

## Summary of Public Comments, Responses, and Plan Modifications to the Draft 2019 South Carolina Aquatic Plant Management Plan

### Comments and Revisions:

To Whom it May Concern,

I -----, as a voting and tax paying citizen, a recreational boater, a fisherman and waterfowl enthusiast, of which utilizes the Santee Lake System, do hereby strongly request that the following amendments be made to the 2019-2020 SC Aquatic Management Plan.

These below requests are founded and based on the factual scientific data that both fisheries and avian species including waterfowl need and desire aquatic vegetation within a reservoir system for their survival.

Furthermore, the health index studies of the currently present triploid grass carp show the captured fish as well underweight as compared to length and age structure. Thus, any person of sound mind can deduce that the aquatic management plan has gone beyond its scope as to aquatic vegetation allowances and control. Simply put, more aquatic vegetation is needed to create better water quality, better fisheries and better waterfowl and other avian habitat.

Requests :

1. That the 10,000 triploid grass carp noted as to be stocked be changed to 5,000.
2. That triploid grass carp introduced into Potato Creek Hatchery, a public CAT 2 waterfowl area that was completely destroyed as to waterfowl benefit by triploid carp stocking, be reduced from 1,428 to zero.
3. That triploid grass carp introduced into the Hatchery WMA, also a CAT 2 waterfowl area be reduced from 15 fish per acre to zero per acre.

A concerned and voting citizen,

Bill Wilkins [bill.wilkins.prcn@statefarm.com](mailto:bill.wilkins.prcn@statefarm.com), Eric Kolb [eric29150@gmail.com](mailto:eric29150@gmail.com), Buren Rothwell [oldensoar1960@outlook.com](mailto:oldensoar1960@outlook.com), Philip Messina [philip\\_messina@hotmail.com](mailto:philip_messina@hotmail.com), Russell Boykin [boykin.russell@gmail.com](mailto:boykin.russell@gmail.com), Miles Altman [miles.a.altman@gmail.com](mailto:miles.a.altman@gmail.com), Conor Dills [conor\\_dills@yahoo.com](mailto:conor_dills@yahoo.com), David Johnson [dkjohnson1@comporium.net](mailto:dkjohnson1@comporium.net), Tyler Veronee [tyler@ppcllc.net](mailto:tyler@ppcllc.net), Justin Clamp [justinclamp72@gmail.com](mailto:justinclamp72@gmail.com), Trey Morris [TreyM@NALC.npcam.com](mailto:TreyM@NALC.npcam.com), Jeffrey Sawyer [jeff@rlapls.com](mailto:jeff@rlapls.com), Cody Harper [harperca216@gmail.com](mailto:harperca216@gmail.com), Wade Skinner [skinnerw57@gmail.com](mailto:skinnerw57@gmail.com), Jacob Bowdler [ibatler85@yahoo.com](mailto:ibatler85@yahoo.com), Brice Peper [Brice@hoffmanlawfirm.com](mailto:Brice@hoffmanlawfirm.com), Ron Barnes [fracas714@icloud.com](mailto:fracas714@icloud.com), Perry Trouche [perrytrouche@gmail.com](mailto:perrytrouche@gmail.com), Adam Deal

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[brycem843@gmail.com](mailto:brycem843@gmail.com), Justin Richardson [jrichardson@colite.com](mailto:jrichardson@colite.com), Denny Townsend [townsedl4@gmail.com](mailto:townsedl4@gmail.com), Wes Thompson [wes.thompson@thompson-logistics.com](mailto:wes.thompson@thompson-logistics.com), Keith Campbell [keith@campbellsbody.com](mailto:keith@campbellsbody.com), Chris White [whitehousebuildersllc@yahoo.com](mailto:whitehousebuildersllc@yahoo.com), Ian Cundiff [icundiff4@gmail.com](mailto:icundiff4@gmail.com), Marvin Morgan [Marvin@jhiers.com](mailto:Marvin@jhiers.com), Bilton, Jeff D [Jeff.Bilton@centuryaluminum.com](mailto:Jeff.Bilton@centuryaluminum.com), Henry Hickman [hmhickman13@gmail.com](mailto:hmhickman13@gmail.com), Chase Canipe [chase.canipe1@gmail.com](mailto:chase.canipe1@gmail.com), Chuck Langston [blangston5@sc.rr.com](mailto:blangston5@sc.rr.com), Josh Keesey [keeseyj85@gmail.com](mailto:keeseyj85@gmail.com), Steven Atwell [steven@avionex.com](mailto:steven@avionex.com), Travis Swanda [swandatv@gmail.com](mailto:swandatv@gmail.com), Clark Coker [ccoker@carolinaone.com](mailto:ccoker@carolinaone.com), Brian Martin [btm1971.bm@gmail.com](mailto:btm1971.bm@gmail.com), Cameron Luden [cameronluden1987@gmail.com](mailto:cameronluden1987@gmail.com), Britt Oswald [brittoswald78@gmail.com](mailto:brittoswald78@gmail.com), Ty Bodiford [tybonumber1@gmail.com](mailto:tybonumber1@gmail.com), Alexander Sims [fowlplayer9191@gmail.com](mailto:fowlplayer9191@gmail.com), John Crofts [johnmcrofts@gmail.com](mailto:johnmcrofts@gmail.com), Greg Elliott [gle101971@gmail.com](mailto:gle101971@gmail.com), John Phillips [jmphillips38@gmail.com](mailto:jmphillips38@gmail.com), Drew Bozard [bozard@shiprls.com](mailto:bozard@shiprls.com), Renny Delossantos [Renny.DelosSantos@bmwmc.com](mailto:Renny.DelosSantos@bmwmc.com),

Re: The 2019 apmp-

Please consider NOT releasing any more Triploid grass carp into the Santee Cooper lakes system this year. The native grasses are making a return and would get set back AGAIN with the

release of 10000 more grass carp. Please manage the any remnant of hydrilla by other methods.

Sincerely,

**Jesse N. Williams III** [norwil@ftc-i.net](mailto:norwil@ftc-i.net)

To whom it may concern,

In regards to the proposed stocking of 10,000 triploid grass carp into the Santee Cooper/Lake Marion/Moultrie system, I have to grossly protest. With an estimated population of 36,217 in the lake system currently, this restocking in 2019 seems unnecessary based on historical trends of both the fish population and estimated acreage of hydrilla. Continuing to monitor both levels along with the herbicide plan proposed, I see no reason to stock 10,000 more carp into this system.

Thank you in advance for your time,

**Alex Brammer** [brammer03@yahoo.com](mailto:brammer03@yahoo.com)

I would like to request that DNR and Santee Cooper sign and adhere to the re-newed MOA, and also demand that DNR not stock carp in any Cat 2 Waterfowl areas. It is asinine that the Nuisance Species program would spearhead putting carp in Potato Creek Hatchery, knowing full and well they will deplete the area of any SAV.

A landlocked pond specifically used for waterfowl hunting should be blooming with SAV.

Quit trying to put them in there Chris.

**Clark McCrary** [cmccrary@netsourcek12.com](mailto:cmccrary@netsourcek12.com)

I Manning Rushton, as a voting and tax paying citizen, a recreational boater, a fisherman and an waterfowl enthusiast of which utilizes the Santee Lake System, do hereby strongly request that the following amendments, found below, be made to the 2019-2020 SC Aquatic Management Plan.

Control of saw grass, hyacinths, and crested floating heart should be highest priority. Saw grass and hyacinths create floating mats that support other vegetation, leading to open water becoming peat bogs.

Carp are not solving our real vegetation problems and decimate native SAV.

Once grass carp were introduced into our lakes, what had been wonderful grass flats and beautiful coves full of vegetation quickly became dead, sterile lake bottom where nothing could survive except catfish, carp, and cormorants. Once "invasive" vegetation was gone, carp began decimating native vegetation, yet did nothing to control sawgrass, hyacinths, or crested floating heart.

There are many thousands of acres of Lakes Marion and Moultrie that will never see a ski boat, a pontoon, or a jet ski. These acres should be treated for sawgrass, hyacinths, and crested floating heart, but native SAV should be allowed to grow.

Areas such as Santee NWR, Jacks Creek Hatchery, Hatchery WMA, Potato Creek Hatchery, and Sparkleberry should be allowed to once again become home to vegetation beneficial to fish and waterfowl.

Areas of cypress, tupelo, and other native trees should not be counted as acres of vegetation under the proposed plan.

I have no problem with increasing open waters for boating in some portion of the lakes, (below I-95 bridge for instance) but let the fish, waterfowl, and us that enjoy them also have portions of the lakes to enjoy.

A concerned and voting citizen,

**Manning Rushton** [manningdrushton@gmail.com](mailto:manningdrushton@gmail.com)

This letter is written as someone that has spent most of my 65 years visiting lakes and rivers in SC.

Control of saw grass, hyacinths, and crested floating heart should be highest priority. Saw grass and hyacinths create floating mats that support other vegetation, leading to open water becoming peat bogs.

Stocking of grass carp on all SC public lakes in quantity currently allowed and proposed massive restocking should be discontinued. Carp are not solving our real vegetation problems and decimate native SAV.

When I began visiting the lakes, there was virtually no sawgrass (giant cord grass), there were no hyacinths, no crested floating heart, or other invasive that benefit no one. We had cattails, oak tree ridges, buck brush flats, and lots of native vegetation under water.

Explosion of Brazilian Elodea and Hydrilla in 60's and 70's brought amazing fishing and clouds of waterfowl. We had duck numbers on our lakes that rivaled Arkansas.

However, once grass carp were introduced into our lakes, what had been wonderful grass flats and beautiful coves full of vegetation quickly became dead, sterile lake bottom where nothing could survive except catfish, carp, and cormorants.

Once "invasive" vegetation was gone, carp began decimating native vegetation, yet did nothing to control sawgrass, hyacinths, or crested floating heart.

There are many thousands of acres of Lakes Marion and Moultrie that will never see a ski boat, a pontoon, or a jet ski. These acres should be treated for sawgrass, hyacinths, and crested floating heart, but native SAV should be allowed to grow.

Areas such as Santee NWR, Jacks Creek Hatchery, Hatchery WMA, Potato Creek Hatchery, and Sparkleberry should be allowed to once again become home to vegetation beneficial to fish and waterfowl.

Areas of cypress, tupelo, and other native trees should not be counted as acres of vegetation under the proposed plan.

Having read past years comments, I am aware of well rehearsed, repetitive letters from "boat clubs" that want a "cement pond" with no native vegetation so they can fly around in their jet skis and speedboats.

I have no problem with them doing that in some portion of the lakes, (below I-95 bridge for instance) but let the fish, waterfowl, and us that enjoy them also have portions of the lakes to enjoy.

**James M Green** [jmgreen4@live.com](mailto:jmgreen4@live.com)  
Orangeburg SC

To Whom It May Concern,

As an avid South Carolina fisherman and hunter, I am concerned with the objectives of this plan. In particular I am concerned with the plan for my home lake, Lake Murray.

This plan contradicts itself, at the expense of wildlife. In particular it contradicts this objective, "Maintain *diverse aquatic plant community* through selective application of control methods and *introduction of desirable native plant species*". The plan lists Hydrilla, Water Primrose, Illinois Pond Weed, Southern Naiad as problem plant species on Lake Murray. Hydrilla *is* a problem plant species because it is invasive, but the others listed are *not* problem species, as they are native to SC. These native plants are incredibly beneficial to our states wildlife, and is supposed to be "Maintained" and "Introduced", not listed as problem species and eradicated.

Furthermore, it is cited that the total size of Lake Murray is 50,000 acres, and its reported that there are only 50 acres worth of aquatic plants. Therefore the stocking of an additional 1,800 grass carp to control 0.1% of Lake Murray is overkill, and the current population of grass carp are clearly doing their job.

SCDNR is caving to the pressure of recreational lake users, and essentially turning Lake Murray into a swimming pool. Outdoorsmen also deserve to have their needs and wants met. It is the responsibility of SCDNR to balance the two parties wants and needs, when in reality you are caving to the recreational users.

Thank You,  
**Harrison Kinard** [samuel.kinard@newberry.edu](mailto:samuel.kinard@newberry.edu)

I'd like to request that the following amendments be made to the

Requests :

1. That the 10,000 triploid grass carp noted as to be stocked be changed to 5,000.
2. That triploid grass carp introduced into Potato Creek Hatchery, a public CAT 2 waterfowl area that was completely destroyed as to waterfowl benefit by triploid carp stocking, be reduced from 1,428 to zero.
3. That triploid grass carp introduced into the Hatchery WMA, also a CAT 2 waterfowl area be reduced from 15 fish per acre to zero per acre.

a taxpayer and sportsman,

I'd like to express my concerns over the proposed plan for grass carp in the Santee Lake System. I'm particularly concerned about the lack of aquatic vegetation for the wildlife. This plan has a tremendous impact on our natural resources as well as taxpayers and sportsmen.

I would like to urge the plan to be more proactive to monitor the existing grass carp and show that the existing carp are not enough.

A concerned resident,

**Ray McFaddin** [ray.mcfaddin@gmail.com](mailto:ray.mcfaddin@gmail.com)

Mr. Chairman and Council,

I have read the Draft Plan for 2019 and payed particular attention to the Santee Cooper Lakes section. The plan as written continues to reflect appropriate management strategies for invasive aquatic plant species which occur in the lake system. As in the recent past, the plan reflects solid aquatic plant management strategies developed cooperatively by Santee Cooper and SCDNR biologists with experience and knowledge of lake management and wildlife management issues specifically relating to the Santee Cooper lake system. Input from interested organizations and individuals should continue to be reviewed and considered, however, final decisions concerning lake management issues should be made by professionals who understand the complex and diverse biology of this large reservoir system. I urge the Council to approve the 2019 SC Aquatic Plant Management Plan as written.

Thank you for the opportunity to provide comments.

Larry McCord [rlmccord31@gmail.com](mailto:rlmccord31@gmail.com)

Good day Mr Page,

Very nice plan, if I can be of any help please let me know.

Glenn Stafford [sloopchannel@gmail.com](mailto:sloopchannel@gmail.com)

Would like to voice my opinion that spraying of invasive plants near our docks and water close to our homes on lake Marion is essential in order to deter these nuisance species.

Thank you for allowing me, as a homeowner, to comment.

**Anthony Del Re**

**Carolee Del Re** [delreemail@yahoo.com](mailto:delreemail@yahoo.com)

To whom it may concern:

I have read your draft Aquatic Plant Management Plan and fully support your actions. I am a homeowner whose property lies on the shores of Lake Marion and an avid boater and fisherman. Your efforts over the past few years have prevented any further spread of nuisance plants in our lakes and river systems ensuring a safe and enjoyable body of water for everyone's use. Boaters, fishermen, hunters and water enthusiasts of all types benefit from your goals of controlling these invasive weeds. Thanks for your in-depth research in this area and your team's hard work deploying the grass carp and herbicides. Your efforts are greatly appreciated.

**Dale Cozart** [cozartd@gmail.com](mailto:cozartd@gmail.com)

S.C. Department of Natural Resources and Aquatic Plant Management Council.

I would like to express my full support for the implementation of the 2019 draft S.C. Aquatic Plant Management Plan. I am a resident of Clarendon County and I live on Lake Marion. I have personally witnessed the invasion of weeds in the past that virtually rendered the lake unusable.

It is my belief that the 2019 draft S.C. Aquatic Plant Management Plan is a reasonable approach to control the invasive weeds and should be implemented.

Respectfully submitted,

**Eddie Gleaton** [egleaton@yahoo.com](mailto:egleaton@yahoo.com)

I live on the shores of Lake Marion and want to express my support for the 2019 invasive plant management plan....

**Sherry Newsome** [ssleepytimegal@gmail.com](mailto:ssleepytimegal@gmail.com)

I have lived on Lake Marion for 19 years and have been enjoying the lake since 1979 so I remember well when the lake was clogged with hydrilla. I never want to see that happen again! For the past several years I have seen Crested Floating Heart covering Nelson's Cut and many of the shallow coast areas. And, now Giant Salvinia is the newest and additional threat to our beautiful lake ! For these reasons I give SCDNR and Santee Cooper my support for the 2019 Aquatic Plant Management Plan !

Thank You,

**Debra Gleaton** [debgleaton@gmail.com](mailto:debgleaton@gmail.com)

I support SCDNR's efforts to control the aquatic weeds in Lake Marion.

Sincerely,

**Lesley Dykes** [lesleypd@msn.com](mailto:lesleypd@msn.com)

I, Angela Gamble, am in favor of your 2019 invasive weed management project for Lake Marion.

Thanks,

**Angie Gamble** [angela.elise.gamble@gmail.com](mailto:angela.elise.gamble@gmail.com)



I, Alfred Kelley, am in favor of the plan of action on the 2019 Invasive Weed Management Plan for the Lake Marion area. I support your efforts to keep our lake free of Hydrilla, Crested Floating Heart and Giant Salvinia and various other invasive plants.

Sincerely,

**Alfred H. Kelley** [alfredhkelley@gmail.com](mailto:alfredhkelley@gmail.com)

Well, I am a tax paying citizen in one of the counties the lakes reside in. I own a house on lake Marion. We have all of the carp because it wasn't too long ago you could walk across the lake on all the grass. I NEVER EVER want it to even look at a piece of grass in that lake again! If you only stock 5k of Carp then up the application of Sonar. I have several young children & animals and with the threat of alligators I don't need anything that they could possibly hide in. Not too mention how nasty the grass is. Most of the individuals sending the emails are tax paying citizens in counties no where near the lake. There are plenty of ducks and fish as it is. Until they are able to walk across the lake imitating Jesus they will not be satisfied. They all want to kill a limit of ducks in 5 min and more than a limit of fish ever outing. DO NOT MESS WITH THE CURRENT GRASS CONTROL METHODS!!!!!! Unless you plan to up the Carp and or Chemical applications!

Thank you

**Devlin Curl** [devlincurl@hotmail.com](mailto:devlincurl@hotmail.com)

As a homeowner on Lake Marion, I appreciate the efforts made by the SCDNR to control the invasive weeds. I agree and welcome all of the Invasive Weed Management.

**Kris Blesie** [kblesie@gmail.com](mailto:kblesie@gmail.com)

As a resident of Lake Marion I would like to say I am in total agreement with this year's management plan. Thank you for all you do for our lake systems.

Best Wishes,

**Jerry Hatcher** [jhatch8@sc.rr.com](mailto:jhatch8@sc.rr.com)

I support Santee Cooper's plan to control invasive weeds on Lake Marion. I am a resident of Clarendon County and live on the Lake. I am a member of the Goat Island Boat Club and we support Santee Cooper.

**Doug Blesie** [dblesie@gmail.com](mailto:dblesie@gmail.com)

Thank you for your actions and efforts to keep SC waterways clear and clean from Invasive aquatic plants. I currently live in Aiken, SC, but own property on Lake Marion. When we bought the property on Lake Marion, our waterway became blocked by floating hearts and we were unable to remove and clean the waterway. This plant is very aggressive and cannot be removed without your help. Thanks to you, our waterway is currently clear of floating hearts. I grew up in Williamsburg county and cherish Black River, Pee Dee, and the surrounding waterways. We love the ability to navigate from Lake Marion to Lake Moultrie, The Cooper River, The Inter Coastal Waterway, Charleston, Georgetown, etc. via water. This is one of the attractions of Lake Marion. Without your support and planning to prevent invasive aquatic plants, this may be prohibited. I support the 2019-2020 Aquatic Plant Management program and hope it continues to keep SC beautiful and attractive. Thanks for all you do.

**Scott, Karen** [ScottKaren@bfusa.com](mailto:ScottKaren@bfusa.com)

In favor of Aquatic Nuisance species program.

**Mona LeFeat** [mlefeat@gmail.com](mailto:mlefeat@gmail.com)

**Response:** The 10,000 Triploid grass carp mentioned in the plan are part of an integrated approach along with spot herbicide applications to control of the federally listed invasive species hydrilla. That 10,000 number represents an age class stocking more so than an increase in numbers as every year a 32% mortality rate takes more fish than we are stocking. It also represents a concerted scientific effort to never have to place 100,000 + fish into that system. By doing maintenance stocking the Council is trying to strike a balance which will allow control of the hydrilla while allowing the other submersed species to flourish and not have massive stockings in the future. Current number of carp in the system based on 160,000 acres is close to 1 fish per 4 surface acres. This is a well thought out adaptive management approach which does not rely on being reactive but proactive. The goal is within reach with some patience.

Health index studies of the currently present carp have also been questioned. The most recent study shows that the carp in age class 6 and below compare directly to 1994 when the carp in 1994 had more than they could eat with 37,000+ acres of hydrilla present. The current condition is 0.88 compared to 1994 fish 1.0. This number does not indicate malnourishment nor do those fish appear to be underweight as many have said. The study is done yearly by SCDNR Fisheries biologist working with bow fishermen to collect samples which can be weighed, sized and aged. The study was done with diligent scientific methods in the fall in 2017 and 2018, will continue for several more years to get scientifically sound data.

The two CAT 2 waterfowl areas of Potato Creek and the Hatchery WMA were remnants of previous years when stocking was considered. They will be removed from the plan and prescriptions provided will be utilized to make sure ramp access is available and the water hyacinth, crested floating heart, cutgrass, and primrose is controlled for better access to open water areas.

On Lake Greenwood and Lake Murray, we were asked in the comments to remove Southern Naiad, Illinois Pondweed, and Vallisneria americana from the nuisance list. Those species are not on the State's invasive species list but can be problematic in some areas on public waters.

**Plan Modifications:**

The grass carp stockings in the two CAT 2 waterfowl areas of Potato Creek and the Hatchery WMA will be removed from the plan and prescriptions provided will be utilized to make sure ramp access is available and the water hyacinth, crested floating heart, cutgrass, and primrose is controlled for better access to open water areas.

## Grass Carp Population Monitoring (DRAFT)

### Introduction

Hydrilla was first discovered in Lake Marion in 1982 and unsuccessfully managed with herbicides through 1988 (Kirk and Henderson, 2006). From 1989-1996, Santee Cooper stocked 769,058 triploid grass carp *Ctenopharyngodon idella* to control the expansion of hydrilla and to eradicate it, if possible (Table 1). Grass carp were successful in halting the expansion of hydrilla and consumed it to the point that surveys in 1997 found it was largely eliminated in Lakes Marion and Moultrie (Kirk and Henderson, 2006). However, complete eradication of hydrilla was not possible because an established tuber bank was present, and this was a continual supply of new growth of hydrilla in the system.

Table 1. Grass Carp stocking numbers in Lakes Marion and Moultrie, 1989-2019

<b>Year</b>	<b>Number of Grass Carp Stocked</b>
1989	100,000
1990	100,000
1991	100,000
1992	100,000
1993	50,000
1994	152,500
1995	91,001
1996	75,557
1997-2006	0
2007	2,620
2008	0
2009	8,300
2010	12,000
2011	17,000
2012	109,000
2013	114,000
2014	0
2015	0
2016	0
2017	10,000
2018	10,000
2019	10,000

The South Carolina aquatic plant management council currently makes management decisions on the number of grass carp stocked in Lakes Marion and Moultrie to try to maintain 10% coverage of native vegetation while also minimizing hydrilla. Grass carp management plans are typically based on a set number of fish/vegetated acre and in order to meet management goals an accurate population estimate must be derived (Stich et al. 2013, Kirk et al 2000). Estimating an accurate population size is difficult in Lakes Marion and Moultrie for a few reasons: 1) the

reservoirs are open to the Cooper River via Pinopolis Navigation Lock and the Santee River during times of spillage at Santee Dam, allowing for emigration; 2) grass carp are long-lived (>25 years) with annual mortality rates that may vary with age (Stich et al. 2013); and 3) the Santee Cooper system is vast, with ~160,000 acres of reservoirs and ~120 miles of unimpeded tributary rivers.

An alternative method for evaluating grass carp stocking efforts is to compare the condition of fish currently collected in the reservoirs to those collected during times of optimal condition, to try to compare vegetation levels based on the condition of herbivorous grass carp. This method appears to be feasible because of the positive correlation that exists between annual mean condition and hydrilla acreage (Figure 1).

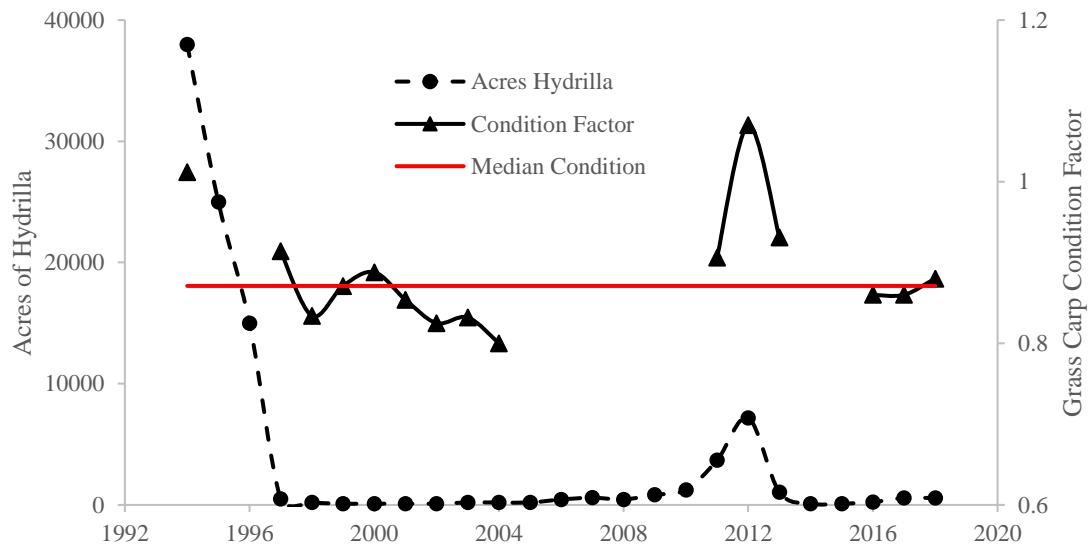


Figure 1. A comparison of acres of hydrilla in the Santee Cooper System and grass carp condition factor, 1994-2018. Condition factor data was only available for 16 years during the time series.

Morrow et al. 1997 developed a benchmark based on a weight to length relation (Ricker 1975) for condition, and the relation is a power function that follows:

$$\text{Weight (g)} = 0.00000425 * \text{Total Length (mm)}^{3.185}.$$

The condition factor was derived from fish collected in 1994, a time when all grass carp in the system were  $\leq 6$  years old and hydrilla was readily available for consumption. When using this condition factor to draw conclusions on the condition of fish that are currently in the reservoir it must be considered that grass carp may become less rotund as they grow in length (Stich et al. 2013), and current hydrilla coverage is a few hundred acres in comparison to ~37,000 acres in 1994. Therefore, it would be expected that during times of a mixed age structure and less vegetative coverage the condition factor of grass carp would be less than 1.0.

## Methods

### *Fish Collection*

Grass carp were collected, via nighttime bowfishing, in October 2018. All sampled fish were measured (TL), weighed (g), and otoliths were extracted for age estimation.

### *Age Estimation*

Grass carp otoliths were mounted on a microscope slide using CrystalBond, and the otolith was sanded until the core was visible under a dissecting scope. Two independent readers estimated an age for each otolith. If there was a disagreement on the estimated age, the otolith was reviewed with both readers present to try to reach a consensus. Consensus on otoliths with estimated ages  $\geq 20$  years old was often not reached due to the difficulty of differentiating closely packed annuli, and instead of discarding these fish from the dataset they were lumped into a category of  $\geq 20+$  years old.

## Results

A total of 75 grass carp were collected during five sampling nights and TL ranged from 487 – 1180 mm, average TL 899 mm (Table 2). Otoliths were extracted from 74 fish and estimated ages ranged from 1 – 20+ years old (Figure 2). Seventy-three percent of sampled fish were  $\leq 10$  years old, while 23% were  $\geq 20$  years old. The older fish were part of the initial stocking efforts from 1989-1996 and have persisted in the reservoirs longer than expected.

Condition factor for all ages combined was 0.84 (Figure 3) and for grass carp  $\leq 6$  years old was 0.88 (Figure 4). There was no significant difference ( $P = 0.59$ ) in mean condition of grass carp  $\leq 6$  years old from 2016, 2017, and 2018 (Figure 5).

Table 2. Grass carp bowfishing collections from Lakes Marion and Moultrie, October 2018.

Date	Location	# Grass Carp Collected	Size Range TL (mm)
10/01/18	Lake Marion (Cathead Landing)	10	784-1025
10/08/18	Lake Marion (Big Oak Landing)	12	555-1147
10/15/18	Lake Marion (Big Oak Landing)	8	868-995
10/22/18	Lake Moultrie (Hatchery Landing)	20	487-1147
10/30/18	Lake Moultrie (S & S Landing)	25	800-1180

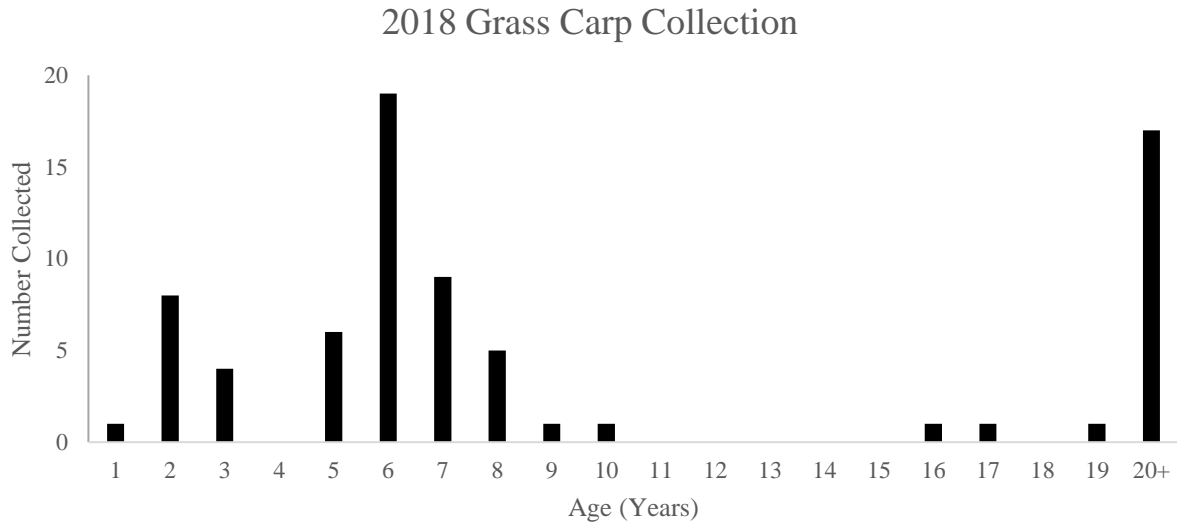


Figure 2. Estimated ages of grass carp collected from Lakes Marion and Moultrie, October 2018.

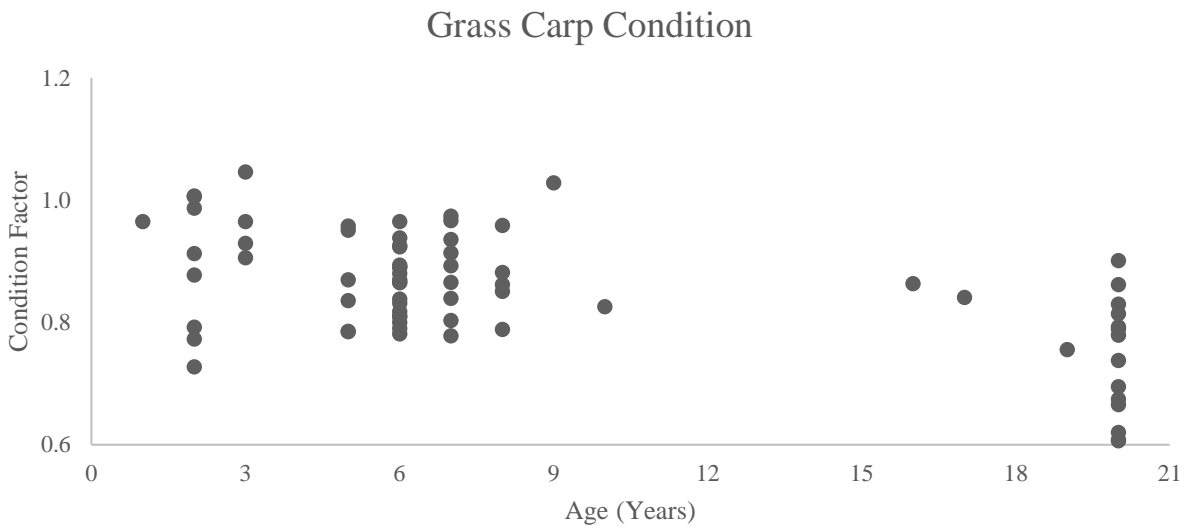


Figure 3. Calculated condition of grass carp collected from Lakes Marion and Moultrie, October 2018. Due to a lack of consensus on estimated ages for older fish, all fish  $\geq 20$  years old were grouped as 20 years old for this figure.



Figure 4. Calculated condition of grass carp  $\leq 6$  years old collected from Lakes Marion and Moultrie, October 2018.

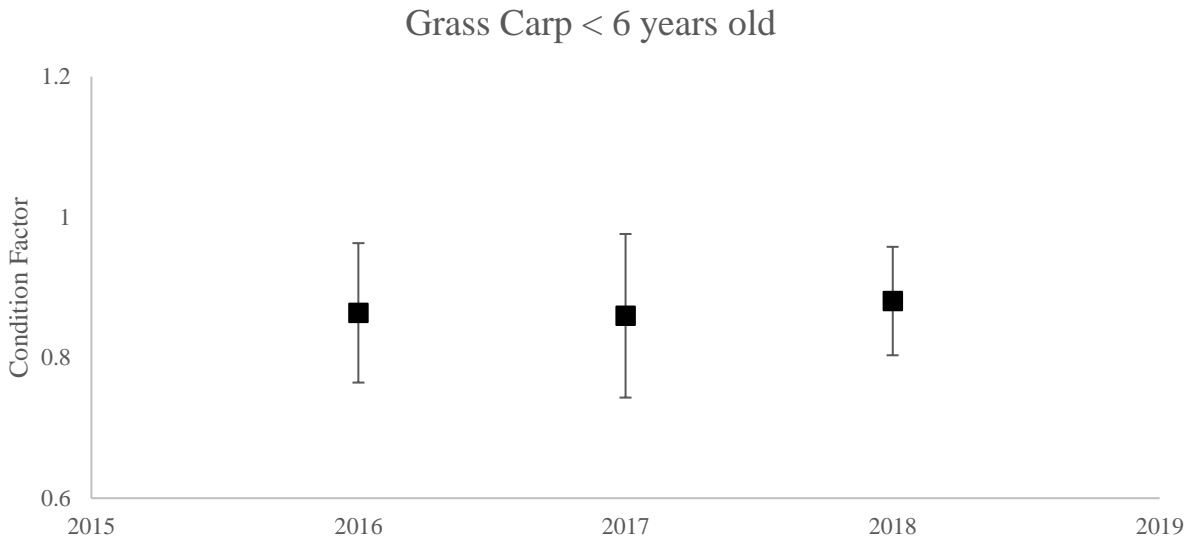


Figure 5. Mean condition and standard deviation of grass carp  $\leq 6$  years old from Lakes Marion and Moultrie, collected 2016-2018. Mean condition was similar across years ( $P = 0.59$ ).

### Discussion

Grass carp sampling, via bowfishing, provides an opportunity to monitor a population of fish that is often not thought of, but plays an important role in the amount of quality habitat available for game and non-game fish species. Ideally, we would like to produce an accurate grass carp population estimate that could be correlated to acres of aquatic vegetation, however the current



population model does not account for emigration or variable mortality throughout the life-span of grass carp. As an alternative, we are using condition factor of grass carp as an indicator of the amount of hydrilla in the reservoir. A mean condition factor has not been calculated for every year, but data exists for 16 years during the time frame 1994 – 2019. When these mean condition factors are compared with annual estimates of hydrilla acreage a positive correlation between the two variables is apparent. The only years in the time series when mean grass carp condition was >1.0 were years when hydrilla acreage was expanding to a point of concern. We can not state what is the ideal mean condition of grass carp in the Santee Cooper system, but evidence would indicate that levels in excess of 1.0 could be indicative of a situation where a large stocking event may be needed to curb the expansion of hydrilla.

Grass carp in the Santee Cooper system have lived beyond the 10-year expected life-span that Morrow et al 1997 theorized, leading to questions surrounding the population size and the effectiveness of these older grass carp in suppressing hydrilla growth. Growth of grass carp has been observed to decrease after age 4 in native systems, due to the thought they are not consuming as much vegetation as younger fish (Gorbach 1961); however, Stich et al 2013 noted that in Lake Gaston, NC, growth remained approximately linear with age after age 4. The contribution to nuisance vegetation control of older grass carp should not be discounted, and a biomass model, like one presented in Stich 2011, may be a more appropriate way to model the population to account for herbivory of large, older grass carp. Continuing to collect annual data and partnering with a research university would allow us to better understand grass population dynamics in the Santee Cooper System.

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