TIDAL BASS SURVEY
Standard Operating Procedure

Prepared by Joseph W. Love, Ph.D.
Tidal Bass Program Manager
Maryland Department of Natural Resources
Freshwater Fisheries Program
Tidal Bass Program

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1. Scope of the Survey

1.1 Mission of Survey

- To ensure population integrity and sustainability of tidal populations of black bass in Maryland;
- To promote and protect angling opportunities of constituents;
- To respond to public concerns of the black bass fishery in tidal freshwater rivers of Maryland with well-researched answers and awareness programs or materials.

1.2 Objectives of Survey

The objectives of the tidal bass survey are: 1) to generate indices for assessing populations of black bass (particularly largemouth bass) and habitat conditions; and 2) to report trends in these indices. During surveys, data regarding selected environmental factors and additional species collected will be recorded. These data are important for standardizing catch estimates and providing more reliable catch indices.

1.3 Period of Survey

The Tidal Bass Survey conducts a survey that targets adults and juveniles from September through October. In all cases, specific dates and times will be specified by regional managers who are crew leaders for survey efforts. Dates may vary by weather conditions. All adult surveys should be completed prior to November, when water temperatures reach 10° Celsius.

1.4 Rivers of Survey

There are approximately 25 major tidal rivers of the Chesapeake Bay watershed in Maryland. While largemouth bass likely inhabit all of these tidal rivers, financial and time constraints prevent meaningful surveys of all of these rivers. A collaborative effort among stakeholders resulted in a ranking of 12 major tidal rivers of the Chesapeake Bay watershed. Tidal rivers were scored from 1 (do not agree) to 10 (strongly agree) for the following criteria: 1) lacks ample baseline data; 2) important as a major fishery; 3) there are perceived problems with the fishery; and 4) there is good evidence for problems with the fishery. Rivers ranked of high priority included: Choptank River, upper Bay rivers, Patuxent River, Pocomoke River, Sassafras River and Wicomico River. The Potomac River and upper Chesapeake Bay are the most popular tidal fisheries in Maryland and therefore require annual monitoring. In support of the Fishery Management Plan for Largemouth Bass (*Micropterus salmoides*), 10 years of baseline, reference data from the survey is required for prioritized rivers. Other fisheries may be assessed less frequently. Once a 10-year reference data set is generated, it will be used as a benchmark for assessing the periodic status of the population. The 10-year reference dataset embodies natural variation in population dynamics. As targeted rivers for the Tidal Bass Survey change, this Standard Operating Procedure (SOP) will be updated with both the change and the justification of the change.

Table 1.4. During the 2018 caucus of the Tidal Bass Program, it was agreed to adopt a 50 year plan for sampling. As of 2023, baseline datasets are available for most of the popular fisheries.

Future	River	Total # Years	Since 1999	Baseline?
Annually	Potomac	33	23	YES
Annually	Sus/NE/Flats	24	21	YES
Every 3 yr or as needed	Chester	15	11	YES
Every 3 yr or as needed	Choptank	20	16	YES
2023, Annually?	Gunpowder	10	9	NO
Every 3 yr or as needed	Marshyhope	15	13	YES
Every 3 yr or as needed	Patuxent	14	11	YES
Every 3 yr or as needed	Pocomoke	14	10	YES
Every 3 yr or as needed	Wicomico	14	11	YES
2028 – 2038, or never	Bohemia	1	0	NO
2023 – 2027	Bush	8	3	NO
2028 – 2038, or never	Elk	3	0	NO
2023 – 2027	Middle	7	5	NO
2028 – 2038, or never	Patapsco	2	0	NO
2023 – 2033	Sassafras	5	3*	NO

*Yearly data inadequate for population assessment.

1.5 Supplies for Survey

Supplies for the survey are listed in Appendix 1.

2. Tidal Bass Survey

2.1 General

The experimental design used to generate indices for the tidal bass survey is a stratified, random design. The strata are defined by two habitat types: prime or habitat with a high level of submerged complexity; and marginal or habitat with little or no submerged complexity. Habitats were stratified in order to improve efficiency of the survey. More effort will be directed to prime sites than marginal sites. Approximately 3-times as many prime sites should be sampled to marginal sites. The variance in catch among prime sites is greater than that for marginal sites, which necessitates a greater sample size within that stratum. The sites are randomly selected within each of the strata.

The catch or relative abundance estimate is the most common index used by fishery biologists to monitor populations. The index and its variance calculated from a stratified design depend on: 1) the proportion of prime and marginal habitat in the river; 2) the number of sites sampled within each stratum; 3) environmental conditions at the time of sampling; and 4) the time spent electrofishing.

2.2 Protocol for Defining Stratum Coverage

Sites were classified by habitat and stratified according to habitat type. Linear shoreline habitat for each prioritized river was divided into regions of prime or marginal habitats for tidal bass based on previous site-inspections (annually, 1999 – 2008). Marginal regions were defined as mostly downstream reaches and/or those lacking significant submerged structure and prone to significant water loss during falling or ebb tides. Prime habitats were defined as those with clear and fresh water and submerged structure. Prior analyses indicated that variance in catch estimates within the prime habitat stratum was much greater than that for the marginal stratum. As a result, the number of sites within the prime habitat stratum should be approximately three times that for the marginal stratum. This proportion should be re-evaluated each year after the survey is completed.

All potentially sampled sites have been classified using a combination of field inspections, aerial imagery, and GIS data. The coverage of each stratum in the river will be computed by summing up the linear shoreline distances (in meters) of sites representing each stratum.

2.3 Protocol for Choosing Number of Sites

Sites are randomly chosen within each habitat stratum. The number of sites that can potentially be sampled ranges from 29 (Middle River) to 508 (Potomac River)(Table 2.1), depending on river length, its level of branching, and extent of upriver tidal influence. Only sites within the tidal fresh reaches of the river are surveyed.

The minimum proposed number of surveyed sites is 25, except in cases when habitat that can be sampled during the fall survey is extremely limited (e.g., Middle River). The maximum proposed number of surveyed sites is 45, which is a maximum value determined based on sampling ability within a year, but may be greater in some cases when the percentage of all sites surveyed is low (e.g., Potomac River). Each year, the number of sites per river will be at least 2 sites greater than needed in order to account for the need to abandon a site if occupied by an angler. Sites should be scrutinized prior to surveys by regional managers and/or staff to ensure that they can be sampled; and if not, changed prior to surveys.

For most sites, the average number of sites surveyed for tidal rivers was deemed sufficient for detecting a change in CPUE among years (Table 2.2). Assuming 5% type I error rate ($\alpha = 0.05$), the number of sites needed to detect a change in CPUE among assessments ranges from 2 to 6810 (Table 2.2). Large sample sizes were identified when there was little difference in CPUE among assessments. Routine power assessments may be needed as more catch data become available.

Table 2.1. For targeted rivers of the tidal bass survey, the average number of sites surveyed from 1999 - 2021 (Ave) and the potential number of surveyed sites (Pot). The proposed number (Prop) is subject to change.

River	Ave	Pot	Prop	Percent of All
Bush	10	22	10	45%
Chester	27	259	30	12%
Choptank	33	248	30	12%
Gunpowder	18	52	18	35%
Marshyhope	25	181	25	14%
Middle	7	29	7	24%
Patuxent	27	153	25	16%
Pocomoke	27	147	25	17%
Potomac	47	508	45	9%
Sassafras	0	127	25	20%
Upper Bay	30	185	30	16%
Wicomico	24	73	25	34%

Table 2.2. Sample size to detect a change for targeted tidal rivers of the conventional tidal bass survey. SD = standard deviation in CPUE.

River	Average SD	Sample Size
Chester	2.87	4
Choptank	3.49	2
Marshyhope	11.47	259
Patuxent	11.55	9
Pocomoke	5.18	6810
Potomac	12.84	10
Sassafras	4.95	3
Upper Bay	7.54	11
Wicomico	6.67	48

2.4 Protocol for Sampling

2.4.1 General

Dates and location of sampling will be made known at least 1 month in advance of sampling so that this information can reviewed by regional managers and, if needed, shared with interested parties.

A minimum of three researchers is required for this boat electroshocking survey. The captain will be responsible for generating float plans, piloting the vessel to georeferenced locations, helping to spot stunned black bass, and recording data. The remaining two researchers will be responsible for spotting and netting fish as they are stunned.

2.4.2 Environmental Conditions

Equipment needed to measure environmental variables will be checked for measurement accuracy and calibrated 1 week prior to sampling. Throughout the sampling season, water quality equipment will be calibrated once a week. All faulty equipment should be repaired prior to the next sampling day. When costly repairs or replacement units are needed, the appropriate regional manager and the tidal bass manager should be notified so that a resolution can be quickly reached. Water quality tools generally includes: 1) a hand-held meter (temperature, salinity, conductivity, dissolved oxygen); 2) a Secchi disk; and 3) a GPS unit.

Prior to sampling for fish, water quality measurements with the hand-held meter should be made at 0.3 m from surface (i.e., surface measurements). A Secchi disk measurement should be made in centimeters. The Secchi disk (20 cm in diameter) should be used between 10:00 – 2:00 pm and on a shady side of the boat[1]. It will be affected by eyesight of the viewer, contrast of the disk and surrounding water, and reflectance of disk. The measurement should be taken while the reader is not wearing polarized sunglasses.

At each site, the relative ranking of submerged aquatic vegetation (SAV) species will be assessed for the 250 m of sampling habitat. A key of SAV can be found at:

https://dnr.maryland.gov/waters/bay/Pages/sav/key.aspx.

2.4.3 Electroshocking Conditions

A common method to survey fishes is electroshocking (i.e., electrofishing). For riverine assessments, a boat or barge electroshocker is often used. For the Tidal Bass Survey, a boat electroshocker will be used. It is hereafter assumed that electrode and equipment designs are similar among boats in the Tidal Bass Survey; when not so, power goal tables (note below) may need to be

[1] Cole, G.A. 1994. Textbook of Limnology, 4th edition. Waveland Press, Inc., Prospect Heights, Illinois.

developed for each boat. Boat electroshocking is not expected to survey all species or largemouth bass size classes equally well and has led to under-representation of age 1 fish while sampling during the Tidal Bass Survey. In addition to size of fish, gradients of conductivity in tidal rivers is a principal factor influencing the electrotaxis (or stunning) of a bass.

Successful electrofishing has been subjectively defined as *electrotaxis of largemouth bass observed at the booms or arrays, immobilized such that fewer than 10% of observed bass escape from the electric field*.

Power output that elicits electrotaxis in fish can be optimized for many levels of conductivity. For warmwater fishes and when using a pulsed DC waveform, the power output may be optimized with a frequency of 120 pulses per second (pps) and a percent of range of 40% to 60%. In 2014, however, the Tidal Bass Program examined power output at various conductivities (up to 4000 microSiemens) using an oscilloscope and determined other settings also have created the power output needed to successfully electrofish largemouth bass (low conductivity, 680 Volts, 50 – 80% range, 60 pps; high conductivity, 340 Volts, 50 – 80% range, 60 pps). Because low conductivity (<= 50 microSiemens) equals greater resistance, either more metal in the water and greater voltage, or alternating current (AC) may be tried to maintain power; when conductivity is extremely high, AC waveform can be tried.

Though box settings on an electrofishing boat can vary across sites, ensuring that those settings produce a standardized power output across sampling sites is important. Power output affects catch efficiency (or catchability), which directly influences relative abundance that is used for population assessments. Electrofishers should use guidance from U.S. Fish and Wildlife Service when standardizing power output. This guidance is:

- Measure water conductivity, preferentially in a reference area where bass will be electrofished.
- Decide between DC or AC waveform (see also, above).
- Electrofish with low or high voltage settings, or settings considered appropriate.
- Determine if electrofishing is successful (see definition, above).
    - If electrofishing is successful, reduce voltage and try again; repeat until power output is too low to result in successful electrofishing (i.e., minimum threshold).
    - If electrofishing is not successful, increase applied voltage and repeat until the minimum threshold for successful electrofishing is reached.
    - Upon reaching minimum threshold for successful electrofishing, record outputs of voltage, amperage and power (if available).
- Use Electrofishing Tool application from USFWS to determine goal amperage for other sites based on successful electrofishing settings at reference site; or use a general Appendix 2 goal table, if necessary.

https://trainingcenter.fws.gov/courses/tools/electrofishing/index.html

- It is assumed that rivers or waterbodies differ in conductivity, submerged grass density, turbidity, reef and/or woody debris availability; therefore, bullets 1 – 5 should be repeated for each river or waterbody.

Prior to the Tidal Bass Survey, it is recommended to test power density at the booms using an oscilloscope. Rust of probes or electrical problems may be undetected unless power density is estimated prior to the field season. Thus, it is recommended that an oscilloscope be used to ensure that the power output is sufficient for successful electrofishing.

The time spent electrofishing will differ among sites, but a minimum amount of effort is spent across sites. From 1999 – 2009, the median number of shocking seconds was 253 (4.2 minutes) and ranged from 63 – 1449 seconds in habitats lacking structure or significant habitat for largemouth bass (Fig. 2.2). Approximately 9% of the values were 150 seconds or less. It is recommended to expend at least 150 seconds of shock time at a site. As more effort is expended in shock time for the river, the precision of the catch estimate for the river increases (Fig. 2.3)(Bonar et al. 2009). The precision, as measured with a coefficient of variation in catch within a year and river, was near a minimal value of 10% when the river had been electrofished for at least 1.75 hours. (Fig. 2.3).

Additional factors of consideration:

- Avoid retrieval of escaped fish when it will significantly increase electrofishing time.
- Sample every observable microhabitat, which traditionally has encompassed a shoreline of approximately 250 meters.
- Starting and ending coordinates will be provided for each site by the tidal bass manager at least 1 month in advance.
- Tidal flow moves the boat and the stunned fish. To prevent fish from being carried beneath the boat, electrofishing should be conducted in direction of tidal flow when the nearshore current is greater than 0.5 meters per second. When the current is less than 0.5 meters per second, electrofishing may be conducted in either direction.
- Owed to dangerously high power output, electrofishing will cease when a person is within 100 feet of the boat and has not granted permission for electrofishing to continue.

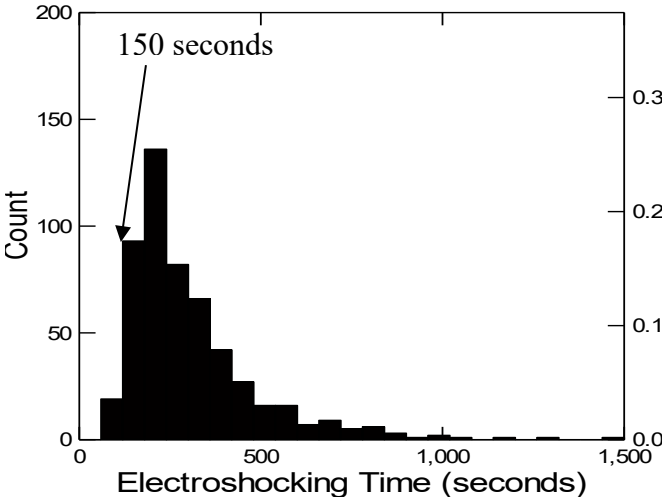

Figure 2.2. Histogram of electroshocking (or electrofishing) time (in seconds) spent in marginal habitats during the conventional survey (1999 – 2009).

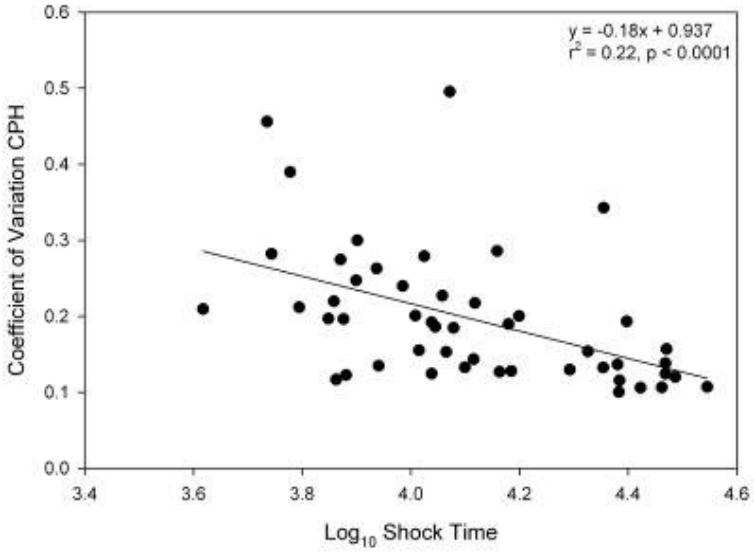

Figure 2.3. The coefficient of variation (CV) in the catch, standardized per unit effort or hour (CPH), or relative abundance of tidal bass versus seconds spent electroshocking among all targeted rivers and years of the conventional survey (1999 – 2009).

2.4.4 Operation of Boat on Site

Sampling shall commence as: 1) a slowing of boat speed just prior to sampling; 2) the researcher at the bow instructing the captain when sampling should begin; 3) a researcher at the bow applying electricity to the water constantly as the boat vessel travels parallel to the shoreline, or as the boat vessel travels 1 – 3 boat lengths toward the shoreline, if surveyed using a scalloped matter (Fig. 2.4); and 4) sampling all microhabitats within the site with equal effort. In the cases where scalloping is used, the captain will be responsible for ensuring that the moves toward shore occur at equidistant increments along the stretch of surveyed stream. However, in shallow water areas, researchers on the bow have the responsibility to tell the captain when in shallow water (< 1 foot; 0.3 meters) or when obstructions occurred (e.g., downed logs). Parallel electrofishing may be conducted when vessel moves parallel the shoreline, but should be avoided because while diversity and size structure results may be similar, relative abundance is lower.[2]

[2] Trumbo, B.A. M.D. Kaller, A.R. Harlan, T. Pasco, W.E. Kelso, and D.A. Rutherford. 2016. Effectiveness of continuous versus point electrofishing for fish assemblage assessment in

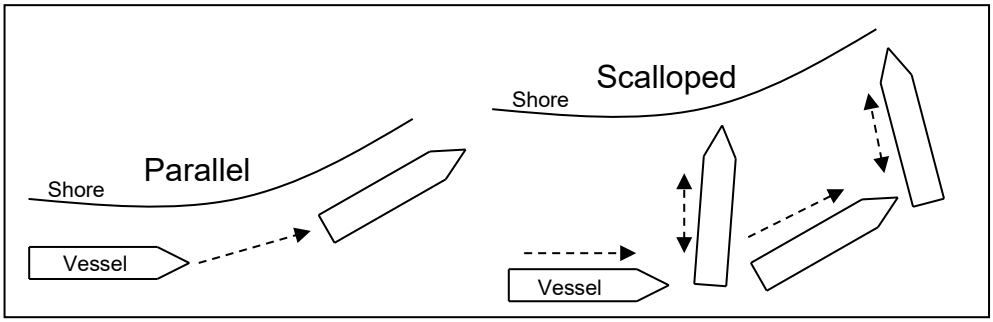

Figure 2.4. Figure depicting two sampling methods utilized by the tidal bass survey. Parallel surveys are defined by times when electroshocking is conducted while the boat vessel is moving parallel with the shoreline. Scalloped surveys are defined by times when electroshocking is conducted while the boat vessel moves 1 – 3 boat lengths toward the shoreline.

2.5 Protocol for Handling Procedures

When a black bass is stunned by the electroshocking boat, they should be quickly transferred to an oxygenated (near or above 100% oxygen saturation), re-circulating holding tank. Temperature and dissolved oxygen of the water in the holding tanks should be monitored regularly to ensure ambient, oxygenated water is provided the tidal bass.

Most black bass will be measured for total length (in millimeters) and weighed (in grams) before being returned to the site from where they were taken. Each fish will be inspected for lesions or injuries that will be recorded. When a tagged fish is encountered, then the tag number will also be recorded. In some cases, it may not be possible to obtain a weight. In those cases, the fish will be released following its length measurement; “NA” will be recorded for the weight measurement.

At the discretion of the tidal bass program manager and regional managers, a small random sample of individuals may be sacrificed for life history information. This random sample will not exceed 25 individuals per river in a year. A maximum of 5 individuals from discrete size classes (Table 2.5) sampled within each river may be taken. The first 5 individuals meeting the length requirements will be sacrificed. Sacrificed individuals will be measured, weighed, placed in a bag with a waterproof label detailing river and date, and euthanized by chilling or freezing.

Other fishes collected will be identified and noted on datasheets. For quick reference, a photo atlas of common fishes is provided in Appendix 3. A whiteboard at the bow and/or a digital voice recorder will be necessary for netters to record species as they are encountered. At the discretion of managers, counts or measurements for particular fishes may be additionally required.

shallow, turbid aquatic habitats. North American Journal of Fisheries Management 36:398-406.

2.6 Protocol for Handling Atlantic (or Shortnose) Sturgeon

According to Biological Opinion (Section 11.3) issued by NMFS to U.S. FWS regarding the handling of the endangered species Atlantic Sturgeon[3], the following shall be performed:

1. For electrofishing, no sturgeon over 2 feet in length shall be netted. All observations of netted sturgeon must be reported to NMFS as required… All observations of non-netted sturgeon should also be reported to NMFS via e-mail (incidental.take@noaa.gov), as soon as practicable. This report must contain the date, location, tentative species identification, and approximated size of the fish.
2. If the sturgeon comes in contact with sampling gear, all electrofishing must cease for 5 minutes or until the fish is observed to recover and leave the area.

3. Data Collection and Disposition

3.1 Protocol for Data Collection

Prior to collecting data, all researchers participating in the survey should be made fully aware of the information they are recording and how that information is obtained. **Researchers will collect data in a consistent and uniform manner, using similar gear.** A meeting prior to sampling events may be necessary for ensuring quality of the data collection.

All data should be recorded using an iPad with digital datasheets created using Apple Numbers. An updated, digital version of the datasheet will be made available at least 1 month in advance of the survey. If a paper copy is necessary (not encouraged), then electronic versions are available upon request.

3.2 Protocol for Data Disposition

Following data collection, all digital datasheets will be collated to a common network drive for long-term data storage. **Collated datasheets will be stored using an electronic file name of river and year and will be stored at the common network drive,** /inland fisheries/tidal bass drives.

Original data sheets will be stored at the regional office with whom the survey was conducted. No data sheets will be discarded until all sheets have been scanned and the scanned copy, checked by at least two researchers. No data sheets will be discarded without notifying the regional managers.

[3] https://repository.library.noaa.gov/

3.3 Protocol for Data Entry

Data will be uploaded into a relational, archival data base. This database is currently called the Geographic Inland Fisheries Survey System, or GIFS. Data will be imported into GIFS from digitally saved datasheets that were exported from the iPad Number's program. The regional office responsible for the survey will administer the entry of data into the relational, archival data base. The catch data tab for GIFS will include all species observed during survey. For species that are counted and measured during survey, those data will ALSO be entered to the Individual Fish data tab for GIFS.

3.4 Protocol for Quality Assurance/Quality Control Procedures

All (or most) data will be imported into GIFS directly from datasheets populated during field surveys. Therefore, data entry errors to GIFS should be rare or uncommon. On occasion, data may need to be entered manually into GIFS (e.g., biologist uses a paper datasheet). Therefore, data entered into GIFS will be cross-checked by a second researcher. It will be the responsibility of a database manager, tidal bass program manager, or other assigned staff to verify accuracy of data in GIFS. Pass data will be checked against those presented on the data sheet. Corrections will be made to the pass data in the archival data base.

Data exported from the archival database to a worksheet will be checked for errors. The minimum and maximum values will be determined for variables within the worksheet. Additional procedures, such as scatterplots, may also be employed for determining errors. When discovered, errors will be cross-referenced with recorded data to datasheets. Corrections will then be made to the spreadsheet and the archival database.

The number of fish caught during a survey will be plotted by effort. The expected, positive relationship will be evaluated for each dataset. Outliers may be removed from analysis, but noted in all reports.

The length-weight relationship will be evaluated using a scatterplot. Outliers will include those data points that deviate significantly from the global, length-weight relationship. When an outlier is discovered, the values will be cross-checked with datasheets to determine if mass or length were recorded in units different from those generally used (i.e., grams, millimeters). When necessary, data may be removed from analysis, but such outliers will be noted in all reports.

4. Required Staff Training

All staff who were born on or after July 1, 1972 and who collect data during the Tidal Bass Survey as described in Section 2 are required to have a Maryland Safe Boating Certificate. A certificate may be obtained after successfully completing a boating safety course. Staff can register here:

https://dnr.maryland.gov/nrp/Pages/BoatingSafety/Safety_Certificate.aspx.

All staff will ensure that the boat vessels do not transport aquatic nuisance species for unwitting introduction by following the associated and adopted Hazzard Analysis Critical Control Point Plan (Appendix 4).

All staff who collect data during the Tidal Bass Survey as described in Section 2 are required to review electroshocking safety material in Appendix 5. Staff will, unless otherwise trained by USFWS, satisfactorily complete the USFWS online safety training course offered via National Conservation Training Center (CSP2202 - Principles and Techniques on Electrofishing). This online training is free. Instructional videos for Electrofishing Essentials that review safety and operation of electrofishing equipment. Please visit this website:

https://www.fws.gov/training/Electrofishing-Safety-CSP2202

For additional course resources and video training in electrofishing, please visit:

https://www.fws.gov/training/electrofishing-essentials-course-resources
https://trainingcenter.fws.gov/courses/CSP/CSP2C01/resources/

5. Common Sense Provision

Safety of researchers and living organisms supersedes the desire for quality or robust data. Field ecology is challenged by changing environmental conditions, perception and background of the researchers, and "demonic intrusion" or unpredictably, maligning events. The best defense against challenging conditions is common sense. When an event arises that challenges the traditional collection of data, then researchers should collectively choose the best course of action by weighing ramifications of such a choice against the act of doing nothing. Researchers are held accountable for their actions and the data they collect. The highest standard of scientific ethics is expected.

6. Revision of Tidal Bass Standard Operating Procedure

This Standard Operating Procedure will be reviewed annually and revised, as needed. The Tidal Bass Program Manager will have the responsibility of coordinating the revision process. The revision date is on page 1 and the most up-to-date adopted revision will be available on-line at:

https://dnr.maryland.gov/fisheries/Pages/bass/index.aspx.

Revisions may occur at any time during the year; but, all revisions will be reviewed once a year by regional managers *prior to* adoption.

APPENDIX 1

Supply List for Survey

Supply List

For each boat:

- Anode droppers (at least 2 array sets)
- Automated External Defibrillator (recommended, not required).
- Batteries (for GPS, YSI camera)
- Digital camera
- Dip nets (at least 2, long handled, 0.25-inch mesh nets; 30 cm deep with a 2 m, fiberglass handle)
- Dry erase board and marker (i.e., tally sheet for presence-absence data)
- Fire extinguisher (inspected) mounted away from gas can, generator or other fire sources.
- First Aid Kit
- GPS unit (with programmed site coordinates)
- Hearing protection for those who want it; if generator creates noise at or above 85 decibels, then crew must wear hearing protection.
- iPad (or datasheets if needed)
- Length measuring board
- Maps of site locations (printed, optional)
- Nonslip or skid resistant pad to decrease slipping on boat bow deck.
- Plastic bags (sealable)
- Secchi disk
- Standard Operating Procedure
- Water quality meter
- Weight scale
- Wireless phone

For each crew member:

- Polarized sunglasses, required when there is glare
- Rubber gloves long enough to isolate hands from touching external surfaces must be worn while electrofishing. Gloves may be made from neoprene, polyurethane, butyl, silicone, natural rubber, and PVC material
- Rubber gloves with punctures must be recycled or disposed
- Rubber-soled boots or other boots rated for electrical hazard protection must be worn
- U.S. Coast Guard approved PFDs must be worn by crew members when boat is underway.

APPENDIX 2

Recommended Peak Amperage and Peak Power

For reference, target power and current for boat electroshocking in warm water. This table provides guidance at various levels of conductivity. Data obtained from equations developed by the U.S. Fish and Wildlife Service; a mobile application is also available. Peak Amperage and peak Watts at various conductivities were estimated assuming a 50 cm distance of the electrical field from anode center.

Water Conductivity (Ambient)	Peak Amperage Goal	Peak Power Goal
50	6	513
100	8	436
150	10	441
200	12	468
250	14	503
300	16	541
350	18	583
400	20	625
450	22	669
500	24	713
550	26	758
600	28	803
650	30	849
700	32	895
750	34	941
800	36	987
850	38	1033
900	40	1079
950	42	1126
1000	44	1172
1050	46	1219
1100	48	1266
1150	50	1312
1200	52	1359
1250	54	1406
1300	55	1452
1350	57	1499
1400	59	1546
1450	61	1593
1500	63	1640
1550	65	1687
1600	67	1734
1650	69	1780
1700	71	1827
1750	73	1874
1800	75	1921
1850	77	1968
1900	79	2015

1950	81	2062
2000	83	2109
2050	85	2156
2100	87	2203
2150	89	2250
2200	91	2297
2250	93	2344
2300	95	2391
2350	97	2438
2400	99	2485
2450	101	2532
2500	103	2579
2550	105	2626
2600	106	2674
2650	108	2721
2700	110	2768
2750	112	2815
2800	114	2862
2850	116	2909
2900	118	2956
2950	120	3003
3000	122	3050
3050	124	3097
3100	126	3144
3150	128	3191
3200	130	3238
3250	132	3286
3300	134	3333
3350	136	3380
3400	138	3427
3450	140	3474
3500	142	3521
3550	144	3568
3600	146	3615
3650	148	3662
3700	150	3709
3750	152	3757
3800	154	3804
3850	155	3851
3900	157	3898
3950	159	3945
4000	161	3992
4050	163	4039
4100	165	4086
4150	167	4133
4200	169	4181

4250	171	4228
4300	173	4275
4350	175	4322
4400	177	4369
4450	179	4416
4500	181	4463
4550	183	4510
4600	185	4558
4650	187	4605
4700	189	4652
4750	191	4699
4800	193	4746
4850	195	4793
4900	197	4840
4950	199	4887
5000	201	4934
5050	203	4982
5100	205	5029
5150	206	5076
5200	208	5123
5250	210	5170
5300	212	5217
5350	214	5264
5400	216	5312
5450	218	5359
5500	220	5406
5550	222	5453
5600	224	5500
5650	226	5547
5700	228	5594
5750	230	5641
5800	232	5689
5850	234	5736
5900	236	5783
5950	238	5830
6000	240	5877
6050	242	5924
6100	244	5971
6150	246	6019
6200	248	6066
6250	250	6113
6300	252	6160
6350	254	6207
6400	255	6254
6450	257	6301
6500	259	6348

6550	261	6396
6600	263	6443
6650	265	6490
6700	267	6537
6750	269	6584
6800	271	6631
6850	273	6678
6900	275	6726
6950	277	6773
7000	279	6820
7050	281	6867
7100	283	6914
7150	285	6961
7200	287	7008
7250	289	7056
7300	291	7103
7350	293	7150
7400	295	7197
7450	297	7244
7500	299	7291
7550	301	7338
7600	303	7386
7650	305	7433
7700	306	7480
7750	308	7527
7800	310	7574
7850	312	7621
7900	314	7668
7950	316	7715
8000	318	7763
8050	320	7810
8100	322	7857
8150	324	7904
8200	326	7951
8250	328	7998
8300	330	8045
8350	332	8093
8400	334	8140
8450	336	8187
8500	338	8234
8550	340	8281
8600	342	8328
8650	344	8375
8700	346	8423
8750	348	8470
8800	350	8517

8850	352	8564
8900	354	8611
8950	355	8658
9000	357	8705
9050	359	8753
9100	361	8800
9150	363	8847
9200	365	8894
9250	367	8941
9300	369	8988
9350	371	9035
9400	373	9083
9450	375	9130
9500	377	9177
9550	379	9224
9600	381	9271
9650	383	9318
9700	385	9365
9750	387	9413
9800	389	9460
9850	391	9507
9900	393	9554
9950	395	9601
10000	397	9648

APPENDIX 3

Photo Atlas of Common Fishes
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APPENDIX 4

Photo Atlas of Bass Disease
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APPENDIX 5

HAACP Plan for Tidal Bass Program

Tidal Bass Program HACCP plan

HACCP Step 1 - Activity Description

Facility:

Maryland Department of Natural Resources, Inland Fisheries, Tidal Bass Program - Tawes Building

Site:

Aquatic habitats in tidal rivers of Chesapeake Bay

Project Coordinator:

Joseph Love

Project Description:

Fishery Resource Management

Site Manager:

Project biologists include: Mary Groves, Tim Groves, Branson Williams, Ross Williams, Mark Staley, Adam Eschleman, Todd Heard, Brett Coakley, and Jerry Stivers

Address:

580 Taylor Avenue, B-2

Annapolis, MD 21401

Phone:

410-260-8257

Project Description

(Who, What, Where, When, How & Why)

Maryland Department of Natural Resources staff conducts fishery surveys, tagging, spawning and monitoring of Largemouth Bass and Smallmouth Bass. Invasive species management includes control of northern snakehead, blue catfish, and flathead catfish, where possible.

Sampling methods include boat and backpack electrofishing

These activities are conducted in the major tributaries to the Chesapeake Bay including (but not limited to)
the Potomac, Choptank, Susquehanna, Northeast, Pocomoke, Wicomico, Gunpowder, Middle,
and Patuxent Rivers.

Tidal Bass Program HACCP plan

HACCP Step 2 - Potential Hazard Identification
Vertebrates: Channa argus (northern snakehead) Pylodictis olivaris (flathead catfish) Ictalurus furcatus (blue catfish)
Invertebrates: Dreissena polymorpha (zebra mussel)
Plants: Hydrilla verticillata (hydrilla) Trapa natans (water chestnut) Myriophyllum spicatum (eurasian milfoil) Eichornia crassipes (water hyacinth)
Other Biologics:
Others:

Tidal Bass Program HACCP plan

HACCP Step 3 - Flow Diagram

Task # 1	Arrive at location, dress in personal gear and prepare gear needed for the sampling effort

Task # 2	Deploy boat or walk to sampling location and bring supplies to water

Task # 3	Conduct sampling (electrofish)

Task # 4	Identify species, measure length, and collect samples of aquatic species

Task # 5	Measure water quality, qualify habitat, and collect GPS coordinates at sampling locations

Task # 6	After survey is complete, return to truck and load sampling gear and personal gear

Task # 7	Return to office
Task # 8	If specimens have been collected, process samples, place in aquaria or freeze for later analysis
Task # 9	Unload and attend to sampling gear and personal gear

Tidal Bass Program HACCP plan

HACCP Step 4 - Hazard Analysis					
Task	Hazard	Probable?	Justification	Control Measures	CCP?
Arrive at location, dress in personal gear and prepare gear needed for the sampling effort	Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)	No	if gear has been properly attended to following prior sampling events, there should be no transport		No
	Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)	No	if gear has been properly attended to following prior sampling events, there should be no transport		No
	Invertebrate: Dreissena polymorpha (zebra mussel)	No	if gear has been properly attended to following prior sampling events,		No

Tidal Bass Program HACCP plan

			there should be no transport		
Deploy boat or walk to sampling location and bring equipment to water	Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)	No	if gear has been properly attended to following prior sampling events, there should be no transport		No
	Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)		if gear has been properly attended to following prior sampling events, there should be no transport		No
	Invertebrate: Dreissena polymorpha (zebra mussel)	No	if gear has been properly attended to following prior sampling events, there should be no transport		No

Tidal Bass Program HACCP plan

Conduct sampling (electrofish)	Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)	Yes	northern snakeheads could be transported from one sample location to another	secure northern snakeheads in enclosed tanks when travelling between sites	No
	Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)	Yes	sampling could be conducted in more than one watershed or more than one localized area	Ensure that plants and nets is free from electrofishing probes, array, and prop before driving to a new waterway.	Yes
	Invertebrate: Dreissena polymorpha (zebra mussel)	Yes	sampling could be conducted in more than one watershed or in more than one localized area	Pumps should be off and tank or bilge water should be empty when going from one waterway to another	Yes
Identify species, measure length, and collect samples of captured aquatic species	Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)	Yes	Samples could be transported as part of a sample collection.	Secure fish in enclosed tanks when transporting between waterways.	No

Tidal Bass Program HACCP plan

Identify species, measure length, and collect samples of captured aquatic species	Plant: Hydrilla verticillata (hydrilla)	No	this process occurs at one location		No
	Invertebrate: Dreissena polymorpha (zebra mussel)	No	this process occurs at one location		No
Measure water quality, qualify habitat, and collect GPS coordinates at locations	Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)	No	this process occurs at one location		No
	Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)	No	this process occurs at one location		No
	Invertebrate: Dreissena polymorpha (zebra mussel)	No	this process occurs at one location		No
After survey is complete, return to truck and load sampling gear and personal gear	Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)	Yes	fish are often transported back to the office for experiments or for	secure fish in enclosed tanks when travelling	Yes

After survey is complete, return to truck and load sampling gear and personal gear					
	Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)	Yes	Plants could be attached to sampling and/or personal gear	remove vegetation and mud from botas and gear/	Yes
	Invertebrate: Dreissena polymorpha (zebra mussel)	No	boats and gear will be visually cleared before the return trip to the office	remove vegetation and mud from boats and gear	Yes
Return to office					
	Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)	No	boats and gear will be visually cleared before the return trip to the office		Yes

Tidal Bass Program HACCP plan

Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)				boats and gear will be visually cleared before the return trip to the office	No
	process samples, place in aquaria or freeze for later analysis	Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)	No	Specimens will be held in aquaria or killed and disposed of properly	No
		Invertebrate: Dreissena polymorpha (zebra mussel)	Yes	boats and gear will be	
			No	No specimens are retained	No
Plant: Hydrilla verticillata (hydrilla); Trapa nata chestnut); Myriophyllum spicatu milfoil); Eichornia crassipes (water hyacinth)		Invertebrate: Dreissena polymorpha (zebra mussel)	No	No specimens are retained	No
	Unload and attend to sampling gear	Vertebrate: Channa argus (northern snakehead); Ictalurus furcatus (blue catfish); Pylodictus olivaris (flathead catfish)	No	Specimens will be held in aquaria or disposed of properly	Debris will be visibly inspected and removed from trailer, bilge, prop, probes and hull	No
		Plant: Hydrilla verticillata (hydrilla)	Yes	Hydrilla could be attached to sampling or personal gear	Pressure wash trailer and outside of boat, bleach the live well, and dry completely before moving a new watershed.	Yes
		Invertebrate: Dreissena polymorpha (zebra mussel)	Yes	Zebra mussel larvae could be attached to sampling or personal gear		Yes

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Tidal Bass Program HACCP plan

HACCP Step 5 - HACCP Plan

Critical Control Point #1:

Task # 3: Conduct sampling (electrofish)

Significant Hazards:
Invertebrate: Dreissena polymorpha (zebra mussel)
Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)

Control Measures:

check array, probes, prop and dip nets for debris and remove before moving to another sampling location, if in a separate watershed.

Limits for Control Measures:

visually inspect nets array, probes, props, dip nets before moving to another site, if in a separate watershed.

Monitoring: What?

that debris (SAV, mud) is removed from areas that come in direct contact with vegetation and mud in shallow areas and likely cling

Monitoring: How?

visually

Monitoring: Frequency?

every time a site a different watershed is sampled

Monitoring: Who?

Biologists

Evaluation & Corrective Actions:

boat and nets can be checked at the office and reinspected

Supporting Documentation: Britton, David. Zebra Mussel (Dreissena polymorpha). ANS Taskforce Web site. 2006.<http://www.anstaskforce.gov/spoc/zebra_mussels.php> (Accessed December 1, 2008).

Tidal Bass Program HACCP plan

Critical Control Point #2:

Task # 6: After survey is complete, return to truck and load sampling gear and personal gear

Significant Hazards:

Vertebrate: Channa argus (northern snakehead)
Vertebrate: Ictalurus furcatus (blue catfish)
Vertebrate: Pylodictus olivaris (flathead catfish)

Control Measures:

secure fish in enclosed tanks when travelling between sites

Limits for Control Measures:

Fish will be placed in a secure tank for transport

Monitoring: What?

that the tank is closed and secured

Monitoring: How?

visually

Monitoring: Frequency?

each time a fish is caught and transported

Monitoring: Who?

biologists

Evaluation & Corrective Actions:

if no lid is available for a tank, either transport fish inside the truck or kill it before transporting

Supporting Documentation: Courtenay, Walter Jr., and Williams, James D. Snakeheads (Pisces, Channidae) — A Biological Synopsis and Risk Assessment. US Geological Survey Circular 1251. <http://fisc.er.usgs.gov/Snakehead_circ_1251/circ_1251_courtenay.pdf > (Accessed December 1, 2008).

Tidal Bass Program HAACP plan

Critical Control Point #3:

Task # 6: After survey is complete, return to truck and load sampling gear and personal gear

Significant Hazards:

Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)

Control Measures:

remove vegetation and visible sediment from boats and gear, if travelling outside the watershed, power wash boat and trailer and bleach the live well

Limits for Control Measures:

Remove vegetation and mud from boats and gear

Monitoring: What?

That boats and gear are clean

Monitoring: How?

visually

Monitoring: Frequency?

each time the truck is packed for return to the office, additional steps (pressure washing boat and bleaching live well) will be taken if travelling outside of the watershed

Monitoring: Who?

biologists

Evaluation & Corrective Actions:

If boat and trucks are extremely muddy, trucks and boats will be washed at a car wash before leaving the watershed

Supporting Documentation:

Elwell, Leah.,Spaulding, Sara. 2007. Increase in nuisance blooms and geographic expansion of the freshwater diatom Didymosphenia geminate. White paper. <http://www.macfff.org/pdf/ScientificKnowledgeofDidymo.pdf> (Accessed December 1, 2008).

Tidal Bass Program HACCP plan

Critical Control Point #4:

Task # 6: After survey is complete, return to truck and load sampling gear and personal gear

Significant Hazards:

Invertebrate: Dreissena polymorpha (zebra mussel)

Control Measures:

remove vegetation and visible sediment from boats and gear remove vegetation and visible sediment from boats and gear, if travelling outside the watershed, power wash boat and trailer and bleach the live well

Limits for Control Measures:

Remove vegetation and mud from boats and gear

Monitoring: What?

That boats and gear are clean

Monitoring: How?

visually

Monitoring: Frequency?

each time the truck is packed for return to the office or to a different watershed, additional steps (pressure washing boat with hot water and bleaching live well) will be taken if travelling outside of the watershed

Monitoring: Who?

biologists

Evaluation & Corrective Actions:

If boat and trucks are extremely muddy, trucks and boats will be washed at a car before leaving the watershed

Supporting Documentation: Britton, David. Zebra Mussel (Dreissena polymorpha). ANS Taskforce Web site. 2006.<http://www.anstaskforce.gov/spoc/zebra_mussels.php> (Accessed December 1, 2008).

Tidal Bass Program HACCP plan

Critical Control Point #5:

Task # 9: Unload and attend to sampling gear and personal gear

Significant Hazards:

Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)

Control Measures:

Pressure wash trailer and outside of boat, bleach the live well, and dry completely before moving to a new watershed.

Limits for Control Measures:

If travelling outside the watershed,
power wash boat and trailer, bleach the live well, and allow 48 hours of drying time

Monitoring: What?

That dip nets and boats are washed and dried

Monitoring: How? visually

Monitoring: Frequency?

at the completion of sampling, before gear is used in another body of water

Monitoring: Who?

biologists

Evaluation & Corrective Actions:

If mud persists, scrub and dip in salt solution again.

Supporting Documentation: Elwell, Leah.,Spaulding, Sara. 2007. Increase in nuisance blooms and geographic expansion of the freshwater diatom Didymosphenia geminate. White paper. <http://www.macfff.org/pdf/ScientificKnowledgeofDidymo.pdf> (Accessed December 1, 2008).

Tidal Bass Program HACCP plan

Critical Control Point #6:

Task # 9: Unload and attend to sampling gear and personal gear

Significant Hazards:

Invertebrate: Dreissena polymorpha (zebra mussel)

Control Measures:

Pressure wash trailer and outside of boat, bleach the live well, and dry completely before moving to a new watershed.

Limits for Control Measures:

If travelling outside the watershed, power wash boat and trailer, bleach the live well, and allow 48 hours of drying time

Monitoring: What?

That nets and boats boats are completely dry before changing watersheds and that boats and trailers are washed and dried

Monitoring: How? visually

Monitoring: Frequency?

at the completion of sampling, before gear is used in another body of water

Monitoring: Who?

biologists

Evaluation & Corrective Actions:

If mud persists, scrub and dip in salt solution again.

Supporting Documentation: Britton, David. Zebra Mussel (Dreissena polymorpha). ANS Taskforce Web site. 2006.<http://www.anstaskforce.gov/spoc/zebra_mussels.php> (Accessed December 1, 2008).

Tidal Bass Program HACCP plan

Facility:	Activity:
Maryland Department of Natural Resources Address:	Fishery Resource Management
580 Taylor Avenue Annapolis, MD 21401 (Headquarters) Signature:	Date:

Tidal Bass Program HACCP plan

HACCP Checklist:

Fishery Resource Management

Facility	Maryland Department of Natural Resources
Site	Chesapeake Bay and Tributaries
Coordinator	Joe Love
Manager	Staff (Joe Love, Mary Groves, Time Groves, Ross Williams, Branson Williams, Mark Staley, Adam Eshelman, Todd Heard, Brett Coakley, Jerry Stivers, Rebecca Bobola
Address	580 Taylor Avenue, Annapolis, MD 21401 (Headquarters)

Task # 1: Arrive at location, dress in personal gear and prepare gear needed for the sampling effort

Task # 2: Deploy boat or walk to sampling location and bring sampling gear to water

Task # 3: Conduct sampling (electrofish)

CRITICAL CONTROL POINT

Hazards were contained

Hazards: Invertebrate: *Dreissena polymoropha* (zebra mussel); Plant: *Hydrilla verticillata* (hydrilla); *Trapa natans* (water chestnut); *Myriophyllum spicatum* (eurasian milfoil); *Eichornia crassipes* (water hyacinth)
Control measures were implemented

Control Measures: Check array, probes, nets, and prop before moving to a new watershed.

Control limits were maintained

Control Limits: Visually inspect nets and boat.

Corrective actions were (performed if necessary)

Corrective Actions: Boats can be re-inspected at the office.

Task # 4: Identify species, measure length, and collect samples of captured aquatic species

Task # 5: Measure water quality, qualify habitat, and collect GPS coordinates at sampling locations

Task # 6: After survey is complete, return to truck and load sampling gear and personal gear

CRITICAL CONTROL POINT

Hazards were contained

Hazards: Vertebrate: *Channa argus* (northern snakehead); Vertebrate: *Pylodictus olivaris* (flathead catfish); Vertebrate: *Ictalurus furcatus* (blue catfish)

Control measures were implemented

Control Measures: secure fish in enclosed tanks when travelling between sites

Control limits were maintained

Control Limits: fish will be placed in a secure tank for transport

Corrective actions were (performed if necessary)

Corrective Actions: If no lid is available for a tank, either transport fish inside the truck or kill it before transporting

Tidal Bass Program HACCP plan

Hazards were contained

Hazards: Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)

Control measures were implemented

Control Measures: remove vegetation and visible sediment from boats and gear, if travelling outside the watershed, power wash boat and trailer and bleach the live well

Control limits were maintained

Control Limits: remove vegetation and mud from boats and gear

Corrective actions were (performed if necessary)

Corrective Actions: If boat and trucks are extremely muddy, trucks and boats will be washed at a car wash before leaving the watershed

Hazards were contained

Hazards: Invertebrate: Dreissena polymorpha (zebra mussel)

Control measures were implemented

Control Measures: remove vegetation and visible sediment from boats and gear remove vegetation and visible sediment from boats and gear, if travelling outside the watershed, pressure wash boat and trailer and bleach the live well

Control limits were maintained

Control Limits: Remove vegetation and mud from boats and gear, boats should be pressure washed with hot water (>140° if possible) and live wells should be treated with a bleach solution (at least 2%), if traveling outside of the watershed.

Tidal Bass Program HACCP plan

Corrective actions were (performed if necessary)

Corrective Actions: If boat and trucks are extremely muddy, trucks and boats will be washed at a car wash before leaving the watershed

Task # 7: Return to office

Task # 8: If specimens have been collected, either process samples or place them in either aquaria or the freezer for later analysis

Task # 9: Unload and attend to sampling gear and personal gear

CRITICAL CONTROL POINT

Hazards were contained

Hazards: Plant: Hydrilla verticillata (hydrilla); Trapa natans (water chestnut); Myriophyllum spicatum (eurasian milfoil); Eichornia crassipes (water hyacinth)

Control measures were implemented

Control Measures: Pressure wash trailer and outside of boat, bleach the live well, and dry completely before moving to a new watershed.

Control limits were maintained

Control Limits: If travelling outside the watershed, power wash boat and trailer, bleach the live well, and allow 48 hours of drying time

Tidal Bass Program HACCP plan

Corrective actions were (performed if necessary)

Corrective Actions: If mud persists, scrub and dip in salt solution again.

Hazards were contained

Hazards: Invertebrate: Dreissena polymorpha (zebra mussel)

Control measures were implemented

Control Measures: Pressure wash trailer and outside of boat, bleach the live well, and dry completely before moving to a new watershed.

Control limits were maintained

Control Limits: If travelling outside the watershed, power wash boat and trailer, bleach the live well, and allow for several days of drying time

Corrective actions were (performed if necessary)

Corrective Actions: If mud persists, scrub again.

APPENDIX 6

Electrofishing Safety Policy
Selected from U.S. Fish and Wildlife Service

What design specifications are applicable to electrofishing boats and rafts?

A. Design.

(1) Boat design and equipment must be in compliance with U.S. Coast Guard and State regulations and U.S. Department of the Interior policy (also see 241 FW 1). The boat or raft crew must follow the additional guidelines in this electrofishing safety policy.

(2) The netting area must have substantial safety rails to help prevent netters from falling overboard. Safety rails must withstand netters leaning on them without collapsing.

> **(a)** On solid-hulled boats, safety rails should be at least 42 inches from the top of the rail to the deck. The top of the rail should be at or above the waistline of netters.
>
> **(b)** Safety rails on rafts may be lower, but netters must kneel to keep the top of the rail at or above their waistline.

(3) The team leader must ensure the boat bow deck is equipped with a nonslip or skid-resistant material or roughened in some manner to decrease the chance of slipping.

(4) Electrode booms (anodes with DC) must be mounted in a stationary position on a metal-hulled boat. Moveable anodes (prod poles) may be used on metal-hulled boats with non-conductive deck surfaces and railings.

(5) All metal surfaces on a boat or raft must be electrically connected (in electrical continuity) to eliminate differences in electrical potential that may cause electric shock. Ground the generator case to the hull or rowing frame (raft) by a direct attachment, with a ground strap, or 8 AWG sized wire. We recommend that you connect a ground wire from the pulsator to the hull or rowing frame. You may use a metal boat hull as a cathode.

(6) An acid proof, nonmetallic enclosure and holder must be provided for wet cell batteries.

(7) For typical power sources, the recommended conductor voltage capacity is 600 volts RMS minimum for the main circuit and 300 volts RMS maximum for the safety circuit.

(8) For typical power sources, the recommended conductor size is 10 AWG for the generator power cord and main circuit. The suggested safety circuit size is 14 – 16 AWG.

(9) For typical power sources, the recommended connector plug and socket rating is 600 volts/32 amps minimum for the main circuit and 250 volts/30 amps for the plug to the generator.

(10) All conductors must be enclosed in liquid-tight conduits. Where external connections are necessary (e.g., to the booms, pulsator, or foot safety switch), use

appropriately rated SOOW and SJOOW cables, watertight condulet/junction boxes, and connector plugs and sockets (meeting the NEMA 4 and IP65 standards or greater). All conductors installed in a common raceway (conduit) must be continuous (without connectors, breaks, or splicing) and independently and correctly insulated. High and low voltage (safety circuit) conductors do not need to be placed in separate conduits.

(11) Mount fire extinguishers away from gas cans, generators, or other fire sources.

(12) Mark watercraft with "Danger Electricity" signage.

B. Controls for Electrical Equipment.

(1) The boat/raft operator must have ready access to a generator or pulsator on/off, emergency stop, or safety switch to cut the power in case of an accident.

(2) At least one netter on the bow work deck must have a safety switch connected to the power control circuit.

C. Lighting.

(1) When operating at night, you must have adequate lighting for working areas. Lighting may include fixed lights (12-24 volts) or head-lamps.

(2) You must use adequate lighting outside the watercraft to avoid safety hazards, such as striking logs, rocks, and overhead tree branches.

(3) Lighting and other auxiliary circuits should not exceed 24 volts. Light emitting diode (LED) lamps can provide effective lighting with low amperage draw, usually requiring 12 volts. If shielded with a protective housing, you may use 120 volt lamps.

PERSONAL PROTECTIVE EQUIPMENT AND SAFETY PRACTICES

6.11 What personal protective equipment and safety practices are applicable to all electrofishing operations?

A. Gloves.

(1) All team members must wear rubber gloves that are long enough to isolate hands from touching external surfaces. Common glove materials include neoprene, polyurethane, butyl, silicone, natural rubber, and PVC. Rubber insulating ("lineman's") gloves are not required. Class 0 rubber insulating gloves (maximum use voltage = 1,000 V RMS) with leather glove protectors are a practical glove system and allow for dexterity.

(2) Team members must visually inspect gloves for punctures before each use and replace them immediately if they are torn or punctured.

B. Net Handles. Net handles must be constructed of a nonconductive material and be long enough to avoid hand contact with the water.

C. Polarized Sunglasses. Team members should wear polarized sunglasses when there is glare.

D. Noise.

(1) If using a generator, a noise survey to document Sound Pressure Level (SPL) exposures to electrofishing crew members must be performed. When subjected to sound levels at or above 85 decibels (dBA), regardless of time exposed, crew members must wear hearing protection to reduce sound levels (see 242 FW 3). Also, whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level of 85 dBA, a continuing effective hearing loss prevention program, in accordance with 242 FW 3, must be administered. The team leader should ensure that any time a generator is used, hearing protection is available for anyone who wants to wear it, whether or not it is required. Inverter generators are substantially quieter than traditional generators, but require a special stabilizer sold by electrofishing equipment manufacturers.

(2) More information about personal protective measures for preventing hearing loss, such as using earplugs, is available in 242 FW 3.

(3) Project Leaders may buy 2-way communication headphones using duty station funds. If you use 2-way communication headphones, you should do so in accordance with 242 FW 3. To be effective, headphones should provide clear communication among personnel.

E. Gloves and Wader Repair or Replacement. Electrofishing operations should be discontinued if a crew member feels electroshock through gloves or waders. Replace or repair gloves or waders to eliminate electroshock.

F. First Aid Kit. Maintain and have available a well-equipped first aid kit (see 243 FW 1, Exhibit 1).

G. Automated External Defibrillators (AED). We recommend, but do not require, that all electrofishing crews be equipped with an AED. If AEDs are provided, then a minimum of two team members must be AED-certified and a formal written program established at the local level. A medical director must oversee the program.

H. Exhaust From Power Source. The exhaust from gasoline powered engines must be directed away from the equipment operator. Enclose any added exposed hot pipes in a protective covering (e.g., screening) that you may paint with high temperature yellow paint, or position them so that crew members will not be burned. Do not use plastic or galvanized pipe for exhaust because it may release toxic gases when extremely hot.

I. Fuel Storage.

(1) Store and transport gasoline and other fuels in approved safety cans. Unless specifically designed as a fuel tank for a generator, pump, or outboard motor, safety cans that meet OSHA standards are required (29 CFR 1926.152(a), 155(a), 155(l)). OSHA recognizes safety cans approved by testing laboratories as Factory Mutual (FM) or United Underwriters Laboratory (UL). We recommend that you use approved plastic containers with stainless steel fittings to reduce corrosion issues. Screw-cap type containers that do not meet safety standards are not permissible for such flammable liquids as gasoline.

(2) If rough transport could result in spillage from an approved safety can, then the team must use U.S. Department of Transportation (DOT)-compliant transport and dispensing safety cans. These are commonly referred to as DOT/OSHA cans and have filler caps you can lock down to avoid leaks during transport. You can also release the locking mechanism so that the container will function as a safety cap during fueling operations.

J. Refueling.

(1) Turn off all equipment before refueling the generator and allow hot surfaces to cool. We recommend that you fill all tanks before each operation to avoid the potential for explosion or fire while refueling.

(2) Only fuel away from any open flame or a flame-generating device. You should use a properly sized flexible filling spout or funnel during refueling to avoid spills.

(3) Place portable fuel tanks on a dock or pavement for refueling. Do not refuel portable fuel containers on a plastic surface (e.g., a plastic lined pickup truck bed). We recommend that you use a bonding wire between metal tanks/containers.

K. Handling Electrodes.

(1) After operation of an electrofishing unit, before handling electrodes, disconnect the electrodes from the rest of the system (e.g., with backpack shockers, unplug handheld electrode from the pulsator; with boats, unplug the power output cable from the pulsator). Capacitors in the pulsator hold a charge for a period of time after the power is turned off. Capacitors self-discharge, often in less than 5 minutes. Check with the equipment manufacturer to determine capacitor discharge times for your pulsator model.

(2) Never touch both electrodes simultaneously while the power source is running, when both electrodes are connected to the equipment circuit, or prior to capacitor discharge time after power shutdown.

L. Servicing Pulsator. Before opening a pulsator to service it (e.g., changing fuses), capacitors must be in a discharged state. Do not service the pulsator unit until the capacitor self-discharge time has elapsed, typically within 5 minutes (contact

manufacturer for the discharge time). We recommend that you label pulsators with their capacitor discharge time.

M. Making Connections or Repairs. Prior to adjusting connections or making repairs, disconnect the power source.

N. Startup of Electrofishing Unit. Before turning on the electrofishing unit, warn all team members and check to be sure they are aware electrofishing is about to begin.

O. Equipment Inspection. Maintain all electrofishing equipment in a safe condition. Visually inspect external wiring, cables, and connectors for physical damage before each use and periodically during use. Test safety switch operation with a multimeter. Any equipment deficiency that may present a safety hazard must be corrected before beginning or resuming electrofishing activities.

P. Protecting Others. Discontinue electrofishing if anyone outside of the electrofishing team approaches within 30 feet (for backpack operations) or 100 feet (for all other electrofishing operations).

Q. Weather. Discontinue electrofishing during dangerous weather conditions.

6.13 What additional personal protective equipment and safety practices are applicable to electrofishing boats and rafts?

A. Standard Safety Equipment.

(1) All watercraft occupants must wear U.S. Coast Guard-approved personal flotation devices at all times in accordance with the U.S. Department of the Interior and Service watercraft safety policy (see 485 DM 22 and 241 FW 1).

(2) Boat crew members must wear, at a minimum, rubber-soled boots or other boots rated for electrical hazard protection (e.g., those meeting standards in ASTM F2412-11, ASTM F2413-11, and ASTM F2892-11).

(3) Netters in rafts that have a non-conductive work-deck surface must wear hip waders to prevent contact with wet surfaces.

(4) Motorized electrofishing boats must be outfitted with required safety equipment (also see 241 FW 1, Watercraft Safety).

B. Clear Working Space. There must be adequate working space to conduct safe operations. The team leader and all crew members must be careful to prevent clutter that may cause safety hazards.