UMRR LTRMP Fish component hoop net study: Results from comparative *in situ* bait trials seeking comparable substitute bait for standardized LTRMP hoop net sampling (2014 addendum)

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US Army Corps of Engineers, Rock Island District, Summary letter
UMRR LTRMP 2013B14
Submitted to the U.S. Geologic Survey's Upper Midwest Environmental Sciences Center
12 May, 2014

Preface

U.S. Army Corps of Engineers' Upper Mississippi River Restoration Long Term Resource Monitoring Program (LTRMP) element is implemented by the United States Geological Survey Upper Midwest Environment Sciences Center (UMESC), in cooperation with the five Upper Mississippi River System (UMRS) states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The US Army Corps of Engineers (Corps) provides guidance and has overall program responsibility.

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Executive Summary

This letter details the results of paired hoop net bait trials, conducted to identify and evaluate alternative and demonstrably equivalent bait, required to maintain standardized sampling efforts in the Upper Mississippi River Restoration's Long Term Resource Monitoring Program (LTRMP) Fish component. We evaluated our standard bait (mechanically extruded and dried soy bean cake) relative to a prospective substitute (a mechanically processed non-caked soy bean product). This assessment was necessary because the plant that manufactures our present standardized bait does not plan to continue production in the near future.

Paired baited sets were made in two LTRMP river reaches (Pool 8 and Open River), representing the widest range of flows possible. Bait performance was assessed as the catch-per-unit-effort (CPUE) of channel catfish (*Ictalurus punctatus*) in standardized LTRMP large hoop nets (Gutreuter et al., 1995). The standard bait received a standard and full annual sample allocation as per standardized LTRMP sampling protocols. The alternative bait was fished adjacent and opposite-bank of the standard LTRMP set in identical nets. This assured the bait scents did not interfere with each other. Tolerable deviances in catches between bait treatments were defined *a priori* to the study by the full complement of LTRMP Fish Component staff. Moreover, acceptable assurances of observing these deviances were set by LTRMP Fish Component staff and used to set requisite sample sizes to assure observing a stated effect.

No difference in channel catfish mean CPUE between paired bait trials were observed in the Pool 8 study reach. The design of the study, which considered existing catch rate data and its variance, assured sufficient power to detect a stated effect size at a stated level of confidence. Thus, for Pool 8, we can definitively conclude that both baits, as fished procedurally in the study, produce comparable catches of target organisms in large hoop net methods used as part of LTRMPs standardized fish community assessments (Gutreuter et al., 1995). This conclusion supports transitioning to the alternative bait (Mercer) when it becomes necessary.

Similarly, no differences in the mean CPUE of channel catfish were observed in the Open River study locality during the 2012-2013 study. However, several issues preclude a definitive conclusion on bait effects on catch for the Open River locality. First, due to drought issues, pre-defined sampling requirements to achieve a stated effect size at a given level of confidence, were compromised. Drought conditions resulted in 16% fewer samples than intended due to standardized procedure issues with

deploying LTRMP compliant hoop net sets (Gutreuter et al., 1995). Secondly, catches during the 2012 assessment were much more variable than historically observed, and upon which sample size requirements were determined *a priori*, perhaps also a consequence of low flow and river stages through the drought period. Correspondingly, *post hoc* power assessments demonstrated that the intended power of the sampling design was compromised by these issues. Thus, while formal tests revealed no differences in catch between the bait types in the Open River study area, our power to detect these differences given the study data were insufficient to draw definitive conclusions.

The Open River study location was chosen to maximize differences in flow environments across the study. However, given the drought in 2012, this study objective was at least partially compromised. Given the unusual circumstance of the drought of 2012, we repeated the Open River study again in 2013-2014, considering the assessment complete for the Pool 8 study area. This summary letter details the original findings from 2012–2013, and also addends new findings from the 2013–2014 effort in the Open River Reach.

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Introduction

In a highly standardized ecological monitoring program, it is necessary to ensure data continuity and empirical integrity in core sampling efforts over time and space, even when conditions arise that require modifications in methodology. As part of its fish community assessment protocols (Gutreuter et al., 1995), the fisheries component of the Upper Mississippi River Restoration Environmental Management Program 's Long Term Resource Monitoring Program element (UMRR LTRMP, simply LTRMP from hereon), uses baited hoop nets to sample channel-oriented, benthic, and chemosensory species not readily collected with other gear types. The bait used for 20+ years is a mechanically processed soymeal product, known colloquially as bean cake, which has 38% protein, 10% fat, and 5% residual oil content (manufacture's label; West Bend Elevator, Lansing Iowa). Recently, the supplier of the bean cake used for the past 20 years by LTRMP has stated when its machinery breaks they will cease production of this product. This creates a standardization issue within the LTRMP fish component sampling protocols because today, most modern processors use chemical solvent (hexane) methods to extract oil from the soymeal, rather than mechanical methods. The chemical methods are nearly 100% effective at oil extraction. Consequently, readily available bean cake from chemical solvent plants differs substantially in protein and oil content relative to our standardized mechanically processed bean cake. Thus, our primary standardized source of baits for hoop net sampling in the LTRMP fisheries component is in danger of not being available in the near future (1–3 years), and compositionally comparable substitutes are not readily apparent. We initiated this study to determine whether a reasonable substitute could be found and proven comparable. This letter presents results from efforts to identify an alternative bean cake and test its utility, via *in situ* bait trials, as a substitute standardized bait in LTRMP hoop net samples.

Methods

Independent of identifying and testing alternative bait, we used existing LTRMP data to determine whether such a study was even feasible (in terms of practicality and expense). We developed and followed the subsequent protocol:

Step 1: Choose a study subject

We choose channel catfish (*Ictalurus punctatus*) as our study subject to test for the effects of alternative baits on catch rates. Hoop netting, as an assessment method, is used as one set of methods in a multiple gear approach to fish community sampling within the LTRMP (Ickes et al., 2005). Hoop nets use

baits to attract and retain chemosensory species, typified by channel catfish. They are the most effective gear for Ictalurids within the LTRMP portfolio of sampling methods (Ickes and Burkhardt 2003).

Step 2: Characterize LTRMP catch data, by study reach, for channel catfish in hoop nets

Period of record (1993–2011) annual means were extracted from the LTRMP graphical data browser (http://www.umesc.usgs.gov/data_library/fisheries/graphical/randcpue.shtml; accessed 28 January 2012) for poolwide stratified random sample (SRS) estimates of channel catfish sampled using large hoop nets. Tabulated annual means were used to calculate a grand mean and associated standard deviation for each study reach (Table 1). These two pieces of information are required, in part, to estimate how many samples would be required in a prospective study seeking to determine significant differences between our standard bean cake and a possible alternative bait, given an acceptable deviation from historical data collected using our standard bait and an acceptable confidence in detecting such a difference, if it truly exists (i.e., a demonstrably non-random bait effect on channel catfish catch per unit effort).

Table 1: Grand means and associated standard errors calculated from annual poolwide mean CPUEs for channel catfish (*Ictalurus punctatus*) from 1993–2011, for each study reach from Long Term Resource Monitoring Program fish component data (http://www.umesc.usgs.gov/data_library/fisheries/graphical/randcpue.shtml, accessed 28 January 2013).

Reach	Mean	Stdev
Pool 4	1.069	0.598
Pool 8	1.837	1.062
Pool 13	0.296	0.366
Pool 26	1.579	1.415
Open River	1.158	0.8232
La Grange	1.666	2.0793

Step 3: Survey component staff on acceptable deviations a new type of bait may cause relative to our standard bait and the level of certainty required to demonstrate such.

Four pieces of information are needed to estimate the sample size for a prospective sampling effort to detect a given effect size from "pilot data", here LTRMP data 1993–2011: (1) A measure of the mean (Table 1); (2) Standard deviation (Table 1); (3) a stated effect size (here an unacceptable change in mean

catch per unit effort of channel catfish using a new bait relative to our standard bait, expressed as a percentage change); and (4) a statement of how confident one wishes to be that such an effect has been observed (a confidence interval). Items (1) and (2) are provided in Table 1 and derive from the perhaps the largest database of baited hoop net samples in the Mississippi River, if not North America. Items (3) and (4) are judgments.

From 27 Feb 2011 to 1 March 2011, a survey was conducted upon LTRMP fish component specialists from the natural resources offices of the following states: Minnesota, Wisconsin, Iowa, Illinois, and Missouri. Two questions were asked:

(1) How large a change in mean catch, in your judgment, would represent an unacceptable effect of new bait on channel catfish catchability relative to our present bait (in the context of having data that are comparable to bean cake samples made since 1993)?
Options for answers included 1%, 5%, 10%, 20% or 30%.

(2) How confident do you wish to be that such an effect, if it exists, can be demonstrated non-random (or in other words, that the new bait is significantly different from our standard bait)?
Options for answers included 90%, 95%, or 99%.

Respondent answers are found in Table 2.

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Table 2: Respondent answers to the questions "How large a change in mean catch, in your judgment, would represent an unacceptable effect of a new bait on channel catfish catchability relative to our present bait (in the context of having data that are comparable to bean cake samples made since 1993)?" and "How confident do you wish to be that such an effect, if it exists, can be demonstrated non-random (or in other words, that the new bait is significantly different from our standard bait)?". Respondents were a complete census of LTRMP fish component specialists operating in the Midwestern states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri for state natural resource agencies (N = 8).

Respondent	State	Error	CIE
DeLain	MN	10%	95%
Bartels	WI	10%	95%
Bowler	IA	10%	90%
Ratcliff	IL	20%	95%
Gittinger	IL	20%	95%
Ruebush	IL	10%	90%
Solomon	IL	20%	90%
Ridings	MO	10%	95%

Step 4: Calculate sample size requirements for a given mean, standard deviation, acceptable effect size, and level of confidence.

Sample size estimation for a two-tailed t-test for a given mean, standard deviation, stated effect size, and level of confidence is given by the equation:

Sample size = (t–crit * SD) / Error)^2, where

> **t–crit** is the critical rejection threshold from a *z*–distribution table for a given confidence interval estimate [CIE] (1.645 when CIE = 90%, 1.96 when CIE = 95%, and 2.575 when CIE = 99%);
>
> **SD** is the standard deviation of the grand mean presented in Table 1; and
>
> **Error** is the acceptable deviation from the pilot data mean attributable to the alternative bait.

Sample size requirements were calculated for all permutations of LTRMP study reach, error options presented in the previous section under question (1), and confidence interval estimates (CIE's) presented in the previous section under question (2). These calculations are presented in Appendix A. Combinations of CIE's and error deemed widely acceptable by LTRMP fish component staff (Table 2)

were highlighted in Appendix A for consideration, discussion, and decision (see color shaded legend presented in Appendix A for a description).

A conference call was then held on 26 March 2012 and acceptable error tolerances and confidence interval thresholds were discussed and decided. The LTRMP fish component staff arrived at unanimity to accept a 20% error rate at a 95% confidence interval estimate as the criteria for assessing significant differences between our standard bait and our prospective substitute bait.

Step 5: Identify an alternative, long–term, and secure source of hoop net bait.

Our present supplier is West Bend Elevator in Lansing, Iowa. Our present bait (used for 20+ years) is a mechanically extruded soy-based product. Its sole ingredient is soy beans which are hammer milled, extruded while heated to ~300 ^{o}F, and then pressed and dried into cake form. Processed this way, the compositional qualities of the bean cake are 43–45% protein and 5% residual oil and fat (West Bend Elevator, Lansing, Iowa, product label). However, West Bend Elevator has expressed to us that they can no longer guarantee production of this product in the future.

Mr. Eric Ratcliff (Illinois Natural History Survey, National Great River Research and Education Center; East Alton, Illinois LTRMP Fish Specialist), identified a prospective substitute bait and a supplier with intentions to produce product far into the future. Mercer Elevator, located in Ohio, makes a very similar bean cake product to our standard bait. It is composed of 46% protein and 5% residual oil and fat (Mercer Elevator, Mercer, Ohio, product label). However, we remained uncertain of other qualities like caking properties, persistence in flowing water environments, and bait size. We presume the chemical properties of both baits are sufficiently similar to adopt the Mercer bait as a viable alternative, subject to empirical confirmation it can reproduce catches comparable to our previous supplier. Our field tests were designed to ensure any such chemical differences that may be present, in addition to physical property differences, do not unduly affect standardized catch rates of channel catfish in large hoop nets used in standardized LTRMP assessment activities.

Step 6: Develop study design.

Two field stations were selected to perform a full annual allocation for our standard bait and the alternative Mercer bait, based on minimizing sample size requirements to detect the consensus acceptable error response (20%) at 95% confidence (see Appendix A). This assures a cost effective study design with high probability of detecting any differences due to bait characteristics. This resulted in

selection of the Open River Reach (Cape Girardeau, Missouri) and Pool 8 (La Crosse, Wisconsin). By selecting fewer than all 6 LTRMP study reaches, we are adopting the implicit assumption that catch rates between the two baits do not vary as a function of study reach. Because we chose two study reaches, one from a lower flow environment (Pool 8) and a higher flow environment (Open River), our study design encompasses the full range of flow differences within the sampling environment that may interact with differences in the physical composition of the two baits to affect catches. Should we find no significant differences between our standard bait and the alternative bait at either study location, we can be safe in adopting our assumption for all six study reaches.

Large hoop nets were fished in paired fashion, one possessing our standard bait, and one possessing our prospective alternative bait, in each of Pool 8 and the Open River LTRMP study reaches, as per allocations detailed in Appendix A. Field staff followed standard LTRMP fish protocols (Gutreuter et al., 1995) for rigging, baiting, deploying, and retrieving large hoop nets, and reporting catches therein. Sample sites were those randomly selected for standard annual LTRMP fish component monitoring, selected by randomization procedures detailed in Gutreuter et al., (1995). Paired sets were located adjacent to one another in such a way as to assure the bait plumes minimize interaction with one another (e.g., opposite banks). A random draw for bank side was made for each pair prior to deployment by coin flip at the time of deployment. This resulted in a full standard annual allocation for large hoop nets in each of Pool 8 and Open River, using our standard bait (West Bend), and a full second annual allocation for each study location using the alternative bait (Mercer).

Standard bait (West Bend Elevator) sets were recorded as standard LTRMP annual allocation observations. Alternative bait (Mercer Elevator) observations were recorded as a special project (Special Project code E-027; Ben Schlifer, LTRMP database manager, personal communication). Each paired net replicate received an identical barcode. All additional site data and environmental data typically collected as part of LTRMP's annual monitoring effort (Gutreuter et al., 1995) were also recorded for alternative bait sets as special project data.

Hoop net sampling protocols in LTRMP (Gutreuter, et al., 1995) require: 3 kg of soybean cake, 1 kg placed in a 1.9-cm (0.75-inch)-diameter mesh bag attached to the rear of the net, and 2 kg placed loosely in the rear of the net (where current velocity is high, this bag may consist of 0.6-cm [0.25-inch] mesh and all bait may be placed in this bag). The standard bait is a "cake" product and of large size (generally > 7.5 cm diameter pieces). The alternative bait was of granular consistency, with particle size ranging from 0.2–2.5cm. The standard bait bags would not effectively contain the alternative bait, thus,

smaller mesh (0.2-cm) bags were acquired for the alternative bait sets. Three kg of alternative bait, all contained within the bags, was used in each of the experimental net sets (Mercer Elevator bait).

Design-based poolwide annual means were calculated for each full allocation of (1) standard bait sets, and (2) alternative bait sets (see Gutreuter et al., 1995; Ickes et al., 2005). Differences between channel catfish catch per unit effort means, calculated from each bait type, were tested with a simple two-way paired student's t-test, using +/– 0% deviation from the standard bait mean with 95% confidence as the criteria for rejecting a null hypothesis of no difference between bait types. This "zero difference in the paired means" null hypothesis is more restrictive than the +/- 20% difference deemed admissible by LTRMP fish component staff. If differences in mean catches were observed during testing from the "zero difference" null hypothesis, additional tests were performed at the more conservative +/- 20% difference.

Results

Pre-study planning, detailed in an earlier section of this letter, resulted in stated permissible deviances in mean catch between the standard bait and the new bait being evaluated. At a permissible 20% deviance in the mean catch of channel catfish in large hoop nets between the baits, and a 95% confidence statement in observing the difference in field data, Pool 8 crews were provided an allocation of 32 paired hoop net trials, while Open River was provided an allocation of 49 paired hoop net trials to achieve stated study objectives. Pool 8 achieved 30 of their 32 allocations while Open River achieved 41 of their 49 allocations in 2012-2013. During the 2013-2014 follow-up study in the Open River Reach, all annual allocations were achieved (N = 55).

Total catch by study site and bait type are provided in Table 3. Total catch between bait types in paired hoop net sets were remarkably similar in Pool 8, but differed notably in Open River in 2012-2013. Open River samples in 2013-2014 were more comparable. In 2012-2013, catch-per-unit-effort ranged from 0 to 16.1 fish in Pool 8 standard bait sets (West Bend bait), 0 to 15.4 fish in Pool 8 test bait sets (Mercer bait), 0 to 205.4 fish in Open River standard bait sets (West Bend bait), and 0 to 43.7 fish in Open River test bait sets (Mercer bait). In 2013-2014, catch-per-unit-effort ranged from 0 to 0.13 in standard bait sets (West Bend bait), and 0 to 0.185 fish in the test bait sets (Mercer bait) for the Open River reach.

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Table 3: Total channel catfish ((*Ictalurus punctatus*) catch data observed in paired LTRMP large hoop net samples in Pool 8 and the Open River UMRR LTRMP study areas using a standard bait (West Bend) and a prospective substitute bait (Mercer).

2012-2013 Study Area	Bait source *	Scheduled Samples	Completed Samples	Total Catch	Minimum catch	Maximum catch
Pool 8	West Bend	32	30	39	0	16
Pool 8	Mercer	32	30	43	0	15
Open River	West Bend	49	41	437	0	202
Open River	Mercer	49	41	175	0	39

*West Bend is the standard LTRMP bait, Mercer is the prospective replacement bait being tested

2013-2014 Study Area	Bait source *	Scheduled Samples	Completed Samples	Total Catch	Minimum catch	Maximum catch
Open River	West Bend	55	55	60	0	6
Open River	Mercer	55	55	35	0	9

*West Bend is the standard LTRMP bait, Mercer is the prospective replacement bait being tested

Mean CPUE of channel catfish in each study reach and bait type are summarized in Table 4. Mean CPUE differed 10% in the Pool 8 paired trials, but 144% in the Open River reach paired trials in 2012-2013. Relative to the long term mean expressed in Table 1, both Pool 8 bait trial mean CPUEs were marginally lower than the long term observed average (1.84 long term average [Table 1] versus 1.33 [West Bend bait] and 1.46 [Mercer bait]), yet were within the historical observed variance with the long term mean [standard deviation = 1.06; Table 1]). Catch rates for both baits were notably higher in the Open River reach during the 2012-2013 assessment, and relative to the long term mean expressed in Table 1 (long term average = 1.16). Our standard bait (West Bend) produced a mean CPUE during the study of 11.01, while our test bait (Mercer) produced a mean CPUE of 4.50, both well outside of the observed variance associated with the long term mean (standard deviation = 0.82; [Table 1]) observed in the Open River study area.

In the 2013-2014 Open River follow-up study, mean CPUE was lower than historically observed (Table 1; Table 4), as were the variance estimators. In 2012-2013, channel catfish CPUE statistics were much larger than historically observed (see above).

Table 4: Mean channel catfish ((*Ictalurus punctatus*) catch-per-unit-effort observed in paired LTRMP large hoop net samples in Pool 8 and the Open River UMRR LTRMP study areas using a standard bait (West Bend) and a prospective substitute bait (Mercer).

2012-2013 Study Area	Bait source *	Scheduled Samples	Completed Samples	Mean CPUE	Standard Deviation	Standard Error
Pool 8	West Bend	32	30	1.328	3.091	0.564
Pool 8	Mercer	32	30	1.461	3.706	0.677
Open River	West Bend	49	41	11.012	38.719	6.047
Open River	Mercer	49	41	4.497	10.387	1.622

*West Bend is the standard LTRMP bait, Mercer is the prospective replacement bait being tested

2013-2014 Study Area	Bait source *	Scheduled Samples	Completed Samples	Mean CPUE	Standard Deviation	Standard Error
Open River	West Bend	55	55	0.0228	0.036	0.005
Open River	Mercer	55	55	0.0134	0.036	0.005

*West Bend is the standard LTRMP bait, Mercer is the prospective replacement bait being tested

Paired two-way t-tests failed to reject a null hypothesis of "no mean difference" between paired baits in each of Pool 8 (t-stat = -0.28; 29 degrees of freedom; p=0.78), and Open River (t-stat = 1.03; 40 degrees of freedom; p=0.31) in the 2012-2013 study. Post-hoc estimates of power to detect mean differences were marginally lower than planned in the Pool 8 trials (Beta = 0.72), yet remained reasonably sufficient to draw a strong conclusion of no difference in mean channel catfish CPUE between bait types in the Pool 8 study locale. Alternately, post-hoc estimation of power to detect mean differences in the Open River locale was rather poor (Beta = 0.17).

Hydrology during the 2012 assessment period was unusual, and outside the range typically observed since 1993, when LTRMP began statistical sampling. A pronounced drought was experienced throughout the study basin in 2012. The 2012 drought affected not only prescribed sample allocations for the study (most so in Open River; Table 3), but also field logistics in placing nets according to LTRMP standard protocols (Gutreuter et al., 1995), particularly so in the Open River reach where decades of channel incision and levee development result in lower stages at low flows (Pinter et al., 2008), complicating net placements on shore slopes at low flows (Joe Ridings, Missouri Department of

Conservation, Big Rivers and Wetlands Field Station, Jackson, Missouri, personal communication). Mid-study, additional alternative stratified random sampling site were generated, because all primary and alternate sites were either sampled or deemed not able to be sampled. This was a historically unique occurrence in the LTRMP fish component. Accordingly, the Open River study site was unable to achieve the full study design sampling allocation (design required 49 samples, only 41 achieved; 16% loss of intended samples) in 2012-2013.

In the 2013-2014 follow-up study at the Open River locality, a full sample allocation was achieved, though catches were much lower than the historic highs observed in the 2012-2013 study (Tables 3 and 4), and lower than the long-term average as well (Table 1). Data from the 2013-2014 study, though lower in catch rates, revealed no significant difference between bait types (t-stat = 1.372; 54 degrees of freedom; p=0.18). Post hoc power assessments revealed a power of 0.63, marginally below planned power, but much higher than observed in the 2012-2013 study.

Conclusions and recommendations

No difference in channel catfish mean CPUE between paired bait trials were observed in the Pool 8 study reach in the 2012-2013 study. The design of the study, which considered existing catch rate data and its variance, assured sufficient power to detect a stated effect size at a stated level of confidence. Thus, for Pool 8, we can definitively conclude that both baits, as fished procedurally in the study, produce comparable catches of target organisms in large hoop net methods used as part of LTRMPs standardized fish community assessments (Gutreuter et al., 1995). This conclusion supports transitioning to the alternative bait (Mercer) when it becomes necessary.

Similarly, no differences in channel catfish mean CPUE between paired bait trials were observed in the Open River study locality during the 2012-2013 study. However, several issues preclude a definitive conclusion on bait effects on catch for the Open River locality at that time. First, due to drought issues, pre-defined sampling requirements to achieve a stated effect size at a given level of confidence, were compromised. Drought conditions resulted in 16% fewer samples than intended due to standardized procedure issues with deploying LTRMP compliant hoop net sets (Gutreuter et al., 1995). Secondly, catches during the 2012 assessment were much more variable that historically observed, and upon which sample size requirements were determined *a priori*, perhaps also a consequence of low flow and river stages through the drought period. Correspondingly, *post hoc* power assessments demonstrated that the intended power of the sampling design was substantially compromised by these issues. Thus,

while formal tests revealed no differences in catch between the bait types in the Open River study area in 2012-2013, our power to detect these differences given the study data were insufficient to draw definitive conclusions.

The Open River study location was chosen to maximize differences in flow environments across the study. However, given the drought in 2012, this study objective was at least partially compromised. The drought likely had a much more pronounced effect in the Open River (unimpounded) reach than in the pool reaches, and certainly more so than the Pool 8 study locality. Given the unusual circumstance of the drought of 2012-2013, we repeated the Open River study again in 2012-2013, considering the assessment complete for the Pool 8 study area. As a consequence, the 2013-2014 follow-up study in the Open River reach resulted in much stronger conclusions. While post hoc power assessments, coupled with historic low catch rates, were less than ideal based upon our sampling and analytic designs, no bait effect was found, and post hoc power assessments revealed that this conclusion is reasonable (though less definitive than planned and prescribed by the study design). Thus, when market forces dictate (likely in the 2014-2015 field season), the UMRR LTRMP Fish Component can transition to the alternate bean cake source.

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Literature cited

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Appendix A

Sample size estimate tables for Long Term Resource Monitoring Program large hoop nets capturing channel catfish (*Ictalurus punctatus*), for a given study reach mean annual catch per unit effort (1993–2011), standard deviation, acceptable error, and necessary confidence interval. *

The table sections representing criteria selected by at least one respondent's preferences are shaded

The table sections representing criteria selected by the most respondents are shaded

The table sections representing criteria selected by unanimous consent as study criteria for paired tests are shaded

* Values in bold represent the LTRMP monitoring localities selected for the study based upon consensus error and confidence thresholds required to judge significant differences in channel catfish Catch Per Unit Effort between paired large hoop net samples fishing a standard and prospective alternate bait.

Sample size estimates for HL bait study based on "pilot" mean stats and 1% error *

Reach	Mean	Stdev	Error (1%)	CIE	t–crit	Sample size
Pool 4	1.069	0.598	0.01069	90	1.645	8468
Pool 8	1.837	1.062	0.01837	90	1.645	9044
Pool 13	0.296	0.366	0.00296	90	1.645	41372
Pool 26	1.579	1.415	0.01579	90	1.645	21731
Open River	1.158	0.8232	0.01158	90	1.645	13675
La Grange	1.666	2.0793	0.01666	90	1.645	42152
Pool 4	1.069	0.598	0.01069	95	1.96	12022
Pool 8	1.837	1.062	0.01837	95	1.96	12839
Pool 13	0.296	0.366	0.00296	95	1.96	58734
Pool 26	1.579	1.415	0.01579	95	1.96	30850
Open River	1.158	0.8232	0.01158	95	1.96	19414
La Grange	1.666	2.0793	0.01666	95	1.96	59841
Pool 4	1.069	0.598	0.01069	99	2.575	20749
Pool 8	1.837	1.062	0.01837	99	2.575	22161
Pool 13	0.296	0.366	0.00296	99	2.575	101376
Pool 26	1.579	1.415	0.01579	99	2.575	53248
Open River	1.158	0.8232	0.01158	99	2.575	33508
La Grange	1.666	2.0793	0.01666	99	2.575	103285

Sample size estimates for HL bait study based on "pilot" mean stats and 5% error *

Reach	Mean	Stdev	Error (5%)	CIE	t–crit	Sample size
Pool 4	1.069	0.598	0.05345	90	1.645	339
Pool 8	1.837	1.062	0.09185	90	1.645	362
Pool 13	0.296	0.366	0.0148	90	1.645	1655
Pool 26	1.579	1.415	0.07895	90	1.645	869
Open River	1.158	0.8232	0.0579	90	1.645	547
La Grange	1.666	2.0793	0.0833	90	1.645	1686
Pool 4	1.069	0.598	0.05345	95	1.96	481
Pool 8	1.837	1.062	0.09185	95	1.96	514
Pool 13	0.296	0.366	0.0148	95	1.96	2349
Pool 26	1.579	1.415	0.07895	95	1.96	1234
Open River	1.158	0.8232	0.0579	95	1.96	777
La Grange	1.666	2.0793	0.0833	95	1.96	2394
Pool 4	1.069	0.598	0.05345	99	2.575	830
Pool 8	1.837	1.062	0.09185	99	2.575	886
Pool 13	0.296	0.366	0.0148	99	2.575	4055
Pool 26	1.579	1.415	0.07895	99	2.575	2130
Open River	1.158	0.8232	0.0579	99	2.575	1340
La Grange	1.666	2.0793	0.0833	99	2.575	4131

Sample size estimates for HL bait study based on "pilot" mean stats and 10% error *

Reach	Mean	Stdev	Error (10%)	CIE	t–crit	Sample size
Pool 4	1.069	0.598	0.1069	90	1.645	85
Pool 8	1.837	1.062	0.1837	90	1.645	90
Pool 13	0.296	0.366	0.0296	90	1.645	414
Pool 26	1.579	1.415	0.1579	90	1.645	217
Open River	1.158	0.8232	0.1158	90	1.645	137
La Grange	1.666	2.0793	0.1666	90	1.645	422
Pool 4	1.069	0.598	0.1069	95	1.96	120
Pool 8	1.837	1.062	0.1837	95	1.96	128
Pool 13	0.296	0.366	0.0296	95	1.96	587
Pool 26	1.579	1.415	0.1579	95	1.96	309
Open River	1.158	0.8232	0.1158	95	1.96	194
La Grange	1.666	2.0793	0.1666	95	1.96	598
Pool 4	1.069	0.598	0.1069	99	2.575	207
Pool 8	1.837	1.062	0.1837	99	2.575	222
Pool 13	0.296	0.366	0.0296	99	2.575	1014
Pool 26	1.579	1.415	0.1579	99	2.575	532
Open River	1.158	0.8232	0.1158	99	2.575	335
La Grange	1.666	2.0793	0.1666	99	2.575	1033

Sample size estimates for HL bait study based on "pilot" mean stats and 20% error *

Reach	Mean	Stdev	Error (20%)	CIE	t–crit	Sample size
Pool 4	1.069	0.598	0.2138	90	1.645	21
Pool 8	1.837	1.062	0.3674	90	1.645	23
Pool 13	0.296	0.366	0.0592	90	1.645	103
Pool 26	1.579	1.415	0.3158	90	1.645	54
Open River	1.158	0.8232	0.2316	90	1.645	34
La Grange	1.666	2.0793	0.3332	90	1.645	105
Pool 4	1.069	0.598	0.2138	95	1.96	30
Pool 8	**1.837**	**1.062**	**0.3674**	**95**	**1.96**	**32**
Pool 13	0.296	0.366	0.0592	95	1.96	147
Pool 26	1.579	1.415	0.3158	95	1.96	77
Open River	**1.158**	**0.8232**	**0.2316**	**95**	**1.96**	**49**
La Grange	1.666	2.0793	0.3332	95	1.96	150
Pool 4	1.069	0.598	0.2138	99	2.575	52
Pool 8	1.837	1.062	0.3674	99	2.575	55
Pool 13	0.296	0.366	0.0592	99	2.575	253
Pool 26	1.579	1.415	0.3158	99	2.575	133
Open River	1.158	0.8232	0.2316	99	2.575	84
La Grange	1.666	2.0793	0.3332	99	2.575	258

Sample size estimates for HL bait study based on "pilot" mean stats and 30% error *

Reach	Mean	Stdev	Error (30%)	CIE	t–crit	Sample size
Pool 4	1.069	0.598	0.3207	90	1.645	9
Pool 8	1.837	1.062	0.5511	90	1.645	10
Pool 13	0.296	0.366	0.0888	90	1.645	46
Pool 26	1.579	1.415	0.4737	90	1.645	24
Open River	1.158	0.8232	0.3474	90	1.645	15
La Grange	1.666	2.0793	0.4998	90	1.645	47
Pool 4	1.069	0.598	0.3207	95	1.96	13
Pool 8	1.837	1.062	0.5511	95	1.96	14
Pool 13	0.296	0.366	0.0888	95	1.96	65
Pool 26	1.579	1.415	0.4737	95	1.96	34
Open River	1.158	0.8232	0.3474	95	1.96	22
La Grange	1.666	2.0793	0.4998	95	1.96	66
Pool 4	1.069	0.598	0.3207	99	2.575	23
Pool 8	1.837	1.062	0.5511	99	2.575	25
Pool 13	0.296	0.366	0.0888	99	2.575	113
Pool 26	1.579	1.415	0.4737	99	2.575	59
Open River	1.158	0.8232	0.3474	99	2.575	37
La Grange	1.666	2.0793	0.4998	99	2.575	115

* Values in bold represent the LTRMP monitoring localities selected for the study based upon consensus error and confidence thresholds required to judge significant differences in channel catfish Catch Per Unit Effort between paired large hoop net samples fishing a standard and prospective alternate bait.