Habitat Assessment and Monitoring Program

2006 Annual Report

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Columbia Fishery Resources Office
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Prepared for United States Army Corps of Engineers

Executive Summary

The objective of the second year of HAMP was to build upon the frame work for a long term multi-agency monitoring program. Much of the work conducted during 2006 field season focused on maintaining a strict, monthly sampling regime in Segment 13 and initial sampling in Segment 10. A power analysis will be run on Segment 13 sampling data to determine the level of sampling effort needed to detect changes in the fish community.

Sampling in 2006 was conducted on the Lower Missouri River on eleven pre-selected bends consisting of five bends between the Kansas River and the Grand River and six bends between the Osage River and the Grand River. Before/After/Control/Impact (BACI) was used as a sampling design to test physical and biological habitat modifications in discrete sections of the river as a controlled experiment (in as much as this is possible in a dynamic large river). Sampling gears selected for HAMP were intended to evaluate a variety of different habitats as well as a variety of fish species and sizes.

Data collection efforts during 2006 consisted of a total of 240 gear deployments capturing 19,855 fish in Segment 10 and 1,109 gear deployments capturing 60,043 fish in Segment 13. A total of six pallid sturgeon and 793 shovelnose sturgeon were captured during 2006. Shovelnose sturgeon were captured on all bends sampled. Young of the year and juvenile sturgeon data were analyzed separately since Shallow Water Habitat is intended to provide nursery habitat for sturgeon and that was a priority in sampling objectives. A total of 56 YOY and 363 Juvenile shovelnose sturgeon were captured with all gears in 2006.

Chub species are a primary food item for pallid sturgeon and may be indicator species of pallid sturgeon habitat. A total of 275 sturgeon chubs, 2,065 sicklefin chubs and 6,150 speckled chubs were captured during the 2006 season. Speckled chubs were the most widespread and consistently captured chub in 2006 sampling. Most chubs were collected in trawls.

The Columbia Fishery Resources Office (FRO) HAMP crew conducted a variety of cursory analysis to examine the differences in bends. This included CPUE's, MANOVA's, community similarity, discriminate function analysis, and canonical correspondence analysis. In general, fish communities are different between bends and through the sampling season but

Results from this initial year of monitoring indicates that species CPUEs were not significantly different between 25 and 75% radius bends. However, catch rates for the five target species were generally higher on the 75% bends than the 25% bends. It is presumed that the 25% bends more closely mimic natural and preferred habitat types of the pre-channelized lower Missouri River than shorter, dike dominated 75% bends because they more frequently contain large inside-bend sandbars.

Analysis of microhabitats by gears suggests that the two experimental gears were successful in collecting young and small fishes. Push trawl improves time efficiency for sampling shallow and near-shore habitats where many YOY occur. It samples these habitats that were previously sampled by seining and others areas (i.e., natural steeps, soft muddy substrates, fast current) not suitable for seining.

Ecomorphology is an important factor in habitats used by fishes. Young-of-the-year sicklefin chubs and YOY unidentified chubs were most associated with slow moving pool habitat around un-notched wing and L-dikes. Results of both discriminant function and canonical correspondence analysis indicate that higher velocity habitats (e.g., sandbars) were more associated with fishes suited for fast current.

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Introduction

Rivers and streams are important components of the landscape in the United States and the world. These areas, along with their associated floodplain and upland areas are important corridors of economic, social, cultural and environmental value. Stream corridor ecological processes and their interaction with the surrounding terrestrial habitats create a mosaic of environments rich in soil, vegetation and species diversity. Stream corridors are among the most biologically productive ecosystems in the world (Federal Interagency Stream Restoration Working Group 1998). Undisturbed, stream corridors exist in a dynamic equilibrium that support and nurture diversity in both aquatic and terrestrial environments allowing high productivity and diversity in plants and animals in a landscape capable of supporting this richness and abundance. Development of stream corridors affects carrying capacity and the diversity of its flora and fauna.

On the Missouri River, development has addressed flood control, recreation, hydropower and other important societal purposes. The upper 1,500 miles of river has been converted into reservoirs habitat through a series of dams. The remaining river starting 50 miles below the last dam, (Gavins Point), has been modified by dikes, armored banks, and levees, turning a dynamic, multi-channeled, highly variable river system into a predominantly deep and swift, single channel. These modifications of the river allowed agriculture and other land-based developments within the fertile floodplains. Development that trained the lower river has decreased overall habitat diversity of both aquatic and terrestrial habitats (Federal Interagency Stream Restoration Working Group 1998).

The cumulative effects of development actions have resulted in significant changes to the Missouri River ecosystem. Changes include loss of habitat for fish and wildlife through degradation of banks and river bed, conversion to cropland, and the resulting suppression or alteration of natural ecosystem processes (i.e. flood events, natural flow regime, sediment transport, etc.). While all Missouri River species have been impacted, several have been greatly negatively affected. These include pallid sturgeon, least terns and piping plover (FWS 2000). In 2003, the U.S. Fish and Wildlife Service issued the Amended Biological Opinion (ABO) on pallid sturgeon which set forth guidelines and mandates for recovery efforts. The ABO addressed destruction, degradation, and fragmentation of Missouri River habitat which is the driving force behind today's decline in species richness and biodiversity(FWS 2003)

Habitat restoration has been identified as an important component to restoring populations of threatened and endangered species. Restoration focuses on reestablishing the structure and function of the ecosystem (National Research Council 1992). Two strategies being used on the Missouri River to create habitat are: 1) construct the desired end-state to immediately provide useable habitat and 2) modify the habitat to promote or allow natural processes to create the habitat over time. These strategies are thought to have value in developing habitat on the Missouri River mainstem. Both strategies focus on site specific ends states. An action (i.e. creation of a chute or pilot channel) is designed to create a specific habitat component in a specific area. For example, chutes are created to provide habitat with diverse velocity and deposition structure throughout the chute. The desired end-state is then a dynamic riverine

ecosystem that changes in function within the changing hydrology of the main channel with regard to species use.

All action specific end-states designed as individual pieces of a larger whole have the potential to move the Missouri river towards a more natural aquatic environment. Under the ABO, COE is required to restore some natural form and function to the Missouri river, including the hydrograph, to provide the necessary habitat in quantity and quality to benefit the species. The desired end-state of all restoration actions will be a Lower Missouri River that resembles a dynamic and self-sustaining habitat for the listed species.

Currently, the desired end state for the Missouri River mainstem system is thought to be a river with increased top width (increased habitat diversity in depth and velocity), increased function in alluvial and ecological processes that have value in eliciting a positive biological response from the pallid sturgeon and other native big river fishes. The influence and importance of specific physical and physiochemical characteristics (habitat, flow, temperature, turbidity, etc) are not clearly understood at this time. As this information becomes available, it will influence the desired end-state through an adaptive management process.

Omaha and Kansas City Districts of the COE are engaged in actions that would provide a diversity of depths and velocities in an attempt to create habitat that meet the ABO criteria for navigation flows. The habitat creation effort includes various structural modification activities: notching, chute development, pilot channels, chevrons, backwaters and dredging activities. Habitat creation work is still underway to address restoration of form and function of riverine processes thought to be necessary to sustain these habitats in quantity and quality. The ABO has identified shallow water habitat as the limiting habitat in the system and has established acreage goals to increase this habitat.

The ABO describes shallow water habitat as being less than five feet in depth with current velocities less than 2 feet/second. It is thought that this habitat is lacking in the channelized portion of the Missouri River and may be important for survival of pallid sturgeon during early life history (directly or indirectly). It is also understood that these modifications will increase habitat diversity of the lower river and will likely benefit other native big river fishes.

The Habitat Assessment and Monitoring Project (HAMP) is being developed to quantify the results of habitat creation projects. HAMP is divided into physical and biological monitoring. Physical portion of the project will examine and quantify (acreage) the amount of shallow water habitat being created by COE projects. Biological portion of the project will explore the fish community response to shallow water habitat development. The initial year (2005) of biological monitoring served to develop and experiment with gears that would appropriately sample target species.

Study Site

The USFWS Columbia Fishery Resources Office (Columbia FRO) HAMP crew worked on sites located in the state of Missouri. Sampling in 2006 was conducted on eleven pre-selected bends of the Lower Missouri River. Five of the six pre-selected bends (Table 1) between the Kansas

River and the Grand River were sampled, designated as Segment 10 in the Pallid Sturgeon Population Assessment Program (PSPAP). These bends were: Malta Bend, Baltimore Bend, Sni Bend, and Camden Bend. Lower Miami Bend was not sampled in 2006 and Fishing River Bend was sampled only once.

Six pre-selected bends (Table 2) between the Osage River and the Grand River were sampled, designated as Segment 13 in the PSPAP. The selected bends were: Eureka Bend, Searcy Bend, Rocheport Bend, Slaughterhouse Bend, Robinson Bend, and Wilhotie Bend. These six bends included duplicates of Control (C), treatment Before/After (B/A), and treatment after or Impact (I) as described for the Before/After/Control/ Impact (BACI) design. The details of how and why these bends were selected will be discussed in the Methods section.

Table 1. Segment 10 bends sampled for HAMP by Columbia FRO in 2006.

COE bend #	Segment - RM#	Bend Name	Bend Rm	Treatment Type	Bend Radius
104	10-3	Lower Miami	260.2	Impact	25%
110	10-9	Malta	274.0	Before/After	25%
119	10-18	Batlimore	304.4	Before/After	75%
125	10-24	Sni	321.1	Control	75%
127	10-26	Camden	327.1	Control	25%
129	10-28	Fishing River	335.3	Impact	75%

Table 2. Segment 13 bends sampled for HAMP by Columbia FRO in 2006.

COE bend #	Segment - RM#	Bend Name	Bend Rm	Treatment Type	Bend Radius
69	13-13	Eureka Bend	162.4	Impact	25%
75	13-19	Searcys Bend	180.5	Before/After	25%
77	13-21	Rocheport Bends	183.5	Impact	75%
87	13-31	Slaughterhouse bend	205.6	Control	75%
89	13-33	Robinson Bends	209.3	Before/After	75%
97	13-41	Wilhoite Bend	234.5	Control	25%

Methods

Goals and objectives

The HAMP Team has determined the following goals and objectives will provide sufficient focus and guidance to the evaluation efforts. These goals and objectives will ensure the end product will be useful in (1) providing important habitat information necessary in guiding future habitat development efforts, (2) providing important biological information necessary to build

our knowledge of pallid sturgeon life history and habitat requirements, and (3) provide pertinent information to the managers and decision-makers of the Missouri River Basin.

We have determined the need for a program goal and specific monitoring goals. The program goal of the HAMP is to effectively assess the physical and biological responses to mechanical habitat alteration intended to create functional habitat to benefit the pallid sturgeon and other native fishes in the Lower Missouri River System. The intent of the program is to provide a predictive understanding to guide future restoration actions. To help accomplish the programmatic goal, and fulfill its intent, the program has developed specific monitoring objectives.

The monitoring objectives are to assess the (1) physical and (2) biological responses to habitat creation actions. The research questions that this document will address are as follows:

Are physical treatments producing the habitats (quality and quantity) described in Appendix A?
a. Hypotheses: There is no physical difference between the constructed site and the control site.
b. The constructed habitat site has less physical value than the control site

Are important fish variables influenced by physical treatments?
a. There are no differences in fish species composition, richness and relative abundance of targeted life stages between the constructed site and the control site.
b. Fish species composition, species richness, and relative abundance of targeted life stages are less at the constructed site than at the control site.

Study Design

To assess the habitat changes and account for the temporal and spatial variation in the Lower Missouri River, we will employ the quasi-experimental control/impact design. This design has many variations and can be adapted to many unique situations. For our need, the BACI (Before/After/Control/Impact) design provides the ability to capture the variability within the various segments and begin to identify potential cause and effect relationships so an understanding can be gained as to how management actions are affecting available habitat as it relates to the pallid sturgeon and other organisms. The sample unit most appropriate for this design is the bend. To ensure we capture as much information as possible and reduce the variation as much as possible we will sample the bend at both the bend and structure level.

To further isolate the variation within the Lower Missouri River we have broken the river down into hydrologic segments. These segments are consistent with the segments used by the Pallid Sturgeon Population Assessment Program (PSAP—Table 3). Within each segment there are at least two treatments, representing the 25th and 75th percentiles of bend size based on the Bend Assessment done by the Engineering Sections of USACE Omaha and Kansas City Districts (Appendix A).

Table 3. Segments and specific Treatment sites.

District	Segment
Omaha	Ponca to Platte R.
	Platte R. to Kansas R. (Platte R to Rulo)
Kansas City	Platte R. to Kansas R (Rulo to Kansas R)
	Kansas R. to Grand R.
	Grand R. to Osage R.
	Osage R. to St. Louis

The study design will attempt to assess the physical and biological responses to the habitat manipulation that have occurred by identifying a control bend for each treatment bend. Each of these sites (treatment and control) will be assessed using a standard sampling approach to allow for comparison between the two sites. This control/impact portion of the design will provide insight into current differences at the bend level based on actions that have already been taken within the bend, but gives no direct information on the magnitude of the change attributed to specific actions within a bend. The cause and effect relationship between the physical modifications and the biological response before/after comparisons will be made using another selection of control bends. In conjunction with the control/impact assessments, the teams will sample all selected bends (treatment and two controls) with equal intensity. Then a planned suite of modifications will occur in the Before/After control bends to capture the direct affect of the specific action. Hence, each treatment will have two controls: one to be a control for the control/impact aspect of the design and the other is to be used in the before/after portion of the study.

The controls will be as minimally altered as possible. A list of controls has been developed based on a Bend Assessment conducted by the COE Omaha and Kansas City Districts Engineering Sections (Appendix A). The controls for each treatment were selected by reviewing pertinent information on the best controls possible based on our ability to plan/carry out specific actions (See Table 2). To capture the greatest amount of variability regarding the manipulations of the second control for the B/A experiment, modifications should take place after three years of "before" modification data collection and should be monitored for a minimum of 3 to 5 years after the modification. Both physical and biological data will be collected at each treatment and control bend.

In the Lower Missouri River, because of the upper basin dams, channelization and controlled flows in the section from Sioux City, Iowa to the Platter River, the Omaha reach and the Kansas City reach experience very different hydrologic and morphologic regimes. The section from Gavins Point to Rulo, Nebraska can be generally characterized as a narrow, deep and swift channel with short training dike structures. Habitat diversity is low, especially from Sioux City

to the Platte River. In this section, the creation activities have changed little in relation to our expectations because of the limited hydrologic energy and sediment transport throughout the reach. The section below Rulo can generally be characterized as channelized, but habitat diversity is more variable due to peripheral habitats off the thalweg. Tributary influences from the Platte River downstream provide flow and sediment to carry out a semblance of the habitat forming characteristics normally active in the riverine environment. Creation actions in this stretch are evolving/maturing faster than the Omaha section and hence provide more opportunity for structure evaluations and biological response detection.

Physical data collections will be sufficient to produce 2-D models of the bends. Substrate, depth, velocity (bottom and average column) and elevation data will be collected throughout each bend at the appropriate scale and intensity (# of transects per bend). Data collection methods will be consistent with professional standards described by COE standard operating procedure (SOP) for physical data.

Biological data collections will occur at two levels, the bend level and the structure level. For each bend sampled, a suite of gears (e.g., trawling and trammel nets) will be used consistent with PSAP protocols. This bend level sampling will be sufficient to quantify/characterize the bend. Under the current PSAP protocols two mesohabitats per macrohabitat are to be sampled with a minimum of 8 sets per gear. For HAMP, at least one half of the PSAP effort will be applied. This translates into sampling one meso-habitat per macro-habitat or 4 trawls and 4 trammel nets per bend. The underlying goal is to sample enough to quantify the fish community of the bend and provide the ability to identify trend differences within the bend over time.

The remainder of the time within a bend will be spent sampling the “footprint” of the structures within the bend. Year one was exploratory in terms of gears needed to quantify fish species. Year two continued to explore gears needed to quantify small bodied fishes and explored effort levels needed to detect change in fish populations throughout the sampling season. The micro-habitat classifications developed for the PSAP by Doyle and Starostka (Columbia FRO) provided the mechanism to articulate those unique habitats found in a Missouri River bend. Based on the habitat classification, the HAMP team used a suite of appropriate gears to quantify differences in the fish community between unique habitats and bend treatments.

Sample Design

Due to the large geographic scope and variation inherent in large-scale restoration efforts, the sample design must be concise and statistically valid. To assess the habitat changes and account for the temporal and spatial variation in the Lower Missouri River, HAMP employed the quasi-experimental control/impact design. This design has many variations and can be adapted to many unique situations. For our need, the BACI design provides the ability to capture the variability within the various segments. It also allows us to examine the cause and effect relationship that is essential in understanding how COE actions are impacting pallid sturgeon and other fishes.

For this BACI design, three types of bends were identified: Control (C), Before/After (B/A), and Impact (treatment) (I). Control bends will serve as the unmodified bend in C/I comparisons and the control bend in B/A comparisons. A list of bend types has been developed based on bend

assessments conducted by the COE Omaha & Kansas City districts. The BACI approach is designed to evaluate COE modifications from two different aspects. The first aspect, designated Control/Impact (C/I), is to compare an unmodified bend to a similar bend that received habitat modification through time. Habitat construction primarily consists of dike modifications ie (notching). This C/I portion of the design will provide us with insight into the overall change at the bend level based on the construction actions taken within the bend, but gives no direct information relative to the magnitude of the change from a specific action. The second aspect, designated B/A, is to evaluate the changes over time between two bends: a Control, and a Before bend, during, and after modification. This comparison will attempt to assess the cause and effect relationship between the physical modifications and the biological response.

Control bends were selected by reviewing bend radius information provided by COE engineers based on the ability to plan and carry out specific actions (Appendix A). The controls will be as minimally altered as possible. To capture the greatest amount of variability regarding the manipulations for the B/A experiment, modifications should take place after three years of "before" modification data collection and should be monitored for a minimum of 3 to 5 years after the modification. Therefore, B/A bends were chosen based on an agreement with the COE that modifications would not occur until three years after monitoring began. Both physical and biological data will be collected at each bend.

Bends with radii in the 25th and 75th quartile range were used as our experimental units to treat the effects of modifications over a range of bend types in the river bends. Control bends were selected on river bends where modifications (either for navigation or habitat creation) are not likely, but that still meet the criteria for bend radius. B/A bends were selected where habitat work is likely to be conducted in the near future and also meet the criteria for bend radius. Impact bends were selected from bends were habitat construction had been conducted in 2004 that meet the criteria for bend radius (Table 1).

Because of the differences in physical characteristics between the Omaha and Kansas City reaches of the Lower Missouri River described above, there are some differences in the basic sampling design between reaches (e.g., intensity and type of sampling) to ensure necessary data is being collected throughout the full extent of the study. These modifications are described in the following sections (Columbia FRO and Nebraska Game and Parks Commission—NGPC). These modifications are exploratory and short-term in nature and information gained from these efforts will be used to further refine the long-term efforts of the program. The standard design covers 4 segments with 12 bends sampled within each segment for a total of 48 bends (Tables 4 and 5). Segment 1 (Ponca to the Platte) and 2a (2a: Platte River to Rulo) are contracted to NGPC. Segment 2b and 3 (2b: Rulo to Kansas River, 3: Kansas River to Grand River), segment 4 (Grand River to the Osage River), and segment 5 (Osage River to confluence of Mississippi River) are contracted to the Columbia FRO. Because of the lack of controls in the Omaha reach sampled by NGPC, segments 1 and 2a are 10 bend segments. Each bend will be sampled according to the descriptions above (i.e., at least half of the PSAP protocol using the standard gears.)

The treatments within the design are bends where a type of physical creation action (dike mod, chevron, etc.) has been taken. The 2 major categories of treatments are Dike Modification and Major Modification (Table 4). The BACI design is captured in the table below.

Table 4. Blocked BACI Design.

Reach	Radius of Curvature 25th Percentile			Radius of Curvature 75th Percentile		
1	Dike Mod	Control c/i	Control b/a	Dike Mod	Control c/i	Control b/a
	Major Mod	Control c/i	Control b/a	Major Mod	Control c/i	Control b/a
2a	Dike Mod	Control c/i	Control b/a	Dike Mod	Control c/i	Control b/a
	Major Mod	Control c/i	Control b/a	Major Mod	Control c/i	Control b/a
2b						
	Major Mod	Control c/i	Control b/a	Major Mod	Control c/i	Control b/a
3	Major Mod	Control c/i	Control b/a	Major Mod	Control c/i	Control b/a
4	Major Mod	Control c/i	Control b/a	Major Mod	Control c/i	Control b/a
5	Major Mod	Control c/i	Control b/a	Major Mod	Control c/i	Control b/a

The category Dike Modification includes Type B notches, which occurred only in the Omaha Reach (Appendix A). Major Modification includes other types of bank notches, revetment notches, pilot channels, and chevrons. In 2006, due to the need for more creative or aggressive actions, additional modifications, reverse sills, rootless dikes, and segmented revetments, were added to the Omaha reach (Appendix A).

The physical data to be collected within each of the treatment and control bends is to include water elevation, channel geometry, depth, velocity and substrate within the channel and land surveys sufficient to allow the creation of two dimensional models of each bend. LiDAR is being tested as a means of providing terrestrial information for the modeling efforts. Some information regarding its value should be available by the end of 2006, or early 2007. Physical data is to be housed and managed by the COE Omaha District. This data will be used to generate models that, once calibrated, could provide habitat availability curves for use in future actions. It was determined that developing 12 models (6 from Rulo up, 6 from Rulo down) per year would allow development of models of all bends over the course of 4 years. Data would be collected from each bend in every year and continuous surface elevation maps would be developed to provide information regarding habitat change over time in the years the bend is not being modeled.

The biological data to be collected would be used to determine presence/absence, habitat use, fish abundance, and abundance change over time. Where possible, sampling efforts within this evaluation will be consistent with the standard gears and protocols of PSAP. Some non-standard gears (i.e., exploratory) will be used to sample unique habitats not effectively sampled by the standard gears (i.e., trammel, 16’ otter trawl, mini-fyke nets) to target larval and juvenile sturgeon. The amount of effort spent on each of the sampling areas (i.e., standard or exploratory) will vary based on reach (Omaha versus Kansas City) because of the very different habitats available in these two reaches (See individual descriptions below). The indicators to be focused on are: all life history stages of pallid sturgeon, particularly young-of-year (YOY) and juvenile stages and prey/native species identified by the PSAP as surrogate species. Biological data will

be processed and managed in the same database as the PSAP by the Missouri Department of Conservation database manager.

Table 5. 2006 Modified Sample Design Including Bend Sampled.

Reach	Radius of Curvature 25th Percentile			Radius of Curvature 75th Percentile		
1 NGPC	Dike Mod	Control c/i	Control b/a	Dike Mod	Control c/i	Control b/a
	Lower Little Sioux Bend	Boyer Bend	Lower Decatur Bend	Tyson Bend	DeSoto Bend	Lower Peterson Bend
2a	Pin Hook	Lower A Civil	Otoe	Tobacco	Van Horns	Upper Civil
	Upper Hamburg	Upper Barney	Lower Calhoun	Nebraska City	Lower Copeland	Upper Littler Sioux Reach
2b Columbia FRO			Upper Louisville			Upper Glovers Point
	Major Mod	Control c/i	Control b/a	Major Mod	Control c/i	Control b/a
	Dallas Bends	Nemaha Bends	Tarkio Bend	Rushville Bend	Kenmore Bend	Upper Latan Bend
3	Lower Miami Bend	Camden Bend	Malta Bend	Fishing River Bend	Sni Bends	Baltimore Bend
4	Rocheport Bend	Slaughterhouse Bend	Robinson Bend	Marion Bend	Wilhoite bend	Searcys Bend
5	Isbell Bends	Chamois Bend	Pinckney Bend	Doziers Bend	Washington Bend	Creve Coeur Bend

Biological sampling design

Much of the sampling conducted during 2005 season involved evaluation of sampling gears and development of sampling design. Multiple gears were utilized to find gears that were efficient at collecting target species and meet the needs of HAMP. Several gears used on other large river projects and new or experimental gears that are novel to riverine systems were evaluated. Most gears used were targeting small bodied fish and sturgeon species. Both active and passive gears were evaluated.

In 2006, the focus shifted to refining gears for HAMP needs and determining effort level needed to detect differences between treatments. For the Kansas City reach, there was a more intense focus on seeking out the early life history stages of pallid sturgeon. The effort was targeted in nature and was focused on providing specific habitat use/biological response information to guide the overall program actions in the future. To accomplish this intensive effort, the number of bends sampled per segment was set at six. This allowed for habitat-specific, targeted sampling while still ensuring each bend will be quantified at the bend level.

Sampling for HAMP by the Columbia FRO on the Lower Missouri River will consist of monthly sampling of 6 selected bends per segment. As described above, the intent of the BACI design is to use “standard” traditional gears to quantify fish communities of the bend as well as new and innovative gears that provide more sampling flexibility and meet specific sampling needs of HAMP (i.e., YOY sturgeon and habitat use/biological response).

Standard Gear Sampling

The first tier of sampling in a bend consisted of sampling with gears standard to the PSAP using established PSAP protocols (Drobish 2007). The only difference was that HAMP effort was half of that described for PSAP (Table 6). For HAMP that translated into 4 samples each of 16’

standard otter trawls, 1” trammel nets and minifyke nets per bend. These gears were deployed with at least one sample in all available macrohabitats in the sampling bend. If less than four marcohabitats were available, the gears were set in proportion to the amount of macrohabitat available for the particular bend. Gear dimensions and deployment was consistent with the PSAP (Table 7).

Directed Sampling

The second tier of sampling in a bend consisted of targeted efforts. This included gears that were specifically designed to sample YOY fish and other small bodied fishes: the push trawl and a 16’ small mesh otter trawl (Table 6). Big river sampling is a new field and although traditional techniques have been employed in the past, they have not been effective or efficient in acquiring the samples needed to evaluate unique habitats.

The push trawl is an eight foot trawl made of a 4 mm polyester Rachelle net with an envelope style cod end that is used in conjunction with a set of 24” wood otter boards. An outboard jet drive boat was used to push this net in front of the boat with a set of booms. The push trawl was specifically designed to sample shallow water (<2 m deep). The push trawl was used over a variety of substrates and fished over a range (0-1+ m/s) of water velocities. Push trawling allowed the flexibility to sample habitats that, in the past, were difficult or impossible to sample. Areas such as steep clay banks that were too steep and swift to seine or set minifykes in the past are now being sampled with this gear.

The 16’small mesh trawl was designed to be used in deeper water and deployed from a stern trawl boat. This net can be bow trawled when larger trawl boats are not available. The 16’ small mesh otter trawl is made from the same 4 mm polyester Rachelle as the push trawl but was deployed using 30” otter boards. As with the push trawl, this net was specifically designed to sample YOY and other small bodied fishes. It is capable of capturing fishes as small as 15 mm in total length. Since both the push trawl and the small mesh 16’ trawl are made of the same mesh, catches should be more comparable between gears than with other gears used in the past.

The sampling design for the push and small mesh trawl was more intensive and random (Table 7). The bend was partitioned into cells based on the structures present (Figure 1) with each cell partitioned into eight sub-cells using a linear grid parallel to the current (Figure 2). The sub-cells sampled and the order in which they are sampled was determined by randomly selecting a cell and then randomly selecting a sub-cell within the cell to be sampled. Sub-cells were sampled without replacement (i.e., no sub-cell within a bend could be sampled more than once). Cells were sampled with replacement until all sub-cells within the cell have been sampled once or the number of sub-samples collected for a bend had been achieved. Sampling with replacement of cells provided the potential for multiple sets per cell/structure. The number of samples collected was determined based upon the total number of cells available (i.e., longer bends included more samples than shorter bends so that the proportion of the bend sampled remained consistent among bends). When present, large sand bars were partitioned into sampling cells that are similar in size as the average distance between dikes of that bend. If the sub-cell that is randomly selected had no appropriate sampling areas for the gear being deployed, the next random cell on the list was used. The intent of the sampling cell and sub-cell system is to provide a system

where all available habitats are randomly sampled when conditions are appropriate for that particular gear.

Sampling consisted of the random selection of sub-cells to provide a representative sample of the fish community at the bend level. The overall average effort for the push and small mesh trawl was 15 “sets” or trawls per bend. Longer bends had more (15-20) and shorter bends had less (10-15).

Table 6. Description of gears used in the 2006 HAMP sampling field season.

Gear	Notation	Standard or Directed	Materials and Dimensions
16 foot Otter Trawl	OT16	S	Faulkner custom Skate design, # 9 Sapphire®, 1.5 inch stretch, 16ft wide and deployed using a set of 30 inch otter boards
16 foot Small mesh Trawl	OT01	D	Faulkner custom Skate design, 4 mm mesh, 16 ft. wide and deployed using a set of 30 inch otter boards
8 foot Push Otter Trawl	POT02	D	Faulkner custom Skate design, 4 mm mesh, 8 ft wide and deployed off the bow using a set of 24 inch otter boards
1 inch Trammel Net	TN	S	125 ft. X 6 ft. outer wall X 8 ft. inner wall; 1 inch bar X 8 inch bar panels
Mini-Fyke	MF	S	2 cab frames @ 4 ft. X 2 ft., two 2 ft. hoops, 15 ft. X 2 ft. lead, 1/8th mesh

Table 7. USFWS CFRO Gear/Effort/Stratification Table.

GEARS	EFFORT	STRATIFICATION
	(# samples/gear/bend/month)	
Standard		
Minifyke	4	Macro habitat
1" trammel nets	4	Macro habitat
16' standard otter trawls	4	Macro habitat
Directed		
Push trawl	10-20 (mean=15)	Random
Small mesh 16'otter trawl	10-20 (mean=15)	Random

Standard = Standard gear for the Sturgeon Monitoring Project
Directed = New gears specific to the HAMP project.

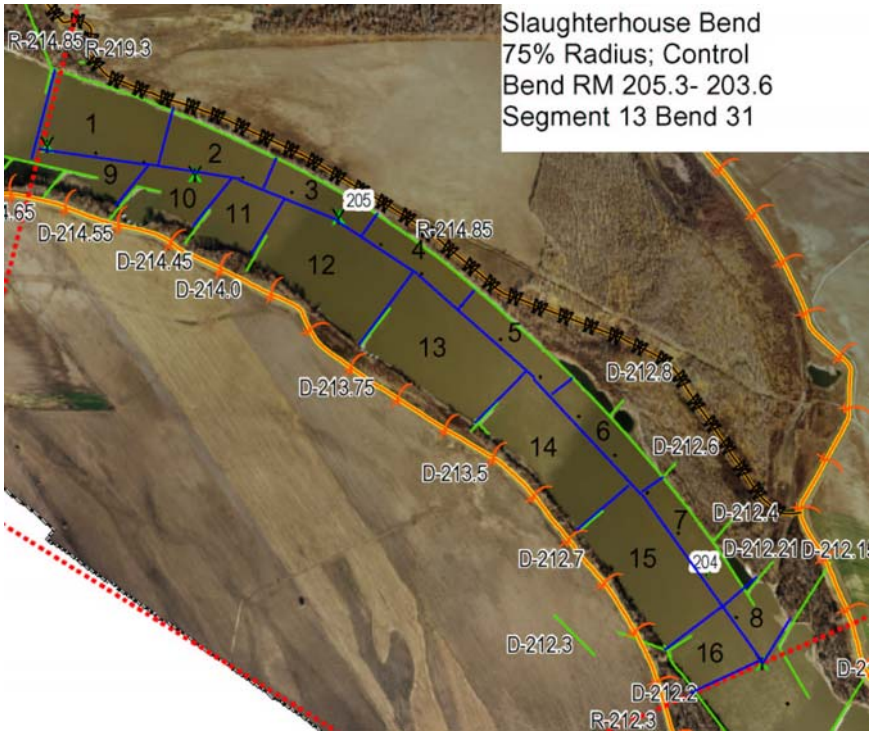

Figure 1. Example of a sampling bend subdivided into sampling cells to be randomly selected.

Figure 2. Example of a sampling cell divided into 8 sub-cells.

Gear evaluation and paired sampling of new gears

Both the push trawl and the small mesh 16' otter trawl are new gears that have little or no baseline data to compare sampling effectiveness with other gears that target larval and YOY fishes. Comparison sampling of the push trawl gear with the standard minifyke nets was used to determine if these gears sample differently. Comparisons using traditional paired sampling designs could not adequately address the concerns over gear interactions (depletion and/or behavioral) due to relatively small habitat sizes. Therefore, gear comparisons were made at the bend level. To do these comparisons, in addition to the randomly selected sub-cells sampled within a bend by standard gears, 10-20 randomly selected sub-cells were sampled using the minifyke net and 10-20 using the small mesh eight foot push trawl per month in each bend. Differences in relative abundance and species composition between minifyke nets and trawls both within and among bends were used to assess the similarity of catch of the two gears.

Additionally, statistical comparisons are needed between the standard 16' otter trawl and the small mesh 16' otter trawl. Although both of these nets are the same size (16' foot rope), these nets likely fish differently due to differences in mesh size, head pressure (i.e., the way water flows into the mouth of the net), and the speed at which the net can be pulled. A 8' otter trawl was used in the 2005 sampling season but was dropped in 2006 due to redundancy with current gears.

Adaptive Sampling Plan

Through a series of meetings with USGS, basin partners and the Sustainable Ecosystems Institute (SEI), the HAMP study has shifted focus from 2005 to 2006 and is on a track to change into 2007. In 2005, the study was conceived to use the Pallid Monitoring data on the river-wide scale to provide a comparison of fish communities to the pre-selected BACI sites. In 2006, the team agreed with the SEI panel in Omaha to focus our efforts on smaller fishes, since these fishes would show the change occurring in the system more quickly and provide the best guidance for "good habitat", which is the goal for the project. There was some discussion on what fish represented a "goodness" factor, at the January 17-18, 2006 HAMP meeting in Kansas city, engineers had perceived this to be pallid sturgeon, however biologists had perceived this to be the fish community as a whole since there is little chance of catching pallids at a high enough frequency to show real use of specific habitat areas. It was decided that a telemetry approach would be a more appropriate tool to monitor pallid use of these habitats and this tool would be explored at a later time. There was additional discussion at this meeting about the focus of sampling and whether or not we would target dikes that had been modified or the target bend. With the help of the engineers input, we concluded that the structures were created conceptually at the bend level and should not be evaluated at the footprint level. However, information on how fish used those modified structures was important to how the engineers proceeded with future modifications and an important informational need. The final meeting for Columbia FRO took place late in the spring with USGS including, Mark Wildhaber and Darin Simpkins. The goal was to set up a design that would include the items identified by previous meetings that year and provide a foundation to work from for a long term monitoring program. It was important that the team lay out a design that would address some initial confounding environmental and elementary sampling issues early in the project, these decisions were to:

- Incorporate a design that would allow us to detect changes at the structure level and depth level but evaluate the program at the selected bend level.

- Use high intensity and high frequency sampling in an effort to detect the environmental factors that would confound the data in future years.

- Use a random approach at the structure level that would allow us to detect the use of fish at the structure to help engineers make timely decisions in their efforts.

- Take on a random depth sampling approach with a newly designed push trawl to document use of small fish and sturgeon at shallow depths to address the position of the BiOp that shallow depths are important to sturgeon.

- Incorporate small mesh gears with high intensity to show change in the forage community and detect young of year use of newly created shallow water habitat.

- Use high frequency sampling, thereby reducing the number of bends but providing adaptive management guidance for the future in developing a sampling design that described when and how often the bends should be sampled with respect to the temporal changes in fish community in the system.

The guidance these decisions will provide for the future are as follows:

- The amount of sub-sampling needed to get precision in evaluating the community make-up at the bend level.
    - Which gears should be used and how many sub-samples per gear?
    - Determine which gears may be excluded in the future if they are redundant.
    - Determine which gears may be expanded in the future if they are more effective.

- The frequency at which sampling needs to be performed at each segment bend series to account for variation in seasonal and environmental affects in the river. Sampling may be expanded to bi-monthly or tri-monthly.

- Developing a sampling scheme that may need to be more frequent in certain times of the year and less frequent in other times of the year.

- Before and control bends may not be able to be accurately compared year to year if they occur outside of seasonal variability parameters (ie. if there is a significant change in abundance of fish after spawning events, it is important to monitor the same bend within the same time period each year to document the relative change).

The data provided from 2006 and 2005 will guide us into making sound decisions in setting up a long term project. Intense efforts this year will allow us to account for confounding environmental factors in the system that effect all the current Missouri River projects. Describing the parameters of these factors will enable the project to reduce the variability in the data and arrive at quicker and more statistically sound conclusions in the future. It is important

to understand the effort needed to describe the variability in the system before stating that effort level in cost needed to contract this work long term. Statistical results of 2006 and 2005 data should lead us to setting up a program that will reduce the need for adaptive management and lost data from program changes.

Target Species

HAMP is an assessment and monitoring offshoot of the BO developed for the pallid sturgeon. The objective is to quantify results of ACOE constructed habitat for pallid sturgeon that is mandated by the ABO. Pallid sturgeon are a rare species and few are captured while conducting field work each year. Inferences about habitat requirements for pallid sturgeon are impossible because only a small number of pallid sturgeon are captured through HAMP. In absence of this data, other common associated species are being used to provide inferences toward successful habitat creation.

Five species were selected as target species for analysis of habitat creation success in terms of pallid sturgeon recovery. These include pallid sturgeon, shovelnose sturgeon, sturgeon chub, sicklefin chub and speckled chub. Shovelnose sturgeon is a common species in the Lower Missouri River and the most closely related to the pallid sturgeon so it is a common surrogate species in many studies. It is assumed that at early life stages, shovelnose sturgeon have similar habitat requirements as pallid sturgeon. The three selected chub species are frequently found in the same habitats as the pallid sturgeon and are also known to be a prey item for adult pallid sturgeon providing useful information (Gerrity and Guy 2006). Therefore, the production of prey may provide another important role for constructed habitat sites and another metric for measure habitat creation success. The use of surrogate species to imply habitat information about pallid sturgeon should be used cautiously until research can quantify these relationships.

Pallid Sturgeon

The pallid sturgeon were federally listed as an endangered species in 1990. Most of the known ecology of the pallid sturgeon is related to adults. There is little knowledge of the requirements for larval and juvenile pallid sturgeon in the wild. Pallid sturgeon prefer open channels of large turbid rivers. They are more pisciverous than the shovelnose sturgeon. This benthic species prefer areas with current and firm substrate along sand bars and behind wing dikes with deeply scoured trenches. Although the pallid sturgeon often occur in association with shovelnose sturgeon, pallid sturgeon are more commonly found in areas with higher stream velocities (Pflieger 1997).

Shovelnose Sturgeon

Shovelnose sturgeon are the most abundant sturgeon species in the Missouri River. Although, shovelnose are a common species, abundance has been in decline since 1900 when the first documented records occurred (Pflieger 1997). Though closely related to the pallid sturgeon, there are slight differences in habitat and prey preferences. Shovelnose sturgeon inhabit open channels of large rivers often in areas with current and a sand or gravel bottom (Pflieger 1997). They prefer lower velocity areas than pallid sturgeon. Shovelnose sturgeon food habits tend to be more insectivorous than pallid sturgeon (Pflieger 1997).

Sturgeon Chub

The sturgeon chub is a relatively rare fish in the Missouri River and were a candidate species for listing under the endangered species act in 1999. The sturgeon chub preferred habitat is areas associated with deep swift water with shifting sand bottoms (Pflieger 1997). This combination of physical features is usually associated with large channel sand bar – main channel interface. The sturgeon chub is confined to the open channels of large rivers where it lives in strong current over a bottom of sand and fine gravel. Affinity of the sturgeon chub for gravel substrate has been noted (Pflieger 1997). The sturgeon chub is the least common of the chub species captured in the Lower Missouri River. Sturgeon chubs are captured in similar habitats as that of pallid sturgeon.

Sicklefin Chub

The sicklefin chubs is also a relatively rare fish in the Missouri River (though more common than the sturgeon chub) and were a candidate for listing under the endangered species act in 1999. The sicklefin chub's preferred habitat is areas associated with high velocity currents with shifting sand bottoms. Pflieger (1997) describes habitat preference of the sicklefin chub as being the same as the sturgeon chub. Although, sicklefin chubs are found on channel border and sand bar habitats. Observations by Columbia FRO's field crews suggest they occur in areas with less current than the sturgeon chub. This combination of physical features is usually associated with a large channel sand bar - main channel interface, but can also be found in other areas that are relatively deep and have flowing water. Sicklefin chubs are captured in moderate numbers when compared to other chub species in the lower Missouri River.

Speckled Chub

Currently, the speckled chub is the most abundant chub species encountered in the Lower Missouri River. Historically, speckled chubs were relatively rare and only accounted for 0.2% of small fishes in survey collections in the 1940's. By the 1980's this percentage had increased to 4.7% of small fishes in survey collections (Pflieger 1997). Although this apparent population increase has not been thoroughly explored, it may be that improvements in sampling gears specific to larger rivers could be the cause. Speckled chubs inhabit open channels of large low-gradient streams and can be found over sand and fine gravel with noticeable current (Pflieger 1997). Speckled chubs were found more often in areas with less current than either the sturgeon and sicklefin chub.

Life Stages of Target Species

One of the intents of shallow water habitat creation is to provide nursery habitat for young-of-year (YOY) and juvenile fishes. It is known that habitat requirements for many fish species change by life stage**.** In an attempt to quantify habitat use by life stage, target species were classified as YOY, juveniles, or adults based on lengths. Analyses of target species were reported as life stages and as a total catch.

Pallid and shovelnose sturgeon were divided into three life stages: YOY, juvenile and adult. Spawning and recruitment of pallid sturgeon is extremely limited or nonexistent in the Lower Missouri River with no YOY pallid sturgeon sampled in four years of intensive trawl efforts.

Therefore, no length category was set for YOY pallid sturgeon. Juvenile pallid sturgeon were fish that measured less than 700 mm. Pallid sturgeon measuring greater than 700 mm were considered adults (Keenlyne and Jenkins 1993).

Shovelnose sturgeon were also divided into three life stages: YOY, juvenile, and adult. YOY fish were between 0-200 mm in length which translates fish in the first year of life. Juvenile shovelnose sturgeon measured between 201 and 540 mm in length and adults were those greater than 541 mm in length (Hesse 2004; Morrow et. al. 1998).

Chub species were separated into two life stages: YOY and adult. YOY chubs were 0-40 mm in length while adults were greater than 40mm (Johnson in press, Everett 1999, Stewart 1981).

Unidentified chubs (UHY) and unidentified sturgeon (USG) are also included when enough samples were present. UHY and USG are YOY fish though positive identification to species in the field is difficult or impossible. Although identification to species was not possible, both classifications consist of the five target species and should be considered.

Results

Sampling effort

Sampling was conducted from June 1, 2006 to October 31, 2006. Data collection efforts during 2006 consisted of a total of 1,349 gear deployments consisting of 240 sets in Segment 10 (Table 8) and 1,109 sets in Segment 13 (Table 9). A total of 79,898 fish were captured during the 2006 field season with 19,855 captured in Segment 10 (Table 10) and 60,043 captured in Segment 13 (Table 11).

Table 8. Sampling effort for each bend by month for Segment 10 by Columbia FRO HAMP during the 2006 field season. Effort in this table is defined as gear deployments

			Number of Gear Deployments						
GEAR	MONTH		25% Bend Radius				75% Bend Radius		
			Bend - 3 Impact	Bend - 9 Before/After	Bend – 26 Control		Bend -18 Before/After	Bend – 24 Control	Bend – 28 Impact
16 foot Small mesh Trawl	JUNE							10	14
	JULY								
	AUGUST								
	SEPT								
	OCT								
16 foot Otter Trawl	JUNE							4	4
	JULY								
	AUGUST								
	SEPT								
	OCT								
8 foot Push Otter Trawl	JUNE				15			10	15
	JULY								
	AUGUST			11	20		15	10	
	SEPT			15	15		14	13	
	OCT			10	15		15	15	
TOTAL				36	65		44	62	33
GRAND TOTAL 240									

Table 9. Sampling effort for each bend by month for Segment 13 by Columbia FRO HAMP during the 2006 field season. Effort in this table is defined as gear deployments.

			Number of Gear Deployments						
GEAR	MONTH		25% Bend Radius				75% Bend Radius		
			Bend – 19 Before/After	Bend -41 Control	Bend – 13 Impact		Bend – 33 Before/After	Bend – 31 Control	Bend – 21 Impact
16 foot Small mesh Trawl	JUNE		6	10	17		2		3
	JULY		14	9	18		15	13	12
	AUGUST		15	7	14		13	12	14
	SEPT		16	11	27		16	12	13
	OCT		15	12	16		14	15	9
	Total		66	49	92		60	52	51
16 foot Otter Trawl	JUNE		7	4	4		7	8	11
	JULY		4	3	4		6	4	6
	AUGUST		4	4	4		2	4	4
	SEPT		4	4	4		2	4	4
	OCT		6	4	4		4	4	4
	Total		25	19	20		21	24	29
8 foot Push Otter Trawl	JUNE		15	16	22		8	6	13
	JULY		16	15	19		15	12	14
	AUGUST		15	14	15		14	15	13
	SEPT		14	12	15		16	11	9
	OCT		10	15	15		10	11	14
	Total		70	72	86		63	55	63
1 inch Trammel Net	JUNE								
	JULY		4	4	4		6	4	4
	AUGUST		4	4	4		4	4	4
	SEPT		4	4	4		4	4	4
	OCT		5	4	4		4	4	4
	Total		17	16	16		18	16	16
Mini-Fyke	JUNE								
	JULY		4	4	4		4	4	4
	AUGUST		4	4	4		4	4	4
	SEPT		3	4	4		4	4	4
	OCT		3	3	4		4	4	4
	Total		14	15	16		16	16	16
TOTAL			192	171	230		178	163	175
GRAND TOTAL 1109									

Table 10. Number of fish captured for each bend by month for Segment 10 by Columbia FRO HAMP during the 2006 field season.

			Number of Fish Caught						
GEAR	MONTH		25% Bend Radius				75% Bend Radius		
			Bend – 3 Impact	Bend – 9 Before/After	Bend – 26 Control		Bend – 18 Before/After	Bend – 24 Control	Bend – 28 Impact
16 foot Small mesh Trawl	JUNE							977	2717
	JULY								
	AUGUST								
	SEPT								
	OCT								
16 foot Otter Trawl	JUNE							106	100
	JULY								
	AUGUST								
	SEPT								
	OCT								
8 foot Push Otter Trawl	JUNE				1869			856	3704
	JULY								
	AUGUST			420	1206		618	339	
	SEPT			617	787		725	615	
	OCT			1111	1320		657	1111	
TOTAL				2148	5182		2000	4004	6521
GRAND TOTAL 19855									

Table 11. Number of fish captured for each bend by month for Segment 13 by Columbia FRO HAMP during the 2006 field season.

			Number of Fish Caught						
GEAR	MONTH		25% Bend Radius				75% Bend Radius		
			Bend – 19 Before/After	Bend -41 Control	Bend – 13 Impact		Bend – 33 Before/After	Bend – 31 Control	Bend – 21 Impact
16 foot Small mesh Trawl	JUNE		290	323	186		55		51
	JULY		316	1098	787		1550	424	603
	AUGUST		1024	1377	109		1409	367	316
	SEPT		865	1005	172		565	653	732
	OCT		332	690	263		106	433	303
16 foot Otter Trawl	JUNE		44	44	20		274	72	30
	JULY		31	555	41		362	64	69
	AUGUST		92	461	33		559	242	14
	SEPT		19	127	21		124	250	44
	OCT		106	98	60		54	16	121
8 foot Push Otter Trawl	JUNE		3274	583	1989		1507	739	1027
	JULY		777	448	329		741	644	955
	AUGUST		877	1782	336		994	799	1015
	SEPT		500	353	1920		445	770	1985
	OCT		1043	731	1044		577	687	772
1 inch Trammel Net	JUNE								
	JULY		5	17	9		18	42	21
	AUGUST		6	4	6		4	4	4
	SEPT		6	47	4		25	19	60
	OCT		4	18	26		5	5	12
Mini-Fyke	JUNE								
	JULY		171	748	111		111	241	280
	AUGUST		106	47	123		1691	1315	162
	SEPT		231	445	98		1296	515	159
	OCT		127	170	371		57	455	548
TOTAL			10246	11171	8058		12529	8756	9283
GRAND TOTAL 60,043									

Segment 10 CPUE

The majority of sampling consisted of push trawling. Stern trawling was only conducted on two bends for one month. Due to minimal data for OT16 and OT01, results of these gears for segment 10 were reported without tables.

Pallid Sturgeon

OT16, OT01, and POT02 – all PDSG

No pallid sturgeon were captured in Segment 10 during the 2006 HAMP field season. The majority of the gear deployments were with the Push trawl (POT02) that is designed to sample shallow (< 2.0 m) littoral areas.

Shovelnose Sturgeon

OT16 and OT01 – all SNSG

Bend 24 (75% Control) and bend 28 (75% Impact) were sampled for one month (June) using standard otter trawls (OT16) and small mesh otter trawls (OT01). With a limited data set of these gears, no tables were constructed, and the results will be described with text. On bends 24, 38 and 13 shovelnose sturgeon were captured using OT16 and OT01 respectively. Catch rates for bend 24 were 1.39 fish/100 m (2SE=1.85, N=4) for OT16 and 1.63 fish/100 m (2SE=1.6, N=10) for OT01. On bend 28, five and four shovelnose sturgeon were captured using OT16 and OT 01 respectively. Catch rates were 0.475 fish/100 m (2SE=0.709, N=4) for OT16 and 0.144 fish/100 m (2SE=0.133, N=14) for the OT01.

POT02 – all SNSG

Two shovelnose sturgeon were captured for all bends and months using push trawl (POT02) on Segment 10. Both sturgeon were captured in September on bends 9 and 24. CPUE was 0.005 fish/10 m (2SE=0.010, N=15) and 0.009 fish/10 m (2SE=0.017, N=13) respectively.

Sicklefin chub

OT16 and OT01 – all SFCB

A total of 13 and 14 sicklefin chubs were captured with OT16 & OT01 in June. CPUE for the OT16 was 1.00 fish/100 m (2 SE=0.200, N=4 and 0.465 fish/100 m (2 SE=0.4, N=4) for bends 24 and 28 respectively. CPUE for the OT01 was 0.420fish/100 m (2SE=0.400, N=10) and 0.191 fish/100 m (2SE=0.100, N=14) for bends 24 and 28 respectively.

POT02 - all SFCB

A total of 95 sicklefin chubs were captured with the push trawl during the 2006 sampling season. CPUE for all bends and months were less than 1 fish/10 m trawled (Table 12). Catch rates were highest on the 75% Control and Impact bends in June. In general, catch rates were consistent or declined slightly through out the summer.

Graphical Display – all SFCB

Figures 3, 4 and 5 are CPUE for all sicklefin chubs captured with OT16, OT01 and POT02 for the five bends sampled in segment 10. Lines depict the sample location of OT16 and OT0, while points are the locations of POT02. All samples for the entire season have been pooled in these maps. Water conditions may have been different when these samples were collected than depicted on the map. Samples with higher catch rates for Before/After bends appear to be clustered at the top and bottom of the bend (Figure 3). In Figure 4 and Figure 5, increased catch rates appear to be found on channel border and larger sand bar habitats.

POT02 - YOY SFCB

A total of 89 YOY sicklefin chubs were captured in Segment 10 with POT02. The majority of sicklefin chubs captured were YOY and followed the same trends as the total catch (Table 13). The 75% Impact bend had the highest CPUE in June with 0.867 fish/10 m, however variability was high (2SE=1.364, N=15). In October, no YOY sicklefin chubs were captured on either of the Before bends. No consistent trend was observed through the season or by treatment types.

POT02 - Adult SFCB

A total of six adult sicklefin chubs were captured in Segment 10 using the POT02. No adult sicklefin chubs were captured in 10 of 15 month-bend samples (Table 14). Catch rates were low for the five samples where adult sicklefin chubs were captured. The majority of adult sicklefin chubs are found in areas deeper than can be effectively sampled by the push trawl.

Table 12. Segment 10 push trawl (POT01) CPUE, fish/10 m trawled ((2 SE) and N), by bend and month for all sicklefin chub captured by Columbia FRO in the 2006 field season. NC=no catch.

	Push Trawl (POT02)					
	25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June		0.133 (0.267) 15			0.333 (0.667) 10	0.896 (1.360) 15
July						
August	0.075 (0.068) 11	0.096 (0.153) 20		0.028 (0.056) 15	0.025 (0.050) 10	
September	0.080 (0.160) 15	NC 15		0.093 (0.146) 14	0.092 (0.133) 13	
October	NC 10	0.014 (0.028) 15		NC 15	0.193 (0.216) 15	
TOTAL	**0.056 (0.069) 36**	**0.064 (0.065) 65**		**0.039 (0.050) 44**	**0.160 (0.156) 48**	**0.896 (1.360) 15**

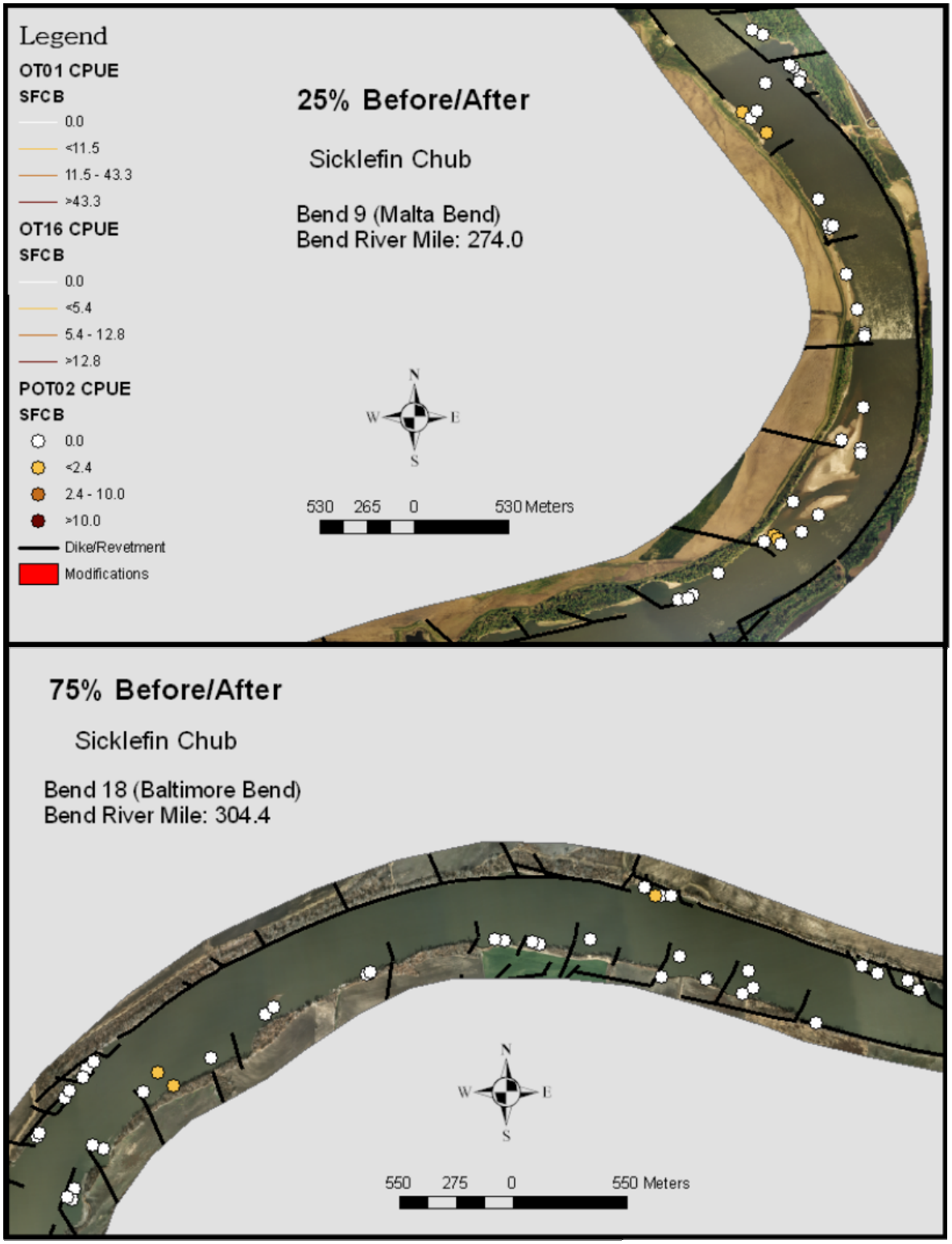

Figure 3. GIS overlay of CPUE data for sicklefin chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Before/After bends in Segment 10.

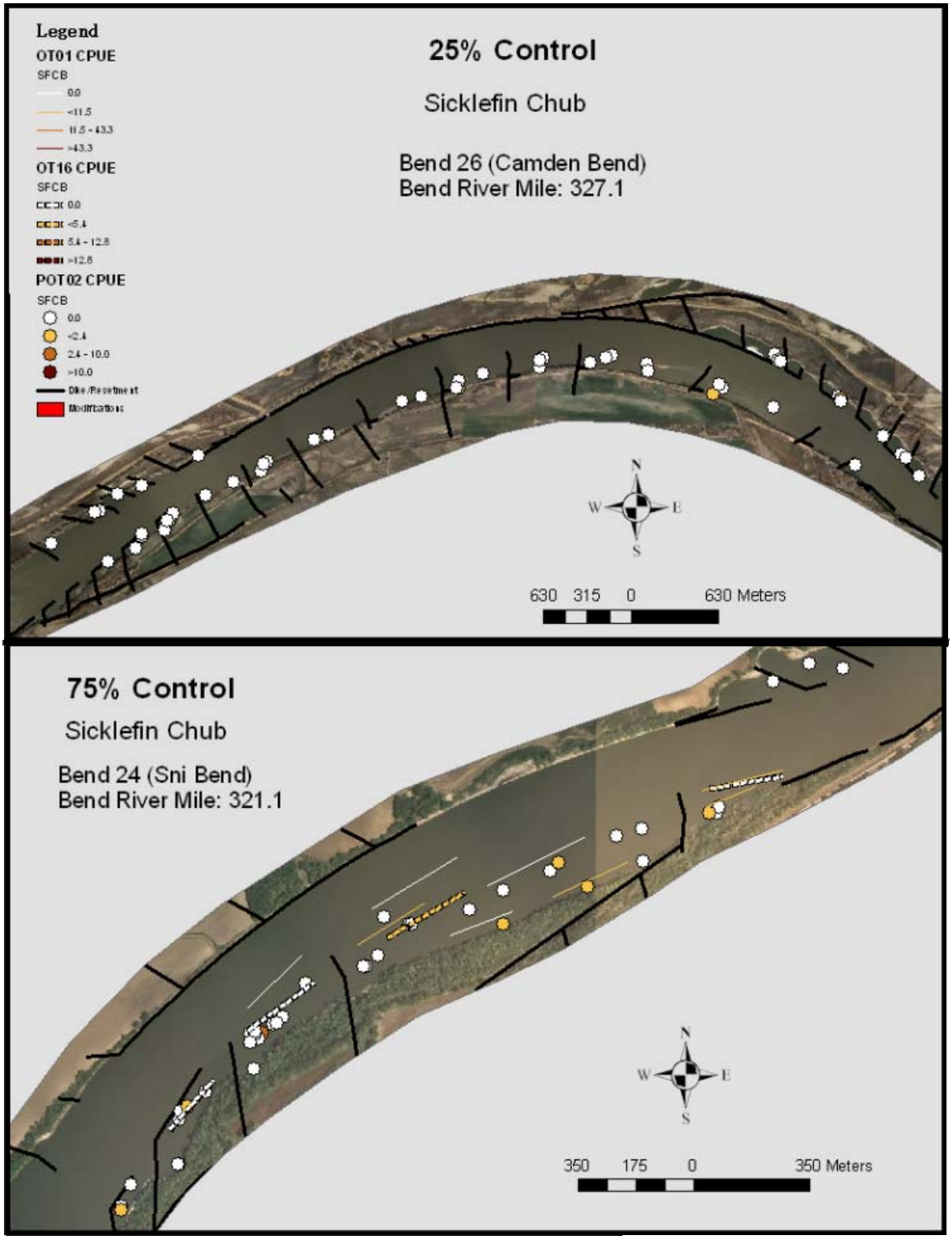

Figure 4. GIS overlay of CPUE data for sicklefin chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Control bends in Segment 10.

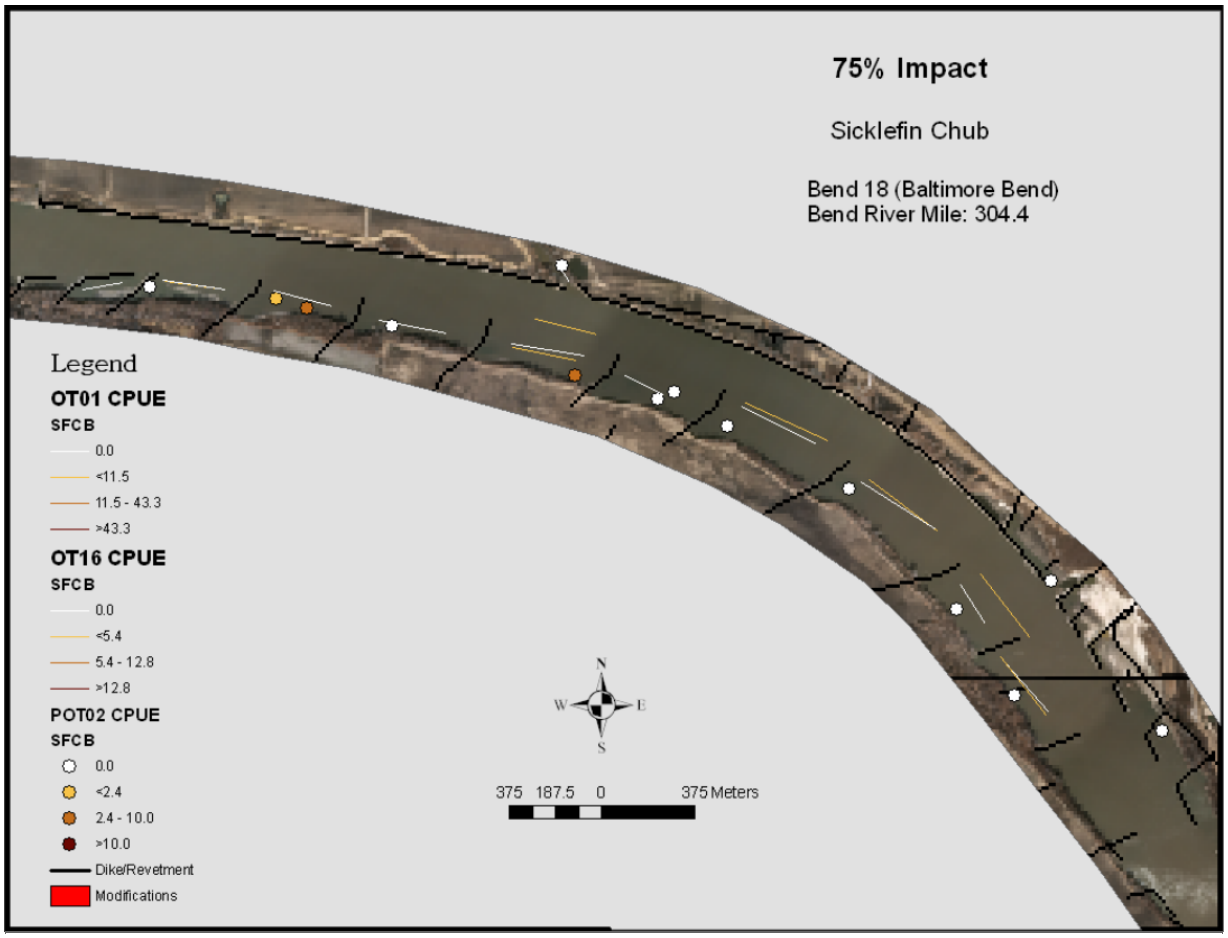

Figure 5. GIS overlay of CPUE data for sicklefin chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Impact bend in Segment 10.

Table 13. Segment 10 push trawl (POT01) CPUE, fish/10 m trawled ((2 SE) and N), by bend and month for YOY sicklefin chub captured by Columbia FRO in the 2006 field season. NC=no catch.

	Push Trawl (POT02)					
	25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June		0.133 (0.267) 15			0.267 (0.533) 10	0.867 (1.364) 15
July						
August	0.066 (0.063) 11	0.090 (0.153) 20		0.028 (0.056) 15	0.025 (0.050) 10	
September	0.080 (0.160) 15	NC 15		0.093 (0.146) 14	0.092 (0.133 13	
October	NC 10	0.014 (0.028) 15		NC 15	0.159 (0.173) 15	
TOTAL	**0.066 (0.085) 36**	**0.095 (0.119) 65**		**0.075 (0.095) 44**	**0.209 (0.192) 48**	**0.867 (1.364) 15**

Table 14. Segment 10 push trawl (POT01) CPUE, fish/10 m trawled ((2 SE) and N), by bend and month for adult sicklefin chub captured by Columbia FRO in the 2006 field season.

	Push Trawl (POT02)					
	25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June		NC 15			0.067 (0.133) 10	0.029 (0.058) 15
July						
August	0.009 (0.019) 11	0.006 (0.013) 20		NC 15	NC 10	
September	NC 15	NC 15		NC 14	NC 13	
October	NC 10	NC 15		NC 15	0.034 (0.068) 15	
TOTAL	**0.004** **(0.007)** **36**	**0.003** **(0.006)** **65**		**NC** **44**	**0.038** **(0.053)** **48**	**0.029** **(0.058)** **15**

Sturgeon Chub

OT16 and OT01 – all SGCB

No sturgeon chubs were captured with OT16 and one sturgeon chub was captured with OT01 in segment 10 (Table 15) with a total of 8 and 24 net tows respectively. Sampling with these two gears was conducted only in June and for two bends. Sturgeon chubs are the least common chub species in the Lower Missouri River and catch rates are low throughout the projects.

POT02 – all SGCB

A total of five sturgeon chubs were captured with POT02 in Segment 10 (Table 16). Of the five sturgeon chubs captured, three were YOY and two were adults. Of the 15 bend/month samples, sturgeon chubs were only captured in three. In general, the majority of the sturgeon chubs captured were found in deep swift channel border areas that are not effectively sampled with the push trawl. Catch rates for sturgeon chubs were low for all bends. With so few captured it is difficult to detect trends even when looking at Figure 6, Figure 7, and Figure 8.

Table 15. Segment 10 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/100 m trawled ((2 SE) and N) by bend and month for all sturgeon chub captured by Columbia FRO in the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June					NC 4	NC 4					NC 10	0.239 (0.5) 14
July												
August												
September												
October												
TOTAL					**NC** **4**	**NC** **4**					**NC** **10**	**0.239** **(0.5)** **14**

Table 16. Segment 10 push trawl (POT01) CPUE, fish/10 m trawled ((2 SE) and N), by bend and month for all sturgeon chub captured by Columbia FRO in the 2006 field season. NC=no catch.

	Push Trawl (POT02)					
	25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June		NC 15			0.060 (0.085) 10	NC 15
July						
August	NC 11	NC 20		NC 15	NC 10	
September	0.005 (0.010) 15	NC 15		NC 14	NC 13	
October	0.017 (0.034) 10	NC 15		NC 15	NC 15	
TOTAL	**0.007** **(0.010)** **36**	**NC** **65**		**NC** **44**	**0.013** **(0.018)** **48**	**NC** **15**

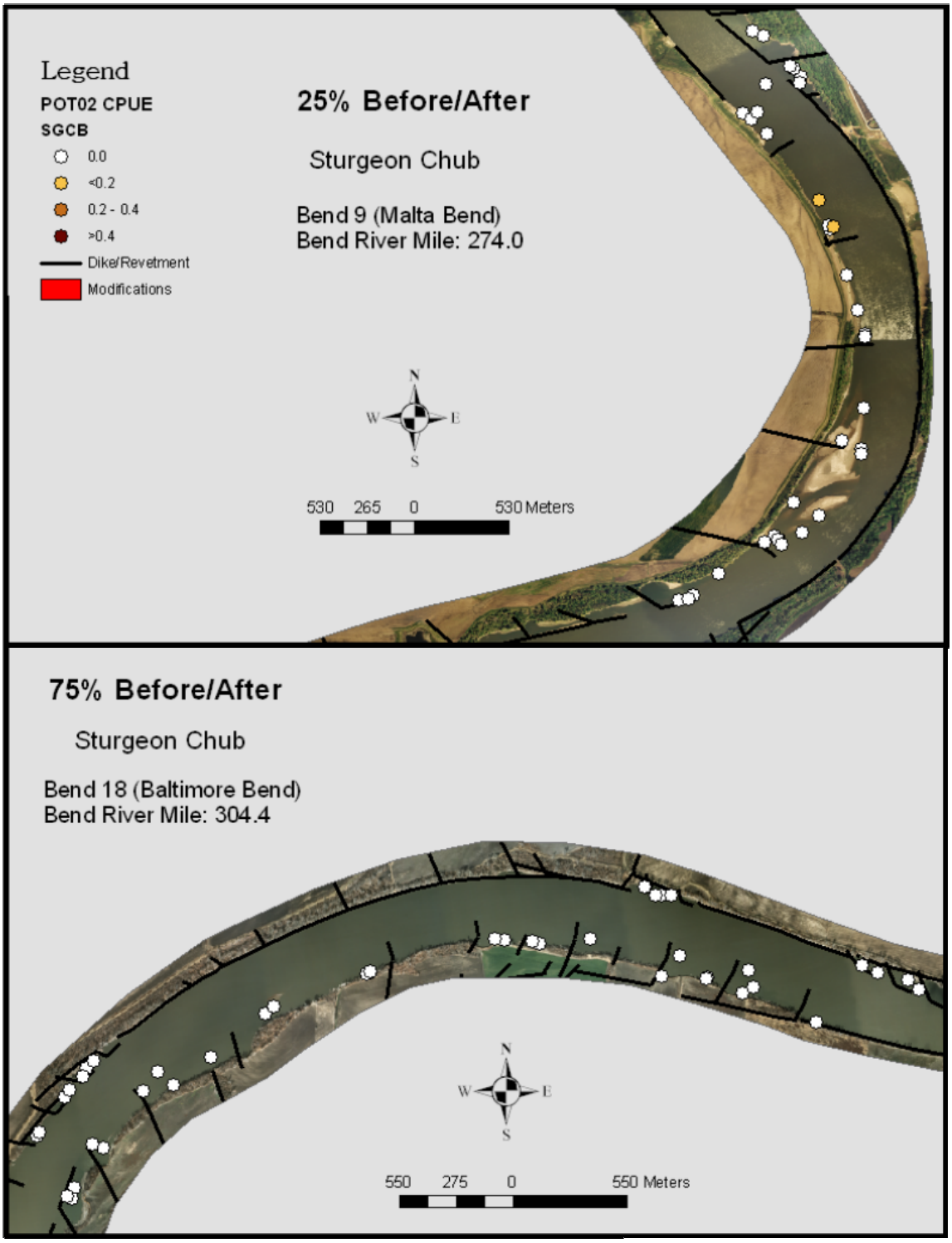

Figure 6. GIS overlay of CPUE data for sturgeon chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Before/After bends in Segment 10.

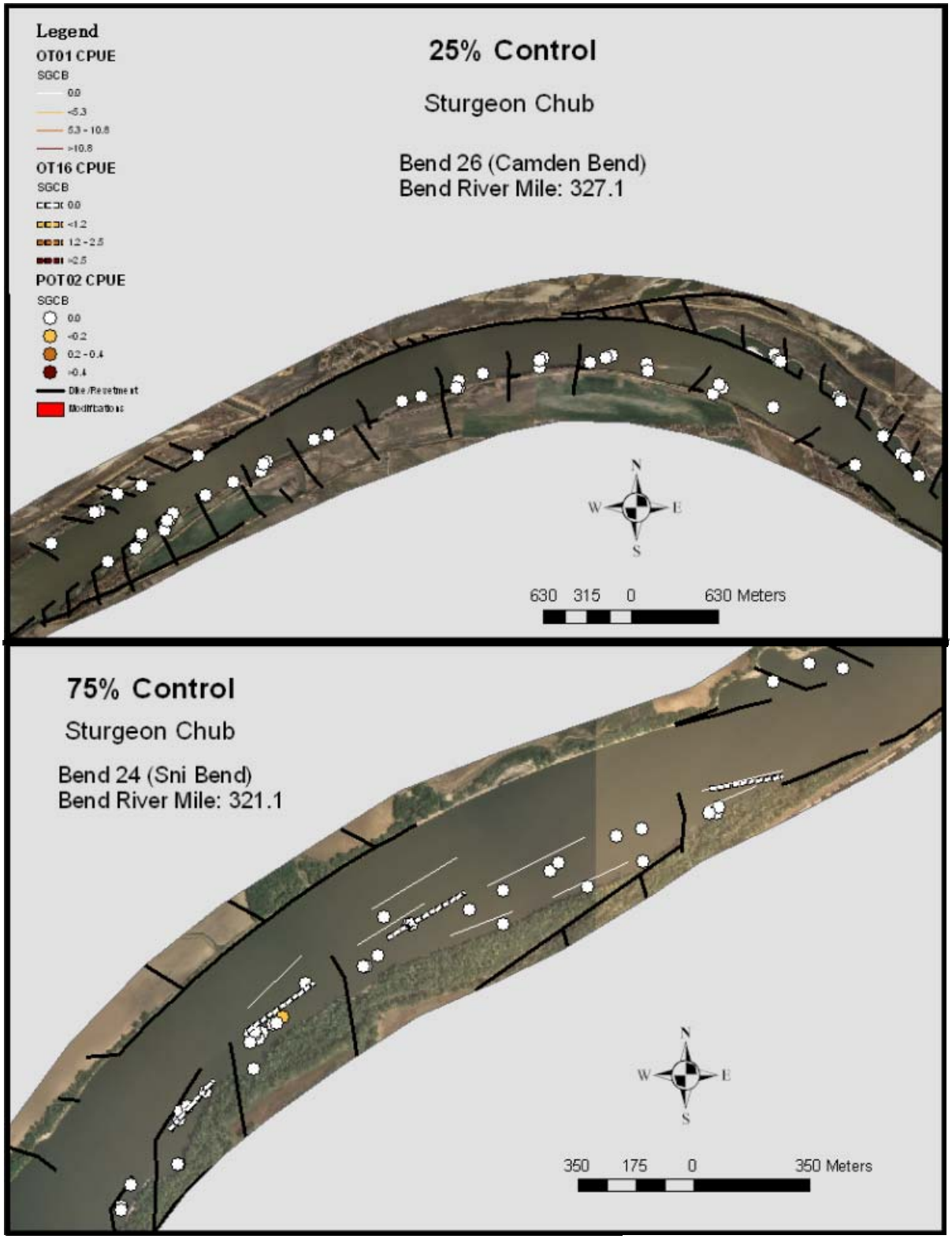

Figure 7. GIS overlay of CPUE data for sturgeon chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Control bends in Segment 10.

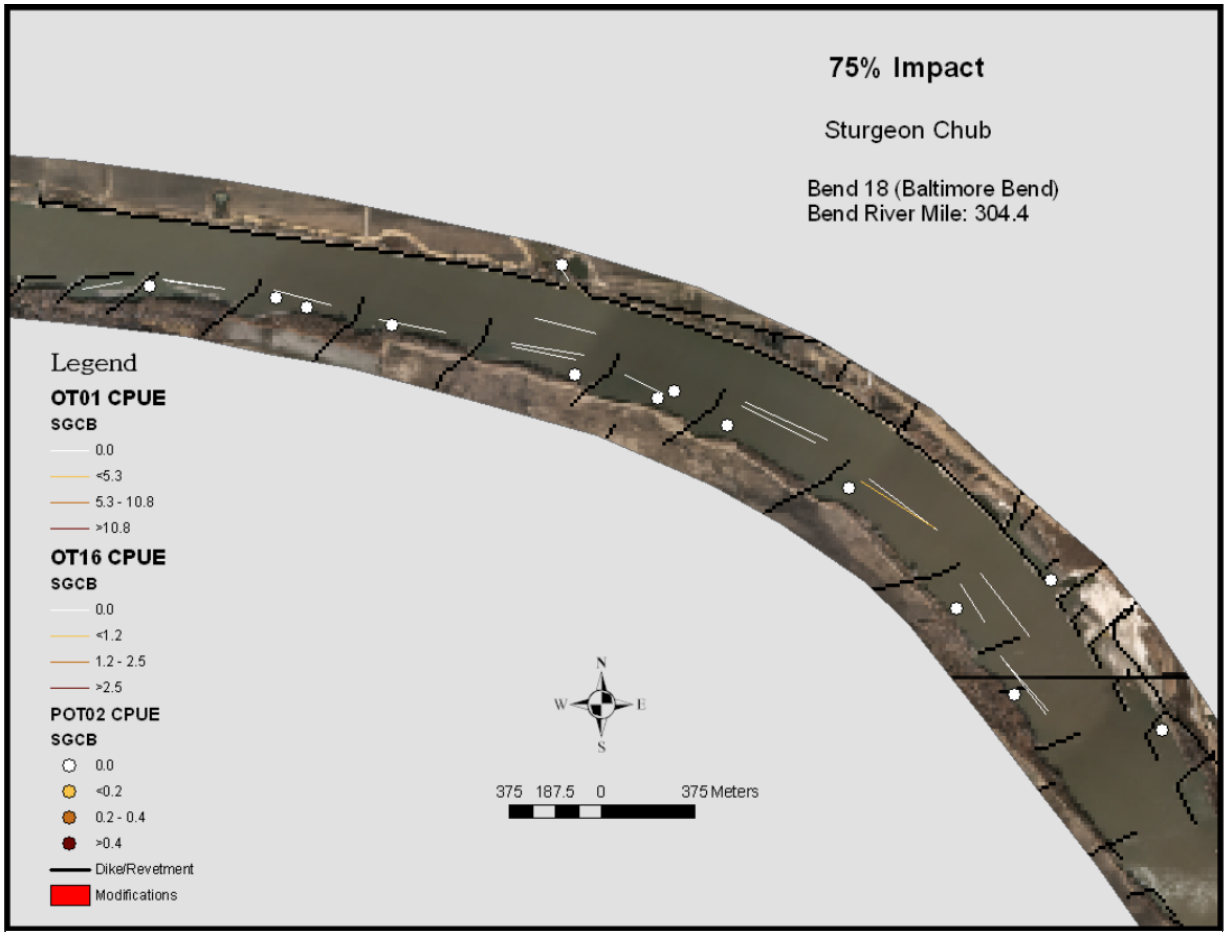

Figure 8. GIS overlay of CPUE data for sturgeon chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Impact bend in Segment 10.

Speckled Chub

OT16 and OT01 – all SKCB

A total of five and 82 speckled chubs were captured with the OT16 and OT01 respectively. Of these, five speckled chubs were captured in OT16 and were all adults. Of the 82 speckled chubs captured with OT01, 76 were adult and six were YOY. Catch rates for bend 24 (75% Control) were 0.409 fish/100 m (2SE=0.478, N=4) and 2.41 fish /100 m (2SE=4.66, N=10) for OT16 and OT01 respectively. Catch rates for bend 28 (75% Impact) were 0.125 (2SE=0.25, N=4) and 0.425 fish/ 100m (2SE=0.628, N=14) for OT16 and OT01 respectively.

POT02 – all SKCB

A total of 704 speckled chubs were captured with the POT02. Of these, 608 were YOY and 96 were adult. Total catch rates ranged from no fish caught (NC) to 1.739 fish/10 m (Table 17). In general, total catch rates increased through the season with all catch rates over 1 fish/10 m trawled occurring in September and October. Twenty-five percent Before bend had higher catch rates than 25% Control bend through the season. This trend is not apparent for the 75% bends

Graphical Display – all SKCB

Speckled chubs were captured on all portions of all bends Figure 9, Figure 10, and Figure 11. The only potential trend is that higher catch rates appear to be associated with areas of wide dike spacing and large inside bend sand bars.

POT02 – YOY SKCB

A total of 608 YOY speckled chubs were captured with the POT02. Catch rates for YOY speckled chubs captured with POT02 followed the same seasonal trend as total catch, catch rates increasing through the season. Twenty-five percent Before bend had higher catch rates than 25% Control bend through the season. This trend is not apparent for the 75% bends (Table 18).

POT02 – Adult SKCB

A total of 96 adult speckled chubs were captured with push trawls in Segment 10. The seasonal trend of increasing catch rates observed with total and YOY is not as strong with adult catch rates (Table 19). No trends in catch rates were observed between 25 and 75% bends, treatment types or months.

Table 17. Segment 10 push trawl (POT01) CPUE, fish/10 m trawled ((2 SE) and N), by bend and month for all speckled chub captured by Columbia FRO in the 2006 field season. NC=no catch.

	Push Trawl (POT02)					
	25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June		0.278 (0.377) 15			0.707 (0.575) 10	NC 15
July						
August	0.322 (0.336) 11	0.008 (0.017) 20		NC 15	NC 10	
September	1.570 (1.085) 15	0.485 (0.401) 15		0.495 (0.319) 14	1.085 (0.624) 13	
October	1.739 (1.521) 10	0.610 (0.551) 15		0.955 (0.842) 15	0.655 (0.653) 15	
TOTAL	**1.236 (0.643) 36**	**0.320 (0.185) 65**		**0.483 (0.321) 44**	**0.646 (0.303) 48**	**NC 15**

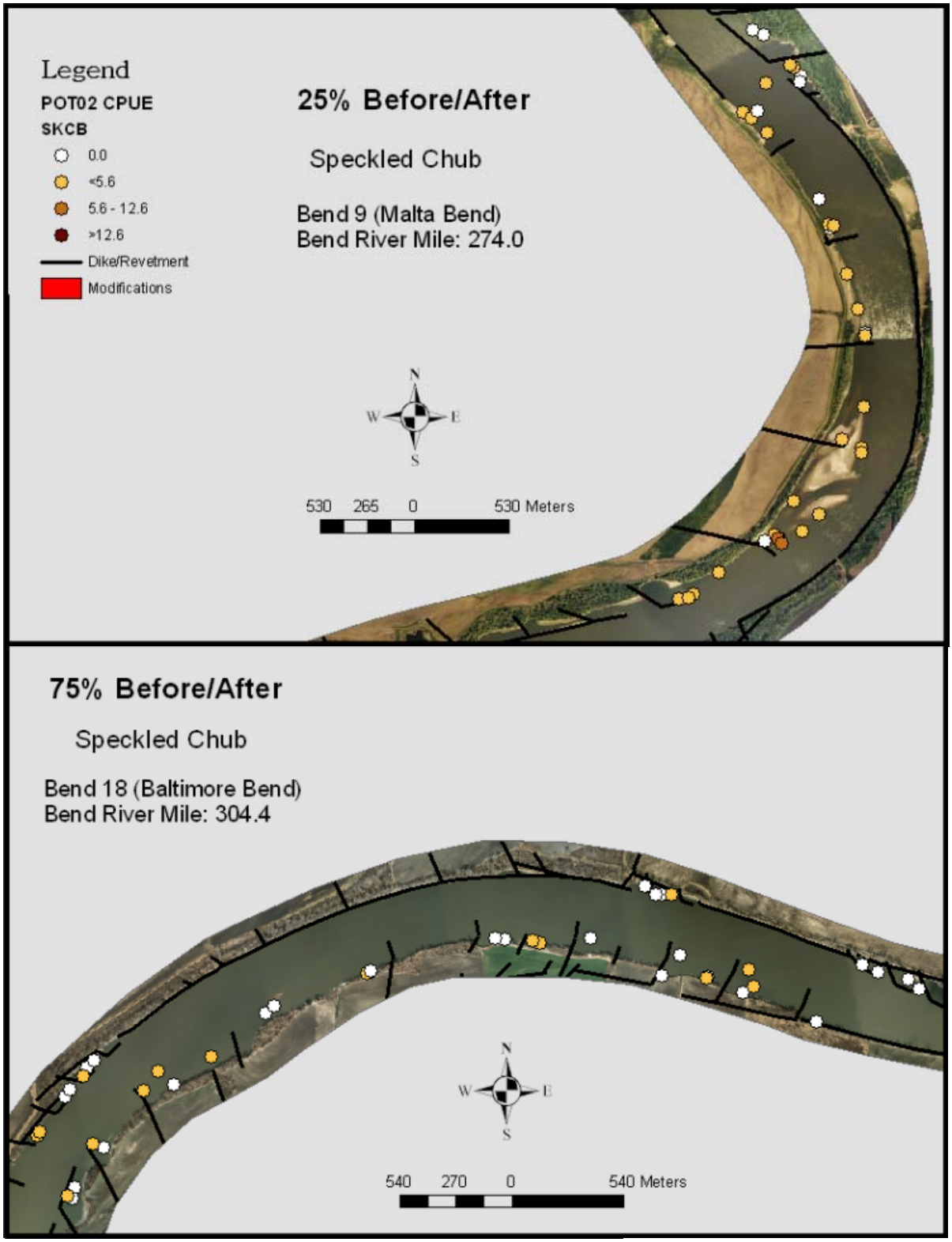

Figure 9. GIS overlay of CPUE data for speckled chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Before/After bends in Segment 10

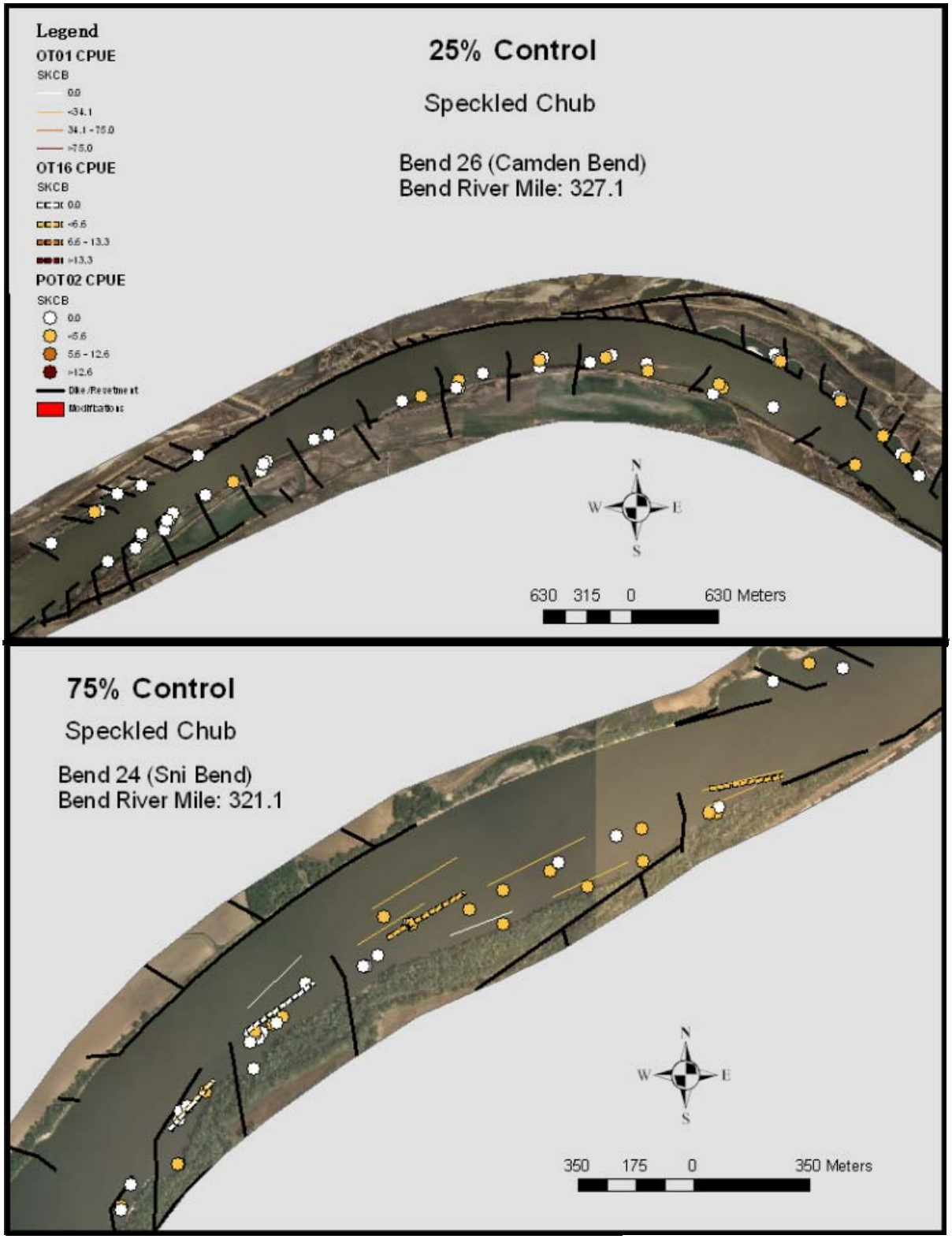

Figure 10. GIS overlay of CPUE data for speckled chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Control bends in Segment 10.

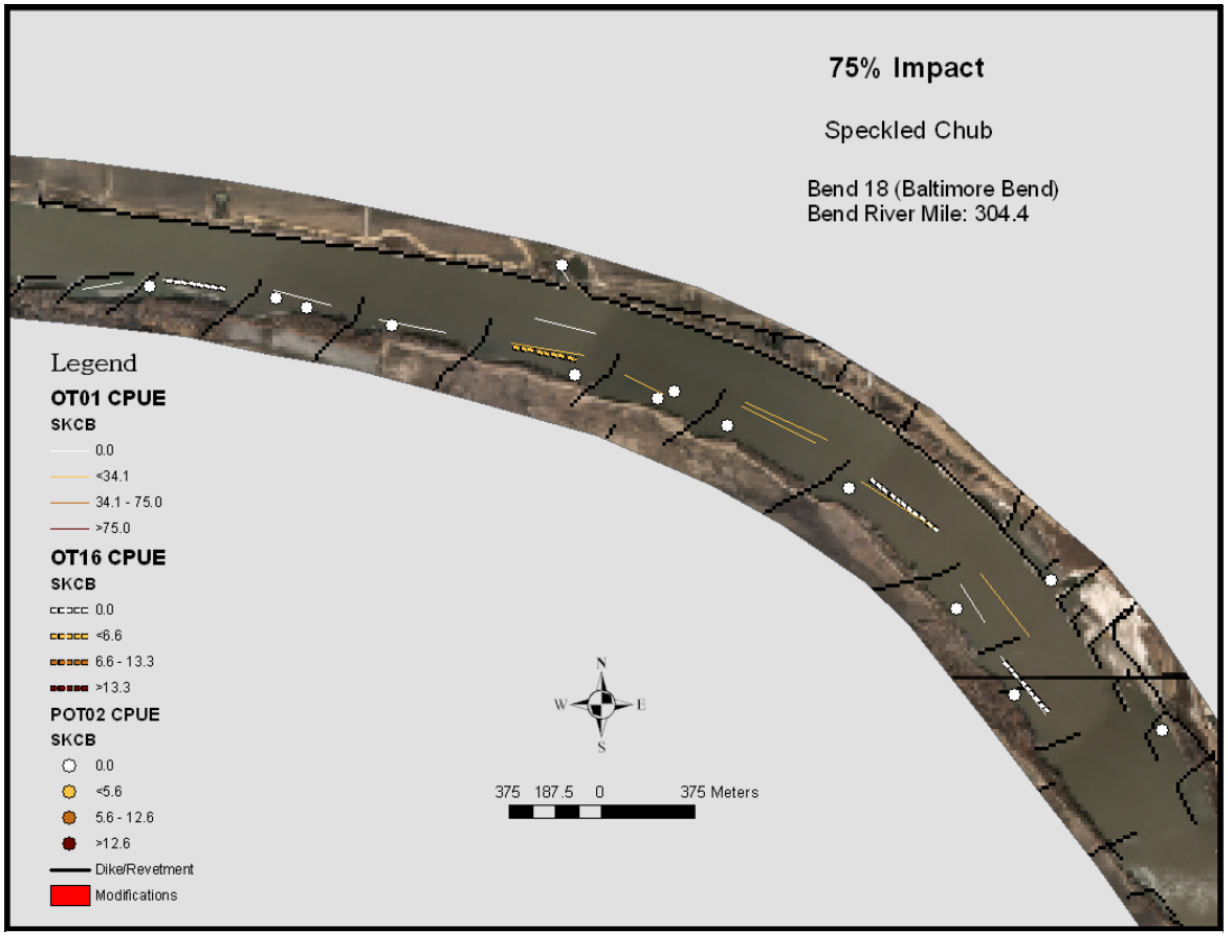

Figure 11. GIS overlay of CPUE data for speckled chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl POT02 for Impact bend in Segment 10.

Table 18. Segment 10 push trawl (POT01) CPUE, fish/10 m trawled ((2 SE) and N), by bend and month for YOY speckled chub captured by Columbia FRO in the 2006 field season. NC=no catch.

	Push Trawl (POT02)					
	25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June		0.245 (0.371) 15			0.073 (0.115) 10	NC 15
July						
August	0.315 (0.337) 11	0.008 (0.017) 20		NC 15	NC 10	
September	1.469 (1.079) 15	0.388 (0.352) 15		0.481 (0.313) 14	1.004 (0.620) 13	
October	1.689 (1.501) 10	0.407 (0.265) 15		0.936 (0.845) 15	0.570 (0.615) 15	
TOTAL	**1.462 (0.753) 36**	**0.376 (0.200) 65**		**0.903 (0.559) 44**	**0.721 (0.399) 48**	**NC 15**

Table 19. Segment 10 push trawl (POT01) CPUE, fish/10 m trawled ((2 SE) and N), by bend and month for adult speckled chub captured by Columbia FRO in the 2006 field season. NC= no catch.

	Push Trawl (POT02)					
	25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June		0.033 (0.054) 15			0.635 (0.574) 10	NC 15
July						
August	0.008 (0.015) 11	NC 20		NC 15	NC 10	
September	0.101 (0.090) 15	0.097 (0.084) 15		0.014 (0.029) 14	0.081 (0.077) 13	
October	0.051 (0.071) 10	0.203 (0.361) 15		0.076 (0.039) 15	0.084 (0.133) 15	
TOTAL	**0.072 (0.053) 36**	**0.119 (0.132) 65**		**0.022 (0.030) 44**	**0.280 (0.211) 48**	**NC 15**

Unidentified chubs

Unidentified chubs are those that can not be identified to species in the field. The majority of these are YOY fish early in the growing season. Chubs are known to have a protracted spawning season and so it is possible to have unidentifiable chubs into the late summer (Johnson, in press). Several factors must be taken into consideration with this data. UHY consists of more than one species of *Macrhybopsis*, and differences in habitat selection of different species may have a confounding effect. As growing season progresses, more UHY were identified to species. Overall abundance of YOY chubs may be increasing through the season, but as these fish become large enough to identify, UHY numbers will decline. Some chub species are easier to identify than others so it may not be appropriate to assign UHY at the same ratio as the identified YOY chubs.

OT16 and OT01 – all UHY

A total of 200 UHY were captured in Segment 10 during June, which was the only month where these gears were used. Nine and 191 were captured with OT16 and OT01 respectively. All nine UHY sampled with OT16 were captured in Bend 24 for a catch rate of 0.818 fish/100 m (2SE=1.636, N=4). OT01 captured 53 fish on Bend 24 for a catch rate of 2.188 fish/100 m (2SE=3.710, N=10). One hundred thirty eight UHY were captured on Bend 28 for a catch rate of

9.833 fish/100 m (2SE=31.455, N=14). This high catch rate and high variability is due to one net deployment where 107 UHY were captured.

POT02 and MF – all UHY

A total of 990 UHY were captured with the push trawl. Catch rates were high in June, then declined in August and slowly increased or remained stable for the rest of the season (Table 20). Abundances of YOY fishes were high in June then declined through the summer. Unidentified chubs followed this trend. It is to be expected that UHY numbers decline through the season as they become large enough to be identified to species.

Table 20. Segment 10 push trawl (POT01) CPUE, fish/10 m trawled ((2 SE) and N), by bend and month for unidentified chubs (UHY) captured by Columbia FRO in the 2006 field season. NC= no catch.

	Push Trawl (POT02)					
	25% Bend			75% Bend		
Month	Before 9	Control 26	Impact 3	Before 18	Control 24	Impact 28
June		8.047 (6.865) 15			2.719 (2.531) 10	12.349 (10.921) 15
July						
August	NC 11	0.107 (0.093) 20		0.102 (0.161) 15	0.052 (0.103) 10	
September	0.044 (0.089) 15	NC 15		0.157 (0.205) 14	NC 13	
October	0.103 (0.207) 10	0.311 (0.622) 15		1.033 (2.067) 15	0.008 (0.016) 15	
TOTAL	**0.047 (0.067) 36**	**1.962 (1.759) 65**		**0.437 (0.706) 44**	**0.580 (0.599) 48**	**12.349 (10.921) 15**

Unidentified Sturgeon

OT16, OT01, and POTO2

No unidentified sturgeon were captured in Segment 10 with OT16, OT01 or POTO2. Unidentified sturgeon consists of YOY *Scaphirhynchus* spp. To positively identify to species, genetics tests are required for sub 40 mm *Scaphirhynchus* spp.

Segment 13 CPUE

The majority of field sampling in 2006 was conducted in Segment 13 with a total of 1,109 gear deployments and 60,043 fish captured from June to October (Tables 3 and 4). Unlike the data set for segment 10 that was of limited scope, Segment 13 data are complete with five gear types used and all months sampled. This data should provide better insight into the differences between bends, bend types and treatments.

Pallid Sturgeon

OT16 and OT01 – all PDSG

A total of two and three pallid sturgeon were captured with OT16 and OT01 respectively. Catch rates for both gears ranged from NC (no fish) to a high of 0.532 fish/100 m (2SE=0.106, N=6) (Table 21). All other catch rates were below 0.06 fish/ 100 m. Catch rates continued to be low with many NC's by bends and months for pallid sturgeon.

In 2006, four pallid sturgeon were captured on 75% bends compared to one captured on 25% bends. Seventy five percent bend are short, straight bends that are dominated by dike structures. Twenty five percent bend are long sweeping bends that are dominated by large inside bend sandbars and widely spaced dikes. The 25% bends are presumed to be a better representation of Missouri River in its natural state while the 75% bends are more altered by infrastructure for Bank Stabilization and Navigation Project. In 2005, HAMP captured four pallid sturgeon all collected on 25% bends (Starostka et. al., 2006). At this time, we are unable to attribute this shift in pallid captures from 25% bends in 2005 to 75% bends in 2006 for the majority of the pallid captures. Due to small sample sizes, these observations should be viewed with caution.

It is difficult to distinguish the samples that collected pallid sturgeon because of the substantial number of trawls conducted on each bend (Figure 12, Figure 13, and Figure 14). Inside bend channel border habitats, where pallid sturgeon have been captured in the past, appear to be adequately sampled.

Five stocked pallid sturgeon were captured in segment 13. These five pallid sturgeon originated from three different Federal fish hatcheries and four different year classes (Table 22). All have increased in length and weight while at large indicating that these hatchery reared pallid sturgeon can survive in the wild. Four of the five hatchery fish were stocked at Booneville, Missouri (RM 195) with the remainder fish was stocked at Miami, Missouri (RM 263). The majority of stocked pallid sturgeon appear to stay near stocking locations for several years.

Table 21. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for all pallid sturgeon by Columbia FRO during the 2006 field season. NC=no catch.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	NC 4	NC 4	NC 7	NC 8	NC 11	NC 6	NC 10	0.024 (0.047) 17	NC 2		NC 3
July	NC 4	NC 3	NC 4	0.532 (0.106) 6	NC 4	0.060 (0.121) 6	NC 14	NC 9	NC 18	NC 15	NC 13	NC 12
August	NC 4	NC 4	NC 4	NC 2	NC 4	NC 4	NC 15	NC 7	NC 14	NC 13	NC 12	NC 14
September	NC 4	NC 4	NC 4	NC 2	NC 4	NC 4	NC 16	NC 11	NC 27	NC 16	NC 12	NC 13
October	NC 6	NC 4	NC 4	NC 4	NC 4	NC 4	NC 15	NC 12	NC 16	NC 14	0.027 (0.053) 15	NC 9
TOTAL	**NC** **25**	**NC** **19**	**NC** **20**	**0.015** **(0.030)** **21**	**NC** **24**	**0.013** **(0.025)** **29**	**NC** **66**	**NC** **49**	**0.004** **(0.009)** **92**	**NC** **59**	**0.008** **(0.015)** **52**	**NC** **51**

Table 22. Pallid Sturgeon caught by HAMP in 2006 in Segment 13.

Set Date	Bend	Gear	Net River Mile	Macro	Meso	Micro	Length	Weight	Tag Number	Stock Length	Stock Weight	Hatchery	Stocking Site	Stock Date
6/14/2006	13	OT01	159	ISB	CHNB	631230	369	205	4421523013	242	61	Neosho	Boonville	7/30/2004
7/7/2006	33	OT16	208	ISB	CHNB	221310	294	80	462377655C	200	26	Neosho	Miami	6/30/2005
7/18/2006	33	TN	208.0	ISB	CHNB	221230	421	247	44240E2D7C	235	56	Garrison	Boonville	7/8/2004
7/25/2006	21	OT16	182.1	OSB	CHNB	114310	900	2575	460D3F341C					
10/24/2006	31	OT01	205.2	CHXO	CHNB	211320	571	660	444301450D	322	120	Gavins	Boonville	9/4/2003
10/24/2006	31	OT01	205.2	CHXO	CHNB	211320	674	1085	4312101062	210		Garrison	Boonville	4/11/2002

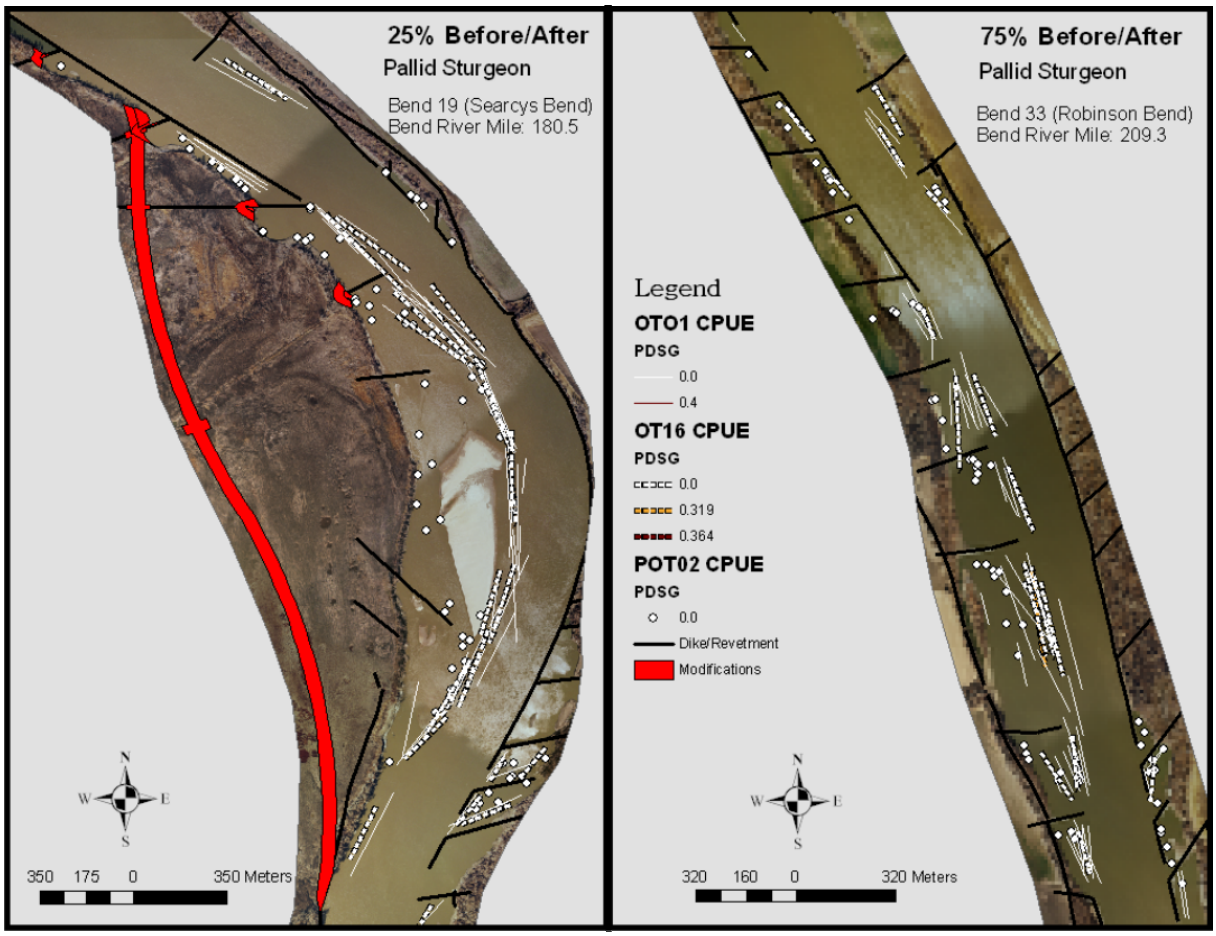

Figure 12. GIS overlay of CPUE data for pallid sturgeon captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Before/After bends in Segment 13.

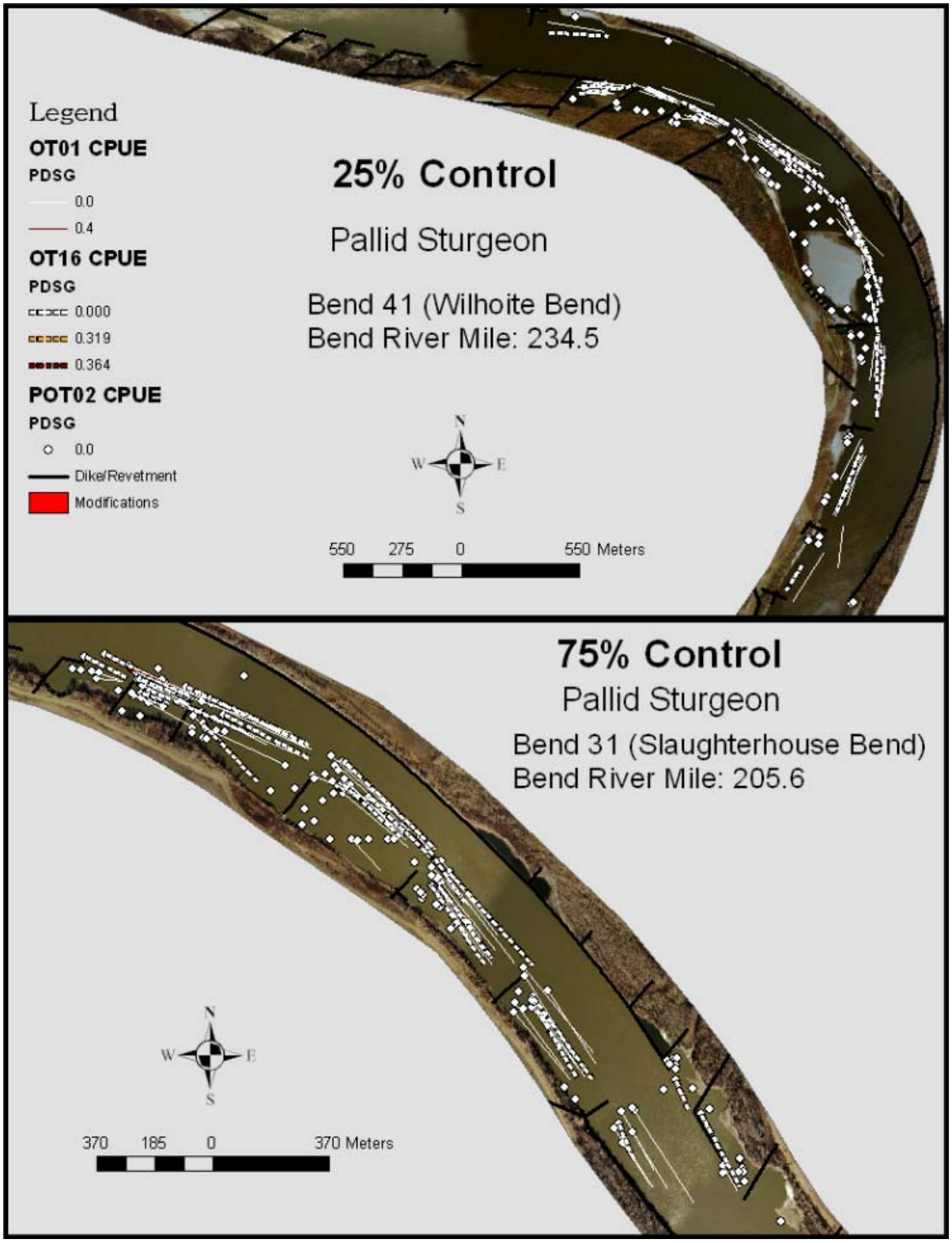

Figure 13 GIS overlay of CPUE data for pallid sturgeon captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Control bends in Segment 13.

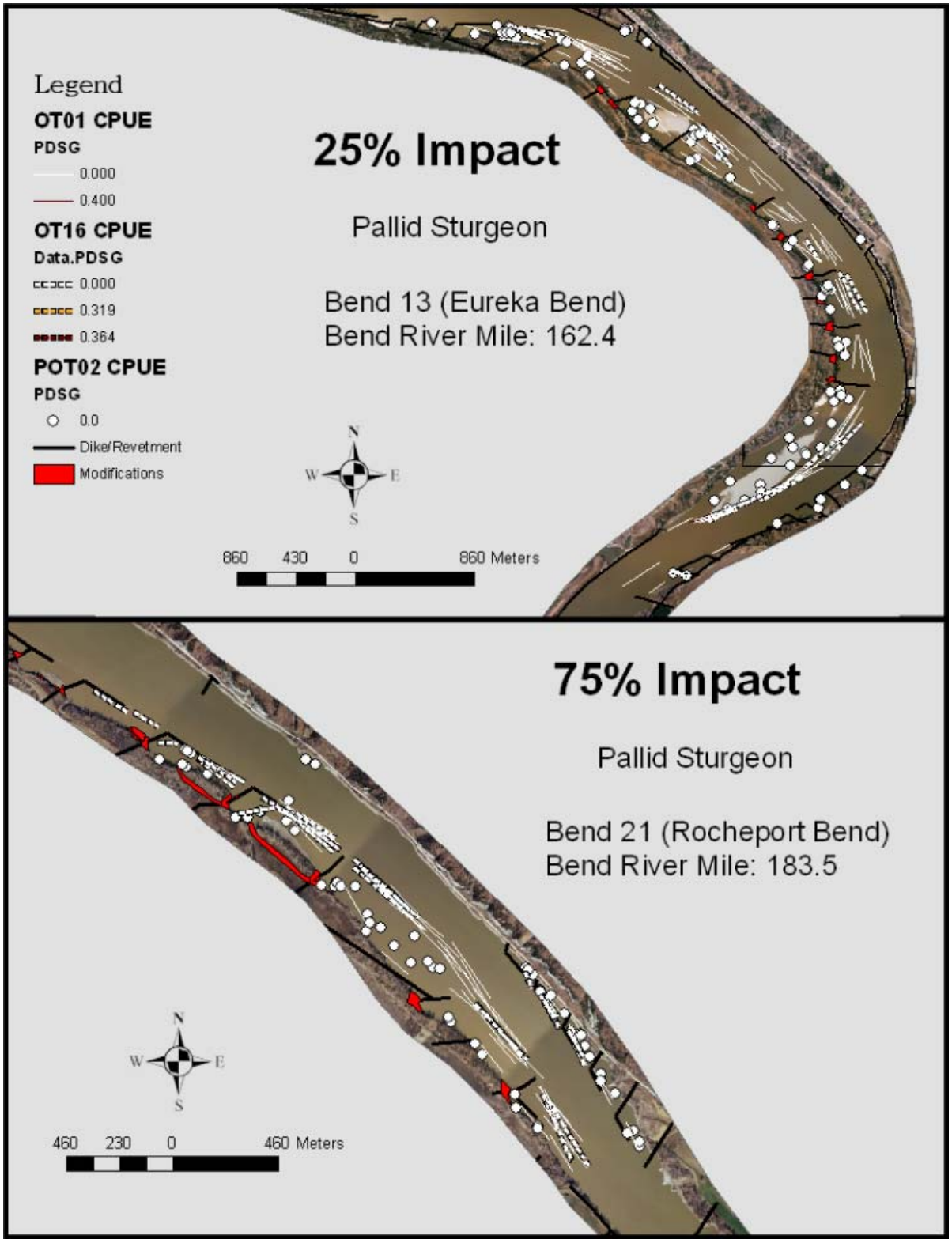

Figure 14. GIS overlay of CPUE data for pallid sturgeon captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Impact bends in Segment 13.

OT16 and OT01 – Juvenile PDSG

Four juvenile pallid sturgeon were captured while stern trawling. Pallid sturgeon are considered juvenile if they are less than 700 mm in length (Keenlyne and Jenkins 1993). Catch rates were low for all samples with the high CPUE of 0.532 fish/100 m (2SE=0.136, N=6) and the majority of the sampled capturing no pallid sturgeon (Table 23). Three juvenile pallid sturgeon were captured on 75% bends and one captured on 25% bends. Two juvenile pallid sturgeon were captured in the same trawl haul on bend 31 in October. The capture of multiple pallid sturgeon in a single net haul may indicate that this species aggregates.

Table 23. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for juvenile pallid sturgeon by Columbia FRO during the 2006 field season. NC= no catch.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	NC 4	NC 4	NC 7	NC 8	NC 11	NC 6	NC 10	0.024 (0.047) 17	NC 2		NC 3
July	NC 4	NC 3	NC 4	0.532 (0.106) 6	NC 4	NC 6	NC 14	NC 9	NC 18	NC 15	NC 13	NC 12
August	NC 4	NC 2	NC 4	NC 2	NC 4	NC 4	NC 15	NC 7	NC 14	NC 13	NC 12	NC 14
September	NC 4	NC 4	NC 4	NC 2	NC 4	NC 4	NC 16	NC 11	NC 27	NC 15	NC 12	NC 13
October	NC 6	NC 4	NC 4	NC 4	NC 4	NC 4	NC 15	NC 12	NC 16	NC 14	0.058 (0.116) 15	NC 9
TOTAL	**NC** **25**	**NC** **17**	**NC** **20**	**0.015** **(0.030)** **21**	**NC** **24**	**NC** **29**	**NC** **66**	**NC** **49**	**0.004** **(0.009)** **92**	**NC** **59**	**0.017** **(0.033)** **52**	**NC** **51**

OT16 and OT01 – Adult PDSG

One adult pallid sturgeon was captured during the 2006 field season. This fish was captured on Bend 21 (75% impact) in July with an OT16 (Table 24). In past years, pallid sturgeon have been collected by Columbia FRO in this area, indicating that it may contain important habitat.

TN – all PDSG

One pallid sturgeon was captured with TN. This fish was a juvenile captured on bend 33 in July (Table 25). TN were considered an effective gear to capture pallid sturgeon, however with 99 TN deployments only one pallid was captured.

POT02 and MF – all PDSG

No pallid sturgeon were captured with POT02 or MF. These two gears are intended to sample shallow (<2 m) littoral zone areas. Pallid sturgeon are known to prefer areas that are deeper than can effectively be sampled with the POT02 or MF.

Table 24. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for adult pallid sturgeon by Columbia FRO during the 2006 field season. NC= no catch.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	NC 4	NC 4	NC 7	NC 8	NC 11	NC 6	NC 10	NC 17	NC 2		NC 3
July	NC 4	NC 3	NC 4	NC 6	NC 4	0.11 (0.22) 6	NC 14	NC 9	NC 18	NC 15	NC 13	NC 12
August	NC 4	NC 2	NC 4	NC 2	NC 4	NC 4	NC 15	NC 7	NC 14	NC 13	NC 12	NC 14
September	NC 4	NC 4	NC 4	NC 2	NC 4	NC 4	NC 16	NC 11	NC 27	NC 15	NC 12	NC 13
October	NC 6	NC 4	NC 4	NC 4	NC 4	NC 4	NC 15	NC 12	NC 16	NC 14	NC 15	NC 9
TOTAL	**NC** **25**	**NC** **17**	**NC** **20**	**NC** **21**	**NC** **24**	**0.022** **(0.044)** **29**	**NC** **66**	**NC** **49**	**NC** **92**	**NC** **59**	**NC** **52**	**NC** **51**

Table 25. Segment 13 trammel net (TN) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for all pallid sturgeon by Columbia FRO during the 2006 field season. NC= no catch.

	Trammel Net (TN)					
	25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June						
July	NC 4	NC 4	NC 4	0.060 (0.119) 6	NC 4	NC 4
August	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
September	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
October	NC 4	NC 5	NC 4	NC 4	NC 4	NC 4
TOTAL	**NC** **17**	**NC** **16**	**NC** **16**	**0.020** **(0.040)** **18**	**NC** **16**	**NC** **16**

Shovelnose sturgeon

OT16 and OT01 – all SNSG

A total of 201 and 324 shovelnose sturgeon were captured with OT16 and OT01 respectively (Table 26). OT16 catch rates ranged from NC to 8.118 fish/100 m. 75% Control and Impact bends (Bends 31 and 21) had the highest catch rates with 3.772 and 1.419 fish/100 m. These high total catch rates are driven by single month catch rates higher than 8 fish/100 m in June (bend 31) and October (bend 21). Monthly catch rates for OT16 are variable and appear not to have any patterns. Catch rates for OT01 ranged from NC to 4.372 fish/100 m. Total catch rates for OT01 were highest for 75% Control and Impact bends with catch rates of 1.920 and 0.690 fish/100 m. Higher catch rates in June, July and again in October for bends 31 and 21 appear to be the cause of these higher catch rates. Overall, monthly catch rates for OT01 are variable and appear to not have any patterns.

Graphical Display – all SNSG

Increased catch rates for 25% bends appear to be associated with inside bend sand bars (Figure 15, Figure 16, and Figure 17). Differences are apparent as to where shovelnose sturgeon were captured on the 75% bends. At this time, no explanation can be given to these differences.

Table 26. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for all shovelnose sturgeon by Columbia FRO during the 2006 field season. NC= no catch.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.257 (0.514) 7	0.379 (0.758) 4	1.129 (2.258) 4	0.985 (0.772) 8	8.148 (5.356) 8	0.463 (0.360) 11	0.934 (0.649) 6	0.378 (0.592) 10	0.507 (0.315) 17	NC 2		3.333 (6.667) 3
July	0.081 (0.161) 4	0.896 (0.954) 3	0.076 (0.152) 4	0.482 (0.614) 4	0.849 (1.698) 4	0.190 (0.246) 6	0.275 (0.295) 14	0.204 (0.303) 9	0.159 (0.184) 18	0.306 (0.253) 15	4.372 3.508) 12	1.079 (1.218) 12
August	0.083 (0.167) 4	0.167 (0.333) 4	0.025 (0.030) 4	0.570 (0.029) 4	3.538 (4.150) 4	0.386 (0.483) 4	0.158 (0.132) 15	0.123 (0.246) 7	0.081 (0.134) 14	0.703 (0.763) 13	0.797 0.722) 14	0.078 (0.355) 14
September	2.072 (2.636) 4	0.658 (0.250) 4	0.038 (0.048) 4	9.869 (10.850) 4	0.333 (0.471) 4	NC 4	0.912 (0.946) 16	0.185 (0.197) 11	0.056 (0.037) 27	0.360 (0.379) 15	0.050 0.072) 13	0.321 (0.316) 13
October	0.250 (0.152) 6	0.833 (0.793) 4	0.008 (0.017) 4	4.778 (8.163) 4	1.616 (2.661) 4	8.346 (12.363) 4	1.137 (0.585) 15	0.278 (0.267) 12	0.007 (0.010) 16	0.140 (0.125) 14	2.189 (2.376) 9	0.455 (0.316) 9
TOTAL	**0.663 (0.513) 25**	**0.535 (0.290) 19**	**0.255 (0.450) 20**	**0.537 (0.361) 21**	**3.772 (2.312) 24**	**1.419 (1.839) 29**	**0.659 (0.289) 66**	**0.242 (0.154) 49**	**0.157 (0.079) 92**	**0.357 (0.207) 59**	**1.920 (1.184) 52**	**0.690 (0.492) 51**

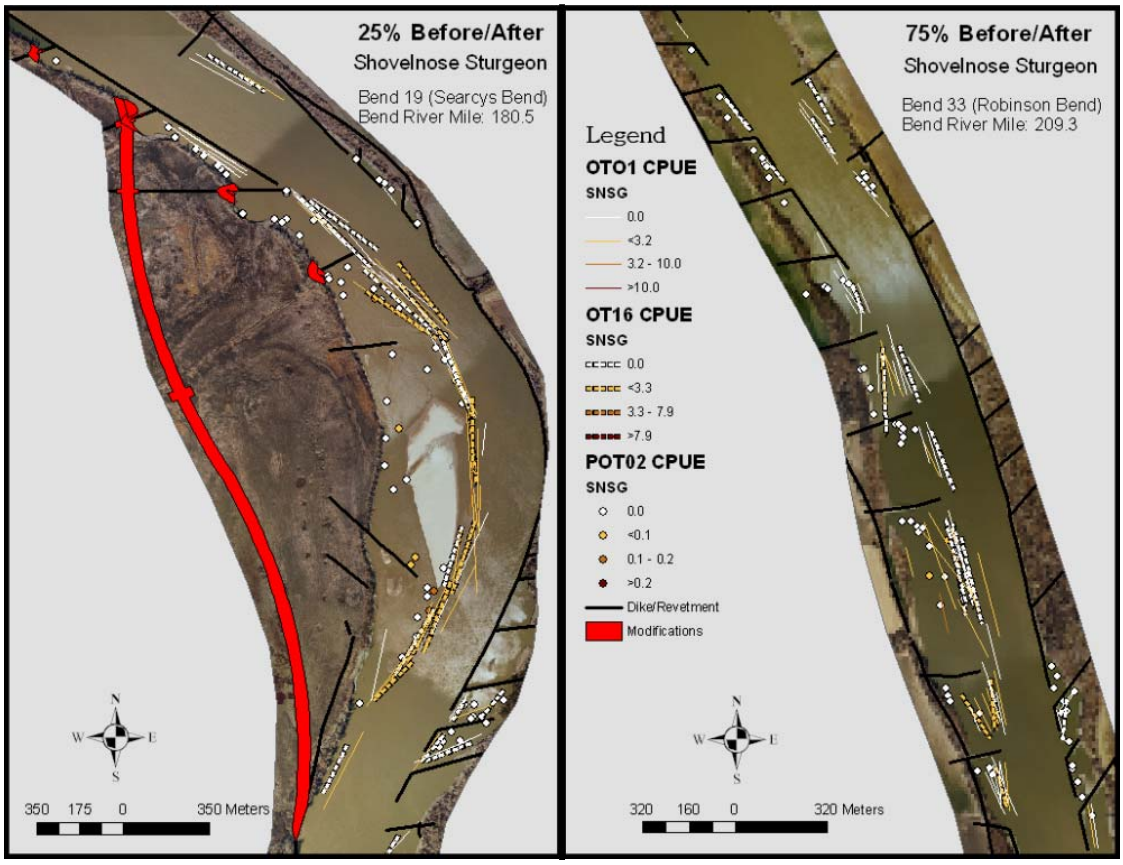

Figure 15. GIS overlay of CPUE data for shovelnose sturgeon captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Before/After bends in Segment 13.

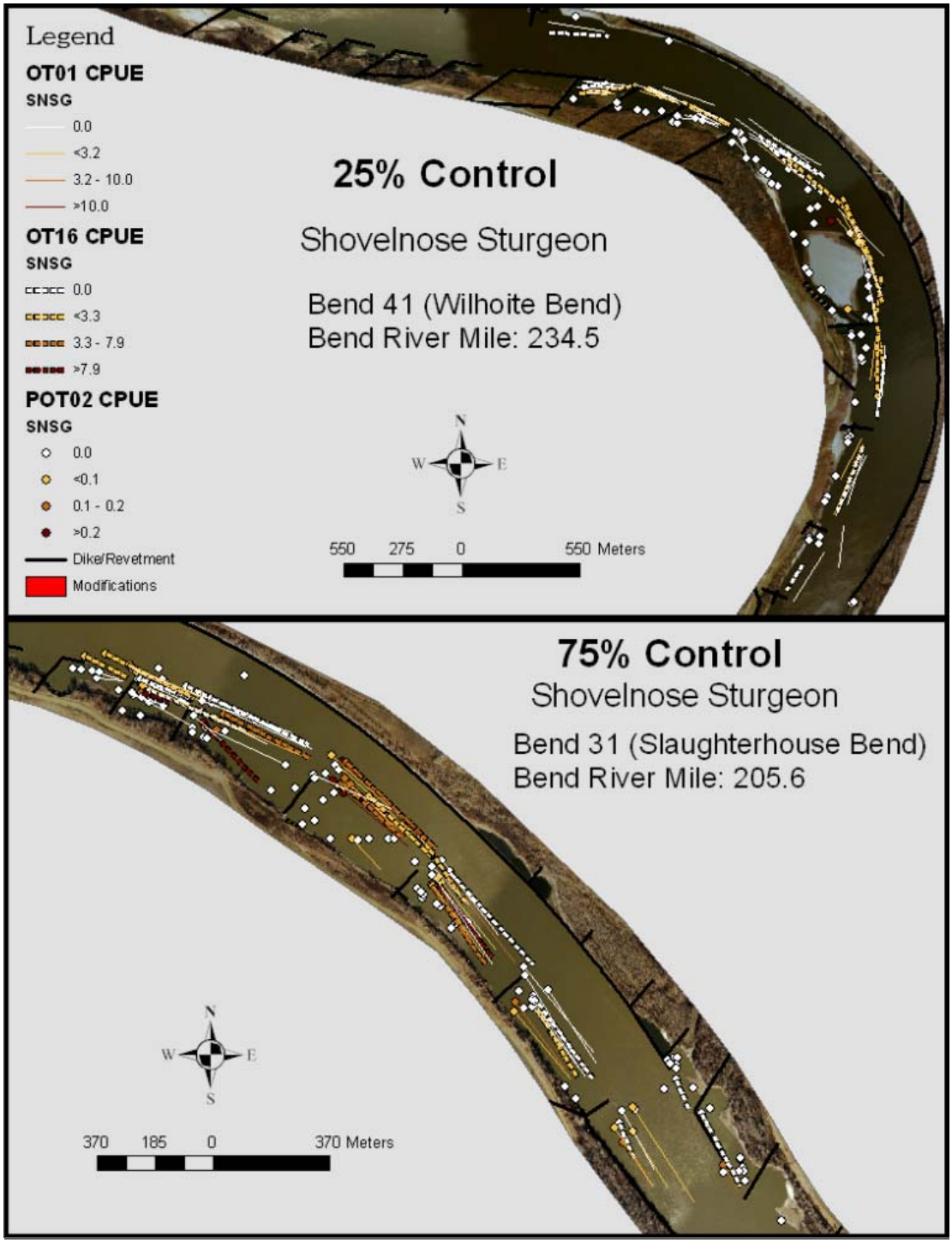

Figure 16. GIS overlay of CPUE data for shovelnose sturgeon captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Control bends in Segment 13.

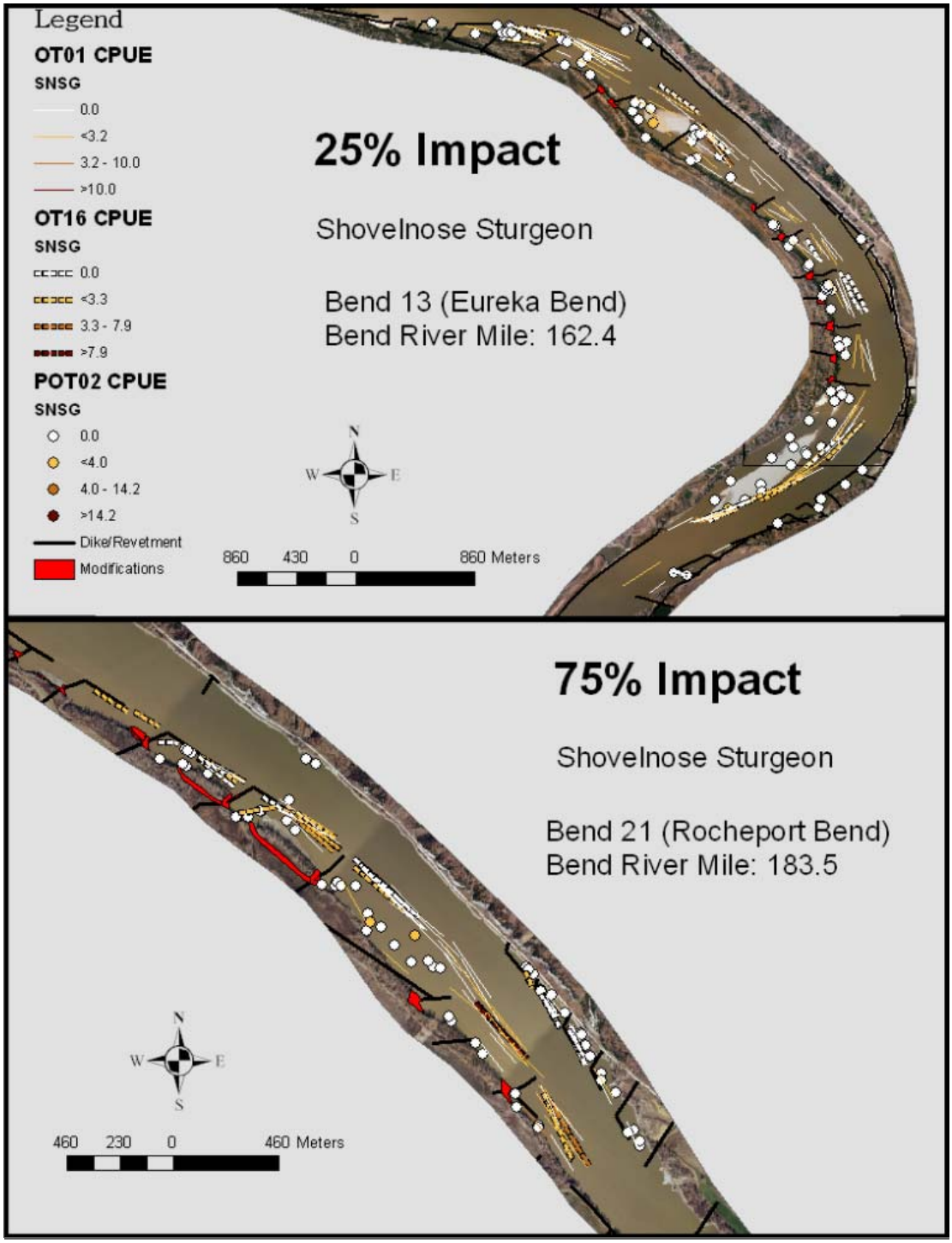

Figure 17. GIS overlay of CPUE data for shovelnose sturgeon captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Impact bends in Segment 13.

OT16 and OT01 – YOY SNSG

A total of 19 and 26 YOY shovelnose sturgeon were captured with OT16 and OT01 respectively (Table 27). OT16 catch rates ranged from NC to 0.250 fish/100 m for bend 21 in October. No YOY shovelnose sturgeon were captured on any bend in July. No YOY sturgeon were captured on 75% bends in July, August and September. No YOY sturgeon were captured on 75 % Before (bend 33) in any month. YOY shovelnose sturgeon were captured on more 25% bends and in more months than 75 % bends. Total catch rates were higher for the 25% bends.

Catch rates for OT01 ranged from NC to 0.160 for 75% Before (bend 33). Catch rates were low for all bends and months sampled. A single YOY shovelnose sturgeon was captured in October on the 25% Control (bend 41). Three YOY shovelnose sturgeon were captured in August on 75% Before (bend 33).

Catch rates were lower for the OT01 catch rate than the OT16 catch rate. OTO1 captured fish on more bends and in more months than OT16. This may be due to higher sample size (N) of the OT01 than the OT16. In general, total catch rates for the OT16 were higher than the OT01 but the OT01 captured YOY sturgeon on more bends and in more months. Catch rates were low for both gears on all bends and all months. No fish were captured (NC) on 19 of 30 bend-months for OT16 and 13 of 29 bend-months sampled with OT01. OT16 and OT01 NC did not follow the same trends and this likely indicated that YOY shovelnose sturgeon densities were very low during the 2006 sampling season.

OT16 and OT01 – Juvenile SNSG

A total of 97 and 146 juvenile shovelnose sturgeon were captured with OT16 and OT01 respectively. OT16 catch rates ranged from NC to 1.358 fish/100 m (Table 28). Catch rates were low with most samples less than 0.5 fish/100 m trawled. Fish were captured on all bends in June and October with OT16 indicating more fish or an even distribution between bends. NC accounted for 7 of 30 bend-month samples for OT16. Total catch rates on both Impact bends were the lowest of the six bends for OT16.
OT01 catch rates ranged from NC to 0.550 fish/100 m. Overall there may be a declining trend in catch rate, but this trend is not found on all bends. Catch rates were low and no solid trends could be detected.

Fish were captured on more bends with the OT01 than the OT16, this is likely because of more net deployments per bend-month than with the OT16. Catch rates are lower for OT01 than OT16. Uneven sample sizes may be the cause of this. Catch rates for the two gears do not appear to follow the same trends, but both have high variability in catch rates. This may be an indication that densities are low or sample size is too small.

Table 27. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for YOY shovelnose sturgeon by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	0.076 (0.152) 4	NC 4	NC 7	0.090 (0.118) 8	0.059 0.079 7	0.083 (0.167) 6	NC 10	0.024 (0.047) 17	NC 2		NC 3
July	NC 4	NC 3	NC 4	NC 6	NC 4	NC 6	0.025 (0.050) 14	NC 9	0.022 (0.044) 18	NC 15	0.058 (0.116) 13	0.033 (0.066) 12
August	NC 4	NC 4	0.102 (0.204) 4	NC 2	NC 4	NC 4	0.045 (0.062) 15	NC 7	0.024 (0.047) 14	0.160 (0.244) 13	0.128 (0.141) 12	NC 14
September	0.233 (0.465) 4	0.086 (0.172) 4	0.167 (0.333) 4	NC 2	NC 4	NC 4	0.077 (0.084) 16	NC 11	0.029 (0.040) 27	NC 15	NC 12	0.075 (0.102) 13
October	0.194 (0.181) 6	0.083 (0.167) 4	NC 4	NC 4	0.080 (1.060) 4	0.250 0.500) 4	NC 15	0.028 (0.056) 12	NC 16	NC 14	0.019 (0.037) 15	0.044 (0.089) 9
TOTAL	**0.084 (0.088) 25**	**0.058 (0.062) 17**	**0.054 (0.076) 20**	**NC 21**	**0.043 (0.048) 24**	**0.057 (0.074) 29**	**0.042 (0.031) 66**	**0.007 (0.014) 49**	**0.021 (0.018) 92**	**0.035 (0.055) 59**	**0.049 (0.046) 52**	**0.035 (0.034) 51**

Table 28. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for juvenile shovelnose sturgeon by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.193 (0.386) 7	0.227 (0.455) 4	0.403 (0.806) 4	0.239 (0.343) 7	0.554 (0.488) 8	0.301 (0.271) 7	0.550 (0.534) 6	0.378 (0.592) 10	0.137 (0.236) 17	NC 2		0.111 (0.222) 3
July	0.081 (0.161) 4	0.461 (0.626) 3	NC 4	0.482 (0.614) 6	0.417 (0.833) 4	NC 6	0.048 (0.066) 14	0.049 (0.099) 9	0.078 (0.122) 18	0.184 (0.170) 15	0.219 (0.147) 13	0.123 (0.135) 12
August	0.083 (0.167) 4	NC 4	NC 4	NC 2	0.900 (1.052) 4	0.100 (0.200) 4	NC 15	0.123 (0.246) 7	0.276 (0.450) 14	0.259 (0.435) 13	0.483 (0.476) 12	0.105 (0.117) 14
September	1.358 (2.140) 4	0.370 (0.280) 4	0.208 (0.250) 4	NC 2	0.333 (0.667) 4	NC 4	0.465 (0.477) 16	NC 11	0.370 (0.233) 27	0.135 (0.224) 15	0.086 (0.125) 12	0.132 (0.116) 13
October	0.444 (0.410) 6	0.292 (0.394) 4	0.083 (0.167) 4	0.139 (0.278) 4	0.192 (0.385) 4	0.375 (0.285) 4	0.375 (0.231) 15	0.153 (0.207 12	0.044 (0.060) 16	0.024 (0.048) 14	0.212 (1.122) 15	0.248 (0.301) 9
TOTAL	**0.404 (0.379) 25**	**0.291 (0.180) 17**	**0.139 (0.168) 20**	**0.244 (0.216) 21**	**0.492 (0.291) 24**	**0.180 (0.123) 29**	**0.258 (0.143) 66**	**0.141 (0.137) 49**	**0.199 (0.110) 92**	**0.144 (0.119) 59**	**0.247 (0.134) 52**	**0.142 (0.075) 51**

OT16 and OT01 – Adult SNSG

A total of 85 and 152 adult shovelnose sturgeon were captured with OT16 and OT01 respectively. OT16 catch rates ranged from NC to 1.717 fish/100 m (Table 29). Control bends had the highest total catch rates. Catch rates of OT16 were variable by both bends and months with no distinctive patterns. Catch rates for OT01 ranged from NC to 0.762 fish/100 m. As with the OT16, no patterns were observed in catch rates by bends or month.

TN – all SNSG

A total of 183 shovelnose sturgeon were captured with drifted one inch trammel nets. Trammel nets were not used in June on any bends. Catch rates were higher on 75% Before and Control bends (Table 30). Catch rates in August were low with a total of five fish being captured for all bends combined. Catch rates in September were relatively high and consistent for all bends.

TN – Juvenile SNSG

A total of 81 juvenile shovelnose sturgeon were captured with trammel nets in segment 13. One juvenile shovelnose sturgeon was captured in August for all bends. 75% bends had higher catch rates than 25% bends (Table 31). Two fish were captured on 25% Impact bend for the entire season.

TN – Adult SNSG

A total of 109 adult shovelnose sturgeon were captured with trammel nets in Segment 13. Catch rates ranged from NC to 1.510 fish/100 m (Table 32). Four shovelnose sturgeon were captured in August on all bends combined. A total five (one in July and four in August) SNSG were captured on bend 21 for the entire season.

POT02 and MF – all SNSG

A total of 16 shovelnose sturgeon were captured in push trawls (Table 33). Of the16 sturgeon, 7 were YOY and 9 were juvenile. No sturgeon were captured in minifyke nets. Both gears are intended to sample shallow littoral zone on sandbars and bank lines. The push trawl is able to sample maximum depths of 2.0 m allowing it to capture species that are not usually associated with shallow sandbar habitats. No shovelnose sturgeon were captured on the 75% Impact bend during any month. No shovelnose sturgeon were captured in the month of August using the push trawl. Shovelnose sturgeon were captured on all 25% bends in June. Overall, catch rates were low in all months and bends.

Table 29. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for adult shovelnose sturgeon by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.064 (0.129) 7	0.076 (0.152) 4	0.726 (1.452) 4	0.719 (0.720) 7	0.544 (0.481) 8	0.315 (0.345) 7	0.300 (0.272) 6	NC 10	0.347 (0.265) 17	NC 2		0.222 (0.444) 3
July	NC 4	0.434 (0.869 3	0.076 (0.152) 4	NC 6	0.208 (0.417) 4	0.268 (0.419) 6	0.202 0.272) 14	0.154 (0.214) 9	0.068 (0.076) 18	0.122 (0.134) 15	0.371 (0.310) 13	0.087 (0.175) 12
August	NC 4	NC 4	0.147 (0.294) 4	NC 2	1.717 (2.452) 4	0.143 (0.286) 4	0.113 (0.129) 15	NC 7	0.514 (0.899) 14	0.284 (0.346) 13	0.319 (0.358) 12	NC 14
September	0.483 (0.558) 4	0.201 (0.239) 4	NC 4	NC 2	0.266 (0.326) 4	NC 4	0.370 (0.474) 16	0.185 (0.197) 11	0.166 (0.151) 27	0.224 (0.230) 15	0.059 (0.117) 12	NC 13
October	0.333 (0.344) 6	0.458 (0.370) 4	NC 4	0.278 (0.556) 4	0.128 (0.256) 4	NC 4	0.762 (0.406) 15	0.098 (0.105) 12	0.023 (0.046) 16	0.116 (0.123) 14	0.201 (0.159) 15	0.137 (0.140) 9
TOTAL	**0.175 (0.138) 25**	**0.250 (0.184) 17**	**0.190 (0.293) 20**	**0.292 (0.285) 21**	**0.568 (0.460) 24**	**0.195 (0.143) 29**	**0.359 (0.169) 66**	**0.094 (0.066) 49**	**0.208 (0.153) 92**	**0.178 (0.105) 59**	**0.238 (0.127) 52**	**0.058 (0.054) 51**

Table 30. Segment 13 trammel net (TN) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for all shovelnose sturgeon by Columbia FRO during the 2006 field season.

	Trammel Net (TN)					
	25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June						
July	0.19 (0.2) 4	1.26 (1.5) 4	0.33 (0.7) 4	1.412 (2.2) 6	14.58 (27) 4	1.25 (1.5) 4
August	NC 4	0.25 (0.3) 4	0.29 (0.6) 4	NC 4	NC 4	NC 4
September	1.87 (2.5) 4	NC 4	0.25 (0.3) 4	5.887 (8.6) 4	5.855 (3.9) 4	1.292 (2.1) 4
October	0.89 (0.8) 5	1.37 (1.6) 4	NC 4	1.594 (1.4) 4	0.263 (0.5) 4	NC 4
TOTAL	**0.747** **(0.756)** **17**	**0.705** **(0.571)** **16**	**0.163** **(0.214)** **16**	**2.114** **(2.118)** **18**	**5.175** **(6.820)** **16**	**0.635** **(0.671)** **16**

Table 31. Segment 13 trammel net (TN) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for juvenile shovelnose sturgeon by Columbia FRO during the 2006 field season.

	Trammel Net (TN)					
	25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June						
July	0.069 (0.139) 4	0.316 (0.633) 4	NC 4	0.310 (0.422) 6	0.221 0.441 4	0.926 (1.096) 4
August	NC 4	0.083 (0.167) 4	NC 4	NC 4	NC 4	NC 4
September	0.455 (0.909) 4	NC 4	0.167 (0.333) 4	3.813 (5.242) 4	1.341 0.714 4	0.819 (1.327) 4
October	0.273 (0.375) 5	0.250 (0.500) 4	NC 4	0.858 (0.858) 4	NC 4	NC 4
TOTAL	**0.204 (0.235) 17**	**0.162 (0.195) 16**	**0.042 (0.083) 16**	**1.101 (1.277) 18**	**0.390 (0.343) 16**	**0.436 (0.446) 16**

Table 32. .Segment 13 trammel net (TN) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for adult shovelnose sturgeon by Columbia FRO during the 2006 field season.

	Trammel Net (TN)					
	25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June						
July	0.125 (0.25) 4	0.94 (1.2) 4	0.33 (0.67) 4	1.1 (1.79) 6	1.51 (2.73) 4	0.078 (0.156) 4
August	NC 4	0.17 (0.197) 4	0.29 (0.58) 4	NC 4	NC 4	NC 4
September	1.42 (2.06) 4	NC 4	0.083 (0.167) 4	2.07 (3.4) 4	0.536 (0.765) 4	0.662 (1.06) 4
October	0.613 (0.823) 5	1.06 (1.13) 4	NC 4	0.832 (0.774) 4	0.263 (0.526) 4	NC 4
TOTAL	**0.543** **(0.559)** **17**	**0.542** **(0.441)** **16**	**0.178** **(0.215)** **16**	**1.013** **(0.953)** **18**	**0.576** **(0.708)** **16**	**0.185** **(0.279)** **16**

Table 33 Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for all shovelnose sturgeon by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.013 (0.018) 15	0.026 (0.038) 16	0.010 (0.014) 22	NC 8	NC 8	NC 13						
July	0.005 (0.011) 16	NC 15	NC 19	0.002 (0.004) 15	NC 12	NC 14	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
August	NC 15	NC 14	NC 15	NC 14	NC 15	NC 13	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
September	0.032 (0.044) 14	NC 12	NC 15	0.004 (0.008) 16	NC 11	0.071 (0.063) 9	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
October	0.020 (0.037) 10	NC 15	NC 15	NC 10	NC 11	0.020 (0.041) 14	NC 4	NC 3	NC 4	NC 4	NC 4	NC 3
TOTAL	**0.013 (0.011) 70**	**0.006 (0.009) 72**	**0.003 (0.004) 86**	**0.002 (0.002) 63**	**NC 55**	**0.009 (0.013) 63**	**NC 15**	**NC 15**	**NC 16**	**NC 16**	**NC 16**	**NC 16**

Sicklefin Chub

OT16 and OT01 – all SFCB

A total of 161 and 2,391 sicklefin chubs were captured in OT16 and OT01 respectively. OT16 catch rates ranged from NC to 12.193 fish/100 m trawled for bend 21 in October (Table 34).XX34 Catch rates were low in September with 4 bends having no sicklefin chubs captured (NC). Sicklefin chubs were only captured in July and October on bend 33. Overall, catch rates declined during mid to late summer and were higher in early summer (June and July) and fall (October).

Sicklefin chubs were captured with OT01 on all bends and months that were sampled. Catch rates ranged from 0.122 to a high of 40.248 fish/ 100 m trawled on bend 21 in July (Table 34).Table X34) Total catch rates were higher for the 75% bends than 25% bends. Catch rates were highest in July.

Graphical Display – all SFCB

Sicklefin chubs were captured on all portions of the bends (Figure 18, Figure 19,Figure 18, 19 and Figure 2020). The majority of the OT16 and OT01 hauls with higher catch rates were captured on inside bends of 75% bends (Figure 19Figures 19 and Figure 2020).

OT16 and OT01 – YOY SFCB

A total of 119 and 1,410 YOY sicklefin chubs were captured in OT16 and OT01 respectively. OT16 catch rates ranged from NC to 8.252 fish/100 m trawled for bend 19 in July (Table 35). July had the highest catch rates overall. No YOY sicklefin chubs were captured in bend 33. Catch rates were generally low for the OT16 with 19 of the 30 bend-month samples capturing no fish (NC). OT01 catch rates were from NC to 6.373 fish/100 m. Catch rates were highest in July and August for all bends. 75% bends had higher catch rates from 25% bends.

OT16 and OT01 – Adult SFCB

A total of 115 and 262 adult sicklefin chubs were captured with OT16 and OT01 respectively (Table 36). September catch rates were low with no fish captured on five of the six bends. Adult sicklefin chubs were captured on all bends in July and October with the OT16.

Catch rates for the OT01 ranged from NC to 2.225 fish/100 m for bend 21 in June. Fish were captured on all bends sampled except bend 33 and 41 in August. Catch rates were stable or declined slightly through the season.

POT02 and MF – all SFCB

A total of 450 and 15 sicklefin chubs were captured with POT02 and MF respectively. Catch rates ranged from NC to 1.036 fish/10 m trawled for the POT02 and NC to 2.500 fish/net-night with MF (Table 37). Catch rates peaked in July and August for POT02.

Sicklefin chubs were captured on four of 24 bend-month samples using the MF. Catch of sicklefin chubs should be considered incidental with MF.

POT02 and MF – YOY SFCB

A total of 403 and 15 YOY sicklefin chubs were captured with POT02 and MF respectively. In general, catch rates were low and variable throughout all bends and months (Table 38). Increased Total catch rates by bend are driven by one large sample.

All sicklefin chubs captured with MF were YOY. YOY sicklefin chubs were captured in three bend-months with MF. Collection of sicklefin chubs with the MF should be considered incidental.

POT02 and MF – Adult SFCB

A total of 47 adult sicklefin chubs were captured with POT02. No adult sicklefin chubs were captured with MF. No adult sicklefin chubs were captured on 19 of the 30 bend-month samples (Table 39). No adult sicklfin chubs were captured in August and only one fish was captured in September.

Table 34. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for all sicklefin chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.048 (0.095) 7	0.462 (0.298) 4	0.164 (0.189) 4	NC 4	3.852 (5.385) 8	0.206 (0.173) 11	1.086 (1.581) 6	0.227 (0.208) 10	0.122 (0.116) 17	1.597 (1.655) 2		6.667 (6.667) 3
July	8.870 (12.176) 4	0.252 (0.503) 3	0.411 (0.491) 4	1.005 (1.280) 6	0.472 (0.943) 4	3.943 (4.798) 6	2.021 (1.222) 14	1.459 (1.191) 9	1.549 (1.865) 18	3.035 (3.236) 15	16.271 (15.099) 13	40.248 (32.764) 12
August	2.499 (3.930) 4	0.083 (0.167) 4	0.085 (0.098) 4	NC 2	0.545 (0.866) 4	2.359 (2.786) 4	3.591 (2.543) 15	0.238 (0.476) 7	0.114 (0.075) 14	0.140 (0.195) 13	0.339 (0.295) 12	10.762 (10.809) 14
September	NC 4	0.172 (0.345) 4	NC 4	NC 2	0.100 (0.200) 4	NC 4	1.440 (0.719) 66	0.543 (0.345) 49	0.351 (0.376) 92	1.371 (0.950) 59	5.611 (4.324) 52	13.066 (9.146) 51
October	0.222 (0.301) 6	0.167 (0.192) 4	0.028 (0.033) 4	1.000 (1.155) 4	1.111 (2.222) 4	12.193 (20.188) 4	0.394 (0.631) 9	0.288 (0.191) 12	0.058 (0.049) 16	0.498 (0.495) 14	4.911 (5.038) 15	0.394 (0.631) 9
TOTAL	**1.886 (2.226) 25**	**0.226 (0.134) 19**	**0.138 (0.117) 20**	**0.478 (0.453) 21**	**1.655 (1.876) 24**	**2.901 (3.048) 29**	**1.440 (0.719) 66**	**0.543 (0.345) 49**	**0.351 (0.376) 92**	**1.371 (0.950) 59**	**5.611 (4.324) 52**	**13.066 (9.146) 51**

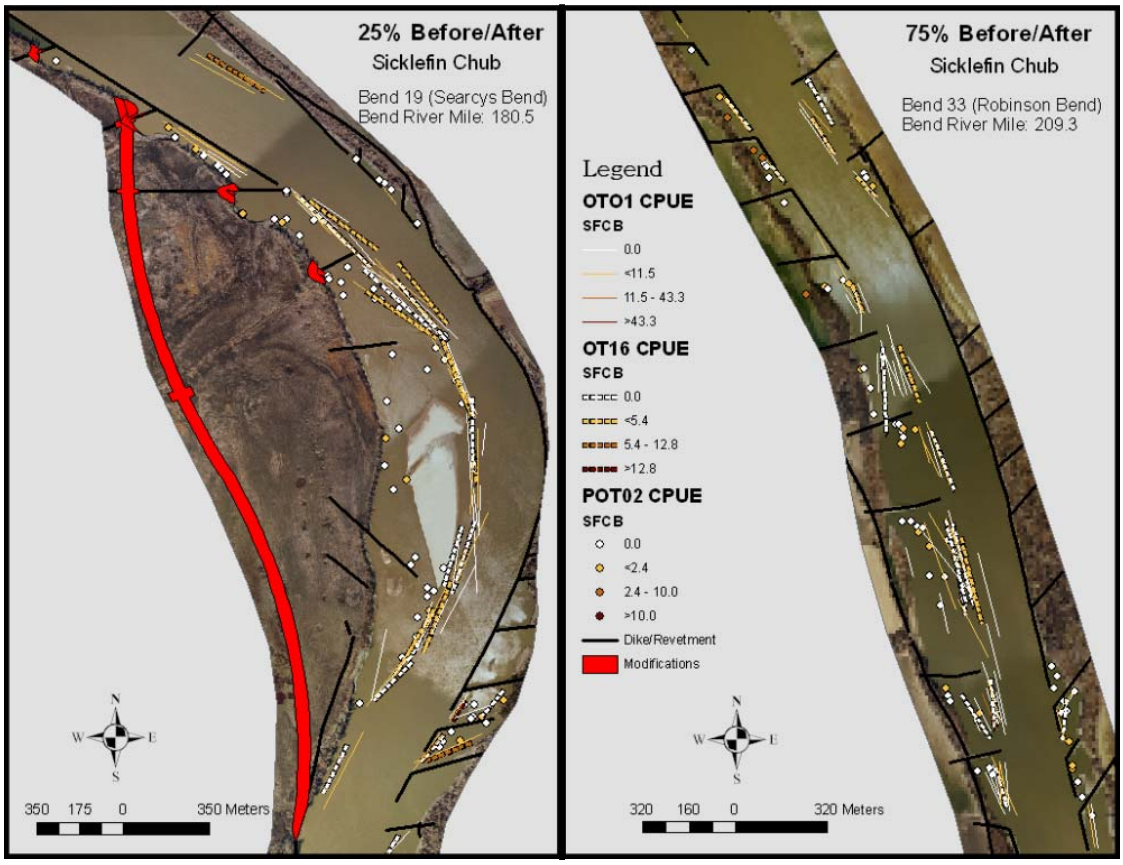

Figure 18. GIS overlay of CPUE data for sicklefin chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Before/After bends in Segment 13.

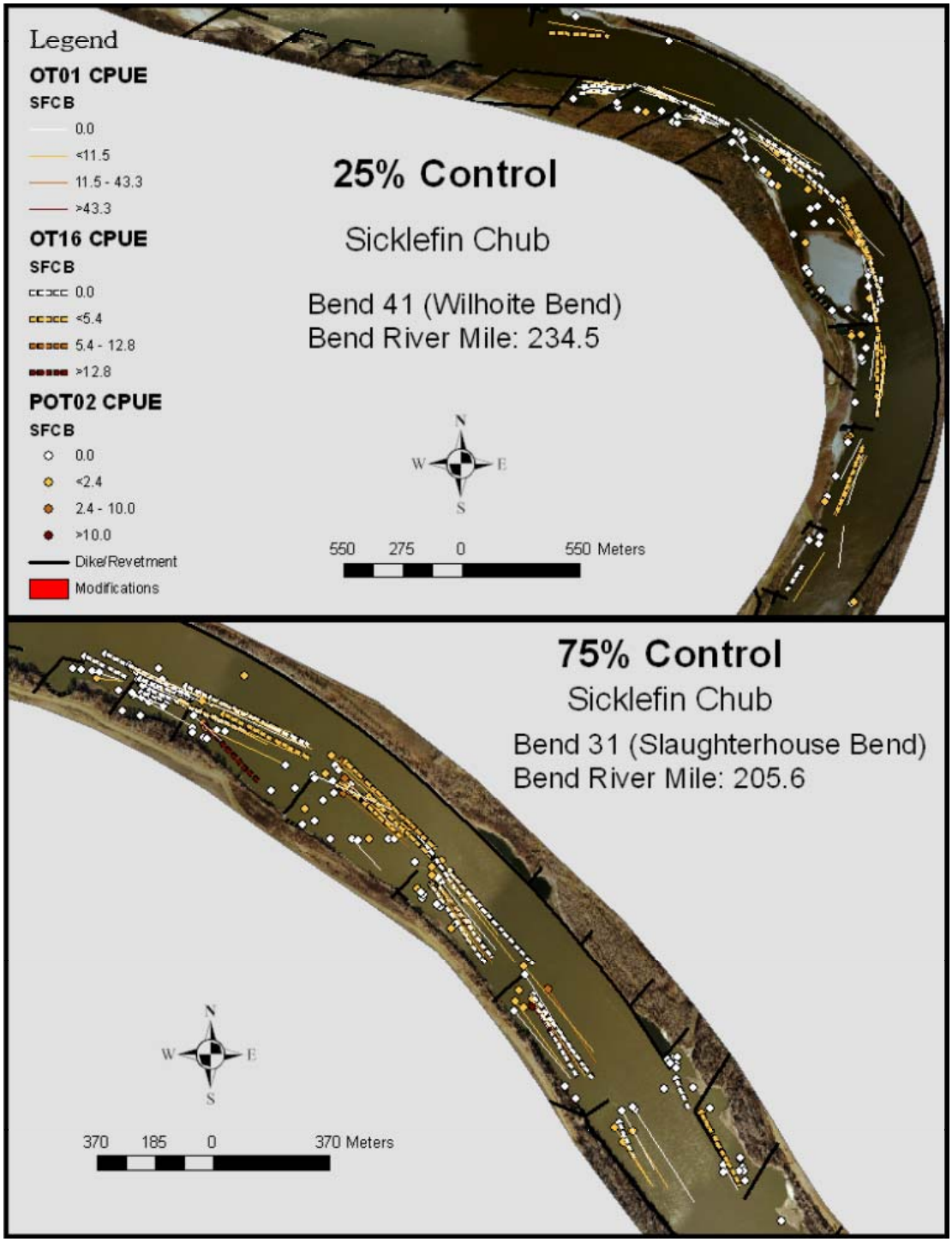

Figure 19. GIS overlay of CPUE data for sicklefin chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for control bends in Segment 13

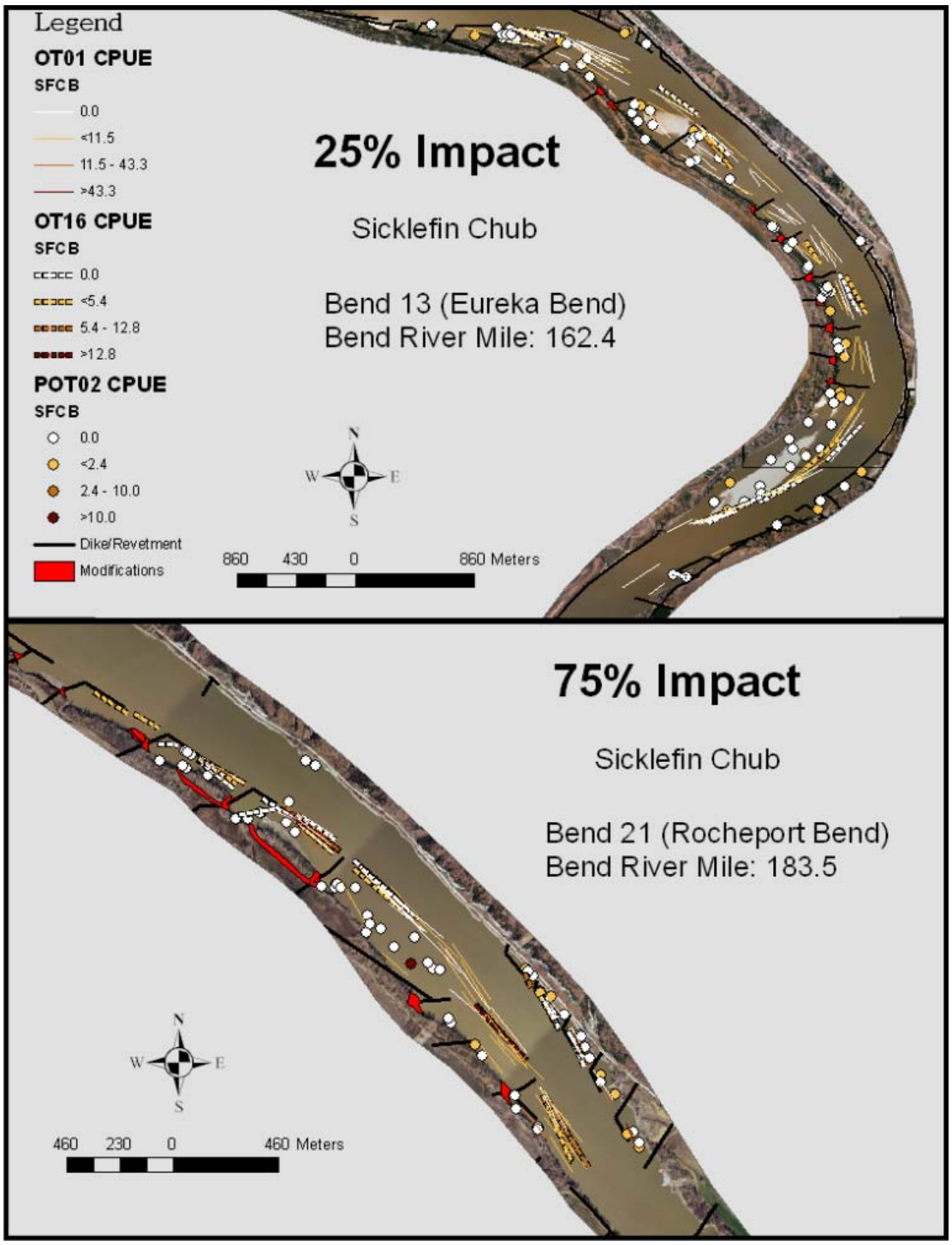

Figure 20. GIS overlay of CPUE data for sicklefin chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Impact bends in Segment 13.

Table 35. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for YOY sicklefin chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	NC 4	NC 4	NC 7	0.049 (0.098) 8	NC 7	0.250 (0.500) 6	NC 10	NC 17	0.303 (0.606) 2		NC 3
July	8.252 (10.234) 4	0.126 (0.252) 3	0.244 (0.488) 4	NC 6	0.278 (0.556) 4	4.496 (5.931) 6	4.389 (2.649) 14	1.186 (1.149) 9	0.999 (1.050) 18	2.661 (2.891) 15	2.031 (2.128) 13	6.373 (3.242) 12
August	2.207 (3.584) 4	NC 4	NC 4	NC 2	NC 4	0.286 (0.571) 4	3.187 (2.489) 15	0.238 (0.476) 7	0.736 (0.623) 14	0.140 (0.195) 13	0.500 (0.669) 12	2.742 (2.217) 14
September	NC 4	NC 4	NC 4	NC 2	0.095 (0.191) 4	NC 4	0.079 (0.119) 16	0.524 (1.049) 11	0.035 (0.049) 27	1.526 (1.614) 15	NC 12	0.026 (0.051) 13
October	0.056 (0.111) 6	NC 4	0.139 (0.278) 4	NC 4	NC 4	NC 4	NC 15	0.069 (0.139) 12	0.170 (0.281) 16	0.237 (0.383) 14	0.369 (0.544) 15	NC 9
TOTAL	**1.687** **(1.956)** **25**	**0.022** **(0.044)** **17**	**0.077** **(0.110)** **20**	**NC** **21**	**0.079** **(0.100)** **24**	**0.970** **(1.330)** **29**	**1.697** **(0.906)** **66**	**0.387** **(0.335)** **49**	**0.347** **(0.242)** **92**	**1.162** **(0.869)** **59**	**0.729** **(0.599)** **52**	**2.259** **(1.190)** **51**

Table 36. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for adult sicklefin chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.048 (0.095) 7	0.462 (0.298) 4	0.164 (0.189) 4	NC 7	0.290 (0.288) 8	0.274 (0.200) 7	2.225 (3.365) 6	0.227 (0.208) 10	0.122 (0.116) 17	1.294 (1.049) 2		0.588 (0.593) 3
July	2.141 (2.666) 4	0.126 (0.252) 3	0.167 (0.333) 4	1.005 (1.280) 6	0.069 (0.139) 4	0.377 (0.483) 6	0.095 (0.147) 14	0.272 (0.336) 9	0.039 (0.053) 18	0.374 (0.409) 15	0.270 (0.232) 13	0.650 (0.558) 12
August	0.292 (0.394) 4	NC 4	0.849 (0.982) 4	NC 2	0.727 (0.951) 4	1.543 (2.155) 4	0.393 (0.237) 15	NC 7	0.407 (0.347) 14	NC 13	0.106 (0.113) 12	0.914 (0.611) 14
September	NC 4	0.172 (0.345) 4	NC 4	NC 2	NC 4	NC 4	0.256 (0.202) 16	0.030 (0.061) 11	0.358 (0.409) 27	0.031 (0.062) 15	0.325 (0.366) 12	0.454 (0.459) 13
October	0.167 (0.228) 6	0.167 (0.192) 4	0.143 (0.286) 4	1.000 (1.155) 4	0.256 (0.513) 4	0.750 (1.287) 4	0.067 (0.133) 15	0.219 (0.168) 12	0.375 (0.373) 16	0.262 (0.244) 14	0.188 (0.170) 15	0.271 (0.443) 9
TOTAL	**0.443 (0.492) 25**	**0.211 (0.133) 17**	**0.265 (0.238) 20**	**0.478 (0.453) 21**	**0.272 (0.209) 24**	**0.498 (0.371) 29**	**0.389 (0.328) 66**	**0.157 (0.089) 49**	**0.262 (0.149) 92**	**0.209 (0.199) 59**	**0.221 (0.115) 52**	**0.602 (0.257) 51**

Table 37 Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for all sicklefin chub sturgeon by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 15	0.013 (0.025) 16	0.071 (0.060) 22	0.042 (0.083) 8	NC 8	NC 13						
July	0.043 (0.052) 16	1.036 (1.507) 15	0.472 (0.463) 19	0.272 (0.247) 15	0.115 (0.201) 12	0.146 (0.160) 14	NC 4	NC 4	NC 4	NC 6	NC 4	NC 4
August	0.368 (0.314) 15	NC 14	0.144 (0.142) 15	0.472 (0.474) 14	0.039 (0.066) 15	3.101 (5.798) 13	NC 4	NC 4	NC 4	2.500 (5.000) 4	NC 4	0.500 (1.000) 4
September	0.017 (0.034) 14	0.676 (0.757) 12	0.014 (0.020) 15	0.829 (0.775) 16	0.003 (0.006) 11	NC 9	NC 3	NC 4	NC 4	NC 4	NC 4	NC 4
October	0.175 (0.332) 10	0.362 (0.650) 15	NC 15	0.040 (0.059) 10	0.035 (0.037) 11	0.004 (0.006) 14	NC 3	0.250 (0.577) 3	NC 4	0.500 (0.577) 4	NC 4	NC 4
TOTAL	**0.117 (0.089) 70**	**0.407 (0.367) 72**	**0.150 (0.111) 86**	**0.392 (0.238) 63**	**0.043 (0.048) 55**	**0.673 (1.201) 63**	**NC 14**	**0.063 (0.125) 15**	**NC 16**	**0.750 (1.245) 16**	**NC 16**	**0.125 (0.250) 16**

Table 38 Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for YOY sicklefin chub sturgeon by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 15	NC 16	0.044 (0.044) 22	NC 8	NC 6	NC 13						
July	0.09 (0.12) 16	0.665 (1.09) 15	0.472 (0.463) 19	0.272 (0.247) 15	0.122 (0.165) 12	0.385 (0.33) 14	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
August	0.44 (0.34) 15	NC 14	0.144 (0.142) 15	0.472 (0.474) 14	0.141 (0.222) 15	0.93 (1.02) 13	NC 4	NC 4	NC 4	2.500 (5.000) 4	NC 4	0.500 (1.000) 4
September	0.017 (0.034) 14	0.3 (0.31) 12	0.014 (0.020) 15	0.829 (0.775) 16	0.031 (0.063) 11	NC 9	NC 3	NC 4	NC 4	NC 4	NC 4	NC 4
October	0.175 (0.35) 10	0.341 (0.65) 15	NC 15	0.034 (0.057) 10	0.08 (0.14) 11	0.036 (0.071) 14	NC 3	0.250 (0.5) 4	NC 4	0.67 (0.67) 4	NC 4	NC 4
TOTAL	**0.139 (0.098) 70**	**0.260 (0.269) 72**	**0.143 (0.111) 86**	**0.385 (0.238) 63**	**0.087 (0.076) 55**	**0.278 (0.235) 63**	**NC 14**	**0.063 (0.125) 16**	**NC 16**	**0.750 (1.245) 16**	**NC 16**	**0.125 (0.250) 16**

Table 39 Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for adult sicklefin chub sturgeon by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 15	0.013 (0.025) 16	0.027 (0.046) 22	0.042 (0.083) 8	NC 6	NC 13						
July	NC 16	0.371 (0.451) 15	NC 19	NC 15	0.02 (0.04) 12	0.007 (0.014) 14	NC 4	NC 4	NC 4	NC 6	NC 4	NC 4
August	NC 15	NC 14	NC 15	NC 14	NC 15	NC 13	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
September	0.017 (0.034) 14	NC 12	NC 15	NC 16	NC 11	NC 9	NC 3	NC 4	NC 4	NC 4	NC 4	NC 4
October	NC 10	0.21 (0.32) 15	NC 15	0.0060 (0.012) 10	0.08 (0.092) 11	0.018 (0.036) 14	NC 3	NC 4	NC 4	NC 4	NC 4	NC 4
TOTAL	**0.003 (0.007 70**	**0.011 (0.098) 72**	**0.007 (0.012) 86**	**0.006 (0.0110 63**	**0.020 (0.021) 55**	**0.005 (0.008) 63**	**NC 14**	**NC 16**	**NC 16**	**NC 18**	**NC 16**	**NC 16**

Sturgeon Chub

OT16 and OT01 – all SGCB

A total of 26 and 227 sturgeon chub were captured with OT16 and OT01 respectively. Catch rates for OT16 ranged from NC to 1.250 fish/100 m (Table 40).Table 39) Catch rates were low with the OT16 with no fish captured on 18 of the 30 bend-months. Sturgeon chubs were captured more in the 75% bends in June and July while captures on the 25% bends were in late summer and fall though the trend for the 25% bends is not strong.

Catch rates for OT01 ranged from NC to 3.333 fish/100 m. Bends 21 and 31 had the highest total catch rate for the year with 1.296 and 1.134 fish/100 m trawled respectively. In general, catch rates decreased in the late summer for all bends. Sturgeon chubs were the least common of the chub species in the Lower Missouri River. Low catch rates for all gears, even those that can effectively sample preferred habitats for sturgeon chubs were an indication of low abundance.

Graphical Display – all SGCB

Sturgeon chubs were captured on all bends and gears sampled (Figure 21, Figure 22,Figures 21, 22 and Figure 2323). Trawls with higher catch rates were collected on inside bends on the 75% bends. Higher catch rates are associated with inside bend sand bars and dike structures with wide spacing.

OT16 and OT01 – YOY SGCB

A total of 9 and 77 YOY sturgeon chubs were captured with OT16 and OT01 respectively. YOY sturgeon chubs were captured only on bends 19 (25% before) and 31 (75% Impact) for the entire season (Table 41). Capture of YOY sturgeon chubs with OT16 is low. Low abundance on all bends and months may be a factor in the many NC's with this gear.

Catch rates for OT01 of YOY sturgeon chubs ranged from NC to 1.66 fish/100 m. No YOY sturgeon chubs were captured on 15 of the 29 bend-months sampled. YOY sturgeon chubs were captured in all months sampled on bend 19. YOY sturgeon chubs were captured on all bends in the month of July.

OT16 and OT01 – Adult SGCB

A total of 17 and 150 adult sturgeon chubs were captured with OT16 and OT01 respectively. Catch rates for OT16 ranged from NC to 0.333 fish/100 m (Table 42). Catch rates for adult sturgeon chubs was low for all months and bends samples. There exists a potential trend from higher abundance for 75% bends in June and July to 25% bends in September and October.

Catch rates for OT01 ranged from NC to 1.030 fish/100 m. Adult sturgeon chubs were captured on bends 19 and 21 in all months sampled. October was the only month in which adult sturgeon chubs were captured on all bends.

POT02 and MF – all SGCB

A total of 16 sturgeon chubs were captured with the POT02. No sturgeon chubs were captured with minifyke nets. Sturgeon chubs were captured on 6 of 30 bend-months. Catch rates were highest on the Before bends (bend 19 and 33) (Table 43). No sturgeon chubs were captured on either of the Impact bends (bends13 and 21).

POT02 – YOY SGCB

A total of 14 YOY sturgeon chubs were captured with POT02. YOY sturgeon chubs were captured on bends 19, 31 and 33 (Table 44). All catch rates were very low <0.063 fish/100 m.

POT02 – Adult SGCB

A total of 2 sturgeon chubs were captured with POT02, one each on bends 19 and 41 in September. Sturgeon chubs normally occupy habitats that are deeper than can be effectively sampled with POT02. Collection of sturgeon chubs with this POT02 should be considered incidental.

Table 40 Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for all sturgeon chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	0.083 (0.167) 4	NC 4	NC 7	0.543 (1.087) 8	0.052 (0.104) 11	0.322 (0.422) 6	NC 10	0.024 (0.047) 17	NC 2		3.333 (3.849) 3
July	NC 4	NC 3	NC 4	0.078 (0.155) 6	0.313 (0.625) 4	0.079 (0.159) 6	0.117 (0.149) 14	0.389 (0.778) 9	0.184 (0.309) 18	0.309 (0.360) 15	2.258 (2.887) 13	3.000 (3.409) 12
August	0.708 (1.205) 4	NC 4	NC 4	NC 2	NC 4	0.333 (0.471) 4	0.903 (1.426) 15	NC 7	0.002 (0.005) 14	NC 13	0.098 (0.142) 12	0.813 (0.969) 14
September	NC 4	NC 4	0.011 (0.023) 4	NC 2	NC 4	NC 4	1.110 (1.129) 16	NC 11	0.027 (0.028) 27	0.087 (0.122) 15	0.117 (0.235) 12	0.486 (0.815) 13
October	0.250 (0.152) 6	NC 4	0.030 (0.041) 4	NC 4	NC 4	1.250 (2.500) 4	0.678 (0.921) 15	0.028 (0.056) 12	0.024 (0.022) 16	0.039 (0.078) 14	1.803 (1.462) 15	0.269 (0.356) 9
TOTAL	**0.173 (0.203) 25**	**0.018 (0.035) 19**	**0.008 (0.010) 20**	**0.022 (0.044) 21**	**0.233 (0.373) 24**	**0.255 (0.349) 29**	**0.683 (0.469) 66**	**0.078 (0.143) 49**	**0.076 (0.065) 92**	**0.110 (0.101) 59**	**1.134 (0.858) 52**	**1.296 (0.925) 51**

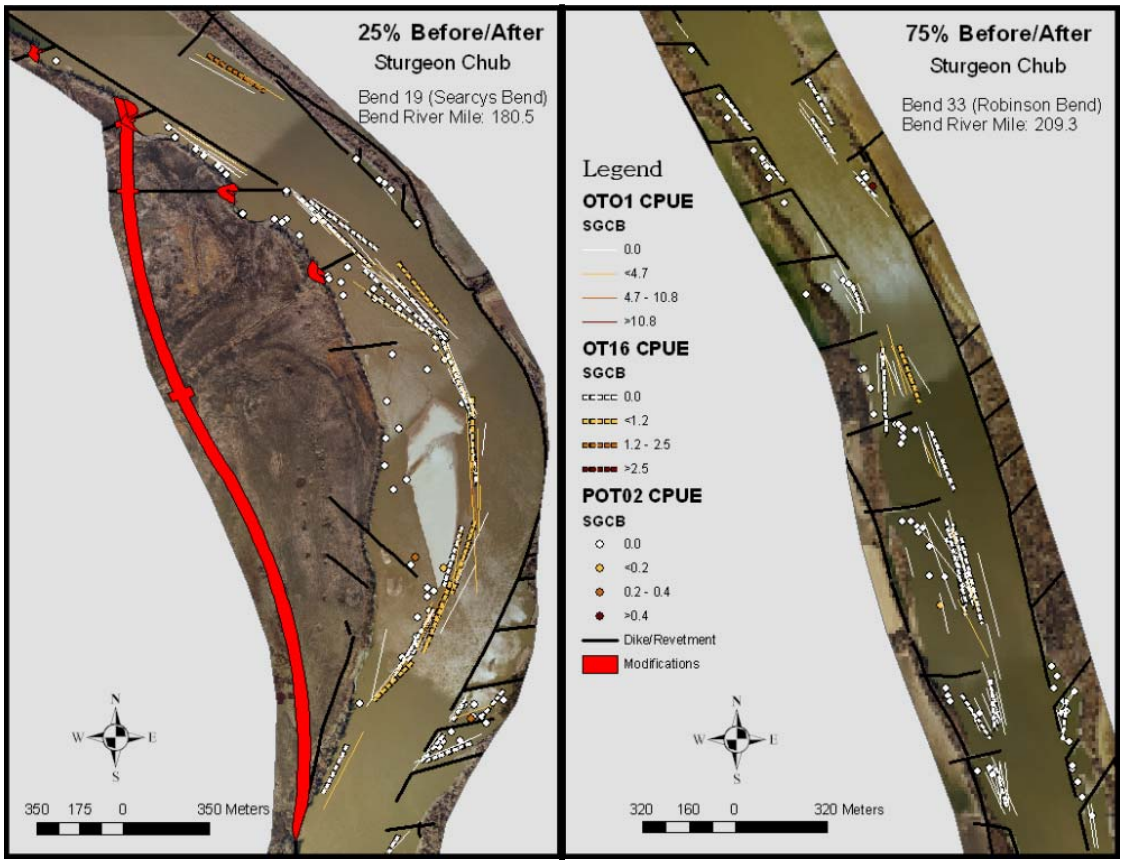

Figure 21. GIS overlay of CPUE data for sturgeon chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Before/After bends in Segment 13.

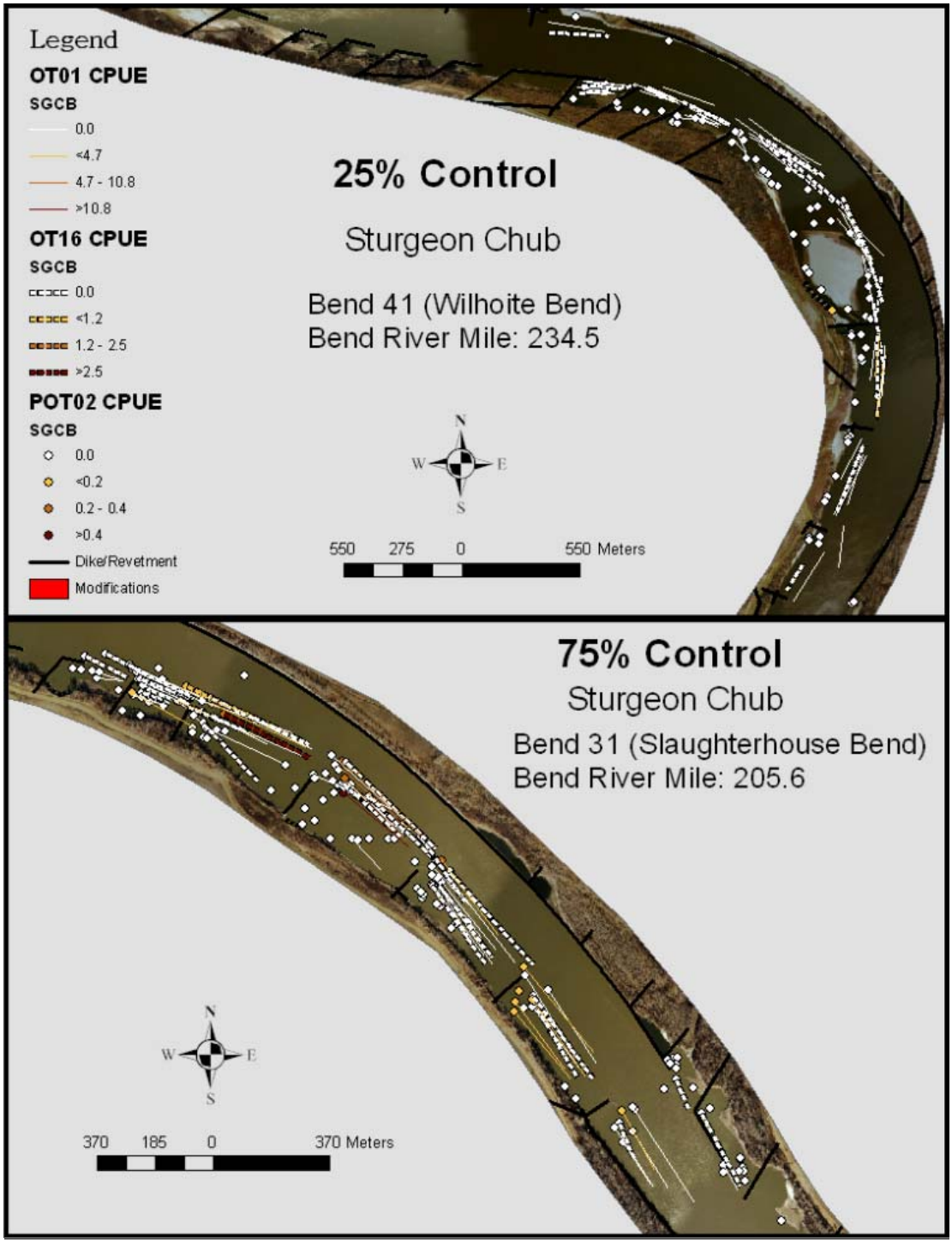

Figure 22. GIS overlay of CPUE data for sturgeon chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Control bends in Segment 13.

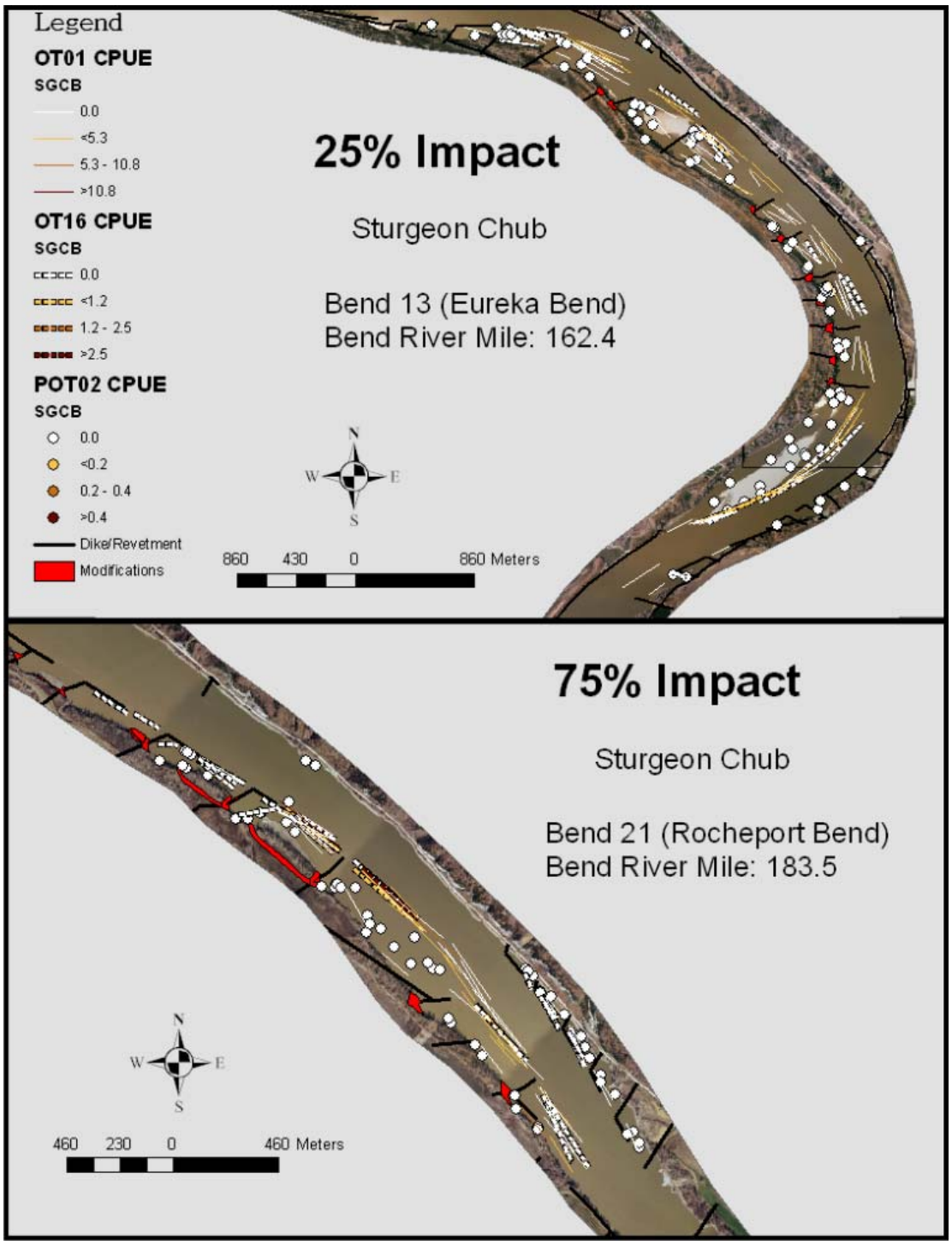

Figure 23. GIS overlay of CPUE data for sturgeon chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Impact bends in Segment 13.

Table 41. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for YOY sturgeon chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	NC 4	NC 4	NC 7	NC 8	0.03 (0.06) 7	0.111 (0.222) 6	NC 10	NC 17	NC 2		NC 3
July	NC 4	NC 3	NC 4	NC 6	NC 4	NC 6	0.95 (1.46) 14	1.666 (0.333) 9	0.303 (0.308) 18	0.236 (0.333) 15	0.271 (0.237) 13	0.321 (0.356) 12
August	0.604 (0.998) 4	NC 4	NC 4	NC 2	NC 4	00.183 (0.213) 4	0.344 (0.495) 15	NC 7	0.024 (0.027) 14	NC 13	NC 12	0.069 (0.096) 14
September	NC 4	NC 4	NC 4	NC 2	NC 4	NC 4	0.079 (0.11) 16	NC 11	NC 27	NC 15	0.098 (0.196) 12	NC 13
October	NC 6	NC 4	NC 4	NC 4	NC 4	NC 4	0.066 (0.13) 15	NC 12	NC 16	NC 14	NC 15	0.081 (0.108) 9
TOTAL	**0.097 (0.168) 25**	**NC 17**	**NC 20**	**NC 21**	**NC 24**	**0.037 (0.041) 29**	**0.143 (0.125) 66**	**0.031 (0.061) 49**	**0.063 (0.064) 92**	**0.060 (0.087) 59**	**0.090 (0.079) 52**	**0.109 (0.094) 51**

Table 42. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for adult sturgeon chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	0.083 (0.17) 4	NC 4	NC 7	0.042 (0.083) 8	0.03 (0.06) 11	0.21 (0.22) 6	NC 10	0.024 (0.047) 17	NC 2		0.312 (0.39) 3
July	NC 4	NC 3	NC 4	0.078 (0.16) 6	0.076 (0.15) 4	0.054 (0.11) 6	0.22 (0.44) 14	0.22 (0.44) 9	NC 18	0.073 (0.12) 15	0.54 (0.73) 13	0.26 (0.52) 12
August	0.1 (0.21) 4	NC 2	NC 4	NC 2	NC 4	NC 4	0.58 (0.95) 15	NC 7	NC 14	NC 13	0.085 (0.12) 12	0.22 (0.21) 14
September	NC 4	NC 4	0.11 (0.23) 4	NC 2	NC 4	NC 4	1.03 (1.05) 16	NC 11	0.27 (0.28) 27	0.087 (0.12) 15	NC 12	0.23 (0.27) 13
October	0.33 (0.3) 6	NC 4	0.3 (0.41) 4	NC 4	NC 4	0.078 (0.16) 4	0.61 (0.1) 15	0.028 (0.056) 12	0.22 (0.22) 16	0.039 (0.08) 14	0.18 (0.13) 15	0.04 (0.09) 9
TOTAL	**0.097 (0.092) 25**	**0.020 (0.039) 17**	**0.083 (0.099) 20**	**0.022 (0.044) 21**	**0.027 (0.037) 24**	**0.034 (0.037) 29**	**0.544 (0.391) 66**	**0.048 (0.082) 49**	**0.123 (0.094) 92**	**0.050 (0.045) 59**	**0.085 (0.052) 52**	**0.152 (0.097) 51**

Table 43. Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for adult sturgeon chub by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.027 (0.053) 15	NC 16	NC 22	NC 8	NC 8	NC 13						
July	NC 16	NC 15	NC 19	0.063 (0.125) 15	NC 12	NC 14	NC 4	NC 4	NC 4	NC 6	NC 4	NC 4
August	NC 15	NC 14	NC 15	NC 14	NC 15	NC 13	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
September	0.039 (0.053) 14	0.015 (0.030) 12	NC 15	NC 16	NC 11	NC 9	NC 3	NC 4	NC 4	NC 4	NC 4	NC 4
October	NC 10	NC 15	NC 15	0.008 (0.017) 10	0.002 (0.004) 11	NC 14	NC 3	NC 3	NC 4	NC 4	NC 4	NC 4
TOTAL	**0.013 (0.016) 70**	**0.003 (0.005) 72**	**NC 86**	**0.016 (0.030) 63**	**<0.001 (0.001) 55**	**NC 63**	**NC 14**	**NC 16**	**NC 16**	**NC 18**	**NC 16**	**NC 16**

Table 44. Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for YOY sturgeon chub by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.027 (0.053) 15	NC 16	NC 22	NC 8	NC 6	NC 13						
July	NC 16	NC 15	NC 19	0.063 (0.125) 15	NC 12	NC 14	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
August	NC 15	NC 14	NC 15	NC 14	NC 15	NC 13	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
September	0.023 (0.045) 14	NC 12	NC 15	NC 16	NC 11	NC 9	NC 3	NC 4	NC 4	NC 4	NC 4	NC 4
October	NC 10	NC 15	NC 15	0.008 (0.017) 10	0.01 (0.02) 11	NC 14	NC 3	NC 4	NC 4	NC 4	NC 4	NC 4
TOTAL	**0.010 (0.014) 70**	**NC 72**	**NC 86**	**0.016 0.030 63**	**0.002 (0.004) 55**	**NC 63**	**NC 14**	**NC 16**	**NC 16**	**NC 18**	**NC 16**	**NC 16**

Speckled Chubs

OT16 and OT01 – all SKCB

A total of 161 and 1,808 speckled chubs were captured with OT16 and OT01 respectively. Catch rates for OT16 ranged from NC to 11.199 fish/100 m (Table 45). Of the six bend-months where no fish were captured, five were 75% bends. No fish were captured on 75% bends and catch rates were low for 25% bends in September. Overall no consistent trends were observed.

Catch rates for OT01 ranged from NC to 25.248 fish/100 m (Table 45). Catch rates were higher for OT01 than OT16. Catch rates varied greatly by months and bends with no consistent trends observed.

Graphical Display – all SKCB

Speckled chubs were captured on all bends and gears sampled (Figure 24, Figure 25,Figures 24, 25 and Figure 2626). Speckled chubs were captured on all portions sampled of the bends. Trawls with higher catch rates were collected on inside bends on the 75% bends. Higher catch rates are associated with inside bend sand bars and dike structures with wide spacing.

OT16 and OT01 – YOY SKCB

A total of 51 and 1,410 YOY speckled chubs were captured with OT16 and OT01 respectively. Catch rates for OT16 ranged from NC to 1.940 fish/100 m (Table 46). Catch rates were low with no fish captured on 21 of 30 bend-months. No YOY speckled chubs were captured on any bend in the months of June and September. No YOY speckled chubs were captured on bend 41.

Catch rates for YOY speckled chubs using OT01 ranged from NC to 4.39 fish/100 m (Table 46). Catch rates increase through the sampling season. Total catch rate for 25% and 75% Before bends were highest and 25% and 75% Impact bends were lowest. This trend was not observed for OT16.

OT16 and OT01 – Adult SKCB

A total of 110 and 882 adult speckled chubs were captured with OT16 and OT01. Catch rates for OT16 ranged from NC to 2.500 fish/100 m (Table 47). A trend of increasing catch rates was observed through the sampling season. Of the nine bend-months with NC, seven were 75% bends. Both Control bends had the lowest catch rates for OT16.

Catch rates for OT01 ranged from NC to 4.568 fish/100 m (Table 47). Catch rates appear to drop slightly for all bends with either August or September having the lowest CPUE for the season.

POT02 and MF – all SKCB

A total of 1,799 and 63 speckled chubs were captured with POT02 and MF. Catch rates for POT02 ranged from NC to 6.192 fish/10 m (Table 48). Speckled chubs were captured on every bend and month except bend 31 in June.

Overall, catch rates increased as the season progressed. Catch rates for MF ranged from NC to 3.500 fish/ net-night (Table 48). No fish were captured in 13of 24 bend-months sampled. One fish each for July and August were captured for all bends. One fish was captured on bend 19 for all months. Catch rates increased as the season progressed. Catch rates were low for all bends and consisted of single digit catches for all bend-months.

POT02 and MF – YOY SKCB

A total of 1,454 and 55 YOY speckled chubs were captured with POT02 and MF respectively. Catch rates for POT02 ranged from NC to 2.34 fish/10 m (Table 49). A weak trend of increasing catch rates through the season for most bends.

Catch rates for MF ranged from NC to 3.25 fish/net-night (Table 49). No fish were captured on 13 of 24 bend-months sampled with MF. One YOY speckled chub each for July and August was captured on all bends combined. Catch rates increased as the season progressed. Overall catch rates were low for all bends and months sampled with MF.

POT02 and MF – Adult SKCB

A total of 345 and 8 adult speckled chubs were captured with POT02 and MF. Catch rates for POT02 ranged from NC to 0.517 fish/10 m trawled (Table 50). In general, catch rates increased through the sampling season. No fish (NC) were captured in three of five months for bend 31. Catch rates for MF ranged from NC to 0.750 fish/net-night (Table 50). No adult speckled chubs were captured with MF in July or August. Two adult speckled chubs were captured in September. All adult speckled chubs captured with MF were in September and October with a substantial increase for October.

Table 45. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for all speckled chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.095 (0.190) 7	0.152 (0.175) 4	0.697 (0.337) 4	NC 7	NC 8	0.108 (0.115) 7	3.262 (2.711) 6	1.010 (0.977) 10	1.370 (0.687) 17	NC 2		18.889 (8.8890 3
July	0.573 (0.497) 4	NC 3	0.083 (0.167) 4	0.321 (0.6410 6	0.189 (0.377) 4	1.111 (2.222) 6	0.906 (0.460) 14	1.390 (0.993) 9	0.367 (0.257) 18	4.369 (5.084) 15	12.127 (10.803) 13	8.930 (12.383) 12
August	0.604 (0.999) 4	0.083 (0.167) 4	0.074 (0.147) 4	0.570 (0.029) 2	2.808 (5.377) 4	0.136 (0.272) 4	1.101 (0.775) 15	2.434 (3.456) 7	0.208 (0.164) 14	4.894 (2.795) 13	2.715 (2.189) 12	5.110 (4.125) 14
September	0.125 (0.250) 4	0.167 (0.333) 4	0.013 (0.025) 4	NC 2	NC 4	NC 4	3.900 (2.464) 16	4.552 (8.869) 11	0.520 (0.449) 27	7.421 (9.840) 15	4.549 (6.141) 12	2.928 (3.183) 13
October	1.667 (1.388) 6	0.167 (0.192) 4	0.309 (0.425) 4	2.500 (4.359) 4	0.278 (0.556) 4	11.199 (10.492) 4	5.346 (2.141) 15	5.075 (5.473) 12	0.134 (0.114) 16	0.935 (0.942) 14	25.248 (33.830) 15	2.447 (1.418) 9
TOTAL	**0.635 (0.455) 25**	**0.120 (0.090) 19**	**0.235 (0.156) 20**	**0.622 (0.863) 21**	**0.546 (0.905) 24**	**1.834 (1.960) 29**	**2.899 (0.927) 66**	**3.074 (2.425) 49**	**0.527 (0.209) 92**	**4.297 (2.887) 59**	**11.991 (10.302) 52**	**5.793 (3.368) 51**

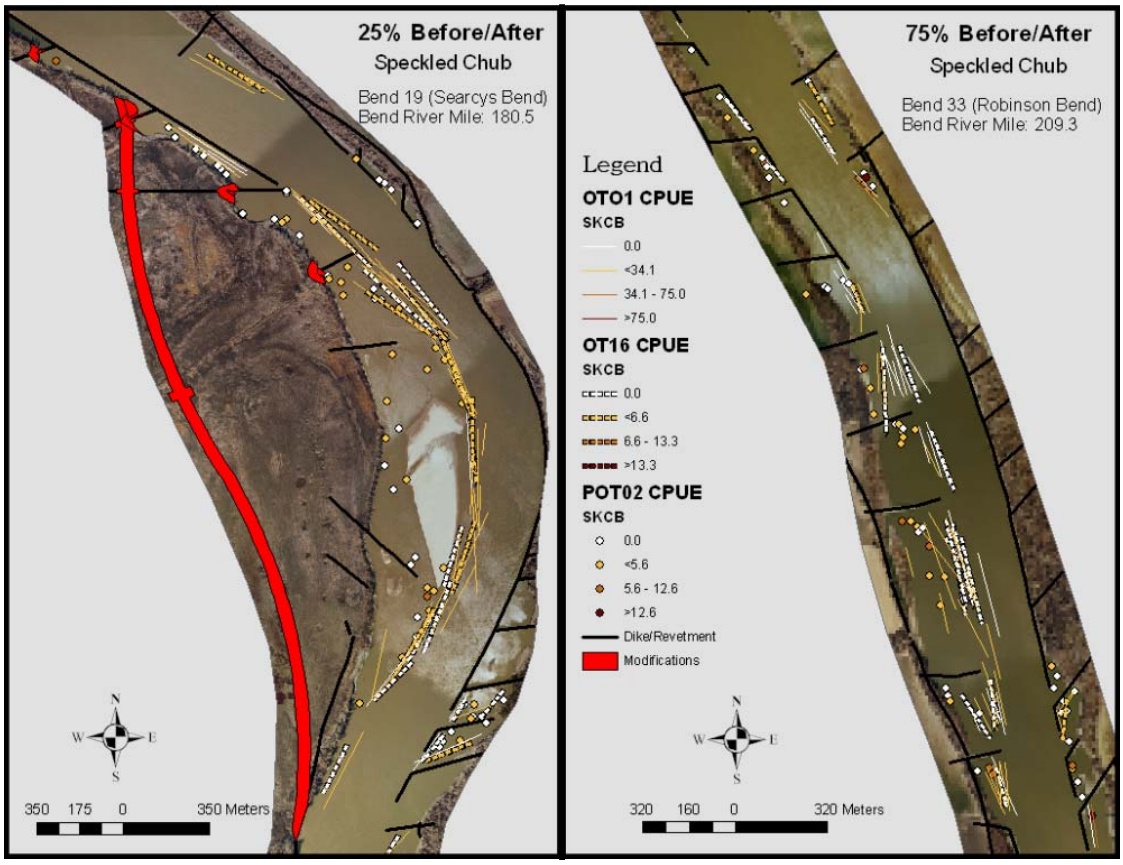

Figure 24. GIS overlay of CPUE data for speckled chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Before/After bends in Segment 13.

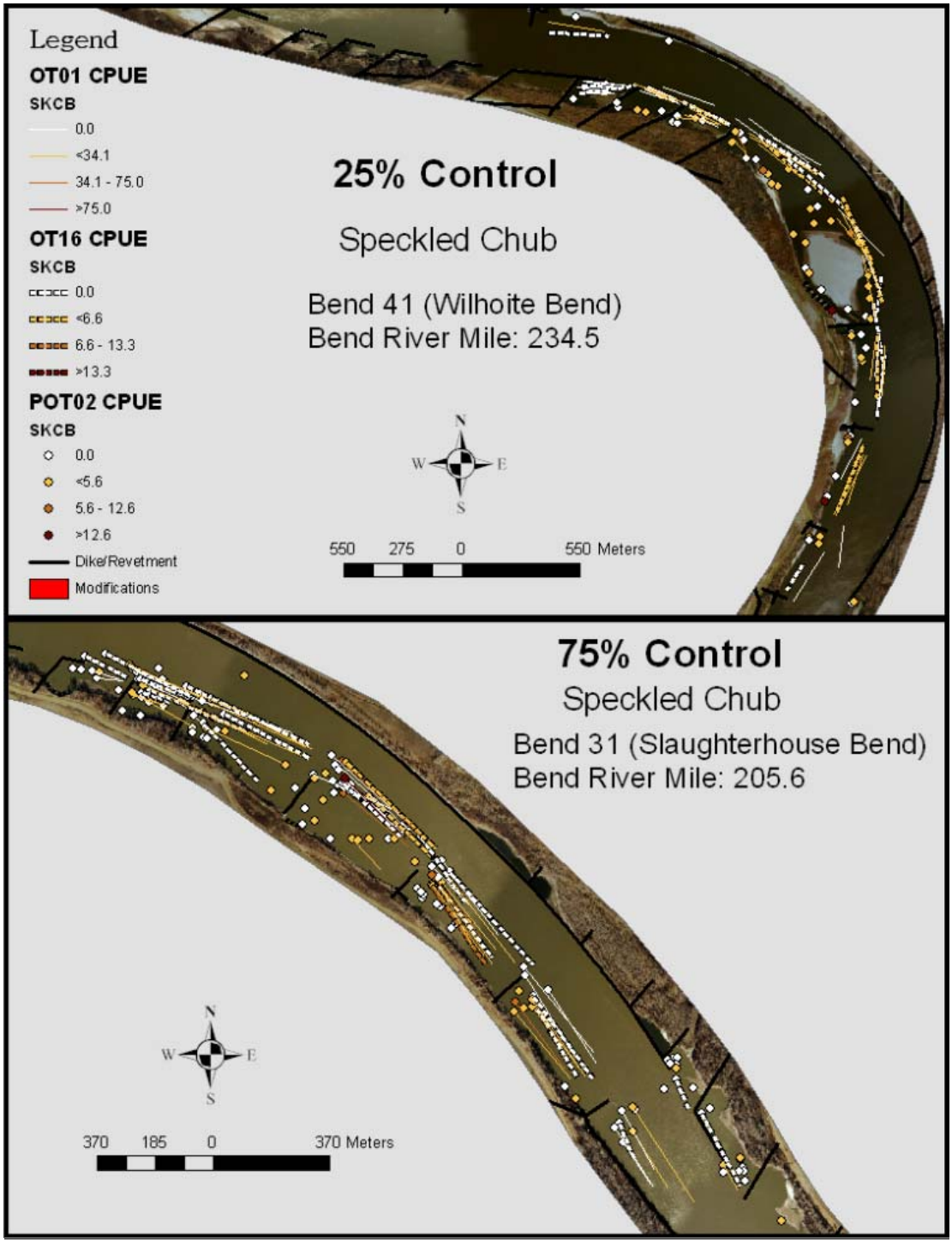

Figure 25. GIS overlay of CPUE data for speckled chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for control bends in Segment 13.

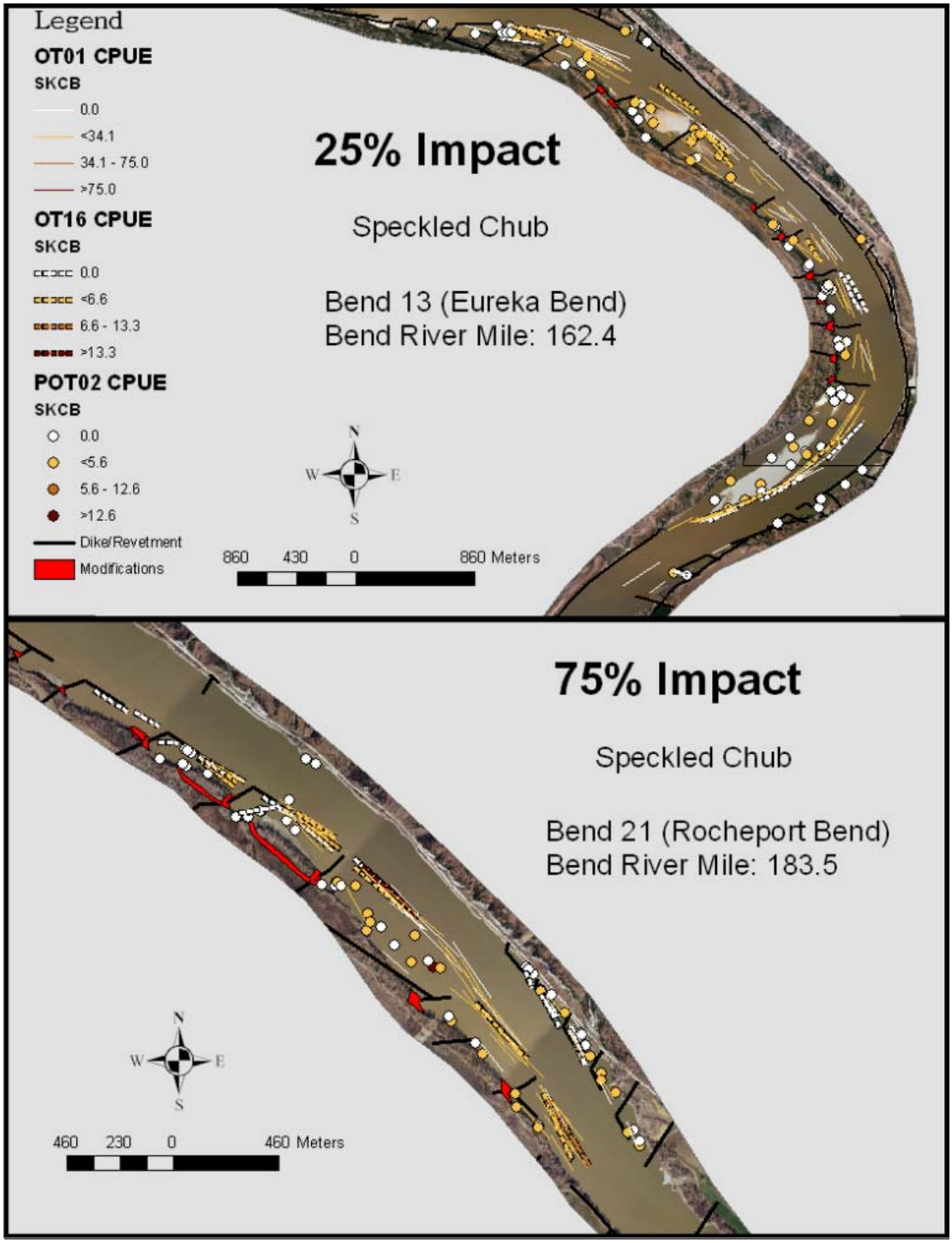

Figure 26. GIS overlay of CPUE data for speckled chub captured with small mesh trawl (OT01), standard otter trawl (OT16) and push trawl (POT02) for Impact bends in Segment 13.

Table 46. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for YOY speckled chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	NC 4	NC 4	NC 7	NC 8	NC 11	0.083 (0.166) 6	NC 10	NC 17	NC 2		NC 3
July	0.343 0.496 4	NC 3	NC 4	NC 6	NC 4	0.163 (0.327) 6	0.193 (0.187) 14	1.2 0.99 9	NC 18	2.47 (3.26) 15	0.513 (0.1) 13	0.735 (0.718) 12
August	0.729 (1.45) 4	NC 2	NC 4	0.57 (0.029) 2	0.833 (1.66) 4	NC 4	0.599 (0.492) 15	2.43 (3.46) 7	1.08 (1.07) 14	4.39 (2.45) 13	2.14 (2.61) 12	1.52 (1.8) 14
September	NC 4	NC 4	NC 4	NC 2	NC 4	NC 4	2.28 (1.92) 16	2.53 (5.05) 11	0.598 (0.584) 27	3.43 (3.92) 15	2.12 (2.91) 12	1.59 (1.5) 13
October	0.555 (0.723) 6	NC 4	1.94 (3.88) 4	NC 4	0.064 (0.128) 4	0.078 (0.156) 4	3.14 (2.07) 15	1.13 (0.963) 12	0.889 (1.13) 16	0.516 (0.577) 14	2.48 (2.5) 15	0.533 (0.312) 9
TOTAL	**0.305 (0.296) 25**	**NC 17**	**0.389 (0.778) 20**	**0.054 (0.075) 21**	**0.150 (0.278) 24**	**0.045 (0.070) 29**	**1.819 (0.802) 66**	**1.412 (1.249) 49**	**0.495 (0.312) 92**	**2.589 (1.426) 59**	**1.715 (1.153) 52**	**1.093 (0.649) 51**

Table 47. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for adult speckled chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.095 (0.190) 7	0.152 (0.175) 4	0.697 (0.337) 4	NC 7	NC 8	0.105 (0.111) 7	4.568 (3.432) 6	1.010 (0.977) 10	1.370 (0.687) 17	NC 2		1.726 (0.814) 3
July	0.612 (1.223) 4	NC 3	0.083 (0.167) 4	0.321 (0.641) 6	0.139 (0.278) 4	0.599 (1.198) 6	0.414 (0.405) 14	0.185 (0.296) 9	0.347 (0.257) 18	0.255 (0.204) 15	1.572 (1.148) 13	0.535 (0.592) 12
August	0.083 (0.166) 4	NC 4	0.735 (1.471) 4	NC 2	0.644 (0.805) 4	0.143 (0.286) 4	0.502 (0.424) 15	NC 7	1.003 (0.897) 14	0.501 (0.613) 13	0.762 (0.628) 12	0.516 (0.385) 14
September	0.125 (0.250) 4	0.167 (0.333) 4	0.125 (0.250) 4	NC 2	NC 4	NC 4	1.656 (1.063) 16	0.108 (0.149) 11	2.971 (1.728) 27	0.253 (0.289) 15	0.036 (0.072) 12	0.934 (0.958) 13
October	1.167 (0.955) 6	0.167 (0.192) 4	1.144 (0.520) 4	2.500 (4.359) 4	NC 4	0.938 (0.533) 4	4.326 (2.480) 15	1.876 (1.173) 12	0.371 (0.277) 16	0.419 (0.402) 14	0.952 (0.736) 15	1.104 (0.581) 9
TOTAL	**0.438 (0.337) 25**	**0.114 (0.096) 17**	**0.557 (0.342) 20**	**0.568 (0.867) 21**	**0.130 (0.159) 24**	**0.313 (0.274) 29**	**2.002 (0.801) 66**	**0.724 (0.405) 49**	**1.410 (0.582) 92**	**0.339 (0.186) 59**	**0.852 (0.403) 52**	**0.802 (0.324) 51**

Table 48. Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N) and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for all speckled chub by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.037 (0.043) 15	0.171 (0.171) 16	0.390 (0.245) 22	0.302 (0.528) 8	NC 8	0.018 (0.036) 13						
July	0.263 (0.256) 16	0.676 (0.478) 15	0.750 (0.640) 19	0.814 (1.286) 15	0.134 (0.190) 12	0.463 (0.172) 14	0.250 (0.500) 4	NC 4	NC 4	NC 6	NC 4	NC 4
August	1.150 (1.023) 15	0.289 (0.442) 14	0.029 (0.057) 15	0.875 (1.217) 14	0.109 (0.189) 15	1.433 (2.326) 13	NC 4	NC 4	NC 4	NC 4	NC 4	0.250 (0.500) 4
September	0.624 (0.660) 14	6.192 (4.062) 12	0.473 (0.357) 15	4.572 (2.762) 16	0.082 (0.108) 11	0.397 (0.361) 9	NC 3	0.750 (1.500) 4	3.500 (7.000) 4	0.250 (0.500) 4	0.250 (0.500) 4	0.750 (1.017) 4
October	1.818 (1.983) 10	1.161 (1.135) 15	0.645 (0.741) 15	4.086 (4.393) 10	1.463 (1.572) 11	0.439 (0.571) 14	NC 3	3.250 (2.728) 4	0.500 (0.577) 4	2.750 (2.754) 4	2.750 (5.500) 4	NC 4
TOTAL	**0.699 (0.409) 70**	**1.509 (0.867) 72**	**0.466 (0.213) 86**	**2.236 (1.135) 63**	**0.368 (0.344) 55**	**0.547 (0.500) 63**	**0.071 (0.143) 14**	**1.000 (0.931) 16**	**1.000 (1.742) 16**	**0.750 (0.866) 16**	**0.750 (1.372) 16**	**0.250 (0.387) 16**

Table 49. Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for total speckled chub by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 15	0.27 (0.54) 16	0.32 (0.31) 22	NC 8	NC 6	NC 13						
July	0.977 (0.71) 16	0.648 (0.472) 15	0.68 (0.64) 19	0.397 (0.515) 15	0.411 (0.491) 12	0.127 (0.657) 14	0.250 (0.500) 4	NC 4	NC 4	NC 4	NC 4	NC 4
August	1.02 (0.91) 15	0.268 (0.439) 14	0.029 (0.057) 15	0.588 (0.857) 14	0.339 (0.551) 15	0.569 (0.773) 13	NC 4	NC 4	NC 4	NC 4	NC 4	0.25 (0.5) 4
September	0.65 (0.894) 14	1.74 (1.17) 12	0.385 (0.292) 15	2.34 (1.23) 16	0.482 (0.732) 11	0.204 (0.3) 9	NC 3	0.75 (1.5) 4	3.25 (6.5) 4	0.25 (0.5) 4	0.25 (0.5) 4	0.5 (1) 4
October	1.58 (1.98) 10	0.703 (0.709) 15	0.592 (0.741) 15	2.22 (1.77) 10	1.99 (0.877) 11	0.347 (0.392) 14	NC 3	3 (2.45) 4	0.5 (0.577) 4	3 (2.31) 4	2 (4) 4	NC 4
TOTAL	**0.797 (0.422) 70**	**0.630 (0.300) 72**	**0.334 (0.203) 86**	**1.171 (0.508) 63**	**0.676 (0.337) 55**	**0.505 (0.256) 63**	**0.214 (0.429) 14**	**0.938 (0.903) 16**	**0.938 (1.617) 16**	**0.625 (0.704) 16**	**0.563 (0.999) 16**	**0.188 (0.272) 16**

Table 50. Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for adult speckled chub by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.037 (0.043) 15	0.144 (0.163) 16	0.358 (0.235) 22	0.302 0.528 8	NC 6	0.026 (0.051) 13						
July	NC 16	0.027 (0.038) 15	0.07 (0.14) 19	0.01 (0.014) 15	NC 12	0.232 (0.303) 14	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
August	0.092 (0.121) 15	0.021 (0.042) 14	NC 15	0.151 (0.233) 14	0.04 (0.08) 15	0.067 (0.101) 13	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
September	0.105 (0.09) 14	0.593 (0.534) 12	0.09 (0.124) 15	0.103 (0.084) 16	NC 11	0.02 (0.028) 9	NC 3	NC 4	0.25 (0.5) 4	NC 4	NC 4	0.25 (0.5) 4
October	0.21 (0.24) 10	0.251 (0.246) 15	0.053 (0.073) 15	0.083 (0.122) 10	0.517 (0.322) 11	0.065 (0.09) 14	NC 3	0.25 (0.5) 4	0.500 (0.577) 4	0.5 (0.58) 4	0.75 (1.5) 4	NC 4
TOTAL	**0.079** **(0.048)** **70**	**0.193** **(0.116)** **72**	**0.132** **(0.077)** **86**	**0.114** **(0.088)** **63**	**0.114** **(0.085)** **55**	**0.088** **(0.075)** **63**	**NC** **14**	**0.063** **(0.125)** **16**	**0.063** **(0.125)** **16**	**0.125** **(0.171)** **16**	**0.188** **(0.375)** **16**	**0.063** **(0.125)** **16**

Unidentified Chubs

OT16 and OT01 – all UHY

A total of 89 and 306 unidentified chubs were captured with OT16 and OT01. Catch rates ranged from NC to 8.500 fish/100 m for OT16 (Table 51). Unidentified chubs were captured on three of six bends. Catch rates were low for all bends except for bend 31 in September with a CPUE of 8.500 fish/100 m (Table 51).50 Catch of unidentified chubs with OT16 was low and could be considered incidental. Catch rates for OT01 ranged from NC to13.469 fish/100 m. Catch rates for OT01 for UHY were low with several outliers. No trends were observed.

POT02 and MF – all UHY

A total of 3,072 and 2 unidentified chubs were captured with POT02 and MF. Catch rates for POT02 ranged from NC to 14.850 fish/10 m (Table 52). Catch rates for unidentified chubs declined at season progressed. As the season progresses, YOY chubs become large enough to be identified in the field. The decline in catch rates is likely due to this fact and not an indication the chub numbers are declining. MF are not an effective tool for sampling unidentified chubs with 96 net-nights of effort capturing two fish.

Table 51. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for unidentified chub by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	NC 4	NC 4	NC 7	NC 8	0.018 (0.036) 7	0.102 (0.204) 6	1.619 (2.198) 10	0.156 (0.157) 17	1.154 (2.308) 2		NC 3
July	NC 4	NC 3	NC 4	NC 6	NC 4	NC 6	NC 14	0.333 (0.667) 9	0.029 (0.056) 18	0.330 (0.357) 15	NC 13	4.563 (7.918) 12
August	0.104 (0.208) 4	NC 4	NC 4	NC 2	NC 4	NC 4	0.718 (0.980) 15	NC 7	NC 14	NC 13	NC 12	13.469 (21.552) 14
September	0.116 (0.233) 4	NC 4	NC 4	NC 2	8.500 (17.000) 4	NC 4	0.177 (0.288) 16	0.524 (1.049) 11	0.003 (0.006) 27	0.396 (0.677) 15	0.283 (0.498) 12	0.242 (0.297) 13
October	NC 6	NC 4	NC 4	NC 4	NC 4	NC 4	NC 15	NC 12	NC 16	NC 14	2.366 (4.731) 15	NC 9
TOTAL	**0.035** **(0.049)** **25**	**NC** **19**	**NC** **20**	**NC** **21**	**1.417** **(2.833)** **24**	**0.007** **(0.014)** **29**	**0.215** **(0.238)** **66**	**0.509** **(0.529)** **49**	**0.035** **(0.033)** **92**	**0.224** **(0.208)** **59**	**0.748** **(1.367)** **52**	**4.833** **(6.238)** **51**

Table 52. Segment 13 push trawl CPUE, fish/ 10 m trawled ((2 SE) and N), and minifyke net (MF) CPUE, fish/net-night ((2 SE) and N), by bend and month for unidentified chub by Columbia FRO during the 2006 field season.

	Push Trawl (POT02)						Minifyke Net (MF)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	0.554 (0.337) 15	4.771 2.862) 16	3.860 (3.904) 22	14.850 (12.839) 8	1.576 (0.917) 8	5.109 (3.061) 13						
July	0.142 (0.086) 16	0.719 (0.842) 15	0.769 (0.560) 19	0.551 (0.985) 15	3.341 (2.323) 12	0.280 (0.184) 14	NC 4	NC 4	NC 4	NC 6	NC 4	NC 4
August	0.186 (0.323) 15	0.560 (0.373) 14	NC 15	1.434 (1.9750 14	0.011 (0.021) 15	0.049 (0.081) 13	NC 4	NC 4	NC 4	NC 4	NC 4	NC 4
September	0.136 (0.272) 14	2.078 (3.988) 12	NC 15	1.425 (1.253) 16	NC 11	0.667 (1.333) 9	NC 3	NC 4	0.500 (1.000) 4	NC 4	NC 4	NC 4
October	0.063 (0.119) 10	NC 15	0.107 (0.213) 15	NC 10	0.014 (0.023) 11	0.046 (0.113) 14	NC 3	NC 3	NC 4	NC 4	NC 4	NC 4
TOTAL	**0.227** **(0.121)** **70**	**1.665** **(1.004)** **72**	**1.176** **(1.049)** **86**	**2.698** **(2.024)** **63**	**0.907** **(0.623)** **55**	**1.232** **(0.815)** **63**	**NC** **14**	**NC** **16**	**0.125** **(0.250)** **16**	**NC** **18**	**NC** **16**	**NC** **16**

Unidentified Sturgeon

OT16 and OT01 – all USG

No unidentified sturgeon were captured with OT16. Five unidentified sturgeon were captured with OT01. All five were captured in June, one on bend 13, two from bend 21 and two from bend 33 (Table 5352) In the past, larval sturgeon have been captured on submerged sand bars with moderate water velocities.

POT02 and MF – all USG

Six unidentified sturgeon were captured with the POT02. All were captured on bend 19 in June. This is an intiresting finding since the push trawl samples shallow habitats. Further exploration of using the POT02 for sampling YOY sturgeon will investigated in next season. No unidentified sturgeon were caught with MF.

Table 53. Segment 13 standard otter trawl (OT16) and small mesh otter trawl (OT01) CPUE, fish/ 100 m trawled ((2 SE) and N), by bend and month for unidentified sturgeon by Columbia FRO during the 2006 field season.

	16' Standard Otter Trawl (OT16)						Small Mesh 16' Otter Trawl (OT01)					
	25% Bend			75% Bend			25% Bend			75% Bend		
Month	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21	Before 19	Control 41	Impact 13	Before 33	Control 31	Impact 21
June	NC 7	NC 4	NC 4	NC 7	NC 8	NC 7	NC 6	NC 10	0.2 (0.39) 17	0.68 (0.2) 2		2.22 (4.4) 3
July	NC 4	NC 3	NC 4	NC 6	NC 4	NC 6	NC 14	NC 9	NC 18	NC 15	NC 13	NC 12
August	NC 4	NC 4	NC 4	NC 2	NC 4	NC 4	NC 15	NC 7	NC 14	NC 13	NC 12	NC 14
September	NC 4	NC 4	NC 4	NC 2	NC 4	NC 4	NC 16	NC 11	NC 27	NC 15	NC 12	NC 13
October	NC 6	NC 4	NC 4	NC 4	NC 4	NC 4	NC 15	NC 12	NC 16	NC 14	NC 15	NC 9
TOTAL	**NC** **25**	**NC** **19**	**NC** **20**	**NC** **21**	**NC** **24**	**NC** **29**	**NC** **66**	**NC** **49**	**0.004** **(0.007)** **92**	**NC** **59**	**NC** **52**	**0.131** **(0.261)** **51**

MANOVA Analysis

Data were sent to Dr. Craig Paukert at Kansas State University for analysis using SAS statistical package. OT01 and POT02 data were used for this analysis because these two gears had the largest sample sizes (Net deployments). Segment 10, unknown and microhabitat codes with small sample sizes were removed from the analysis because sample sized were low. Analysis were conducted by bend type (25 and 75%) when comparisons were made at the bend level because of small sample sizes for individual bends.

MANOVA of small mesh otter trawl (OT01)

No significant difference (P=0.1515) was found in CPUE between the 25 and 75% bends at the 0.05 level. There was no significant difference in CPUE between notched and unnotched dikes (P=0.6132). There was a significant difference between the different structure types (dike structure types dikes and sand bars) (P<0.0001). MANOVA analysis indicated a CPUE significant difference for CPUE in one or more species, but did not distinguish what species were different. Table 54 provides the P value matrix with values that are significant at the 0.05 alpha level represented in bold.

MANOVA of the push trawl (POT02)

There was no significant difference in CPUE between 25 and 75% bends (P=0.4157). There was a significant difference between in CPUE between segment 10 and segment 13 (all bend types combined) (P=0.008). There was a significant difference in CPUE between notched and unnotched dikes (P=0.0005). There was a significant difference between the different structure types (dike structure types dikes and sand bars) (P<0.0001). MANOVA analysis indicated a difference in CPUE, but did not distinguish what species were different. Table 5555 provides the P value matrix with values that are significant at the 0.05 alpha level in bold.

Table 54. OT01W MANOVA P values testing for significant differences in CPUE between microhabitats at the 0.05 level. Significant differences are bolded.

Comparison	UHY	Adult SNSG	Juvenile SNSG	YOY SNSG	Adult SKCB	YOY SKCB	Adult SGCB	YOY SGCB	Adult SFCB	YOY SFCB	Juvenile PDSG
L-Dike vs. Rootless Dike	**0.0077**	0.9891	0.9604	0.7584	0.2301	0.0569	**<0.0001**	0.9245	0.0907	**0.0063**	0.7466
L-Dike vs. Sand Bar	**<0.0001**	**0.0104**	0.0797	**0.0193**	**<0.0001**	0.5121	**<0.0001**	**0.0170**	0.1280	**<0.0001**	0.2446
L-Dike vs. Wing Dike	**0.0001**	0.0944	0.1003	0.2993	**0.0487**	0.8327	0.1194	0.2194	0.1474	**0.0009**	0.6990
Rootless Dike vs. Sand Bar	0.6718	0.0899	0.2712	0.0662	0.0919	0.1464	0.1964	0.0968	0.5003	0.7070	0.2799
Rootless Dike vs. Wing Dike	0.5238	0.2888	0.3318	0.3188	0.8963	**0.0423**	**0.0002**	0.3819	0.3084	0.3065	0.5431
Sand Bar vs. Wing Dike	0.0703	0.1502	0.6333	0.0712	**0.0009**	0.5593	**0.0004**	0.0944	0.6947	**0.0194**	0.3054

Table 55. POT02W MANOVA P values testing differences in CPUE between segments, unnotched and notched and among structure type microhabitat codes. Significant differences at the 0.05 level are bolded.

Comparison	UHY	Juvenile SNSG	YOY SNSG	Adult SKCB	YOY SKCB	Adult SGCB	YOY SGCB	Adult SFCB	YOY SFCB
Segment 10 vs. 13	**0.0005**	0.4796	0.2087	0.3780	0.6193	0.5314	0.8536	0.7749	**0.0330**
Unnotched vs. notched	0.3313	0.7655	0.5365	0.0866	**0.0004**	0.6097	0.4911	**0.0067**	**0.0146**
Bankline vs. L-Dike	**0.0359**	0.9321	0.8082	**0.0029**	0.3571	0.8870	0.6216	0.5684	0.4493
Bankline vs. Rootless Dike	0.5519	0.1552	0.9455	**0.0025**	0.2341	0.9470	0.4666	**0.0006**	0.7754
Bankline vs. Sand Bar	0.6729	0.0757	**0.0495**	0.6742	0.4082	0.4644	0.5546	0.6511	0.1065
Bankline vs. Wing Dike	0.1095	0.8228	0.7368	0.0703	0.5901	0.7851	0.5640	0.4477	0.2870
L-Dike vs. Rootless Dike	**0.0067**	0.0897	0.7537	**<0.0001**	0.5336	0.8284	0.6553	**<0.0001**	0.7228
L-Dike vs. Sand Bar	**<0.0001**	**0.0004**	**0.0003**	**<0.0001**	**0.0004**	0.0711	0.7989	0.8518	0.0618
L-Dike vs. Wing Dike	0.1832	0.7598	0.8508	**0.0033**	0.3407	0.3412	0.8873	**0.0023**	0.5314
Rootless Dike vs. Sand Bar	0.7559	0.9861	0.0530	**0.0013**	**0.0281**	0.5410	0.7563	**<0.001**	0.2365
Rootless Dike vs. Wing Dike	**0.0227**	0.1003	0.6851	**<0.0001**	0.2957	0.8650	0.6842	**0.0002**	0.5285
Sand Bar vs. Wing Dike	**0.0001**	**0.0015**	**0.0008**	**<0.0001**	**0.0077**	0.3274	0.8950	**0.0206**	0.1915

Frequency of Occurrence

The total number of species for all gears found in a bend by month was examined for segment 13 (Figure 27). This included all species that could be identified, native and non-native. All bends showed similar trends in frequency of occurrence from June through August. The number of species increased from June to July and then decreased in August. September and October were variable.

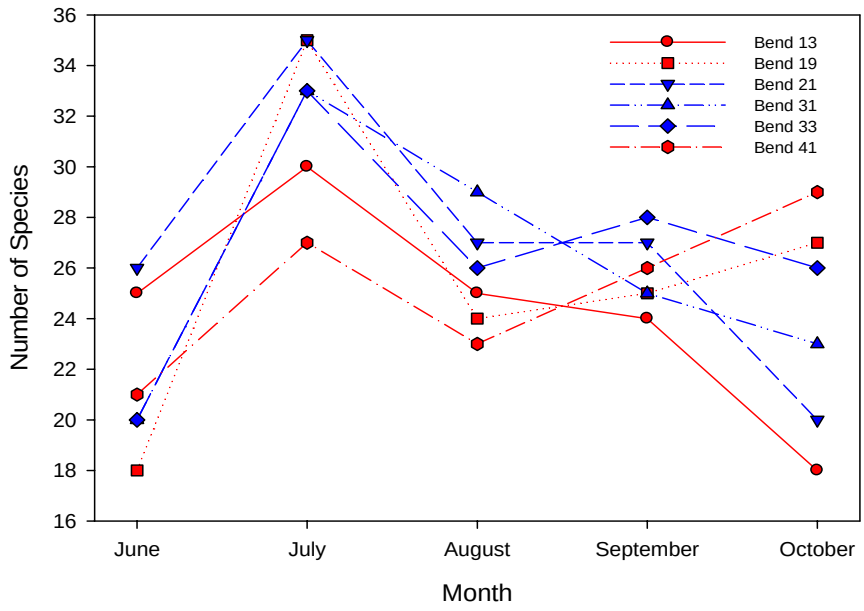

Figure 27. Number of Species Present by Bend by month in segment 13 bends. Seventy-five percent bends are in blue and 25% bends are in red.

Sorensens Index

We calculated Sorenson similarity values for all Segment 13 bend pairs by month (Figure 28, Figure 29, Figure 30, Figure 31, Figure 32, and Figure 33).28-33). Sorensons Index was used to compare fish communities of one bend to the other five bends. For example, Figure 28 compares Bend 13 community similarity to bends 19, 21, 31, 33 and 41. We calculated Sorensen Community Similarity values using the equation:

$$Cs = 2c/s1 + s2$$

Where s1 and s2 are the numbers of species in communities 1 and 2, respectively, c is the number of species common to both communities. Bends with Sorensen values above 0.75 were considered similar (Fabricus et al. 2003). Similarity comparisons can only be made between the bend and the other five bends, so individual bend lines can not be compared to other bend lines in the same figure. Sorensen's community similarity index does not take into account the relative abundances of the various species or the ecological importance of a species (i.e. Asian carp would be negative). Sorensens community index only takes into account species presence or absence. We used Sorensen's index as a beginning point to compare bends. All bends were similar and dissimilar to each other throughout the field season but not at the same time.

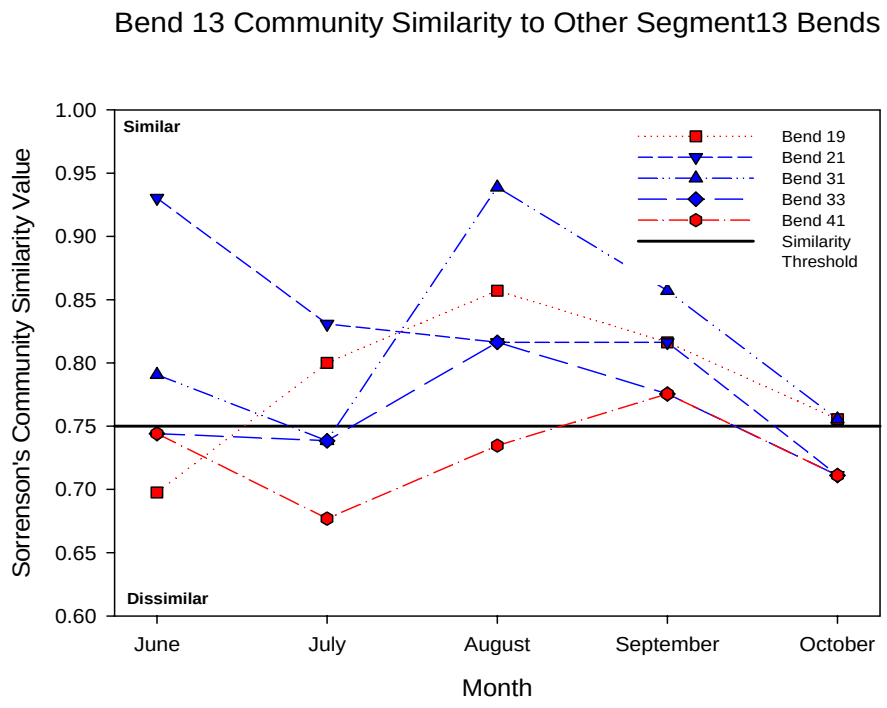

Figure 28. Bend 13 (25% Impact) Community Similarity to Other Segment 13 bends by month. Seventy-five percent bends are in blue and 25% bends are in red.

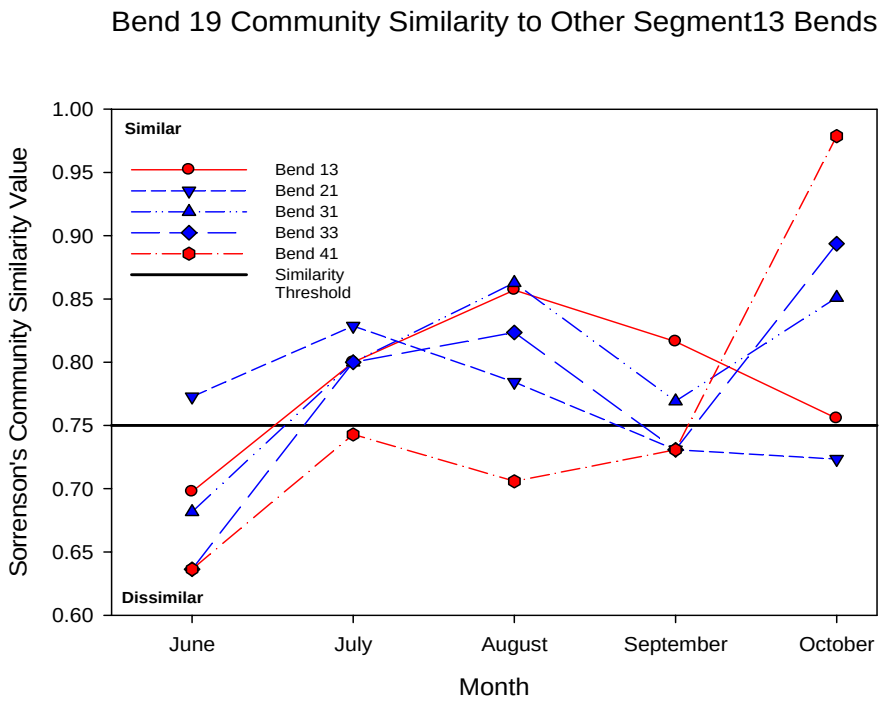

Figure 29. Bend 19 (25% Before/ After) Community Similarity to Other Segment 13 Bends. Seventy-five percent bends are in blue and 25% bends are in red.

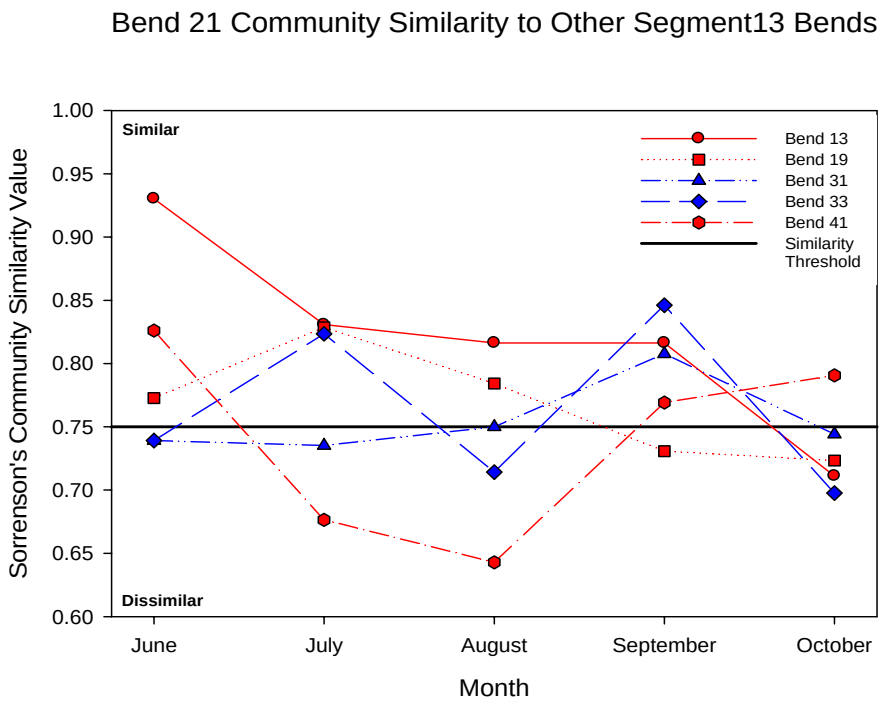

Figure 30. Bend 21 (75% Impact) Community Similarity to Other Segment 13 Bends. Seventy-five percent bends are in blue and 25% bends are in red.

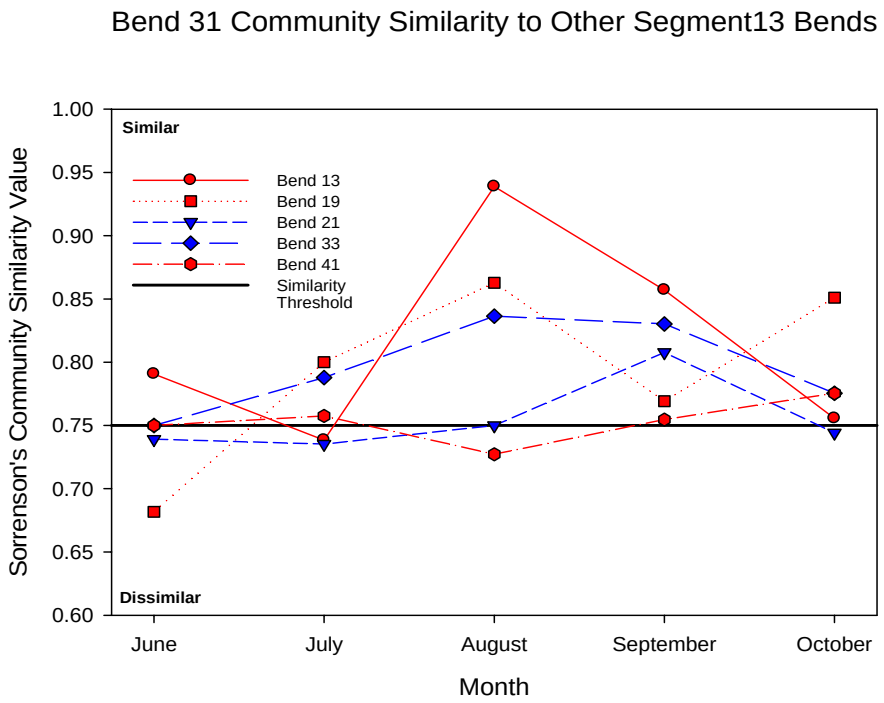

Figure 31. Bend 31 (75% Control) Community Similarity to Other Segment 13 Bends. Seventy-five percent bends are in blue and 25% bends are in red.

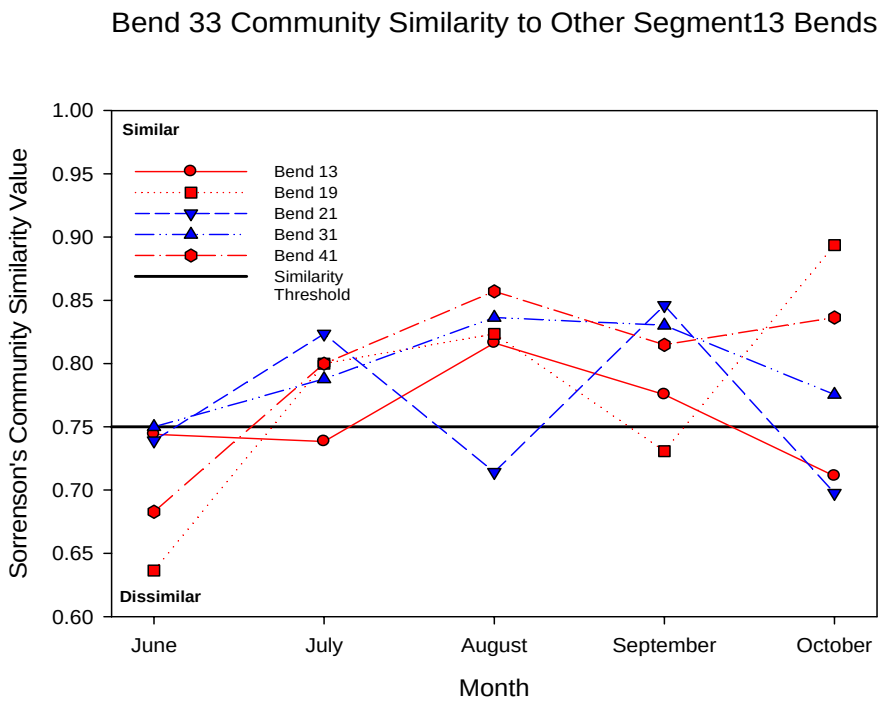

Figure 32. Bend 33 (75% Before/After) Community Similarity to Other Segment 13 Bends. Seventy-five percent bends are in blue and 25% bends are in red.

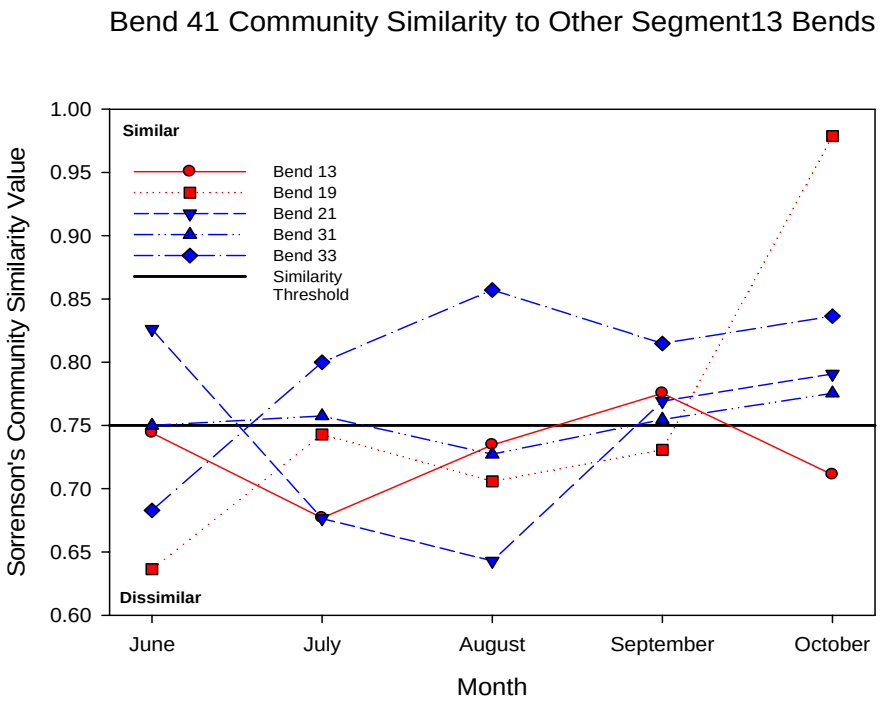

Figure 33. Bend 41 (25% Control) Community Similarity to Other Segment 13 Bends. Seventy-five percent bends are in blue and 25% bends are in red.

Microhabitat species composition by gear type

Catch composition varied among microhabitat types for each gear type. Results of discriminant function analysis in species composition indicates the catch of standard and small-mesh otter trawls discriminated in species composition most between L dike and sandbar microhabitats along the first canonical axis (Figures 34 andFigure 35). When interpreting these data, microhabitats that are close together on the graph have similar target fish communities. The CPUE pie charts are visual representations of species composition of target species for the tested structure types. The first canonical axis explained 71% of the variation in species composition among microhabitat types for standard and small-mesh otter trawls. YOY sicklefin chubs made up the greatest proportion of the catch at L dikes, and adult speckled chubs contributed the greatest proportion at sandbars. Rootless dikes and wing dikes were separated more along the second canonical axis than the first. Whereby, standard otter trawl samples composed of a greater proportion of larger or older fishes while small-mesh otter trawls tended to collect small or young fishes.

Push trawl samples were characterized by small or young fishes. Composition at sandbars tended to differ from dikes (i.e., L-, wing-, rootless-) among microhabitats sampled by push trawl (Figure 36). The first canonical axis explained 61% of the variation in catch composition among microhabitat types. YOY speckled chub made up the greatest proportion of the catch among most microhabitats, except rootless-dikes where adult speckled chubs composed the greatest proportion of the catch. Only

speckled chub (YOY and adult) and YOY sicklefin chub were collected at bank line microhabitats.

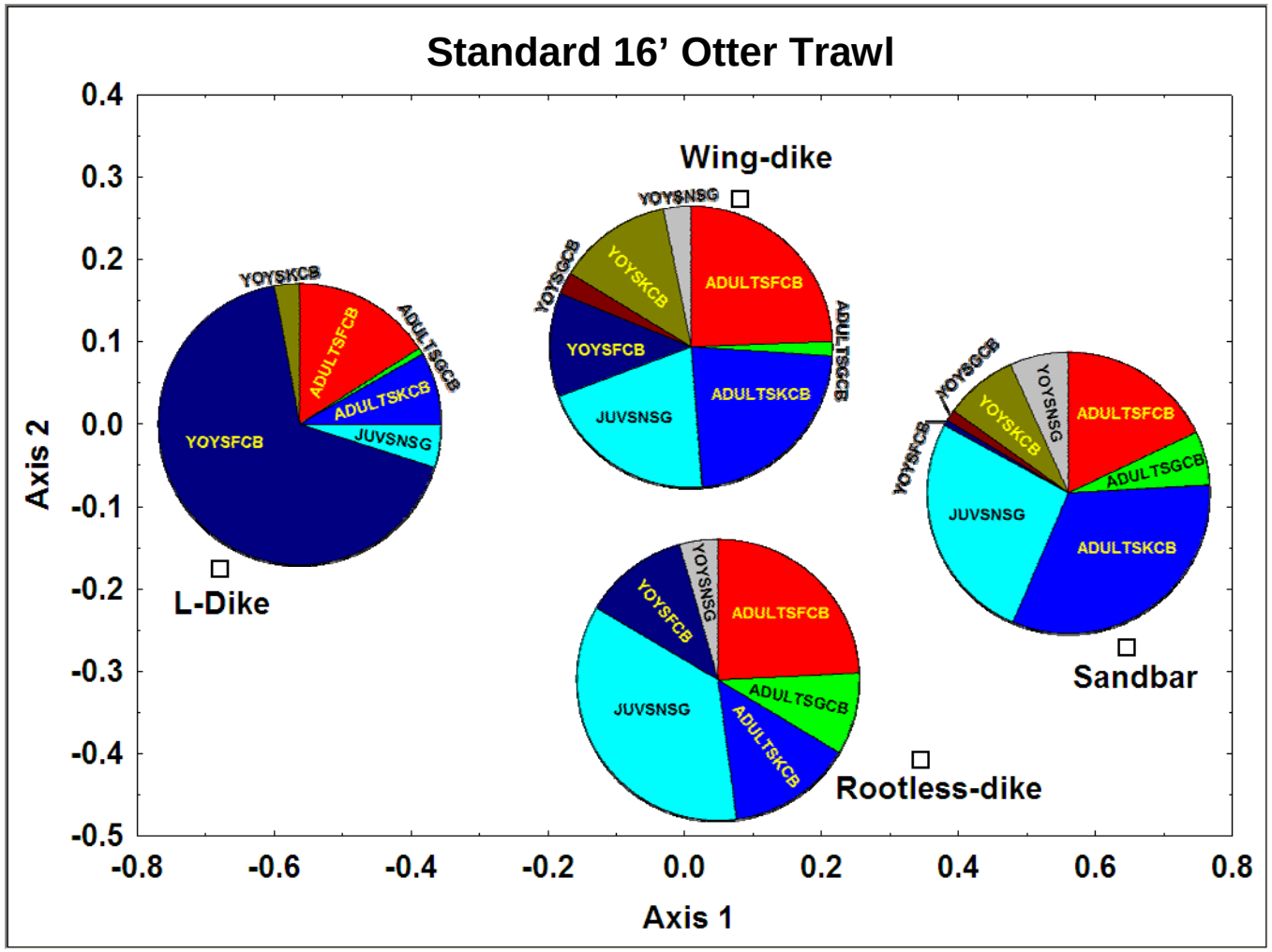

Figure 34. Discriminant function analysis of microhabitat types (open squares) sampled with standard 16 foot otter trawl and relative abundance (CPUE; pies) of associated target species by age class.

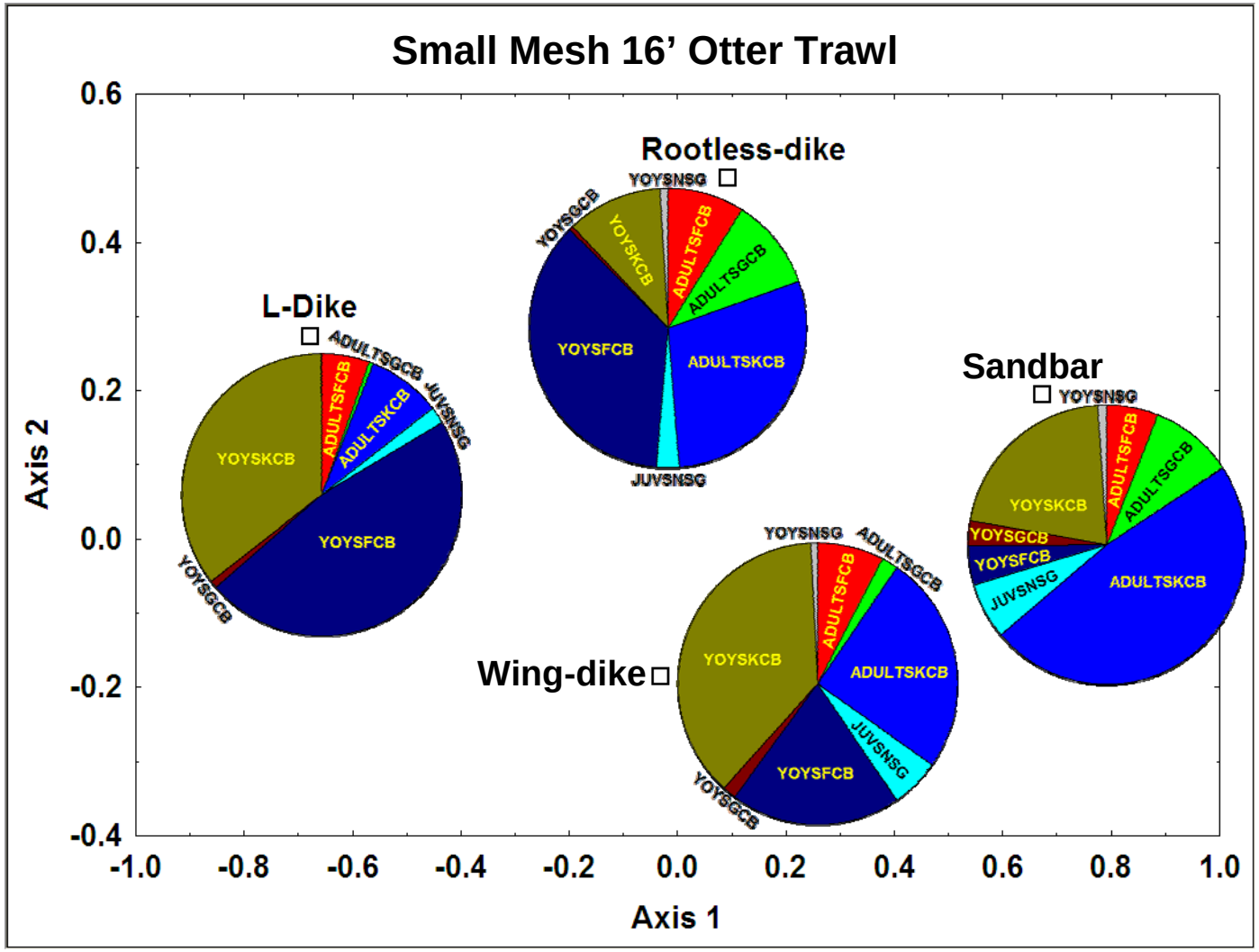

Figure 35. Discriminant function analysis of microhabitat types (open squares) sampled with experimental small-mesh 16 foot otter trawl and relative abundance (CPUE; pies) of associated target species by age class.

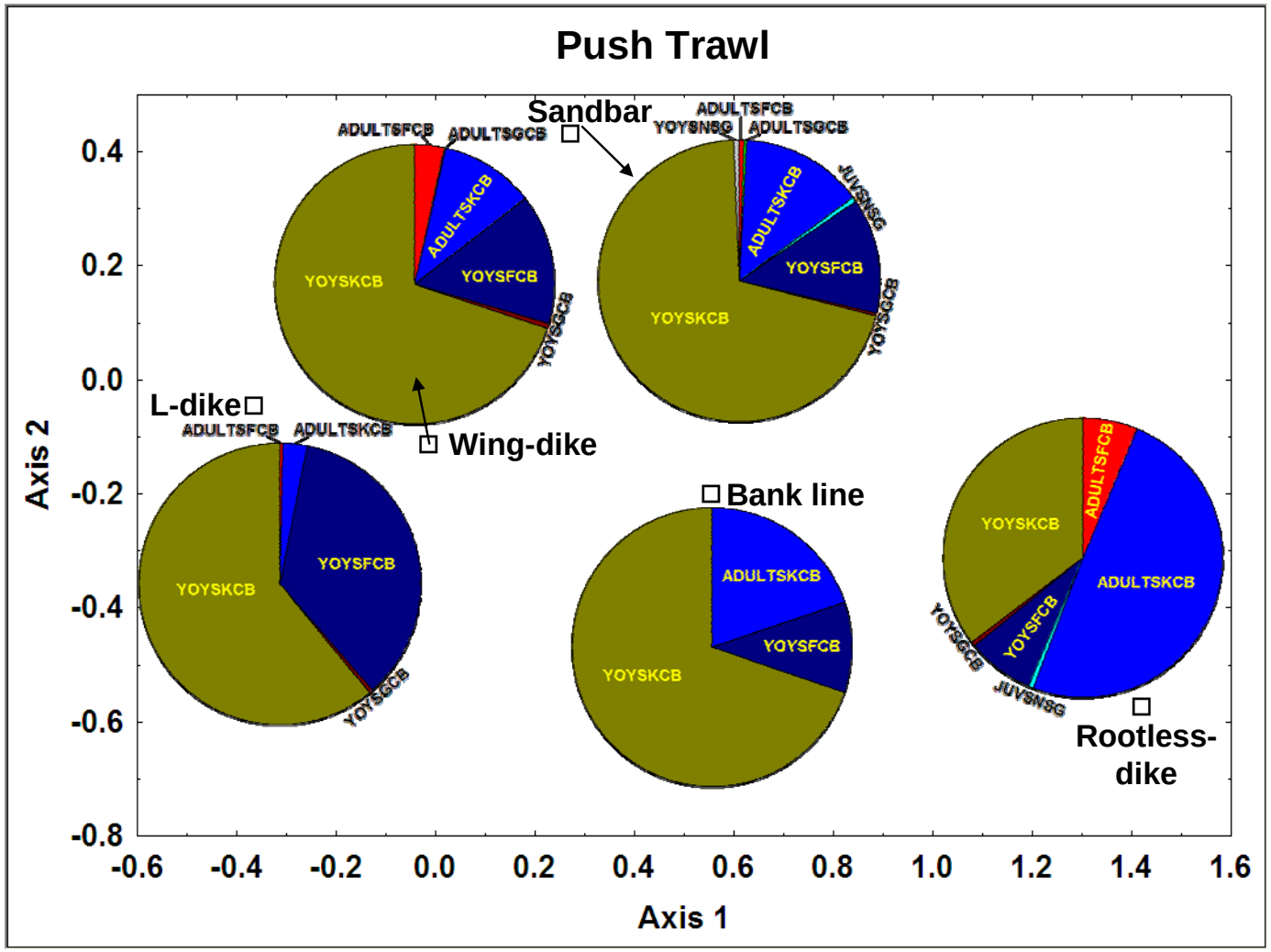

Figure 36. Discriminant function analysis of microhabitat types (open squares) sampled with experimental push trawl and relative abundance (CPUE; pies) of associated target species by age class.

Canonical Correspondence Analysis

Patterns in the distribution of different length classes of target species were analyzed using direct gradient analysis by means of a Canonical Correspondence Analysis (CCA; Palmer 1993). The purpose of CCA is to derive axes that maximize the dispersion of the species in relation to the samples while at the same time being subject to the constraint of the linear combinations of measured or observed environmental variables (Palmer 1993). Because of this, CCA can be used to determine whether or not the length classes of target species are distributed in the river relative to habitat and can be used to measure the significance of this association. In this case, habitat is referring to the type of dike, sandbar, or whether a notch is present. We used the software package CANOCO version 4.5 to perform the ordinations. All fish were $\log_{10}+1$ transformed and rare species were down weighted. We used biplot scaling and focused on inter-species distances. A Monte-Carlo permutation test was performed to test the significance of the canonical axes.

These plots are intended to visually represent associations of variables. In theses instances, these would include target species and habitat types. Species with similar habitat associations will plot together on the graph. Habitat types are represented with arrows. The length of the arrow determines the strength of the habitat type and point in the direction of increasing value. Habitats with similar target species communities will point in a similar direction

To determine the strength of a species association to a habitat, draw a line perpendicular to the axis of the habitat arrow so that it intersects the species point. The farther this intersection point is from the arrow origin, the stronger the species-habitat association.

We noticed similar trends when looking at the 75% bends with 63.0% of the variation in the fish data explained in the first axis (Figure 37). A significance test indicated a significant relationship between the selected habitat variables and the patterns found in the fish data (P= 0.0180). Again, YOY sicklefin chubs and unidentified YOY chubs were most associated with known pool habitat around L dike structures. As in the 25% bends, all other length classes of target species were associated with the fast moving shallow water around rootless dikes and sandbars (Figure 38Figure 38).

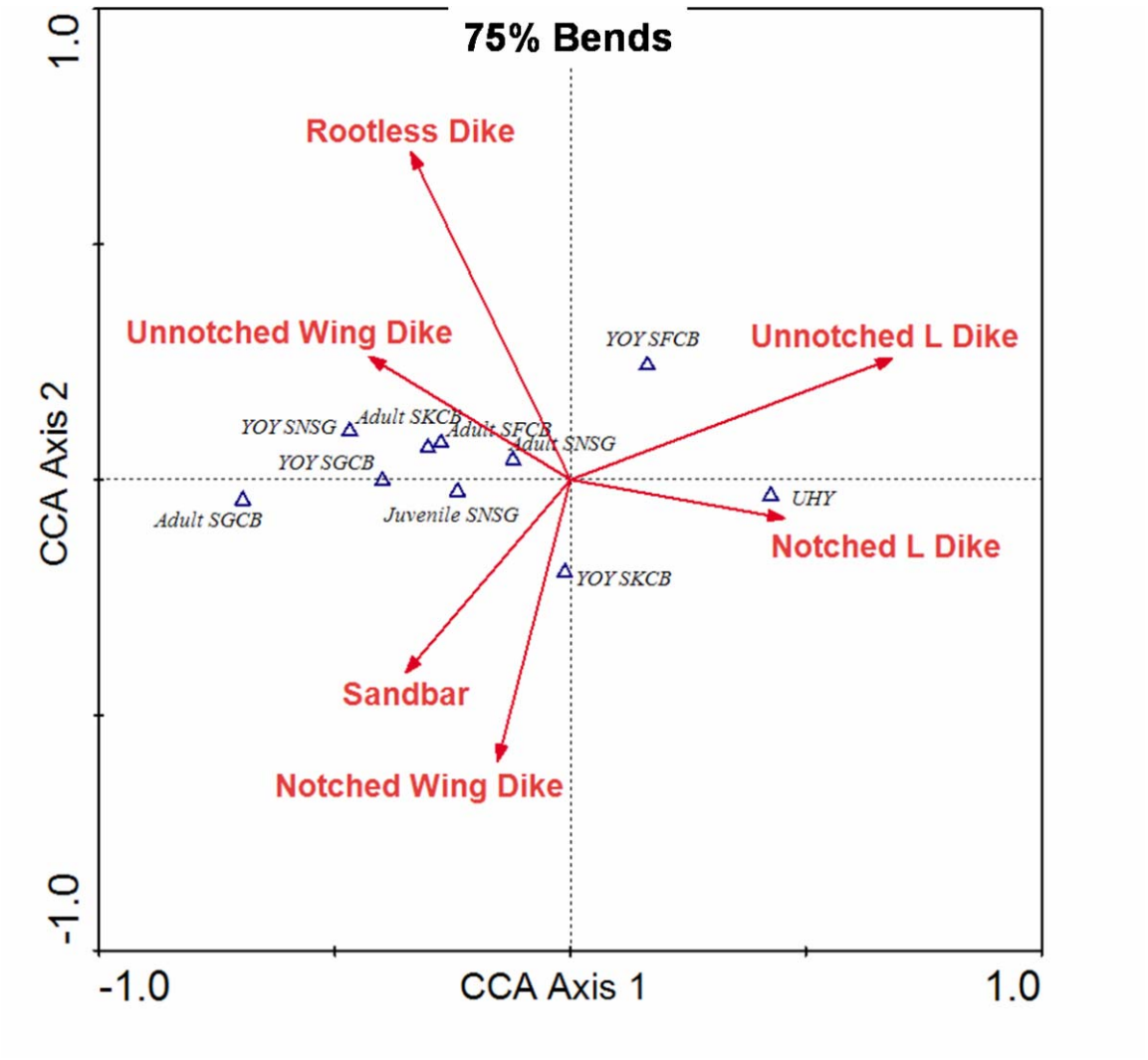

Figure 37.37. CCA ordination plot for length classes of target species captured in 75% bends using all gear over the entire 2006 sampling season. Axis 1 explained 63.0% and axis 2 explained an additional 16.8% of the variation in the fish data for length classes of these target species.

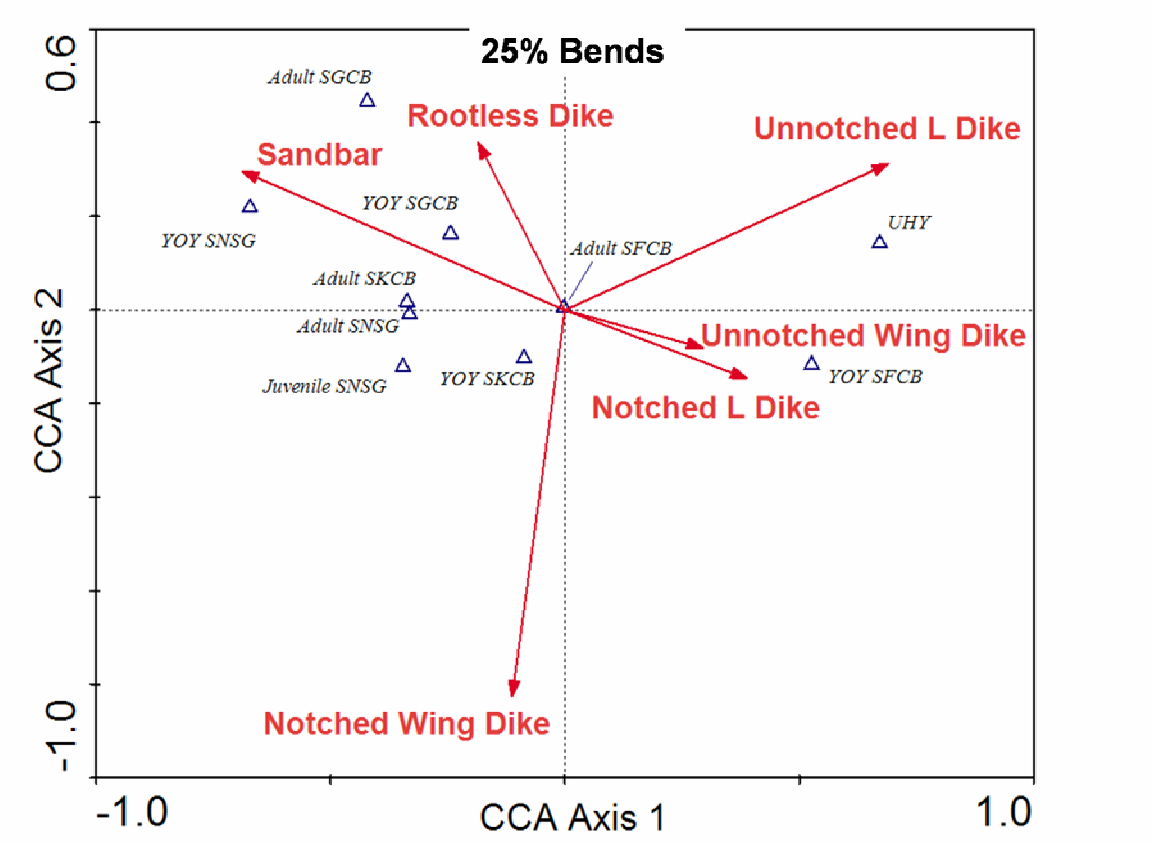

Figure38.Figure 38. CCA ordination plot for length classes of target species captured in 25% bends using all gear over the entire 2006 sampling season. Axis 1 explained 79.1% and axis 2 explained an additional 8.5% of the variation in the fish data for length classes of

Discussion

The BACI design was the chosen framework for HAMP to begin assessing the success of COE Missouri River SWH projects. This design has two components. The Before/After component is a comparison of biological change through time with river modifications serving as the separation point. Since we are only in the second year of monitoring, comparisons cannot be completed at this time. The second component of the BACI design is Control and Impact (treatment) bends. Comparisons between bend types can currently be analysed. Preliminary analysis indicated there are differences between bends, although it is unknown if the differences are because of the treatments, random chance or other variables. Continued analysis will be needed to determine the basis for the differences.

In 2006, Columbia FRO caught nearly 80,000 fish for HAMP. Considering the number of fish caught, Columbia FRO lacked the time and expertise to completely analyze the data. With this in mind, we narrowed our focus down to five target species based on ecological connections with the pallid sturgeon. Since HAMP is a derivative of the pallid sturgeon BO and COE projects, looking at these species makes sense. Target species only accounted for ~9,000 fish or ~11.5% of the total fish caught. Future analyses could incorporate additional fish species and individual analyses as another indicator of differences between bends.

The primary objective of HAMP is to monitor areas that are defined as SWH (<5 feet deep and <2 feet/s velocity). Although only a small portion of the target species were captured in SWH, these areas are an important component of the Missouri River ecosystem as demonstrated by HAMP catch rates. Approximately 55% of sampling was conducted in water deeper than 5 feet (OT16, OT01, and TN) but ~76% of fish were captured with the POT02 and MF were caught in areas that would be considered SWH in segment 13.

Results from the second year of monitoring indicated that species CPUE's were not significantly different between 25% and 75% radius bends. However, catch rates for the five target species were generally higher on the 75% bends than the 25% bends. The 25% bends likely mimic natural and preferred habitat types of the pre-channelized lower Missouri River better than shorter, dike dominated 75% bends because they more frequently contain large inside-bend sandbars.

Structure and microhabitats appear to offer distinct habitat need to different species at various life stages. Dr. Pauckert is currently analyzing this data with assistance of a graduate student that will quantify these differences. Different species appear to be affected by habitat modifications than others.

Young-of-year fishes are expected to be most abundant in summer and early autumn (i.e., growing season) because many big-river species use increased spring discharge and temperature to cue spawning. The increase in species richness (# of species) we find in our samples from June to July and subsequent decrease in August may be due to the addition of species to nursery habitats in July. Adults of species that do not often use archetypical big-river nursery habitats (i.e., shallow, slow velocity), may have had offspring that used these habitats and therefore been

more vulnerable to our small fish gear (i.e., small-mesh otter trawl and push trawl). Since YOY are most abundant in summer, and most probably use shallower, slower habitats as nursery, declining catch rates beginning in October suggests: 1) that many of the YOY fishes collected during the growing season may have performed ontogenetic habitat shifts beginning in October and were no longer vulnerable to our gear, or 2) mortality was high among YOY fishes leading to the observed decline in catch beginning in October. Another source of increased species richness may be from tributary stream contributions of non-typical big-river fishes such as orangespotted sunfish and johnny darter.

Catch rates for all bends appear to decline during the late summer (August and September). This observation has been noted by field crews of other river projects as well (personal communication). Catch rates increase as water temperatures begin to decline in October. Further, paired bends that were in close proximity to each other (i.e., bend 19 and 21; 31 and 33), even though they were different bend types (25% vs. 75%), showed signs of similar species richness and abundance trends. However, additional data that will be collected in the following years is needed to quantitatively evaluate the relationship between paired bends and the ecological relevance of bend type to Missouri River fishes.

The target species do not appear to occupy shallow water areas (<2.0 m) with regularity. The POT02 did capture target species in small numbers. The importance of shallow sand bar habitats may be under represented by the current diurnal sampling protocol. Irwin et al. (2002) found that cyprinid communities on sand and gravel bars in the Alabama River to be different between day and night periods. Ridenour (2007) found small fishes in shallow water at sand bars in the Lower Missouri River were significantly more abundant at night than during the day. Nocturnal sampling of shallow habitats for HAMP needs to be investigated.

Analysis of microhabitats by gears suggested the two experimental gears were successful in collecting young and small fishes. POT02 improves time efficiency for sampling shallow and near-shore habitats where many YOY occur. It samples these habitats that were previously sampled by seining and others areas (i.e., natural steeps, soft muddy substrates, fast current) not practical by seining.

Structure and microhabitats appear to offer distinct habitat needs to different species at various life stages. Dr. Pauckert is currently analyzing this data with assistance of a graduate student who will quantify these differences.

Ordination separated species composition of sandbars from composition of “dikes”. When combining fish collected with all gear over the entire 2006 sampling season; length classes of target species in the 25% bends were clearly associated with habitat type (Figure 38). A significance test indicated a strong relationship between the selected habitat variables and the patterns found in the fish data ($p = 0.0020$). The first axis, which explains most of the variation (79.1%), was clearly related to velocity with habitat variables associated with flowing, open water conditions to the left and habitat variables associated with slow water and pool conditions to the right. Most length classes of target species were most associated with flowing water near sandbars and rootless dikes. This is likely because these areas are typically associated with each other in the river.

Ecomorphology is an important factor in habitats used by fishes. YOY sicklefin chubs and YOY unidentified chubs were most associated with slow moving pool habitat around un-notched wing and L-dikes. Results of both discriminant function and canonical correspondence analysis indicated that higher velocity habitats (e.g., sandbars) were more associated with fishes suited for fast current.

Another tool that maybe useful, but is not currently available is an index of biotic integrity (IBI) or similar index to evaluate bend differences. The benthic fishes study, carried out on the Missouri River in the 1990's, constructed an initial IBI that can serve as a starting point in developing a specific index to assess bend differences in the context of HAMP goals and objectives. Although certain species were chosen based on presumed associations with pallid sturgeon habitat and forage needs, it may be important to focus on a community index considering the thousands of fish sampled. Consolidating all captured fish into standard indices reduces the ability to detect change in terms of ecosystem change. Additional effort on developing tools for analyzing collected data will become increasingly important as we attempt to evaluate the success of habitat modifications.

The data collected present many opportunities for a variety of different analyses. The focus of this report was on field sampling accomplishments and a cursory analysis to begin investigating potential bend differences. Further analysis is needed in these beginning years of HAMP to help refine goals and objectives and identify sampling techniques and the effort required to test the hypotheses.

Large river biology and monitoring is a rather new science. Much of what is being done through HAMP and other monitoring projects on the Missouri River have not been attempted before. The development and modification of current sampling techniques and data analysis will be needed to meet the unique requirements of the large river sampling and in particular on the Missouri River.

Acknowledgements

Thank you to the staff of Columbia FRO for assisting in the collection of field data and assisting with creating this report. A special thanks to Tammy Knecht and Brian Elkington for assisting with building of the many tables, figures and appendices. Colby Wrasse and Craig Williamson for initial editing and other constructive comments. Dr. Craig Paukert for willingly conducting statistical analysis of these data . Funding for this project was provided by US Army Corps of Engineers.

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Appendices

Appendix A. Four digit alphabetic species code with common and scientific names used by HAMP, 2006.

Common name	Scientific name	Code
Age0 fish	(youngoftheyear)Unidentified	YOYF
Alabama shad	Alosa alabamae	ALSD
Alewife	A. pseudoharengus	ALWF
American eel	Anguilla rostrata	AMEL
American grayling	Thymallus articus	AMGL
Banded darter	Etheostoma zonale	BDDR
Banded killifish	Fundulus diaphanus	BDKF
Banded sculpin	Cottus carolinae	BDSP
Bigeye shiner	Notropis boops	BESN
Bighead carp	Hypopthalmichthys nobilis	BHCP
Bigmouth buffalo	Ictiobus cyprinellus	BMBF
Bigmouth shiner	Notropis dorsalis	BMSN
Black buffalo	Ictiobus niger	BKBF
Black bullhead	Ameiurus melas	BKBH
Black crappie	Pomoxis nigromaculatus	BKCP
Black redhorse	Moxostoma duquesnei	BKRH
Blacknose dace	Rhinichthys atratulus	BNDC
Blacknose shiner	Notropis heterolepis	BNSN
Blackside darter	Percina maculata	BSDR
Blackspotted topminnow	Fundulus olivaceus	BPTM
Blackstripe topminnow	F. notatus	BTTM
Bleeding shiner	Luxilus zonatus	BDSN
Blue catfish	Ictalurus furcatus	BLCF
Blue sucker	Cycleptus elongatus	BUSK
Bluegill	Lepomis macrochirus	BLGL
Bluegill-Redear Sunfish Hybrid	L. macrochirus X L. macrolophus	BGRE
Bluestripe darter	Percina cymatotaenia	BTDR
Bluntnose minnow	Pimephales notatus	BNMW
Bonneville ciscoe	Prosopium cylindraceum	BVSC
Bowfin	Amia calva	BWFN
Brassy minnow	Hybognathus hankinsoni	BSMW
Brook silverside	Labidesthes sicculus	BKSS
Brook stickleback	Culaea inconstans	BKSB
Brook trout	Salvelinus fontinalis	BKTT
Brown trout	Salmo trutta	BNTT
Brown Bullhead	Ameiurus nebulosus	BNBH
Bullhead minnow	Pimephales vigilax	BHMW
Burbot	Lota lota	BRBT
Central Mudminnow	Umbra limi	MDMN
Central stoneroller	Campostoma anomalum	CLSR
Channel catfish	Ictalurus punctatus	CNCF

Common name	Scientific name	Code
Channel Shiner	Notropis wickliffi	CNSN
Chestnut lamprey	Ichthyomyzon castaneus	CNLP
Chinook salmon	Oncorhynchus tshawytscha	CNSM
Ciscoe	Coregonus artedi	CSCO
Coho salmon	Oncorhynchus kisutch	CHSM
Common carp	Cyprinus carpio	CARP
Common shiner	Luxilus cornutus	CMSN
Conditions did not allow for Gear Deployment	(e.g. you accessed the chute, but no flow to drift trammel net)	CNFH
Could Not Access	(e.g. Water in Chute too low to access)	CNA
Creek chub	Semotilus atromaculatus	CKCB
Crystal darter	Ammocrypta asprella	CLDR
Cutthroat trout	Salmo clarki	CTTT
Emerald shiner	Notropis atherinoides	ERSN
Fantail darter	Etheostoma flabellare	FTDR
Fathead minnow	Pimephales promelas	FHMW
Finescale dace	Phoxinus neogaeus	FSDC
Flathead catfish	Pylodictus olivaris	FHCF
Flathead chub	Platygobio gracilis	FHCB
Freckled madtom	Noturus nocturnus	FKMT
Freshwater drum	Aplodinotus grunniens	FWDM
Ghost shiner	Notropis buchanani	GTSN
Gilt darter	Percina evides	GLDR
Gizzard shad	Dorosoma cepedianum	GZSD
Golden redhorse	Moxostoma erythrurum	GDRH
Golden shiner	Notemigonus crysoleucas	GDSN
Golden trout	Salmo aguabonita	GDTT
Goldeye	Hiodon alosoides	GDEY
Goldfish	Carassius auratus	GDFH
Grass carp	Ctenopharyngodon idella	GSCP
Grass pickerel	Esox americanus vermiculatus	GSPK
Gravel chub	Erimystax punctatus	GVCB
Green sunfish	Lepomis cyanellus	GNSF
Greenside darter	Etheostoma blennioides	GSDR
Highfin carpsucker	Carpiodes velifer	HFCS
Hornyhead chub	Nocomis biguttatus	HHCB
Hybognathus spp.	Hybognathus sp.	HBNS
Iowa darter	Etheostoma exile	IODR
Johnny darter	Etheostoma nigrum	JYDR
Lab fish to be ID in lab		LAB
Lake chub	Couesius plumbeus	LKCB
Lake sturgeon	Acipenser fulvescens	LKSG
Lake trout	Salvelinus namaycush	LKTT
Lake whitefish	Coregonus clupeaformis	LKWF
Largemouth bass	Micropterus salmoides	LMBS
Largescale stoneroller	Campostoma oligolepis	LSSR

Common name	Scientific name	Code
Larval fish Unidentified		LVFS
Larval lamprey Unidentified		LVLP
Least darter	Etheostoma microperca	LTDR
Logperch	Percina caprodes	LGPH
Longear sunfish	Lepomis megalotis	LESF
Longnose dace	Rhinichthys cataractae	LNDC
Longnose gar	Lepisosteus osseus	LNGR
Longnose sucker	Catostomus catostomus	LNSK
Mimic shiner	Notropis volucellus	MMSN
Mississippi silvery minnow	Hybognathus nuchalis	SVMW
Missouri saddled darter	Etheostoma tetrazonum	MSDR
Mooneye	Hiodon tergisus	MNEY
Mosquitofish	Gambusia affinis	MQTF
Mottled sculpin	Cottus bairdi	MDSP
Mountain sucker	Catostomus platyrhyncus	MTSK
Mountain whitefish	Prosopium williamsoni	MTWF
Muskellunge	Esox masquinongy	MSKG
No fish caught	Nocatchus pisces	NFSH
Net Did Not Fish	(Gear Failure)	NDNF
Northern brook lamprey	Ichthyomyzon fossor	NBLP
Northern hog sucker	Hypentelium nigricans	NHSK
Northern pike	Esox lucius	NTPK
Northern redbelly dace	Phoxinus eos	NRBD
Northern studfish	Fundulus catenatus	NTSF
Orangespotted sunfish	Lepomis humilis	OSSF
Orangethroat darter	Etheostoma spectabile	OTDR
Ozark minnow	Notropis nubilus	OZMW
Paddlefish	Polyodon spathula	PDFH
Pallid sturgeon	Scaphirhynchus albus	PDSG
Peamouth	Mylocheilus caurinus	PEMT
Pearl dace	Margariscus margarita	PLDC
Plains killifish	Fundulus zebrinus	PKLF
Plains minnow	Hybognathus placitus	PNMW
Plains topminnow	Fundulus sciadicus	PTMW
Pugnose minnow	Opsopoeodus emiliae	PGMW
Pumpkinseed	Lepomis gibbosus	PNSD
Quillback	Carpiodes cyprinus	QLBK
Rainbow darter	Etheostoma caeruleum	RBDR
Rainbow smelt	Osmerus mordax	RBST
Rainbow trout	Oncorhynchus mykiss	RBTT
Redear Sunfish	Lepomis microlophus	RESF
Red shiner	Cyprinella lutrensis	RDSN
Redfin Shiner	Lythrurus umbratilus	RFSN
Redside shiner	Richardsonius balteatus	RDSS
River carpsucker	Carpiodes carpio	RVCS

Common name	Scientific name	Code
River darter	Percina shumardi	RRDR
River redhorse	Moxostoma carinatum	RVRH
River shiner	Notropis blennius	RVSN
Rock bass	Ambloplites rupestris	RKBS
Rosyface shiner	Notropis rubellus	RYSN
Rudd	Scardinius erythrophthalmus	RUDD
Sacromento Perch	Archoplites interruptus	SOPH
Sand shiner	Notropis stramineus	SNSN
Sauger	Sander canadensis	SGER
Sauger x Walleye	Sizostedion canadense x vitrieum	SGWE
Shorthead redhorse	Moxostoma macrolepidotum	SHRH
Shortnose gar	Lepisosteus platostomus	SNGR
Shovelnose sturgeon	Scaphirhynchus platorynchus	SNSG
Shovelnose x Pallid Hybrid	Scaphirhynchus platorynchus x Scaphirhynchus albus	SNPD
Sicklefin chub	Macrhybopsis meeki	SFCB
Silver carp	Hypopthalmichthys molitrix	SVCP
Silver chub	Macrhybopsis storeriana	SVCB
Silver lamprey	Ichthyomyzon unicuspis	SVLP
Silver redhorse	Moxostoma anisurum	SVRH
Silverband shiner	Notropis shumardi	SBSN
Silverstripe shiner	Notropis stilbius	SSPS
Skipjack herring	Alosa chrysochloris	SJHR
Slender madtom	Noturus exilis	SDMT
Slenderhead darter	Percina phoxocephala	SHDR
Slough darter	Etheostoma gracile	SLDR
Smallmouth bass	Micropterus dolomieu	SMBS
Smallmouth buffalo	Ictiobus bubalus	SMBF
Sockeye salmon	Oncorhynchus nerka	SESM
Southern brook lamprey	Ichthyomyzon gagei	SBLR
Southern redbelly dace	Phoxinus erythrogaster	SRBD
Speckled chub	Macrhybopsis aestivalis	SKCB
Speckled chub x Sturgeon chub	Macrhybopsis aestivalis x gelida	SPST
Spotfin shiner	Cyprinella spiloptera	SFSN
Spottail shiner	Notropis hudsonius	STSN
Spotted bass	Micropterus punctulatus	STBS
Spotted gar	Lepisosteus oculatus	STGR
Spotted sucker	Minytrema melanops	SPSK
Stippled darter	Etheostoma punctulatum	STPD
Stonecat	Noturus flavus	STCT
Striped bass	Morone saxatilis	SDBS
Striped bass x White bass	M. saxatilis X M. chrysops	SBWB
Striped shiner	Luxilus chrysocephalus	SPSN
Sturgeon chub	Macrhybopsis gelida	SGCB
Sturgeon chub x Sticklefin chub	Macrhybopsis gelida x meeki	SCSC
Suckermouth minnow	Phenacobius mirabilis	SMMW

Common name	Scientific name	Code
Threadfin shad	Dorosoma petenense	TFSD
Tiger Muskellunge	E. lucius X E. masquinongy	TGMG
Topeka shiner	Notropis topeka	TPSN
Troutperch	Percopsis omiscomaycus	TTPH
Unidentified	Unidentified	UNID
Unidentified Asian Carp	Hypopthalmichthys spp.	UAC
Unidentified Bullhead	Ameiurus spp.	UBH
Unidentified Etheostoma	Etheostoma sp.	UET
Unidentified Ictalurus	Ictalurus spp.	UIC
Unidentified Catfish	Other than Ictalurus	UCF
Unidentified Crappie	Pomoxis spp.	UPM
Unidentified Lepomis	Lepomis sp.	ULP
Unidentified Percidae	Unidentified Percidae	UPC
Unidentified Percina	Percina sp.	UPN
Unidentified Stizostedion	Stizostedion sp.	UST
Unidentified buffalo	Ictiobus sp.	UBF
Unidentified carpsucker	Carpiodes sp.	UCS
Unidentified chub	Macrhybopsis sp.	UHY
Tadpole madtom	Noturus gyrinus	TPMT
Unidentified darter	Percina or Etheostoma sp.	UDR
Unidentified lamprey	Petromyzontidae	ULY
Unidentified Micropterus spp.	Micropterus spp.	UMC
Unidentified minnow	Unidentified Cyprinidae	UCY
Unidentified redhorse	Moxostoma sp.	URH
Unidentified shiner	Notropis sp.	UNO
Unidentified Sturgeon	Scaphirhynchus sp.	USG
Unidentified Catastomus	Catastomus spp.	UCA
Unidentified sucker	Unidentified Catostomidae	UCT
Unidentified sunfish	Unidentified Centrarchidae	UCN
Walleye	Sander vitreum	WLYE
Warmouth	Lepomis gulosus	WRMH
Wedgespot shiner	Notropis greenei	WSSN
Western redfin shiner	Lythrurus umbratilis	WRFS
Western silvery minnow	Hybognathus argyritis	WSMW
White bass	Morone chrysops	WTBS
White crappie	Pomoxis annularis	WTCP
White-black crappie hybrid	P. annularis X P. nigromaculatus	WCBC
White perch	Morone americana	WTPH
White sucker	Catostomus commersoni	WTSK
Yellow bass	Morone mississippiensis	YWBS
Yellow bullhead	Ameiurus natalis	YLBH
Yellow perch	Perca flavescens	YWPH
Gizzard shad x Threadfin shad	Dorosoma cepedianum x petenense	GSTS
Goldfish x Common carp	Carassius auratus x Cyprinus carpio	GFCC
Flathead chub x sicklefin chub	Platygobio gracilis x Macrhybopsis meeki	FCSC

Common name	Scientific name	Code
Blue catfish x Channel catfish	Ictalurus furcatus x punctatus	BCCC
Green sunfish x Bluegill	Lepomis cyanellus x macrochirus	GSBG
Green sunfish x unknown	Lepomis cyanellus x sp.	GN*?
Green sunfish x Orangespotted	Lepomis cyanellus x L. humilis	GSOS

Appendix B. Segment 10 total CPUE by species for small mesh 16' otter trawls (OT01), from before (bend 9), control (bend 26) and impact (bend 3) sites.

Segment 10 **Gear OT01**

Species (2 SE)	Bend 18, Before					Bend 24, Control					Bend 28, Impact				
	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
						N=10					N=14				
BHMW											0.169 (0.2)				
BLCF						2.176 (1.6)					2.283 (2)				
BNMW						0.283 (0.4)					0.587 (1.2)				
BUSK						0.4 (0.8)									
CARP											0.549 (0.2)				
CNCF						4.539 (3.1)					4.943 (3.3)				
ERSN						0.333 (0.3)					0.126 (0.3)				
FHCF						0.5 (0.1)									
FWDM						32.13 (3.1)					145 (183)				
GDEY						0.54 (0.8)					0.444 (0.6)				
RDSN						0.417 (0.8)									
RVCS						0.75 (0.2)					2.23 (3.6)				
SFCB						0.42 (0.4)					0.191 (1)				
SGCB											0.239 (0.5)				
SGER						0.333 (0.7)					0.298 (0.3)				

SKCB						2.74 (2.9)					0.425 (0.3)				
SNGR											0.117 (0.2)				
SNSG						1.63 (1.6)					0.144 (0.1)				
UAC											0.26 (0.5)				
UHY						2.188 (2.3)					9.833 (17)				
YOYF											0.482 (0.8)				
Total						47.29 (33)					166.7 (23)				

Appendix C. Segment 10 total CPUE by species for 16' otter trawls (OT16), from before (bend 9), control (bend 26) and impact (bend 3) sites.

Segment 10 **Gear OT16**

	Bend 18, Before					Bend 24, Control					Bend 28, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)						N=4					N=4				
BLCF						1.698 (1.5)					3.871 (4)				
BUSK											0.125 (0.3)				
CARP						0.125 (0.3)					0.125 (0.3)				
CNCF						2.745 (2.8)					4.115 (4.6)				
FHCF											0.125 (0.3)				
FWDM						5 (6.1)					1.465 (1.7)				
RVCS											0.1 (0.2)				
SFCB						1 (0.2)					0.465 (0.4)				
SKCB						0.5 (0.5)					0.125 (0.3)				
SMBF						0.114 (0.2)									
SNSG						1.395 (1.9)					0.475 (0.8)				
UHY						0.818 (1.6)									
Total						11.45 (5.3)					1.991 (9.8)				

Appendix D. Segment 10 total CPUE by species for push trawls (POT02), from before (bend 9), control (bend 26) and impact (bend 3) sites.

Segment 10 Gear POT02

	Bend 9, Before					Bend 26, Control					Bend 3, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)			N=11	N=15	N=10	N=15		N=20	N=15	N=15					
BHMW			3.264 (4.7)	0.444 (0.8)	4.166 (2.8)	4.726 (7.2)		5.45 (4.8)	2.988 (6)	15.73 (18)					
BLCF			0.182 (0.2)	0.333 (0.7)		0.467 (0.7)			0.267 (0.4)						
BLGL				0.167 (0.3)	0.979 (0.2)			0.252 (0.3)	0.122 (0.1)	0.556 (1)					
BNMW				2.882 (3)		0.244 (0.3)		0.457 (0.6)	12.87 (9.1)	0.457 (0.8)					
CNCF			0.127 (0.1)	1.468 (0.8)	0.482 (0.4)	0.822 (1.5)		0.785 (0.2)	1.653 (1.6)	0.147 (0.1)					
CNSN					0.385 (0.8)										
ERSN			1.515 (1.6)	0.8 (1)	2.827 (2.1)	0.436 (0.7)		3.634 (3.3)	0.453 (0.4)	2.399 (1.2)					
FHCF				0.667 (0.1)						0.159 (0.3)					
FHMW						0.417 (0.8)									
FWDM				0.183 (0.2)	0.12 (0.2)	5.386 (25)		0.574 (0.5)	0.36 (0.3)	0.316 (0.4)					
GDEY			0.159 (0.3)												
GZSD					0.979 (0.2)					0.356 (0.5)					
HBNS									0.595 (0.1)						
MQTF					0.417 (0.8)					0.333 (0.7)					
OSSF					0.979 (0.2)	0.889 (0.2)			0.122 (0.2)	0.437 (0.6)					

RBST										0.385 (0.5)					
RDSN			0.294 (0.3)	0.94 (1.6)	3.857 (2.3)			0.222 (0.4)	0.188 (0.2)	2.495 (1.4)					
RVCS				0.4 (0.5)		1.219 (2)		0.67 (0.6)	0.914 (0.1)						
RVSN			0.395 (0.8)	0.833 (0.2)	0.445 (0.5)			0.187 (0.2)		0.888 (0.9)					
SFCB			0.753 (0.7)	0.8 (0.2)		0.133 (0.3)		0.962 (0.2)		0.139 (0.3)					
SFSN			0.957 (0.2)												
SGCB				0.513 (0.1)	0.172 (0.3)										
SJHR								0.12 (0.2)							
SKCB			0.322 (0.3)	1.57 (1.8)	1.739 (1.5)	0.278 (0.4)		0.847 (0.2)	0.485 (0.4)	0.699 (0.6)					
SNGR								0.125 (0.2)	0.444 (0.9)						
SNSG				0.513 (0.1)											
SNSN			0.849 (0.8)		0.675 (0.1)				0.444 (0.7)	0.113 (0.2)					
SVCB			0.195 (0.2)	0.253 (0.3)	0.197 (0.2)	0.687 (1.7)		0.684 (1.1)	0.411 (0.3)	0.361 (0.6)					
UCF						0.957 (0.9)									
UCN								0.125 (0.2)	0.556 (0.8)	0.159 (0.3)					
UHY				0.444 (0.9)	0.134 (0.3)	8.479 (6.9)		0.165 (0.9)		0.311 (0.6)					
WTBS			0.38 (0.5)	0.233 (0.4)		0.333 (0.7)		0.9 (0.2)							
YOYF								0.152 (0.3)							
Total			6.16 (4.6)	8.836 (3.8)	14.14 (6.7)	67.75 (33)		11.87 (7.1)	19.86 (1.9)	22.97 (20)					

Appendix E. Segment 10 total CPUE by species for push trawls (POT02), from before (bend 18), control (bend 24) and impact (bend 28) sites.

Segment 10 **Gear POT02**

	Bend 18, Before					Bend 24, Control					Bend 28, Impact				
Species (2 SE)	June	July	Aug. N=15	Sept. N=14	Oct. N=15	June N=10	July	Aug. N=10	Sept. N=13	Oct. N=15	June N=15	July	Aug.	Sept.	Oct.
BHMW			6.27 (7.3)	5.452 (7.9)	4.921 (2.9)	0.751 (1.2)		3.676 (3.7)	0.462 (0.9)	5.925 (4.2)	7.829 (7.2)				
BLCF						0.286 (0.6)									
BLGL			0.178 (0.2)	0.214 (0.4)				0.36 (0.5)		0.382 (0.4)					
BNMW			0.131 (0.2)	6.138 (6)				0.819 (0.9)	7.864 (6)	0.926 (0.2)	0.376 (0.3)				
BUSK						0.2 (0.4)									
CARP						0.5 (0.1)					0.333 (0.7)				
CNCF			0.111 (0.2)	1.474 (1.2)	0.286 (0.4)	0.4 (0.6)		0.826 (0.2)	0.936 (0.9)	0.236 (0.3)	5.384 (8.3)				
CNSN			0.155 (0.3)												
ERSN			0.677 (1.4)	0.317 (0.3)	1.176 (0.6)	0.154 (0.4)		1.13 (1.3)	1.432 (1.4)	2.986 (1.4)	0.642 (0.7)				
FHCF						0.286 (0.6)			0.659 (0.1)		0.333 (0.7)				
FHMW						0.7 (0.1)					0.267 (0.5)				
FWDM			0.492 (0.4)	0.425 (0.3)	0.217 (0.2)	28.5 (3.8)		0.528 (0.8)	0.114 (0.2)	0.592 (0.8)	75.93 (4.3)				
GDEY			0.139 (0.3)								0.1 (0.2)				
GZSD			0.221 (0.3)		0.23 (0.5)			0.167 (0.3)		0.232 (0.2)					
HBNS				0.476 (1)											

MMSN			0.222 (0.4)								2.533 (5.7)				
MNEY															
MQTF					0.167 (0.3)					0.142 (0.3)					
NFSH									0.256 (0.5)						
OSSF			0.966 (0.2)	0.228 (0.3)	0.278 (0.4)			0.134 (0.3)		0.742 (0.8)					
RBST					0.213 (0.3)					0.142 (0.3)					
RDSN			0.384 (0.6)	0.318 (0.3)	0.655 (0.5)	0.571 (0.1)		0.312 (0.4)	1.689 (2.1)	1.92 (1.6)	0.847 (1.5)				
RVCS			0.252 (0.4)			0.667 (0.1)		0.36 (0.5)	0.924 (1)	0.766 (0.2)	6.757 (9.4)				
RVSN			0.318 (0.6)		0.389 (0.5)					0.447 (0.7)					
SFCB			0.278 (0.6)	0.929 (0.1)		0.333 (0.7)		0.248 (0.5)	0.924 (0.1)	0.193 (0.2)	0.896 (1.4)				
SFSN								0.133 (0.3)							
SGCB						0.6 (0.9)									
SGER						0.667 (0.1)					0.122 (0.2)				
SKCB				0.495 (0.3)	0.955 (0.8)	0.773 (0.6)			1.855 (0.6)	0.655 (0.7)					
SMBF										0.175 (0.4)					
SNGR			0.155 (0.3)							0.333 (0.7)					
SNSG									0.855 (0.2)						
SNSN						0.385 (0.8)			0.377 (0.6)	0.363 (0.4)	0.29 (0.6)				

Appendix E (continued). Segment 10 total CPUE by species for push trawls (POT02), from before (bend 18), control (bend 24) and impact (bend 28) sites

SVCB			0.622 (0.7)	0.694 (1)	0.138 (0.2)	2.235 (4)		0.125 (0.2)	0.432 (0.3)	0.787 (0.7)	8.39 (8.3)				
UCF						2.277 (2.3)					0.182 (0.4)				
UCN				0.612 (0.9)							0.278 (0.6)				
UCY								0.366 (0.5)							
UHY			0.128 (0.2)	0.157 (0.3)	1.333 (2.7)	2.719 (2.5)		0.517 (0.1)		0.784 (0.2)	12.35 (1.9)				
WTBS			0.187 (0.2)					0.478 (0.7)			0.178 (0.4)				
Total			8.325 (7.8)	15.49 (8.8)	8.684 (5.3)	38.49 (32)		5.617 (3.9)	14.3 (6.8)	12.57 (5.6)	122.2 (41)				

Appendix F. Segment 13 total CPUE by species for mini-fyke nets (MF), from before (bend 19), control (bend 41) and impact (bend 13) sites.

Segment 13 **Gear MF**

	Bend 19, Before					Bend 41, Control					Bend 13, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)		N=4	N=4	N=3	N=3		N=4	N=4	N=4	N=3		N=4	N=4	N=4	N=4
BHMW		2.00 (2)		8.33 (11)	3.33 (4.7)		0.75 (1.5)	1.25 (1.9)	2.00 (2.2)	2.00 (2.5)		0.50 (0.6)	2.25 (2.2)	3.75 (2.5)	2.00 (2.8)
BKBH												0.25 (0.5)			
BKSS													0.25 (0.5)		
BLCF			0.50 (1)				0.25 (0.5)					0.25 (0.5)			
BLGL		0.75 (1)		0.67 (1.9)	0.33 (0.5)		1.25 (2.5)		0.25 (0.5)	0.50 (1.2)			2.00 (4)	0.75 (1.5)	
BNMW		1.50 (1.3)	0.75 (0.5)	0.33 (0.5)	0.67 (1.9)		6.00 (7.8)	3.25 (4.3)				2.00 (1.6)	0.50 (1)		
CARP								0.25 (0.5)							
CNCF		1.25 (0.5)	0.25 (0.5)		5.00 (7.4)		0.75 (1.5)	1.00 (1.4)	0.50 (1)			1.25 (1.9)		3.75 (7.5)	1.25 (1.9)
CNSN				0.33 (0.5)											
ERSN		7.00 (9.2)	1.00 (1.4)	15.67 (4.8)	11.33 (2)		0.75 (1)	4.25 (6)	11.25 (14)	1.75 (17)		11.00 (17)	7.50 (8.8)	15.75 (14)	19.75 (2.3)
FHCF			0.25 (0.5)					0.25 (0.5)				0.50 (0.6)			
FWDM		4.75 (5)	0.75 (1)				6.50 (12)	0.50 (0.6)	0.25 (0.5)	0.75 (1.2)		8.50 (12)	0.75 (1.5)	1.25 (1.3)	0.25 (0.5)
GDEY		0.25 (0.5)													
GZSD					0.33 (0.5)					0.25 (0.6)		0.25 (0.5)	0.50 (1)		
LMBS									0.25 (0.5)			0.50 (0.6)	0.25 (0.5)		
LNGR					0.33				0.25					0.25	

					(0.5)				(0.5)					(0.5)	
MMSN					0.33 (0.5)		2.00 (4)	0.25 (0.5)	0.25 (0.5)	0.25 (0.6)					
MQTF		0.25 (0.5)		0.33 (0.5)	0.33 (0.5)			1.00 (1.2)	0.50 (1)				1.25 (2.5)	0.75 (1.5)	
NFSH													0.25 (0.5)		0.25 (0.5)
OSSF		0.25 (0.5)	0.50 (1)		1.67 (2.7)				0.25 (0.5)					0.75 (1.5)	0.25 (0.5)
RDSN		2.50 (2.8)	6.75 (3.5)	2.00 (11)	1.33 (6.6)		2.75 (3.8)	14.75 (26)	5.00 (5.8)	73.50 (160)		6.75 (9.4)	6.25 (9.9)	21.50 (25)	6.50 (6.4)
RVCS		2.50 (2.9)	0.75 (0.5)	11.00 (1.4)	1.00 (1.6)		1.75 (2.9)	2.25 (2.2)				5.50 (7.9)	3.75 (5.6)	0.50 (0.6)	
RVSN				2.00 (3.3)			1.00 (2)	0.25 (0.5)							
SFCB										0.25 (0.6)					
SKCB		0.25 (0.5)							0.75 (1.5)	3.25 (2.7)				3.50 (7)	0.50 (0.6)
SMBF															0.25 (0.5)
SNGR		1.00 (1.4)	0.25 (0.5)	0.67 (1.9)			0.75 (1)	1.00 (0.8)	2.75 (4.3)	0.75 (1.2)		0.25 (0.5)	0.75 (1)	3.00 (2.9)	
SNSN					0.33 (0.5)		1.50 (1.9)		0.25 (0.5)					0.75 (1.5)	
SVCB		0.25 (0.5)		0.33 (0.5)				0.25 (0.5)		0.25 (0.6)		3.25 (4.3)		0.75 (1.5)	0.50 (1)
SVCP												0.25 (0.5)			
UCY					0.33 (0.5)										
UHY														0.50 (1)	
ULP		0.50 (1)													

Appendix F (continued). Segment 13 total CPUE by species for mini-fyke nets (MF), from before (bend 19), control (bend 41) and impact (bend 13) sites

UNO							0.25 (0.5)								
WTBS		2.00 (2.4)					1.25 (1.9)	0.25 (0.5)				1.75 (2.9)	0.25 (0.5)		0.25 (0.5)
WTCP							0.25 (0.5)			0.25 (0.6)				0.25 (0.5)	
Total		27.00 (19)	11.75 (5.7)	59.67 (38)	35.67 (9.5)		27.75 (3.6)	3.75 (43)	24.50 (25)	92.75 (166)		42.75 (4.6)	26.50 (29)	57.75 (49)	31.75 (27)

Appendix G Segment 13 total CPUE by species for mini-fyke nets (MF), from before (bend 33), control (bend 31) and impact (bend 21) sites.

Segment 13 **Gear MF**

	Bend 33, Before					Bend 31, Control					Bend 21, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)		N=4	N=4	N=4	N=4		N=4	N=4	N=4	N=4		N=4	N=4	N=4	N=4
BHMW		21 (22)	5.5 (1.7)	2.75 (3.6)	63.5 (81)		0.5 (0.6)	9.5 (13)	32 (44)	6 (7.6)		6.5 (7.6)	0.5 (0.6)	15 (14)	2.5 (3.3)
BKCP				0.25 (0.5)								0.25 (0.5)	0.25 (0.5)		
BKSS				0.25 (0.5)				0.25 (0.5)					4.5 (9)		
BLCF			0.25 (0.5)											(0.1)	
BLGL		1.25 (1.3)	3 (4.8)	4.25 (7.8)			0.5 (0.6)	1.75 (2.4)		0.25 (0.5)			0.5 (0.6)	0.75 (1.8)	1 (2)
BNMW		2.75 (4.3)	4.5 (5.4)				3.5 (2.9)	3.5 (6.4)	6.75 (13)			4.25 (6.6)	18.75 (19)	3.5 (1.8)	0.25 (0.5)
BPTM														0.25 (0.4)	
CARP		0.25 (0.5)					0.25 (0.5)					0.25 (0.5)			
CNCF			0.25 (0.5)	2 (3.4)	1.75 (1.3)		0.25 (0.5)	1 (2)	4.5 (7.5)	0.75 (1)		1 (0.8)	1 (0.8)	0.25 (0.4)	
CNSN							0.75 (1.5)						0.25 (0.5)		
ERSN			2.25 (2.2)	14.25 (2.7)	13 (8)		8 (9.8)	284.3 (547)	55.5 (84)	21 (25)		3.25 (3.9)	341 (674)	215 (277)	1 (0.8)
FHCF		0.25 (0.5)													
FHMW							0.75 (1.5)								
FWDM		1.75 (2)	2.5 (1.3)	1.5 (1.9)	0.5 (0.6)		13.25 (8.8)	1 (1.4)	0.5 (1)	0.5 (1)		6.25 (5.9)	4.75 (4.3)	0.5 (0.4)	
GDEY								0.5 (1)							

GNSF							0.5 (0.6)	2 (2.4)						0.25 (0.4)	0.25 (0.5)
GZSD		6.5 (12)					2.25 (3.9)	4.25 (5.6)		0.75 (1.5)				0.25 (0.4)	
HBNS															0.25 (0.5)
LESF		0.25 (0.5)													
LNGR														0.25 (0.4)	
MMSN		8 (8.7)	2 (4)		0.5 (1)		0.25 (0.5)	2.5 (5)		1.25 (1.9)					
MQTF		0.25 (0.5)	4.5 (9)	0.25 (0.5)				0.25 (0.5)	2 (3.4)			0.75 (1.5)		1.25 (1.2)	
OSSF			0.75 (1.5)	2.25 (4.5)	0.75 (0.5)			0.5 (0.6)	1.5 (2.4)					0.5 (0.4)	1 (1.4)
RDSN		6.5 (3.7)	4 (6.6)	8.75 (8.5)	53.5 (39)		1 (2)	3.5 (4.7)	22.75 (29)	8.5 (93)		3.5 (2.6)	47 (89)	82.5 (80)	7.5 (14)
RVCS		4.75 (4.3)	3.25 (2.5)	0.25 (0.5)			14.5 (22)	7.75 (14)	1.25 (1)			0.75 (1)	2.25 (1.3)	1.25 (1.4)	0.25 (0.5)
RVSN			1 (1.4)					1 (2)						0.25 (0.4)	
SFCB			2.5 (5)		0.5 (0.6)								0.5 (1)		
SGER												0.25 (0.5)		0.25 (0.4)	
SJHR			0.25 (0.5)												

Appendix G (continued). Segment 13 total CPUE by species for mini-fyke nets (MF), from before (bend 33), control (bend 31) and impact (bend 21) sites

SKCB				0.25 (0.5)	2.75 (2.8)				0.25 (0.5)	2.75 (5.5)			0.25 (0.5)	0.75 (1.2)	
SNGR		2.5 (2.6)	3 (1.6)	1.25 (2.5)	0.25 (0.5)		0.25 (0.5)	2 (2.4)	0.25 (0.5)			0.75 (1)		0.5 (0.5)	
SNSG														(0.5)	
SNSN		2.75 (5.5)		0.75 (1.5)			0.25 (0.5)	1.25 (2.5)	0.75 (1.5)			0.25 (0.5)	0.5 (1)		
SVCB		0.5 (0.6)	0.5 (1)					1.5 (2.4)				0.25 (0.5)	0.5 (1)	0.25 (0.3)	0.25 (0.5)
UCN		0.5 (1)													
UCY															
WTBS		1.25 (1.5)					3 (3.5)	0.5 (0.6)	0.75 (1)			2.75 (4)	0.25 (0.5)	0.5 (0.8)	
WTCP			0.5 (1)	0.75 (1.5)			1.5 (1.7)								
Total		7 (42)	4.5 (1.9)	39.75 (36)	137 (12)		6.25 (64)	328.8 (563)	128.8 (14)	113.8 (121)		27.75 (2)	422.8 (765)	324 (396)	14.25 (16)

Appendix H. Segment 13 total CPUE by species for small mesh 16' otter trawls (OT01), from before (bend 19), control (bend 41) and impact (bend 13) sites.

Segment 13 **Gear OT01**

	Bend 19, Before					Bend 41, Control					Bend 13, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)	N=6	N=14	N=15	N=16	N=15	N=10	N=9	N=7	N=11	N=12	N=17	N=18	N=14	N=27	N=16
BHMW		0.11 (0.15)	1.59 (2.34)	0.84 (1.39)	0.27 (0.32)		0.28 (0.38)	0.12 (0.23)	0.58 (0.12)	0.25 (0.56)		0.29 (0.56)	0.32 (0.65)	0.11 (0.15)	0.18 (0.28)
BLCF	1.29 (1.24)	4.99 (3.55)	4.23 (2.27)	5.32 (3.79)	0.16 (0.32)	0.22 (0.24)	11.11 (16.8)	4.66 (1.68)	0.57 (0.45)	0.23 (0.24)	0.50 (0.46)	0.76 (0.69)	0.36 (0.19)	0.36 (0.26)	0.16 (0.11)
BLGL			0.73 (0.15)	0.28 (0.57)											
BNMW		0.34 (0.56)		0.47 (0.95)			0.11 (0.22)							0.18 (0.35)	0.78 (0.18)
BUSK		0.92 (0.14)	0.26 (0.51)		0.44 (0.89)		0.12 (0.16)			0.25 (0.56)	0.20 (0.39)	0.02 (0.04)	0.36 (0.73)	0.12 (0.25)	
CARP				0.50 (0.1)		0.44 (0.89)									
CNCF	1.30 (0.78)	2.63 (1.3)	2.59 (1.36)	5.58 (2.95)	9.84 (3.45)	0.16 (0.21)	11.37 (19)	2.79 (1.67)	4.17 (4.77)	2.19 (1.25)	1.64 (1.62)	0.41 (0.42)	0.76 (0.57)	0.32 (0.25)	0.14 (0.14)
CNSN		0.24 (0.47)					0.27 (0.35)					0.18 (0.23)			
ERSN	0.53 (0.87)	0.14 (0.21)	2.25 (2.94)	1.86 (2.23)		0.13 (0.18)	1.25 (1.94)	0.14 (0.27)	0.62 (1.14)	0.28 (0.56)	0.32 (0.64)	0.48 (0.89)	0.74 (1.41)	0.41 (0.43)	0.48 (0.62)
FHCF		0.44 (0.6)	0.34 (0.67)	0.59 (0.82)	0.44 (0.93)										
FHMW		0.52 (0.14)									0.32 (0.64)				
FWDM	0.24 (0.49)	5.46 (3.65)	5.20 (3.98)	5.37 (3.78)	0.95 (0.2)	0.29 (0.39)	32.36 (41.3)	1.77 (1.2)	1.24 (1.63)	0.44 (0.68)	0.34 (0.29)	0.84 (1)	0.52 (0.57)	0.56 (0.53)	0.12 (0.17)
GDEY	0.47 (0.64)	2.64 (2.47)	0.73 (0.62)	1.00 (0.13)	0.67 (0.14)	0.24 (0.46)	0.79 (0.73)			0.83 (0.17)		1.62 (0.95)	0.56 (0.77)	0.62 (0.75)	
GZSD					0.44 (0.93)					0.28 (0.56)		0.37 (0.74)			0.29 (0.54)
LNGR		0.24 (0.47)				0.83 (0.17)				0.39 (0.62)		0.43 (0.56)			

MMSN		0.19 (0.18)	0.48 (0.66)									0.29 (0.56)			
NFSH									0.67 (0.81)			0.26 (0.48)		0.12 (0.25)	0.61 (0.98)
PDFH	0.61 (1.23)			0.22 (0.45)		0.63 (0.78)					0.33 (0.34)				
PDSG											0.24 (0.48)				
QLBK														0.25 (0.49)	
RDSN	0.92 (1.33)	1.56 (2.49)	0.44 (0.48)	0.28 (0.24)		0.33 (0.67)	2.16 (3.68)			0.56 (0.11)	0.59 (0.85)	0.18 (0.17)	0.43 (0.86)		0.17 (0.19)
RVCS	0.24 (0.49)	1.36 (1.22)	3.66 (4.23)	0.75 (0.63)	0.44 (0.49)		1.67 (1.9)	0.24 (0.31)			0.39 (0.78)		0.18 (0.14)	0.82 (0.83)	0.33 (0.63)
RVSN		0.78 (0.16)					0.37 (0.75)								
SFCB	1.86 (1.58)	2.26 (1.22)	3.60 (2.54)	0.33 (0.27)	0.67 (0.14)	0.23 (0.28)	1.46 (1.19)	0.24 (0.48)	0.55 (1.45)	0.29 (0.19)	0.12 (0.12)	1.55 (1.87)	0.11 (0.75)	0.39 (0.47)	0.58 (0.49)
SFSN						0.33 (0.67)									
SGCB	0.32 (0.42)	0.12 (0.15)	0.93 (1.43)	1.20 (1.13)	0.68 (0.93)		0.39 (0.78)			0.28 (0.56)	0.24 (0.48)	0.18 (0.39)	0.24 (0.48)	0.27 (0.28)	0.24 (0.22)
SGER	0.56 (0.11)	0.76 (0.11)			0.76 (0.19)							0.49 (0.65)			
SJHR			0.73 (0.15)												
SKCB	3.26 (2.71)	0.96 (0.46)	1.11 (0.77)	3.90 (2.46)	5.35 (2.15)	1.15 (0.98)	1.39 (0.99)	2.43 (3.46)	4.55 (8.87)	5.75 (5.47)	1.37 (0.69)	0.37 (0.26)	0.28 (0.16)	0.52 (0.45)	0.13 (0.11)
SMBF					0.16 (0.22)					0.25 (0.56)					
SMMW		0.22 (0.45)													
SNGR			0.39 (0.78)	0.15 (0.3)			0.53 (0.16)								
SNSG	0.93 (0.65)	0.28 (0.3)	0.16 (0.13)	0.91 (0.95)	1.14 (0.58)	0.38 (0.59)	0.24 (0.33)	0.12 (0.25)	0.19 (0.2)	0.28 (0.27)	0.57 (0.31)	0.16 (0.18)	0.81 (0.13)	0.56 (0.37)	0.72 (0.99)

. Appendix H (continued). Segment 13 total CPUE by species for small mesh 16' otter trawls (OT01), from before (bend 19), control (bend 41) and impact (bend 13) sites

SNSN			0.15 (0.26)	0.83 (0.13)			0.11 (0.22)	0.13 (0.26)			0.85 (0.13)				
STCT		0.25 (0.5)			0.44 (0.93)		0.53 (0.16)							0.16 (0.33)	
SVCB	0.14 (0.19)	0.28 (0.17)	0.65 (0.87)	1.25 (1.53)	1.24 (0.99)		2.75 (1.93)	0.12 (0.25)	0.91 (1.62)	0.32 (0.28)	0.24 (0.48)		0.11 (0.12)	0.13 (0.12)	0.33 (0.38)
SVCP								0.12 (0.25)							
UAC						0.33 (0.67)									
UCF				0.28 (0.57)		2.25 (2.12)	0.28 (0.44)				2.73 (1.19)				
UCY	0.37 (0.61)														
UHY	0.12 (0.24)		0.72 (0.98)	0.18 (0.29)		1.62 (2.2)	0.33 (0.67)		0.52 (1.49)		0.16 (0.16)	0.29 (0.56)		0.32 (0.64)	
UNID												0.29 (0.56)			
USG											0.20 (0.39)				
WTBS		0.27 (0.52)	0.12 (0.17)				0.28 (0.35)								
WTCP							0.11 (0.22)								
YOYF						5.97 (7.86)					1.92 (1.57)				
Total	11.73 (5.48)	22.99 (1.22)	28.29 (13.5)	27.68 (13.7)	19.75 (6.72)	13.48 (11.4)	67.76 (6.4)	12.88 (4.69)	13.44 (16.9)	9.23 (6.83)	8.58 (3.52)	6.97 (4.68)	3.13 (2.93)	1.58 (0.92)	1.37 (1.2)

Appendix I. Segment 13 total CPUE by species for small mesh 16' otter trawls (OT01), from before (bend 33), control (bend 31) and impact (bend 21) sites.

Segment 13 **Gear OT01**

	Bend 33, Before					Bend 31, Control					Bend 21, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)	N=2	N=15	N=13	N=15	N=14		N=13	N=12	N=12	N=15	N=3	N=12	N=14	N=13	N=9
BHCP														0.154 (0.4)	
BHMW		0.292 (0.6)	0.855 (0.2)	13.14 (19)	4.913 (9.5)		0.943 (1.3)	0.274 (0.5)	4.68 (5.8)	2.293 (2.8)	3.333 (6.7)	3.611 (5.7)	5.379 (35)	0.4 (0.5)	
BKSS															0.142 (0.3)
BLCF	2.145 (1.9)	2.286 (1.3)	3.124 (2.8)	1.392 (1)	0.326 (0.2)		17.78 (13)	7.238 (8.2)	1.639 (1.8)	1.162 (1.3)	7.778 (9.7)	2.573 (22)	1.986 (6.8)	2.936 (1.9)	0.136 (0.1)
BLGL			0.143 (0.2)	0.135 (0.2)			0.183 (0.4)		0.225 (0.3)			3.175 (5.5)		0.138 (0.2)	
BNMW			0.326 (0.5)		0.364 (0.6)			0.833 (0.2)					4.183 (2.3)		
BUSK					0.952 (0.2)					0.333 (0.7)					
CARP	1.924 (3.8)														
CLSR			0.546 (0.2)												
CNCF	1.212 (2.4)	0.391 (0.3)	2.362 (1.7)	2.726 (2.9)	1.339 (1.9)		1.655 (1.9)	2.544 (3)	1.853 (1.4)	11.93 (14)		18.45 (14)	1.863 (7.5)	1.194 (1.4)	2.616 (3.7)
CNSN							0.733 (1.5)						(0.1)		
ERSN		0.714 (1.2)		2.158 (3.6)	3.69 (7.4)			0.146 (0.2)	0.377 (0.6)	1.744 (2.2)	1.111 (2.2)		5.234 (3)	0.883 (1.4)	
FHCF									0.587 (0.1)			0.583 (0.9)	(0.2)		0.717 (0.1)
FHMW		0.283 (0.4)													
FWDM		2.597 (3.7)	4.623 (4.9)	1.996 (2)	0.693 (0.9)		6.461 (8.3)	3.274 (5.5)	2.964 (3.2)	1.972 (2.7)		139.2 (174)	1.582 (12)	1.435 (1)	0.62 (1)

GDEY	1.597 (1.7)	0.519 (0.7)			0.473 (0.9)		12.43 (13)	0.278 (0.6)			1.111 (2.2)	5.695 (6.4)	1.625 (2.5)		
GZSD		0.283 (0.4)	0.546 (0.2)									171.9 (338)	0.482 (0.2)		
LKSG		0.283 (0.4)													
LNGR					0.862 (0.1)										
MMSN							0.668 (0.9)			0.133 (0.3)		0.167 (0.3)			
NFSH				0.222 (0.4)	0.571 (0.1)				0.167 (0.3)						
OSSF				0.467 (0.9)											
PDFH	4.298 (6.5)										7.778 (16)				
PDSG										0.267 (0.5)					
RBST										0.216 (0.4)					
RDSN	1.212 (2.4)	0.558 (0.6)		0.955 (1.6)	0.142 (0.3)		0.844 (0.9)	0.192 (0.3)	2.932 (4.4)	0.133 (0.3)	5.556 (8.1)	0.583 (0.9)	(0.2)	1.894 (1.3)	
RVCS		0.144 (0.2)	2.587 (3.2)	0.133 (0.3)	0.118 (0.2)		0.399 (0.5)	0.737 (0.9)	1.143 (1.3)	0.55 (0.7)		11.34 (9.5)	8.839 (6.8)	0.124 (0.2)	
RVSN		0.625 (0.1)		0.267 (0.5)	0.142 (0.3)				0.492 (1)				(0.5)	0.615 (0.1)	
SDBS								0.214 (0.4)							
SFCB	1.597 (1.7)	3.348 (3.2)	0.143 (0.2)	1.557 (1.7)	0.498 (0.5)		16.27 (16)	0.339 (0.3)	0.278 (0.2)	4.911 (5.4)	6.667 (6.7)	4.248 (33)	1.355 (1.9)	0.759 (0.7)	0.394 (0.6)
SGCB		0.392 (0.4)		0.867 (0.1)	0.393 (0.8)		2.258 (2.9)	0.981 (0.1)	0.117 (0.2)	1.834 (1.5)	3.333 (3.8)	3 (3.5)	0.735 (1)	0.486 (0.8)	0.269 (0.4)
SGER	0.667 (1.2)	0.417 (0.8)		0.242 (0.5)			0.375 (0.6)							0.279 (0.6)	
SJHR												0.833 (1.7)	(0.2)		

Appendix I (continued). Segment 13 total CPUE by species for small mesh 16' otter trawls (OT01), from before (bend 33), control (bend 31) and impact (bend 21) sites

SKCB		4.369 (5.8)	4.894 (2.8)	7.427 (9.8)	0.935 (0.9)		12.13 (1.8)	2.715 (2.2)	4.549 (6.1)	25.25 (34)	18.89 (8.9)	8.93 (12)	0.6 (4.1)	2.928 (3.2)	2.447 (1.4)
SMMW					0.473 (0.9)										
SNGR	0.769 (1.5)		0.95 (0.2)	0.242 (0.5)										0.154 (0.4)	
SNSG		0.357 (0.3)	0.734 (0.8)	0.36 (0.4)	0.14 (0.1)		4.372 (3.6)	0.797 (0.7)	0.5 (0.7)	2.189 (2.4)	3.333 (6.7)	1.787 (1.2)	0.781 (0.4)	0.321 (0.3)	0.455 (0.3)
SNSN		0.417 (0.8)	0.726 (0.1)					0.278 (0.6)						0.154 (0.4)	
SVCB		3.272 (4.4)	2.537 (3.4)	0.267 (0.4)	0.454 (0.4)		7.952 (9.2)	0.259 (0.3)	0.574 (0.6)	5.341 (9.4)		9.642 (1.5)	0.699 (9.9)	0.512 (0.5)	1.599 (1.7)
SVCP			0.466 (0.9)												
TTPH												0.397 (0.8)			
UCF							0.214 (0.4)		0.167 (0.3)			0.333 (0.7)	(0.9)		
UCN														0.154 (0.4)	
UHY	1.154 (2.4)	0.331 (0.4)		0.396 (0.7)					0.283 (0.5)	2.366 (4.7)		4.563 (7.9)	(22)	0.242 (0.3)	
USG	0.688 (0.2)										2.222 (4.4)				
WLYE								0.278 (0.6)							
WTBS		0.625 (0.9)	0.95 (0.2)	0.667 (0.1)			0.192 (0.4)					3.981 (5.5)	0.758 (1.7)		
WTCP								0.278 (0.6)	0.333 (0.7)					0.154 (0.4)	
Total	16.92 (6.2)	19.58 (15)	21.93 (13)	33.44 (38)	13.81 (20)		85.65 (46)	18.71 (16)	2.996 (20)	61.98 (72)	61.11 (34)	448.3 (550)	17.56 (75)	13.17 (7.1)	8.211 (6.7)

Appendix J. Segment 13 total CPUE by species for 16' otter trawls (OT16), from before (bend 19), control (bend 41) and impact (bend 13) sites.

Segment 13 **Gear OT16**

	Bend 19, Before					Bend 41, Control					Bend 13, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)	N=7	N=4	N=4	N=4	N=6	N=4	N=3	N=4	N=4	N=4	N=4	N=4	N=4	N=4	N=4
BHMW		3.58 (6.5)	0.51 (0.6)												
BLCF	1.11 (1.3)	3.8 (2.4)	4.51 (5.2)	3.72 (3.4)	0.11 (0.1)	0.15 (0.3)	1.67 (1.7)	0.17 (0.3)	0.35 (0.8)	0.92 (1.6)	0.66 (0.9)	2.12 (3.2)	0.51 (0.8)	0.69 (0.7)	0.12 (0.2)
BNMW															0.28 (0.6)
BUSK	0.79 (0.2)	0.16 (0.2)			0.11 (0.1)		0.19 (0.2)			0.83 (0.2)					
CNCF	0.19 (0.2)	13.6 (21)	3.72 (3)	3.47 (2.4)	1.78 (1.7)	0.83 (0.2)	2.56 (3.9)	0.65 (0.5)	0.57 (0.7)	3.38 (2.4)	0.4 (0.5)		0.45 (0.6)	0.54 (0.7)	0.44 (0.7)
ERSN		3.35 (3.8)	0.4 (0.8)												0.14 (0.3)
FHCF		0.49 (0.5)	0.83 (0.2)		0.11 (0.2)					0.17 (0.2)		0.12 (0.2)			
FWDM		6.21 (7.2)	6.89 (8.9)	1.51 (11)			0.18 (0.4)	0.54 (0.9)	0.12 (0.2)	1.78 (2.8)		0.24 (0.5)	0.26 (0.5)		0.39 (0.8)
GDEY	0.4 (0.8)	6.36 (8.3)	0.57 (0.8)									0.37 (0.7)			
MMSN			0.84 (0.2)												
NFSH	0.13 (0.1)							0.19 (0.4)							
PDFH						0.76 (0.2)					0.71 (0.1)				
RDSN	0.45 (0.9)	7.79 (1.6)				0.83 (0.2)									
RVCS		1 (1.8)	4.39 (5.7)	0.56 (0.7)			0.23 (0.2)						0.91 (0.2)	0.13 (0.3)	0.19 (0.2)
RVSN		0.24 (0.5)													

SFCB	0.48 (1)	8.87 (12)	2.5 (3.9)		0.22 (0.4)	0.46 (0.3)	0.25 (0.5)	0.83 (0.2)	0.17 (0.3)	0.17 (0.2)	0.16 (0.2)	0.42 (0.5)	0.85 (1)		0.28 (0.3)
SGCB			0.78 (1.2)		0.25 (0.2)	0.83 (0.2)								0.11 (0.2)	0.37 (0.4)
SGER							0.18 (0.4)								
SKCB	0.95 (0.2)	0.57 (0.5)	0.64 (1)	0.13 (0.3)	1.67 (1.4)	0.15 (0.2)		0.83 (0.2)	0.17 (0.3)	0.17 (0.2)	0.7 (0.3)	0.83 (0.2)	0.74 (0.1)	0.13 (0.3)	0.39 (0.4)
SNSG	0.26 (0.5)	0.86 (0.2)	0.83 (0.2)	2.73 (2.6)	0.97 (0.6)	0.38 (0.8)	0.9 (1)		0.66 (0.3)	0.83 (0.8)	1.13 (2.3)	0.76 (0.2)	0.25 (0.3)	0.38 (0.5)	0.83 (0.2)
SVCB	0.89 (0.2)	1.38 (1.5)	0.84 (1.7)		0.17 (0.3)	0.76 (0.2)		1.42 (2.2)		0.83 (0.2)	0.15 (0.2)		0.6 (0.8)	0.13 (0.3)	0.83 (0.2)
UCF											0.21 (0.4)				
UHY			0.14 (0.3)	0.12 (0.2)											
WTBS		0.26 (0.5)	0.14 (0.3)												
Total	2.64 (1.4)	56.7 (64)	26.9 (18)	2.55 (12)	5.39 (3.7)	1.55 (0.4)	6.64 (5.6)	3.13 (2.7)	2.38 (1.3)	7.5 (6.6)	3.48 (3.2)	3.42 (4.9)	1.51 (1.8)	0.3 (0.2)	1.37 (2.1)

Appendix K. Segment 13 total CPUE by species for 16' otter trawls (OT16), from before (bend 33), control (bend 31) and impact (bend 21) sites.

Segment 13 **Gear OT16**

	Bend 33, Before					Bend 31, Control					Bend 21, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)	N=7	N=6	N=2	N=2	N=4	N=8	N=4	N=4	N=4	N=4	N=11	N=6	N=4	N=4	N=4
BHMW					0.25 (0.5)				3.3 (6.6)				0.14 (0.3)	0.83 (0.2)	
BLCF	0.69 (0.5)	2.32 (1.5)	0.57 (0.3)	9.87 (1.8)	4.78 (8.2)	6.53 (5.4)	4.34 (3.9)	1.6 (18)	2.48 (2.4)	0.28 (0.6)	1.85 (1.4)	5.87 (5)	15.5 (19)	4.74 (1.4)	9.43 (8.8)
BLGL						0.11 (0.2)			0.8 (1.6)			0.13 (0.3)		0.83 (0.2)	
BNMW					0.75 (1)										
BUSK		0.53 (0.2)				1.24 (1.6)		1 (0.2)		0.28 (0.6)	0.73 (0.1)	0.79 (0.2)			
CARP	0.13 (0.3)										0.19 (0.2)				
CNCF	0.42 (0.8)	0.16 (0.1)		0.59 (1.2)	8.28 (9.8)	9.61 (9.9)	0.31 (0.4)	8.33 (16)	0.42 (0.6)		0.71 (0.7)	1.33 (1.4)	17.5 (15)	0.54 (0.4)	12.8 (15)
FHCF		0.78 (0.2)									0.45 (1)		0.17 (0.3)		
FWDM	0.18 (0.2)	0.22 (0.3)	1.99 (0.5)	8.39 (2.7)	8.28 (12)	0.35 (0.7)	0.94 (0.2)	9.69 (19)	8.16 (15)		0.45 (0.5)	1.34 (5.3)	21.6 (3.7)	1.69 (8.3)	
GDEY		1.26 (1.4)				0.35 (0.7)	0.94 (0.2)	0.18 (0.4)			6.45 (13)	1.96 (3.2)	0.83 (0.2)		
GDFH													0.83 (0.2)		
GZSD			0.29 (0.6)								0.62 (0.7)	0.36 (0.5)	0.33 (0.7)		
LKSG						0.6 (1.2)									
MNEY					0.14 (0.3)										
NFSH	0.48 (1)				0.11 (0.2)					0.14 (0.3)					

PDFH	0.16 (0.2)					0.6 (1.2)					0.11 (0.1)				
PDSG		0.53 (0.2)										0.67 (0.1)			
RVCS			0.56 (1.1)	0.59 (1.2)			0.44 (0.6)	2.44 (4.7)	0.5 (1)		0.34 (0.7)	2.96 (2.2)	2.69 (34)	1.32 (1.6)	
SFCB		1.54 (1.3)			1 (1.2)	3.85 (5.4)	0.47 (0.9)	0.55 (0.9)	0.1 (0.2)	1.11 (2.2)	0.26 (0.2)	3.94 (4.8)	2.36 (2.8)		12.2 (2.2)
SGCB		0.78 (0.2)				0.54 (1.9)	0.31 (0.6)				0.52 (0.1)	0.79 (0.2)	0.33 (0.5)		1.25 (2.5)
SGER										0.25 (0.5)					
SKCB		0.33 (0.6)	0.57 (0.3)		2.5 (4.4)		0.19 (0.4)	2.88 (5.4)		0.28 (0.6)	0.18 (0.1)	1.11 (2.2)	0.14 (0.3)		11.2 (1.5)
SMBF										0.28 (0.6)					
SNGR				0.28 (0.6)					0.1 (0.2)					0.19 (0.4)	
SNSG	0.96 (0.8)	0.48 (0.6)			0.42 (0.8)	8.15 (5.4)	0.85 (1.7)	3.54 (4.2)	0.33 (0.5)	1.62 (2.7)	0.46 (0.4)	0.19 (0.2)	0.39 (0.5)		8.35 (12)
STCT							0.94 (0.2)								
SVCB					2.5 (4.4)			0.96 (1.8)				0.93 (1.7)	0.36 (0.5)	0.14 (0.3)	12.6 (14)
UCF		0.53 (0.2)							0.1 (0.2)				1.25 (2.5)		
UHY									8.5 (17)		0.18 (0.4)				
WLYE								0.36 (0.7)							
WTBS												0.13 (0.2)			
WTCP									0.2 (0.4)						
Total	2.58 (1.9)	5.52 (2.3)	3.98 (0.9)	19.4 (15)	29 (3.2)	31.8 (23)	7.19 (7.4)	39.5 (68)	25 (42)	4.23 (6.8)	1.42 (13)	27.8 (15)	8.92 (45)	17.8 (9.6)	67.2 (62)

Appendix L. Segment 13 total CPUE by species for push trawls (POT02), from before (bend 19), control (bend 41) and impact (bend 13) sites.

Segment 13 **Gear POT02**

	Bend 19, Before					Bend 41, Control					Bend 13, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)	N=15	N=16	N=15	N=14	N=10	N=16	N=15	N=14	N=12	N=15	N=22	N=19	N=15	N=15	N=15
BHMW		0.36 (0.7)	4.72 (2.2)	1.71 (1.2)	2.71 (2)	0.14 (0.3)	0.99 (0.2)	3.98 (3.9)	13.98 (12)	5.52 (4.1)	0.17 (0.1)	0.37 (0.4)	6.84 (5.9)	3.68 (1.9)	4.90 (3.7)
BLCF			0.98 (0.2)	0.40 (0.5)	0.13 (0.3)						0.57 (0.1)		0.16 (0.2)	0.18 (0.3)	
BLGL			0.24 (0.4)	0.90 (0.1)	0.13 (0.2)								0.20 (0.3)	0.46 (0.5)	0.39 (0.8)
BNMW	0.27 (0.5)	0.43 (0.5)	0.14 (0.3)	0.12 (0.2)	0.64 (0.8)			0.47 (0.5)	0.24 (0.5)	0.18 (0.4)		0.47 (0.7)	0.27 (0.3)	0.28 (0.4)	0.60 (1.6)
CARP		0.32 (0.5)				0.13 (0.3)	0.17 (0.3)				0.23 (0.3)	0.42 (0.8)			
CNCF	0.33 (0.3)	0.49 (0.6)	2.35 (1.5)	0.53 (0.4)	1.67 (1.4)	0.26 (0.2)	0.39 (0.4)	0.45 (0.6)	2.63 (1.7)	0.99 (0.9)	0.23 (0.2)	0.19 (0.2)	0.15 (0.1)	0.35 (0.1)	0.69 (0.6)
CNSN		0.16 (0.3)					0.17 (0.3)					0.15 (0.2)			
ERSN		0.35 (0.5)	0.29 (0.2)	0.58 (0.8)	0.74 (0.8)	0.86 (0.8)	0.17 (0.3)	0.36 (0.4)	0.53 (0.5)	1.31 (0.9)	0.17 (0.3)	0.63 (0.9)	1.88 (2.9)	1.12 (0.7)	5.62 (2.6)
FHCF					0.33 (0.6)						0.56 (0.1)		0.12 (0.2)		
FHMW		0.78 (0.2)									0.15 (0.3)				
FWDM	0.52 (0.4)	0.40 (0.3)	1.99 (1.3)	0.85 (0.9)	0.66 (0.6)	15.85 (12)	1.27 (0.8)	0.26 (0.2)	0.63 (0.5)	0.43 (0.4)	0.86 (1.3)	4.72 (3.7)	0.52 (0.5)	0.17 (0.2)	0.16 (0.2)
GDEY	0.92 (0.1)	0.11 (0.2)				0.14 (0.3)					0.18 (0.1)	0.22 (0.3)			
GZSD		0.28 (0.4)				0.84 (1.7)		0.29 (0.6)		0.34 (0.7)		0.36 (0.7)	0.63 (0.1)		0.19 (0.9)
LMBS		0.11 (0.2)										0.42 (0.8)	0.16 (0.3)		
LNGR															
MMSN		0.18					0.43		0.28		0.32				

		(0.4)					(0.9)		(0.4)		(0.4)				
MQTF									0.24 (0.5)						
NFSH			0.18 (0.4)		0.63 (0.1)			0.18 (0.4)							0.13 (0.3)
OSSF	0.53 (0.2)					0.50 (0.1)	0.27 (0.4)		0.42 (0.8)			0.22 (0.4)	0.16 (0.3)	0.17 (0.1)	0.47 (0.9)
OTDR									0.19 (0.3)	0.72 (0.1)					
PDFH											0.13 (0.3)				
RBST									0.73 (1)						
RDSN	0.19 (0.1)	0.54 (0.4)	0.39 (0.8)	0.20 (0.3)	1.58 (1.6)	0.16 (0.1)	0.11 (0.2)	0.48 (0.6)	3.98 (7)	1.63 (1.2)	0.19 (0.2)	0.32 (0.4)	0.48 (0.6)		4.95 (5.9)
RVCS		0.98 (0.1)	2.64 (2)	0.27 (0.5)	0.26 (0.2)	0.14 (0.3)	0.24 (0.3)	0.14 (0.2)	0.11 (0.1)	0.78 (0.1)	0.12 (0.1)	1.30 (1.5)	1.74 (1.8)	0.30 (0.5)	0.16 (0.2)
RVSN									0.18 (0.1)	0.91 (0.2)					
SFCB		0.43 (0.5)	0.37 (0.3)	0.18 (0.3)	0.18 (0.3)	0.13 (0.3)	1.36 (1.6)		0.68 (0.8)	0.36 (0.6)	0.71 (0.6)	0.47 (0.5)	0.14 (0.1)	0.14 (0.2)	
SGCB	0.27 (0.5)			0.39 (0.5)					0.15 (0.3)						
SGER		0.11 (0.2)									0.57 (0.6)				
SHDR						0.89 (0.2)									
SJHR												0.18 (0.4)			
SKCB	0.37 (0.4)	0.26 (0.3)	1.15 (1.2)	0.62 (0.7)	1.82 (2)	0.17 (0.2)	0.68 (0.5)	0.29 (0.4)	6.19 (4.6)	1.17 (1.1)	0.39 (0.2)	0.75 (0.6)	0.29 (0.6)	0.47 (0.4)	0.65 (0.7)
SMMW									0.72 (0.1)						
SNGR		0.25 (0.5)	0.16 (0.3)										0.19 (0.4)		

Appendix L. (continued). Segment 13 total CPUE by species for push trawls (POT02), from before (bend 19), control (bend 41) and impact (bend 13) sites

SNSG	0.13 (0.2)	0.54 (0.2)		0.32 (0.4)	0.20 (0.4)	0.26 (0.4)					0.12 (0.1)				
SNSN		0.42 (0.8)	0.34 (0.5)				0.14 (0.3)		0.56 (0.1)	0.72 (0.1)	0.20 (0.3)		0.71 (0.1)	0.16 (0.3)	
SVCB		0.27 (0.1)	1.98 (1.3)	0.11 (0.1)	0.24 (0.2)	0.25 (0.5)	0.31 (0.3)	0.26 (0.3)	0.43 (0.5)	0.25 (0.2)	0.11 (0.2)	1.26 (0.7)	0.17 (0.1)	0.58 (0.1)	0.13 (0.2)
SVCP												0.19 (0.3)			
UAC	0.32 (0.6)					2.64 (5.3)									
UCF	0.80 (0.2)					0.92 (0.1)					1.57 (0.9)				
UCN				0.87 (0.1)											
UCY				0.18 (0.1)											
UHY	0.55 (0.3)	0.14 (0.9)	0.19 (0.3)	0.14 (0.3)	0.63 (0.1)	4.77 (2.9)	0.72 (0.8)	0.57 (0.4)	2.79 (4)		3.86 (3.9)	0.77 (0.6)			0.17 (0.2)
USG	0.67 (0.2)														
WTBS	0.27 (0.5)	0.68 (0.5)	0.71 (1)				0.17 (0.2)	0.29 (0.4)				0.41 (0.3)	1.53 (2.9)		
WTCP			0.22 (0.4)			0.39 (0.6)		0.16 (0.3)			0.11 (0.2)				
YOYF	0.67 (1)					0.33 (0.3)					15.37 (14)				
Total	1.82 (0.8)	1.68 (0.5)	16.13 (5.6)	4.62 (2.7)	9.65 (6.2)	25.32 (17)	4.84 (2.7)	7.28 (3.4)	31.82 (18)	12.27 (7.1)	23.15 (17)	1.88 (6)	13.70 (9.3)	6.33 (2.2)	17.96 (9.7)

Appendix M. Segment 13 total CPUE by species for push trawls (POT02), from before (bend 33), control (bend 31) and impact (bend 21) sites.

Segment 13 **Gear POT02**

	Bend 33, Before					Bend 31, Control					Bend 21, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)	N=8	N=15	N=14	N=16	N=10	N=6	N=12	N=15	N=11	N=11	N=13	N=14	N=13	N=9	N=14
BHCP												0.325 (0.6)			
BHMW		0.648 (0.9)	16.65 (15)	12.16 (6.5)	6.246 (6.6)	0.111 (0.2)	0.268 (0.3)	7.942 (5.2)	1.917 (1.6)	0.544 (0.7)		0.286 (0.6)	3.194 (4.6)	1.444 (2.8)	2.669 (2.7)
BLCF		0.25 (0.5)	0.189 (0.3)	0.463 (0.5)				0.154 (0.1)			0.214 (0.4)			0.214 (0.2)	
BLGL	0.417 (0.8)	0.251 (0.4)	0.179 (0.4)	0.192 (0.4)		0.556 (0.1)	0.587 (0.1)	0.184 (0.4)	0.86 (0.9)	0.535 (0.2)				0.714 (2.5)	0.357 (0.7)
BNMW		0.251 (0.4)	0.474 (0.8)		0.654 (1.2)		0.24 (0.4)			0.138 (0.2)	0.142 (0.2)		1.67 (3.7)	2.456 (1.7)	0.143 (0.3)
BSDR							0.556 (0.1)								
CARP						0.556 (0.1)					0.659 (0.1)				
CNCF	0.125 (0.1)	0.312 (0.4)	1.544 (1.3)	1.794 (1.1)	0.348 (0.4)	0.178 (0.3)	0.253 (0.6)	0.23 (0.3)	0.646 (0.7)	0.227 (0.3)	0.763 (0.1)	0.258 (0.2)	0.699 (0.9)	(0.2)	0.195 (0.2)
CNSN		0.256 (0.5)													
ERSN		0.296 (0.6)	1.184 (1.2)	1.778 (1.8)	2.395 (2.2)	0.267 (0.3)		0.125 (1)	0.231 (0.4)	0.466 (0.6)		0.341 (0.7)	0.374 (0.5)	1.5 (1.3)	1.169 (1.9)
FHCF				0.156 (0.3)											
FHMW												0.714 (1)			
FWDM	23.51 (14)	2.598 (2.6)	0.475 (0.5)	0.589 (0.4)	0.5 (0.1)	3.184 (2.4)	1.455 (1.6)	0.663 (0.8)	0.828 (0.8)	0.213 (0.3)	16.69 (14)	0.977 (0.4)	0.249 (0.3)	0.455 (0.3)	0.183 (0.3)
GDEY	0.368 (0.3)	0.353 (0.4)	0.357 (0.7)			0.533 (0.8)					0.366 (0.5)	0.565 (0.4)			
GNSF		0.286 (0.6)					0.442 (0.6)								
GZSD		0.444	0.286		0.286		0.126	0.148		0.33	0.14	0.464	0.162		0.143

		(0.9)	(0.6)		(0.6)		(0.3)	(0.3)		(0.6)	(0.3)	(0.5)	(0.2)		(0.3)
JYDR	0.833 (0.2)						0.556 (0.1)				0.593 (0.5)	0.341 (0.7)			
LMBS											0.699 (0.1)	0.286 (0.6)			
LNGR											0.22 (0.4)				
MMSN	0.417 (0.8)	0.337 (0.5)	0.218 (0.3)	0.283 (0.3)						0.519 (0.1)		0.246 (0.3)	0.377 (0.6)		
MQTF				0.962 (0.2)					0.333 (0.7)						
NFSH		0.17 (0.2)													
OSSF	0.119 (0.2)			0.434 (0.6)				0.267 (0.5)	0.195 (0.4)	0.233 (0.5)	0.344 (0.5)	0.524 (0.7)		0.125 (0.1)	
RBST				0.962 (0.2)											
RDSN	0.399 (0.8)	0.365 (0.4)	1.247 (2.6)	2.774 (2.4)	7.146 (7.5)	0.448 (0.5)		0.843 (1.7)	0.137 (0.3)	0.126 (0.2)	0.675 (0.7)	0.241 (0.2)	0.976 (0.1)	0.395 (0.2)	0.328 (0.2)
RVCS	0.5 (0.5)	0.24 (0.4)	1.472 (1.6)	0.773 (0.1)		0.197 (0.4)	0.38 (0.5)	0.317 (0.3)	0.698 (0.9)		0.12 (0.2)	0.282 (0.3)	0.246 (0.2)	0.125 (0.1)	0.193 (0.4)
RVSN		0.126 (0.3)	0.194 (0.4)		0.286 (0.6)			0.533 (0.2)							
SFCB	0.417 (0.8)	0.272 (0.2)	0.472 (0.5)	0.829 (0.8)	0.434 (0.6)		0.115 (0.2)	0.387 (0.7)	0.333 (0.7)	0.345 (0.4)		0.146 (0.2)	3.113 (5.8)		0.429 (0.6)
SGCB		0.625 (0.1)			0.833 (0.2)					0.182 (0.4)					
SGER	0.833 (0.2)			0.125 (0.3)		0.144 (0.3)					0.256 (0.5)	0.341 (0.7)	0.712 (0.1)		
SJHR		0.13 (0.3)													
SKCB	0.324 (0.5)	0.814 (1.3)	0.875 (1.2)	4.573 (2.8)	4.857 (4.4)		0.134 (0.2)	0.188 (0.2)	0.82 (0.2)	1.463 (1.6)	0.18 (0.4)	0.463 (0.2)	1.433 (2.3)	0.397 (0.4)	0.439 (0.6)
SMBF				0.25 (0.5)											

Appendix M (continued).. Segment 13 total CPUE by species for push trawls (POT02), from before (bend 33), control (bend 31) and impact (bend 21) sites

SMMW										0.267 (0.5)					
SNGR											0.874 (0.2)	0.529 (0.2)			
SNSG		0.222 (0.4)		0.417 (0.8)										0.714 (0.6)	0.248 (0.5)
SNSN		0.444 (0.9)	0.126 (0.2)	0.142 (0.3)	0.286 (0.6)				0.333 (0.7)						
SVCB	0.424 (0.8)	2.463 (2.4)	0.399 (0.2)	0.14 (0.1)	0.188 (0.1)	0.143 (0.2)	0.652 (0.8)	0.22 (0.4)	0.643 (0.9)	0.184 (0.2)	0.243 (0.5)	0.958 (0.8)	0.874 (0.1)	0.556 (0.6)	0.178 (0.3)
SVCP			0.357 (0.7)									0.357 (0.7)			
TTPH												0.277 (0.6)			
UAC						0.722 (0.1)					0.111 (0.2)				
UCF		0.167 (0.3)					0.958 (0.2)								
UCN	0.417 (0.8)	0.154 (0.4)							0.828 (0.1)		0.142 (0.2)				
UHY	14.85 (13)	0.551 (1)	1.434 (2)	1.425 (1.3)		1.576 (0.9)	3.349 (2.3)	0.167 (0.2)		0.141 (0.2)	5.185 (3.7)	0.28 (0.2)	0.493 (0.9)	(1.3)	0.462 (0.6)
WTBS	0.417 (0.7)	0.424 (0.7)	0.115 (0.1)			0.337 (0.3)	0.339 (0.2)	0.293 (0.5)	0.395 (0.8)			0.255 (0.2)	0.867 (0.1)		
WTCP	0.283 (0.3)		0.376 (0.8)	0.156 (0.3)	0.25 (0.5)	0.222 (0.4)		0.133 (0.3)			0.256 (0.5)				
Total	41.55 (24)	8.584 (6.6)	26.95 (16)	25.14 (8)	2.787 (17)	5.322 (2.7)	6.313 (4.6)	1.631 (5.9)	2.654 (1.5)	2.66 (2.8)	23.82 (16)	2.462 (0.7)	11.93 (8.3)	7.736 (6)	5.289 (3.2)

Appendix N. Segment 13 total CPUE by species for trammel nets (TN), from before (bend 19), control (bend 41) and impact (bend 13) sites.

Segment 13 **Gear TN**

	Bend 19, Before					Bend 41, Control					Bend 13, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)		N=4	N=4	N=4	N=5		N=4	N=4	N=4	N=4		N=4	N=4	N=4	N=4
BHCP		0.13 (0.3)													
BLCF		0.68 (0.7)		1.39 (2.2)	0.84 (0.1)				0.18 (0.2)				0.15 (0.3)	(0.8) (0.2)	0.1 (0.2)
BUSK		0.22 (0.4)		1.13 (1.5)			0.16 (0.3)			0.34 (0.4)					
CNCF		0.19 (0.2)								0.24 (0.3)					
GDEY										0.28 (0.3)					
GSCP					0.67 (0.1)										
GZSD								0.83 (0.2)							
LNGR				0.19 (0.2)						0.25 (0.5)					
NFSH			0.39 (0.1)	0.76 (0.1)	0.13 (0.2)		0.37 (0.5)	0.24 (0.3)	0.29 (0.4)			0.31 (0.2)	0.42 (0.4)	0.2 (0.2)	0.45 (0.4)
RVCS										0.25 (0.5)					
SGER		0.19 (0.2)								0.13 (0.3)					
SMBF		0.14 (0.3)			0.13 (0.2)				0.12 (0.2)						
SNGR										0.25 (0.5)					
SNSG		0.19 (0.2)		1.87 (2.5)	0.89 (0.8)		1.26 (1.5)	0.25 (0.3)		1.37 (1.6)		0.33 (0.7)	0.29 (0.6)	0.25 (0.3)	
SVCP										0.23 (0.5)					
Total		1.58	0.39	4.57	1.31		1.79	0.58	0.52	3.28		0.65	0.86	0.53	0.55

		(0.7)	(0.1)	(4.3)	(0.6)		(1.3)	(0.3)	(0.2)	(3)		(0.5)	(0.6)	(0.3)	(0.3)

Appendix O. Segment 13 total CPUE by species for trammel nets (TN), from before (bend 33), control (bend 31) and impact (bend 21) sites.

Segment 13 **Gear TN**

	Bend 33, Before					Bend 31, Control					Bend 21, Impact				
Species	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.	June	July	Aug.	Sept.	Oct.
(2 SE)		N=6	N=4	N=4	N=4		N=4	N=4	N=4	N=4		N=4	N=4	N=4	N=4
BLCF		0.177 (0.2)		0.47 (0.6)	0.425 (0.5)				1.667 (3.3)	0.125 (0.3)		1.542 (2.5)	0.1 (0.2)	1.231 (1.6)	0.179 (0.4)
BUSK		0.258 (0.4)					7.5 (15)		0.662 (0.8)						
CNCF				0.111 (0.2)					0.833 (1.7)			0.417 (0.6)			
LNGR				0.111 (0.2)	0.463 (0.9)		1.25 (2.5)							0.283 (0.3)	
NFSH		0.137 (0.1)	0.987 (0.4)	0.496 (0.6)			0.163 (0.3)	1.117 (0.8)		0.247 (0.3)			0.292 (0.2)		0.433 (0.3)
PDSG		0.595 (0.1)													
QLBK							0.883 (1.6)		0.833 (1.7)						
RVCS				0.111 (0.2)											
SGER												0.125 (0.3)			
SMBF				0.222 (0.4)	0.194 (0.4)		1.25 (2.5)		0.278 (0.6)						
SNGR														0.833 (0.2)	
SNSG		1.412 (2.2)		5.887 (8.6)	1.594 (1.4)		14.58 (27)		5.855 (3.9)	0.263 (0.5)		1.25 (1.5)		1.292 (2.1)	
Total		1.958 (2.5)	0.987 (0.4)	7.345 (9.4)	2.591 (2.2)		25.63 (46)	1.117 (0.8)	1.128 (9.2)	0.635 (0.3)		3.333 (2.6)	0.392 (0.4)	2.786 (3.9)	0.611 (0.1)

Appendix P. List of all bends used in the selection of HAMP sample bends in the BACI design as provided by the COE.

Table 1: SWH by Bend (see color key at bottom)

Bend Data					Dike Notches					Revetment Notches									
Bend	DS RM	US RM	Length	r_c (mi)	< 50	50-75	75-100	100 +	total	< 50	50-75	75-100	100 +	total	Bank Notches	Pilot Channels	Chutes	Total All	
1	0.0	3.8	3.8	1.4	2	2	0	0	4	0	0	0	0	0	0	0	0	4	
2	3.8	6.1	2.3	1.2	1	0	0	0	1	0	0	0	0	0	0	0	0	1	
3	6.1	9.4	3.3	6	3	1	1	0	5	0	0	0	0	0	0	0	0	5	
4	9.4	10.7	1.3	1.5	0	2	0	0	2	0	0	0	0	0	0	0	0	2	
5	10.7	16.9	6.2	1.6/2.3/1.2/2.2	1	8	0	0	9	0	1	0	0	1	0	0	0	10	
6	16.9	21.9	5.0	1.9/S/1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	21.9	25.4	3.5	2.7/1.2	3	6	0	0	9	2	0	0	0	2	0	0	0	11	
8	25.4	26.5	1.1	1.7	0	1	1	0	2	0	0	0	0	0	0	0	0	2	
9	26.5	28.4	1.9	2.3	0	1	0	0	1	0	0	2	0	2	0	0	0	3	
10	**28.4**	**31.8**	**3.4**	**2.7**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**1**
11	31.8	34.0	2.2	3.5/0.6	1	0	0	0	1	0	2	0	0	2	0	0	0	3	
12	34.0	37.8	3.8	2.7/1.8/0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	37.8	39.0	1.2	1.8	0	2	0	0	2	0	0	0	0	0	0	0	0	2	
14	39.0	40.9	1.9	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15	40.9	44.0	3.1	1.3/3	0	3	1	0	4	0	0	0	0	0	0	0	0	4	
16	44.0	45.4	1.4	2.3	4	1	5	1	11	0	0	0	0	0	0	0	0	11	
17	45.4	48.6	3.2	2.5	0	5	4	8	17	0	4	0	0	4	0	0	0	21	1
18	48.6	49.8	1.2	1.6	0	0	3	0	3	0	0	0	0	0	0	0	0	3	
19	49.8	51.2	1.4	1.4	0	0	2	0	2	0	2	0	0	2	0	0	0	4	
20	51.2	54.4	3.2	2	3	0	0	0	3	0	0	0	0	0	0	0	0	3	
21	54.4	56.6	2.2	2.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22	**56.6**	**59.1**	**2.5**	**2.5**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**
23	59.1	60.6	1.5	2.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
24	60.6	65.3	4.7	2.8	1	0	0	0	1	0	0	0	0	0	0	0	0	1	
25	65.3	67.0	1.7	2.3	0	2	0	0	2	0	1	0	0	1	0	0	0	3	
26	**67.0**	**69.8**	**2.8**	**2.8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
27	69.8	75.0	5.2	2.4	1	0	0	0	1	0	0	0	0	0	0	0	0	1	

28	75.0	77.2	2.2	3.5/0.9	1	0	0	0	1	0	0	0	0	0	0	0	0	1	
29	77.2	78.3	1.1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
30	78.3	79.9	1.6	6.1	2	0	0	0	2	0	0	0	0	0	0	0	0	2	
31	79.9	81.3	1.4	3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
32	81.3	82.9	1.6	1.9/0.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
33	82.9	85.5	2.6	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
34	85.5	87.0	1.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
35	87.0	88.0	1.0	2.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
36	**88.0**	**89.8**	**1.8**	**4.3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
37	**89.8**	**92.0**	**2.2**	**S/0.9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
38	92.0	94.3	2.3	1.3	0	0	0	0	0	0	0	2	0	2	0	0	0	2	
39	94.3	96.0	1.7	2.5	5	0	0	0	5	0	0	0	0	0	0	0	0	5	
40	96.0	97.2	1.2	S	1	0	0	0	1	0	0	0	0	0	0	0	0	1	
41	**97.2**	**98.2**	**1.0**	**1.8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
42	**98.2**	**100.5**	**2.3**	**S**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**
43	100.5	103.7	3.2	7.9/S	11	1	1	0	13	0	0	0	0	0	0	0	0	13	2
44	103.7	105.2	1.5	0.8	1	0	0	0	1	0	0	0	0	0	0	0	0	1	
45	105.2	106.6	1.4	1.8	0	0	0	0	0	1	0	0	0	1	0	0	0	1	
46	106.6	108.2	1.6	1.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
47	108.2	110.5	2.3	2.2/1.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
48	110.5	112.3	1.8	2.1	2	0	0	0	2	0	0	0	0	0	0	0	0	2	
49	112.3	115.9	3.6	1.5/3.6	0	0	0	0	0	0	4	2	6	12	0	0	0	12	3
50	115.9	119.1	3.2	1.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
51	119.1	121.3	2.2	3.1/1.7	0	2	0	0	2	0	0	0	0	0	0	0	0	2	
52	121.3	122.5	1.2	2	0	1	0	0	1	2	0	0	0	2	0	0	0	3	
53	**122.5**	**125.2**	**2.7**	**2.5**	**1**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**3**
54	125.2	127.3	2.1	1.8	5	5	0	2	12	0	0	0	0	0	0	0	0	12	
55	127.3	128.7	1.4	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
56	128.7	130.3	1.6	2.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
57	130.3	132.8	2.5	2.6	7	4	4	3	18	0	0	0	0	0	4	0	0	22	4
58	132.8	135.0	2.2	S/1.3	1	1	1	0	3	0	0	3	0	3	1	0	1	8	4
59	135.0	136.2	1.2	2/S	3	0	3	0	6	0	0	0	0	0	0	0	0	6	

60	136.2	137.6	1.4	1.6	2	0	1	0	3	0	0	1	0	1	0	0	0	4	
61	137.6	139.3	1.7	4.1	2	2	0	0	4	0	0	0	0	0	0	0	0	4	
62	139.3	142.5	3.2	5.5	3	1	0	0	4	0	0	0	0	0	0	0	0	4	
63	142.5	144.2	1.7	4.7	3	5	2	0	10	0	0	2	0	2	0	0	0	12	
64	144.2	146.3	2.1	4.7/0.4	3	2	0	0	5	0	2	0	0	2	0	0	0	7	
65	**146.3**	**149.7**	**3.4**	**1.9/0.6**	**4**	**0**	**0**	**0**	**4**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**5**	**6**
66	149.7	151.9	2.2	2.3	2	0	0	0	2	0	1	0	0	1	0	0	0	3	
67	151.9	155.4	3.5	2.8	5	3	2	0	10	1	0	0	0	1	0	0	0	11	
68	155.4	159.1	3.7	6.4/0.7	8	2	0	1	11	1	1	3	0	5	0	0	0	16	
69	159.1	162.4	3.3	0.9/S/1.2	5	1	4	0	10	0	0	0	0	0	9	0	0	19	5
70	162.4	167.2	4.8	2/0.6	4	6	10	1	21	0	0	6	0	6	0	0	0	27	
71	167.2	171.2	4.0	1.9/0.8	7	0	1	0	8	0	0	2	0	2	0	0	0	10	
72	171.2	174.6	3.4	1.9	4	0	11	3	18	0	2	0	0	2	6	0	0	26	6
73	174.6	176.8	2.2	2.9	5	4	0	1	10	1	2	0	0	3	5	0	0	18	
74	176.8	178.5	1.7	1	3	5	0	0	8	0	1	0	0	1	1	0	0	10	
75	**178.5**	**180.5**	**2.0**	**0.9**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**5**
76	180.5	181.8	1.3	2.4	2	0	0	0	2	2	1	0	0	3	0	0	0	5	
77	181.8	183.5	1.7	2.3	7	0	1	0	8	1	0	0	0	1	0	0	0	9	
78	183.5	185.0	1.5	2.5	2	3	0	0	5	1	1	0	0	2	0	0	0	7	
79	185.0	187.2	2.2	1.9/0.8	4	1	1	1	7	0	1	0	0	1	0	2	1	11	
80	187.2	189.4	2.2	2.2	3	2	2	0	7	2	0	0	0	2	2	0	1	12	
81	189.4	192.2	2.8	5.1	7	5	2	0	14	0	0	0	0	0	0	0	0	14	
82	192.2	194.0	1.8	4	1	3	3	0	7	0	0	0	0	0	3	0	0	10	
83	194.0	197.3	3.3	2.6	6	8	4	0	18	0	0	1	0	1	0	1	6	26	
84	**197.3**	**199.9**	**2.6**	**2.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**
85	**199.9**	**201.4**	**1.5**	**3**	**2**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**4**
86	201.4	203.8	2.4	2	0	0	0	0	0	1	0	0	0	1	0	0	0	1	
87	203.8	205.6	1.8	2.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
88	205.6	207.2	1.6	1.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
89	207.2	209.3	2.1	2	2	0	0	0	2	1	0	1	0	2	0	0	0	4	
90	209.3	211.1	1.8	3.1/0.6	3	2	0	0	5	1	0	3	0	4	0	0	0	9	
91	211.1	214.0	2.9	1.5/0.5/0.4	1	2	1	0	4	0	0	0	0	0	0	0	0	4	
92	214.0	217.6	3.6	1.9/0.8/2.3/0.5	0	1	2	0	3	3	1	2	0	6	0	0	0	9	

93	217.6	220.0	2.4	1.6	0	0	0	0	0	4	0	0	0	4	0	0	2	6	
94	**220.0**	**222.5**	**2.5**	**1.8**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**6**
95	222.5	228.3	5.8	4.6/0.6	10	0	0	0	10	1	0	0	0	1	0	0	0	11	
96	228.3	232.5	4.2	S/1.3/0.7	2	1	0	0	3	0	0	2	0	2	0	0	0	5	
97	232.5	234.5	2.0	1	2	1	0	0	3	0	0	0	0	0	0	0	0	3	
98	234.5	237.3	2.8	1.9/0.7	4	4	0	0	8	0	0	0	0	0	0	0	0	8	
99	**237.3**	**239.5**	**2.2**	**0.9**	**2**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	3	**5**
100	239.5	246.3	6.8	S/3.8/1.6	20	0	0	0	20	0	0	2	0	2	0	0	0	22	
101	246.3	250.5	4.2	S/1.7/0.9	3	1	0	0	4	0	0	0	0	0	0	0	0	4	
102	250.5	253.2	2.7	1.4	1	0	0	0	1	2	1	0	0	3	0	0	0	4	
103	253.2	257.3	4.1	2.9/1.2/0.6	6	0	0	0	6	0	0	0	0	0	0	0	0	6	
104	257.3	260.2	2.9	1.3	8	2	0	0	10	0	0	0	0	0	0	0	0	10	
105	260.2	261.7	1.5	1.7	0	0	0	0	0	3	0	0	0	3	0	0	0	3	
106	261.7	263.5	1.8	1.3	6	0	1	0	7	0	0	1	0	1	0	0	0	8	
107	263.5	265.3	1.8	1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
108	265.3	267.1	1.8	1.4	4	0	0	0	4	0	0	0	0	0	0	0	0	4	
109	267.1	271.7	4.6	S/1.5	13	2	1	0	16	0	0	0	0	0	5	0	0	21	
110	271.7	274.0	2.3	1.2	0	1	1	0	2	0	0	0	0	0	0	0	0	2	
111	274.0	275.5	1.5	2.7	1	0	0	0	1	0	0	0	0	0	0	0	0	1	
112	275.5	280.0	4.5	2.1/0.9	2	1	0	0	3	6	0	0	0	6	0	0	0	9	
113	280.0	282.4	2.4	0.8	2	1	0	0	3	8	3	0	0	11	0	0	0	14	
114	282.4	284.6	2.2	1.6/0.6	1	0	0	0	1	0	0	0	0	0	0	0	0	1	
115	284.6	289.6	5.0	1/2.2	10	1	0	0	11	0	0	0	0	0	0	0	0	11	
116	289.6	296.4	6.8	S/1.3/4.7/0.7	10	0	0	0	10	0	0	0	0	0	0	0	0	10	
117	296.4	299.4	3.0	1.2	1	0	0	0	1	0	0	0	0	0	5	0	0	6	
118	299.4	301.3	1.9	2.8	1	0	0	0	1	2	0	3	1	6	3	0	0	10	
119	**301.3**	**304.4**	**3.1**	**1.7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	**6**
120	304.4	307.1	2.7	1.4	2	0	0	0	2	1	0	0	0	1	0	0	0	3	
121	307.1	309.2	2.1	2	5	0	0	0	5	0	0	0	0	0	0	0	0	5	
122	309.2	311.2	2.0	1.4	3	0	0	0	3	1	0	0	0	1	0	0	0	4	
123	311.2	318.0	6.8	3.2/7.5	6	0	0	0	6	4	0	0	0	4	0	0	0	10	
124	318.0	319.6	1.6	2.1	2	1	0	0	3	0	0	0	0	0	0	0	0	3	
125	319.6	321.1	1.5	1.8	0	0	0	0	0	1	0	0	0	1	0	0	0	1	

126	321.1	323.7	2.6	1.1	2	1	0	0	3	1	0	0	0	1	0	0	0	4
127	323.7	327.1	3.4	1.3	2	0	0	0	2	1	0	0	0	1	0	0	0	3
128	327.1	332.3	5.2	2.6	2	0	0	0	2	0	0	0	0	0	0	0	0	2
129	332.3	335.3	3.0	1.8	6	1	0	0	7	3	0	0	0	3	0	0	0	10
130	335.3	337.0	1.7	4.8/0.5	6	0	0	0	6	0	0	0	0	0	0	0	0	6
131	337.0	338.8	1.8	1.2	2	0	1	0	3	2	0	0	0	2	0	0	0	5
132	338.8	340.5	1.7	1.5	8	0	0	0	8	1	1	0	0	2	0	0	0	10
133	340.5	342.6	2.1	1.5/0.8	9	1	2	0	12	0	0	0	0	0	0	0	0	12
134	342.6	343.8	1.2	1.9	2	0	0	0	2	2	0	0	0	2	0	0	0	4
135	343.8	346.5	2.7	1.7	11	0	0	0	11	3	0	0	0	3	0	0	0	14
136	346.5	351.3	4.8	4.7/1.4	14	2	0	0	16	3	0	0	0	3	0	1	0	20
137	351.3	354.3	3.0	1.9	8	1	2	0	11	0	2	0	0	2	0	0	0	13
138	354.3	359.0	4.7	2.8/1.5	6	0	1	0	7	2	3	0	0	5	0	0	0	12
139	359.0	363.0	4.0	1.3/3.7/1	5	16	1	9	31	0	0	0	0	0	0	0	0	31
140	363.0	368.6	5.6	2.5/S/0.6/S	0	8	18	8	34	0	2	2	0	4	0	0	0	38
141	368.6	372.1	3.5	1.1	0	10	0	0	10	0	0	0	0	0	0	0	0	10
142	372.1	375.5	3.4	2.7/1/0.6	0	8	3	0	11	0	1	0	0	1	0	0	0	12
143	375.5	378.2	2.7	0.7/1.3	1	8	0	0	9	0	1	0	0	1	0	0	0	10
144	378.2	383.0	4.8	2.4	12	3	0	0	15	1	0	0	0	1	0	0	0	16
145	383.0	385.3	2.3	1.6/0.7	4	0	0	0	4	0	1	0	0	1	0	0	0	5
146	385.3	388.6	3.3	1.6/0.6	4	0	0	0	4	0	0	0	0	0	0	0	0	4
147	388.6	392.7	4.1	1.2/2.9	1	0	0	0	1	0	0	0	0	0	0	0	0	1
148	392.7	397.5	4.8	S/3.8	2	1	0	0	3	0	0	0	0	0	0	0	0	3
149	397.5	398.3	0.8	1.2	1	1	0	0	2	0	0	0	0	0	0	0	0	2
150	398.3	400.3	2.0	1	4	3	0	0	7	0	0	0	0	0	0	0	0	7
151	400.3	404.0	3.7	1/0.6	0	8	0	0	8	1	0	0	0	1	0	2	0	11
152	404.0	407.0	3.0	1.3	6	8	0	0	14	1	0	0	1	2	0	0	0	16
153	407.0	408.2	1.2	0.9	0	0	0	0	0	1	0	0	0	1	0	0	0	1
154	408.2	409.8	1.6	1.3	1	0	0	0	1	1	0	0	0	1	0	0	0	2
155	409.8	412.1	2.3	1.5	2	0	0	0	2	0	0	0	0	0	0	0	0	2
156	412.1	415.7	3.6	2.9	3	0	0	0	3	0	0	0	0	0	0	0	0	3
157	415.7	417.7	2.0	1.3	0	0	0	0	0	1	0	0	0	1	0	0	0	1

158	417.7	425.3	7.6	4.1/2.5/0.8	6	0	0	0	6	4	0	2	0	6	0	1	0	13	
159	425.3	428.8	3.5	1.1/1.6	9	0	0	0	9	1	0	0	0	1	9	0	0	19	7
160	**428.8**	**431.6**	**2.8**	**1.7**	**2**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**7**
161	431.6	433.0	1.4	3.5	1	0	0	0	1	0	0	0	0	0	0	0	0	1	
162	433.0	435.2	2.2	1.8	2	0	0	0	2	0	0	0	0	0	0	0	0	2	
163	**435.2**	**438.8**	**3.6**	**1.4/S**	**3**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**7**
164	**438.8**	**443.1**	**4.3**	**1.7/1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8**
165	443.1	449.2	6.1	1.4/2.1/1.2	16	0	0	0	16	0	0	0	0	0	0	0	0	16	
166	449.2	452.0	2.8	1.6	3	0	0	0	3	1	0	0	0	1	0	0	0	4	
167	452.0	454.9	2.9	4/0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
168	454.9	459.1	4.2	1.5/S/0.8	4	2	0	0	6	0	0	0	0	0	9	0	0	15	8
169	459.1	462.8	3.7	1/1.6/1.1	0	2	0	0	2	3	0	0	1	4	2	1	0	9	8
170	462.8	464.5	1.7	S/1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
171	464.5	467.0	2.5	1	0	0	0	0	0	0	0	0	0	0	5	3	0	8	9
172	**467.0**	**469.1**	**2.1**	**0.9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9**
173	469.1	470.1	1.0	2.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
174	470.1	471.4	1.3	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
175	471.4	472.6	1.2	1.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
176	472.6	475.3	2.7	1.6/0.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
177	475.3	477.1	1.8	1.2/0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
178	**477.1**	**480.6**	**3.5**	**1.5/0.8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8**
179	**480.6**	**483.4**	**2.8**	**1/0.9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**8**
180	483.4	486.0	2.6	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
181	486.0	487.8	1.8	1.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
182	**487.8**	**490.3**	**2.5**	**1.2/0.9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9**
183	490.3	491.4	1.1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	
184	491.4	492.4	1.0	1.3	0	0	0	0	0	1	0	0	0	1	0	0	0	1	
185	**492.4**	**494.4**	**2.0**	**1.1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9**
186	494.4	499.1	4.7	1.7/2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

NOTES ON RADIUS OF CURVATURE:

S = A relatively straight reach.

When more than 1 Rc was measured on a bend, Rc is listed downstream to upstream.

Example Bend Number 182: 1.2 = downstream curvature, 0.9 = upstream curvature.

= a break in hydrologic reach (occurs at the Kansas and Osage Rivers)

= a suggested sample reach

BOLD = a suggested control reach

BOLD = an alternate sample reach