An Analysis of the Success of Head Started Hatchling Spotted Turtles (*Clemmys guttata*) at Brookhaven National Laboratory.

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Abstract:

As turtle species worldwide continue to decline, headstarting has become one of the more popular techniques of ex situ conservation. However, the focus and funding for these projects is usually limited to the raising of the hatchlings, and little evaluation of this costly technique has been performed after their release. At Brookhaven National Laboratory, twenty headstarted spotted turtle (C*lemmys guttata*) donated from Cold Spring Harbor Fish Hatchery and Aquarium were introduced into two wetlands to supplement an existing population. Ten of these turtles were released with radio transmitters glued to their shells in hopes of analyzing their transition from captive to wild turtles.

Introduction:

Spotted turtles *(Clemmys guttata*) were once considered the most common turtle in New York, but are now listed in New York State as a species of special concern (Breisch, 1997). This is a reptile that is highly vulnerable to habitat disruption, and whose distribution covers the most heavily populated area in the united states (Johnson, 1983), Causes of decline include habitat destruction and fragmentation, road mortality,

agricultural tractor and mower mortality, habitat succession, increased predation, pollution, and over collection for the pet trade (Breisch, 1997; Burke, 2000; Ernst, 1976; Graham, 1995; Hunter, et al., 1999). Increased human activity damages a population by attracting predators like raccoons, which destroy nests and prey on hatchlings, and bringing dogs to disturb or chew on the turtles (Hunter, et al., 1999).

Turtles in general have a type III survivorship curve (Zug, 1993), where most juveniles don't survive but most adults do. Mortality in eggs and hatchlings is particularly high, and adult mortality is low (Selina, Crowder, and Crouse, 1996; Wilson, 1997; Zug,1993). Once a turtle becomes an adult, it is likely to survive for an extended period and have many chances to reproduce. Even if most of their offspring don't make it, if they mate enough times at least a few will.

When it comes down to which hatchlings will survive, the common theory is that bigger is better (Bodie, 2000; Haskell, et al., 1996; Jazen, 1974). Larger hatchlings suffer less from predation (Moll and Moll, 2000). Larger turtles of a given age class are more likely to avoid winter mortality (Bodie, 2000). Larger hatchlings run and swim faster than smaller ones (Janzen, 1993).

Headstarting involves obtaining hatchling turtles from monitored or captive bred nests, and then raising them for a prolong time until they are large enough to avoid high mortality before being released into the wild (Haskell, et al., 1996; Heppell, Crowder, and Crouse, 1996; Moll and Moll, 2000; Heppell, 1996). This theoretically increases juvenile survival and recruitment, and in time adds valuable adult turtles to the population.

Not everyone is in favor of headstarting. Frazer (1992) refers to it as halfway technology as it does not address the original threat to the population. With the threat still in place, spending the money to raise the hatchling and releasing them into a sink population would not result in the recovery of the population (Frazer, 1992; Heppell, Crowder, and Crouse, 1996). Other arguments against headstarted include: turtles might not properly imprint on their nesting site, and might not find suitable places to nest (Bowen, 1994); they may not behave like wild-raised turtles (Bowen, 1994; Meylan and Ehrenfeld, 2000); after being raised at constant temperature and an artificial diet, they might not be prepared for environmental stressors when released into the wild (Haskell, et al., 1996); they may spread diseases to wild populations (Meylan and Ehrenfeld, 2000); and headstarted turtles may not avoid humans the way wild turtles do (Meylan and Ehrenfeld, 2000), which may have extreme consequences in a species that suffers from collection, such as the spotted turtle.

Headstarting has yet to be fully evaluated. Programs are usually funded only to raise and release the hatchlings, and not to follow up and analyze the eventual outcome of the project in latter years (Moll and Moll, 2000).

To evaluate headstarting as a conservation technique, twenty head started turtles donated from Cold Spring Harbor Fish Hatchery and Aquarium were released into two wetlands to augment the apparently senescent native population at Brookhaven National Laboratory. Of these twenty turtles, nine had radio transmitters and were followed throughout their acclamation from captivity to the wild.

Methods:

Obtaining the turtles:

Between the late nineties to the early two thousands, six male and three female spotted turtles were collected from a location within 10 miles from the Brookhaven National Laboratory and one other location. These turtles entered a captive breeding program at Cold Spring Fish Harbor Fish Hatchery and Aquarium. Nests were excavated and the eggs incubated, then the hatchlings were kept indoors and well fed over winter. Sixteen hatchlings from the 2002 clutch were donated to the Lab on September 9, 2003. Three more turtles were donated to the lab on June 9, 2004.

Two hoop traps and six box traps were deployed on April 22, 2004 in the gamma forest marsh, and six box traps were deployed on April 8, 2004 in the 12:00 pond to trap for native turtles. One female was caught in a hoop trap at the gamma forest marsh on May 4, 2004.

12:00 Pond:

12:00 Pond is a wide coastal plain wetland, wet during most years but occasionally dry during the summer, and is part of the Peconic River system. The pond measures ## meters long by ## meters wide and 1.5 meters deep. The surrounding upland consists of mixed oak and pitch pine forest, with an under story of low bush blueberry (*Vaccinium angustifolium*). The banks of this wetland are thick with high bush blue berry (*Vaccinium corymbosum*) and cat briar (*Smilax*). Shallow portions of shrubs extend further into the wetland, but the vast majority of the pool is deeper open water. The pool is vegetated by bladderwort (*Utricularia*) and other submergent plants.

The gamma forest marsh:

The gamma forest marsh, also part of the Peconic River system, is ## meters long, by ## meters wide, and is one meter deep. The marsh is surrounded by mixed oak and pitch pine with a short bush blueberry under story (*Vaccinium angustifolium*), with a steep hill to its south and flat lands from all other sides. A large peninsula slopes down hill into the wetland from the south, and a second come in from the north. The eastern portion is mainly thick shrub swamp, dense with high bush blueberry (*Vaccinium corymbosum*), about .25 meter deep. The swamp opens up into a few deeper pools to the south. Sedge (*Carex*) tussocks dominate the middle and western portions of the marsh, with occasional floating sphagnum (*Musci*) mats in the middle portion and high bush blueberry bushes in the eastern portion. High bush blueberry also crowds the banks around the entire pool.

Releasing and following the turtles:

On October 8, 2003 head started turtles and the adult turtle had LF-1 series transmitters attached to their carapace using PC-7 epoxy. On May 4, 2004, a transmitter was glued onto the adult female turtle. Three more head started turtles received their transmitters on June 8, 2004.

Eight head started turtles, including three with transmitters, were released on the south west side of the 12:00 pond and eight turtles, including another three with transmitters, on the western portion of the gamma forest marsh on October 9, 2003. The adult turtle (T-7) was released at her capture site on May 5, 2004. A second round of head started turtles were released on June 8, 2004: 2 turtles into the 12:00 pond (T-9 and

T-10) and one into the gamma forest marsh (T-8) at the same release points. Each turtle was then tracked using a LL Electronics receiver up to five times a week, at varying times during the day.

Data Collection:

When each turtle was located, a GPS point was taken using a Garmin rino110 receiver. The time was recorded, along with the date, turtle ID, location, macro habitat, observer, and whether the animal was actually seen or just pinpointed. The weather was recorded in terms of percent cloud cover, water temperature, air temperature, wind speed, and relative humidity, the latter three of which were measured using a Skymaster SM-28 weather station. The micro habitat was named, and then further described by water depth, distance to shore, substrate type, level of emergent, submergent, woody vegetation, and coarse woody debris.

Results:

Headstarted turtle growth was slow over the study period, resulting in negligible growth. The weight over the past year was variable. During aestivation, some turtle lost weight. Turtle 3 and 10 gained weight and then began losing weight after leaving the wetland. Turtle 2 did the opposite of this by losing weight, leaving the wetland, and then gaining weight before beginning to lighten again. Turtle 9 continually gained weight until late July. All turtles mentioned here gained net weight during the experiment, with the exception of turtle 3 who net lost one gram. (see graph…….)

The adult female turtle and four of the five headstarted turtles aestivated on land during warm weather in late July and in June. The first headstart turtle was found on land on June 25, 2004, then one followed three days latter, and the other two on July 2, 2004. The adult moved onto land also on June 25, 2004, the day the first headstart turtle was found on land. The last water temperature recorded for each turtle before they made these movements ranges 20° - 24°C, with 21°C for the adult turtle and average of 22°C for the headstarted turtles. The air temperature for the same dates ranges from 24.9°C – 30.3 °C with 24.9°C for the adult and an average of 28.2°C for the hatchlings.

Turtles in the Gamma Forest Marsh spent significantly less time on land than the turtles from 12:00 Pond ($p = 0.008868$). The headstarted turtles from this latter pond left left the wetland the begin aestivation earlier than the turtles from the Gamma Forest Marsh. One 12:00 pond turtle even hibernated on land, and didn't return to the wetland until April 19, 2004. (see figure …..)

From June to July, the headstarted turtles were found in water .25 meters or shallower in 93% of observances. The addition 7%, they were found in water .5 meters or shallower. The adult was mainly found on land during this time, but of the five dates it was in water, 2 were at a depth of .25 meters or shallower, 1 at .5 - .25 meters, and 1 at 1 - .75 meters. These depths were estimated using the relative height of the observer's boots, and are by no mean precise.

Microhabitat types varied by what microhabitats were available in each wetland. The most shared microhabitat was shrubs, which is used itself 1.8 times more frequently as much by the turtles at the Gamma Forrest Marsh headstarted turtles than by those at the 12:00 Pond. The 12:00 Pond turtles were found in a forest microhabitat 4.2 times

more frequently than the Gamma Forest Marsh headstarted turtles. Sedge was abundant in the Gamma Forest marsh, but only found in one section of an outlet of the 12:00 Pond. Sedge was used 60.3 times as frequently by headstarted turtles in the Gamma Forest Marsh than those at the 12:00 Pond. Other habitats were not shared between the wetlands.

Within each microhabitat, the vegetation was broken down summarily. Higher levels of emergent vegetation was used at the Gamma Forest Marsh than at the 12:00 Pond by the headstarted turtles. …..ect…...stats……..(see figure….)

When examining the two groups of headstarted turtles, it appears that the Gamma Forest Marsh turtles took move advantage of their habitat. 85.5% of locations were in water, 59.3% of these wet locations had a high level of emergent vegetation, and 77.7% had a high level of shrubby vegetation. Of all the locations found for the Gamma Forest Marsh turtles, 49.3% were in a shrub microhabitat, 36.1% were in a sedge microhabitat, and only 14.5% were in an upland forest.

In the 12:00 Pond, Only 58.9% of locations were in water, 5.7% of these wet locations had a high level of emergent vegetation, and 22.9% had a high level of shrubby vegetation. Of all the locations found for the 12:00 Pond turtles, 13.7% were in a shrub microhabitat, 2.4% were in a sedge microhabitat, and only 20.2% were in an upland forest.

Movements vs temp – distance vs temp + stuff

Discussion:

Spotted turtles become less active and make smaller movements as the summer wears on (Haxton and Berrill, 2001). At about 30°C or as the wetlands dry, the turtles migrate into the uplands or burrow into the mud to begin aestivation (Ernst, 1976; Ernst, 1982; Graham, 1995; Johnson, 1983; Perillo, 1997; Wilson, 1997). It is thought that this aestivation helps minimize energy use and retain water while remaining hidden from predators (Graham, 1995; Haxton and Berrill, 2001; Johnson, 1983; Milam and Melvin, 2001; Ward, 1976). They then remain aestivating until fall and then return to the wetland (Johnson, 1983). The headstarted turtles in this study left their wetlands in late June and early July to begin aestivation. The water temperature at that time averaged 22°C, far below the observed in other studies. This migration appears to have been brought on by rapid drying of the wetlands. As the water level dropped, the Gamma Forest Marsh and the frequented edge habitat of the 12:00 Pond were exposed, forcing the turtles into the uplands.

In spotted turtles, growth mainly takes place in the spring, and slows during the summer (Ernst,1976). Turtle growth per year has been documented in other studies to slow as hatchlings age into adults, with hatchlings growing 42.98 – 55.78% on average their first year, 20.39 – 26.68% their second, and 17.87 - 14.63% their third (Ernst, 1975; Graham, 1970). As larger turtles grow slower than smaller ones (Ernst, 1976), the head started turtles are expected to grow less than the 42.98 – 55.78% expected for a spotted turtle in its first year. Weight of the turtles measured in this study was highly variable, and one turtle even showed a net loss of one gram. Of the two turtles released before the spring and recaptured afterward the growing season, one grew 11 grams and the other

grew 16 grams. Their weight then fluctuated greatly during July, when these turtles were entering aestivation. Carapace length, plastron length, and plastron width (measured at the widest point of the femoral scutes) all increased, but not to a size that could rule out human error.

Spotted turtle habitat is traditionally shallow vegetated wetlands with open canapies, such as vernal pools bogs, and marshes (Ernst, 1982; Grahm 1995; Johnson, 1983; Perillo, 1997) The Gamma Forest Marsh fits this description nicely. It has high levels of emergent and shrub vegetation used consistently by the turtles, an open canopy, and is relatively shallow. In contrast, the 12:00 Pond fit the literature's description more loosely. It is mainly open water with little vegetation and it is relatively deep.

The Gamma Forest Marsh turtles were in the water longer, and were in thick, more desirable vegetation more often than the 12:00 Pond turtles. The Gamma Forest Marsh headstarted turtles also aestivated closer to their wetlands, where the 12:00 Pond turtles appear to be dispersing. One such turtle, turtle 3, is currently moving downstream along the Peconic River system, heading in the direction of the Gamma Forrest Marsh. This turtle may be dispersing to find better wetland.

In conclusion, at both sites no mortality was observed and during their active growing season the turtles gained weight. The headstarted spotted turtles appear to be adjusting better to life in the wild in the Gamma Forest Marsh than at the 12:00 Pond, as they remain in the wetland longer, use microhabitats more characteristic of their species, and don't appear to be emigrating. Should spotted turtles hatchlings be supplemented into other populations on Long Island, we recommend releasing them in a more vegetated pool than one with open water, as headstarting appears to work less at some

wetlands/population than others. Once the turtles are full-grown and can make better use of open water, perhaps they will be able to immigrate to these wetlands on their own. We also recommend that before headstarting as an ex situ conservation technique can be fully evaluated, studies such as this should monitor experimental populations of headstarted turtles for prolonged periods of time after the original threat to the population has been removed, preferably until the headstarted turtles themselves reproduce.

home rang and movement lengths,

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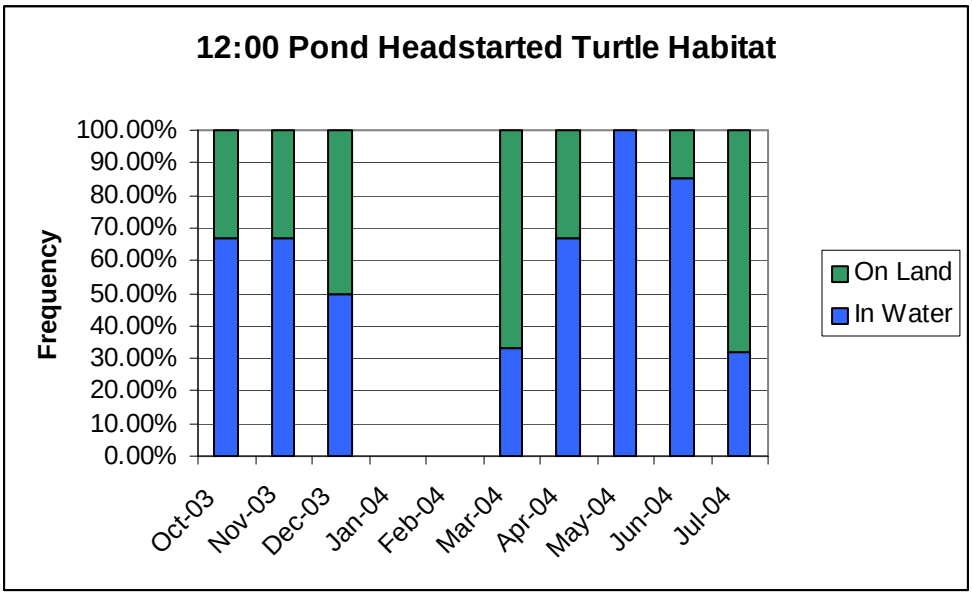
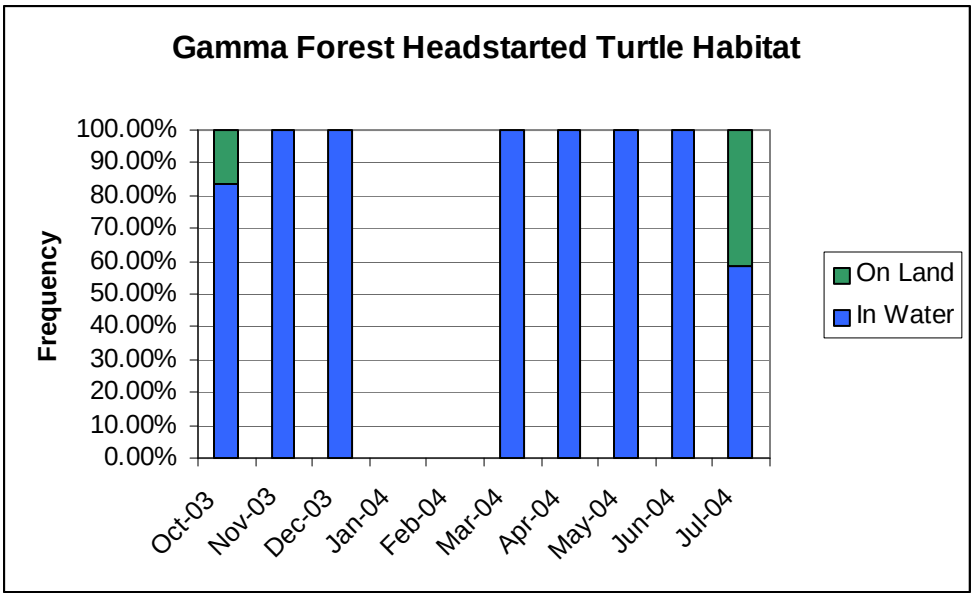
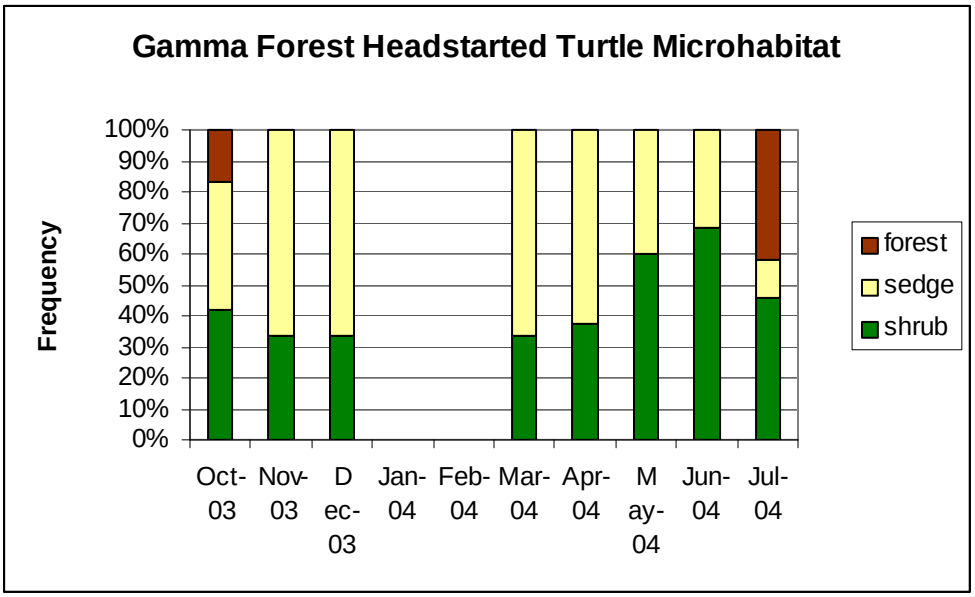
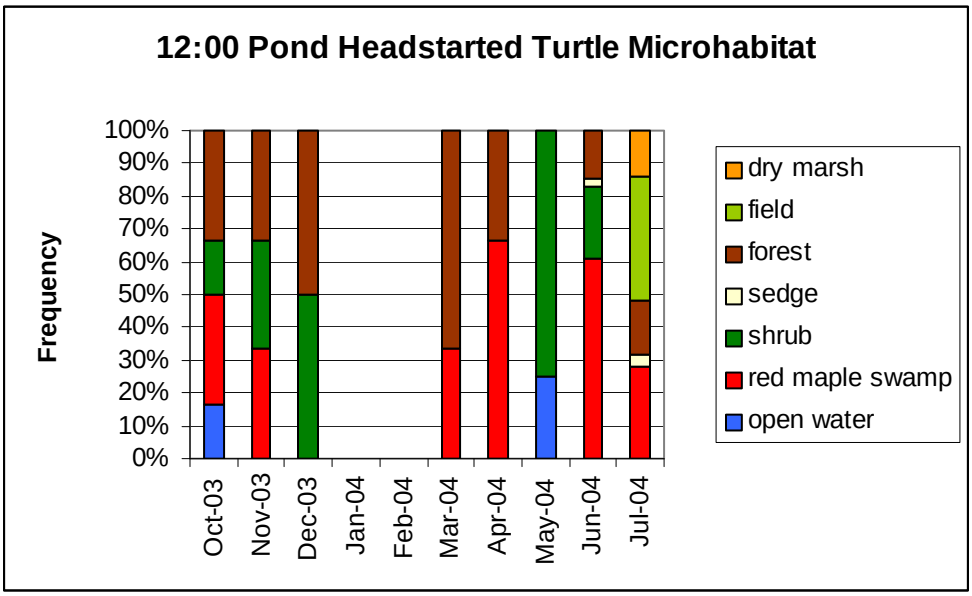
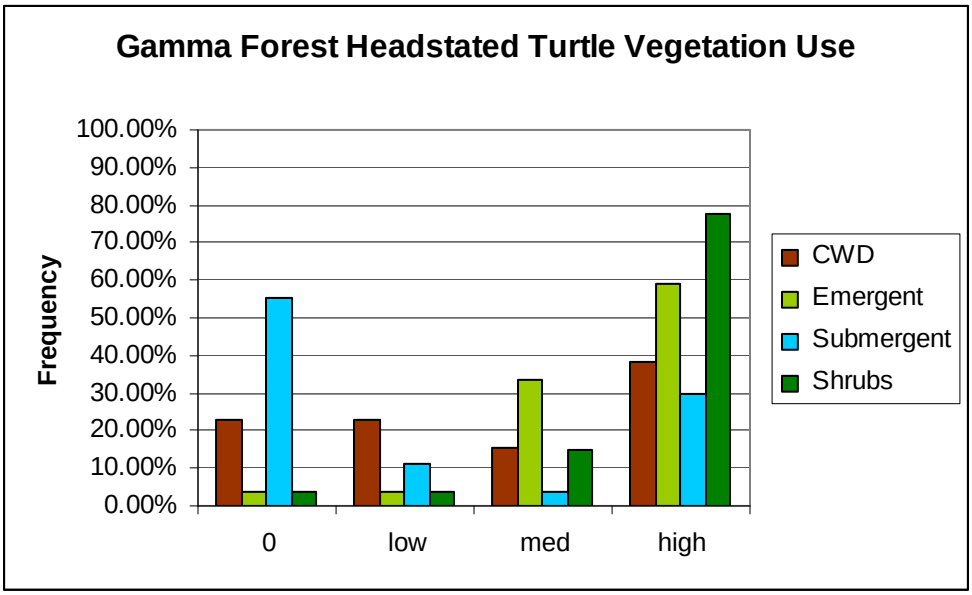
Figures:

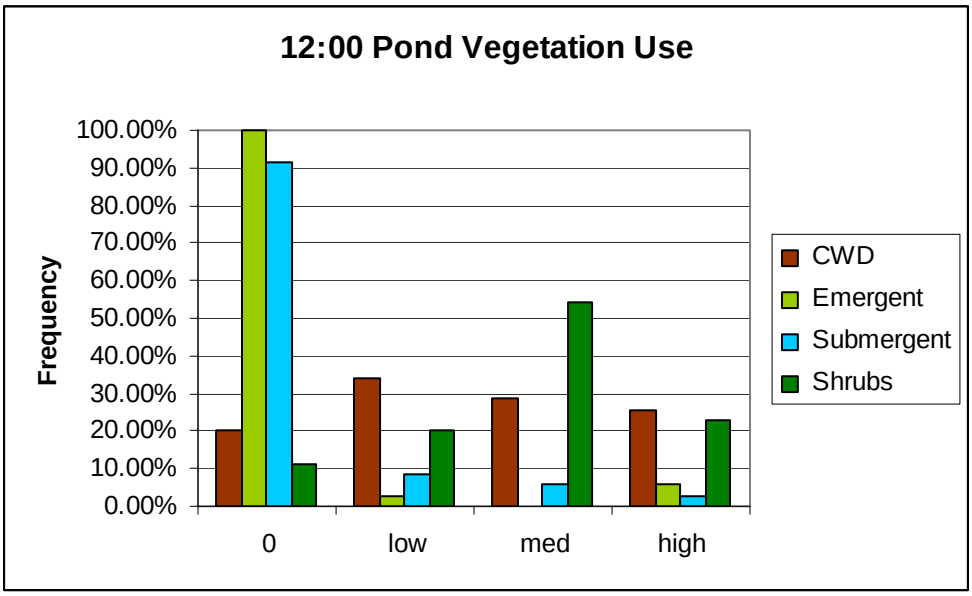


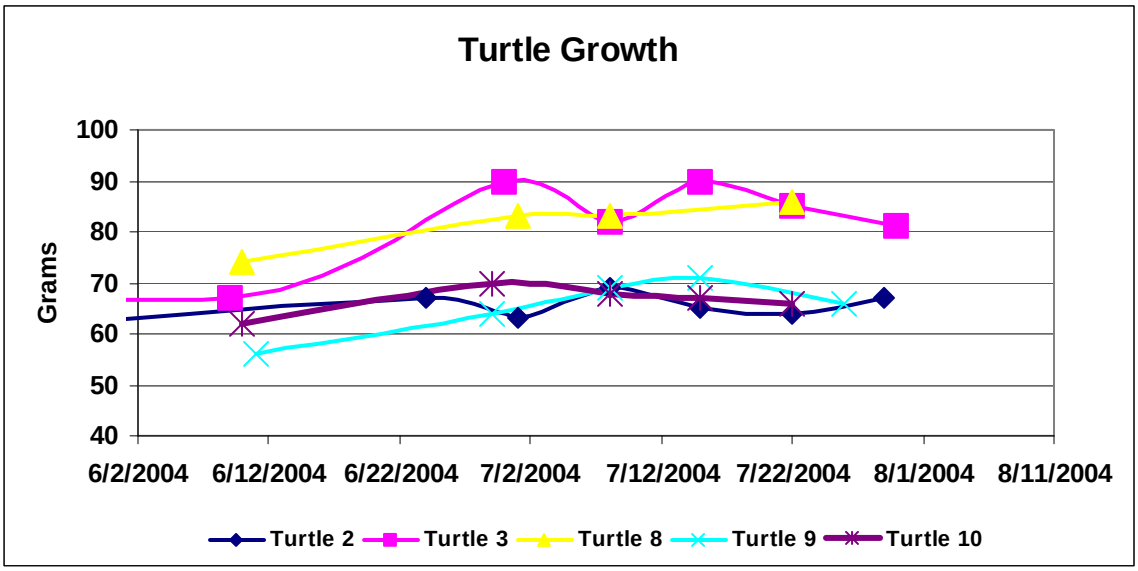



Gamma Forest Headstarted Turtle Microhabitat
Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
forest
sedge
shrub


12:00 Pond Headstarted Turtle Microhabitat
Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Oct-03
Nov-03
Dec-03
Jan-04
Feb-04
Mar-04
Apr-04
May-04
Jun-04
Jul-04
dry marsh
field
forest
sedge
shrub
red maple swamp
open water


Gamma Forest Headstated Turtle Vegetation Use
Frequency
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
0
low
med
high
CWD
Emergent
Submergent
Shrubs


12:00 Pond Vegetation Use
Frequency
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
0
low
med
high
CWD
Emergent
Submergent
Shrubs


Turtle Growth
Grams
100
90
80
70
60
50
40
6/2/2004
6/12/2004
6/22/2004
7/2/2004
7/12/2004
7/22/2004
8/1/2004
8/11/2004
Turtle 2
Turtle 3
Turtle 8
Turtle 9
Turtle 10