The Tagging and Restraint of *Anarhichas lupus or the Atlantic Wolffish*

University of New Hampshire

Ocean Research Projects

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Abstract

The Atlantic wolffish (Anarhichas lupus) is a bottom dwelling fish that lives in the cold waters of the Atlantic ranging from Nunavut, Canada, to Cape Cod, Massachusetts. The species has not been extensively studied because of its large size and incredible strength which makes it difficult to restrain in a manner conducive to tagging. Because the fish have not been tagged they have not been tracked and information about the species is widely unknown. In this project we will test effective methods of restraining and tagging wolffish. Four restraining boards of two sizes and designs were built. One design uses rubber bungee straps and the other uses nylon ratchet straps to secure the fish while tagging is done. The sizes of the boards were chosen to accommodate the average size of a mature fish, between 0.6 and 1.2 meters. Water pumps were installed on each of the boards to keep gill tissue wet and minimize stress to the fish. The fish, once gathered from fisherman local to Hampton, NH, are kept at the UNH Coastal Marine Lab in New Castle, NH. The restraining boards will be used and rated based on functionality and ease of use. Once restrained, the fish will be tagged and the effectiveness of the different boards and types of tags will be assessed. Results of the study will allow for future studies of wolffish to be carried out with a common protocol. Using the best tagging board will make future population studies much easier.

Introduction:

The Atlantic wolfish (*Anarhichas lupus*) is a benthic fish that lives in the cold waters of the Atlantic ranging from as far north as Nunavut, Canada, to as far south as Cape Cod, Massachusetts (Jonsson 1982). The Atlantic Wolffish is distinguished from other species of wolffish in its coloration and its large crushing molars protruding from both the vomer and palatine bones (which gives them a third row of molars). Once a year, during spawning season (October-December), wolfish fast for extended periods of time and actually shed and re-grow their teeth (Templeman 1986). The Atlantic wolffish has recently been classified as a species under Special Concern by the Canadian Species at Risk Act, SARA. It is also a species of concern in US thru NMF. However, wolfish are a fairly fecund species, meaning that the females egg clutches are large. The number of eggs that females lay increases exponentially with length, with 2,440 eggs for a 40cm fish, and 35,320 for a 120cm fish (Templeman 1986). However, egg quality is variable, which could explain low recruitment levels in the wild and in aquaculture settings (Lamarre 2004). The species has not been extensively studied because it usually is not targeted by fishermen but encountered as by-catch (Templeman 1984a). In addition, one limiting factor to wolffish tagging studies is the large size and the incredible strength of the fish which makes it difficult to restrain them for tagging. The limited research on *Anarhichas lupus* has shown that the common stomach contents of fish located in Georges Bank are composed mostly of Green Sea Urchins, about 75%. The remainder generally contains assorted other invertebrates, such as mussels and crabs, as well as some fish species (Keitz *et al* 1986). Primary diet however, is variable, bivalve molluscs (primarily *Placopecten magellanicus or Sea Scallop*) were found to be the main prey source followed by green sea urchins in Eastern Newfoundland (Nelson, Ross

1992). These, in combination with locations where fisherman commonly catch the fish, give some insight into their habitat. Their habitat is cold, deep water that generally ranges from about 75m-120m deep with the greatest concentrations being at around 100m (Nelson, Ross 1992). Atlantic Wolffish do appear to undertake short migrations usually no more than 2-5 miles in a period of 5 years, however, some outliers were notes with some migrations reaching between 200 and 500 miles (Templeman 1984).

In this project we will test effective methods of restraining, tagging, and monitoring wolffish. We have built four prototype restraining boards of two sizes and designs. One design uses rubber bungee straps to hold the fish still against a wooden v-shaped board while tagging is done. The second design uses nylon ratchet straps in an open topped box to restrain the fish. The two designs were each built at lengths of .9 meters and one 1.4 meters. The sizes of the boards were chosen to accommodate all sizes of the fish as a mature fish ranges from .6 meters to just over 1.2 meters. Self-priming water pumps were installed on each of the boards to accommodate keep gill tissue wet and minimize stress to the fish. The fish, once gathered from fisherman local to Hampton, NH are kept at the UNH Costal Marine Lab in New Castle, NH. The restraining boards will be used and rated based on functionality and ease of use. Once restrained, the fish will be tagged and the effectiveness of the different boards will be assessed. Results of the study will allow for future studies of wolffish to be carried out with a common protocol. Using the best tagging board will make future population studies much easier. Stress to the wolffish was taken into consideration and minimized throughout this study.

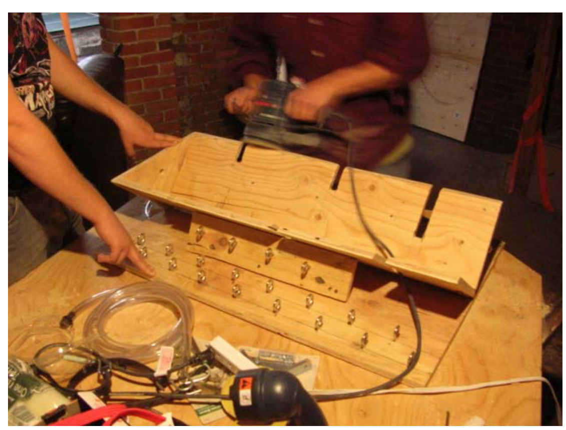
Materials and Methods:

To study and design effective tagging protocols, restraining boards were designed, fish were obtained, tags were implanted, and the health of those tags was monitored. Ten specimens were used in this study. They were obtained from fisherman local to Gloucester, Massachusetts and housed in recirculating seawater tanks at UNH's Coastal Marine Lab in New Castle, New Hampshire.

Restraint

Four restraining boards were built out of marine grade plywood plywood using basic power tools . Two prototype designs were created, A box-board, and a v-board. Each board type was constructed in as a one meter design and a one and a half meter design. The designs differed in the way the fish was cradled as well as in method of restraint.

The v-board used rubber bungee straps which were crimped on to i-bolts on the back side of the board. The free end of the bungee strap could be laced through slits cut in the fish cradle and hooked onto any i-bolt, out of the field of 20, on the front side. The v-board was designed to allow the fish some wiggle room so that internal organs were not at risk while allowing for a quick and effective



A photograph of the v-board design during construction.

restraining process. A second restraint system was devised incase the bungee restraint system failed.

The box-board design used nylon ratchet straps for restraint. The straps were crimped onto an eyebolt on the back side of the board and threaded through the ratchet system, which was screwed onto the front to allow for a quick-draw restraining system. The cradle system on the box-board consisted of two lengths of plywood with three slots apiece fastened perpendicular to the board with brass corner brackets. The ratchet straps ran through these slits across the board. When not being used, the ratchet straps were draped over an angled piece of plywood towards where the fishes head would be. This was designed to minimize the tangling of the restraints. The system was designed so that once a fish was placed on the board, the ends of the ratchet straps could be pulled for the initial restraint of the fish. After the fish was in the restraints and held down, the straps could be ratcheted tight to allow for effective tagging. The board was designed with a support post for the fish to bite onto while being restrained and tagged.

A photograph of the box-board design during construction

In further efforts to reduce harm to the fish, self priming water pumps were mounted on each board designed to keep a constant flow of water into the mouth and through the gills of the fish.

Tagging

The effectiveness of three different types of tags was investigated. The tags were obtained from Floy Tag inc. and are marketed under the following names: t-bar tags, dart tags, and disc tags. Each of the ten fish obtained were tagged with one dart tag and one disc tag. Eight of them were tagged with one t-bar tag.

The t-bar tags were inserted underneath the wolffish's skin using a tagging gun supplied by Dr. Elizabeth Fairchild. The tagging gun is similar to the device used to put price tags on clothing. The sharp, hollow needle of the gun was inserted into sub-dermal layer of the wolffish and the trigger was pulled. With the trigger still depressed the t-bar tag was guided through the hollow needle and underneath the fishs' skin. This manual manipulation of the tag was necessary due to the thick mucosal skin of the wolffish. The t-bar tags were placed in two different locations on the fish, four were inserted behind the head, and four were inserted below the dorsal fin.

The dart tags were implanted into the sub-dermal layer of the fish using a large hollow needle supplied by Floy Tag which was sharpened before use. The dart tag was inserted into the needle with hook on the end of the tag making a "V" shape with the tip of the needle. The needle was then thrust into the sub dermal layer of the fish where the tagger proceeded to rotate the needle one half turn clockwise and remove it. This hooked the dart tag into the skin leaving it behind. These tags were place in two locations on the fish, above the lateral line near the operculum, and below the dorsal fin.

The disc tags were placed through the musculature of the wolffish's tail. A three inch nickel pin was placed through the hole on a numbered disc with the number facing outwards. The nickel pin was manually inserted through the tail of the fish. Once pierced through, a blank pin was placed on the other side. The pin was then crimped over for security of the tag and excess metal was cut off using wire cutters. Disc tags were placed in three locations on the tail, low, medium, and high. Tags placed between 1-3 inches of the caudal fin were designated as low-taitags, those between 3 and 5 inches of the caudal fin were designated as mid-tail tags, and those between 4 and 7 inches are high tail tags.

Monitoring

After tagging, every two days the fish were restrained and tag locations were inspected to determine health as well as overall health to the fish. The fish were inspected with not taken to any injuries to allow for the differentiation of new and pre-existing conditions. The tag location was then ranked as good, okay, and poor. Good indicates a well healed tag, okay indicates a tag that is not quite healed and may be bleeding some. Poor was used to denote any open wounds.

Husbandry

Ten fish were divided into two groups and kept in different tanks with a constant supply of fresh sea water taken from the ocean adjacent to the Coastal Marine Lab in New Castle, NH. The five largest fish were placed in a tank with a diameter of 1.8 meters and the five smallest fish were placed in a tank 1.5 meters in diameter. Lengths of PVC pipe that had been cut in half were put into the tank to create a habitat for the fish. An abundance of green crabs were put into each tank for the fish to feed on. Tanks were cleaned weekly by removing the scraps of crabs left over from feeding.

Objectives:

Determine effective methods of restraining the wolffish and effective tag type and location combinations for future studies on the species.

Results:

The effectiveness of board design was assessed based on its ability to restrain the wolffish (Fig. 1). Ideal restraint was determined to be a fish rendered motionless with zero harm imparted on it.

Board Effectiveness

Board Design	Board Length	Effectiveness	Issues
Box Board	1 m	High	Fourth Strap Could Be Helpful
Box Board	1.5 m	Low	Too Large
V Board	1 m	Moderate	Ineffective for Smaller Fish
V Board	1.5 m	Very Low	Too Large

Figure 1—the effectiveness of the 1m box board was the highest of our four prototypes. The 1m v-board was moderately effective and both boards of 1.5m in length were not effectively at all. Trends show that the 1m restraining boards were generally regardless of type with the ratchet strap restraining system of the box board being more effective than the bungee restraining system of the v boards.

The effectiveness of the different types of tags was judged on two criteria, the retention rate of the tag type in the sample and the health to the fish (Fig. 2). Retention rate of 100% indicates that the tag was not lost by the specimen, however does not necessarily indicate the most effective tag. The health of the tag sites were judged on a one to three scale. Three indicates a healthy tag location and one indicates a very unhealthy tag location.

Tag Effectiveness and Health

Tag Type	Tag Location	Percent Retention	Average % Retention	Average Health Over 2 Weeks (3=healthy)	Average Health For Tag Site
T-Bar	Behind Head	100	75	3	3
	Below Dorsal Fin	50		3	
Dart	Behind Head	80	90	2.81	2.88
	Below Dorsal Fin	100		2.95	
Disc	Low Tail	100	100	2.58	2.39
	Mid Tail	100		2.58	
	High Tail	100		2	

Figure 2—T-bar tags showed the lowest retention rate at 75% retention, however the t-bar tags placed behind the head of the fish experienced no loss while those on the fishes body showed 50% loss. The dart tag showed a 90% retention rate with a 100% retention rate from the tag locations below the dorsal fin. The disc tag showed 100% retention in each location however did have the lowest health rankings.

The healthiest tag locations were observed after applying the t-bar tags. There was virtually no damage incurred from tagging. The dart tags showed some damage to the fish but after two weeks the health average was 2.88. The Disc tags were the most unhealthy tag for the fish with tag health ranking 2.39 out of three.

Retention rates indicate effectiveness of tags in open water environments. If an organism is attempted to be studied using tags with a low retention rate it will results in gaps in data and loss of information. Retention rates of different forms of tags were monitored over a period of about two weeks (Figure 3).

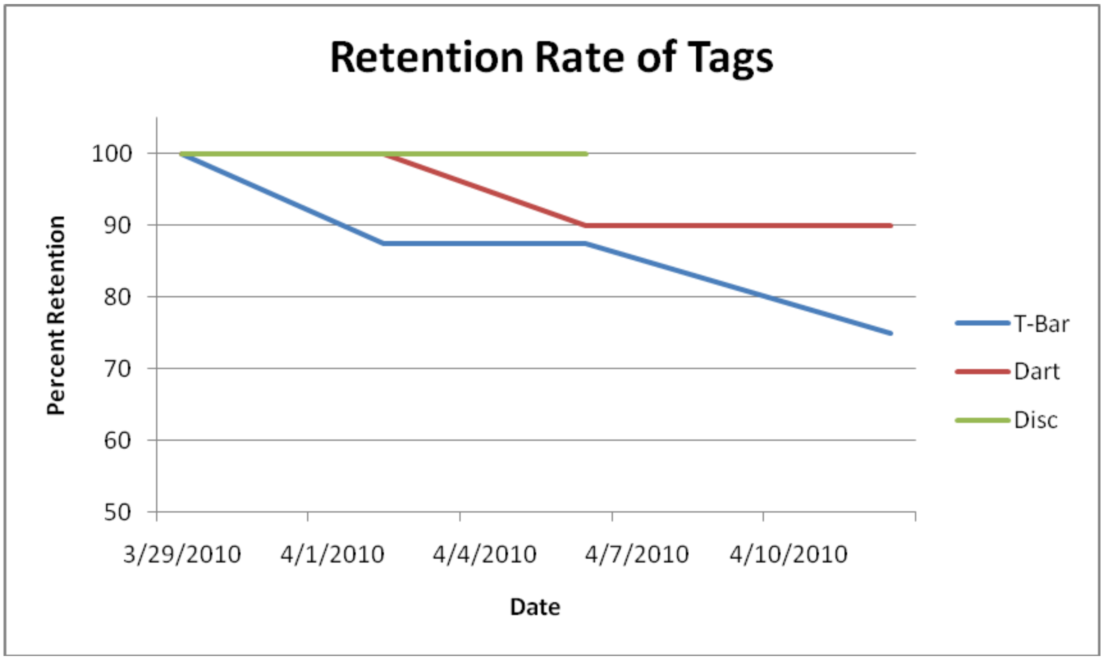


Figure 3—The disc tag showed the highest retention rate with no loss. The dart tag displayed a 90% retention rate over the sample time period. Only one of the ten administered tags was lost. The loss occurred three days into the experiment. The t-bar tag had the lowest retention rate at 75% and experienced the loss of two tags at different times, one third and two thirds of the way through the period.

The average health of the fish is important to note when deciding what type of tag to choose, but it is also important to monitor the healing of the tag sites as a quickly healing tag site may not pose much harm to the fish as the wound will not linger causing lasting damage (Fig 4.)

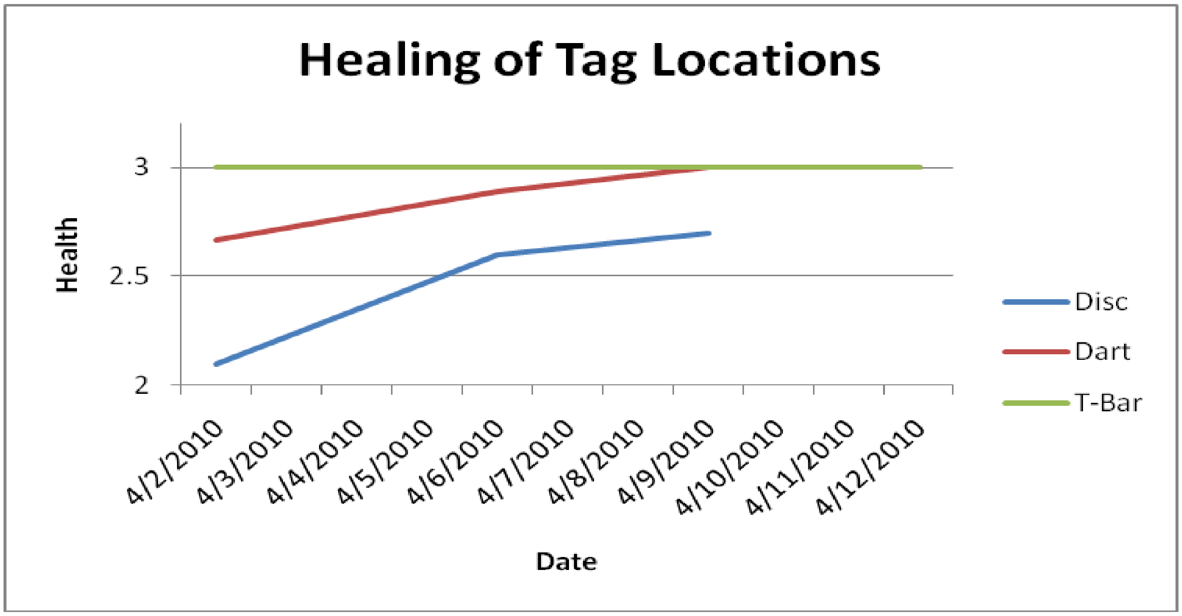


Figure 4—The tags all showed signs of healing. The rate of healing was highest initially with the disc tag but the healing slowed considerbly fter four days of monitoring. The dart tags healed at constant rate until each tag location was healed. Because of the minimal damage caused by t-bar tags, no healing was observed, or necessary.

Discussion:

Based on the data collected in this study, the dart tag in concert with the 1m box-board is the superior method for restraining and tagging *Anarhichas lupus.* Reasons for conclusion are detailed below.

Restraining Boards

The most effective restraining mechanism were the ratchet straps. The sturdy nature of the nylon straps, was more beneficial than the quick bungee straps that gave the fish some wiggle room. The ratchet mechanism was adjustable to any length and able to accomadate any fish. While the bungee system was highly adjustable, the weak tensile strength of the rubber limited its effectiveness.

The cradle of the box-board design was sturdy and restricted side to side movement of the fish. It also had a support beam that provided the fish a biting post which they typically bit down on while being restrained. The angle of the v-board allowed the fish to snake out of the restraints and on to the floor if the restraints were not strong enough.

The 1m boards proved ideal for this sample of wolffish. The smallest fish was 22in and the largest was 38in were both able to be restrained on a board of this length. The larger boards were too large to successfully restrain any of the fish because they were designed to fit larger specimens which have been reported to reach lengths of 54in.

Based on our analysis of the restraint systems we have determined that the 1m box board was ideal for the restraint of *Anarhichas lupus.* Improvements could be made to the board. A fourth slit could be inserted between the head and the mid-dorsal area of the fish. This would allow for better restraint of the smaller fish, which had a higher tendency to escape the restraints.

Tagging Methods

The dart tags experienced a 10% loss. The loss of that one tag can be attributed to human error. Due to tagging inexperience the tag may not have been seeded tightly in the sub-dermal layer of the fish. Because of its looseness the tag was ripped out of the fish by a member of the laboraratory team while tryring to restrain a particularly feisty specimen. Aside from its high retention rate, the dart tags also had quick healing times and imparted minimal damage to the fish.

The application of the dart tag did not seem to cause lasting injury to the fish. All tag locations were healed within eight days. The quick healing times reduce the risk of infection which could kill the fish. While it takes a couple of trys to get the proper technique, the tagging procedure is not difficult to master.

While the disc tag had a 100% retention rate the rate of healing and ease of tagging was far less than that of the dart tag. Inserting the 3” nickle pin through the skin and musculature of the wolffish proved to be difficult because fish of incooperativity, the tough skin and dense muscle that needed to be pierced to tag the fish. While tagging the pin would be to weak to pierce the skin and would bend while tagging. This certainly induced harm and pain to the fish. Once tagged, it was evident that the tag was causing the fish pain. Most fish when put on the floor before restraining would thrash about biting at their tails. Once restrained, if the tag location was touched, the fish would immideately begin trying to flail around violently in the restraining board. When the tags were removed, the behavior stopped.

The tags were removed three quarters of the way through the experiment because the crimped end of the nickle pin was injuring other fish in the tank. Because of the soreness of the tag spot, any intruding fish would cause the other fish to flail about. Several incidences of lacerations caused by the nickel pin were observed.

The disc tags were also prone to becoming tangled in the dip net used to capture the specimens before each monitoring period. This would cause further injury to the tail by gouging out the area around the nickle pin. Because of injuries incurred by the disc tags, the lab team chose to remove to prevent further harm to the the fish.

On the other end of the spectrum, the t-bar tags showed minimal harm to the fish. Each tag location healed quickly. This is most likely because of the small nature of the head of the tag. Unfourtunately, the tag was not secure in the sub-dermal layer for the same reason. While the invasiveness of the tag was minimal, the retention rate was not high enough to realistically use in a study.

Future Applications:

The 1m box-board design can be used with the dart tags to study the Atlantic wolffish in its natural environment. Potentially, the restraining board could be loaded on a vessle and when a wolffish is caught as by-catch it can be tagged, reported, and released back into the ocean. If a wolffish that has already been tagged is pulled up the location and size of the fish can be recorded and cross referenced with previous data. This will give insight into population, growth rate, and movements of the fish.

Appendix 1: Cost Analysis

Estimated Budget

~$1015 all inclusive

Actual Budget

~$980

Pumps--$300

Fish---$200

Plywood---$80

Hardware---$400

Brackets---$75

Screws---$20

Restraining Straps--$50

Eye-Bolts and Screws---$100

Gel Coat and Paint Supplies--------------------------------------$150

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