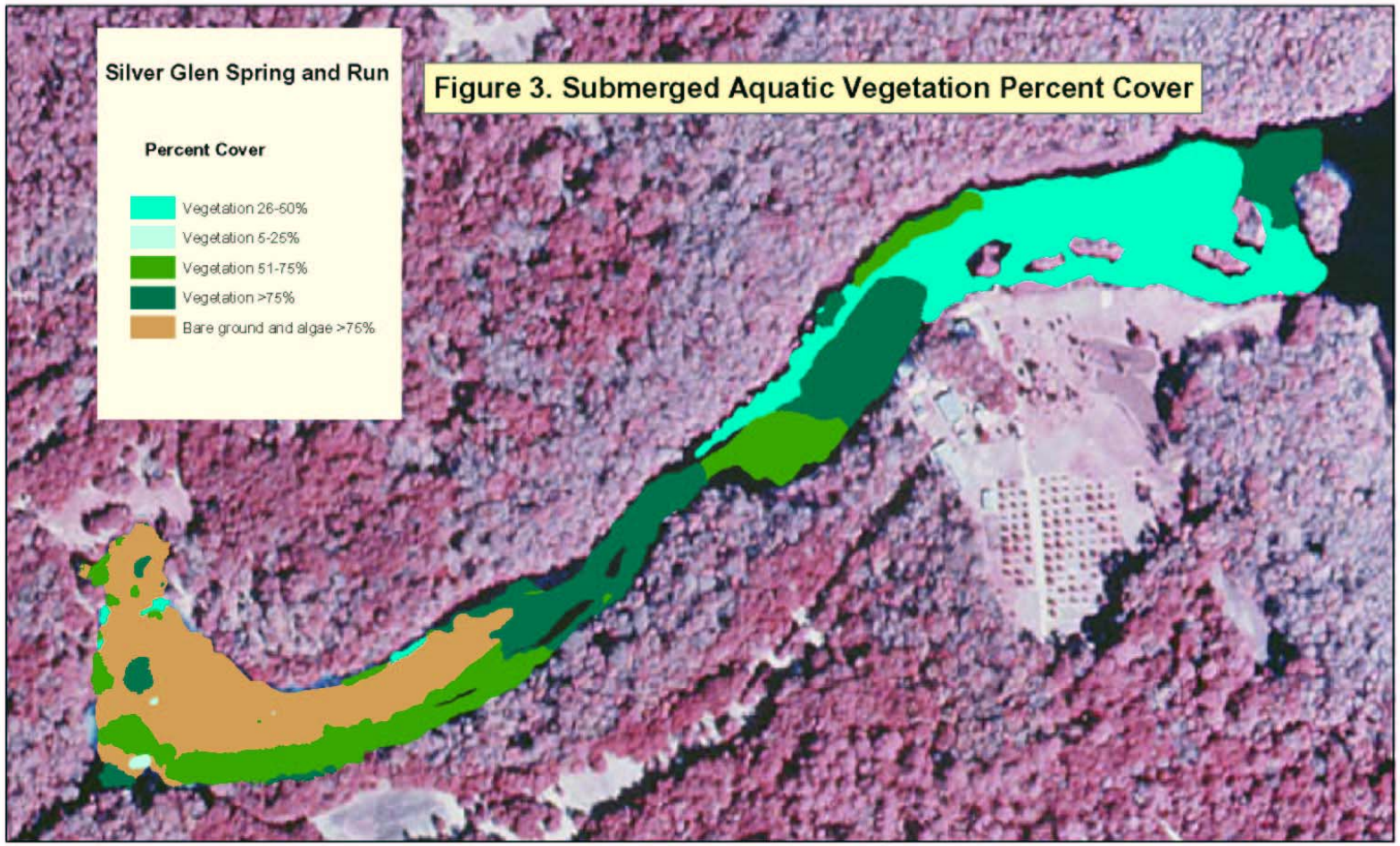


Figure 4. Manatee Use Areas Map

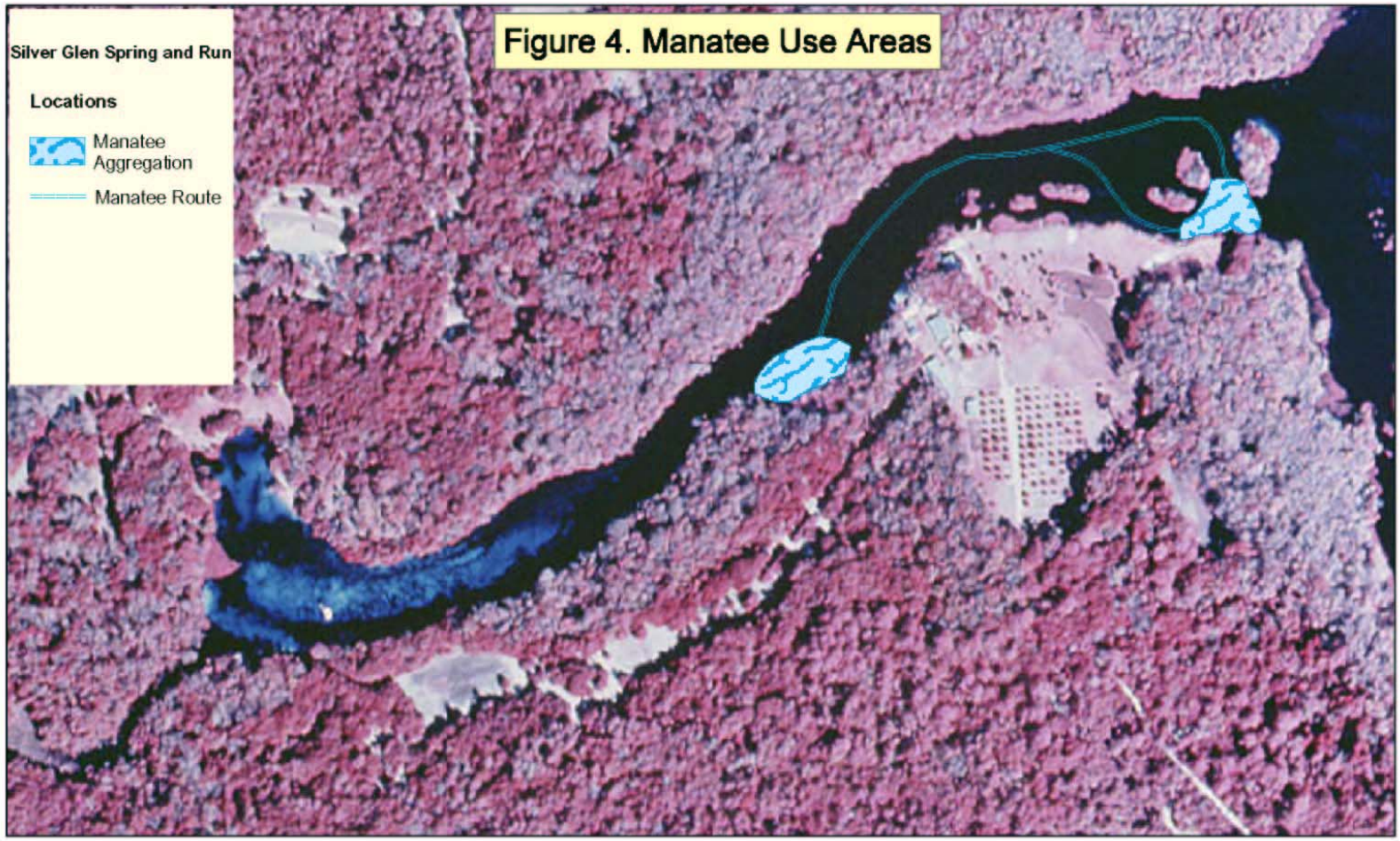
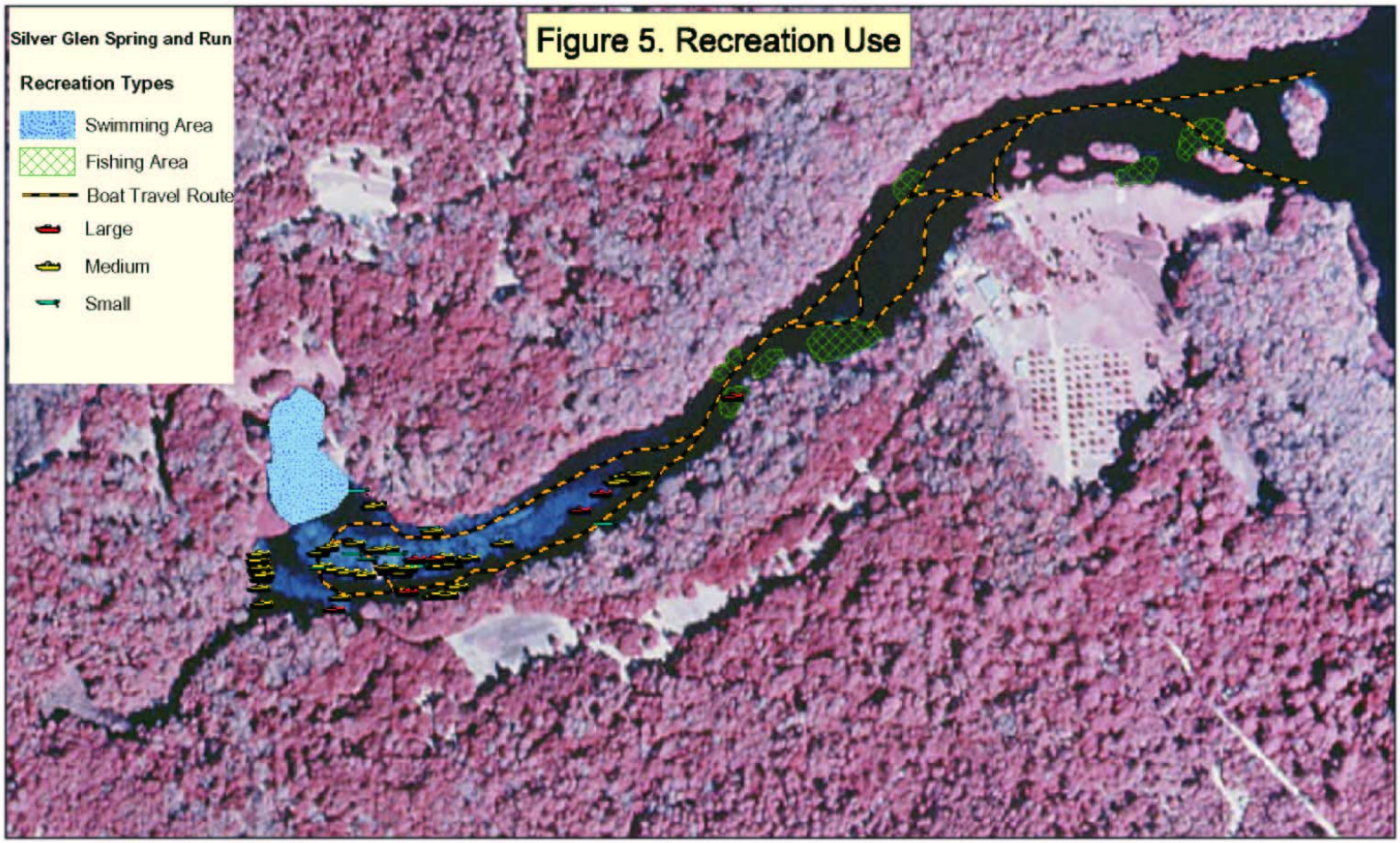


Figure 5. Recreation Use Map



The Effects to Vegetation from Current Recreation Use

The major effects to the vegetation in Silver Glen Spring Run are associated with boat travel route impacts, anchoring impacts, swimming impacts, and invasion of nuisance and exotic species.

Boat Travel Route Impacts

Much of Silver Glen Spring Run showed impacts from recreation (Figures 6 and 7). Since the run is only 200 feet wide on average and approximately 3,300 feet long, impacts covered the majority of the area. In fact, there were only a few areas where impacts were not observed. The areas located in the main travel zone for boats showed many impacts in the form of propeller scars, anchor pits, and grass chopping. The main travel path followed the deepest water of the run (maximum 9 feet). Boats entered the run from Lake George on the north side and kept along the north bank of the run until they passed through the narrow "bottleneck" midway through. Boats then moved to the south side, again following the deeper waters. Once boats reached the western end of the run they generally either anchored or turned around and followed the same path out.

Both traveling and anchoring caused impacts to the run. The travel route was heavily scarred with obvious boat prop marks (Figure 7). In many of these areas (average 4 feet), the scarring went all the way to the substrate, creating bare areas. The recreation impacts map (Figure 6) shows both the path the boats took, as well as the impacts associated with boat travel and anchoring. Other impacts did not occur at the substrate level. Grass chopping was fairly consistent along the boat travel routes. The grass was chopped to approximately three feet below the surface of the water in most places.

The Juniper Club had many small fishing boats that traveled into and out of their dock area on a daily basis, with traffic becoming heavier on weekends. In front of the Juniper Club there was an area that contained grass chopping but much fewer scars than the main travel area. Since the boats going into and out of the Juniper Club were smaller in size than many of the boats accessing from Lake George, their propellers did not seem to

make as much of an impact on the vegetation even though they were traveling through water at a depth of 2-5 feet to reach their docking site. Many small fishing boats, both from the Juniper Club and from Lake George, used trolling motors to maneuver, thus reducing the impacts they make to the vegetation and substrate.

Air boats and specially adapted boats with large "churn props" designed to get into shallow waters were observed crushing and chopping the native emergent vegetation along the shores to get into very shallow areas. The airboats and their impacts are a problem that needs to be addressed. Many of the airboats come into the run at night, making their actions difficult to monitor. Future management of the run will need to consider the airboats and steps should be taken to minimize this impact.

The area midway through the run where a sailboat was permanently moored showed the results of removing boat travel impacts. The sailboat, mentioned earlier in the report, stayed in the same place the majority of the time. Because of the sailboat's long-term location, it showed the potential growth of eelgrass throughout the run if boat impacts are lessened. The sailboat's location made it necessary for boats to move around it as they traveled through the water. This avoidance provided an area to the west of the boat in front of the bow where the grass was growing close to or all the way to the surface of the water allowing the grass to flower and reproduce (Appendix A). The water depth in this location was approximately 4-6 feet. The eelgrass in this location was dense and flowering abundantly during the study period. The flower stalks spiraled to the surface of the water and then lay over with the water flow. Snail populations here were abundant.

Anchoring Impacts

Once a boater found a desirable place in the water, they put out at least one anchor (Appendix A). Most boats observed placed an anchor off the bow and one off the stern. Larger boats such as houseboats and cabin cruisers placed three or four anchors out to secure their vessel. Anchors put in the substrate caused scars to the sediment and to the vegetation in the form of drag marks or pits. Although choice of boat anchoring was made so as to get a preferred recreation spot, anchoring the boats was done without

regard to vegetation. Many boats were seen throwing out anchors two or three times in order to get them to grab the substrate, often dragging them through the vegetation and uprooting it in the process. This was especially prevalent in the large rental houseboats, where experience anchoring in a stream was not apparent. The most desirable places to park appeared to be in the shallower water (3-5 feet deep) that lay over the area of bare sand nearest the springhead.

Once anchored, many boaters disembarked from their boat to swim or wade in the water. Some boaters were observed cleaning the hulls of their boats with brushes while anchored in the shallow water in the sandy area. Although many simply scrubbed their boat with the water in the run, several people were seen using cleaners and even polish on their boats and on one occasion, a boater was observed with solvents (degreasers) cleaning or degreasing the outboard engine.

Swimming Impacts

Swimming and wading were favorite activities at Silver Glen Spring. Although swimming generally caused little impact on vegetation, wading caused trampling to native grasses. Areas near the spring boil where visitors accessed the water from the USFS visitor area were heavily trampled and much of the area was devoid of vegetation. This was also the case with the open sand area where boaters preferred to anchor. The wading caused impacts to the vegetation, possibly hindering the grasses from growing where trampling occurred.

Invasion of Exotic and Other Nuisance Species

Hydrilla was seen to occupy many of the areas where eelgrass was absent (See Figures 2 and 8). It was also seen growing within the eelgrass and in several areas it was the dominant species. Hydrilla was found to be the dominant species across 1.1 acres of the run, and was found to be present but not dominant across 3.4 additional acres.

Research shows that boat traffic and hydrilla occurrence are related (McCann, Arkin, and Williams 1996). In areas where hydrilla is found, its arrival can often be traced to boat traffic into the area since it "hitchhikes" on boats. This is most likely the case with hydrilla at Silver Glen. Although the time of its first occurrence in the run is not known, it is spreading rapidly. Hydrilla is present in Lake George and most likely it arrived in the run from boats traveling into the area. If allowed to continue to spread, the hydrilla has the potential to out compete native vegetation and fill the run.

Hydrilla was first found in Orange Lake, Florida in 1972. By 1976 it had covered 90% of the lake surface (Schmitz and Brown 1994). The resulting impacts to real estate values, recreation, and tourism were immense. One Orange Lake economic study estimated the economic impact from recreation at the lake to be 11 million. When hydrilla covers the lake these economic benefits are mostly lost (Langeland 1990). Dense hydrilla mats reduce plant and animal diversity (Barnett and Schneider 1974), damage sport-fish populations (Colle and Shireman 1980), and can impact recreation and access to the water body (Colle et al. 1987). This has been documented at other Florida springs, especially at historically popular boating areas such as Wakulla Springs. Hydrilla not only destroys the native ecosystem, but is undesirable for swimming, wading, and boating.

Algae (species unknown) was present in large quantities throughout the run (Appendix A). The source of the algae was being researched by the DEP during the time this study was being conducted so it is not known at this time if the algae's presence is related to recreation. In areas where it grew unhindered, it formed large mats that were several feet thick. In areas where it grew near structures or the water's edge, it formed "towers" and grew upward in large, shapeless columns. The algae was concentrated mainly near the banks of the spring boil area and in the buffer zone between the swimming area and boating area. The secondary boil located to the west of the main boil was off limits to recreation. This boil was thickly concentrated with algal mats and algal towers. In fact, moving through the area to collect vegetation data was difficult due to the profusion of algae. Much of the area of barren substrate located in the preferred boat anchoring zone

contained loose algae which in some places only occupied small patches and in others occupied the majority of the substrate.

In areas where the algae formed thick mats, other vegetation did not grow. In fact, sulfurous bubbles emerged from the algal mats when stepped upon, indicating anaerobic decomposition. Places covered by thick algae were often avoided by those recreating in the area, including swimmers and snorkelers. There may be complex factors contributing to algae growth that relate to both water quality and sediment disturbance, which was not part of this study.

Effects to Manatees from Current Recreation Use

Volusia County, which encompasses the mouth of Silver Glen beginning at Lake George, stated in its 2001 *Manatee Protection Plan* that Silver Glen is used by manatees during cold snaps. The plan also says that manatees will move into the spring following a cold front but are not known to inhabit the spring for prolonged periods due to human activity.

Although the evaluation of the effects of recreation use on manatees was not an objective of this study, the effects of recreation use on manatees was observed and subsequently recorded. Manatees were seen on cold days in the run during the time the research was conducted. Statewide, manatees are subject to two human threats: loss of habitat and harassment. Manatees were observed in the run 20-25% of the time during the January-March 2003 research period. They were observed in two primary areas, which corresponded to both deeper areas of the run and areas where boat traffic was less prevalent (Figure 4). The route the manatees took to travel from one area within the run to another was the same as the route traveled by boats.

Manatees stayed near the benthic zone of the spring, and were rarely reported by recreational boaters. When manatee were spotted by boaters, it was usually when the manatee were exiting the western area of the run along the deeper boat route along the northern edge of the run. On the three occasions when researchers observed boaters spotting the manatee attempting to leave the run, boats encircled the manatee to get a

better look. On two of the three occasions, boaters circled the manatee more than a half dozen times, forcing the manatee back to deeper water. During the third encounter, the manatee increased its speed and left the run. It should be noted that in some of the shallower areas of the boat channel the manatee had less than a 2-foot clearance from the surface of the water. This would not allow the manatee enough room to avoid boats if they were to go over the animal. Boaters who said they have been coming to the spring for more than a decade indicated that they had never seen a manatee come into the run and it was a rare occasion when this happened. On the same day this information was collected, researchers documented seven manatees in the spring run.

Figure 6. Recreation Impacts Map

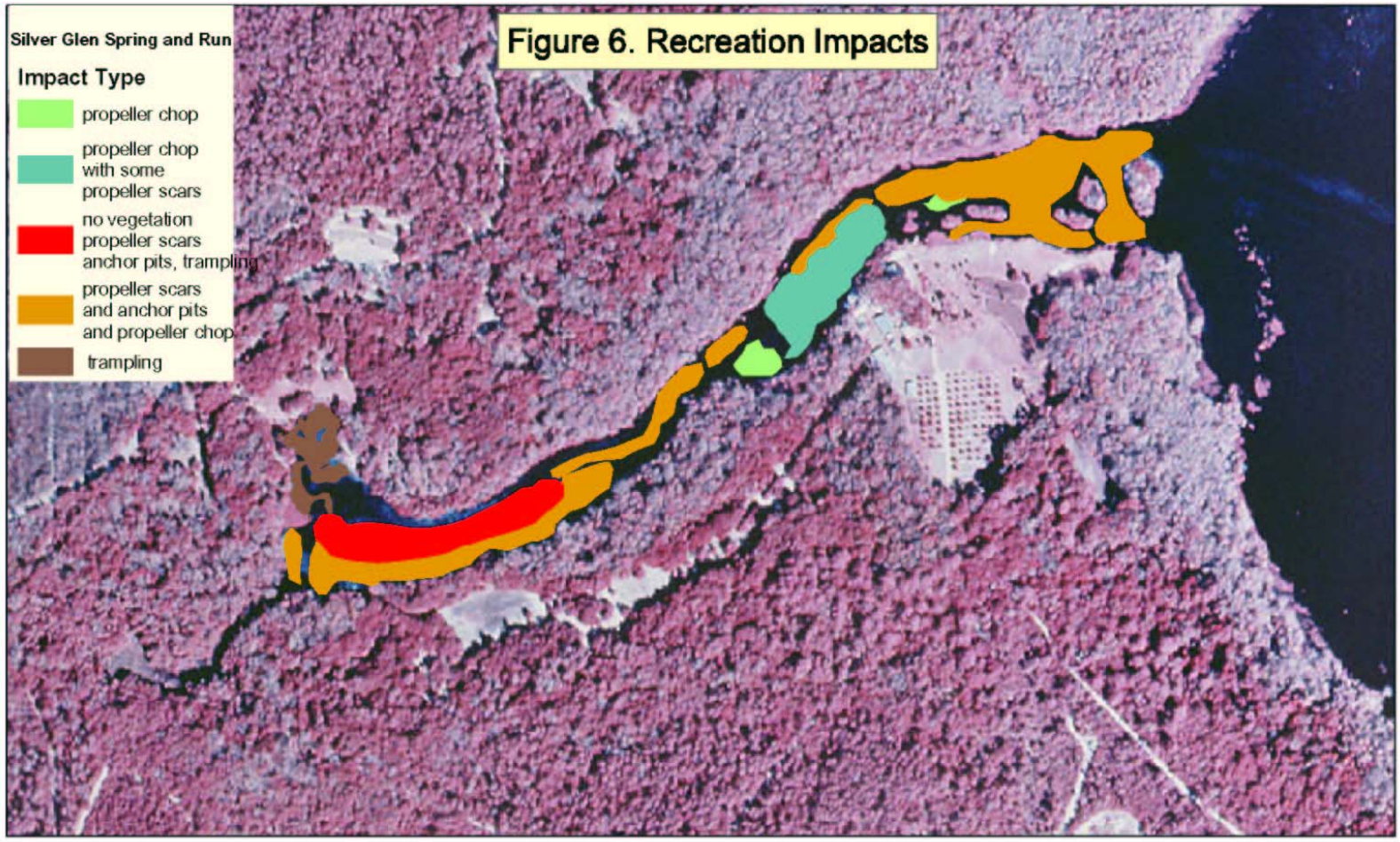


Figure 7. Recreation Use and Impacts Map

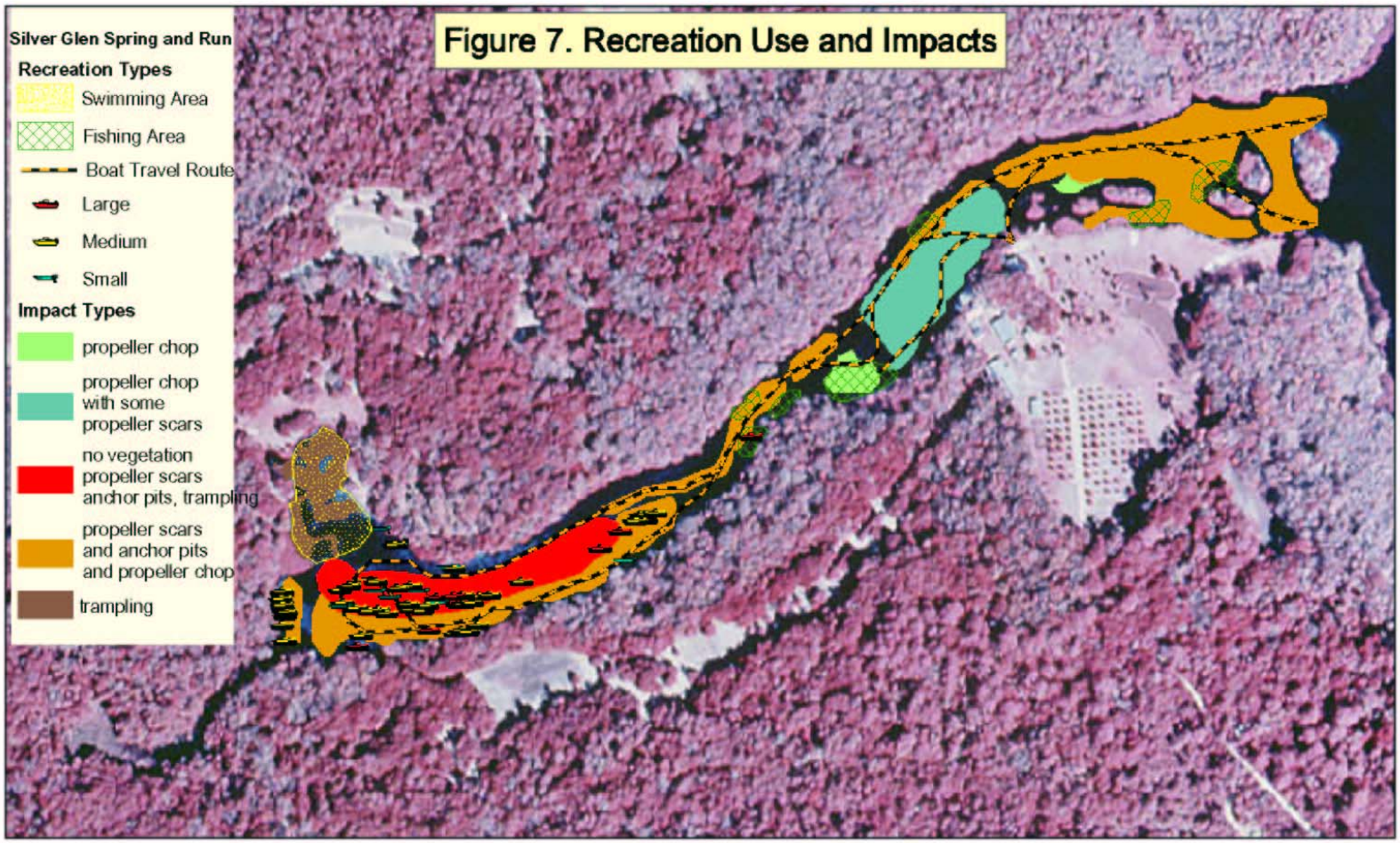
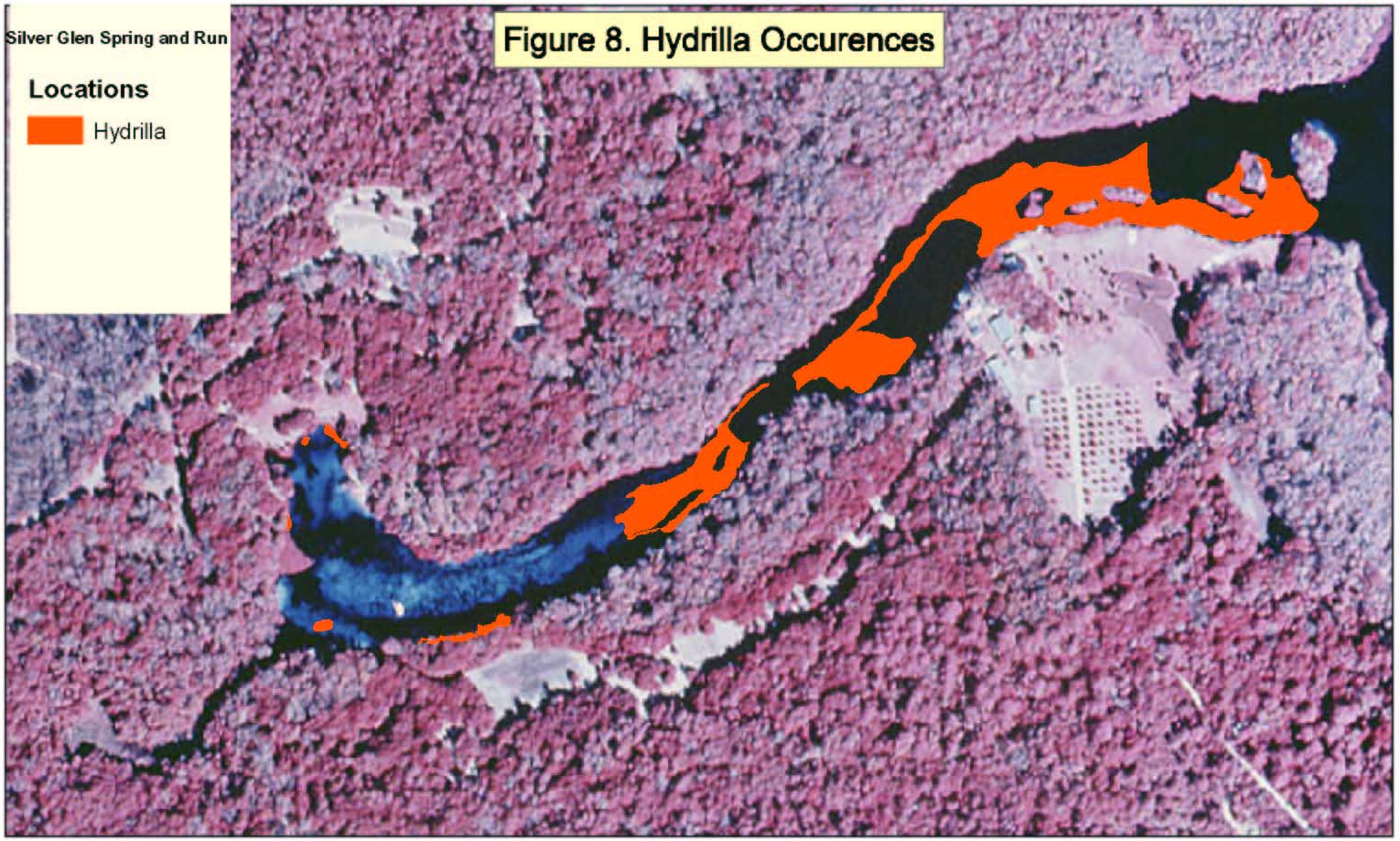


Figure 8. Hydrilla Occurrences Map



Other Possible Impacts to Silver Glen Spring and Run

A primary focus of the Silver Glen Spring Carrying Capacity Study was to document the existing recreation impacts on the submerged aquatic vegetation in the run. During the winter and spring of 2003, physical impacts to the run's ecology were recorded. However it was noted during the study that there were other impacts that were not researched due to the limited scope of the study. Table 3 outlines these possible major impacts to Silver Glen Spring and Run and their sources. The following is a discussion of these possible impacts.

Table 3. Possible Major Human and Boat Impacts to Silver Glen Spring and Run

Value	Human Impacts	Boat Impacts
Water Quality	o Human waste	o Gas/Oil o Detergents
Native Wildlife	o Harassment o Spread and introduction of exotics o Habitat damage/ destruction	o Harassment o Spread and introduction of exotics o Habitat damage/ destruction
User Experience	o Visual degradation (i.e. litter, trampling, noise) o Crowding (land and water) o Safety	o Visual degradation (i.e. litter, trampling, noise) o Crowding (land and water) o Safety

Water Quality

The Florida Department of Environmental Protection conducted a water quality survey of Silver Glen Spring in 2001 and found exceedances for total coliform bacteria at the mouth of the spring run on three occasions following busy spring and summer weekends. With the number of visitors to Silver Glen Spring and Run, contamination from human wastes is a major concern. Boats staying in the run longer than their septic systems can handle (2-3 days on an average vessel) may dump their sewage into the run since the closest pump-out area is located several miles away in Astor. In addition, some visitors are choosing to use the bathroom in the water or onshore in the woods rather than in the restroom facilities provided within the USFS recreation area. Human waste presents a

two-fold water quality problem from both nutrient loading and human intestinal pathogens introduced into the water that may adversely impact the native wildlife.

Another potential impact to water quality is from boats, specifically oil and gas. Fuels from the boat engines, primarily those with two stroke technology, will be introduced into the water and the potential of spillage and leaks from engines and degreasing of engines may have a long term impact on the sediments. Boat washing and engine flushing also adds to water pollutants. Some pollutants will be flushed out of the run because of their physical nature, while others will likely accumulate in the sediments over time, creating cumulative and permanent impacts.

Wildlife

Direct and indirect impacts to native wildlife are also potential considerations for the run. Potential primary disturbances to animal life include: Disruption/destruction of nesting areas including bass, alligator, osprey, and bald eagle; disruption of sunning patterns of reptiles including turtles and alligators; Injuries to birds from discarded fishing equipment; disruption of hunting and foraging for all animals in the run, including problems with visitors feeding wildlife; and general stress caused by the constant presence of humans in the area and the noise from radios, shouting, and motors. This is especially important for manatees.

Manatees have been documented using the run and as discussed previously, their use patterns may also be impacted by recreation due to loss of foraging habitat and indirect harassment (see p. 32). Potential secondary impacts include light and noise pollution, degradation of air quality, degradation of water quality, impacts to fauna from collisions from boat props, and degradation of the primary aquatic baseline ecology. Researchers noticed that increased human presence in the run resulted in observed disruption of the wildlife. Although some wildlife may become acclimated like the black vulture, others may avoid the area especially during high use times.

User Experience

Heavy use of the small area affects the recreation experiences for visitors to the run. Tens of thousands of people visit Silver Glen Spring annually. People arrive by car to the USFS recreation area or arrive by boat via Lake George. Because there are no restrictions on boat use or swimming areas in the run, there is a potential for unsafe conditions to occur.

Boats that enter the run currently anchor wherever they wish. Boats crowd into the run on warm weekends and hundreds can be found anchored throughout the area. The anchors pose a safety concern because they are often difficult to see in the substrate and could be easily stepped on when someone jumps off of their boat into the water or when wading. Because boat access is unlimited, swimmers, snorkelers and divers often use the same areas as moving boats. An inattentive or impaired boat operator could accidentally hit a swimmer if not paying close attention. Several close calls were reported by RRM during the time the research was conducted. The crowding that occurs on warm holiday weekends is unparalleled in any other Florida spring. Boat accidents have and will continue to occur if the historical densities of boats remain. Several deaths have occurred in the run- most recently in 2002 a boater died after diving off a boat and hitting his head on an anchor. On holiday weekends emergency personnel are often called out over a dozen times to attend to boaters who seriously injure themselves while partying in the run. The majority of these injuries are alcohol-related (Capt. Gerald Combs, pers. comm. 2003).

There are also intangible impacts to the recreation experience of the users. Recreation research has shown that users of an area will cease to come if their experience is degraded in some way beyond their acceptable limit. This causes people who would potentially visit a site to avoid the area, thus changing the user base for an area. Warm weekends and unrestricted access lends itself to some visitors feeling crowded and unsatisfied with their visit. Several boaters expressed to researchers that they no longer came to the spring on weekends due to the number of boats that use the area. The high number of powerboats and large crowds makes the run unsuitable for recreation

opportunities such as canoeing and kayaking, thus excluding much of this type of recreation from Silver Glen Run.

Although it has been greatly curbed since the ban on alcohol in the run went into effect in 2000, some boaters exhibit inappropriate behavior when visiting the run. Vulgarity, nudity, illegal alcohol consumption and noise were reasons several boaters said they did not feel the run was appropriate for their family on spring and summer weekends.
In addition, the proliferation of boats that often anchor in the run changes the run from a peaceful, natural area to one with loud music, loud motors, and a view of boats rather than scenery or wildlife. As few as two dozen boats moving into and out of the run can create so much turbidity that the water becomes cloudy and laden with bits of algae and detritus. These factors contribute to the deterioration of the recreation experience for people who come to Silver Glen to enjoy its clear waters, wildlife, natural beauty, and peaceful setting.

Recommendations and Management Options

The primary goal of this study was to develop a solution from an ecological point of view with the objective of having one or more recommendations include a mooring plan that would allow controlled recreation. Recommendations for managing Silver Glen Spring Run were based on the mapping analysis, observations made during the research, and discussions with the DEP. Each of these recommendations reflects a different level of management for the area.

The management recommendations are a framework to begin recovering the spring's vegetation while providing continued sustainable recreation opportunities. Any implemented recommendation will require monitoring and adaptive management to ensure its success. Determining a final and accurate carrying capacity for the area will require time and close attention to the changes in both recreation patterns and the ecology of the area. This research was conducted during the winter and spring of 2003 and reflects observed conditions during that time. At the time research was conducted, the Marion County section of Silver Glen Spring and Run (including the springhead) had 15% vegetation coverage (native and nonnative grasses) and the Lake County end had 37% coverage. In this section we present four options to address the management needs and carrying capacity of Silver Glen Spring and Run. They are:

Option 1: No Action: Current management continues
Option 2: Mooring buoy plan
Option 3: Close Silver Glen Spring and Run
Option 4: Mooring buoy plan with seasonal closure of Silver Glen Spring and Run

Management Option 1: No Action: Current Management Continues

Description: Silver Glen Spring and Run would remain in its current management state. All types of recreation would be allowed. The swimming area would stay the same and boaters would be allowed to anchor and travel throughout the run.
Option 1 goal: To provide for public recreation.

Activities: Boating, swimming, snorkeling, fishing, etc.

Comments: Although this option is for no action, management needs and results are based on the assumption that the popularity of the area will increase and more visitors will use the run in the coming years.

Table 4. Potential Results of Implementing Management Option 1

General Management Issue	Specific Issue	Results of Option 1
Environmental	Native vegetation	o Native vegetation would continue to be impacted by direct impacts such as trampling, anchoring, and propellers in all areas of the run, adversely impacting the linked ecological system over time. o Large barren areas would be maintained and could expand. o As recreation use increases, the health and abundance of native vegetation and habitat will decrease. o The spread of hydrilla is likely, reducing and possibly eliminating the area of native eelgrass and existing communities for bass and other organisms associated with the grasses.
	Exotic/invasive species (hydrilla and algae)	o Hydrilla will continue to expand throughout the run and will likely take hold more aggressively in non-vegetated and impacted areas. There is a strong possibility that hydrilla could become the dominant rooted vegetation and out-compete the native vegetation throughout the run. o Hyacinths and water lettuce will likely continue to expand, and may out compete native emergent vegetation along littoral zones. o Algae may or may not expand depending on the factors contributing to the algae problem. o Algae will likely continue to be excluded from areas where there is heavy recreation use, however, current usage may also expand the problem.
	Wildlife not including manatees	o Likely adverse impacts to native flora and fauna due to recreation impacts and the continued expanse of hydrilla changing the composition of aquatic species. o Likely change over time in terrestrial wildlife dependent upon the run as a food and breeding area, as the aquatic species are impacted and changed.

General Management Issue	Specific Issue	Results of Option 1
Environmental	Manatees	o Manatees will continue to be harassed directly or indirectly, and injuries will likely increase with increased traffic during critical winter seasons. o Foraging areas will not likely increase and may decrease as Hydrilla replaces the favored eelgrass. o Manatees will be restricted to certain areas of the run or will be excluded from entering the run.
	Water quality	o Water quality will remain the same or decline, depending on usage. o Certain pollutants which are not flushed easily will likely accumulate over time with repeated use.
Administration	Staffing needs	o Staffing needs may increase
	Public education needs	o No changes
	Facilities	o May need to provide more facilities for additional visitors
	Management costs	o No changes
Recreation Use	User groups	o No changes or may deter those seeking natural and quiet experiences from coming.
	User experiences/benefits	o As the ecosystem degrades, the natural experience some visitors desire will decline. o If hydrilla spreads throughout the run, boat access, swimming, and wading will be diminished due to the plant growth.
	Recreation areas	o No changes
	Local business impacts	o Depending on the user type that rents boats, business may increase or decrease.
Jurisdictional	Enforcement needs	o May increase with increased visitor use
	Permitting types	o Not applicable
	Permitting costs	o Not applicable
	Permitting process	o Not applicable

Management Option 2: Mooring Buoy Plan

Description: Option 2 would implement a zoning system to provide recreation opportunities while also protecting and restoring the native aquatic ecosystem. The zones are:

Zone 1: Swimming and Wading

Zone 2: Vegetation Restoration

Zone 3: Mooring Area

Zone 4: Travel and Fishing Area

Option 2 goal: Provide for recreation while restoring the ecosystem to an acceptably healthy level.

Comments: Option 2 looks at possibilities for creating a balance between recreation and ecosystem needs. It takes into account potential future visitor use increases while also considering possible changes in visitor type, i.e. from a "party" group to more family and nature-oriented visitors.

Healthy vegetation is that which exhibits normal growth and does not show damage to its structure. It should show evidence of reproduction – either through new plant growth or flowering. The target goals set for vegetative cover are made with the assumption that without any human impacts to the area, the vegetation would regrow and cover close to 100% of the spring and run. The goals for each of the zones are set at lower levels to allow for various levels of recreation and their associated impacts.

Zone 1: Swimming and Wading

Description: Zone 1 is a high use recreation zone. It includes the main boil area and the northern bank of the run extending an average of 50 feet from the bank. This zone extends eastward to the Marion County line.

Zone 1 objectives:

- Ecology: Maintain >25% coverage of native vegetation with >50% of this vegetation considered to be healthy.
- Recreation: Provide opportunities for visitors to attain recreation-related benefits.

Zone 1 activities: Swimming, wading, snorkeling, tubing, nature observation

Zone 2: *Vegetation Restoration*

Description: Zone 2 is the ecological restoration zone. It includes the western side of the boil area beginning at the secondary boil and extends to the southeast to encompass the deeper waters to the south of Zone 1.

Zone 2 objectives:

- Ecology: The goal for the vegetation in this zone is to have >75% coverage of native vegetation with >75% of this vegetation considered to be healthy.
- Recreation: Provide for nature-viewing opportunities and a natural, peaceful setting.

Zone 2 activities: Non-motorized watercraft, snorkeling, nature observation

Zone 3: *Mooring Area*

Description: Zone 3 is where boats will be allowed to moor. It includes the run area east of the Marion/Lake County line and extends to the "bottleneck" area of the spring run.

Zone 3 objectives:

- Ecology: The goal for the vegetation in this zone is to have >50% coverage of native vegetation with >50% of this vegetation considered to be healthy.
- Recreation: Provide opportunities for visitors (families, individuals, small groups) to experience nature, and have safe recreation opportunities.

Zone 3 activities: Boating, swimming, snorkeling, fishing

Discussion

Since Zone 3 will be the primary mooring zone, we include discussion of the following:

- Method for Determining Mooring Zone
- Management Needs
- Facility Needs
- Public Education/Information Needs
- Carrying Capacity
- Boat Size
- Configuration of Mooring Spaces
- Type of Mooring
- Permit Needs
- Maintenance Recommendation

- Policing Recommendations
- Durations of Stay

Method for Determining Mooring Zone:

The mooring zone was selected following analysis of the vegetation and bathymetry data combined with recreation observations and information on use of the land on either side of the run. It also reflects the parameters the DEP set for the area, including vegetation impact reduction, safety considerations, and the rights of private property owners bordering the run. The mooring zone was placed in an area that currently contains deeper waters and moderate vegetation impacts. This area is also close enough to the spring and land-based recreation that visitors still have sufficient access to services, facilities, and recreation opportunities.

The western-most end of the mooring zone lies on the Marion/Lake county line. This was located in this area because of three reasons: 1) the bathymetry and vegetation data indicates that this is the most suitable area for mooring to occur; 2) the highest level of existing recreation impacts were west of the line indicating a need for restoration; and 3) if mooring occurs in only one county, then site permitting and enforcement could be in one jurisdiction, creating a less complex enforcement situation.

Management Needs:

To finance the supervision needed and maintenance of the equipment for this management option, a per-boat charge should be made for mooring in the run. This can be done via a self-serve pay station located at the mooring dock. The location of this do-it-yourself pay area would enable managers of the recreation area to easily check the box and enforce payment of fees. Each boat that pays the fee would have a tag similar to the ones obtained by cars at state parks. Managers would use a small boat to check all boats in the run several times per day to ensure compliance. Annual passes could be bought for those who use the run on a regular basis. Those holding passes would get a decal to go on the hull of their boat indicating compliance.

Facility Needs:

There would be a need to improve access to the USFS recreation area and protect the banks of the run from erosion.

There would be two access areas to the land from the spring run:

- *Swimming Area Entrance:*

  This entrance would be located where there is currently a docking area/access point into the boating area of the spring run. The existing steps are in adequate condition to accommodate increased traffic.

- *Mooring Entrance:*

  A boardwalk would be designed running along the water's edge parallel to the moorings. This would allow access to the land while minimizing impacts to the shoreline. There would be a new entrance created adjacent to the mooring area that would be accessed via the boardwalk. The entrance would provide access to bathroom facilities and picnic tables. These could either be placed in the immediate vicinity of the boardwalk or existing facilities could be utilized in the recreation area and accessed via a trail.

Public Education/Information Needs:

- A large sign placed at the mouth of the run would let boaters know that there is a fee for mooring in the run. This could be similar to USFS signs that indicate fee areas and basic rules associated such as no alcohol, etc.
- A large sign at the entrance to the run that says anchoring is prohibited.
- Restroom/ land recreation entrances would be clearly marked so that they are visible from the water.
- Brochures would be made available at the pay station for those who want them, letting boaters know about acceptable recreation behavior in the run. Information such as ways to minimize prop scarring, proper ways to moor, and proper ways to interact with wildlife (don't feed them) would accompany brief information about the ecology of the run.
- A large interpretive exhibit could be placed on the land to interpret the fish, birds, and other wildlife and plants that make Silver Glen their home. Placing this sign

on the land away from the water would make it visible to those in the land recreation area (accessed from land or water) without cluttering the scenery in the actual run. It would provide much-needed information to visitors about the ecology of the area.

- Managers of the recreation area should attend mandatory training that addresses potential questions and concerns that could arise as the result of the mooring buoy plan. This training should also include information on the ecology, flora and fauna of Silver Glen.

Carrying Capacity:

The maximum number of boats that could be moored using this system is between 78 and 108, depending on the size of the boats. There are mooring sites for 46 boats under 25 feet in length, and for 31 boats 26-39 feet in length. Higher numbers of boats could be accommodated (closer to 108) if small boats moored in the large boat slots and rafted to one another.

Currently close to 200 boats will use this area during holiday weekends. During other times of the year use is much lower. Although mooring opportunities would be provided for 78-108 boats, this is not expected to be at capacity except for certain times of the year. This number reflects the number of boats that could safely moor in the run while maintaining or improving the integrity of the native ecosystem that currently suffers from heavy overuse.

Other boats would be allowed to enter the run and would not be charged for access however they would be charged if they moor in the mooring zone. Visiting boats (those that come in to view the run or to fish- no anchoring) that do not moor would not be charged because to do so would require that there be a designated entry point to the run where boats are monitored and fees are collected. This would require the time of at least one full-time staff person 7 days per week. It would also require continuous monitoring of available mooring sites so that boats entering to moor would not have to pay if their desired or size-appropriate site was not available. Although an entry “gate” could be

utilized in the future, the level of management effort needed to implement the concept at this point seems to be unwarranted.

Boat Size:

Boats over 39 feet in size would be prohibited from using the run. The size of very large boats (40-60 feet) has the potential to create unsafe circumstances due to difficulty with maneuvering boats of this size in the narrow run and into and out of the mooring system. Under the proposed mooring plan, boats would moor and travel in deeper waters, thus lessening the potential for impacts to the vegetation and substrate from boat props. Damage from anchors would be completely eliminated under this plan because anchoring would be prohibited. Although all boats under 39 feet in length would be allowed in the areas of the run designated for boats, larger boats (23-39 feet) would be allowed only in certain mooring spots as indicated on Figure 10.

Configuration of Mooring Spaces:

The actual spaces used for mooring are broken down into categories of boat sizes (Figure 10). Smaller boats would be encouraged to moor in certain areas suited to their size but would not be prohibited from using other spaces. Large boats (23-39 feet) would have 40% of the spaces available in the middle of the main mooring area. The remainder of the spaces (60%) are allocated to boats less than 23' in length. The percentage of spaces allotted for each boat type are partially based on analysis of aerial photos taken of Silver Glen Spring Run during highest use times (Memorial Day, Labor Day and July 4th weekend) in 1999, 2000, and 2001. Boat counts were done and then boat types were broken up into categories (Table 5) according to boat type and average size.

Mooring would be on a first-come, first-serve basis. If the plan succeeds and there is a large demand for the spots, mooring could be placed on a reservation system along with the rest of the Ocala National Forest campgrounds.

Table 5. Average Boat Type and Specs for Holiday Weekends at Silver Glen Spring 1999-2001

	Runabout	Cabin Cruiser	Houseboat Reg.	Houseboat Large
Average number of boats	136	15	18	7
Percent of total	80%	9%	7%	4%
Minimum size	17 feet	23 feet	24 feet	46 feet
Maximum size	22 feet	38 feet	45 feet	60 feet
Average beam (width)	8 feet	10 feet	15 feet	15 feet

Type of Mooring:

A Bahamian-style mooring system would be employed for much of the mooring area. This allows one mooring for the bow and one for the stern of the boat. Rafting of vessels – where vessels tie up to each other – would be allowed in order to minimize the number of mooring buoys needed for the mooring zone. The north bank of the run would use cleats attached to the support pilings for bow mooring. In order to minimize the number of mooring pilings and buoys, boats along the dock would be allowed to raft up to one boat on either side of them. If this rafting system proves to be ineffective, more buoys can be added in the future. All stern mooring and mooring in the central portion of the mooring zone would be done using buoys.

There are several types of construction materials available for the boardwalk/dock. Table 6 details the types and costs of the different options. A cement dock would last the longest and have the least maintenance but cement does not match the aesthetics of the run. Pressure treated wood is the least costly but would require the most maintenance and there are water quality considerations associated with pressure treated wood. The plastic/composite wood dock is probably the best material to use but it slipperier than the other two materials. There is another dock product available called Jet Dock that may be suitable for the run. It is very scalable and long lasting but it may not meet the aesthetic requirements for the run. The cost per square foot for Jet Dock is around $30.

Project:

(1) Install a boardwalk/dock along 900 feet of shoreline that parallels the upland (See Figure 10). The dock would be 8 ft wide with two gangways (20 ft) that would give access to the upland at designated places. In addition there would be a platform or extension (8 ft X 40 ft) that would extend out from the dock that would act as drop off or access point for users if all moorings along the dock are being used.

(2) Install 55 permanent mooring buoys (See Figure 10). Twenty-three would be placed parallel to the dock at the same intervals as the dock tie-offs or pilings forty feet from the dock. Sixteen pairs of buoys would be placed in middle of the run (See Figure 10) approximately 38 ft apart. Each pair of buoys would be 55 ft from one another in order to accommodate length of the vessel and lines to tie the bow and stern of each boat.

Table 6. Costs* associated with different boardwalk/dock materials and mooring buoys..

Material	Approximate Sq. Ft Amount (Includes Installation)	Approximate Proposed Dock Length (ft)	Approximate Proposed Dock Width (ft)	Estimated Dock Cost
Cement Dock	$ 40.00	940	8	$300,800.00
Plastic/Composite Wood Dock	$ 25.00	940	8	$188,000.00
Pressure Treated Wood	$ 20.00	940	8	$150,400.00
Number of Mooring Buoys	55			
Sur-Moor T3C Mooring Buoy (24")	$ 209.99			
Chains and Shackles (2ft 3/4" & 6-10 ft 5/8")	$ 3.00			
Mooring Collar (2.5 ")	$ 13.99			
Mooring Pendant (3/4")	$ 94.99			
Mushroom Anchor or Substitute (330 lb)	$ 339.99			
Estimated Installation Labor/Buoy	$ 400.00			
	$ 1,061.96			
Estimated Total Cost of Mooring Buoys	$ 58,407.80			

Permits and Authorization Needed for Recommended Improvements at Silver Glen Spring * Estimated costs as of June 2003

Permits and Authorization Needed for Recommended Improvements at Silver Glen Spring

Process:

Owner/Applicant: USFS is the owner along the northern shoreline of the spring run and Juniper Club is the owner along the southern shoreline. (The island at the entrance is privately owned by the Juniper Club, but no activity is proposed near there.) The USFS is the managing entity of the surrounding riparian uplands and the spring run. Options for obtaining authorization are for either DEP, the USFS, or someone under contract to apply to the water management district for permit/authorization using the Joint Application Form.

Water Management Districts: Lake County and east Marion County are under the jurisdiction of the St. Johns River Water Management District (Lance Hart, P.O. Box 1429, Palatka, FL 32178-1429, 386-329-4500 or SunCom 860-4500) -- the west side of Marion County is covered by Southwest Florida Water Management District (Karen Gruenhagen, 2379 Broad Street, Brooksville, FL 34604-6899, 352-796-7211 or SunCom 628-7211).

Regulatory Permit Needed:

Whether a de minimus exemption is appropriate, or a Notice General Permit (NGP) or Environmental Resource Permit (ERP) is needed may depend on whether all the parts are recommended to be completed together or whether they might be spaced out over the years to come. If these improvements are determined to be of minimal or insignificant individual or cumulative impacts, then the project might qualify for a de minimus exemption under 373.406(6), F.S. The project may qualify for an NGP under the WMD's rule similar to 62-341.485 for environmental restoration or enhancement. Or, an ERP may be required.

If an Environmental Resource Permit is required, the applicant will need to provide the permitting agency (WMD) reasonable assurance that State water quality standards will not be violated. This may include a plan to deploy turbidity curtains, which surround the

jetting of pilings or any activity that causes sediments to be suspended in the water column. Depending on the size and composition of the water dependent structures (i.e., CCA pilings versus cement pilings), the expected boat use, and the current condition of the area, the applicant may be required to provide additional measures to ensure water quality standards are met.

If the project qualifies for an NGP or de minimus exemption, there is a presumption that state water quality standards will be met. However, the deployment of a turbidity curtain may still be necessary to prevent a turbidity violation.

Proprietary Authorization Needed:

The activities combined or individually may require a lease, easement or letters of consent depending on what activities are recommended and which the Department elects to construct. The structures and activities in (1) and (2) may qualify for a letter of consent if they preempt less than the 10:1 ratio of preempted area to linear footage of shoreline under 18-21.005(1)(a)(2), F.A.C. An easement may be needed for the mooring area.

Any plant removal or planting associated with the plan should qualify for letters of consent under the same rule cite.

Maintenance Recommendations:

The type of material chosen for the boardwalk/dock will dictate the type of maintenance needed. Pressure treated wood may need to be replaced every 10-15 years depending on use and condition while the other types of material will have extended lives. Mooring buoys will need to be replaced as needed, however annual monitoring and maintenance is suggested to ensure buoy integrity, condition, and security of mooring system.

Policing Recommendations:

Most enforcement of recreation compliance would be performed by USFS staff. It is recommended that Recreation Research Management patrol the run several times per day

to check for fee payment, collect fees if needed, provide information to those boaters who need it, and enforce the mooring guidelines. Marion and Lake County sheriffs as well as Florida Fish and Wildlife Conservation Commission officers would be encouraged to patrol the run on occasion as well, especially during warm holiday weekends.

Durations of Stay:

Under this plan, boats would be allowed to stay overnight for a maximum of two nights at a time. After that they must leave for 24 hours prior to returning. This will minimize the risk of boats dumping their sewage into the run since most vessels can hold their waste for 2-3 days.

Figure 9. Mooring Buoy Plan Management Zones

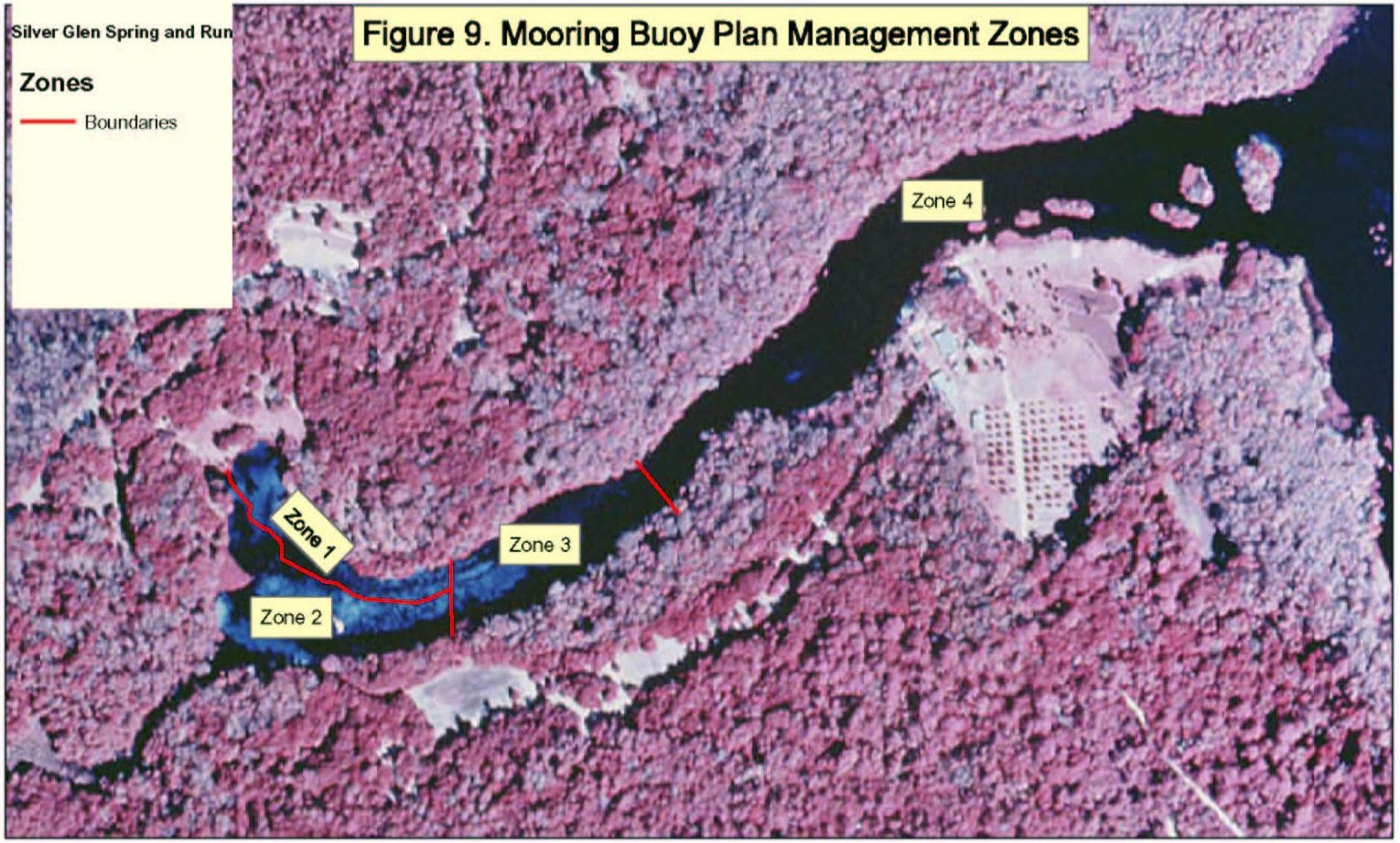
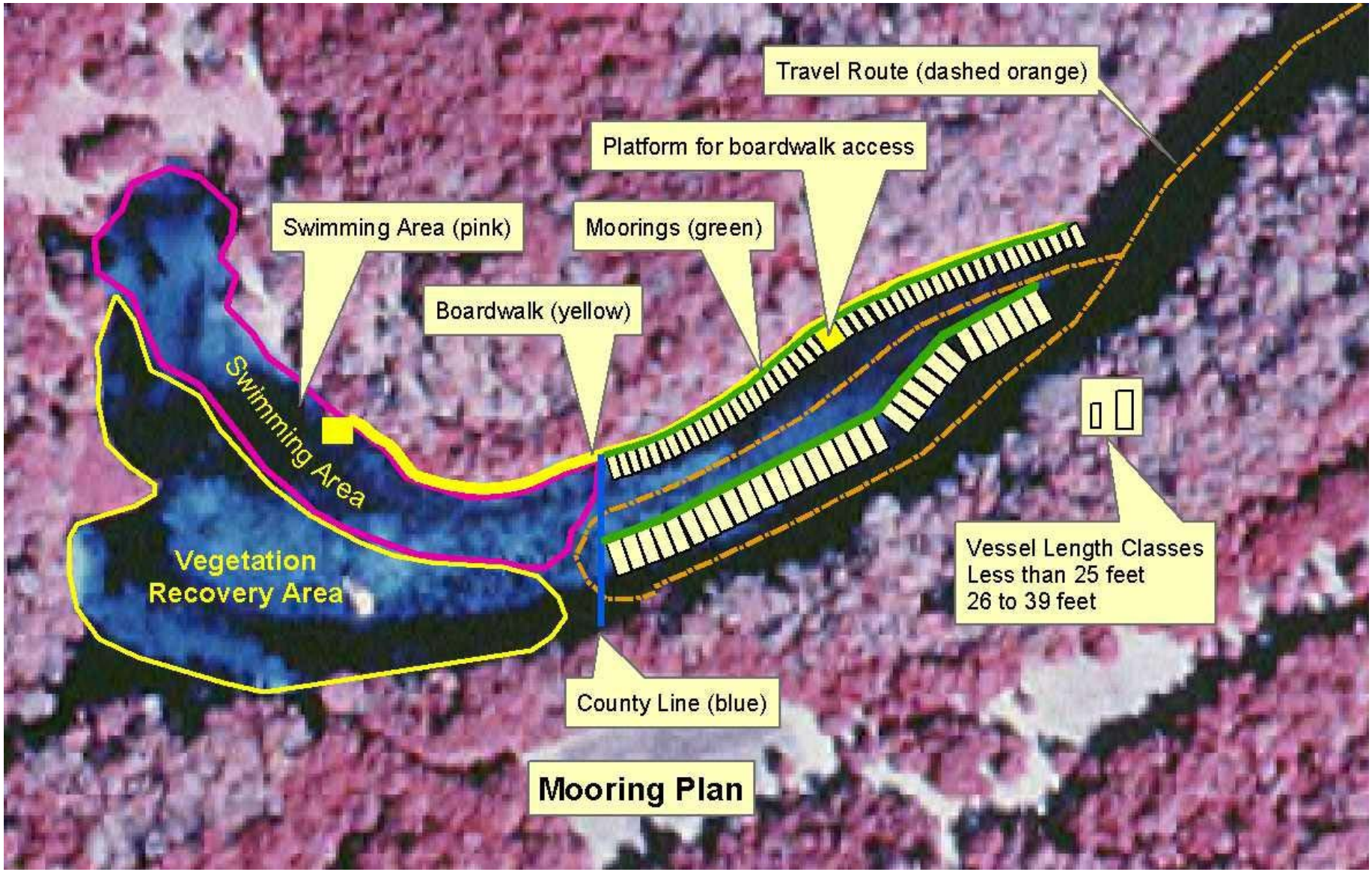


Figure 10. Mooring Buoy Plan



Zone 4: *Travel and fishing area*

Description: Zone 4 is an area for fishing and travel to and from the mooring area. It includes the remainder of the run east of the mooring zone to the mouth of the run. There is no anchoring or mooring allowed.

Zone 4 objectives:

- Ecological: The goal for the vegetation in this zone is to have >50% coverage of native vegetation with >50% of this vegetation considered to be healthy.
- Recreation: Provide for nature experiences and social benefits.

Zone 4 activities: Fishing, boating, nature observation

Public Education Needs: Signs indicating "unofficial" manatee zones could be placed in the two main areas where manatee were seen congregating. These signs could ask visitors to avoid the area.

Table 7. Potential Results of Implementing Management Option 2

General Management Issue	Specific Issue	Results of Option 2
Environmental	Native vegetation	• Zone 2 will allow the reestablishment of native grasses and subsequent "reseeding" of important grasses downstream as the grasses are able to flower and reproduce, sending a seed source throughout the stream. This should enhance the fishing and ecology of the stream long term, both in Zone 2 and as a natural replenishment source for the rest of the run. • Option will allow for restoration of native grasses. • Overall this option will eliminate anchor scars/pits, reduce and localize trampling, prop scarring, and chopping. • In Zone 1, there will be significant trampling impacts. • In Zone 2 native vegetation would be allowed to recover and all boater and wading impacts would be eliminated. • Option will establish a continuous corridor of SAV from Zone 2 to Lake George. • Option will establish and maintain healthy native vegetation seed source in Zone 2. • Some recreation impacts will occur in Zone 3, but efforts should be made to keep the vegetation within the objectives for the area.

General Management Issue	Specific Issue	Results of Option 2
Environmental	Exotic/invasive species (hydrilla and algae)	• Hydrilla, hyacinths and water lettuce will have less opportunity to impact zones 1 and 2 due to a lack of boat traffic to spread them. • With reintroduction of native species exotics may decline. • Hydrilla infestations are manageable at the time of this report in Zones 1 and 2. Hydrilla in Zones 1 and 2 may decrease or be eliminated if active restoration management is taken. • Algae may decrease if active restoration management is taken however if it is not taken algae may colonize impacted areas and take over barren areas, depending upon what actually causes the algae to grow.
	Wildlife not including manatees	• Zone 2 wildlife populations will rebound and flourish. • All wildlife in the run should be enhanced by the new source of eelgrass in the protected zone, providing a protected "nursery" for down stream systems to draw upon over time. • The protected area (Zone 2) should provide native species (bass, sunfish, gar, etc) "recovery" zones where they may go to escape human impacts. • Wildlife that currently lives in the mooring zone may move elsewhere (perhaps Zone 2) to avoid the increase in human use.
	Manatees	• Manatee use of the run may increase. • Manatee foraging habitat will improve. • Manatees will have areas where they are less likely to be harassed (directly and indirectly) by motorized boats. • Manatees will have a protected area to move freely through the deeper waters of the run.
	Water quality	• Water quality will likely improve, due to increased health of the vegetative communities and decreased human impacts in the run.
	Ecological restoration needs	• Active restoration will be needed to keep invasive exotics such as hydrilla from spreading through the run.
Administration	Facilities	• Facilities will better accommodate the needs of most users, thereby encouraging lower impact use of the run.

General Management Issue	Specific Issue	Results of Option 2
Administration	Staffing needs	• Staff will need to patrol the site 3-4 times per day to ensure mooring compliance and to ensure fee payment. • Staff will need to empty the fee station several times per day to deter vandalism and to check for payments.
	Management costs	• A vessel will be needed for patrolling the run.
	Public education needs	• Educational and interpretive signs and information will be needed to inform public about management and regulations. • Increased public education efforts will help to produce more aware visitors and potentially increase stewardship of the area.
Recreation Use	User groups	• User groups may change to more family-oriented and nature-appreciating visitors. • User groups may also change to more ecotourism – oriented visitors that want a natural experience.
	User experiences/benefits	• Users will be able to experience nature while having access to conveniences such as a picnic area, bathrooms, and snack shop. • This option will decrease boater access to the shallow sandy area they have been using previously, allowing visitors to the USFS land-based recreation to view Zone 2, the restoration area, from recreation sites on the land. This will provide a more natural experience for both land-based visitors and boaters with the decreased view of human impacts and increased flora and fauna that will be in the area.
	Recreation areas	• This option may cause many social boaters to use other areas along the St. Johns and Lake George.

General Management Issue	Specific Issue	Results of Option 2
Recreation Use	Local business impacts	• This option may benefit local houseboat rental areas because Silver Glen will offer more of an organized safe family experience. It will also offer more infrastructure for visitors to use if they wish. • This option will eliminate Silver Glen as a destination for some of the larger boats the rental companies offer due to size restrictions. • This option may increase the rental occurrence of canoes from the USFS concessionaire if there are more natural areas and animals to view and less conflicts with boaters. • This option could provide opportunities for local ecotourism businesses if Silver Glen becomes known as a natural attraction with less recreation conflict issues.
Jurisdictional	Enforcement needs	• Enforcement will be needed more frequently at first – especially during the initial startup of the program. • Following initial startup of the program, enforcement needs should be lessened.
	Permit types	• See *Permits and Authorization Needed for Recommended Improvements at Silver Glen Spring*
	Permit costs	• See *Permits and Authorization Needed for Recommended Improvements at Silver Glen Spring*
	Permit process	• See *Permits and Authorization Needed for Recommended Improvements at Silver Glen Spring*

Management Option 3: Close Silver Glen Spring and Run to Motorized Boats

Description: This study has documented that there are ecological impacts from boater and swimmer recreation throughout the run. Under this option swimming would be restricted to the springhead only and would only be accessed from the USFS' current recreation area. All motorized boats would be prohibited from the western two thirds of the run starting immediately to the west of the Juniper Hunt Club boat dock. A barrier system of some sort, such as pilings or some other structure, would be installed to prohibit motorized access to this area. Non-motorized boats would be allowed in this portion of the run but boaters would be restricted from wading or trampling any of the

vegetation. Mooring or anchoring would be prohibited in the eastern third of the run. Fishing would be allowed as long as there was no anchoring. Snorkeling would be allowed as well.

Option 3 goal: Ecological restoration of Silver Glen Spring Run and non-motorized recreation access.

Activities: West of the Juniper Club boat docking area: Nature watching, fishing (non-motorized only), kayaking/canoeing, snorkeling. Fishing and nature watching to the east of the dock with motorized access allowed.

Table 8. Potential Results of Implementing Option 3

General Management Issue	Specific Issue	Results of Option 3
Environmental	Native vegetation	o In the restricted areas the native vegetation would be allowed to recover and all motorized boat and trampling impacts would be eliminated. o Much of the barren and damaged areas would slowly be revegetated through vegetative propagation and seeding, some natural barren substrate would likely be present because of flows, water depths and natural system factors. o If active re-planting is instituted and invasive/exotic controls are implemented, complete recovery of the entire system is possible. o Overall this option will eliminate anchor scars/pits, trampling, prop scarring, and chopping in all areas west of the Juniper Club boat dock except in swimming area. o Option will establish a continuous corridor of native vegetation from the USFS land accessed swimming area to Lake George. o Option will establish and maintain a healthy native vegetation seed source from the USFS land-accessed swimming area to Juniper Club boat dock.

General Management Issue	Specific Issue	Results of Option 3
Environmental	Exotic/invasive species (hydrilla and algae)	o Hydrilla may decrease if active restoration management is taken however if it is not taken hydrilla may colonize previously impacted areas. o Hydrilla, hyacinths and water lettuce will no longer have a source (boat traffic) and because of the flow of the water, will have difficulty migrating upstream and impacting upper zones. o With reintroduction of native species exotics may decline. o Algae may decrease if active restoration management is taken however if it is not taken algae may colonize impacted areas and take over barren areas, dependent upon the causes of the algal growth.
	Wildlife not including manatees	o Terrestrial and wetland wildlife will increase. o Aquatic species will increase. o All wildlife in the run should be enhanced by the new source of eelgrass in the protected zone, providing a protected "nursery" for down stream systems to draw upon over time o The protected area should provide native species (bass, sunfish, gar, etc) "recovery" zones where they may go to escape human impacts. This zone should provide a source for the replenishment of fisheries and other fauna for downstream areas. o Elimination of air boats and other boats which crush emergent vegetation will likely allow more nesting, roosting, and the restoration of native vegetation along littoral zone.
	Manatees	o More manatees will start using the run. o Manatee foraging habitat will improve o Manatees will have areas where they are less likely to be harassed (directly and indirectly) by motorized boats. o Reduced likelihood of injuries and deaths of manatees.
	Water quality	o Water quality will likely improve, due to increased health of the vegetative communities and decreased human impacts in the run.
	Ecological restoration needs	o Active restoration (replanting and exotic species control) will need to be implemented to promote the recovery of native restoration and keep invasive exotics from moving into historically damaged areas.
Administration	Staffing needs	o No changes

General Management Issue	Specific Issue	Results of Option 3
Administration	Public education needs	o There will need to be interpretive or educational signs placed where motorized boats will be restricted.
	Facilities	o No new facilities would be needed.
	Management costs	o None.
Recreation Use	User groups	o User groups will change dramatically. User groups likely to use the run will be kayakers and canoeists, educational groups, ecotourism outfitters, and others who value more tranquil areas. o The swimmers around the springhead will likely remain the same with some additional users.
	User experiences/benefits	o Users will be able to have more tranquil experiences along the run.
	Recreation areas	o This option may cause boaters who visit the run to use the area in front of the Juniper Club for fishing and nature watching or this option may relocate them to other areas along the St. Johns and Lake George.
	Local business impacts	o This option may impact local boat rental businesses because Silver Glen Spring and Run is a popular destination for them to send large houseboats. Sales may decrease if renters are renting because of Silver Glen Spring, although there are many other areas along the St. Johns River that remain accessible. o This will likely increase canoe and kayak rentals, land visitors, the income from ecotourism uses, and group usage for natural experiences. o Bass and recreational fisheries businesses may increase, due to higher native bass populations and other sport fish populations.
Jurisdictional	Enforcement needs	o There will probably need to be some enforcement of the restricted zone especially in the beginning.
	Permit types	o Not applicable
	Permit costs	o Not applicable
	Permit process	o Not applicable

Management Option 4: Mooring buoy plan with seasonal closure of Silver Glen Spring and Run

Description: This option is a combination of Option 2 and 3 where the mooring plan would be implemented but Silver Glen Spring and Run would be closed to all motorized traffic from October to March to give the spring and run time to recover.

Option 4 goal: Ecological restoration of Silver Glen Spring Run and seasonal motorized recreation access.

Activities: October to March- See Option 2; April to September- See Option 3

Table 9. Potential Results of Implementing Option 4

General Management Issue	Specific Issue	Results of Option 4
Environmental	Native vegetation	o In the restricted areas the native vegetation would be allowed to recover and all motorized boat and swimming impacts would be decreased. o During October to March, vegetation in Zone 3 would be allowed to recover (See Option 2). o Much of the barren and damaged areas would slowly be revegetated through vegetative propagation and seeding, some natural barren substrate would likely be present because of flows, water depths and natural system factors. o If active re-planting is instituted and invasive/exotic controls are implemented complete recovery of the entire system is possible. o Option will establish a continuous corridor of native vegetation from the USFS land-accessed swimming area to Lake George. o Option will establish and maintain a healthy native vegetation seed source from the USFS land-accessed swimming area to Juniper Club boat dock.
	Exotic/invasive species (hydrilla and algae)	o Hydrilla may decrease if active restoration management is taken however if it is not taken hydrilla may colonize impacted areas. o With reintroduction of native species exotics may decline. o Algae may decrease if active restoration management is taken however if it is not taken algae may colonize impacted areas and take over barren areas, dependent upon the causes of the algal growth.

General Management Issue	Specific Issue	Results of Option 4
Environmental	Wildlife not including manatees	o Terrestrial and wetland wildlife will increase during October through March. o Aquatic species will increase. o All wildlife in the run should be enhanced by the new source of eelgrass in the protected zone, providing a protected "nursery" for downstream systems to draw upon over time. o The protected area should provide native species (bass, sunfish, gar, etc) "recovery" zones where they may go to escape human impacts. This area should provide a source for the replenishment of fisheries and other fauna for down stream areas.
	Manatees	o More manatees will start using the run and will have full access to the springhead during October to March. o Manatee foraging habitat will improve. o Manatees will have areas where they are less likely to be harassed (directly and indirectly) by motorized boats. o Reduce the likelihood of injuries and deaths of manatees.
	Water quality	o Water quality will likely improve, due to increased health of the vegetative communities and decreased human impacts in the run.
	Ecological restoration needs	o Active restoration (replanting and exotic species control) will need to be implemented to promote the recovery of native restoration and keep invasive exotics from moving into historically damaged areas.
Administration	Staffing needs	• Staff will need to patrol the site 3-4 times per day during the mooring season to ensure mooring compliance and to ensure fee payment. o Staff will need to empty the fee station several times per day during the mooring season to deter vandalism and to check for payments.
	Public education needs	o There will need to be interpretive or educational signs placed when and where motorized boats will be restricted.
	Facilities	o Facilities will better accommodate the needs of most users, thereby encouraging lower impact use of the run.
	Management costs	o A vessel will be needed to patrol the area.

General Management Issue	Specific Issue	Results of Option 4
Recreation Use Recreation Use	User groups	o User groups will change dramatically. User groups likely to use the run will be kayakers and canoeists, educational groups, ecotourism outfitters, and others who value more tranquil areas. o The swimmers around the springhead will likely remain the same with some additional users. o Off-season boater recreation will decrease. • User groups may change to more family-oriented and nature-appreciating visitors.
	User experiences/benefits	o Users will be able to have more tranquil experiences along the run.
	Recreation areas	o This option may cause many social boaters to use other areas along the St. Johns and Lake George. o This option may cause boaters to use the area in front of the Juniper Club during the off season.
	Local business impacts	o This option may impact local boat rental businesses because Silver Glen Spring and Run is a popular destination for them to send large houseboats. Sales may decrease if fall and winter renters are renting because of Silver Glen Spring, although there are many other areas along the St. Johns River that remain accessible. o This will likely increase canoe and kayak rentals, land visitors, the income from ecotourism uses, and group usage for natural experiences o Bass and recreational fisheries businesses may increase, due to higher native bass populations and other sport fish populations
Permitting	Enforcement needs	o There will probably need to be some enforcement of the restricted zone especially in the beginning at the beginning of each seasonal closure.
	Permit types	• See *Permits and Authorization Needed for Recommended Improvements at Silver Glen Spring*
	Permit costs	• See *Permits and Authorization Needed for Recommended Improvements at Silver Glen Spring*
	Permit process	• See *Permits and Authorization Needed for Recommended Improvements at Silver Glen Spring*

Management Strategies

There are a variety of ways to work with visitors when attempting to control their impacts to natural resources. Visitor management strategies are generally categorized into two groups: 1) indirect and 2) direct. Table 10 lists the management strategies that this project showed would most likely be effective in Silver Glen. For each strategy, examples of indirect and direct management tactics are listed.

Indirect management tactics are designed to change visitors' attitudes, so they *voluntarily* comply with behaviors desired by the manager. For example, indirect management tactics to control littering would include education about the negative impacts of littering and placing many trash receptacles in accessible areas. Although visitors still have the option of littering, the combination of providing education and useful facilities would likely reduce littering as a problem. Research has shown that education such as this has a powerful impact on visitors and can alter their behavior in favorable ways. Also, indirect management techniques are cost efficient over the long term. Quality education messages that are designed to alter behavior are often cheaper than hiring enforcement personnel or building facilities that prohibit certain behaviors. However, indirect management strategies are less efficient then direct management techniques. Since visitors still have a choice, some visitors will not alter their behavior, and problems might still persist.

Direct management tactics specifically control the way visitors behave and are more likely to result in managers' preferred outcomes. Unlike indirect management, direct management tactics do not give visitors a choice. In terms of littering, direct management tactics would include posting "do not litter" signs and hiring enforcement personnel to write citations to people who litter. Although direct management tactics are more likely to result in the managers' preferred outcome, they are generally more expensive than indirect techniques. Although initially direct management techniques are much less supported by recreation visitors and could result in more complaints and conflicts for managers, many managers have found that eventually visitors either accept (and often like) the options or choose to recreate elsewhere.

The vegetation and recreation analysis clearly points to a management need for the area. Current indirect management and limited direct management techniques have led to an unacceptable level of environmental impact according the to DEP. A combination of direct and indirect management are outlined in the four management options above. The current damage to the run is not irreversible, as the vegetation regrowth research shows. The current approach, however, has led to environmental degradation. A new mix of direct and indirect management will help restore the ecosystem while providing desired recreation opportunities. A combination of these methods ranging from indirect to direct management will provide land managers with the tools to address Silver Glen's management needs. Flexibility in management will be critical to any plan's success. As needs change, management of the area must change as well. The following table outlines some selected management options that could be explored for Silver Glen Spring and Run. Management issues are broken into five broad categories: Environmental, administrative, infrastructure, recreation use, and jurisdictional.

Table 10. Silver Glen Spring Management Options

Management Option	Management Issue	Indirect Management	⟷	Direct Management
Mooring	Environmental, administrative, infrastructure, recreation use	Encourage anchoring/mooring in certain areas		Require all boats to be moored to established system.
Hours of Operation	Environmental, administration, recreation use	Open all the time		Restricted visiting times i.e. day visits or limited overnight stays
Duration of Stay	Environmental, administration, recreation use	No limitations		Set durations
Activities Allowed	Environmental, administration, recreation use	All activities	Some activities regulated	Specific activities allowed in predetermined areas
Enforcement	Administrative, jurisdictional	Available on request	On site during specific times	Dedicated staff
Boat Types/Size	Environmental,	All boats allowed	Certain	Certain types/sizes

Management Option	Management Issue	Indirect Management	←→	Direct Management
	administrative, infrastructure, recreation use		types/sizes restricted to certain areas	prohibited from entering the run
Seasonal Restrictions	Environmental, administration, recreation use	Ask users to stay out of certain areas during certain seasons		Physically close off areas to use during certain seasons.
Managing for Impacts from Recreation	Environmental, administrative, infrastructure, recreation use	Educate boaters about potential impacts from their actions		Prohibit use and enforce closed areas
Local Economic Impact	Recreation use	Ask houseboat rental companies to inform their customers how to properly visit S.G.	Provide incentives for houseboat rental companies to teach their visitors how to properly visit S.G.	Require houseboat rental companies to teach customers how to properly visit S.G. and only allow those companies in who do so.
Mooring Permits	Administrative, infrastructure, jurisdictional	Provide information on the need for permits and where to obtain permits	Require boat permits for all boats entering the run	Enforcement ranger/guard at entry to S.G. checking for permits
User Fees	Administrative, recreation use	Ask for voluntary donations to use area	Have self serve pay stations for users to pay fees	Have toll booth or station to collect user fees prior to entering the run
Regulatory Control	Administrative, jurisdictional	Place logs and natural barriers in S.G.'s closed areas to restrict access		Place obvious barriers to closed areas with "No Entry" signs. Enforce with staff patrol.

Potential changes to the Run's ecology and recreation as a result of altering management of the area

Altering the run's use will help to protect the native vegetation and assist in its regrowth. However, making these changes could have some unforeseen consequences. Because these recommendations have not actually been tested, we feel that any ecological/ recreation changes should be closely monitored and all management changes should be considered to be flexible – alterations should be made if necessary, in order to find the best balance possible.

Recreation

When considering changing the management of an area where recreation has occurred for so many years, the potential impacts from these changes must also be considered. One of the most obvious impacts is to the current recreation users (social and economic). Silver Glen Spring Run has always been open to recreation of all types and boaters have been able to enter the run unhindered. They have been able to go where they want and do what they wish for decades. Many of the current boaters in the area consider Silver Glen their "paradise" and enjoy the scenery, meeting with friends, clear water, and protection from wind that the area affords them. Restricting boater access in any way will drastically alter the recreation experience these boaters have come to expect from their visit to the run. Silver Glen is known throughout Florida and beyond as both a beautiful place to come and enjoy time with family and friends and as a party place where people get together to play music and celebrate. Some boaters have already expressed their displeasure with the idea of any restrictions to boating access on the run. They have made it clear that they will resist any attempts to control their access and the experience they expect at Silver Glen. Altering the management of the area will be met with strong resistance from some of the boating community.

Research has not been done on the types of boaters that come to Silver Glen. While completing the mapping research of the Glen, we received comments and anecdotal information from some of the people recreating there. A few of the comments are included in this report. This, however, is not a complete representation of the boating

community that comes to the run. We did not research who comes to Silver Glen, why they come, or what they want from their recreation experience. We do not know what, if any, management changes would be accepted or even welcome by the different types of boaters who access the area. We did not talk to any of the houseboat rental companies that send many of their customers to Silver Glen to see what their customers desire from their visit or even how much of their income is based on using Silver Glen as a destination spot for their visitors. Further, although the DEP has heard from boaters who oppose any restrictions on access and anchoring in the run, we do not know if this opinion is representative of the majority of the boating population or just a vocal few. We do not know who the other users are that come to the run and what they are interested in experiencing once they arrive. Further, we do not know what type of boater would begin using the run if the management was changed so that the run became less of a party spot and more of a pristine, natural, quiet experience.

Ecology

Several of the management recommendations were created with restoration of Silver Glen Run's ecology in mind. This includes restriction of recreation access to some areas that are currently used. Changing recreation patterns could have ramifications beyond those intended especially as it relates to algae and hydrilla.

It is known that boats enable the spread of hydrilla. Since it is already introduced into the Silver Glen Spring ecosystem, aggressive tactics should be taken to control it. Without restoration efforts, the spread of hydrilla throughout the run will continue. The proposed management options are intended to assist with the management of hydrilla, although their long-term results are not known at this time.

Algae currently exists throughout the run. Its main concentration is near the springhead along the perimeter of the run and throughout the buffer zone between the swimming area and the boating area. The algae is not as thick in areas where waders are present near the spring boil or where waders and boats are present in the area of bare substrate in the western portion of the run. The causes of this proliferation of algae are currently being

researched by the DEP. The impact these management recommendations may have on algal growth is not known at this time.

Conclusion

Silver Glen Spring is a unique recreation area that holds great ecological and recreation value. Although the spring has endured many changes from human use over time, it has never appeared as threatened as it does now. Visitors to the area will tell of "how it used to be" when the wildlife was more abundant, the vegetation was healthier, algae was present in much smaller amounts, and the recreation experience was more peaceful. If the pattern of increased use continues without any management intervention, Silver Glen is in serious peril. Active, flexible management combined with ecosystem monitoring is needed in order to restore the ecology of Silver Glen while providing a safe, nature-based recreation experience to the thousands of visitors that come there every year.

A good case study for effective spring management is Itchetucknee. It is often cited as a very good example of a carrying capacity analysis for an area. The result of the Itchetucknee work was the restoration of the aquatic ecosystem via limiting recreation on the river to certain numbers of people and certain times of the year. Although the initial Itchetucknee study was completed in the late 1970's, the monitoring continued for many years following. This extended time period allowed land managers to modify the extent and amount of use to the river in order to find the best balance between recreation and ecology. Silver Glen Spring has the potential to strike a balance between recreation and ecology, however this will require adaptive management, like that done at the Itchetucknee, in order to determine where this balance is. This study has shown that present recreation use is causing damage and loss to the native vegetation. It is also affecting the fish and wildlife and the recreation experience for some visitors.

Recreation will increase at Silver Glen Spring and Run. Florida is the number one marine recreation destination in the United States with over 22 million people participating in some form of marine recreation in 1999. Florida far outpaced other states in motorboat recreation participation in 2000 with 3.3 million participants. (V. Leeworthy and P. Wiley, 2001). Boat ownership is increasing statewide. Over 902,000 boats are currently registered in Florida. Thousands more are documented but not registered.

Florida ranks third in the nation in the number of boats registered, but it ranks first in the amount of time people are spending on the water (Bureau of Economic and Business Research, 2002). Table 11 outlines the increases in boating use in counties along the St. Johns River from 1980-2000 and shows the type of growth in boater recreation Silver Glen Spring and Run and surrounding areas have been experiencing over the last 20 years. Proactive management is needed to deal with the growing popularity of the area.

Table 11. Pleasure boat registrations in counties along the St. Johns River in 1980 and 2000.

County	Pleasure Boats Registered in 1980	Pleasure Boats Registered in 2000	Percent Increase
Clay	3,120	9,465	203%
Duval	24,930	30,563	23%
Marion	8,591	17,165	100%
Putnam	4,120	7,441	81%
St. Johns	2,126	8,489	299%
Volusia	11,141	23,118	108%
Lake	9,256	18,033	95%
Total	**63,284**	**114,274**	**81%**

In addition to the overall growth in visitors, one of the major management concerns and impacts from boats is hydrilla. Its presence marks a change in the Spring's ecology that indicates it is in a fragile state. Hydrilla's ability to overtake and choke out native ecosystems is discussed throughout the report. Managing and eliminating the spread of hydrilla is a crucial step that must be taken in order to maintain the integrity of this unique ecosystem. Hydrilla in Silver Glen Spring and Run must be actively managed so that Silver Glen does not suffer the fate of other areas where hydrilla went unchecked.

This study documented the impacts of current recreation to the vegetation. It also developed management options to address those impacts. But with most research, there is a need to gather more information to modify and improve recommendations and management. The following are a few questions or concerns that remain that should be answered to further protect Silver Glen Springs and Run.

- Current boaters that use the run- Who are they, where do the travel from, what recreation experience do they desire from Silver Glen, and what management options would they tolerate or would they like to see implemented?
- Potential boat-based visitors- Who are they, why do they not come to Silver Glen now, what would make Silver Glen a more attractive destination for them?
- Regional research on boater use along the St. Johns River-Where will the boaters go if displaced from Silver Glen?
- Native vegetation in the run- What types of changes will occur to Silver Glen's vegetation following any management changes or what types of changes will occur to Silver Glen's vegetation if no management changes are made?
- Non-native vegetation-What types of changes will occur to hydrilla in Silver Glen Springs and Run?
- Mooring buoy plan- How effective is the plan in terms of providing adequate services?

Finding a balance between people and the environment in the form of carrying capacity recommendations is a challenging, but critical step toward addressing the problems faced by managers of this resource. It is the hope of the researchers that this report will build the foundation for future sustainable management of Silver Glen Spring and Run. With careful, adaptive planning and management a balance can be struck between this truly unique resource and recreation use.

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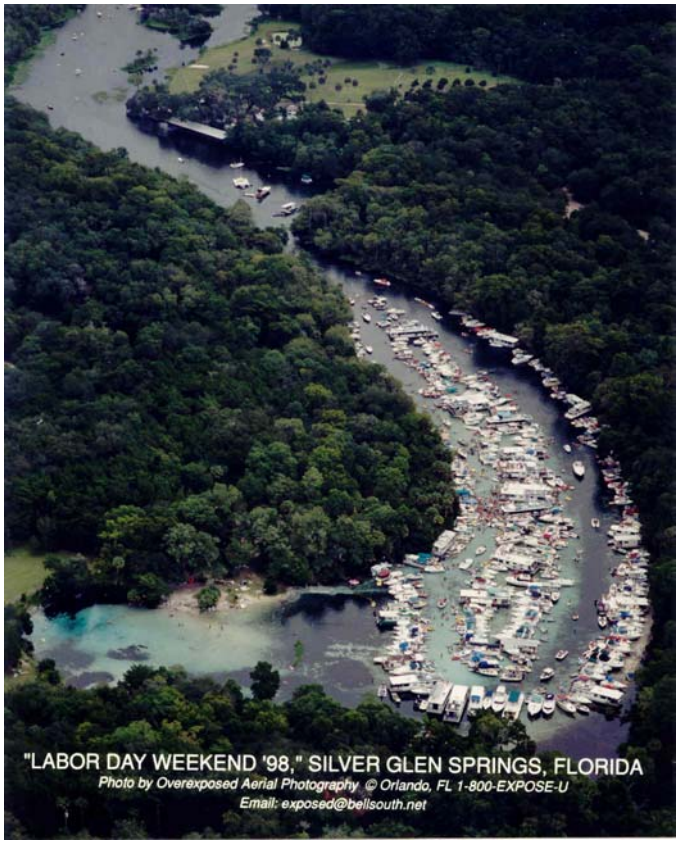
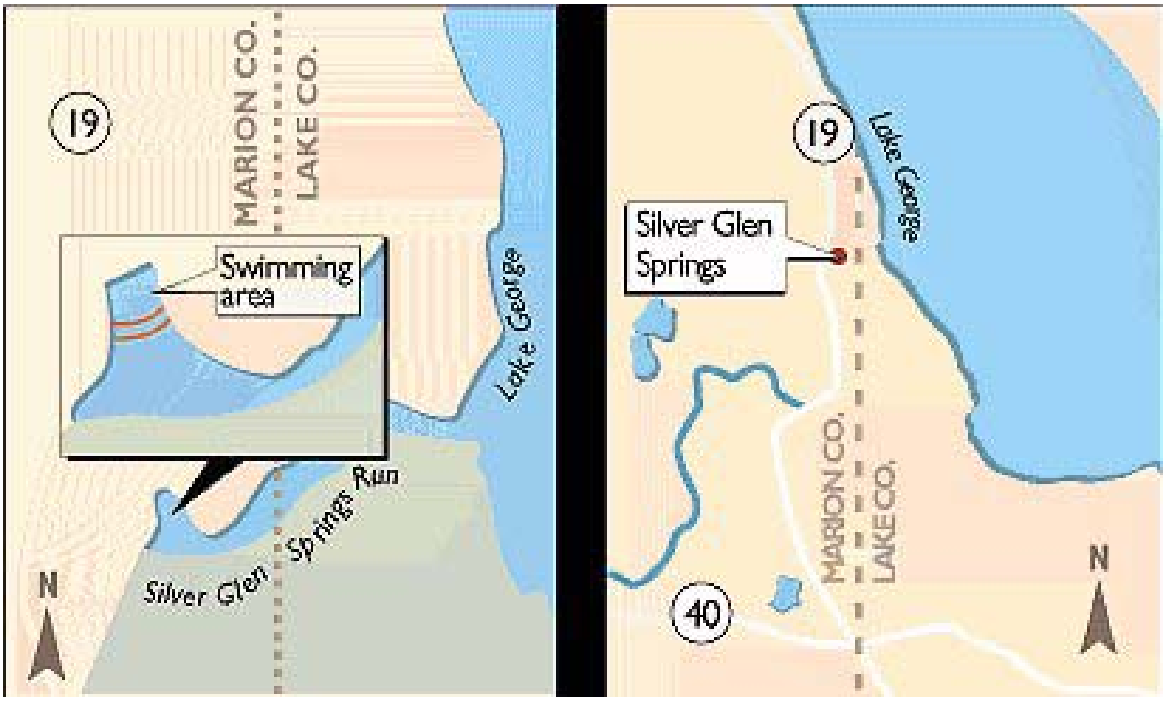
Appendix A

Photos



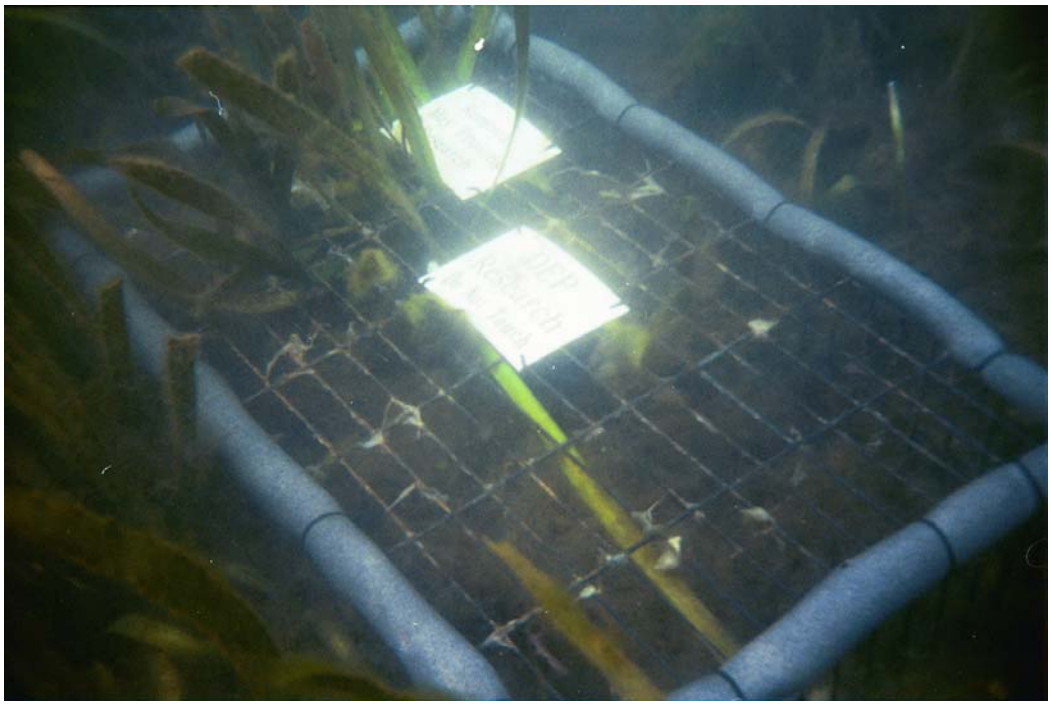
Silver Glen Spring Labor Day Weekend 1998



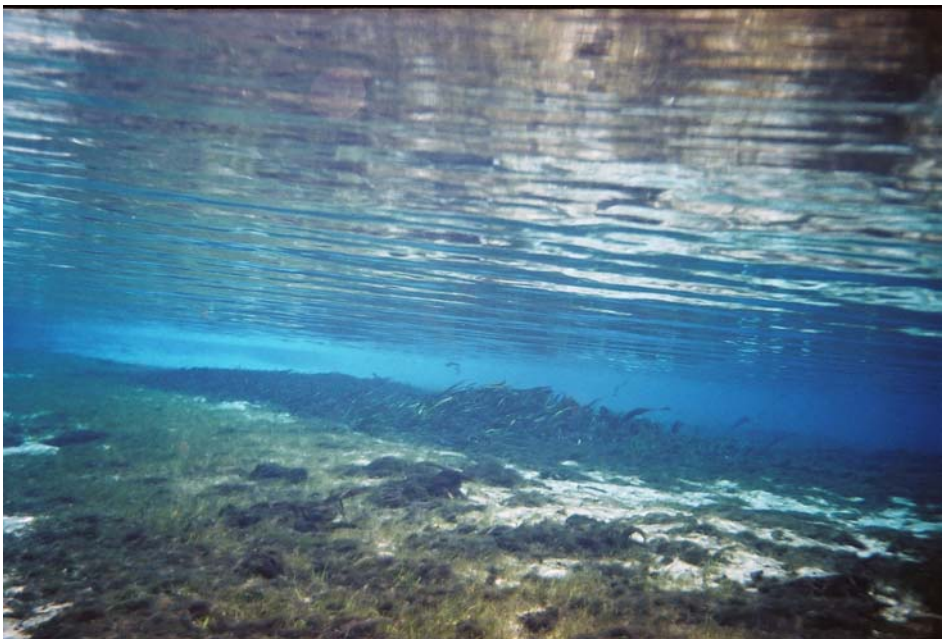
Map of Silver Glen Spring

The main spring boil with eelgrass and fish

Mapping the vegetation at the spring



Research cage under water

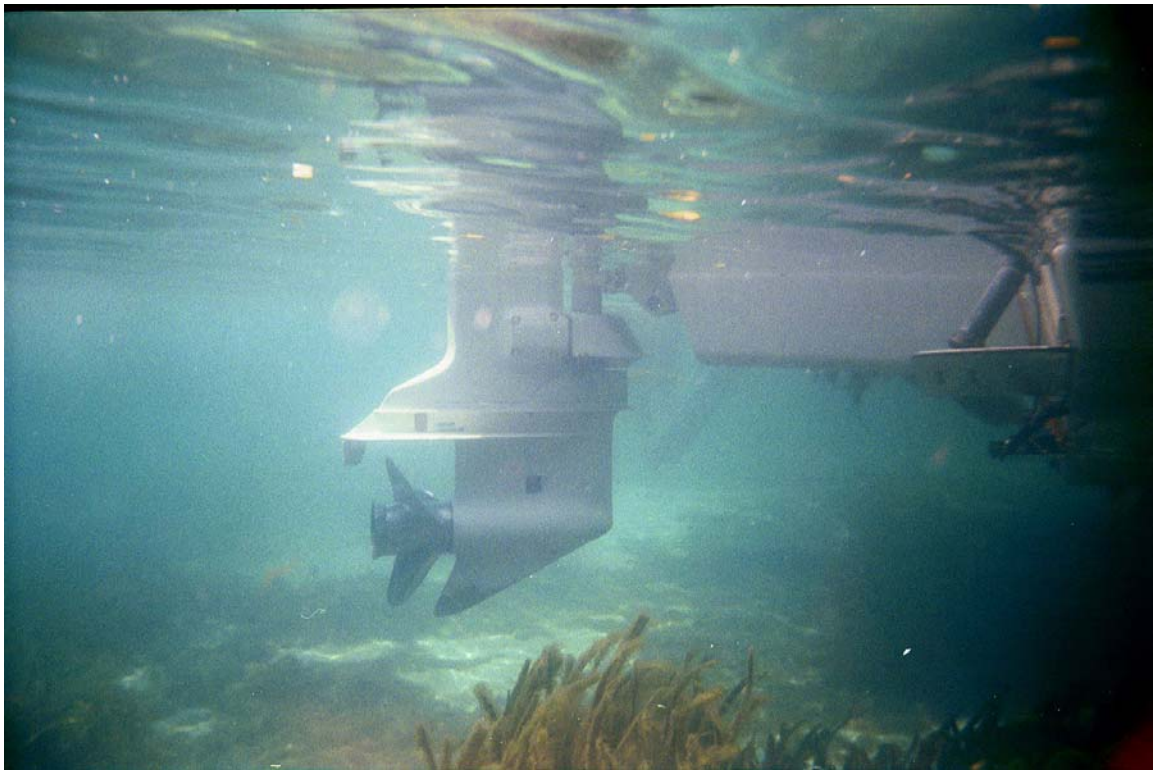


Trampling near the main land-accessed swimming area

Fishing in the Run

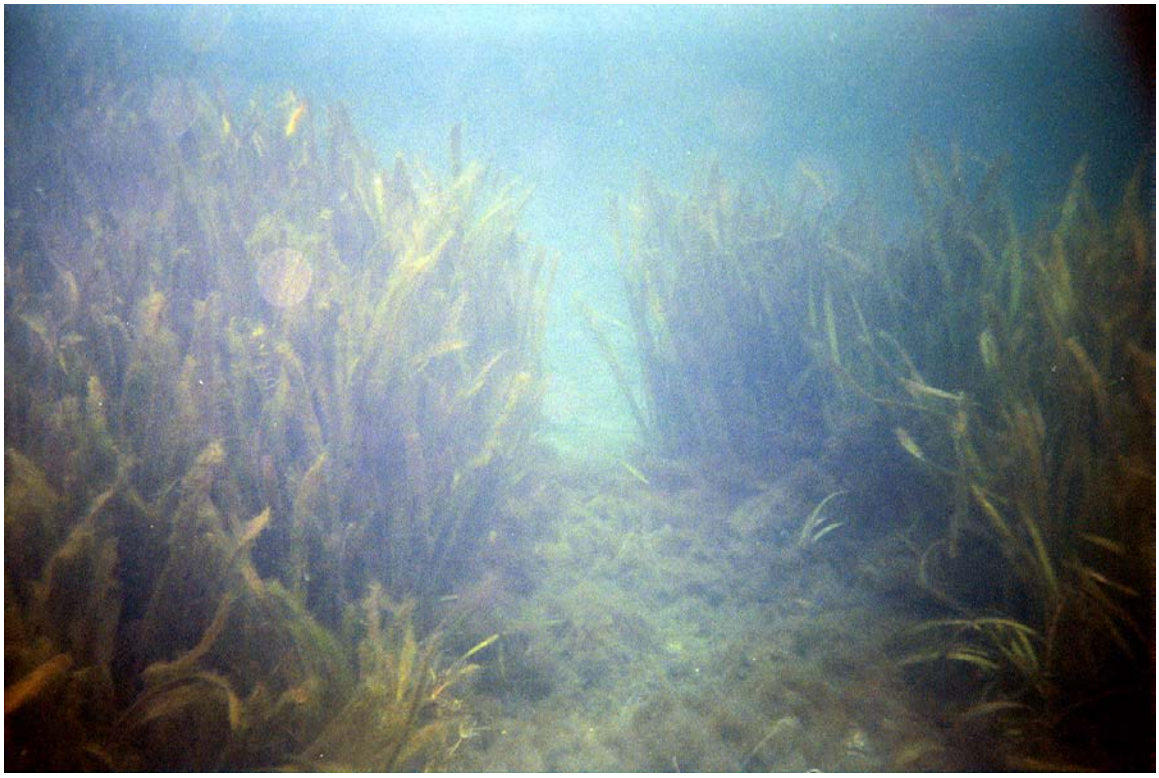
Boats in the western end of the Run

Boats on busy weekend

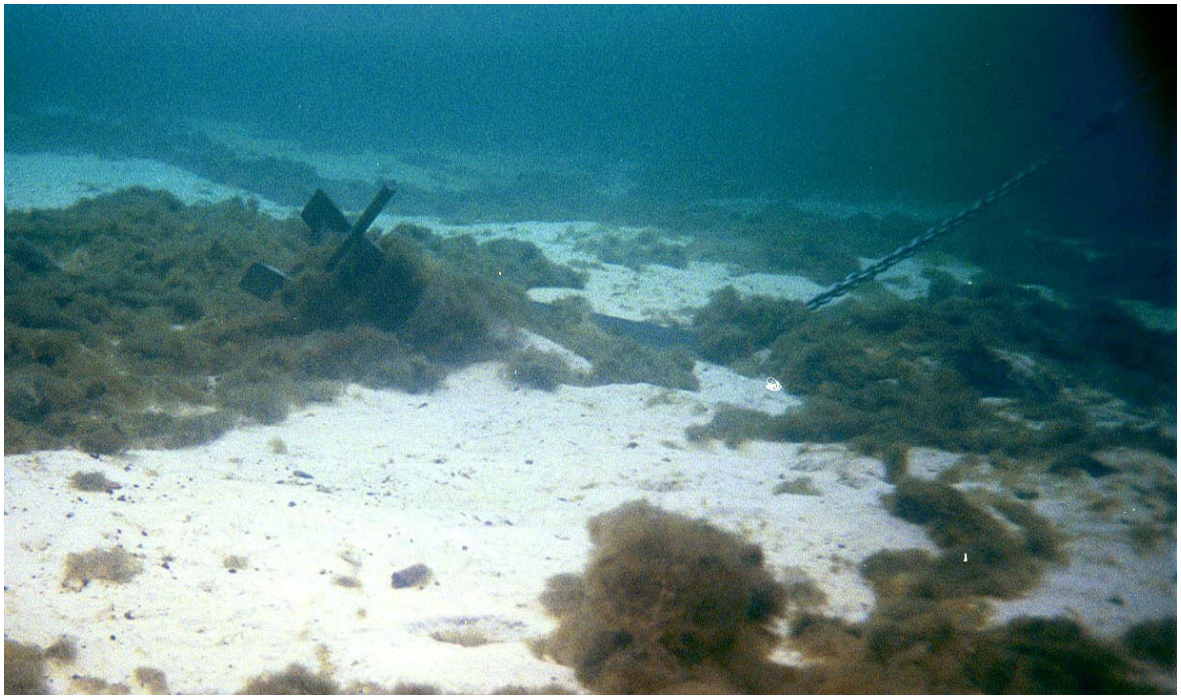


Grass exhibiting propeller chop and boat propeller

Flowering eelgrass and boat propeller



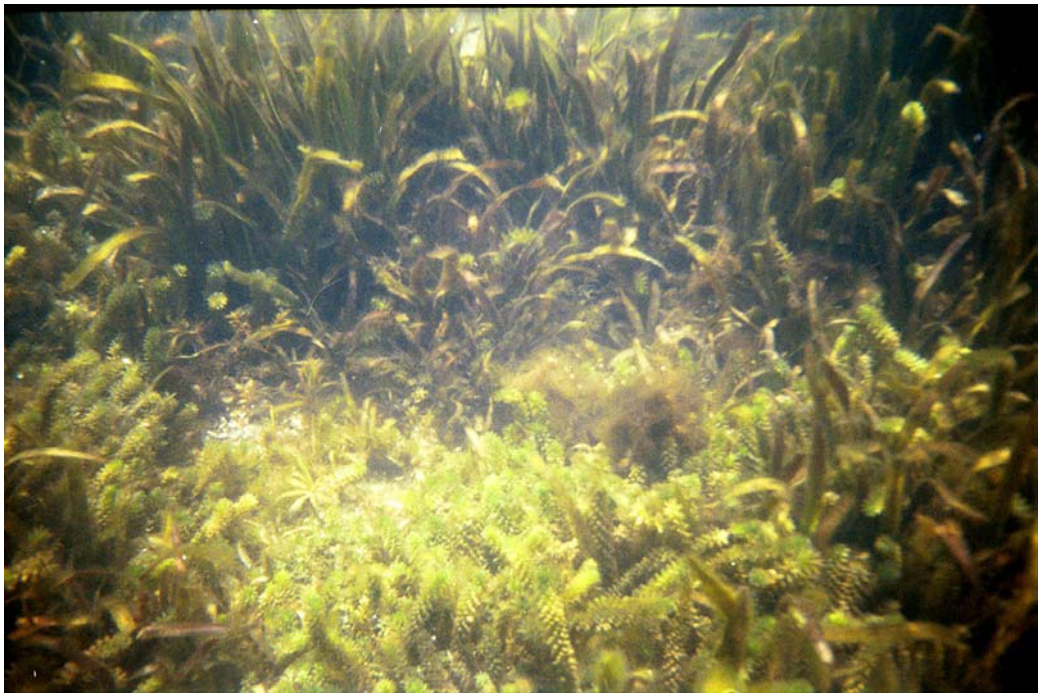
Prop scar in grass



Anchor on substrate

Algae mat near eelgrass

Tilapia on nest

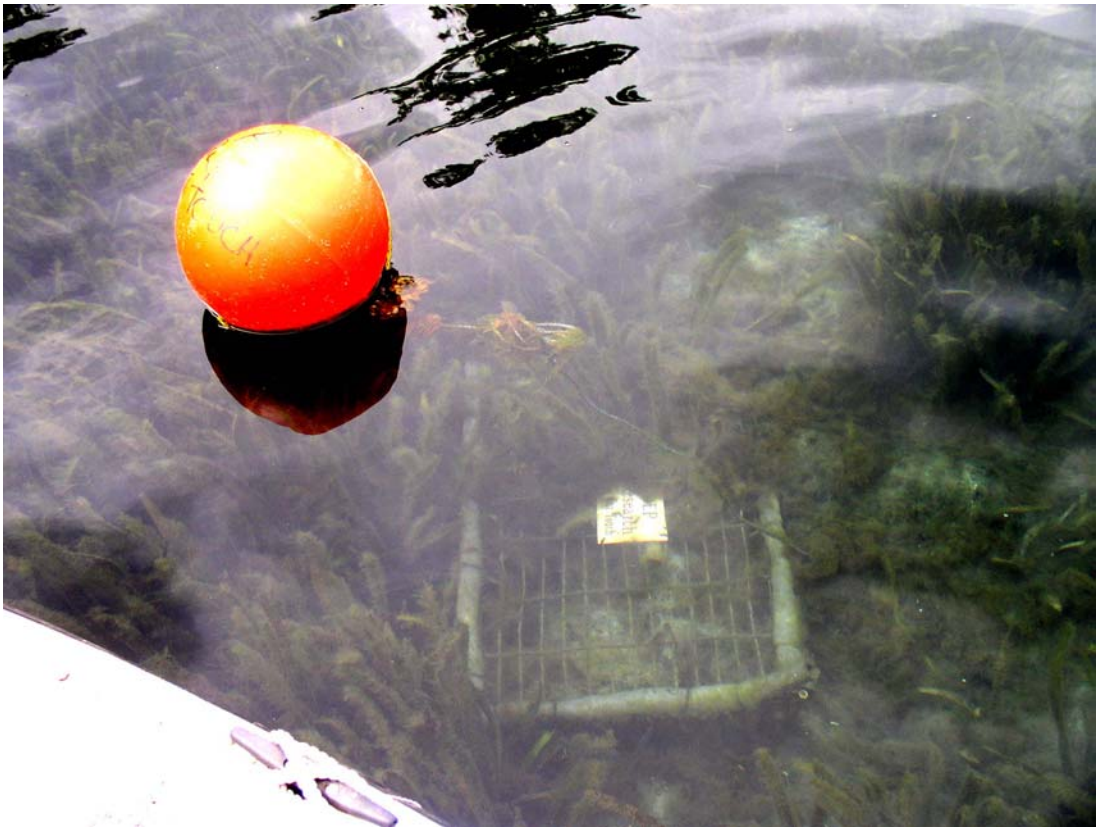


Hydrilla and eelgrass

Bowhunting in the Run

Installation of 5’x5’ buoyed plot

Sailboat moored in Run



Exclusion cage viewed from above water

Juvenile alligator basking

Turtle basking on palm

Silver Glen scenery