FINAL REPORT MONKFISH
RSA 2013-2015

Report title: Influence of temperature and lunar cycle on the distribution and catch rates of monkfish, *Lophius americanus*
Author: Andrea Johnson, Ph.D. and William Gardner, Ph.D.
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1. Abstract (200 words or less)

The monkfish, *Lophius americanus* V., is an important commercial species in the Northwest Atlantic Ocean. The influence of temperature and lunar cycle on monkfish distribution and catch rates was investigated using VEMCO minilog temperature and data loggers. The majority of samples were taken from coastal waters off Montauk, NY and Ocean City, MD. In both cases, collection of bottom temperature and depth was successful by these fishermen. The warmest temperatures occurred during autumn and coolest during winter and spring with little to no relation to lunar cycle. Overall, no consistent pattern was observed between monkish catch number, size and lunar periodicity. This suggests little predictive value for consulting lunar tables in identifying peak fishing times for monkfish.

2. Statement of Problem

Once considered a commercially unimportant species in the United States, monkfish *L. americanus* has become one of the highest valued finfish species in the northeast. Historically, monkfish was often taken as a bycatch species in the groundfish and scallop fisheries (Armstrong et al. 1992). The popularity of monkfish as a food fish began to grow following a decline of traditional groundfish species in the 1970s and 1980s (Armstrong et al. 1992). However, some aspects of monkfish biology and life history are not well known. One such aspect is the effect of thermal conditions on the distribution and abundance of monkfish within their geographic range. Previous findings suggest that sea water temperature shifts may have an effect on seasonal onshore-offshore movements and influence inshore spawning migrations. A number of marine species have shown shifts consistent with response to increasing temperatures (Murawski, 1993; Perry et al., 2005). In the northwest Atlantic, Murawski (1993) examined latitudinal range of 36 Atlantic fish species during 1967-1990 and found a significant northward trend in 12 species that was associated with variation in water temperature. Results from our analysis of NEFSC bottom trawl survey catch and hydrographic data collected during spring and autumn from 1968 to 2008 in U.S. waters (Gulf of Maine, Georges Bank, mid-Atlantic Bight) showed monkfish, *L. americanus*, were strongly associated with temperature and depth distributions that differed significantly from the distributions observed at the sampling stations. Overall, the historical data showed that monkfish are compensating for changes in temperature by shifting their distribution northward in spring to higher latitudes and deeper depths in response to climate change.

Sea water temperature changes could potentially affect the distribution and abundance of adults and juveniles, the timing and locations for spawning, the successful development of larvae, and may also help regulate the movement and availability of important prey species. Acquiring knowledge about the influence of thermal conditions on monkfish behavior is important because it would offer us a better understanding of the biology and life history and provide information to aid in the management of the fishery in the

northeast and mid- Atlantic regions. Furthermore, this research seeks to understand the lunar cycle influences on monkfish catch rates. This knowledge is of particular interest to anglers because of their popular belief in an association.

Monkfish fishermen in the U.S. assert that temperature plays a key role in the distribution of monkfish and in the timing of onshore migration in the spring. Since little is known of the influence of temperature on the behavior of monkfish, we propose to determine the effects of temperature on the distribution and catch rates of monkfish in the Northwest Atlantic and examine the role of temperature in triggering migration in spring (onshore) and fall (offshore). In addition, we will determine reproductive stages of migrating monkfish to address questions related to location and timing of spawning. Thus, the study focused on the 2013 Monkfish Research Set-Aside (RSA) program priorities (1 and 2) and support the Monkfish Fishery Management Plan by conducting cooperative research to enhance the knowledge of the monkfish fishery resource and provide information that can be used for management of this species.

Project Objectives

The overall objective of this study was to investigate the influence of water temperature on monkfish distribution and catch rates.

Objective 1: Investigate whether catch rate correlates with temperature and lunar cycle

Objective 2: Determine whether the seasonal movement of reproductively active monkfish correlates with temperature and lunar cycle

3.Methods

Sampling locations

Sampling for monkfish by commercial gillnet fishermen occurred at various sites throughout the Northwest Atlantic from Montauk, NY south to Chincoteague, VA (Table 1; Figure 1). Data sampling and collection primarily occurred off the coasts of Montauk, NY, Pt. Pleasant, NJ and Ocean City, MD (Table 1; Figure 1.) during the monkfish fishing season. Sampling generally occurred from November to April off Maryland and Virginia coasts and from November to July off Montauk, NY.

Sampling locations were considered fixed sites though on rare occasions, conflicts with other fishing gear or nuisance species (e.g. isopod “sea-lice”) or low catches forced fishermen to move their nets to new locations. Since it was not possible to insure that sampling gear would remain in the exact location of deployment, locations were considered fixed unless changes in position were identifiable through the data.

Sample collection

Bottom temperature (˚C) and depth (m) were recorded at each sampling site and during each gillnet deployment. Temperature and depth (pressure) loggers, VEMCO TDR 8-bit Minilog (temperature range: -4-20˚C, 0.1˚C resolution, ±0.2˚C accuracy; depth range: 204 m, 1.2 m resolution; VEMCO Division, AMIRIX Systems Inc., 2100 Horseshoe Lake Drive, Halifax, N.S. Canada B3S 0B9; http://www.vemco.com) were distributed to three of five gillnet fishermen who attached them to the top and bottom outer edge of one panel of each gillnet with cable wire ties; two loggers were utilized per net. The data loggers

recorded temperature and depth information hourly during the time period that gillnets were deployed; average gillnet soak time was ~2-4 days (48-96 hrs). During sampling, each fisherman was asked to record data regarding the date and time of net deployment and retrieval, location (latitude and longitude), number of fish, total weight of catch and depth.

Data collection

Temperature, depth, and catch data (rough measure of CPUE = # fish caught/24 hour period) in numbers collected at each sampling location were examined separately. Relationships among these variables were explored graphically. Time-series plots of daily average bottom temperature and depth at sampling sites were constructed to examine general trends. Spikes in the data (jumps in temperature and depth reading) associated with the haul back of the fishing gear were removed prior to examining the data. Catch of monkfish was assumed to be a function of effort, catchability, and abundance, therefore proportional to abundance. Nets were assumed to fish at equal intensity throughout the entire soak period. Catchability was assumed constant throughout the sampling time frame. Monkfish total length measurements taken at selected sampling sites were examined graphically for patterns by plotting mean, minimum, and maximum values for each time- series. Relationships between monkfish catch and lunar cycle or moon phase information (obtained on-line: http://aa.usno.navy.mil/data/docs/MoonPhase.php) were also explored graphically to examine whether lunar cycle had an influence on catch rates.

4.**Results and Conclusions**

Of the five commercial gillnet vessels that utilized Days-at-Sea (DAS) during the project period, only the *F/V Wooley Bully* and *F/V Martha Porter* collected temperature and depth data (Table 1). Temperature and depth data, catch and fish size composition data were not collected from the *F/V Sweet Misery* and *F/V Rebecca Mary*. The *F/V Bout Time* utilized one fishing day during the project period and reported only fish size data (Table 1). Fishing for the *F/V Bout Time* occurred near Mudhole, NJ at depths ranging from 237-240 ft (Figure 1). Water temperature on that day averaged about 42°C. Monkfish collected by the *F/V Bout Time* ranged in size from 26.5-32 cm TL (mean = 28.7 cm TL). Catch rates (CPUE) were 6.7 and 10.7 for the two nets fished with probes (6 days soak time). The total landings for the *F/V Bout Time* was 1370 lbs (Table 2).

Gillnet Temperature and Catch Data –

The *F/V Wooley Bully* (Ocean City, MD) used 25.35 RSA DAS days from November 2013 to April 2015 (Table 2). Monkfish catch data as well as ocean bottom temperature and depth time series data were collected off Ocean City, MD by the *F/V Wooley Bully* (Figure 2) Depths fished by the *F/V Wooley Bully* ranged between 25 and 205 meters and temperature ranged from 5.3ºC to 14.7ºC (Figure 2). Monkfish catch rates (CPUE) obtained by the *FV Wooley Bully* consisted of twelve data points. CPUE peaked at a rate of 86 on May 25, 2014. The lowest rates (2.6 fish/day) were achieved in November 2013 and April 2015 (Figure 3). The *F/V Wooley Bully* fished in the fall/winter and spring. The Wooley Bully did not conduct fishing during the summer. Monkfish collected by the *F/V Wooley Bully* ranged in size from 40-98 cm TL (mean 66.5 cm). Water temperature ranged from 5.3 and 14.7°C during the fishing period. The peak in CPUE (86.33 fish/day) occurred relative to a new moon cycle (Figure 3). In general, catch rate declined leading up to and following a full moon. Generally, these data support previous observations from 2012 and 2013 of monkfish catch rates predominantly declining between new and full lunar phases. No discernible relationships were observed between catch (landings data) and lunar cycle

and temperature or depth (Figures 4 and 5).

Overall, monkfish average size (both length and weight) compositions remained stable during the time period (Figure 6 and 7, respectively). Moreover, mean and maximum fish length (total length, TL) remained constant (Figure 6). However, a sharp decline in fish length was observed on May 25, 2014 (TL= 10 cm; Figure 6). This data point was likely an outlier. The average size of captured monkfish ranged between 55.0 and 67.7 cm. The largest and smallest individual monkfish captured were 98 and 40 cm, respectively. Monkfish ranged in weight from 3.0 to 79 lbs. The smallest fish were collected in deep waters (205 meters; Figure 2) off Ocean City (Figures 6 and 7). Monkfish size compositions showed no discernible trend in relation to lunar phase (Figures 6 and 7).

The *F/V Martha Porter* utilized 10.64 RSA DAS between 2013 and 2014 (Table 2). Catch data and ocean temperature time series data was collected off the coast of Montauk, NY (Figure 1). Bottom temperature time series were recorded for spring and fall/winter for 2013 and 2014 (Figures 8 and 9). For both years, bottom temperature time series showed an increasing trend in the spring and the opposite during the fall. The *F/V Martha Porter* ceased fishing at the end of July. In spring 2013 and 2014, mean bottom temperature ranged between 5.1ºC and11.2ºC (Figures 8 and 9). While mean bottom temperature increased from April to July, temperature decreased over the fall/winter season in 2013 and 2014 with temperature ranging from 4.5-13.9 (Figures 8 and 9). Increased monkfish catch rates were observed in late June 2013 and late May 2014 corresponding with an increase in water temperatures and relatively close to a full moon cycle (Figure 11). In 2013, CPUE remained relatively low for the remainder of the year after peaking in late June but there were several small peaks in 2014 (Figure 11). Overall, temperature (Figure 8 and 9), landings (Figure 10), CPUE (Figure 11) and total length (Figure 12) showed little relation to lunar cycle. This finding suggests that lunar tables often referenced by monkfish anglers may lack predictive value for identifying peak fishing times. It is possible that other lunar phases should be considered as well as other environmental variables.

5.**Project Management:**

The major collaborators on this project were from UMES and the fishing industry.

1. **University of Maryland Eastern Shore**
   Monkfish catch data, temperature and depth information were processed and analyzed by Ms. Heather Wolfer and Drs. Gardner and Johnson. Dr. Gardner was responsible for the day-to-day management of the Monkfish RSA grant while Dr. Johnson was on loan to the National Science Foundation.
2. **Monkfish gillnetters**
   Data and sample collection by gillnetters occurred at two sites in the southern management area (SMA; Table 1; Figure 1). These industry collaborators were John Stolgitis (*F/V Martha Porter*) and Roger Wooleyhan (*F/V Wooly Bully*). Chris Hickman (*F/V Bout Time*), Todd Sutton (*F/V Sweet Misery*), and Noah Clark (*F/V Rebecca Mary*) did not provide any data during the funding period.

6. Financial Report

RESEARCH BUDGET				
GRANTEE:		Project Title:	Influence of temperature and lunar cycle on the distribution and catch rates of monkfish	
A. SALARIES AND WAGES				
	1. SENIOR PERSONNEL		**Total Time (Months)**	**Expenditures**
	a. Principal Investigator:	Andrea Johnson	9	$8,867
		William Gardner	9	0
	b. Graduate Student:	Heather Wolfer	6	$9,319
	c. Graduate Student:			
	c. Undergraduate Students (1):			
	Total Salaries and Wages			$18,186
B. PERMANENT EQUIPMENT				
C. EXPENDABLE SUPPLIES AND EQUIPMENT				$589
D. TRAVEL				$6,928
E. PUBLICATIONS AND DOCUMENTATION COSTS				$1,750
F. OTHER COSTS				
TOTAL DIRECT COSTS				$27,453

7. Evaluation

A. Describe the extent to which the project goals and objectives were attained. This description should address the following:

1. Were the goals and objectives attained? How? If not, why?
2. Were modifications made to the goals and objectives? If so, explain.

Objectives:

1. Investigate whether catch rate correlates with temperature and lunar cycle;
2. Determine whether the seasonal movement of reproductively active monkfish correlates with temperature and lunar cycle.

Objective 1: Results from this objective have been completed.
Objective 2: This objective has been modified and will be completed using monkfish

collected during the Northeast Fisheries Science Center's 2009 Cooperative Monkfish Survey. We have analyzed monkfish gonad samples collected in 2009 and are currently in the process of working on two manuscripts. Monkfish spawning locations and correlation with both temperature and lunar cycle will is planned for publication.

a. If significant problems developed which resulted in less than satisfactory or negative results, they should be discussed.

Overall significant problems did not develop during our reporting period. Actual expenditures went as scheduled and funds received from monkfish RSA industry collaborators covered all expenses. However during some time periods fishing by collaborators was slowed for various reasons (i.e. weather-related complications). Furthermore no fish size composition data was received from the F/V Sweet Misery and FV Rebecca Mary (Table 1) and the F/V Bout Time only fished one day. Fishing was not consistent for among fishermen and some data collected were incomplete. Lost fishing probes was also reported by some fishermen and this limited our environmental data collected and prevented us from providing probes to some fishermen, There were no probes available for the *F/V Rebecca Mary*, a new collaborator, for distribution during this period.

2. <u>Dissemination of project results:</u>
Explain, in detail, how the project's results have been, and will be disseminated.

A manuscript of the results of this study is being prepared and will be submitted for publication to the Journal of Fish Biology. This data will be combined with that obtained during the 2011 monkfish RSA project.

8.**References**

Armstrong, M. P., Musick, J. A., and Colvocoresses, J. A., (1992). Age, growth, and reproduction of the goosefish *Lophius americanus* (Pisces: Lophiiformes)*. *Fishery Bulletin 90*, 217 – 230.

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Perry, A.L., P.J. Low, J.R. Ellis, and J.D. Reynolds. 2005. Climate Change and Distribution Shifts of Marine Fishes. *Science.* 308: 1912-1915.

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Steimle, F.W., Morse, W. W., and Johnson, D. L., (1999). *Essential fish habitat source document: Goosefish, Lophius americanus, life history and habitat characteristics*. National Oceanic and Atmospheric Administration Technical Memorandum NMFS – NE – 127.

Stevens, M.M. 2004. Goosefish/Monkfish, *Lophius americanus*. *Seafood Watch Seafood Report.* http://www.montereybayaquarium.org.

Table 1. Data collection for monkfish RSA vessels, May 2013 – April 2015.

Vessel/Partner	***Port***	***Position***	***Dates***	***Data Collected***
FV Martha Porter John Stolgitis	Pt. Judith, RI	Lat: 40°56′41″N Lon: 71°45′16″W	5/3/13-7/22/13 5/6/14-7/21/14	Temperature Depth Catch Length composition
FV Wooley Bully Roger Wooleyhan	Ocean City, MD	Lat: 38°03′21″N Lon: 74°49′56″W	11/26/13-2/18/14 5/15/14-6/12/14 1/3/15-4/19/15	Temperature Depth Catch Length composition
FV Bout Time Chris Hickman	Pt. Pleasant, NJ	Lat: 40°13′00″N Lon: 73°43′00″W	2/8/14	No data collected
FV Sweet Misery Todd Sutton	Pt. Pleasant, NJ	Lat: 40°13′00″N Lon: 73°43′00″W	1/25/15- 3/13/15	No data collected
FV Rebecca Mary Noah Clark	Pt. Judith, RI	Lat: 40°56′41″N Lon: 71°45′16″W	11/7/14 11/27/14	No data collected

Table 2. Monkfish landings data collected from November 2013 through April 2015.

DAS	VTR #	F/V	Fishermen	Date Landed	Port Landed	Total Catch (lb)	Amt Sold ($)	Research Funds ($)
0.625	11284413	Bout Time	Chris Hickman	2/8/14	Pt. Pleasant, NJ	1370.1	$1,922.33	$288.35
0.625						**1370.1**	**$1,922.33**	**$288.35**
0.625	11284415	Martha Porter	John Stolgitis	11/2/13	Pt. Judith, RI	1494.7	No Data	No Data
0.625	11284416	Martha Porter	John Stolgitis	11/16/13	Pt. Judith, RI	1465.6	No Data	No Data
0.625	12385712	Martha Porter	John Stolgitis	4/21/14	Pt. Judith, RI	50	$1,131.80	$170.00
0.625	12385713	Martha Porter	John Stolgitis	4/25/14	Pt. Judith, RI	210		
0.625	12385720	Martha Porter	John Stolgitis	5/18/14	Pt. Judith, RI	1239.2	$2,819.00	$422.00
0.625	12385722	Martha Porter	John Stolgitis	5/21/14	Pt. Judith, RI	1704.6	$3,590.00	$538.00
0.625	12385724	Martha Porter	John Stolgitis	5/25/14	Pt. Judith, RI	2704.7	$4,373.50	$660.00
0.625	12385726	Martha Porter	John Stolgitis	5/30/14	Pt. Judith, RI	3352.3	$5,249.58	$788.00
0.625	12385728	Martha Porter	John Stolgitis	6/3/14	Pt. Judith, RI	2495.2	$4,013.93	$602.00
0.625	1235730	Martha Porter	John Stolgitis	6/7/14	Pt. Judith, RI	4536.7	$6,344.10	$951.00
0.625	12385731	Martha Porter	John Stolgitis	6/9/14	Pt. Judith, RI	3133	$4,499.75	$674.00
1	12385734	Martha Porter	John Stolgitis	6/17/14	Pt. Judith, RI	924.6	$1,544.66	$230.00
0.625	12385735	Martha Porter	John Stolgitis	6/20/14	Pt. Judith, RI	672.8	$1,511.55	$225.00
0.625	12385740	Martha Porter	John Stolgitis	6/28/14	Pt. Judith, RI	1233.3	$2,131.73	$310.00
1.05	12385742	Martha Porter	John Stolgitis	7/3/14	Pt. Judith, RI	1116	$2,097.30	$315.00
0.46	1225211	Martha Porter	John Stolgitis	10/31/14	Pt. Judith, RI	382.91		$150.00
10.635						**26715.61**	**39306.9**	**6035**
1.22	12045297	Wooley Bully	Roger Wooleyhan	11/26/13	Ocean City, MD	737.17	$1,128.75	$169.20
1.25	12360902	Wooley Bully	Roger Wooleyhan	12/10/13	Ocean City, MD	2690.74	$4,500.85	$675.12
1.32	12360905	Wooley Bully	Roger Wooleyhan	12/14/13	Ocean City, MD	2059.1	$3,446.95	$517.04
1.38	12360915	Wooley Bully	Roger Wooleyhan	12/29/13	Ocean City, MD	6207.6	$8,525.35	$1,278.86
1.35	12360917	Wooley Bully	Roger Wooleyhan	1/2/14	Ocean City, MD	6010	$10,169.30	$1,525.39
1.24	12360919	Wooley Bully	Roger Wooleyhan	1/18/14	Ocean City, MD	7351.6	$10,528.95	$1,579.34
1.67	12360918	Wooley Bully	Roger Wooleyhan	2/1/14	Ocean City, MD	1325.6	$1,858.20	$278.73
1.3	12360923	Wooley Bully	Roger Wooleyhan	2/8/14	Ocean City, MD	4324.4	$5,574.90	$504.83
0.92	12360924	Wooley Bully	Roger Wooleyhan	2/9/14	Ocean City, MD	712	$953.00	$142.95
0.99	12360925	Wooley Bully	Roger Wooleyhan	2/18/14	Ocean City, MD	1247.1	$1,700.60	$255.09
1.12	12360939	Wooley Bully	Roger Wooleyhan	5/15/14	Ocean City, MD	6951.8	$7,731.55	$1,159.73
1.08	12360944	Wooley Bully	Roger Wooleyhan	5/25/14	Ocean City, MD	6677.7	$6,559.40	$983.91
2.32	12360946	Wooley Bully	Roger Wooleyhan	5/29/14	Ocean City, MD	3679.3	$3,711.10	$556.67
1.09	12360949	Wooley Bully	Roger Wooleyhan	6/12/14	Ocean City, MD	4101.5	$4,726.30	$708.94
1.37	12417253	Wooley Bully	Roger Wooleyhan	1/3/15	Ocean City, MD	1425.9	$6,619.10	$962.86
1.05	12417272	Wooley Bully	Roger Wooleyhan	3/25/15	Ocean City, MD	299.73	$345.00	$51.79
0.625	12417274	Wooley Bully	Roger Wooleyhan	3/29/15	Ocean City, MD	742.05	$0.00	$0.00
1.42	12417268	Wooley Bully	Roger Wooleyhan	4/2/15	Ocean City, MD	331.74	$1,938.00	$290.00
0.81	12417271	Wooley Bully	Roger Wooleyhan	4/8/15	Ocean City, MD	419.04	$2,298.60	$344.79
0.85	12417277	Wooley Bully	Roger Wooleyhan	4/13/15	Ocean City, MD	1237.72	$1,860.00	$279.03
0.97	12417279	Wooley Bully	Roger Wooleyhan	4/19/15	Ocean City, MD	663.48	$2,944.30	$441.60
25.345						**59195.27**	**$87,120.20**	**$12,705.87**

6		Rebecca Mary	Noah Clark	11/13/14	Pt. Judith, RI	19206	No Data	
4	12385778	Rebecca Mary	Noah Clark	12/1/14	Pt. Judith, RI	9815.43	No Data	$6,000
10						**29021.43**		**$6000**
0.88		Sweet Misery	Todd Sutton	1/26/15	Newport, RI	8859.35	No Data	No Data
0.81		Sweet Misery	Todd Sutton	1/29/15	Newport, RI	525	No Data	No Data
0.82		Sweet Misery	Todd Sutton	2/7/15	Newport, RI	1845.9	No Data	No Data
0.91		Sweet Misery	Todd Sutton	2/12/15	Newport, RI	1648	No Data	No Data
0.69		Sweet Misery	Todd Sutton	2/24/15	Newport, RI	792	No Data	No Data
0.83		Sweet Misery	Todd Sutton	3/1/15	Newport, RI	3933.8	No Data	No Data
0.83		Sweet Misery	Todd Sutton	3/9/15	Newport, RI	4800.99	No Data	No Data
1.01		Sweet Misery	Todd Sutton	3/14/15	Newport, RI	8216.28	No Data	$8,934.20
6.78						**30621.32**	**No Data**	**$8,934.20**
53.385						**146923.73**	**$128,349.43**	**$27,963.42**

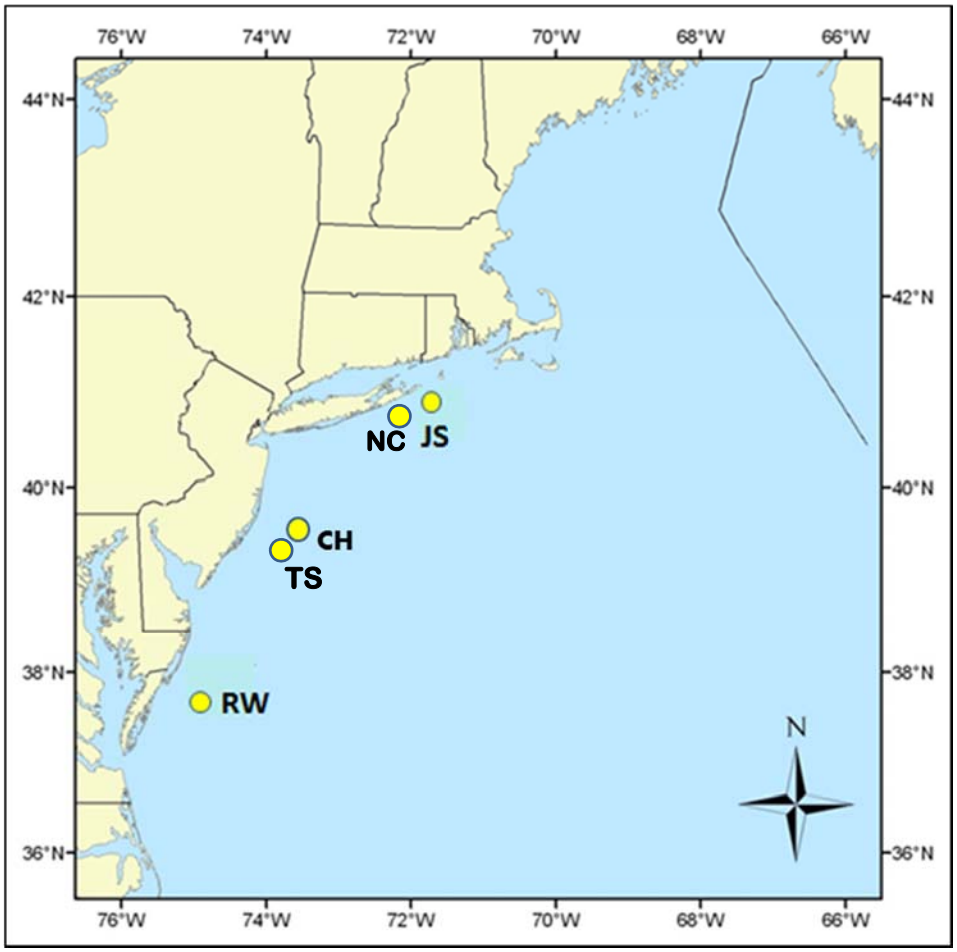


Figure 1. Sampling locations of participating monkfish gillnetters from November 2013 to April 2015 (JS = John Stolgitis, *FV Martha Porter;* NC = Noah Clark, *FV Rebecca Mary*; CH = Chris Hickman, *FV Bout Time; TS*= Todd Sutton, *FV Sweet Misery;* RW = Roger Wooleyhan, *FV Wooley Bully)*

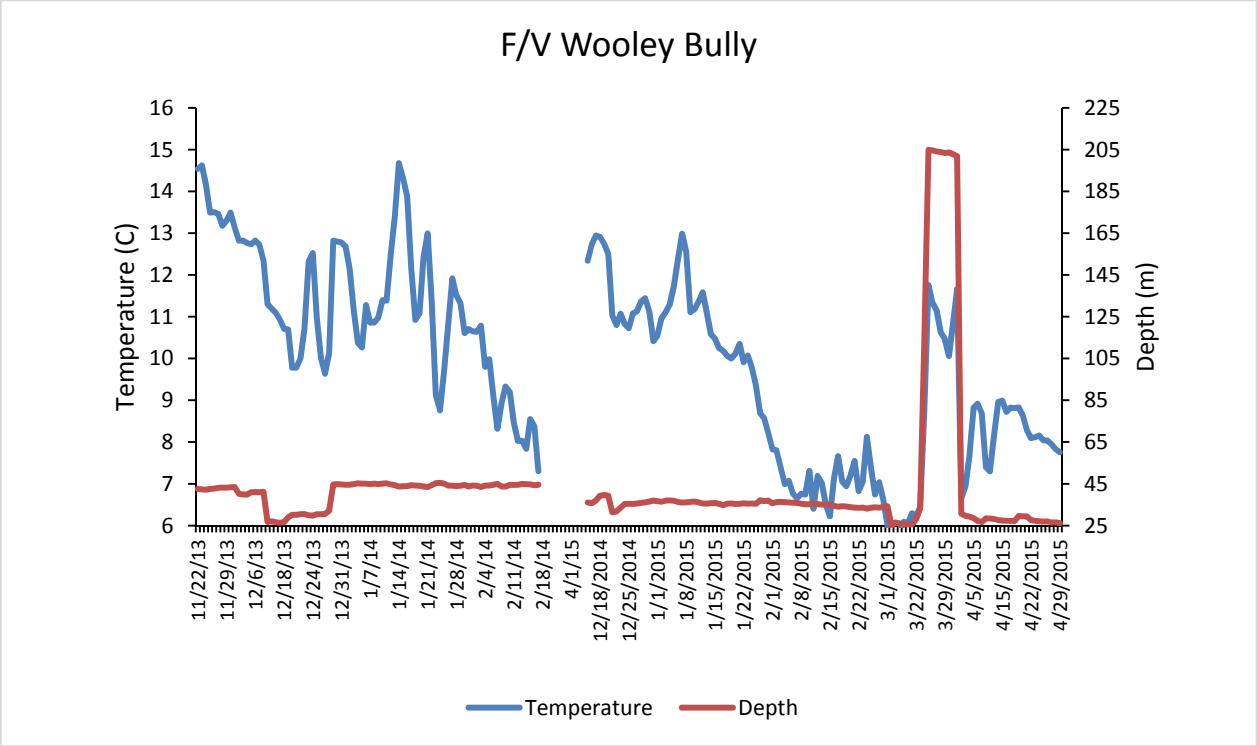


Figure 2. Bottom temperature (ºC) and depth (m) time-series collected from November, 2013 to April, 2015 off Ocean City, MD.

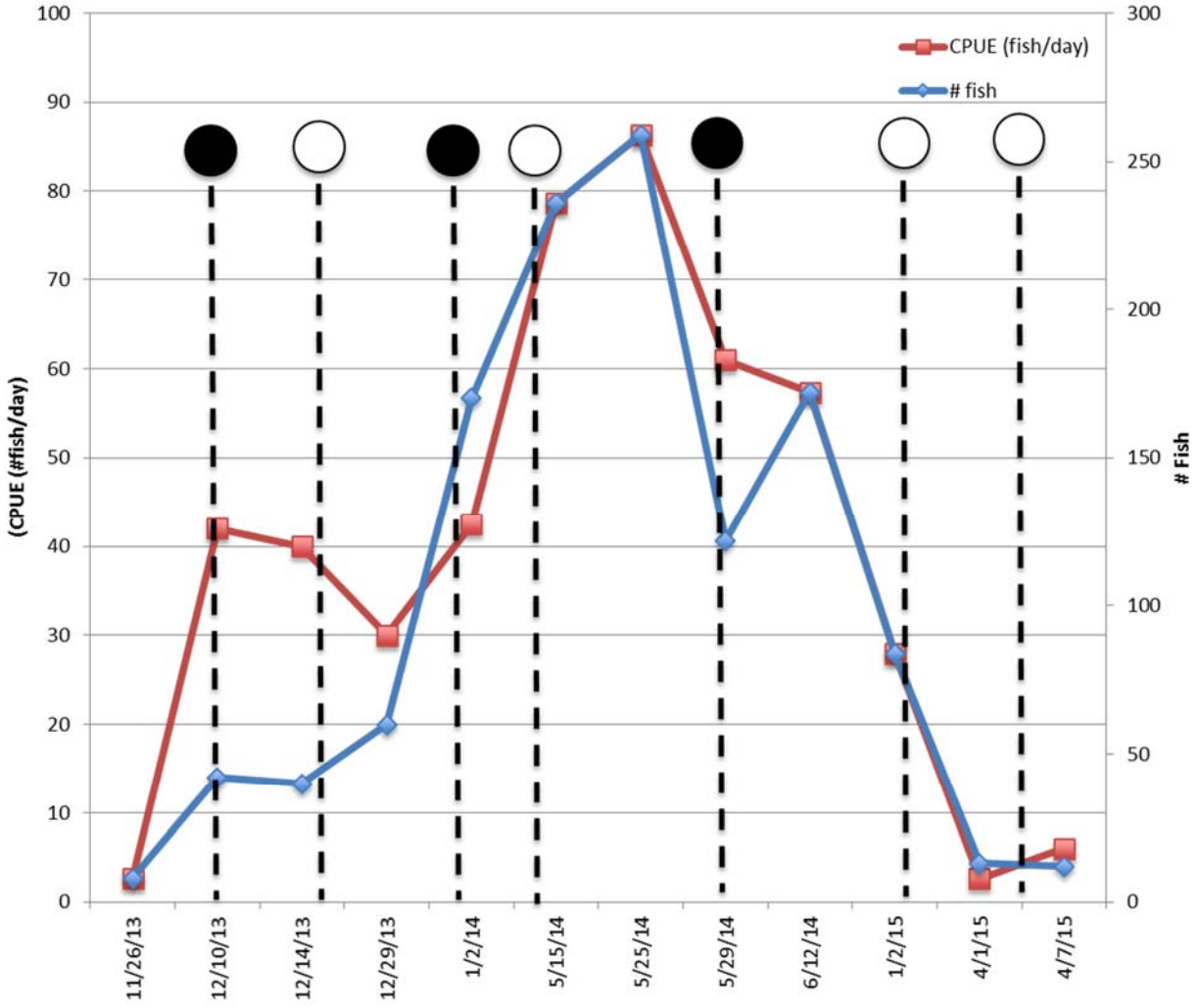


Figure 3. Catch rates (CPUE) for monkfish collected off the coast of Ocean City, MD from November, 2013 to April 2015 and corresponding lunar phases. Full (○) and new (●) lunar phases present during each month are displayed.

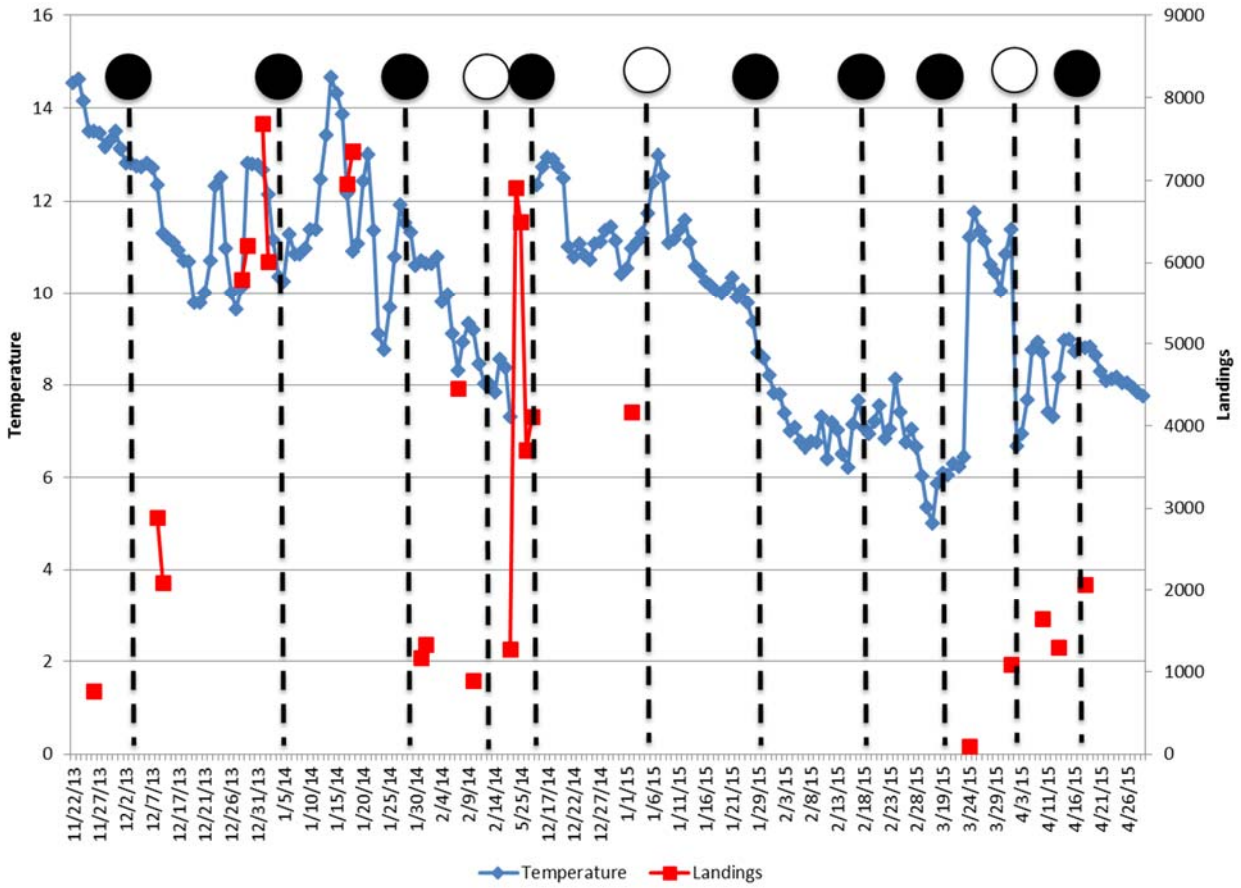


Figure 4. Comparison of temperature with monkfish landings sampled from November, 2013 to April, 2015 off the coast of Ocean City, MD and corresponding lunar phases. Full (○) and new (●) lunar phases present during each month are displayed.

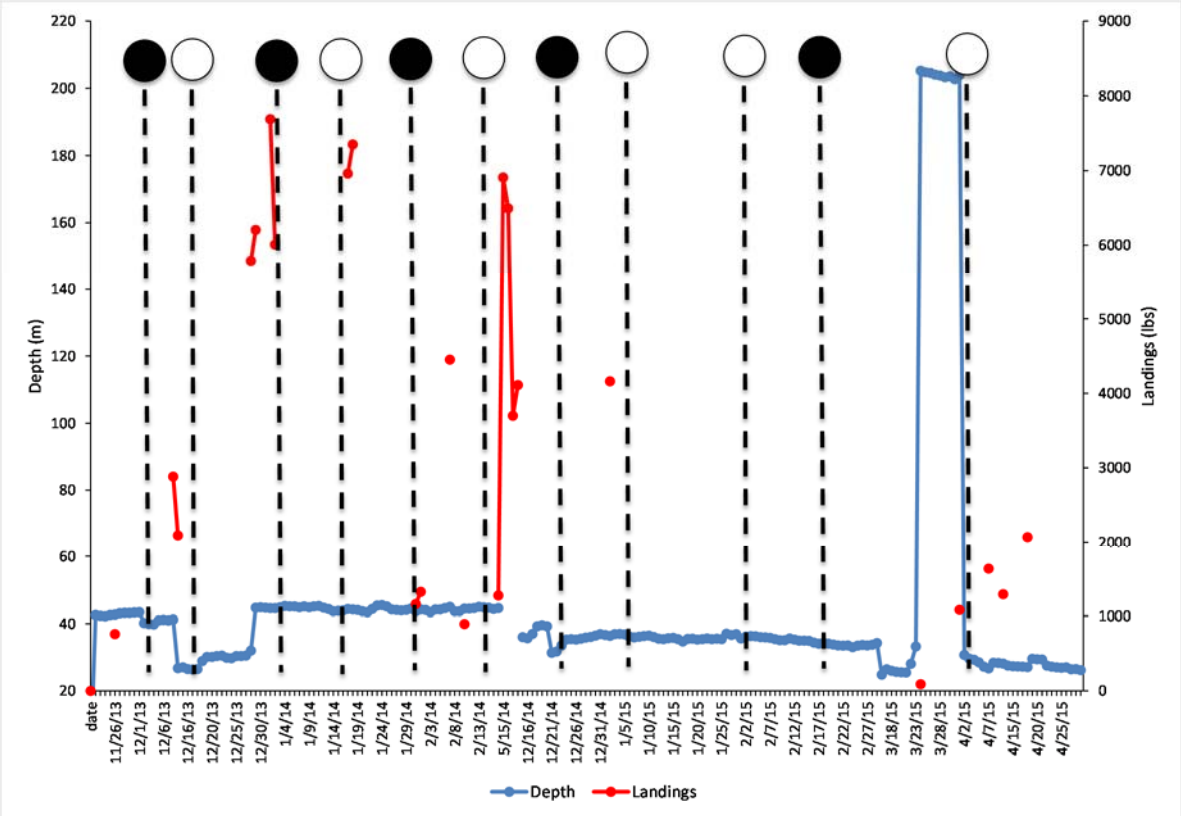


Figure 5. Comparison of depth with monkfish landings sampled from November, 2013 to April, 2015 off the coast of Ocean City, MD and corresponding lunar phases. Full (○) and new (●) lunar phases present during each month are displayed.

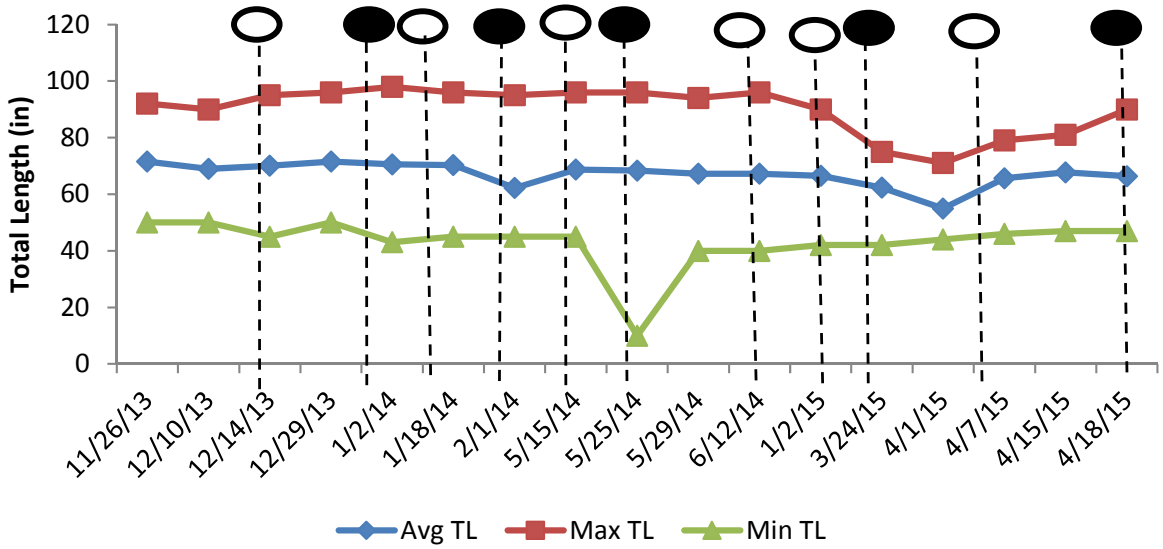


Figure 6. Size composition (TL, cm) of monkfish collected off the coast of Ocean City, MD from March 2013 to April 2015 and corresponding lunar phases. Full (○) and new (●) lunar phases present during each month are displayed.

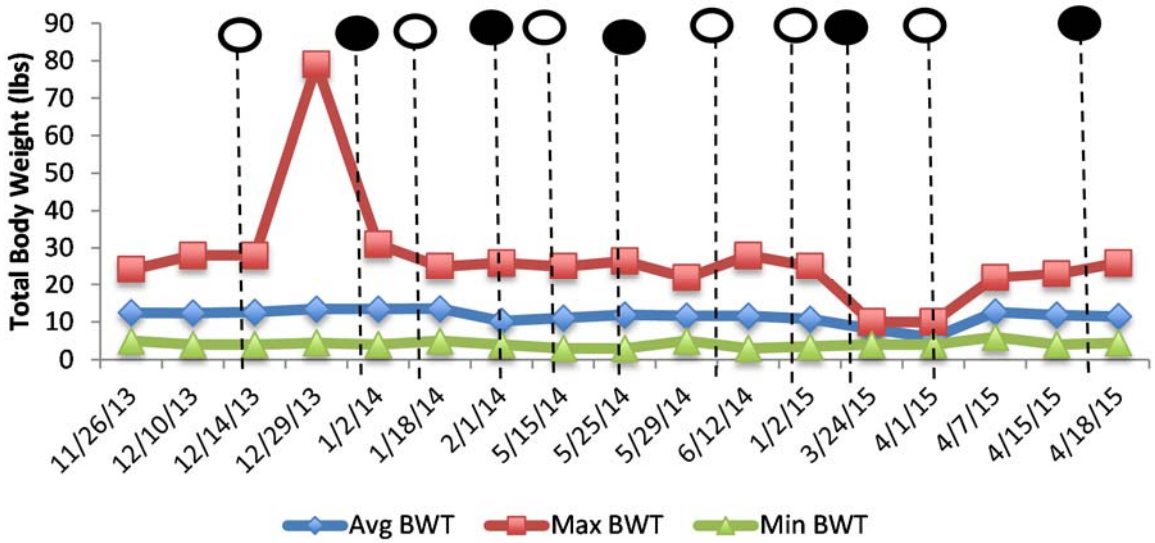


Figure 7. Mean, minimum and maximum weight (lbs) for monkfish collected off the coast of Ocean City, MD from March 2013 to April 2015 and corresponding lunar phases. Full (○) and new (●) lunar phases present during each month are displayed.

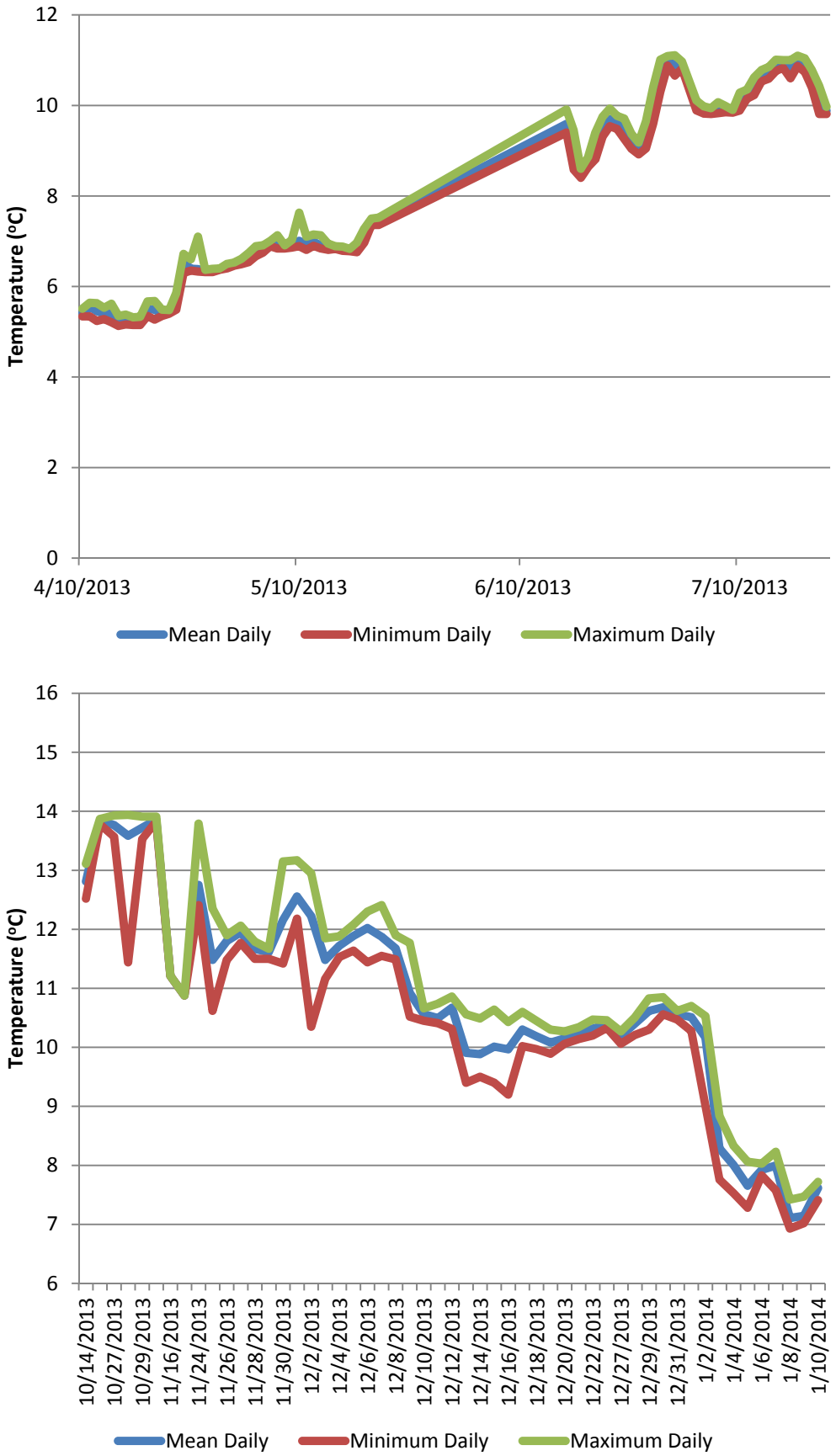


Figure 8. Maximum, mean and minimum daily bottom temperatures (ºC) recorded from April-July, 2013 and October 2013-January 2014 off the coast of Point Judith, RI.

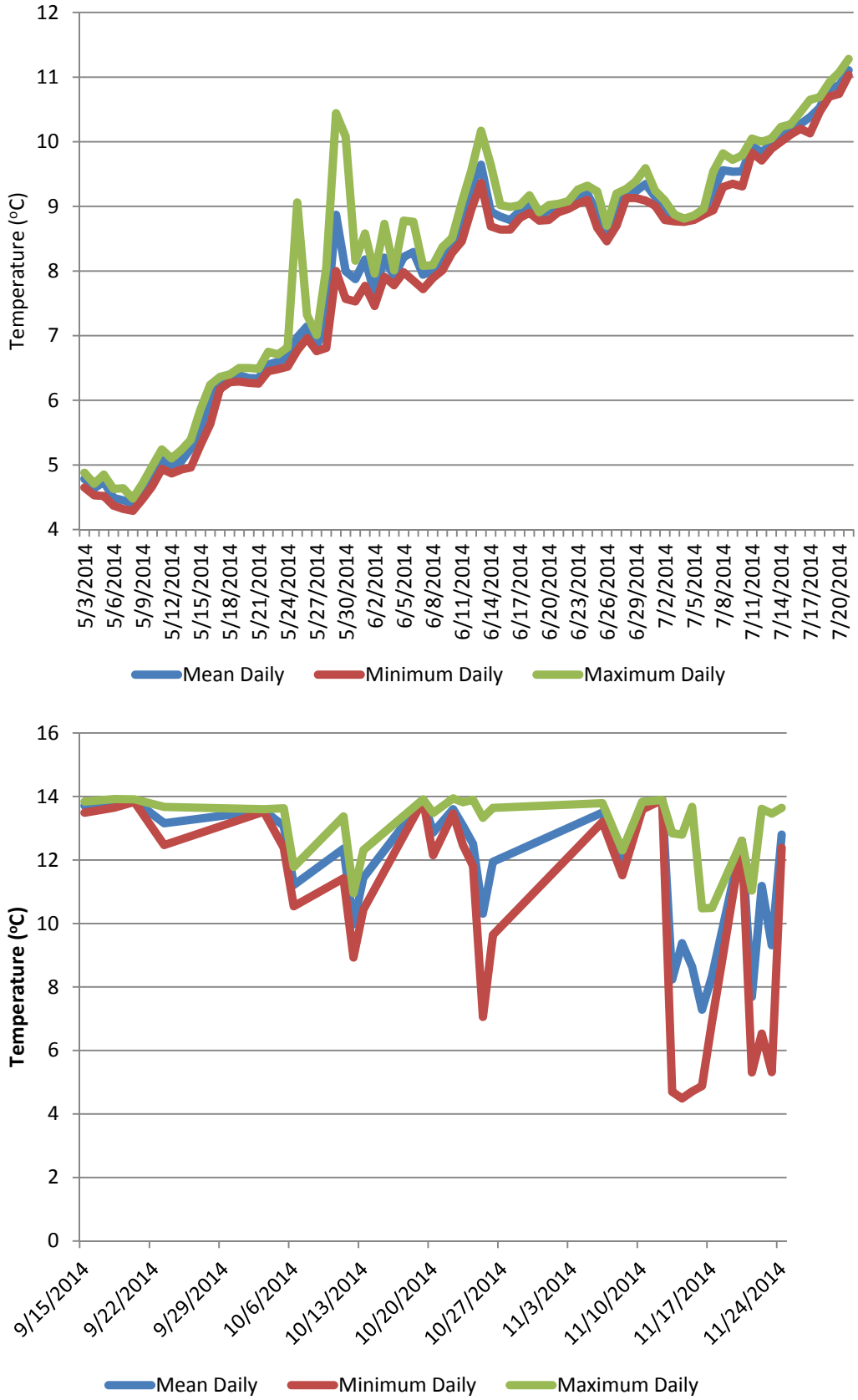


Figure 9. Maximum, mean and minimum daily bottom temperatures (ºC) recorded from May-July, 2014 and September-November 2014 off the coast of Point Judith, RI.

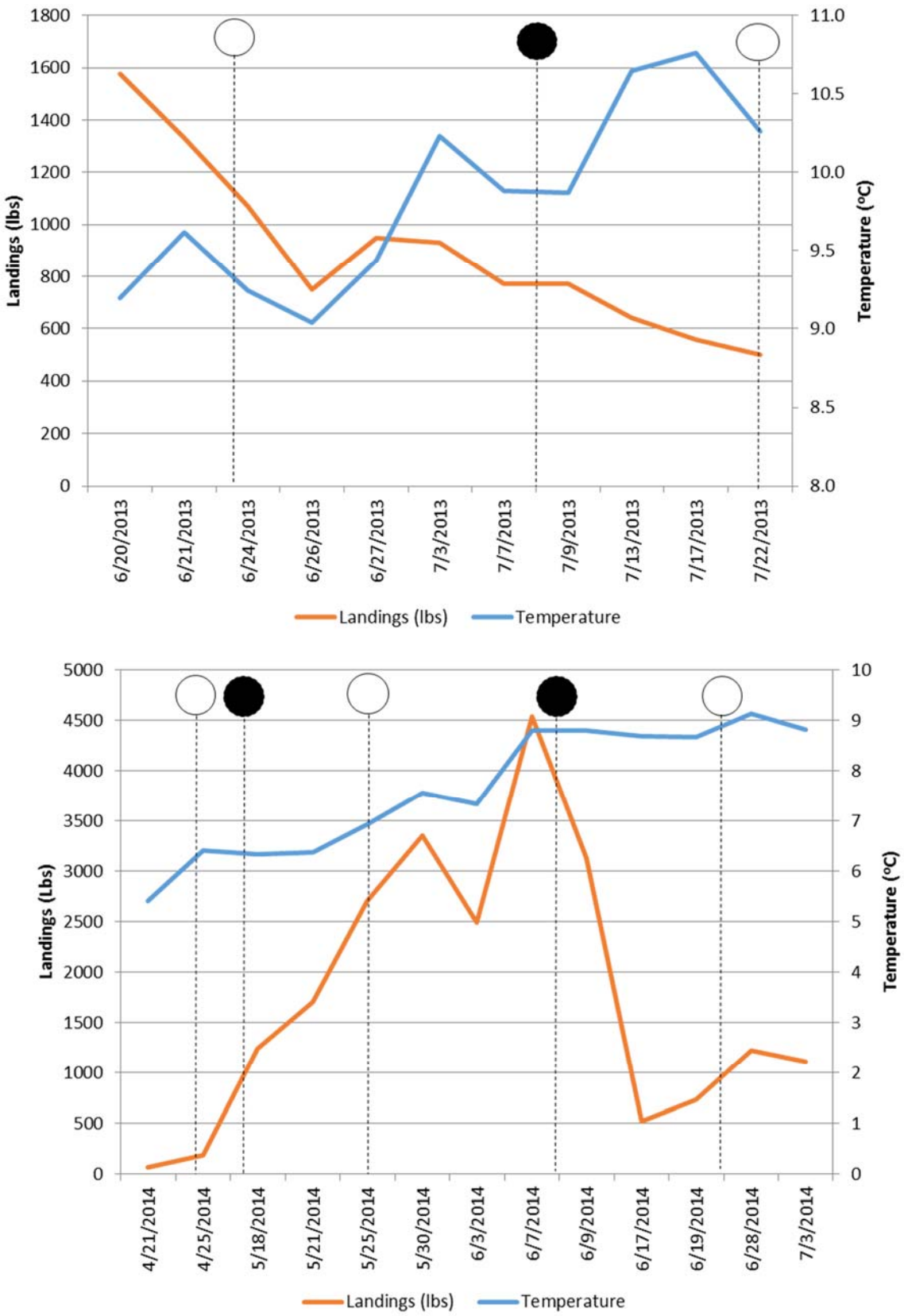
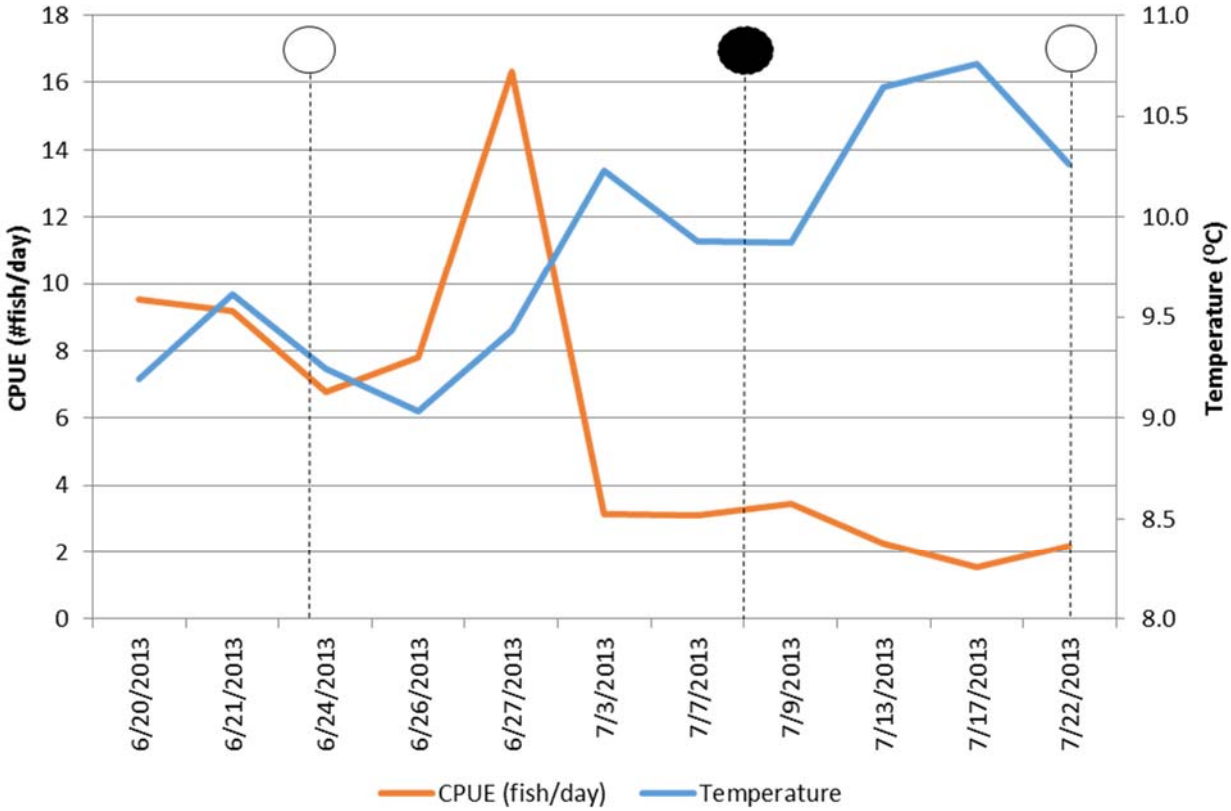


Figure 10. Comparison of temperature with monkfish landings from June-July, 2013 and April-July, 2014 off the coast of Point Judith, RI and corresponding lunar phases. Full (○) and new (●) lunar phases present during each month are displayed.



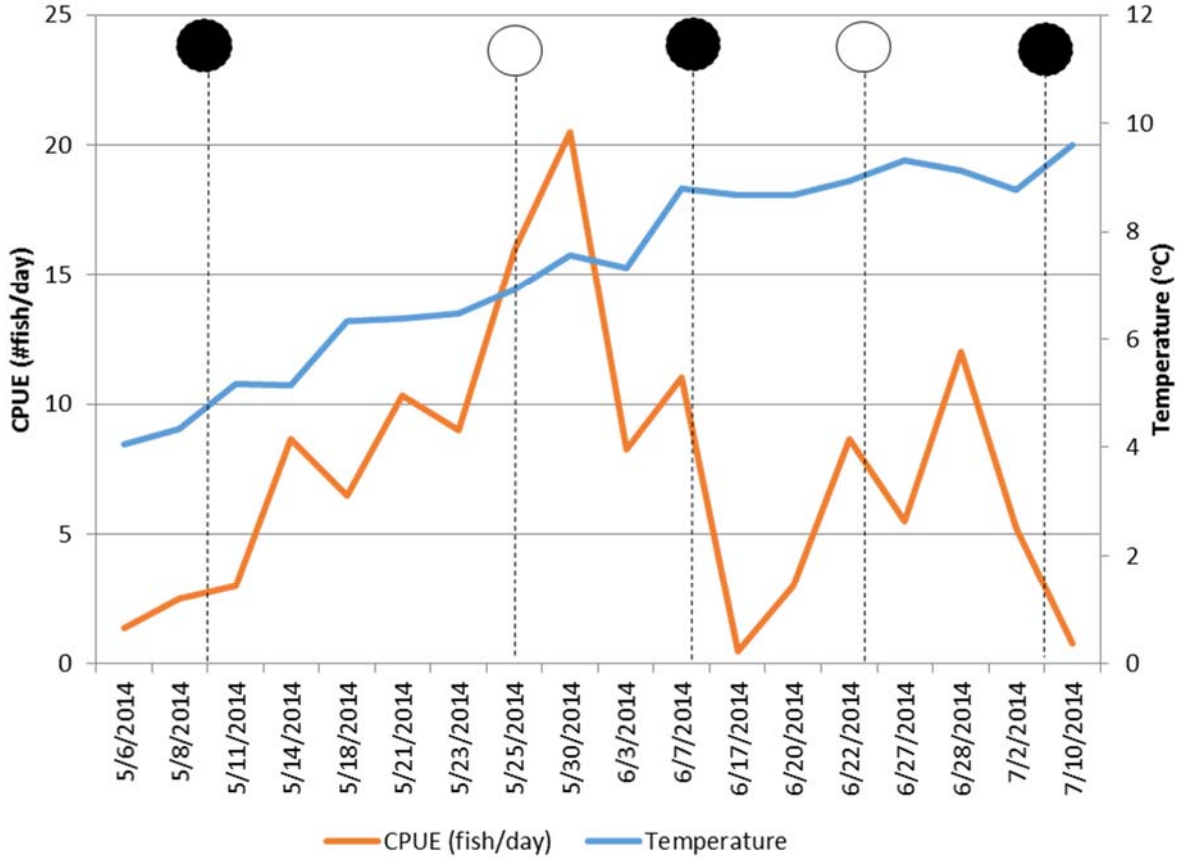


Figure 11. Catch rates (CPUE) for monkfish collected off the coast of Point Judith, RI from June-July 2013 and May-July 2014 and corresponding lunar phases. Full (○) and new (●) lunar phases present during each month are displayed.

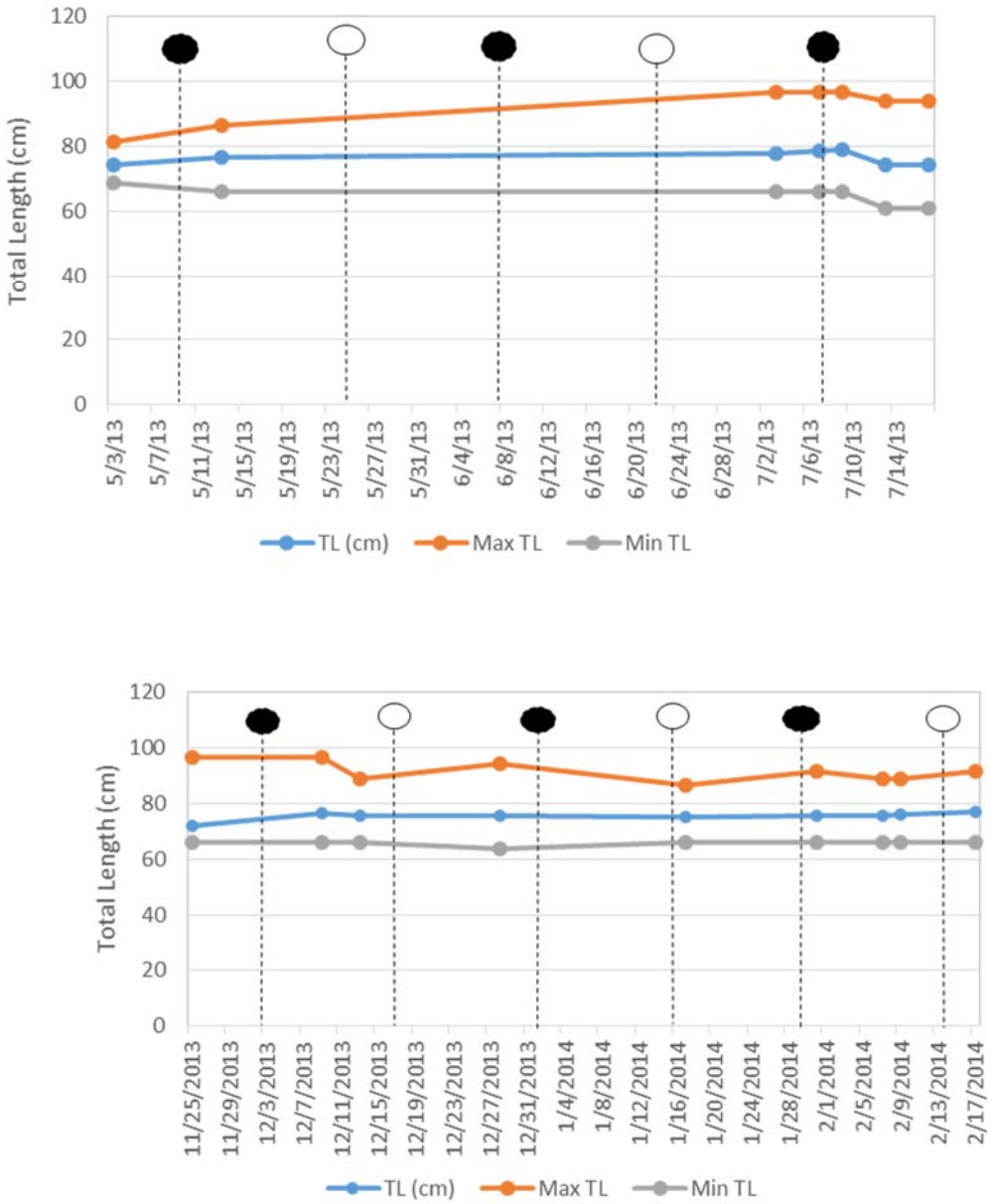


Figure 12. Mean, maximum, and minimum total lengths (TL, cm) for monkfish samples from May- July 2013 and November 2013-February 2014 off the coast of Judith Point, RI and corresponding lunar phases. Full (○) and new (●) lunar phases present during each month are displayed.