Describe if Commercial Low-Frequency Electrofishing Affects the Catch of Blue Catfish Hoop-Net Fishery

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Introduction

The blue catfish *Ictalurus furcatus* was first introduced to Virginia tidal waters in the 1974 and currently inhabit all major Virginia tributaries of the Chesapeake Bay (Jenkins and Burkhead 1994, Schloesser et al. 2011). More recently blue catfish have spread to Maryland waters and are multiplying at an alarming rate. The James River tributary has the largest number of blue catfish (Schloesser et al. 2011) in Virginia. The amount of blue catfish inhabiting the James River in unknown but is likely to be over five million (Fabrizio et al. 2009, Greenlee 2011) and blue catfish are estimated to be over 75% of the freshwater-tidal biomass (Schloesser et al. 2011). While supporting a trophy hook-and-line fishery (Greenlee 2011), management and conservation groups are concerned about the high number of blue catfish in the James River and Chesapeake Bay (Fabrizio et al. 2011, Schlosser et al. 2011). There is commercial interest for blue catfish harvest, and a management plan considered by Fabrizio et al. (2011) was to create a commercial fishery targeting “small (less than 32” total length) blue catfish”.

Because it’s invasive and extremely high abundance blue catfish are a prime candidate for commercial harvest and markets are developing for fish of all sizes. Virginia harvests the majority of its finfish using anchored gillnets (AGN) which have unintended interactions with protected species that inhabit Virginia waters, i.e. Atlantic sturgeon *Acipenser oxyrinchus*, blueback herring *Alosa aestivalis*, Alewife *A. pseudoharengus*, and American shad *A. sapidissima* (Jenkins and Burkhead 1994, Trice and Balazik unpublished data). Blue catfish are laborious to remove from gillnets and are destructive to gear which increases cost to replace nets and adds waste. Hoop-nets are traditional used to catch blue catfish in Virginia Rivers. Studies have shown that a certain form of electrofishing (low-frequency) is very effective in Ictalurid catfish species (Corcoran 1979, Justus 1994, Schlosser et al. 2011) when chase boats are used (Daugherty and Sutton 1995, Bodine et al. 2013). Low-frequency electrofishing is not lethal to Ictalurids and does not affect protected species in Virginia waters.

During 2014 and 2015 Fishery Resource Grant supported work, commercial low-frequency electrofishing (LFE) pilot studies resulted in the catch of almost half a million pounds of invasive catfish (Trice and Balazik 2014, 2015). While most (>95%) of the catch during the pilots studies consisted of blue catfish the invasive flathead catfish *Pylodictis olivaris* was also harvested. No species other than catfish appeared to be effected by the equipment. Several white catfish (*Ameiurus catus*) were observed but were purposely not captured. The commercial LFE likely lowered invasive blue and flathead catfish populations which help relieve resource pressure for native species. Removal of invasive catfish also helps reduce predation of native species. Several species of commercial concern (American eel *Anguilla rostrata*, striped bass *Morone saxatilis*, white perch *M. Americana*, blue crab *Callinectes sapidus*) have been documented in blue catfish stomachs along with several species of concern (American eel, blueback herring, Alewife *A. pseudoharengus*) (Balazik, unpublished data).

It is blatantly obvious that invasive catfish are negatively impacting the Chesapeake Bay watershed. The LFE commercial fishery was developed to reduce the abundance of invasive catfish in Virginia waters while keeping bycatch to a minimum. While LFE appears to be very effective in removing invasive catfish there is concern the new fishing technique may hinder the catch-per-unit-effort (CPUE) of the traditional hoop-net fishery. Because the goal of the LFE was developed to be additive to traditional catfish harvest work needs to be done to see if hoop-net catch is hindered by LFE and if so how can the two fisheries work together to be more efficient.

Method

This study was performed on the Pamunkey River from June 9-August 17, 2016 along a continuous stretch of river starting at Williams Landing and extending downstream. Testing was performed by setting and fishing six baited commercial hoop-nets (3' hoops, 2 ½" stretched mesh) set ~1/4-1/2 mile apart and fished 3 times per week. Nets were baited with menhaden at 25lbs/net. Net set locations were determined by commercial hoop-net fisher collaborating in this study, marked by GPS coordinates, and shared between project partners. Three of the 6 nets were exposed to Low Frequency Electrofishing (LFE) directly above and around the nets (~6000 m^2 area)prior to fishing net, and represented a treatment net. The other 3 nets were not subjected to LFE and fished under normal commercial procedures, and represented the control net. In an alternating method, subsequent nets were designated as treatment then control through the 6 net set, providing 3 control and 3 treatment nets fished for comparison of catch. The sequence determining which nets would be shocked was determined after all nets were set. This sequence was replicated each time (day) fishing occurred. By alternating the control with the treatment nets along the river potential bias as to varying fish densities within the river was thought to be minimized. Soak periods for this study ranged from 2-3 days, with fishing activity excluded during weekends when recreational fishing activity was highest. A Monday, Wednesday, Friday fishing activity period was performed. Nets in this study were not fished outside this study.

An observer was on-board during all fishing activity within this study when comparison testing was performed. Upon emptying nets, the total weight of fish per net was estimated, with fish from each net kept separate within coded fish totes through weigh out at processing facility. Weight by size categories from each net and e-fishing was obtained from fish processor collaborating in this study. It was originally proposed to duplicate this study in the James River upon completion in the Pamunkey River, however, it was decided by both collaborating commercial fishers to stay in the Pamunkey and duplicate the study further downstream. The first study period was from June 9-July20, 2016, and the second study went from July 22-August 17, 2016 (Figure 1). Nets were fished within varying river habitats. In the first study, hoop net 1a was set in deeper water (5.5m) near structure where typical e-fishing would occur, net 2a was set in a strait part of the river (4.5m), net 3a was set on a flat (3.3m), net 4a was set in a turn in deep water (8.5m), net 5a was set on an edge with structure (4.0m), and net 6a was set in the middle and deeper (4.9m) part of the river. In the second study, net 1b was set in a deep (8.5m) river bend, net 2b was set on a river bend near a drop-off (7.9m), net 3b was set on a channel edge (5.5m), net 4b was set in a deep hole (9.7m) near a curve, net 5b was set on a flat (5.5m), and net 6b was set in a deep (9.1m) channel.

It was important that commercial fishers collaborating in this study were not negatively impacted by loss of revenue. Compensation to commercial hoop-net fisher for potential loss of catch due to study design was provided at $80/net fished plus the catch from net.

Table 1. Total catch (lbs) of catfish by hoop-nets (1-6) and e-fishing over hoop-nets1,3,5. (Electroshock unit not operative June13-July 8, 2016).

	Net 1	Net 2	Net 3	Net 4	Net 5	Net 6	Shock Net 1	Shock Net 3	Shock Net 5
9-Jun	348	103	495	18	168	74	90	0	6
6/13/2016	300	80	200	80	130	125	0	0	0
6/15/2016	300	40	120	300	300	200	0	0	0
6/20/2016	300	130	375	250	200	180	0	0	0
6/22/2016	100	30	120	175	175	100	0	0	0
6/24/2016	200	100	110	300	140	210	0	0	0
6/27/2016	210	120	170	200	180	150	0	0	0
6/29/2016	40	80	50	80	120	15	0	0	0
7/1/2016	98	148	92	182	128	221	15	0	0
7/4/2016	200	110	100	220	150	120	0	0	0
7/6/2016	134	41	95	183	66	57	0	0	0
7/8/2016	74	81	84	179	63	67	0	0	0
7/11/2016	61	42	51	141	65	178	13	2	10
7/13/2016	77	39	43	135	171	82	4	8	60
7/15/2016	91	34	35	43	50	40	8	0	42
7/18/2016	114	92	117	149	197	39	10	0	14
7/20/2016	58	8	14	120	85	65	4	2	2
7/22/2016	85	5	36	65	52	5	10	2	39
7/25/2016	415	27	54	564	148	342	80	61	6
7/27/2016	*0	175	309	289	284	275	61	45	0
7/29/2016	153	201	200	120	159	184	95	24	5
8/1/2016	63	87	121	109	172	191	**0	17	2
8/3/2016	64	91	61	159	172	228	32	8	13
8/5/2016	207	50	125	242	77	293	10	8	0
8/8/2016	223	96	88	190	57	162	23	16	5
8/10/2016	167	197	162	125	56	147	40	20	0
8/12/2016	***76	97	143	200	86	174	47	5	0
8/15/2016	98	92	96	220	98	130	30	8	0
8/17/2016	92	81	123	62	116	97	0	0	0

*6 inch hole in net, fish escaped

**Did not shock due to recreational fishermen on site

***Collapsed net, did not fish correctly

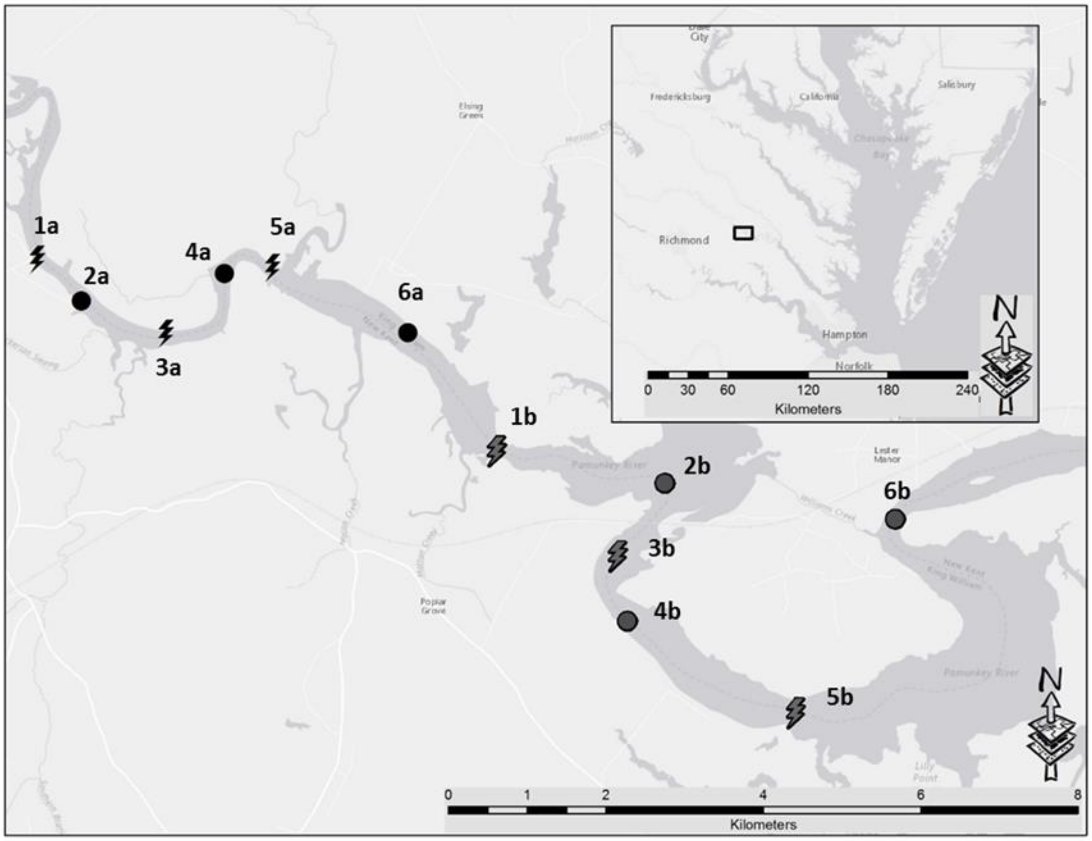


Figure 1. Location of hoop-nets fished in the Pamunkey River over the course of the study. Nets 1a-6a fished June 9-July 20, 2016. Nets 1b-6b fished July 22-August 17, 2016. Nets with lightning bolts are those which were electroshocked over.

<u>Data evaluation</u>

A total of 24,732 lbs. of catfish were caught in this study; 23, 730 by hoop-net, 1002 by e-fishing. In the first study period (June 9-July 20 when LFE unit was not working for most of sampling) a total of 13,610 lbs. of catfish were caught; 13,320 lbs. by hoop-net, 290 lbs. by LFE (Table 1). In the second study period (July 22-August 20, 2016) when LFE gear was working properly, a total of 11,122 lbs. were caught; 10,410 lbs. by hoop-net, 710 lbs. by LFE. Fish caught by both gear types during the second study period were categorized by size (Table 2).

Table 2. Total catch by size from Hoop-nets (1b-6b) and from e-fishing over nets 1b, 3b, 5b from 7-22 through 8-17-2016. (During period of time electroshocking unit was working)

	<1 LB	1-2 LBS	2-3 LBS	3-8 LBS	8-20 LBS	>20 LBS
Net 1b	236	283	381	615	103	0
Net 2b	407	213	179	266	48	82
Net 3b	144	219	326	569	180	0
Net 4b	313	482	486	952	108	0
Net 5b	175	192	263	580	233	24
Net 6b	660	382	308	550	158	24
Shock Net 1b	85	150	93	88	12	0
Shock Net 3b	67	81	23	28	15	0
Shock Net 5b	34	17	9	10	0	0

During the first study period when nets were fished without associated LFE, catch from all hoop-nets declined over time (Figure 2) with little to no significant declines between nets even when LFE was conducted over half of the nets beginning July 11, 2016. A similar pattern was observed during the second study period when LFE was conducted throughout the study (Figure 3). After the initial removal of resident fish by both gear types, fish recruited into those habitats were observed to be removed upon subsequent fishing at decreasing, but similar levels between gear types. Catch was low in all nets when the direct comparison study began on July 22, though having a 2-day soak (set on July 20) and which no shocking was performed at these sites until July 22. Habitat type did not seem to affect catch relative to shocking (Figure 4).

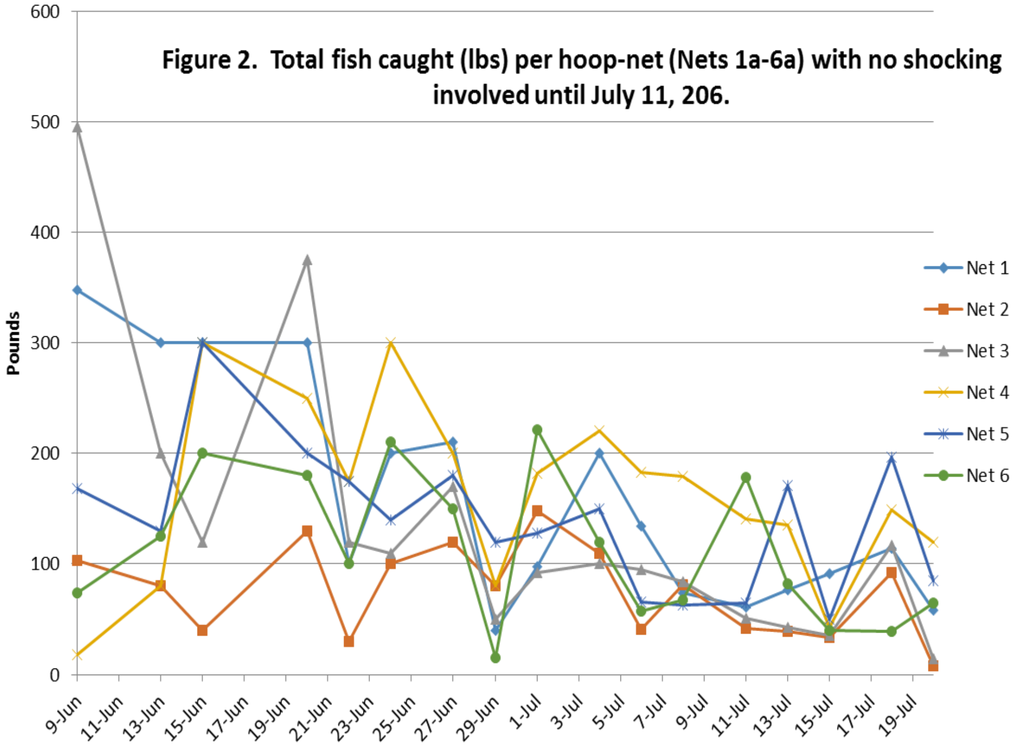


Figure 2. Total fish caught (lbs) per hoop-net (Nets 1a-6a) with no shocking involved until July 11, 206.

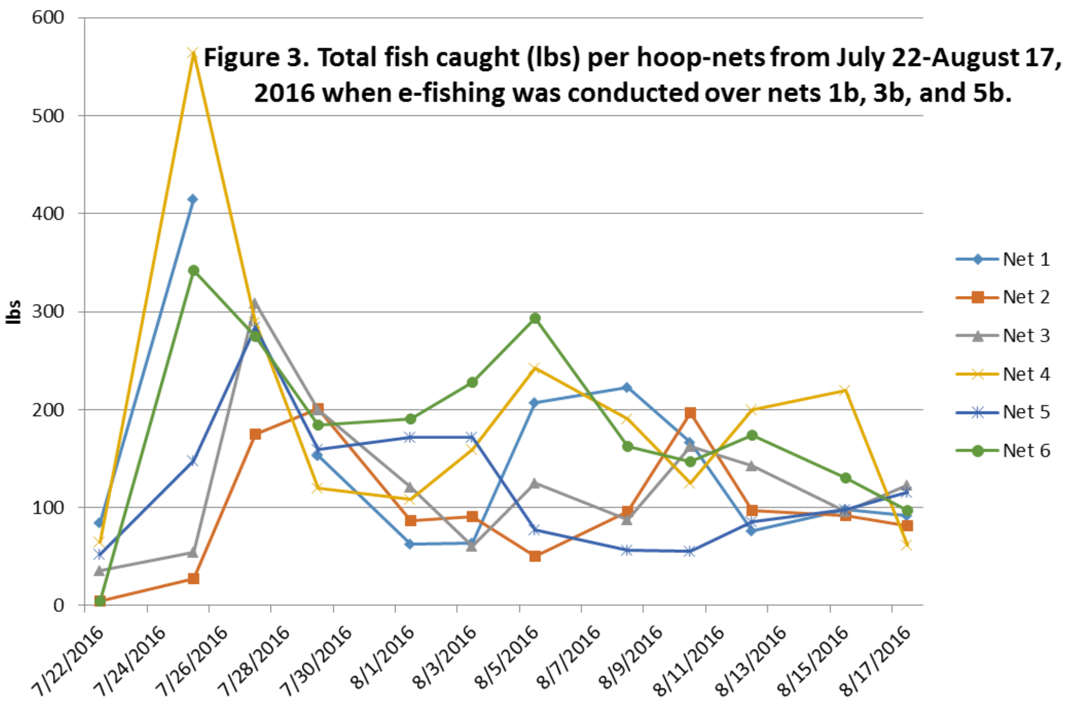
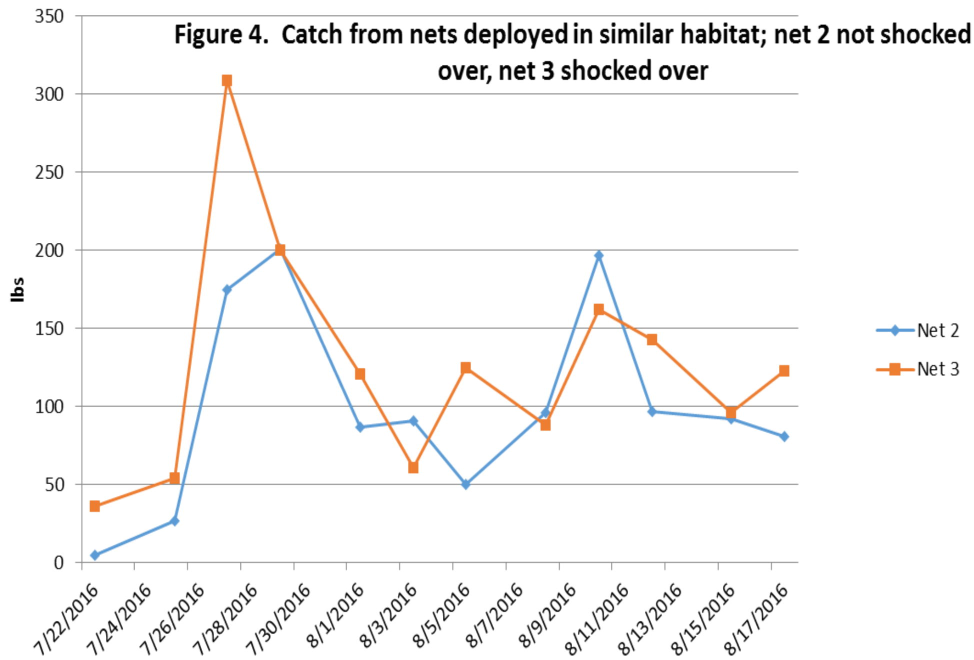


Figure 3. Total fish caught (lbs) per hoop-nets from July 22-August 17, 2016 when e-fishing was conducted over nets 1b, 3b, and 5b.



A statistical analysis of harvest levels at six locations with and without LFE of blue catfish was conducted for the time period between July 22 and August 17, 2016. Both linear and log-linear models were estimated to determine if LFE harvest gear had an impact on hoop net harvest levels. Six sites were compared with harvest from three sites utilizing hoop-net and LFE gears. A comparison of hoop-net harvest levels with and without LFE indicated no statistically significant difference in hoop-net harvest levels. An analysis of variance (Table 3) indicates that the best fit log-linear model with an r-square of 0.085 was not statistically significant at the alpha = 0.05 percent level.

Table 3. Analysis of Variance of hoop-net harvest levels with and without electro-shock gear.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	9	20.1401172	2.2377908	0.64	0.7577
Error	62	216.4515681	3.4911543		
Corrected Total	71	236.5916853			

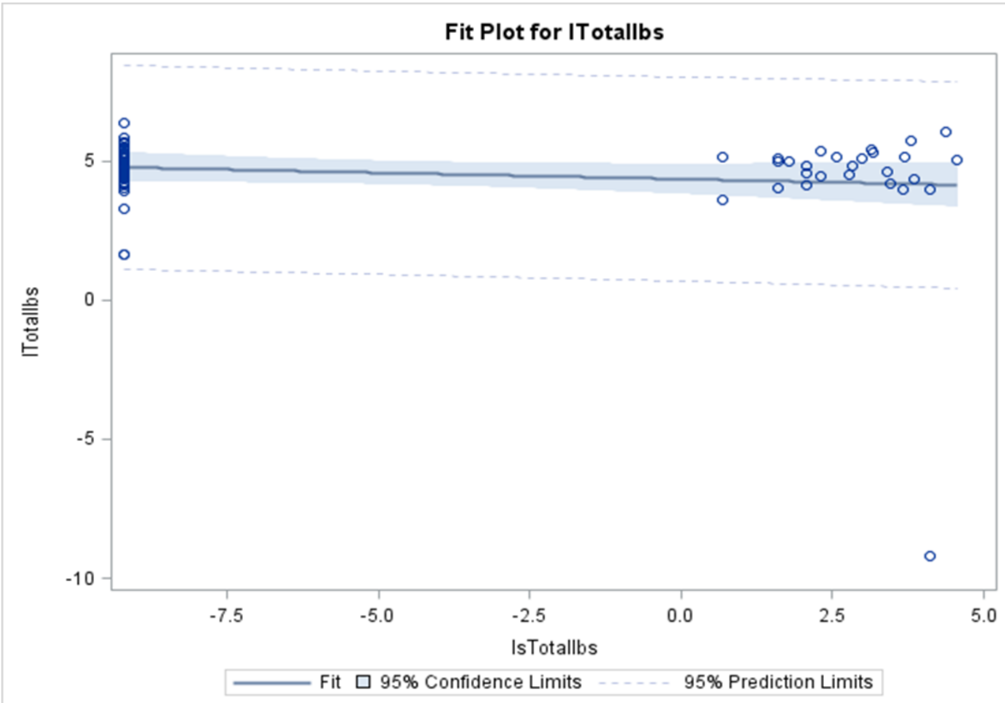
The influence of hoop-net gear with and without LFE, soak time (LSoak), shock time (LShockTime), and water temperature (lWaterTemperature) is presented in Table 4. This analysis indicated that there were no significant differences in harvest levels between Net 2b (Intercept) gear and Net 1b (Net1bGear) with electro-shock gear, Net 3b (Net3bGear) with electro-shock gear, Net 4b (Net4bGear) gear, Net 5b (Net5bGear) with electro-shock gear, or Net 6b gear (Net6bGear) gear at the alpha = 0.05 percent level. While the level of electro-shock gear harvest (LsTotallbs) in Table 4 had a negative parameter coefficient, it was not statistically different from zero at the alpha = 0.05 percent level; that is, LFE harvest levels did not influence hoop-net harvest levels.

Results in a graphical context are presented in Figure 5. Harvest by hoop-net gear (lTotallbs) is presented as a function of harvest from electro-shock fishing gear (lsTotallbs). Although statistically insignificant, the estimated parameter for LFE gear harvest is negative (Table 4) giving hoop-net gear harvest a slightly negative slope in Figure 5. Nonetheless, with most observations in Figure 5 falling within the 95% confidence interval of the predicted value of hoop-net harvest levels, LFE harvest levels have no significant effect on hoop-net harvest levels.

Table 4. Statistical analysis of hoop-net harvest levels with and without LFE. (July 22 and August 17, 2016)

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept(Net 2b)	2.944023928	1.42220798	2.07	0.0426
lsTotallbs	-0.020745697	0.09539927	-0.22	0.8286
Net1bGear	-0.115197852	1.30618947	-0.09	0.9300
Net3bGear	0.948996828	1.38839367	0.68	0.4968
Net4bGear	0.792192496	0.76279686	1.04	0.3031
Net5bGear	0.834685869	1.45884006	0.57	0.5693
Net6bGear	0.643034992	0.76279686	0.84	0.4025
lSoak	1.069886676	1.19419639	0.90	0.3738
lWaterTemperature	0.011257420	0.08207950	0.14	0.8914
lShockTime	-0.021921282	0.09863394	-0.22	0.8249

Figure 5. Ninety-five percent confidence interval for hoop-net harvest levels.



Project Result Summary

This project was conducted to see if commercial LFE has any effects on catch rates of traditional hoop-nets for catfish. We partnered with commercial fisherman Louis Wyatt to fish his hoop-nets for the project. Louis is a highly experienced hoop net fisher that fishes hoop-nets for catfish throughout the year. Louis was able to set and fish nets as needed for the study. Before the experiment began Louis fished nets for several days to get a baseline catch without effects of electrofishing. For the study six hoop-nets were fished every other day following typical commercial methods. The nets were set around a third of a mile apart at various depths and areas of the river. Three of the nets were routinely shocked and three were never shocked. The electrofishing was conducted by George Trice shocking from one boat plus one or two chase boats collecting all catfish that were able to be caught. Shocking was done for 200-220 second durations covering a stretch of river extending up- and downstream from set hoop-net, with shocking directly over top of net being approximately half way through shocking duration. River current and/or tide influenced direction of shocking path and speed of shock boat, but shocking equal distance up- and downstream from deployed hoop-net was targeted. Midway through the project we moved all the nets further down river because both the hoop net and electrofishing catches were cutting back.

In the first part of the project we had various problems with the generated powered pulsator (GPP). Fish were not responding like they have done in previous years so we started trouble shooting starting with things that I could check or change myself first. The technician at

Smith-Root told me that the boat might have a coating of oxidation which prevents the field from being proper size. I proceeded to have the boat sanded on the bottom hull which had no effect on fish behavior or range of the field. Then I took the gpp to a repair shop in Lynchburg where they said it was working properly. When we tried it the next day it still was not working properly. After that I took the boat with the generator and the GPP together so they could check everything out at the same time. They said it was working properly so we proceeded to try it again the next day only to find it was still not working properly. Then we sent it back to Smith-Root, Inc. in Vancouver, Washington and they found nothing wrong with the workings of the unit. Once again we tried the next day only to find out that it still was not correct. After that we took the GPP apart and checked the annunciator, which is the switch that changes the range of the unit. This switch was working properly. Finally the next day when we went to start working, the unit shut down and recalibrated, and it has worked fine ever since. Bottom line of all this was to say that during the first part of this study the GPP was not able to work properly every day, however, we were able to use the hoop-net catches as a baseline of fishing without being shocked over.

In viewing the map in Figure 1, the first segment of the study (Nets 1a-6a) was when the unit was not working properly and sent in for repairs, and Nets 1b-6b represent the second area of the river where we moved to when the unit started to work as it should. During both parts of the study we shocked hoop-nets one, three, and five. Only during the second phase was the unit working properly and able to be used without interruption from breakdowns. However, when shocking in both areas the fish became desensitized very quickly and were not able to be raised. From past experience, after larger fish are shocked they require several days to weeks before they can be raised with LFE. The larger the fish the longer you must wait before they will react with this gear type. Smaller fish are not affected by this gear as much so they will continue to be raised every time we went to the same spots.

In the second study, when the electroshock unit was working, the first several times we shocked each net fish were susceptible to the electrofishing and rose to the surface for easy capture. But as time went on the fish became desensitized to the shocking and our catch was severely reduced. While smaller catfish (>1-2 lbs.) were consistently raised with repeated shocking, it was observed that medium sized catfish (3-8 lbs.) were less effected, routinely seen erratically moving just under the water surface (in-between a "flight response" and "taxis") but not surfacing and becoming immobilized. These fish escaped capture. We continued to shock the three nets for the same duration from start to finish of the project regardless of the amount of fish being raised. Some of the hoop-nets that were set on flats of the river have never been good areas for electrofishing; however, the nets were still shocked over. Other nets that were set on deep bends which seem to hold more fish are where electrofishing operations generally take place. Catch was recorded from all hoop-hoop-nets as well as from shocking.

One thing that was observed in this project was how quick fish become desensitized to LFE, which has been discussed in the literature for years. When the catfish become desensitized they were unable to be raised which hinders catch-per-unit-effort. Electrofishing catch dropped steadily as the project progressed whereas the hoop net catches fluctuated due to soak time or natural occurring circumstances.

We started this project when the water temperature was above 75^0 degrees because the unit will not work below that temperature. The season for shocking ranges from late spring through late fall and is highly dependent on rainfall and temperature. Once the temperature drops in the fall, shocking is over all at once whereas hoop-nets are able to be fished all year. We have the best LFE fishing when weather conditions are hot and still, and hoop-nets seem to do better in the early spring and later in the fall when shocking is not successful. Targeted fishing habitat was noted to vary with the different gear types. Places where hoop-nets produce good catch we are not able to raise many fish, such as on flats and flatter bottom contours. Shocking requires for there to be structure, or edges, for it to work at its best. However, all of the different habitats were used in this study and none of the shocking had an effect on hoop net catches. This study indicates that LFE does not significantly reduce the catch of catfish by commercial hoop-net gear, and it is possible to minimize conflict between LFE and hoop-net gear types in the blue catfish fishery by seasonality and targeted habitat.

Acknowledgements

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