Evaluation of tiedown height in monkfish gillnets on monkfish retention and potential use as a bycatch reduction measure.

Project Final Report: Submitted to National Marine Fisheries Service 2010 Monkfish Research Set-Aside Program

Contract Award Number: NA10NMF4540338

Contract Period of Performance: February 1, 2012 – June 30, 2012

Submitted By: Steve Eayrs[1], Croy Carlin[1], Ted Platz[2], Timothy Caldwell[3]

1. Gulf of Maine Research Institute, Portland, ME
2. F/V Gertrude H.
3. F/V C.W. Griswold

Prepared By:
Steve Eayrs

Date:
October 2, 2012

Ph. 207-228-1659
Email: seayrs@gmri.org

Table of Contents

	p.
List of plates	Iii
List of tables	Iii
List of figures	Iii
Abstract	2
Introduction	4
Objective	5
Participants	6
Methods	7
Results	8
Discussion	10
References	12
Partnerships	14
Impacts/Applications	14
Related projects	14
Published reports/papers	14
Presentations	14
Student participation	14
Future research	14
Plates	15
Tables	16
Figures	17

List of Plates **p.**

Plate 1. Dockside image of the C.W Griswold, one of the participating boats 15

Plate 2. The net spreader bar configuration on the F/V Gertrude H..... 15

List of Tables **p.**

Table 1. Monkfish catch by number of nets hauled 16

Table 2. K-S test of length frequency variation based on tiedown height 16

List of Figures **p.**

Figure 1. Fishing location of both boats, distance apart is 24 miles 17

Figure 2. Total monkfish catch by boat 17

Figure 3. Mean monkfish catch by net-haul, by boat 18

Figure 4 Length frequency of monkfish by tiedown height 18

Figure 5. Percentage of monkfish catch retained per haul from the F/V C.W. Griswold 19

Figure 6. Percentage of monkfish catch retained per haul from the F/V Gertrude H 19

Abstract
In this project two commercial fishermen sampled their monkfish catches using strings of gillnets fitted with 18”, 30”, and 42” tiedown heights. Despite a paucity of data our results suggests that the gillnets with the 42“ tiedowns retained the largest weight of monkfish with a mean weight per net-haul from both boats combined of 39.93 lbs. As tiedown height decreased, so too did monkfish catch, with 30” and 18” tiedown gillnets respectively retaining 17% and 24% less monkfish by weight per individual net-haul. No significant difference in length frequency composition was detected between tiedown heights. It is postulated that a reduction in monkfish with a decrease in tiedown height is due to a reduced ability to retain monkfish swimming clear of the seabed.

Introduction

Monkfish (*Lophius americanus)* are distributed along the east coast of North America from the Gulf of Saint Lawrence to North Carolina (Curuso, 2002; Everly, 2002). In the northeast United States, monkfish are distributed from Maine to North Carolina in depths that range from several fathoms to 500 fathoms or more (Curuso, 2002). In this region, the fishery is divided and managed as two distinct areas, a Northern Management Area (NMA) and a Southern Management Area (SMA), and they are delineated by Georges Bank (Haring and Maguire, 2008). In 2011, the combined catch from these areas totaled almost 19 million pounds valued at just over $26.5 M (http://www.st.nmfs.noaa.gov/st1/commercial/landings/annu-al_landi-ngs.html)

The primary fishing gears used to land monkfish are otter trawl, gillnet, and scallop dredge (NEFSC, 2007). In the NMA, gillnets account for about 30% of the total monkfish catch while the remainder is the result of otter trawling, primarily during dedicated fishing trips targeting groundfish (Haring and Maguire, 2008). In contrast, monkfish landings in the SMA are primarily the result of dedicated monkfish fishing trips. In this area fishing with gillnets accounts for about 65% of total monkfish landings while trawling and dredging accounts for about 25% and 10% of monkfish landings respectively (Haring and Maguire, 2008).

Gillnets used to target monkfish are generally constructed from 12 inch monofilament netting panels and twine tiedowns that range between 36 and 42 inches in length. As their name implies, the purpose of a tiedown is to reduce the operational height of the gillnet on the seabed. This ensures the monofilament netting is relatively slack so that monkfish can be readily entangled and retained following their encounter with netting. While the regulated minimum mesh size in this fishery for monkfish is 10" (Federal Register, 2012), many fishermen use 12" mesh to maximize monkfish catches (Salerno et al., 2010).

The goal of this project was to evaluate the effect of various experimental tiedown heights on monkfish catch using gillnets constructed from monofilament netting panels of the same mesh depth. In this way a comparison could be made of the effect of different nominal gillnet heights on monkfish catch. A review of available literature suggests that many recent gillnet studies in North American fisheries have either focused on other fish species (e.g. Dander, 1996; Hamley et al., 2011), changes in gillnet buoyancy and the absence/presence of tiedowns (e.g. Montgomery, 2001; Fox et al., 2011), the effect of gillnet panel height on fish catches (e.g. Gearhart and Price, 2003; Brown and Price, 2005; Price and Van Salisbury, 2007), the effect of changes in mesh size for a given tiedown height (e.g. Salerno et al., 2011, Pol et al., 2009), or compared the performance of several gillnets each with a different mesh depth and tiedown height (e.g Maldonado et al., 2006). A few studies have evaluated the effect of tiedown height on bycatch and discard species but they have paid relatively scant attention to the target species (e.g. Fox et al., 2011; Murray, 2009; Trippel et al., 2011; D'agrosa et al., 2003; NOAA, 1998).

Objective

This project was conducted with the intent of addressing Research Needs and Priorities #5 of the 2010 Monkfish Scallop Research Set Aside FFO, and specifically, "*Trawl and gillnet gear studies focusing on: (a) size and/or species selectivity, and (b) bycatch reduction, including reducing bycatch of and interactions with protected species*." Several industry members approached GMRI with an idea to test the effect of tiedown height on the catching performance of gillnets. Their concern at the time was that consideration by other stakeholders to reduce tiedown height and subsequently lower the risk to marine mammals and other bycatch species was not adequately considering the potential effect this modification might have on the catch of valuable species. While these members understood the importance of reducing bycatch, their willingness to voluntarily adopt new gear technologies or management strategies was dependent on their confidence in these new practices not having a negative effect on fishing practice and catch. This project was therefore designed to attempt an evaluation of the effect of tiedown height on monkfish catches. The specific objectives of this project were to:

1. Collect data on monkfish and bycatch rates in the monkfish gillnets with varying tiedown heights (18, 30, and 42 inches).

2. Evaluate the effect of tiedown height on catch rates and size composition of monkfish and bycatch.

3. Document gear configurations and shipboard handling of the different tiedown heights.

4. Provide industry and managers with recommendations on monkfish gillnet gear modifications that will aid in the further reduction of bycatch while optimizing monkfish retention.

Participants

Steve Eayrs
Research Scientist
Fish Behavior / Gear Technology
Gulf of Maine Research Institute
350 Commercial Street
Portland, Maine 04101

Croy Carlin
Collaborative Research Technician
Gulf of Maine Research Institute
350 Commercial Street
Portland, Maine 04101

Tim Caldwell
F/V C.W. Griswold
Pt. Judith, RI

Ted Platz
F/V Gertrude H.
New Bedford, MA

Methods

This project was conducted during the late spring and early summer of 2012 aboard the F/V C.W. Griswold (Plate 1) and F/V Gertrude H. Initially, each boat was equipped with two identical strings of 12 gillnets each. Within each of these strings 4 nets were tied down to 18", 4 nets to 30", and 4 nets to the control height of 42". The placement of each net within a string was randomized and the sequence provided to each fisherman prior to commencement of fieldwork. However, soon after the fieldwork commenced it became apparent that gillnets tied at 18" were unable to be deployed effectively from the F/V Gertrude H. As a result, these gillnets were removed and one long 14-gillnet string was used comprising 7 of the 30" gillnets and 7 of the 42" gillnets in a randomized sequence. A three fathom bridle was placed between each individual net in all strings to prevent the tiedown height of a single net influencing the catch of a neighboring net.

All gillnets were designed and constructed to industry standards. Each net was 300' long, 8' heigh, constructed with 12" monofilament mesh netting throughout, and tied down every 25' apart. Each captain was tasked with collecting basic catch data for a total of 25 hauls with each string (50 hauls per boat). Fishing practices with each string were to remain consistent with normal fishing procedures, particularly in terms of soak time, and fishing location was chosen at the discretion of the captain. Fishing was conducted south of Block Island, with the boats fishing approximately 24 miles apart for the duration of the project (Figure 1).

All data for the project was collected by the captain and crew of the boats, based on catch collecting protocols developed by GMRI. This data was to include the date, time, and location of each haul, as well as the soak duration and species composition for each gillnet of each tiedown height. The catch of monkfish was also to be measured for length and weight, categorized by tiedown height.

The catches were standardized from total haul weight to average net weight per (soak) day to allow for comparisons between boats given the different gear configurations, nets per string for a given tiedown height, and soak time. A chi-squared test of proportions compared pooled monkfish catch volumes between boats for all hauls using the 30" and 42" tiedown heights, and a one factor Analysis of Variance test was used to compare catch weight per haul and gain an insight into catch variability between tiedown heights. These data were first log transformed to overcome issues with left-skewed catch weights. A Kolmorogov-Smirnov test for continuous distributions was then performed on the length frequency data to assess variability in monkfish size distribution between tiedown heights.

Results

Sampling for monkfish occurred on both boats in the late spring and early summer of 2012. The F/V C.W. Griswold completed 48 hauls (out of a desired 50) but the F/V Gertrude H. completed only 28 hauls (out of the desired 50).

Early in the fieldwork, problems deploying the 18" tie down gillnets onboard the F/V Gertrude H quickly became apparent. On this boat a spreader bar is used comprising of a triangular-shaped inner frame and a semi-circular outer ring (Plate 2). The purpose of the spreader bar is to facilitate rapid deployment of each gillnet. During deployment, the floatline of the gillnet passes along one side of the triangular-shaped inner frame and the leadline along the other side. In this way the inner frame helps to ensure adequate separation of the floatline and leadline and facilitates removal of twists and tangles in the netting so the gillnet is fishing correctly when it reaches the seabed. The outer framework serves to restrain the gillnet so that its deployment can be controlled over the stern of the boat.

Onboard the F/V Gertrude H the issue was that the base of the inner frame had a width of 21", which made effective spreading of the 18" tiedown gillnets difficult. The only way to address this was for the floatline and leadline to slip up along the sides of this frame, however, this small distance slowed net deployment because additional time was required by the crew to separate the floatline and leadline and remove any twists and tangles in the netting. Without replacing the inner frame these nets could not be easily deployed, so the captain removed these nets from each string and fished with one 14-net string of alternating 30" and 42" tiedown gillnets.

In total just over 27, 000 lbs of monkfish were caught in this project from 772 net-hauls. The limitations aboard the F/V Gertrude H reduced the total number of net-hauls with the 18" tiedown nets by 33% (Table 1; Figure 2). The gillnets with the 42" tiedowns retained the largest weight of monkfish with a mean weight per net-haul of 39.93 lbs from both boats combined, whereas the 30" and the 18" tiedown gillnets respectively retained 17% and 24% less monkfish by weight per individual net-haul[1] (Figure 3). On the F/V C.W. Griswold, the combined weight of monkfish caught from all hauls (n = 47) using the 30" and the 18" tiedown gillnets was respectively 15% and 26% less than that for the 42" tiedown gillnets, while on the F/V Gertrude H the 30" tiedown gillnets retained 22% less monkfish by weight compared to the 42" tiedown gillnets. Despite the differences in total haul weights on the F/V C.W. Griswold for each tiedown height, we were unable to detect a significant difference in monkfish weight per haul between these heights ($F_{(2,138)}$= 1.959, F_{crit} = 3.061, p = 0.145).

Despite different fishing locations between the two boats we found no significant difference (χ^2 =.067, df=1, p = 0.796) in the ratio of monkfish weight retained in 30" and 43" tiedown gillnets. Of the 48 hauls completed by the F/V C.W. Griswold, the gillnet with the 18" tiedowns retained

[1] Standard deviations could not be calculated because monkfish weights for each net were not recorded. Mean weight per net-haul was calculated by dividing the monkfish catch by the number of nets of a given tiedown height in a string.

at least one-third of the catch during 23% of all hauls, the 30” tiedowns retained at least one-third of the catch during 51% of all hauls, and the 42” tiedowns retained at least one-third of the catch during 70% of all hauls (Figure 4). On the F/V Gertrude H, the 42” tiedowns retained at least 50% of the total catch per haul in 12 out of 14 hauls (86% of the hauls) (Figure 5).

Length frequency measurements of monkfish were recorded on the F/V C.W. Griswold from 48 hauls (Figure 6). The mean length of monkfish from the 18”, 30”, and 42” tiedown nets was 24.09 cm +/- 3.74, 24.68 cm +/- 4.01, and 24.82 cm +/- 4.18 respectively. Compared to the 42” tiedown gillnets, the remaining gillnets clearly caught fewer large fish. K-S tests on these length frequency data indicated no significant difference in length frequency distributions between gillnets, with the exception of the 18” and 42” tiedown heights (Table 3). No length frequency measurements were recorded on the F/V Gertrude H.

The F/V C.W. Griswold caught 10, 500 lbs of skates at an average of 617.65 +/- 566.29 lbs per haul while the F/V Gertrude H caught 13, 625 lbs of skate at an average of 972.50 +/- 606.09 lbs per haul. The skate catch was not always identified to species so only total weight data was analyzed.

Discussion

This project failed to fully attain its desired level of success primarily because on one boat the number of requisite hauls was not completed and there was no measurement of monkfish. As a result, our ability to thoroughly analyze catch data was severely curtailed. Despite clear instructions at the onset, and considerable but often unsuccessful efforts to keep in contact with both boats, we were unable to fully achieve the goals of the project. To an extent this was understandable given the commercial focus of each fisherman, the considerable uncertainty that is prevalent across much of the fishing industry at present, and the attendant frustration at regulatory processes and associated decision making. However, collecting incomplete data served no useful purpose other than to highlight the danger of this data collection method as a trade-off against higher project costs.

This project did however ascertain that monkfish catch rates were highest using gillnets with a standard 42"tiedown height. Any attempt to reduce this height in the hope of reducing bycatch is therefore likely to result in significant push-back from fishermen. Based on the limited data from this project, a reduction in tiedown height to 30" could at least be expected to result in an estimated 17% loss of income, assuming size composition remains unchanged. While our limited data could not detect a significant difference in monkfish catch per haul, a loss of income of this magnitude will be a most unsatisfactory outcome for fishermen and their support for such a move can be expected to be negligible or non-existent. Furthermore, a move toward an 18" tiedown height would seem to be totally unacceptable given an even greater estimated loss of income from this modification.

While the data requirements of this project were not primarily focused on bycatch, there was no data indicating any interaction with porpoise, sturgeon, or sea turtles and hence the effect of various tiedown heights on these animals could not be evaluated. It is worth noting, however, that such catches if any should have been recorded in the log books of each fisherman.

Moving forward this project does at least provide a baseline to build upon with future efforts to evaluate the effect of tiedown height on catch. The limited data suggests that gillnets with an 18" tiedown height will result in excessive loss of catch. They also pose significant problems on some boats depending on their spreader bar design. A useful starting point for future efforts may therefore lie in determining when the catch begins to significantly decrease using tiedown heights within the 30-42" range. While this range may seem quite narrow, a tiedown height reduction from 42" to 30" represents a 29% reduction in operating height. Having said that, there is a high likelihood that 42" tiedown heights are commonly used by fishermen because they have already determined that this is the optimum height for catching monkfish, having been established through trial and error experimentation over a considerable period of time.

This project also raises a tantalizing question regarding the rationale for a difference in catch between the tiedown heights tested in this project. With a decrease in tiedown height it might be expected that catch rates should increase because the netting is becoming slacker and greater numbers of monkfish in close proximity to the seabed should become entangled and

retained in the gillnet. This clearly was not the case in this project, and a possible reason for this may have been due to fewer monkfish encountering the gillnets with smaller tiedown heights. While monkfish are considered to be a predominantly benthic species, they are known at times to be highly mobile. Monkfish are known, for example, to make large periodic vertical movements, sometimes over 200 m and extending for 12 h or more (Roundtree et al., 2008). They are also known to make extensive migrations, sometimes swimming several kilometers per day over sustained periods of several months (Sherwood, et al., nd). Conceivably then it is possible that the difference in catch reported in this project is at least in part a reflection of this active swimming behavior, with catch loss due to monkfish swimming clear of the seabed, some of which might otherwise have been caught with the 42" tiedown gillnets.

References

Caruso, J. H. 2002. Goosefish or monkfishes: family Lophiidae. In Bigelow and Schroeder's *Fishes of the Gulf of Maine*, 3rd edn, pp. 264–270. Ed. by B. Collette, and G. Klein-MacPhee. Smithsonian Institution Press, Washington, DC. 748 pp.

Everly, A. W. 2002. Stages of development of the goosefish, *Lophius americanus*, and comments on the phylogenetic significance of the development of the luring apparatus in Lophiiformes. *Environmental Biology of Fishes* 64: 393–417, 2002.

Federal Register. 2012. *NE Multispecies regulated mesh areas and restrictions gear and methods of fishing*. Subpart F – Management measures for the NE Multispecies and Monkfish fisheries. §648.80.

Fox, D. A., Wark, K., Armstrong, J. L. and L. M. Brown. *Gillnet Configurations and Their Impact on Atlantic Sturgeon and Marine Mammal Bycatch in the New Jersey Monkfish Fishery: Year 1*. *PSB Gear Research*. Final Report. NOAA NMFS Contract Number: (number EA133F-10-RQ-1160), 9 Dec. 2011. 19 Sept. 2012. Available at: http://www.nefsc.noaa.gov/read/prot-spp/PR_gear_research/.

NEFSC. 2007a. *Monkfish Assessment Report for 2007*. US Dep Commer, Northeast Fish Sci Center Ref Doc. 07-21; 232 p.

Murray, Kimberly T. "Characteristics and Magnitude of Sea Turtle Bycatch in US Mid-Atlantic Gillnet Gear." *Endangered Species Research* 8 (2009): 211-24.

Richards, R. A., Nitschke, P. C., and Sosebee, K. A. 2008. Population biology of monkfish Lophius americanus. *ICES Journal of Marine Science*, 65. Available at www.nefmc.org/monk/index.ht-ml

Salerno, D. J., Eayrs, S., Pol, M., Lee, S., & Baukus, A. 2011. *Analysis of Size Selectivity and Bycatch in the Gillnet Fishery for Monkfish.* Gulf of Maine Research Institute. Final Report, Contract Award Number PZ07073 (2010).

Haring, P., and Maguire, J-J. 2008. The monkfish fishery and its management in the northeastern USA. *ICES Journal of Marine Science*, 65:1370–1379.

Richards, R. A., Nitschke, P. C., and Sosebee, K. A. 2008. Population biology of monkfish Lophius americanus. – *ICES Journal of Marine Science*, 65: 1291–1305

Sherwood, G.D., Grabouwski, J. H., Stephens, N., Platz, T., and Caldwell, T. nd. *A tagging study to assess migratory patterns of monkfish (Lophius americanus) in the northwest Atlantic*. Poster. Available at http://www.gmri.org/community/seastate/posters/Monkfish%20T-agging%20Poster%20v3.pdf

Trippel, E. A., Strong, M. B., Terhune, J. M. and J. D. Conway. "Mitigation of Harbour Porpoise (Phocoena Phocoena) By-catch in the Gillnet Fishery in the Lower Bay of Fundy." *Canadian Journal of Fisheries and Aquatic Sciences*56.1 (1999): 113-23. Web. 9 Sept. 2012.

D'agrosa, C., Lennert-Cody, C. E. and Omar Vidal. "Vaquita Bycatch in Mexico's Artisanal Gillnet Fisheries: Driving a Small Population to Extinction." *Conservation Biology* 14.4 (2000): 1110-119.

Hamley, J. M., and Regier, H. A. "Direct Estimates of Gillnet Selectivity to Walleye (Stizostedion Vitreum Vitreum." *Journal of the Fisheries Research Board of Canada* 30.6 (1973): 817-30. Web. 25 Sept. 2012.

Partnerships
The partnership between project participants was generally good. A paucity of data on one boat was a disappointment and largely a function of differing priorities at the time of the fieldwork. Efforts to maintain somewhat regular communication with both fishermen was a challenge, albeit no different to any other time, but this made difficult maintaining contact and monitoring data collection to an acceptable standard.

Impacts/Applications
The data collected in this project suggest that efforts to reduce gillnet tiedown height is likely to contribute to a reduction in monkfish catch, although a more extensive effort is required to confirm that this is the case. No marine mammals, sturgeons, or sea turtles were recorded in this study and it remains unknown if a reduction in tiedown height will contribute to reduced capture rates of these animals.

Related projects
This study was not a part of any other work.

Published reports/papers
No reports or papers have been published as a result of this study, nor are likely in the future given the breadth and quality of the data.

Presentations
None.

Student participation
None.

Future research
This study should only be considered a pilot and future, more extensive efforts will be required to confirm if a reduction in tiedown height consistently reduces catches of monkfish.

Plates

Plate 1. The C.W. Griswold was one of the commercial monkfish gillnet boats involved in this project.

Plate 2. The spreader bar aboard at the stern of the F/V Gertrude H. Gillnets are deployed between the inner and outer rings to ensure each net is untangled when deployed.

Tables

Table 1. Monkfish catch based on the number of nets hauled.

Tiedown height (inches)	No. of Net-Hauls	Total Catch (lbs)	Total Soak Time (days)	Weight Caught Per Day (lbs)	Mean Weight Per Net-Haul (lbs)
18”	192	5 837	237.58	24.56	30.40
30”	290	9 605	316.58	30.33	33.12
42”	290	11 581	316.58	36.58	39.93

Table 2: Mean catch weight (pounds) per haul by tiedown height and boat. Note that each haul consisted of 1 string on the C.W. Griswold (4 x 18”, 4 x 30”, and 4 x 42” nets) and 1 string on the Gertrude H (7 x 30” and 7 x 42” nets).

Tiedown height (inches)	C.W. Griswold		Gertrude H	
	$\bar{x}$	sd	$\bar{x}$	sd
18”	121.6	111.2	0.0	0.0
30”	140.3	130.1	205.0	137.2
42”	164.7	138.5	262.5	162.9

Table 3. Length frequency comparison between different tiedown heights.

Tiedown heights	D_{max}	$D_{0.05}$	Significance
18” compared to 30”	.061	.071	ns
30” compared to 42”	.033	.067	ns
18” compared to 42”	.088	.069	$p < 0.01$

Figures

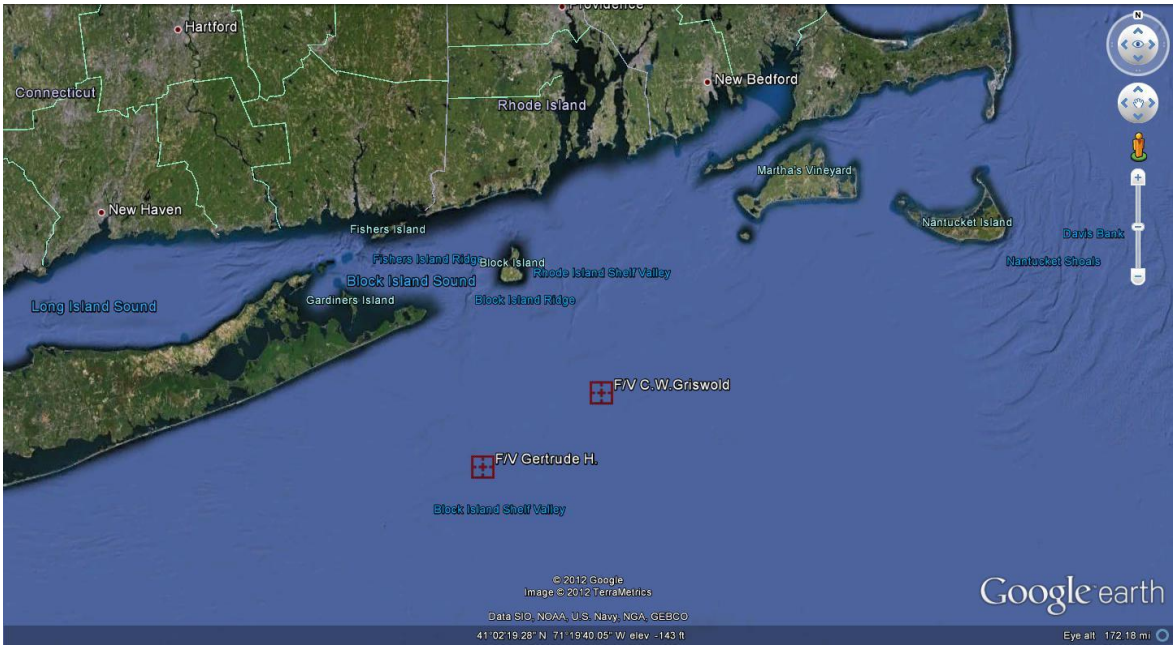

Figure 1. Approximate fishing location of both boats, distance apart is 24 miles.

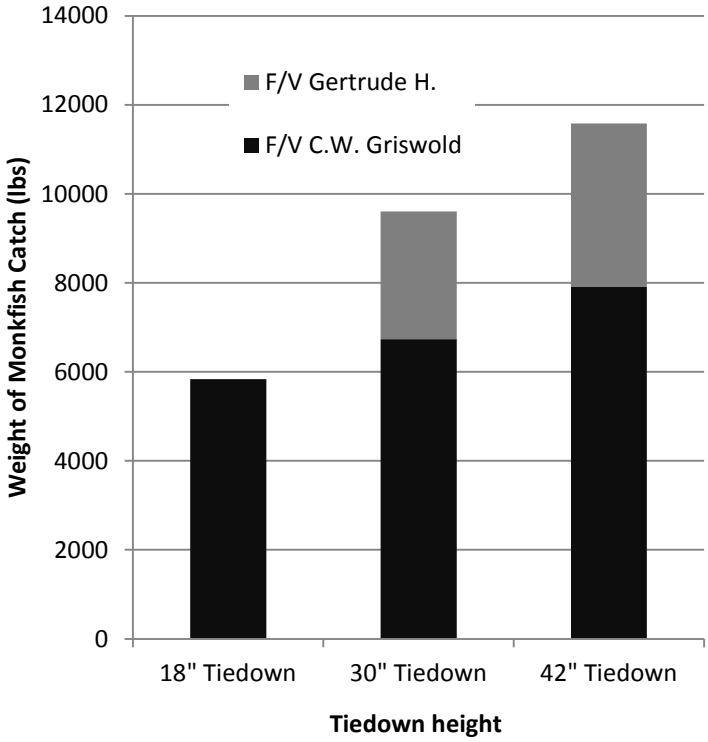

Figure 2. Total monkfish catch by boat

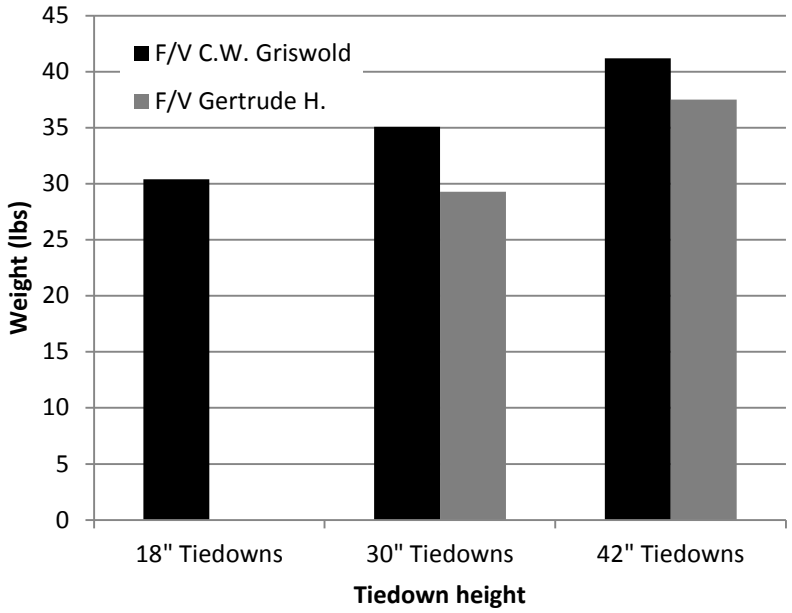

Figure 3. Mean monkfish catch by net-haul, by boat.

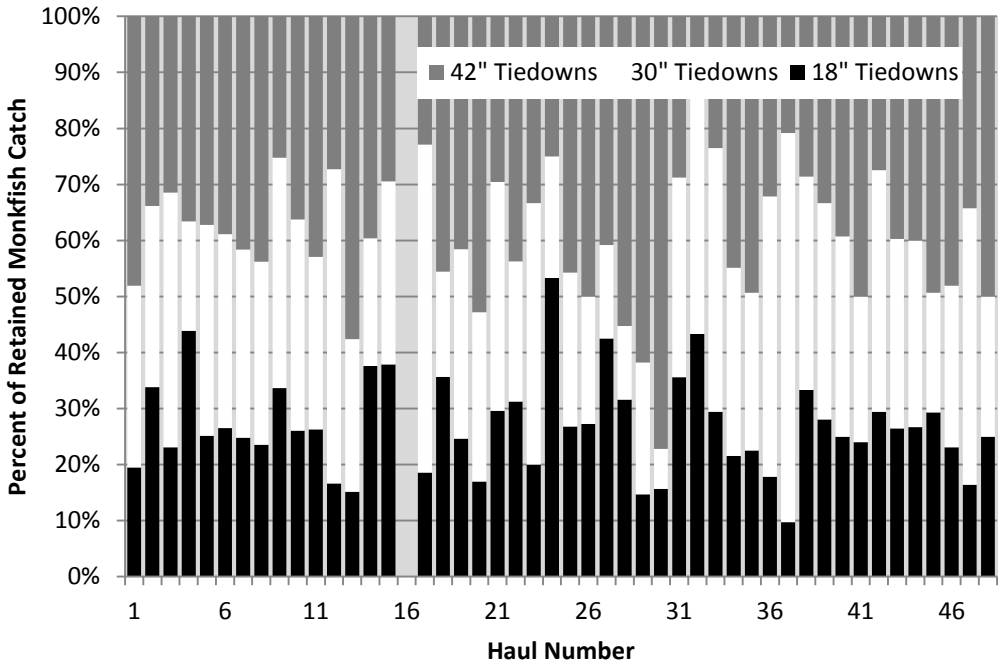

Figure 4. Percentage of total monkfish catch retained per haul by the F/V C.W. Griswold H. by tiedown height.

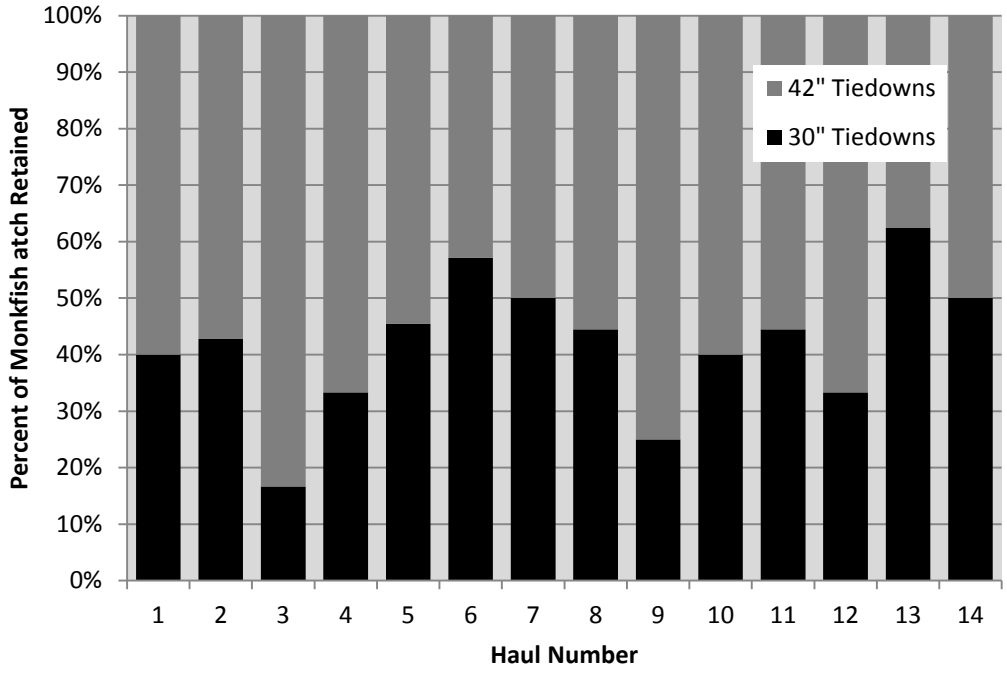

Figure 5. Percentage of total monkfish catch per haul retained by the F/V Gertrude H. by tiedown height.

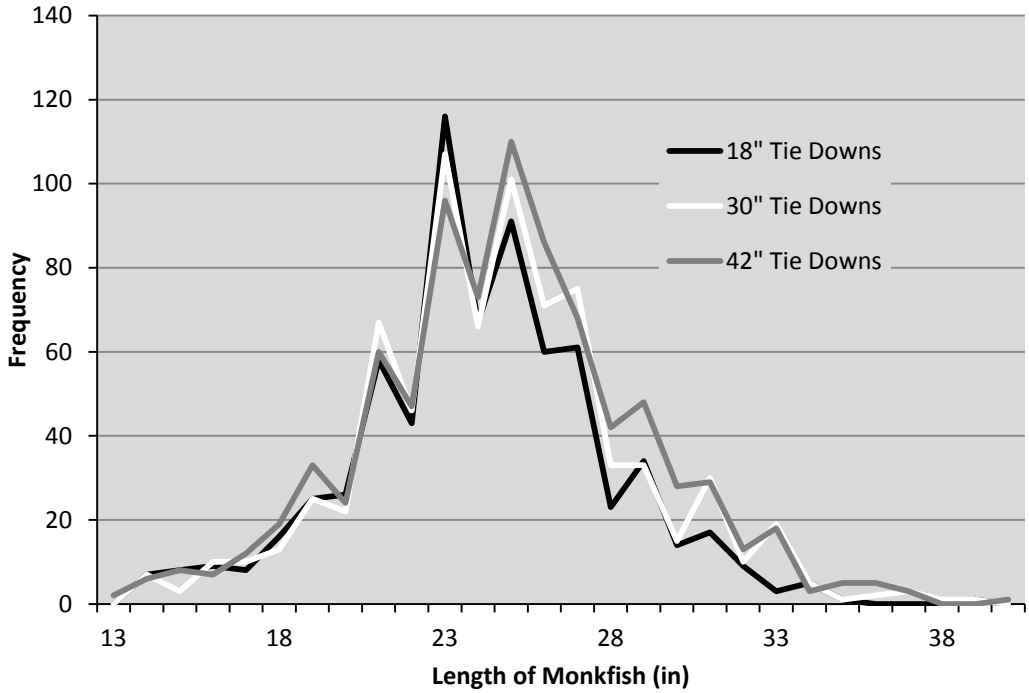

Figure 6. Length-frequency of monkfish by tiedown height.