



University of  
New Hampshire

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# Triploid Grass Carp Tracking in Candlewood Lake

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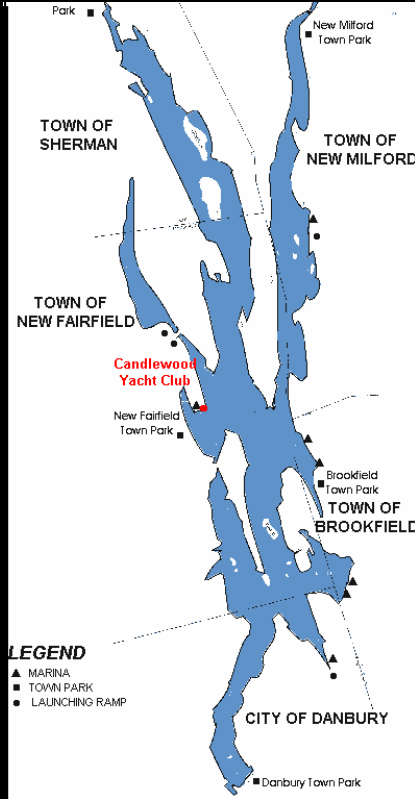
<sup>3</sup> *Candlewood Lake Authority*

<sup>4</sup> *Western Connecticut State University*

# Study Background

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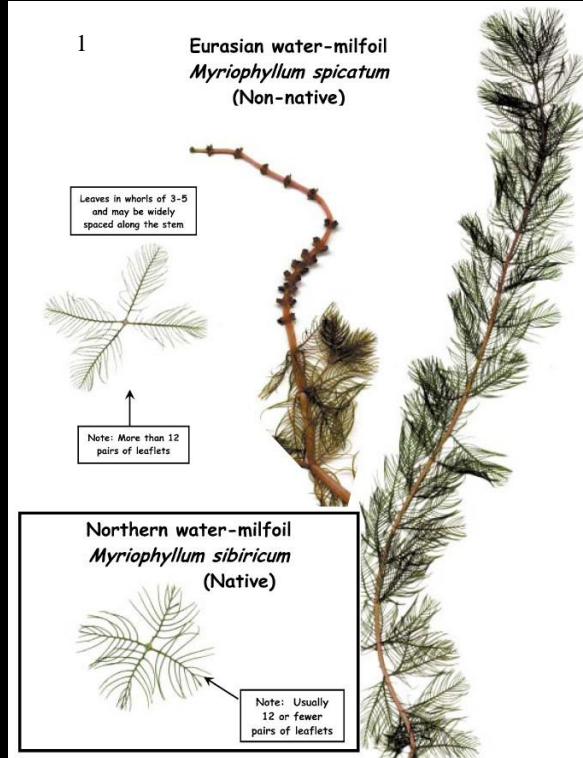
# Candlewood Lake



- Lands from the 5 surrounding towns were flooded in 1928 to create Candlewood Lake as a source of hydroelectric power.
- 11 miles long, 2 miles wide, and a max depth of 90 feet.
- Part of the Housatonic Watershed, and gets its water from the Housatonic River.
- Currently owned by Firstlight.



# Eurasian Water Milfoil



- Invasive species from Europe, Asia, and North Africa
- Can be up to 10 feet long in Candlewood Lake
- Become a significant issue in recent years due to changing lake conditions<sup>2</sup>
- Many methods of control have been attempted, but none have been successful
  - Milfoil Weevils, unsuccessful ( 2008-2013)
  - Chemicals proposed, but were rejected by town of New Fairfield (2016-2017)



1. Borman, S. "Eurasian Water-Milfoil, *Myriophyllum Spicatum* (Non-Native)." DCIST Publications, Door County Invasive Species Team, [map.co.door.wi.us/swcd/invasive/Publications.htm](http://map.co.door.wi.us/swcd/invasive/Publications.htm).

<sup>2</sup>Marsicano, Laurence J., et al. "An historical account of water quality changes in Candlewood Lake, Connecticut, over a sixty year period using paleolimnology and ten years of monitoring data." *Lake and Reservoir Management* 11.1 (1995): 15-28.

# About the Triploid Grass Carp



## Why Carp?

- Used in Ball Pond <sup>1</sup> in New Fairfield to successfully contain Milfoil populations, as well as in many other bodies of water across the US <sup>2 3</sup>.

## In Candlewood Lake

- Triploid Grass Carp (TGC) were added to Candlewood Lake in 2015.
- Currently, there are about 8,000 TGC in the lake.

<sup>1</sup> Mark June-Wells, Timothy Simpkins, A. Michael Coleman, William Henley, Robert Jacobs, Peter Aarrestad, George Buck, Cynthia Stevens & George Benson (2017) *Seventeen years of grass carp: an examination of vegetation management and collateral impacts in Ball Pond, New Fairfield, Connecticut*, *Lake and Reservoir Management*, 33:1, 84-100

<sup>2</sup> Mark B. Bain , David H. Webb , Michael D. Tangedal & Larry N. Mangum (1990) *Movements and Habitat Use by Grass Carp in a Large Mainstream Reservoir*, *Transactions of the American Fisheries Society*, 119:3, 553-561, DOI: 10.1577/1548-8659(1990)119<0553:MAHUBG>2.3.CO;2

<sup>3</sup> Daniel W. Beyers & Clarence A. Carlson (1993) *Movement and Habitat Use of Triploid Grass Carp in a Colorado Irrigation Canal*, *North American Journal of Fisheries Management*, 13:1, 141-150, DOI: 10.1577/1548-8675(1993)013<0141:MAHUOT>2.3.CO;2

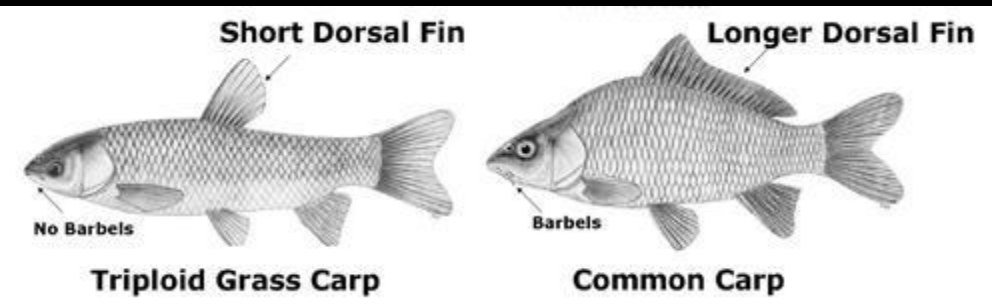
# Grass Carp Facts

<sup>1</sup>Allen Jr, Standish K., and Robert J. Wattendorf. "Triploid grass carp: status and management implications." *Fisheries* 12.4 (1987): 20-24.

<sup>2</sup>Lewis, George W. "Use of sterile grass carp to control aquatic weeds." *Cooperative Extension Service, The University of Georgia College of Agriculture and Environmental Sciences, Georgia, USA. Leaflet* 418 (1999).

<sup>3</sup>Stich, Daniel S., Yan Jiao, and Brian R. Murphy. "Life, death, and resurrection: accounting for state uncertainty in survival estimation from tagged Grass Carp." *North American Journal of Fisheries Management* 35.2 (2015): 321-330.

- On average, Grass Carp range between 23.5 and 29.5 inches long
  - Largest fish ever found was 4.6 feet, and 88 pounds in weight
- Grass Carp will over double their size from spring to fall
- Native to Asia, but have been introduced all over the world
  - Herbivorous diet
  - Can control aquatic plants<sup>1</sup>



# Hypothesis:

*Triploid Grass Carp (TGC) are found in the vegetative beds they use to forage in.*

# Prediction:

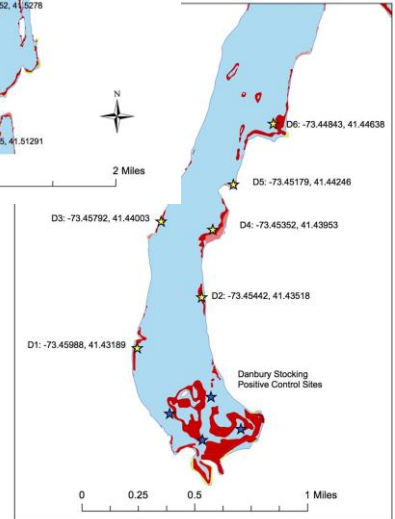
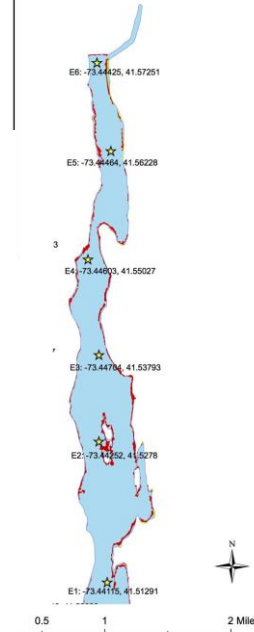
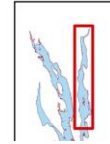
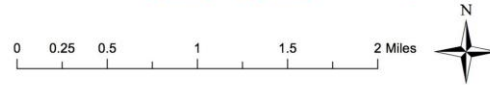
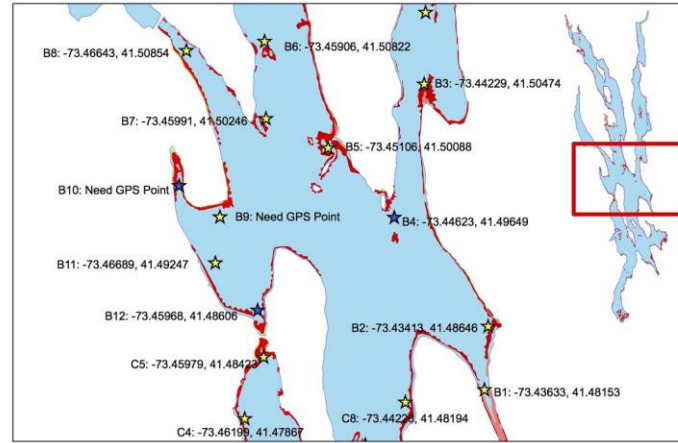
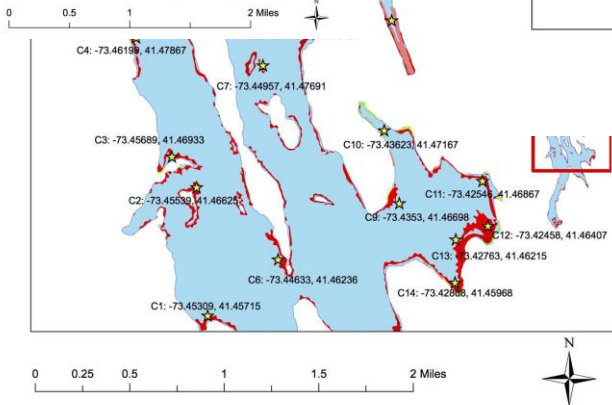
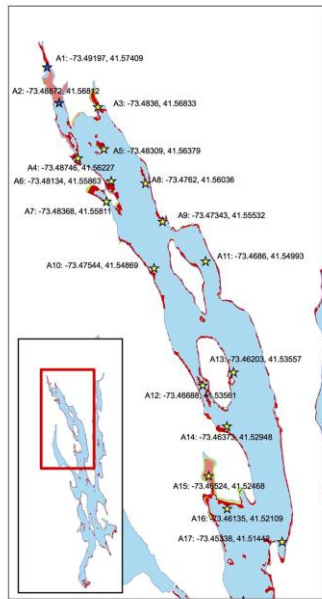
TGC prefer areas with a high concentration of Eurasian Milfoil because it is a readily available food source.



# Methodology

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# Maps



# Methodology

In 2016, 48 Radio tagged Triploid Grass Carp were introduced in the lake. All have a unique radio frequency.

The 48 carp were released in groups of 12 at 4 sites: New Fairfield, Candlewood Lake Club, Sherman, and Danbury.

Our study consisted of scanning 63 different sites, spread out over 5 regions of the lake.

Our equipment consists of a R410 Receiver and a Three-Element Yagi. These are used to pick up the radio signals of the tagged carp.



# Methodology

## Collecting Data:

Once at a site, we scanned through all channels for the 48 carp systematically.

If we heard a fish, we would pause, and place the yagi closer to the water. If we could still hear it, we could confirm that the fish is at that site.

We then pinpoint its location within that site, and record its number on our maps (next slide). The location was then input digitally in Google Maps per individual fish.



# Methodology

## How were the data evaluated?

On Google Maps, every TGC 'sighting' was recorded. We then measured the distance between the two sites that the fish moved to. For consistency, the most linear path to sites was used.

The average overall distance moved for each TGC was then calculated. These numbers were then compared to Milfoil bed sizes.

Movement per day was also calculated, by adding up all movements for a specific fish, and then dividing it by the number of days in the study (43).

Milfoil bed area was obtained from the location to which the TGC moved. The sizes of the beds were taken from GIS, and were mapped by the state. These numbers were based on beds in 2014.

# Methodology

How many TGC can we use for analysis?

Every TGC was treated as a trial. 48 fish, 48 trials.

- 34 out of the 48 TGC, or 71% of the carp were used in the final data based on
  - Never Observed: TGC that had never been seen were eliminated from the final data, 17% (8 fish)
  - Number of times seen: TGC had to have been “seen” at least three times between 2016 and 2017. 10% of fish had been seen less than three times (5 fish)
  - Vitality: if the average overall movement of the TGC was below 200 m, the fish was eliminated from the final data, 2% (1 fish)

# Results and Discussion

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# How many times did we 'hear' each fish?

How does our study compare to others?

Ours (total): 83% (40/48)

Lake Texanna, Texas: 73% (69/95)

Guntersville Reservoir, Alabama: 95% (21/22)

Lake Harris, Florida: 53% (19/36)

## 2016 Sightings

2016 Observations (Fish Stocked)	CLC (12)	SH (12)	DB (12)	NF (12)	All Fish	% All Fish
Observed Once	8	10	8	8	34	71%
Observed Twice	5	8	8	6	27	56%
Observed 3x	4	6	4	2	16	33%
Observed 4x	1	1	0	2	4	8%
Observed 5x	1	0	0	0	1	2%

## 2017 Sightings

2017 Observations (Fish Stocked)	CLC (12)	SH (12)	DB (12)	NF (12)	All Fish	% All Fish
Observed Once	8	12	9	9	38	79%
Observed Twice	8	12	8	9	37	77%
Observed 3x	7	10	6	8	31	65%
Observed 4x	3	6	3	1	13	27%
Observed 5x	0	5	1	1	7	18%



# Is TGC Movement Normal?

## Our study, Candlewood Lake:

- TGC moved an average of 66.3 m/day
- Size of Lake: 8.469 mi<sup>2</sup>
- Fish moved less than expected based on other studies, but Candlewood Lake is significantly smaller.

## Lake Marion, South Carolina<sup>1</sup>:

- TGC moved an average of 290 m/day
- Size of Lake: 171.9 mi<sup>2</sup>

<sup>1</sup>Foltz Study: Foltz, Jeffrey W., J. Philip Kirk, and K. Jack Killgore. "Movements and Habitat Use of Triploid Grass Carp in Lake Marion, South Carolina." *March 7- 95 1994 Gainesville, Florida* (1994).

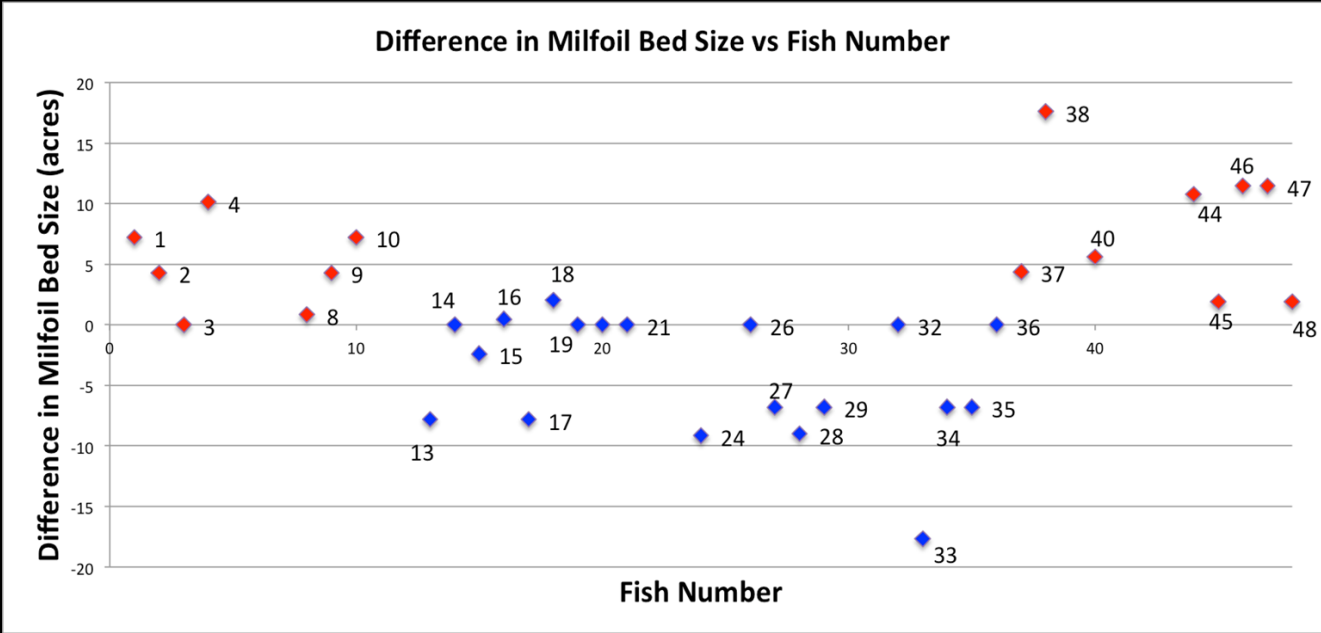
## Guntersville Reservoir, Alabama<sup>2</sup>:

- TGC moved an average of 270 m/day
- Size of Lake: 107.8 mi<sup>2</sup>

<sup>2</sup> Bain Study: Bain Mark B. , Webb David H. , Tangedal Michael D. & Mangum Larry N. (1990) Movements and Habitat Use by Grass Carp in a Large Mainstream Reservoir, Transactions of the American Fisheries Society, 119:3, 553-561, DOI: 10.1577/1548-8659(1990)119<0553:MAHUBG>2.3.CO;2

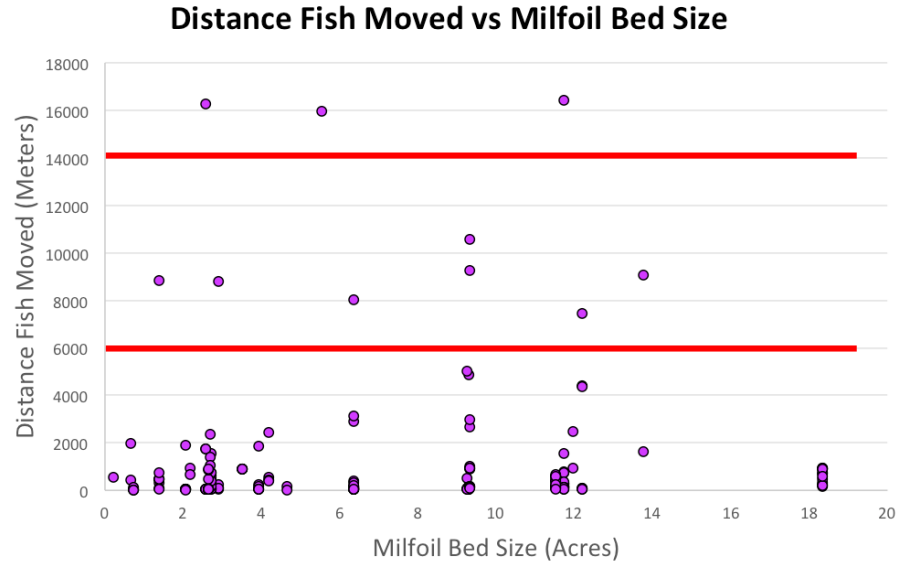
# At a glance: Are TGC Moving?

- 8 fish (24%) stayed at their release point
- 10 fish (29%) went from a larger bed to a smaller bed
- 16 fish (47%) went from a smaller bed to a larger bed

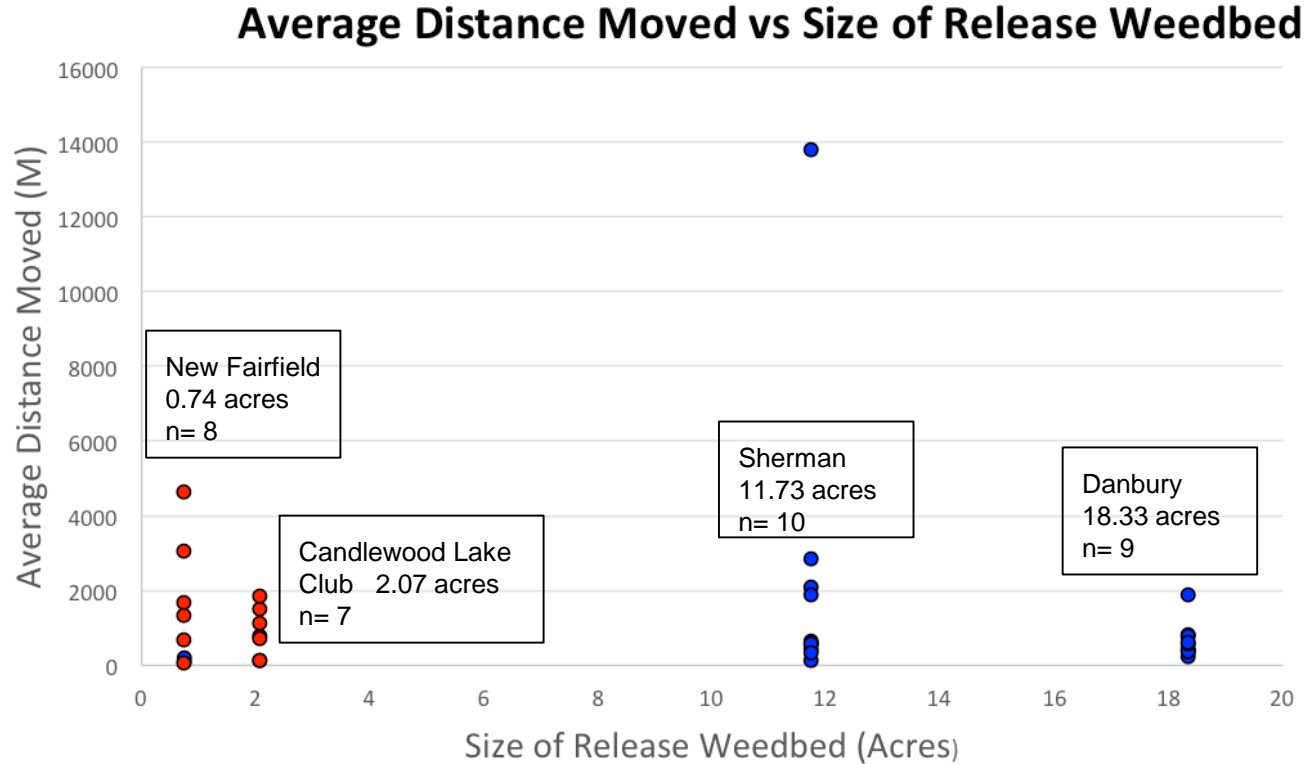


## Carp Movement vs. Milfoil Bed Size

- No distinct positive or negative correlation between Carp movement and the size of the Milfoil beds.
- Three distinct regions seen in the scatter plot
- Majority of points located in the region of low movement, no matter the bed size
- Larger the bed size, the less movement over 6,000 m



# Carp Movement vs. Size of Milfoil Bed at Release Point



# T-Test

P-Value:	Level of Significance:	Conclusion:
0.4028	0.05	$0.4028 > 0.05$

About the t-test:

By comparing every single movement of every fish deemed reliable enough for the study, from both 2016 and 2017, we could see if the difference between movements of fish released in large beds were statistically significant. However, because our P-Value was greater than our level of significance, the differences are statistically insignificant, meaning that the fish appear to move the same, regardless of the bed size they were introduced to.

2016+ 2017 Entire Movements			
Bed Size	Movements	Bed Size	Movements
LARGE	257.556	SMALL	4876.312
	50		160.02
	177.089		50
	21.6408		50
	167.03		103.632
	536.2555		178.918
	764.4384		39.3192
	642.1283		396.5448
	209.093		50
	281.94		50
	179.222		167.335
	10573.39		124.663
	914.1074		86.868
	914.1074		50
	914.1074		1609.34
	1001.012		2655.418
	172.822		1899.026
	167.03		50
	7451.263		50
	888.3579		33.2232
LARGE	869.046	SMALL	34.1376
	163.982		16.1544
	30.48		4393.509
	1850.746		82.9056
	58.8264		42.9788
	34.7472		8787.018
	15948.6		50
	16415.31		145.085
	9060.607		238.658
	281.026		105.766
	745.1263		123.749
	745.1263		50
	50		50
	348.6912		134.417
	85.9536		85.0392
	339.852		308.4576
	54.864		5021.153
	172.822		518.5994
	1564.282		93.528
	1564.282		95.7072
LARGE	296.266	SMALL	34.4424
	64.008		60.6552
	71.628		50
	296.875		142.951
	164.287		0
	377.0376		0
	730.6422		2977.286
	730.6422		2889.726
	357.5304		8030.627
	144.17		3122.127
	110.338		50
	131.064		50
	50		194.767
	16254.37		63.7032
	1738.092		8819.205
	1738.092		233.782
	50		64.6176
	36.5376		471.5378
	59.436		50

Data table used in the calculation of the T-test

# Discussion

## **Is carp movement dependant on Milfoil bed size?**

- Although the number of carp found in weed beds is significant, our analysis does not suggest that there is a significant difference between carp movement in small versus large Milfoil beds.

# Discussion

## Further Research

- Additional data collection
  - Continue to collect more data on the movement of fish to more accurately test if the prediction is significant
  - More radio tagged TGC added to the lake
- Time
  - Years of data collection may be required in order to see a significant difference in movement of fish in large beds versus small beds due to the depletion of Milfoil over time
  - Similar studies have been conducted for ten years or more<sup>1</sup>

<sup>1</sup> M<sup>1</sup> Mark June-Wells, Timothy Simpkins, A. Michael Coleman, William Henley, Robert Jacobs, Peter Aarrestad, George Buck, Cynthia Stevens & George Benson (2017) *Seventeen years of grass carp: an examination of vegetation management and collateral impacts in Ball Pond, New Fairfield, Connecticut, Lake and Reservoir Management*, 33:1, 84-100  
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# Conclusions:

Are the Carp Effective?



- This study demonstrates that the carp are surviving in the milfoil beds. It suggests that areas of high milfoil concentration and managed recreational activity support high concentrations of grass carp. The slide below is the same cove over 2 years. It supports a significant number of grass carp in a predictable fashion. Significantly less milfoil was observed in 2017.

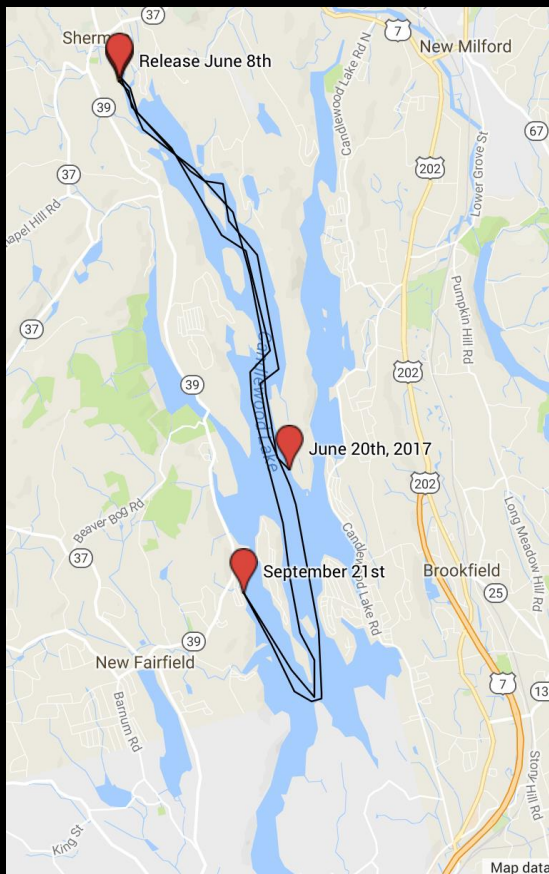
Allen's Cove, Sherman

July 13th, 2016



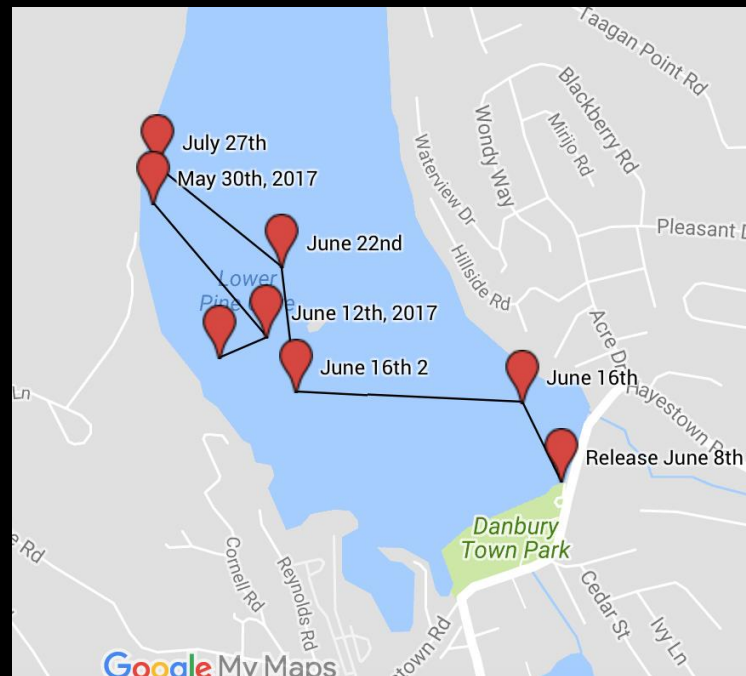
July 18th, 2017





Fish 18's Movement

## Fish 27's, aka Willie Schwartz, Movement



# Special Thanks to:

- Western Connecticut Department of Biology
- Goldring Family Foundation
- Candlewood Lake Authority
- AAUP Award to T. Pinou
- Dr. Stephen Frattini of Center for Aquatic Animal Research and Management
- Todd Bobowick of Rowledge Pond Aquaculture
- Peter Aarrestad, Mindy Barnett, Tim Barry, and Neal Hagstrom from CT DEEP
- FirstLight Power Resources
- Mark Howarth
- David MacAskill
- Allan Brooks
- Frank Krapf
- Phyllis and Len Schaer
- Bill Lohan
- Scott Martus
- Alan and Noreen Michener
- Allan Johnson
- Dave Kenes
- Bob Groechner
- Doug Cushnie