Predator Investigation
2006

Prepared for:

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Predators of Bay Scallops are abundant throughout Nantucket Harbor. A variety of these species are native, however invasive species are becoming more common. A preliminary sampling investigation on the numbers and identities of these predators was initiated in the summer of 2003. The intent was to obtain data that would warrant further studies, and possibly a control program. During the summer of 2004 the investigation was concentrated in the Monomoy area, because the majority of invasive species were found to be localized in the lower harbor. For the summer of 2005 a broader investigation included the mid harbor areas (Map 1). During the summer of 2006, the lower and mid harbor areas were again surveyed, as in 2005; with two stations added (Umass Field Station, and Boat House). Background research and observations have also been conducted to obtain a better understanding on the ecological relationships these predators have with the Bay Scallop (*Argopectan irradians*), of commercial importance.

Sampling procedures during the summer of 2006 attempted to cover a majority of the harbor utilizing 10 crab pots to test lower, and mid harbor sites for the presence, and abundance of invasive predators. These semi-oval fish traps, 26" x 19" x 9", have two round doors 4 3/4" that let fish and crabs in, but prevent them from exiting with a tapered mesh funnel directed towards the center of the trap. The pots were deployed late spring, and were sampled weekly when time allowed. The pots were hauled out early to mid fall. Green and Asian Crabs were culled out and used for bait after each sampling. When these invasive species were not present a single Spider Crab was used for baiting. The earlier sampling rounds included baiting with fish, and seem to improve the catch numbers.

The results from the 2005 sampling indicated that the harbor contained a healthy diversified population of crab species. There were Blue, Spider, Rock, Lady, Green, Asian, Hermit, and Mud Crabs present. Other predators of Bay Scallops included Oyster Drills, Toadfish, Cunner, Tautaug, and Conch, which were also caught in the pots (note data sheet). These fish were released after each sampling. This diversity would imply that most, if not all ecological niches were being filled and utilized. Of special interest were the invasive Green and Asian Crabs. The Green Crabs are believed to have arrived from Europe in the late 1800s, most likely in the ballast of commercial shipping (Van Heertum 2002). The more recently introduced Asian Shore Crab was first seen in New Jersey in 1988 (Richerson 2003). At first it was called the Purple Shore Crab, and also most likely arrived as a result of shipping.

A notable finding made during this investigation, was that these two introduced species were no longer limited in presence to the lower harbor (note data sheet). Spider and Mud Crabs still make up the majority of crab species in Nantucket Harbor. However, Green and Asian crabs appear to be growing in number, and have now been caught in mid harbor areas. Though limited in numbers in the mid harbor areas, the presence of invasives does suggest a change in spatiality. The data tables from '03, '04, '05, and '06 show the variances. This data also shows that the Green and Asian crabs were the minority of the crab species in the harbor. Very few were caught, anywhere other than at the boathouse, and in the area of the Monomoy piers. This localization may be due to these crabs selected habitats, which are a result of their specific morphological

characteristics. Their ideal natural and rocky habitat contains many cracks, crevasses, and jagged out croppings, that allow these crabs places to hide from larger predators of their own. These habitats are similar enough to the many piers, docks, and moorings in the lower harbor, where a man made niche has been created. However the rest of the harbor has a sandy, partially muddy bottom that is in most places covered with eelgrass and other algae. These invaders are now competing for food and space with the native species naturally occurring in those areas.

The selection of limited habitat for these invasive species might be enough to keep their numbers, and expansion to a minimum. This combined with harsh climatological conditions which Nantucket experiences in the winter may be the reason why their range and population has not already risen dramatically throughout the harbor. Green and Asian Crabs do not bury into the sand and mud like the native species (Spider, Mud, ect.), and so they are more susceptible to mortality from extreme cold temperatures. Nevertheless a predator investigation program should continue in Nantucket Harbor in order to note any changes, or possible inaccuracies with these other conclusions.

In an attempt to minimize the predation impact, the 2004 investigation centered on a culling program of these invaders localized in the Monomoy area where they were most prevalent, as seen in the 2003, and 2005 sampling (note data sheet and graphs). In 2006 the sampling revealed high numbers of Green Crabs at the Boat House. In 2006 the native species of crabs were returned to the water, except when occasionally used for bait. The belief is that the native population of crabs actually strengthens the scallop population by culling out the weak, injured, and less healthy individuals. Studies in Maine by (Leonard 1999) show that the presence of crab species directly induces the genetic potential of Blue Mussel (*Mytilus edulis*) towards the thickening of their shells. This "phenotypic plasticity" is directly related to predation in that Mussels open less frequently with predators in close proximity. Genetically blue mussels and other shellfish have the ability to thicken their shells, but may not if predators are not present. This is important, because the lack of use of a genetic trait may result in loss of that trait over time. This then may result in the decline of a species as a result of the loss of a certain phenotype. Leonard also showed that direct contact was not needed, and that the Mussels responded similarly to the presence of "conspecifics" or, the feces of the crabs, and the crushed remains of other Mussels as a result of predation.

Crab species offer an invaluable service to the recycling of biological matter that would otherwise foul an ecosystem. Not only do they clean up after the death of any particular shellfish species, but they also make those species stronger. Through predation of the weak and sick individuals, they remove poor genetic traits from the species as a whole. This predation then induces "phenotypic plasticity" in other individuals, resulting in thicker shells. This creates heartier shellfish, capable of being dredged or raked without being crushed. If this were not the case, the scallop would potentially be destroyed during the collection process, devaluing the stock commercially. On top of their intrinsic value, native crab species also fill a necessary niche in the food web. If any niche were opened up by the removal of the native predators it would undoubtedly be

filled; potentially by a more aggressive and rapidly reproducing invasive species. Also, throughout their life cycle crabs provide food for many other species of fish and birds.

Invasive species however break up the existing system. Green Crabs in certain areas have been documented (Choromanski & Stiles 2001) decimating Scallop populations. The Asian Crabs have not been studied closely enough to understand their full impact, but are thought to be more aggressive and destructive than the Green Crab. It would be beneficial to continue a culling program of these invaders. However not all crab species should be considered a nuisance and eliminated similarly. If the native species were culled, their absence would open up more space for the invasive species. This has been seen in observations made on spatial distribution and competition, (Biologist's office tank 2004) where Spider Crabs were able to maintain territory in spite of the introduction of Asian Crabs.

A large scale culling program or an overall loss in predators in the system would undoubtedly create another imbalance, and ultimately have a negative impact on the scallop population. So a continuation of a culling program would be recommended so long as it did not include the native species of crabs in Nantucket Harbor. Occasionally crab pots should be distributed around the harbor, as in 2003, and 2005, and again in 2006 to sample the spatial distribution of the invaders. However a concentration of baited pots in the lower harbor, as in 2004, should have a greater impact on culling the invasives, as this appears to be their preferred habitat. This would create some base line data that could follow trends and note changes, such as to the success of the program or the need for more control. Data collected, the observations made, and the research done by other scientists corroborates these conclusions.

References:

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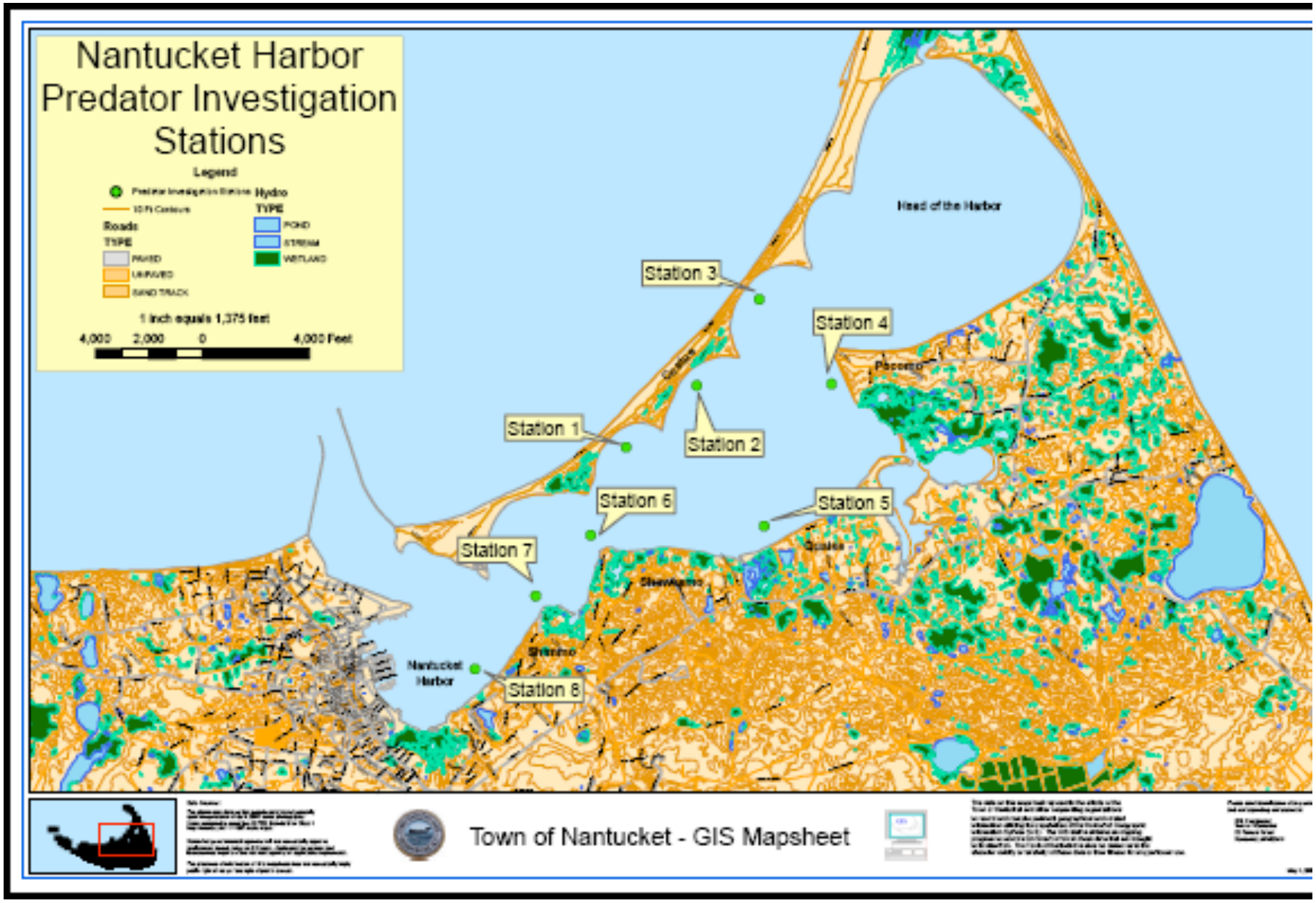
Leonard, G.H. 1999. Crab Predation, waterborne cues and inducible defenses in the blue mussel, *Mytilus edulis*. *Ecological Society of America*. Jan 1999. pp.1-24

Richerson, M.M. 2003. *Hemigrapsus sanguineus* . USGS Nonindigenous Aquatic Species Fact Sheet. *USGS Database, Gainesville FL.* ID 183. 3p.

Van Heertum, R.2002. Introduced species summary project, European green crab (*Carcinus maenas*). *Invasion biology introduced species summary project – Columbia University.* 3p.


Nantucket Harbor
Predator Investigation
Stations
Legend
Predator Investigation Stations
10 Ft Contours
Roads
TYPE
PAVED
UNPAVED
SAND TRACK
Hydro
TYPE
POND
STREAM
WETLAND
1 inch equals 1,375 feet
4,000 2,000 0 4,000 Feet
Head of the Harbor
Station 3
Station 4
Station 1
Station 2
Station 6
Station 5
Station 7
Station 8
Nantucket Harbor
Town of Nantucket - GIS Mapsheet

Predator Investigation 2006

Weekly data collection of species

Map #1,	2nd bend	3rd bend	4th bend	Pocomo	Quaise	UMASS	Abra' Pt.	Piminy Pt.	Monomoy	*Boat House
2-Jun		Pot 10 not in water								
	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	7	0	0	0	0	8	0
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	0	0	0	0	0
spider	1	6	0	3	0	13	0	3	5	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	1	0	0
mud	0	3	0	3	2	0	0	0	0	0
hermit	0	0	0	0	0	0	0	0	0	0
scallop	0	0	0	0	0	0	1	0	0	0
conch	0	0	1	0	0	0	0	0	0	0
fish	0	1	5	1	0	8	0	0	0	0
9-Jun		Pot 10 not in water								
	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	1	0	0	0	0	0	0
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	0	0	0	0	0
spider	0	0	7	0	1	0	0	2	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0

mud	3	4	0	3	0	0	1	1	0	0
hermit	0	0	0	0	0	1	0	0	0	0
scallop	0	0	0	1	0	0	0	0	0	0
conch	0	0	0	2	0	1	0	0	0	0
fish	0	7	11	3	0	6	0	2	1	0

20-Jun Pot 3 was not found

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	1	0	0	2	21
asian	0	0	0	0	0	0	0	0	0	2
blue	0	0	0	0	0	0	0	0	0	0
spider	1	0	0	0	1	2	0	0	0	0
rock	0	0	0	0	0	0	0	0	0	1
lady	0	0	0	0	0	0	0	0	0	0
mud	0	1	0	0	1	0	0	2	1	0
hermit	0	0	0	0	0	0	2	1	0	2
scallop	0	0	0	0	0	0	0	1	0	0
conch	0	0	0	0	0	0	0	0	0	0
fish	2	4	0	0	0	6	5	0	2	2

23-Jun

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	16
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	0	0	0	0	0
spider	0	0	0	2	0	0	0	0	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	2	1	0	4	1	0	2	0	0	0

hermit	0	0	0	1	1	1	0	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	3	2	0	1	0	0	0	0
fish	0	0	7	4	0	1	0	0	1	0

30-Jun — Pot 5 was not found pot 8 was open

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	2
asian	0	0	0	0	0	0	0	0	0	1
blue	0	0	0	0	0	0	0	0	0	0
spider	0	4	0	0	0	0	0	0	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	1	0	0	0	0	1	0
mud	1	8	1	4	0	1	3	0	1	0
hermit	0	0	0	0	0	0	0	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	0	1	0	0	1	0	0	0
fish	1	1	2	2	0	1	1	0	1	2

7-Jul — Pot 4 was not found

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	25
asian	0	0	0	0	0	0	0	0	0	2
blue	0	0	0	0	0	0	0	0	0	0
spider	1	0	0	0	0	2	3	0	1	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	1	0	0	0	0
mud	1	7	0	0	0	13	12	3	1	0
hermit	0	0	1	0	16	1	1	0	0	0

scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	1	0	0	0	0	0	0	0
fish	0	3	4	0	0	4	2	0	0	0

17-Jul

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	15
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	0	0	0	0	0
spider	0	1	4	1	6	6	0	0	5	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	5	1	0	1	5	0	1	5	1	0
hermit	0	0	2	0	1	1	6	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	1	0	0	0	0	0	0	0
fish	0	2	1	2	1	2	0	2	1	0

1-Aug

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	30
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	1	0	0	0	0	0
spider	0	0	0	4	4	0	1	1	2	1
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	1	1	0	0	0	0	0
mud	1	8	1	14	1	8	4	0	0	0
hermit	0	0	0	8	0	1	0	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0

conch	0	1	0	1	0	3	0	0	1	0
fish	1	1	2	6	0	0	0	2	0	1

4-Aug

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	1	0	0
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	0	0	0	0	0
spider	0	1	0	0	0	1	0	0	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	1	0	1	0
mud	0	1	0	10	2	1	5	0	0	0
hermit	0	0	0	1	0	0	0	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	0	1	1	0	0	0	0	0
fish	0	3	4	2	0	1	0	0	0	0

14-Aug Pot 4 was open

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	7
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	1	0	1	0	0	0
spider	0	1	1	0	0	2	1	0	2	1
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	0	0	1	0	0	1	0	4	0	1
hermit	0	0	0	0	0	0	0	1	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	0	0	0	0	0	0	1	0

fish	0	3	0	2	0	1	0	0	0	1

23-Aug

Pot 7 was not found

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	16
asian	0	0	0	0	0	0	0	0	0	3
blue	0	2	0	0	0	0	0	0	0	0
spider	0	4	0	1	0	0	0	1	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	0	8	0	0	0	5	0	1	0	2
hermit	0	0	0	0	0	0	0	0	0	15
scallop	0	0	0	2	0	3	0	0	0	0
conch	0	0	2	0	1	0	0	0	0	0
fish	1	1	3	6	0	2	0	1	2	2

5-Sep

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	30
asian	0	0	0	0	0	0	0	0	0	1
blue	0	0	0	0	0	1	0	0	0	0
spider	0	1	5	0	0	8	3	0	0	9
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	1	10	2	3	2	3	1	1	3	0
hermit	0	0	0	0	0	0	0	0	0	1
scallop	0	0	0	0	1	1	0	0	0	0
conch	0	1	1	0	0	0	0	0	0	0
fish	5	5	0	14	0	0	0	1	0	7

8-Sep Pot 1 was open

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	0
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	0	0	0	0	0
spider	0	4	1	4	3	2	2	0	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	3	14	0	0	0	4	4	3	1	0
hermit	0	0	1	1	0	0	0	0	0	1
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	0	1	1	0	0	0	0	0
fish	0	0	0	8	0	4	0	0	0	2

18-Sep Pot 9 missing from this date forward Pot 1 had a hole

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	30
asian	0	0	0	0	0	0	0	0	0	2
blue	0	0	2	0	0	0	0	2	0	0
spider	1	1	0	2	0	1	0	0	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	2	6	4	8	3	2	3	4	0	0
hermit	0	0	0	0	0	0	0	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	0	0	0	0	0	0	0	0
fish	5	1	0	4	0	2	0	2	0	7

22-Sep

Data page was missing

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	1
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	0	0	0	0	0
spider	0	0	0	0	0	0	0	0	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	0	0	0	0	0	0	0	0	0	0
hermit	0	0	0	0	0	0	0	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	0	0	0	0	0	0	0	0
fish	0	0	0	0	0	0	0	0	0	0

28-Sep

Scallop in pot 8 was seed

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	1	0	0	5
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	0	0	0	0	0
spider	0	0	0	0	0	0	2	3	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	1	0	0	0
mud	4	20	0	8	3	9	0	0	0	0
hermit	0	0	0	0	0	0	1	0	0	0
scallop	0	2	0	0	0	0	0	1	0	0
conch	1	0	0	0	0	0	0	0	0	0
fish	0	2	0	6	0	13	1	0	0	0

10-Oct Pot 3-back hole was broken

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	2
asian	0	0	0	0	0	0	0	0	0	1
blue	0	0	0	1	0	0	0	0	0	0
spider	0	5	0	5	0	1	8	0	0	0
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	3	1	4	15	7	10	6	2	0	0
hermit	0	0	0	0	0	0	0	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	0	0	0	0	0	0	0	0
fish	0	0	2	4	1	15	0	2	0	3

16-Oct

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	1	0	0	0	0	0	0
asian	0	0	0	0	0	0	0	0	0	0
blue	0	1	0	0	0	0	0	0	0	0
spider	0	0	0	0	0	0	0	0	0	0
rock	0	0	0	0	0	0	1	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	2	19	4	6	6	6	6	2	0	0
hermit	0	0	0	0	0	0	0	0	0	0
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	0	1	0	0	0	0	0	0	0
fish	0	3	1	3	0	1	2	0	0	0

23-Oct

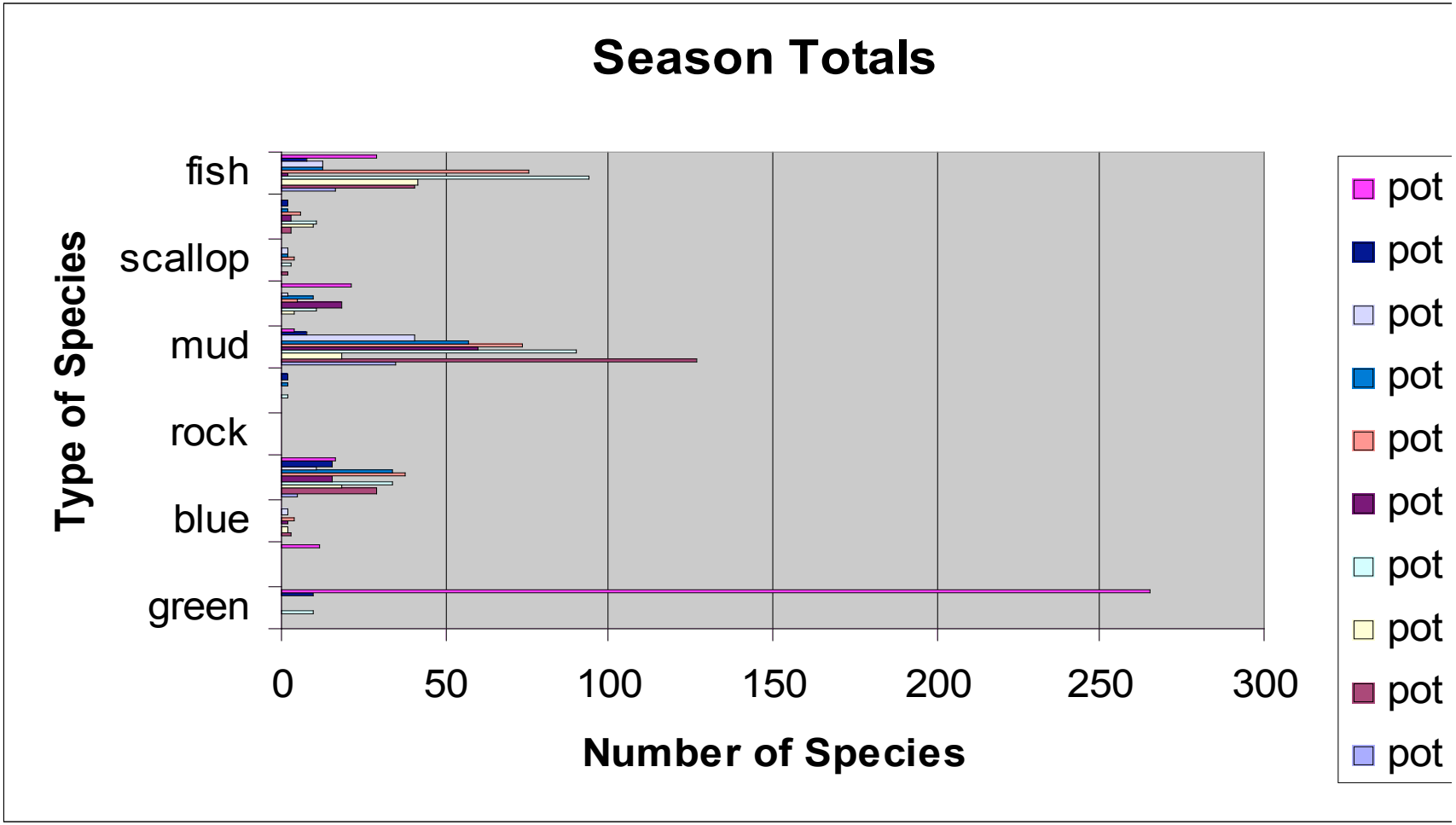
	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	1	0	0	0	0	0	44
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	2	0	0	0	0
spider	0	0	0	1	0	0	8	1	0	2
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	0	4	1	5	12	5	4	0	0	1
hermit	0	0	0	0	0	0	0	0	0	0
scallop	0	0	0	0	0	0	1	0	0	0
conch	0	0	0	0	0	0	0	0	0	0
fish	0	3	0	14	0	7	0	0	0	2

31-Oct

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	0	0	0	0	0	0	21
asian	0	0	0	0	0	0	0	0	0	0
blue	0	0	0	0	0	1	0	0	0	0
spider	1	1	0	11	0	0	6	0	0	3
rock	0	0	0	0	0	0	0	0	0	0
lady	0	0	0	0	0	0	0	0	0	0
mud	7	11	0	6	15	6	5	13	0	0
hermit	0	0	0	0	0	0	0	0	0	2
scallop	0	0	0	0	0	0	0	0	0	0
conch	0	1	0	3	0	1	1	0	0	0
fish	1	1	0	13	0	1	2	1	0	0

Season Totals

	pot 1	pot 2	pot 3	pot 4	pot 5	pot 6	pot 7	pot 8	pot 9	pot 10
green	0	0	0	10	0	1	1	1	10	265
asian	0	0	0	0	0	0	0	0	0	12
blue	0	3	2	1	2	4	1	2	0	0
spider	5	29	18	34	15	38	34	11	15	16
rock	0	0	0	0	0	0	1	0	0	1
lady	0	0	0	2	1	1	2	1	2	0
mud	35	127	18	90	60	74	57	41	8	4
hermit	0	0	4	11	18	5	10	2	0	21
scallop	0	2	0	3	1	4	2	2	0	0
conch	1	3	10	11	3	6	2	0	2	0
fish	16	41	42	94	2	75	13	13	8	29


Season Totals
Type of Species
fish
scallop
mud
rock
blue
green
0
50
100
150
200
250
300
Number of Species
pot
pot
pot
pot
pot
pot
pot
pot
pot
pot