DRAFT MINUTES

29th Meeting of the NECC
June 14, 2000
Holiday Inn - Moline, IL

by

Scott D. Whitney
(CEMVR-PM-R)

Navigation Environmental Coordination Committee (NECC)

June 14, 2000
Holiday Inn, Moline, Illinois

1. WELCOME AND APPROVAL OF MINUTES OF LAST MEETING

The 29th meeting of the Upper Mississippi River-Illinois Waterway System Navigation Study Navigation Environmental Coordination Committee (NECC) was called to order by Ken Barr, Chairman. An attendance list is provided as **Attachment 1**. There were no corrections or additions to the 28th NECC minutes.

2. STUDY STATUS - KEN BARR

Ken provided a handout of the Corps of Engineers Headquarters Policy Review Comments and Responses. These documents are posted on Rock Island Districts home page at http://www.mvr.usace.army.mil/pdw/nav_study.htm **Attachment 2.**

Beorkrem: Questioned the 5% cutoff for the mooring cell queue, from the study of L&D for industry self help. Wants specifics of the considerations for the site specific evaluation.
Barr: The 5% cutoff in the current analysis is the result of a number of factors including lockmaster interviews, safety concerns, and environmental concerns.
Benjamin: What is a queue of 12?
Barr: A queue of 12 consists of 6 barges upriver and six barges downriver waiting to pass.
Beorkrem: When will we see those sensitivity analyses?
Tipple: They will be presented in full in the Feasibility Report.
Barr: Some of this information was presented at previous GLC meetings

Draft Feasibility Report and EIS are currently scheduled to be released for public review on Sept. 30, 2000. Division and Headquarters review should begin on July 11. According to this schedule the Division commanders' notice would come out in March 2001. (**UPDATE: schedule is currently under review**)

Beorkrem: What will the review period be?
Tipple: A sixty day review period is envisioned for these documents.
Duyvejonck: When will the recommended plan be released?
Barr: It will be released at the same time as the Draft feasibility report and EIS.
Beorkrem: The range of sensitivity analysis will not be available until the release of the plan?
Tipple: We have provided discussion of this topic, for some of the runs, at the GLC.
Beorkrem: You will have a recommended plan without review by the GLC?
Tipple: That is correct.

ON-GOING INVESTIGATIONS / HEARINGS
Barr: The Inspector General investigation was extended for 60 days, the National Academy of Science (NAS) Review team has been selected and is published on the web, their review begins in June and runs through November 2000.
Duyvejonck: Will the NAS review go beyond the economics?
Barr: They are specifically tasked to perform a comprehensive evaluation of the methodology the Corps used for this multifaceted and complex feasibility study. Gary and I will be briefing the NAS panel for their kickoff meeting next Monday in Washington DC.

NOTE: Statement of Task from the NAS SOW: *This study will focus on the U.S. Army Corps of Engineers' economic analysis regarding proposed improvements, including economic assumptions, methods, and forecasts regarding barge transportation demand on the Upper Mississippi River-Illinois Waterway. The Corps must also consider larger water resources project planning issues, such as formal U.S. federal water resource planning guidelines, possible environmental impacts, and the costs of navigation improvements. Thus, while the committee will focus on the Corps' economic analysis, they will also comment upon the extent to which these larger issues are being appropriately considered in the navigation system feasibility study.*

Duyvejonck: How many of the Navigation study investigation reports have been released?
Whitney: Currently we have 23 of 41 reports available on the web. However, only 16 reports have come back from the publisher in hardcopy and been distributed. I expect to have several more on the web in the next few weeks and several more distributed in hardcopy. At this time, all but five of the remaining reports are at the publisher, in some stage of publication (editorial review or press). I am getting the reports on the web as soon as they come out of the final edit process, which saves us about a month over waiting for the hardcopy. To date the NECC has seen drafts and

commented on all but 1 of the 41 ENV reports, that report, ENV Rpt. #39 *Ecological Risk Assessment of the Effects of the Incremental Increase of Commercial Navigation Traffic on Freshwater Mussels in the Main Channel and Main Channel Borders* is in the final stage of ITR and will likely be distributed to NECC in the next few months.

Duyvejonck: What about reports dealing with indirect impacts?

Barr: The induced development report was recently received and will be incorporated into the EIS. It will be discussed and distributed to the NECC after it has been through the ITR process.

3. ENV. EFFECTS OF IMPROVEMENT SCENARIONS K AND L – STEVE BARTELL

FISH (Powerpoint Presentation) Attachment 3 (Note: summaries for other alternatives were distributed to NECC as an update of the Oct. 1999 Summary Package)

Beorkrem: Impact to Paddlefish and Sturgeon would be substantial at 1000 individuals.

Barr: The fact that species of concern may be potentially impacted will definitely be considered and addressed in the EIS and Mitigation Plan.

Beorkrem: We have yet to receive this information or see these documents, we would like this information in advance.

Beorkrem: How can you calculate a percentage without knowing the baseline?

Bartell: We have extrapolated from our larval density data to estimates of the total number of larvae in the main channel.

Beorkrm: These numbers are only the incremental effect?

Bartell: That is correct, they represent the incremental effect for each alternative.

Beorkrem: could you show fish impact in another color to better reflect significance

Whitney: There are several ways in which we analyze and represent significance if fish impacts. This table was specifically designed to represent geographical significance of fish impacts. The total percentages of fish impacted for the various reaches are then factored into the mitigation process for the allocation of dollars and measures by river and by reach.

Brummet: What is the source of the open river calculations?

Whitney: Upon looking at these numbers it is obvious that this table does not extrapolate to the number of rivermiles in the open river reach, the numbers you are seeing are for only the open river trend reach. The values in this table need to be multiplied by a factor of 4.625 which is designed to extrapolate the impact by rivermile (i.e. total Open River rivermiles ÷ trend reach rivermiles = 4.625). This table will be revised to reflect fisheries impact to the entire Open River reach.

*****NOTE -** These tables were corrected and included as Attachment 3. *******

MUSSELS (Powerpoint Presentation) Attachment 4

All of the locations show a minimal to no effect on the growth or reproduction of freshwater mussels. Effects only show up under the most extreme and unlikely tow event that would generate extremely high sediment concentrations.

PLANTS (Powerpoint Presentation) Attachment 5

Beorkrem: What about showing current system traffic impacts in comparison to the no-traffic condition.

Barr: We do not have without traffic ambient sediment concentrations.

Bartell: One of the big unknowns is the undetermined threshhold of significance?

Wilcox: We are really dealing with an unknown threshhold we have arbitrarily selected 5% because it is at the very edge of our detection level. Using this as a very conservative level.

Beorkrem: Mitigation for Pool 17 would not be considered since plants are not in this area?

Wilcox: in most years the ambient levels below 13 are too high to allow plant growth, example in Pool 19. Most will experience an edge effect due to growth forms of plants that show up one year or another.

4. RISK AND UNCERTAINTY ANALYSIS – STEVE BARTELL

RISK AND UNCERTAINTY FOR FISH MODELING (Powerpoint Presentation) Attachment 6

Beorkrem: How are you showing the confidence in these values, you are showing the probabilities. Will send an E-mail to better express this point.

Bartell: Will respond to E-mail once he has a better idea of the question being posed.

Barr: Provided response suggesting the Economics Workgroups has attempted to do this with their exercise.

Bertrand: Your Recruitment forgone numbers attempt to project the larval fish up to when they reach maturity, this estimate does not go beyond this point?

Bartell: We reset the model every year using the same data for larval densities by month, pool, and species.

Wilcox: These models assume a fish population that is at equilibrium, therefore the resetting each year, also the

compensatory reserve idea

Beorkrem: When is this (Risk and Uncertainty) scheduled to be released?

Barr: This will be App. M to the EIS.

Bertrand: How can you assess or characterize a declining population when it is reset each year? Would it be possible to enter a mortality coefficient to reflect this.

Bartell: The entrainment mortality calculations and subsequent extrapolations (e.g., EAL, recruitment forgone) assume a population at equilibrium and these calculations begin each year with the same initial larval densities. In contrast, the Leslie matrix models begin with survival and fecundity parameters that describe a population assumed to be at equilibrium. Then the incremental mortality caused by commercial vessels is added as an additional mortality term which causes the population projections to decrease over time.

Beorkrem: What does Equilibrium mean in terms of fish populations?

Bartell: An equilibrium population (i.e., constant fish numbers, without additional tow-induced mortality) is numerically established as a baseline to compare with projected impacts of larval entrainment on time-varying fish population sizes for the different traffic alternatives.

Bertrand: Pallid sturgeon issue. Any losses would be considered unacceptable.

Benjamin: One way to interpret this information is that without any traffic we could have 5000 more fish?

Wilcox: our ability to monitor and sample larval walleye is indicative of inherent underestimate of the actual adult fish population. Therefore our estimates of population are limited by this data gap.

Wilcox: Towboat kills some fraction of the larvae however the model does not account for this assumes larval density remains constant.

Ken Barr: Reiterated the three main assumptions of the larval entrainment modeling effort.

1.) In main channel and channel borders.
2.) Assumes no compensitory reserve.
3.) Model estimates outputs for a single years traffic. Because good population data is un-obtainable, we needed to fall back to current approach.

5. REVIEW OF REC BOATING MODELLING EFFORT (WILCOX AND LANDWEHR)

RECREATIONAL BOATING (Powerpoint Presentation) Attachment 7

Background:

- Estimate recreational boating intensity
  - Trips/day per pool and month
  - Allocated among different vessel types
  - Identified areas of concentrated use in pools
  - Projections of unconstrained growth 2000-2050
- Characterize wave heights for vessel types
- Calculate sediments suspended by traffic
- Estimate impacts on submerged plant growth

Summary

- Results suggest that several recreational vessel classes may impact the growth of submerged aquatic vegetation
- Additional work is being conducted to estimate the volume of water entrained by recreational vessels (~20% of commercial vessel entrainment)

6. Wrap-up

Duyvejonck: Where and when would environmental monitoring occur under the Adaptive Mitigation Plan?

Barr: There would be some up front monitoring to further refine our calculations or impact assessments, however the majority of the monitoring would serve as performance monitoring used to evaluate the success of various mitigation efforts. This monitoring information would then feed back into the adaptive mitigation approach.

Fenedick: I am concerned about the flowchart mentality of this mitigation approach. This does not account for the high degree of uncertainty that we continue to discuss, this may lead to problems in the future in assessing success or failure.

Barr: Our assumption for plants is that all areas less than 1.5 m in depth have plants, first objective is to collect field verification, since we realize our estimates are overly conservative.

Fenedick: This is the best that can be done at this time, however with additional information and the adaptive approach would identify other more appropriate measures. This is an opportunity to make the point to Congress that we need to develop a comprehensive approach.

Duyvejonck: Still concerned as to how flexible we will be in the transfer of funding from fish to plants or vice versa if our evaluations show a greater need.

Fenedick: May be better to look to the watershed to invest dollars.

Barr: Watershed studies are currently underway for the Illinois and Rock Rivers, more will likely follow in the future.

Fenedick: Estimates and bracketing, unreliability, continue to underscore the need for a more comprehensive evaluation of the system environmental needs.

Barr: We will capitalize on the attention of congress to make the point that there are many outstanding environmental needs.

Duyvejocnk: The Natural Resource Inventory maps are currently available, however, only three hardcopies have been made to date. States will be provided with two electronic copies. There will be a public version at some point in time.

Bertrand: Illinois is currently undergoing interagency reorganization, my new supervisor will be tasked with new duties, including the coordination with all three Corp districts. Our administration feels there are many things going on with the Corps that are not being coordinated.

Brummett: Recommend you allow as much time as possible to review materials, our plates are full.

Fenedick: Our organization has also undergone a minor reorganization.

Benjamin: Still find it troubling that we have not discussed the exotic species issue.

Beokrem: BA relating to O&M, will this form the baseline for the Nav study.

Barr: Yes, that is our desire that the O&M serves as the baseline for the Nav study.

Duyvejonck: It may serve as the baseline, assuming all measures for the O&M BA will be implemented.

Beorkrem: What authorities within the Corps do you envision being applied to the mitigation issue, do you envision a need for any additional authorities?

Barr: We are covered under Section 216, we should not need additional authorities to implement.

Beorkrem: Am I correct in concluding that the PED money retraction should only affect the engineering design and not the environmental efforts?

Barr: That is incorrect reiterated the history of the PED allocation, listing several environmental efforts that would be affected (i.e. Fish passage at L&D 19 feasibility study, Adult fish entrainment sampling, site specific mussel surveys, etc.)

Beorkrem: We are sorry to hear that environmental evaluations will be affected by the retraction of PED funds, however we (coalition of environmental interest groups) still feel that this funding should not have been started and we will continue to push to make sure that it is stopped.

7. Next Meeting

The next meeting will be tentatively scheduled for 18-19 September, 2000 from 12PM to 10AM.

Attachment 1

ATTACHMENT 1

Attendence List

NECC Meeting 14 June 2000
Holiday Inn, Moline, IL

Name	Affiliation	Address	Phone	E-mail
Ken Barr	CEMVR-PM-R	P.O. Box 2004, Clock Tower Bldg. Rock Island, IL 61204-2004	(309) 794-5349	Kenneth.A.Barr@mvr02.usace.army.mil
Steve Bartell	Cadmus Group	136 Mitchell Rd. Oak Ridge, TN 37830	(423) 425-0401	sbartell@cadmusgroup.com
Gretchen Benjamin	WI DNR	3550 Mormon Coulee Rd. La Crosse, WI 54601	(608) 785-9982	benjag@dnr.state.wi.us
Mark Beorkrem	Sierra Club / MRBA	P.O. Box 370, 204 Wyandotte Morrisonville, IL 62546	(217) 526-4480	mbeorkrem@hotmail.com
Bill Bertrand	IL DNR	P.O. Box 149, 2106 Southeast Third Aledo, IL 61231	(309) 582-5611	dnrbrp@netins.net
Ken Brummett	MO DNR	Box 428 Hannibal, MO 63401	(573) 248-2530	brummk@mail.conservation.state.mo.us
Jon Duyvejonck	USFWS	4469 48th Ave. Ct. Rock Island, IL 61201	(309) 793-5800	Jon_Duyvejonck@fws.gov
Rich Fristik	CEMVR-PM-R	P.O. Box 2004, Clock Tower Bldg. Rock Island, IL 61204-2004	(309) 794-5308	Richard.Fristik@mvr02.usace.army.mil
Al Fenedick	USEPA	77 West Jackson Boulevard Chicago, IL 60604	(312) 886-6872	Fenedick.Al@epamail.epa.gov
Jen Hensley	Sierra Club	P.O. Box 370, 204 Wyandotte Morrisonville, IL 62546	(309) 788-1526	
Kevin Landwehr	CEMVR-ED-HH	P.O. Box 2004, Clock Tower Bldg. Rock Island, IL 61204-2004	(309) 794-5578	Kevin.J.Landwehr@mvr02.usace.army.mil
Dave Tipple	CEMVR-PM-M	P.O. Box 2004, Clock Tower Bldg. Rock Island, IL 61204-2004	(309) 794-5399	David.A.Tipple@mvr02.usace.army.mil
Bernard Schonoff	IA DNR	3390 Hwy. 22 Muscatine, IA 52761	(319) 263-5062	fishiowa@muscanet.com
Elliot Stefanik	CEMVR-PM-R	P.O. Box 2004, Clock Tower Bldg. Rock Island, IL 61204-2004	(309) 794-5239	Elliot.L.Stefanik@mvr02.usace.army.mil
Lauri Walters	USFWS	4469 48th Ave. Ct. Rock Island, IL 61201	(309) 793-5800	Lauri_Walters@fws.gov
Scott Whitney	CEMVR-PM-R+C5(	P.O. Box 2004, Clock Tower Bldg. Rock Island, IL 61204-2004	(309) 794-5386	Scott.D.Whitney@mvr02.usace.army.mil
Dan Wilcox	CEMVP-PE-M	190 Fifth Street East St. Paul, MN 55101-1638	(612) 290-5276	Daniel.B.Wilcox@mvp02.usace.army.mil

Attachment 2

Attachment 2

Corps of Engineers Headquarters Policy Review Comments and Responses

29th Meeting of the NECC
June 14, 2000

Presented by

Ken Barr

Chief, Environmental Analysis Branch
US Army Corps of Engineers – Rock Island District

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-PE

MAR 16 2000

MEMORANDUM FOR Commander, Mississippi Valley Division, ATTN: CEMVD-PM

SUBJECT: Upper Mississippi River Navigation System Study

1. The purpose of this memorandum is to provide the results of our recent policy review of the subject study. In general, the review found that the district has conducted the study in consonance with the Principles and Guidelines. However, the study results and conclusions are sensitive to certain parameters and assumptions. Accordingly, additional information and explanation is required as indicated in the enclosed policy review comments. Responses to these comments shall be addressed in a policy compliance review memorandum.

2. The Principles and Guidelines provides on page 7, paragraph 6.1(i) that "various schedules, including staged construction, for implementing alternative plans should be considered." It further provides on page 51, paragraph 2.6.3(b)(3) that "project alternatives can differ in their timing as well as in their physical characteristics. Consider the optimal timing of projects and of individual project features in project formulation, so as to maximize net benefits over time." The district incorporated optimal timing into plan formulation, labeling an optimally timed plan as the national economic development plan. Although this approach is generally consistent with the Principles and Guidelines, it may not be the best way to incorporate the Principles and Guidelines guidance. While this approach is acceptable for this project, it should not be applied to other projects without specific approval.

3. An Alternative Formulation Briefing, to discuss the resolution of the enclosed comments and the schedule for completion of the report, shall be scheduled prior to public or interagency coordination of a tentatively selected plan.

FOR THE COMMANDER:

HANS A. VAN WINKLE
Major General, USA
Deputy Commander for
Civil Works

Enclosure

Policy Review Comments

QUALITY MANAGEMENT

The economics and plan formulation independent technical review teams should be expanded to include other Corps districts, navigation industry representatives, and public sector interests. Overlap of membership on the independent technical review teams would also substantially enhance the overall product quality.

ENGINEERING

(a) The district should reexamine the major rehabilitation scheduling and costs in the without and with project conditions by factoring in the projected number of lockages.

(b) The district should complete a rigorous engineering independent technical review of the final array of plans, including operational characteristics, reliability, and cost estimate contingencies.

ECONOMICS

(a) The district should review forecasted traffic volumes in light of actual, observed traffic volumes and any changes that have occurred since the forecasts were made to determine if the assumptions in the underlying model are still valid. Differences between actual and forecasted traffic volumes shall be explained. A statistical analysis demonstrating the relationship of actual traffic volumes to confidence bands associated with the forecasted volumes should be included. Such an analysis may need to consider both the unconstrained, forecasted traffic as well as the demand curves for barge transportation.

(b) The district should reexamine the demand curves and the assumptions regarding the most-likely and potential range on N values. Such reexamination may include time series data, information on markets and prices in states in addition to Iowa, and expert panels.

(c) Consideration should be given to disaggregating the grain movement data by distance from the river and applying demand curves to reflect the distances as well as regional and/or area differences in alternative markets.

(d) To the extent practicable, the district should review the reasonableness of the aggregated data to determine if the model accurately reflects seasonal peak usage and costs of movement.

(e) The district should consider estimating land transport rates to alternative pools for river loading to account for this type of alternative transportation opportunity.

(f) The district should consider consulting with USDA and other experts to determine if there is a potential for measuring national economic development benefits from maintaining net income to producers and export markets by reducing transportation costs. Such effects that

cannot be measured in the national economic development account should be addressed in the regional economic development account.

ENVIRONMENTAL ANALYSIS

(a) More information of the impacts on recreational boating is necessary.

(b) Mitigation for navigation impacts needs to consider the extent of other impacts. For example, if sedimentation from other sources results in losses of biological resources, then any additional sedimentation from proposed changes in navigation in these areas will not increase the losses and mitigation will not be required.

(c) Translate benefits into fish or habitat, rather than using the cost of hatchery reared replacement fish.

(d) Provide more detailed information on how significance was determined.

(e) An incremental analysis in compliance with ER 1105-2-100 is required.

(f) Further discussions in the report are necessary to identify appropriate tools and management framework for working with the mitigation proposed now and into the future.

(g) Further discussion in the report is needed to substantiate or quantify the impacts associated with increased traffic on alternative modes.

PLAN FORMULATION

(a) The district should critically review utilization of mooring devices and industry self help as well as projected traffic growth under the alternative future without conditions.

(b) The district should conduct a sensitivity analysis on its self help analysis and assumptions.

(c) The district should conduct sensitivity analysis on the timing and cost of major rehabilitations in the with and without project conditions.

(d) The district should conduct and document the sensitivity analyses prescribed in the P&G for navigation projects (Paragraph 2.6.15(d)).

(e) The district must assure that all key inputs and outputs (delays, queues, tonnage benefits, etc.) of the formulation process are well documented and are certified by an appropriate independent technical review team.

(f) If the district plans to include Peoria and LaGrange as deferred construction, costs and benefits for such a plan must be included in the district's report.

(g) In order to recommend the tentatively selected plan, the reporting officers need to address other Federal, state, local, and international concerns including regional economics, risk and uncertainty, trade considerations, and environmental effects of alternative modes of transportation. The district should also compute the potential benefits foregone that could result from a delay in completion of the project.

DEPARTMENT OF THE ARMY
MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080
http://www.mvd.usace.army.mil/

REPLY TO
ATTENTION OF:

07 APR 2000

CEMVD-PM-E (1105-2-10c)

MEMORANDUM FOR HQUSACE (CECW-PE), WASH DC 20314-1000

SUBJECT: Upper Mississippi River-Illinois Waterway System Navigation Study--Responses to Policy Review Comments

1. Reference memorandum, CECW-PE, 16 Mar 00, subject: Upper Mississippi River Navigation System Study.

2. Policy review comments provided by referenced memorandum have been considered by the study team. Responses and proposed plan of action to be taken are enclosed in accordance with the Issue Resolution Conference held at HQUSACE on 27 Mar 00. The Issue Resolution Conference was held in lieu of the Alternative Formulation Briefing discussed in referenced memorandum.

3. Pending approval of the enclosed responses, the study team will resume coordination of the feasibility study in accordance with the following schedule:

1 May 00	Release final array of alternatives to USFWS
1 Aug 00	Receive Fish and Wildlife Coordination Act Report from USFWS
30 Sep 00	Release Draft Feasibility Report and DEIS to HQUSACE and public for review (report will include a recommended plan).
1 Mar 01	Division Commander's Notice

4. As you are aware, I have suspended the award of new AE contracts, or new work items to be covered by MIPR, for preconstruction engineering and design (PED) as authorized by WRDA 99 until your office completed the policy review. I have closely examined the policy review comments and our responses. This review leads me to conclude that we are on track with our analyses and that uncertainty with regard to our assumptions will be adequately covered by sensitivity analyses. I remain

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convinced that some future work on the lower locks on the Upper Mississippi is economically justified. I do note however, that the timing and exact scope of construction is still in question and is a major issue to be addressed in the draft report. In summary, because of the potential for saving time to get to construction, the authorizing language in WRDA 99 and the language included in the Energy and Water Development Appropriations Bill for FY 2000, I believe that it is a wise and prudent measure to continue with PED activities for this project.

5. Request approval to proceed with answering the policy review comments in accord with the enclosed responses, the study schedule shown above and to continue with PED activities.

Encl

PHILLIP R. ANDERSON
Major General, USA
Commanding

SUBJECT: UMR-IWW System Navigation Study, Draft Responses to CECW-PE Policy Review Comments, dated 16 Mar 00

RESPONSES TO POLICY REVIEW COMMENTS

QUALITY MANAGEMENT

The economics and plan formulation independent technical review teams should be expanded to include other Corps districts, navigation industry representatives, and public sector interests. Overlap of membership on the independent technical review teams would also substantially enhance the overall product quality.

Response:

The following paragraphs describe the quality management process being used for the study. The number and background of participants plus the interaction between ITR teams will be further assessed as additional work products are completed.

a. The quality management for the Navigation Study is established in its Quality Control Plan (QCP) dated December 1997, and the Quality Control and Quality Assurance Guidance from CEMVD. ITR's are not only performed on the draft Feasibility Report and Environmental Impact Statement (EIS), but also for many of the numerous interim products of this system navigation study. Components of the overall review process are: internal review by the product production team and management; independent technical review performed by qualified individuals not involved with the specific product development or production; and review by appropriate members of the study coordinating committees or their representatives. The lead study team member for the specific product, in coordination with the applicable work group technical leader and Project Management Work Group, distributes the product and comment to the identified ITR members. ITR members provide comments to the lead study team member within 30 calendar days (unless otherwise specified) of receipt of the review package by their organization. Upon receipt of comments, the lead member coordinates with appropriate study team members to provide responses to comments. Comments that cannot be resolved by these parties follow the issue resolution process specified in the QCP. The comment sheets, response sheets, and other applicable documentation are attached to a copy of the draft report and provided with a copy of the final report to CEMVR-PM-M.

b. The study has engaged technical expertise to produce or review interim study products. These include: various Corps Districts (Rock Island, St. Louis, St. Paul, New Orleans, Jacksonville, Huntington, Pittsburgh, Louisville, Omaha, Seattle); the Corps' Navigation Region Design Team and a Corps Headquarters rep; CEWES; CERL; IWR; engineering, economic, and environmental consulting firms; universities (Oregon State, Wisconsin, Iowa State, Iowa, Illinois, Louisville, Texas, Mississippi State, Michigan, Southern Illinois, New Mexico State, Ohio State, Marshall, Maryland, Tennessee, Purdue); Oak Ridge National Laboratory; US Geological Survey; US Fish and Wildlife Service; and, the Illinois State Water Survey. Coordinating committees have also been engaged to participate in the review of many interim products as well as participate in the ongoing dialogue of interim study scope development and refinement, and the ongoing plan formulation process. The coordinating committees are the Governors' Liaison Committee (GLC), Navigation Environmental Coordination Committee (NECC), Economics Coordinating Committee (ECC), Engineering Coordinating Committee (EnCC), and the Public Involvement Coordinating Committee (PICC). The GLC membership is comprised of governor appointees from Illinois (Don Vonnahme, DNR), Iowa (Jim Hall, DOT), Minnesota (Dick Lambert, DOT), Missouri (Stephen Mahfood, DNR), and Wisconsin (Chris Spooner, Governor's Office). The NECC membership includes: DNR reps from MN, IA, IL, and WI; MO DOC; USFWS; and USEPA Regions 5 and 7. The ECC membership includes: reps from the five state DOT's; the Maritime Administration; the Midwest Area River Coalition 2000 (MARC 2000); and the USDA. The EnCC consists of reps from the five study area states from DOT's, DNR's, and Iowa State University for Iowa. The PICC consists of reps from the states DNR's or DOT's. All the coordinating committees are open to the public, and many local, environmental, navigation industry, and agricultural interests attend various forums on a regular basis.

c. A discussion of the general ITR process will be included in the draft Feasibility Report. Also included in the draft Feasibility Report will be a list of interim products that have been ITR's, and a synopsis of the ITR for the draft Feasibility report and EIS. The ITR documentation for the draft Feasibility Report and EIS will be available to the public via a separate volume, as are/will the ITR documentation for the interim products.

d. The size of the ITR team depends on the complexity of the interim product. Many products have also been reviewed by appropriate members of the coordinating committees as part of the review process, as well as input from the public forums, and industry and Corps Operations personnel. **Environmental & Historic Properties:** The 38 environmental and 8 historic properties interim products that have been ITR'd to date have involved some 40 different technical experts from Corps Districts, Corps Labs, academia, state and Federal resource agencies, contractors, the appropriate State Historic Preservation Offices, as well as review by the NECC. **Plan Formulation:** The interim plan formulation documents (Location Screening of Large-Scale Measures, Summary of Small-Scale Measures Screening, and Summary of Large-Scale Measures Screening) have been ITR's by three Corps staff from New Orleans (now at CEMVD), Omaha, and IWR (now Seattle). In addition, information, input, and review discussion for the formulation process of these documents were received from the coordinating committees, public interaction, and focus meetings with industry to discuss viability and safety issue associated with the lockage process for operations in the without-project and with-project conditions and the improvement measures in the with-project condition. **Economics:** Eight economic interim products have been ITR'd to date. Six technical professionals (New Orleans District (2), Huntington District (2), University of Tennessee (1), and Purdue University (1)) have been utilized as ITR members. In addition to these ITR members, most economic products have been afforded input and review by the ECC and technical reps they had participate, some by the NECC, as well as District team and management. **Engineering:** Nine engineering interim products, including an early draft of the Engineering Appendix which rolled up the analysis of earlier interim products, received an ITR from an 11 member team. ITR team members included Jacksonville District (1), Huntington (2), Pittsburgh (4), Louisville (1), New Orleans (1), and Headquarters (1). In addition, multiple presentations to, input from, and discussions with the coordinating committees, and industry and Corps Operations personnel. **Draft Feasibility Report and draft EIS:** In addition to review by the study team and management and quality assurance by CEMVD, the draft Feasibility Report and draft EIS will be reviewed by a full multi-disciplinary teams with members from all work group disciplines. Members will be pulled from the list of previous ITR members as well as engage new members. Total ITR team membership is anticipated at 26: plan formulation (3), economics (4), environmental (5), historic properties (2), engineering (7), operations (3), and public involvement (2). The actual ITR will be performed by Corps staff in view of both technical and Corps policy review requirements.

ENGINEERING

(a) The district should reexamine the major rehabilitation scheduling and costs in the without and with project conditions by factoring in the projected number of lockages.

Response: The schedules for the future rehabilitation of the lock improvements at Locks 20-25 will be analyzed to determine impacts of reduced cycles. This could result in a positive benefit by delaying the need for rehabilitation at these sites. This could potentially have a negative impact on Locks 14-18, as with project cycles could result in accelerating the need for rehabilitation at this sites. The draft report will contain the results of this investigation.

(b) The district should complete a rigorous engineering independent technical review of the final array of plans, including operational characteristics, reliability, and cost estimate contingencies.

Response: All engineering products and efforts on the final array of plans will receive an engineering ITR prior to issuance of the draft Feasibility Report for public review.

ECONOMICS

(a) The district should review forecasted traffic volumes in light of actual, observed traffic volumes and any changes that have occurred since the forecasts were made to determine if the assumptions in the underlying model are still valid. Differences between actual and forecasted traffic volumes shall be explained. A statistical analysis demonstrating the relationship of actual traffic volumes to confidence bands associated with the forecasted volumes should be included. Such an analysis may need to consider both the unconstrained, forecasted traffic as well as the demand curves for barge transportation.

Response: The district will review recent actual traffic (1994-1999) and the underlying assumptions in the traffic forecasts. The purpose of the review will be to determine if actual traffic developments reflect sufficient cause to change the assumptions that form the basis of the traffic projections. The district will employ the original contractor that conducted the analysis of grain forecasts to perform this review. The results of the analysis will be reported in the Draft Feasibility Report.

(b) The district should reexamine the demand curves and the assumptions regarding the most-likely and potential range on N values. Such reexamination may include time series data, information on markets and prices in states in addition to Iowa, and expert panels.

Response: In order to further examine assumptions regarding demand curve shape (N Values), the district will perform additional sensitivity analyses. One sensitivity scenario will be based on data from a 1985 work performed by Robert Hauser, Jeffrey Beaulieu and Philip Baumel (HBB). A second scenario will be based on data from a 1999 work performed by Abner Womack. Dr. Womack is the Co-Director of The Food and Agricultural Policy Research Institute (FAPRI). Both works deal exclusively with grain. Both works are based on data that are not restricted to the state of Iowa. A third scenario will be based on the results produced by the Corps contractor, Mark Burton.

The HBB work estimated grain (corn, soybeans and wheat in aggregate) barge demand elasticity individually for the Upper Mississippi River and the Illinois Waterway. The estimated elasticity for the Illinois Waterway is approximately half of that for the Upper Mississippi River. This difference is attributable to its location relative to other rivers and to production. The waterway specific demand elasticities will be translated to movement specific N values for use in the sensitivity scenario. The scenario will assume the mid elasticity estimates for non-grain commodities and will evaluate a select list of alternatives as required to address NED formulation. In general, the HBB elasticities are lower, in absolute value terms, than the "low elasticity" scenario (N=1.0 for grain) that has previously been evaluated. The results of the analysis will be reported in the Draft Feasibility Report.

The Womack work estimated U.S. export demand elasticity individually for corn, soybeans, and wheat. The commodity specific demand elasticities will be translated to movement specific N values for use in the sensitivity scenario. The scenario will assume the mid elasticity estimates for non-grain commodities and will evaluate a select list of alternatives as required to address NED formulation. In general, the Womack elasticities are lower, in absolute value terms, than the "low elasticity" scenario (N=1.0 for grain) that has previously been evaluated. The results of the analysis will be reported in the Draft Feasibility Report.

The Burton work was based on a theoretical case for the shape of grain transportation demand curves. This work estimated grain N values (N=2.0). The elasticities for this scenario are higher, in absolute value terms, than the "high elasticity" scenario that has been previously evaluated. The results of the analysis will be reported in the Draft Feasibility Report.

(c) Consideration should be given to disaggregating the grain movement data by distance from the river and applying demand curves to reflect the distances as well as regional and/or area differences in alternative markets.

Response: As described above, the HBB work estimated barge demand elasticity individually for the Upper Mississippi River and the Illinois Waterway. These waterway specific estimates should capture the effects of such factors as production area distances to the water and the presence of regional alternative markets as they existed at the time of the analysis. As such, the HBB scenario will be used to reflect, in a general way, the presence of these two effects.

(d) To the extent practicable, the district should review the reasonableness of the aggregated data to determine if the model accurately reflects seasonal peak usage and costs of movement.

Response: The issue of seasonal peak demand has been previously addressed and is documented in the minutes of the Economic Coordinating Committee Meeting of May 24, 1995. The minutes document the conclusion that seasonal peak usage is not a significant consideration. The complete minutes of this meeting are available on the study's web page.

(e) The district should consider estimating land transport rates to alternative pools for river loading to account for this type of alternative transportation opportunity.

Response: The district will investigate the sensitivity of estimating land transportation rates to alternative pools for river loading to account for such an alternative transportation opportunity. The investigation will address this notion of alternative transportation opportunity for grain exclusively. The analysis will be based on land transportation rate data to St. Louis from originating inland locations as estimated by the Tennessee Valley Authority in the original rate analysis conducted for the study. For a select group of movements, a comparison of the pure land transportation rate and the land-to-St. Louis/water-to-export point rate will be made. Based on this comparison, approximated adjustments to the alternative mode costs will be made in the economic model. Selected model runs will be performed to determine a general level of sensitivity. The results of the analysis will be reported in the Draft Feasibility Report.

(f) The district should consider consulting with USDA and other experts to determine if there is a potential for measuring national economic development benefits from maintaining net income to producers and export markets by reducing transportation costs. Such effects that cannot be measured in the national economic development account should be addressed in the regional economic development account.

Response: Farmer net income maintenance that may potentially result from reduced transportation costs would not generally qualify as a national economic development (NED) benefit as described by ER 1105-2-100. Such an effect would typically be considered to be part of the regional economic development account. The National Corn Growers Association has recently completed a study describing farmer net income impacts resulting from water transportation cost increases. The findings of this study will be described in the Draft Feasibility Report.

ENVIRONMENTAL ANALYSIS

(a) More information of the impacts on recreational boating is necessary.

Response: Recreational boating physical effects and impacts in channel border areas will be discussed in the EIS. Forecasts of future boating by vessel size and areas navigated have been developed. Comparisons of wake wave and drawdown effects of commercial and recreation craft will be made. It has been determined that Recreational craft use of the system will not change in response to any of the Alternatives being considered for lock improvements. Therefore the future without project and future with project are the same in relation to Recreational Craft impacts. Thus, no mitigation will be recommended for recreational craft impacts. Impacts which are occurring from recreation craft (like impacts from other stressers on the system) will be addressed in the cumulative impacts assessment. These cumulative impacts will be considered as we develop mitigation measures to offset the impacts from commercial Navigation traffic increases.

(b) Mitigation for navigation impacts needs to consider the extent of other impacts. For example, if sedimentation from other sources results in losses of biological resources, then any additional sedimentation from proposed changes in navigation in these areas will not increase the losses and mitigation will not be required.

Response: Using best available information and expert opinion (as determined after extensive scoping and internal coordination including a SAACR) a cumulative impacts report was prepared. The results of this investigation will be summarized in the draft EIS and has been used in assessing the significance and magnitude of direct effects. The cumulative impact assessment documented geomorphic changes, which have occurred, on the system since construction of the 9-foot channel project and forecast changes that will occur in the future. Using a guild approach, ecological changes were forecasted based on projected geomorphic changes. The cumulative impacts were considered in determining the significance of direct effects of Navigation traffic increases and in developing an appropriate adaptive mitigation strategy. This information will also be useful in the implementation phase of the mitigation process.

(c) Translate benefits into fish or habitat, rather than using the cost of hatchery reared replacement fish.

Response: The Draft EIS will describe how alternative mitigation measures will be assessed based on effects to habitat and fish. The design phase of the mitigation implementation will require additional information on site specific conditions that will support both design and evaluation of habitat benefits.

(d) Provide more detailed information on how significance was determined.

Response: Resources of concern were identified through an extensive scoping process. The geographic extent of threshold impacts was developed using a system screening process. Concepts of acceptable loss were considered at numerous interagency meetings. Areas and resources recommended for impact avoidance, minimization or compensation were developed and presented to the Navigation Environmental Coordination Committee (NECC) in an initial adaptive mitigation strategy. Based on comments from the NECC modifications were made to the mitigation strategy. The EIS will discuss how we arrived at levels of significance for each resource using best available information and interagency coordination.

(e) An incremental analysis in compliance with ER 1105-2-100 is required.

Response: Many of the measures proposed are avoid and minimize measures and a cost effectiveness analysis of methods to be used to protect the resources of concern will be conducted in the PED phase pursuant to the programmatic EIS and System Feasibility Study. An Incremental Analysis will be completed to supplement the programmatic system document for each lock construction site where mitigation is required. An incremental analysis will be completed for Systemic Environmental mitigation measures during the Design Phase. Pursuant to the tiered programmatic approach used in the Navigation study detailed information needed to complete an incremental analysis will be available in the design and implementation phase.

(f) Further discussions in the report are necessary to identify appropriate tools and management framework for working with the mitigation proposed now and into the future.

Response: Alternative coordination frameworks for implementing the adaptive mitigation strategy will be discussed in the draft EIS. Initial discussions have been ongoing with the NECC. The tiered programmatic approach necessitates a structured follow on coordination framework. The success of adaptive mitigation is dependent on a good coordination framework. The final EIS will recommend a coordination framework.

(g) Further discussion in the report is needed to substantiate or quantify the impacts associated with increased traffic on alternative modes.

Response: Following up on previous studies by contractors and the Corps (MVS), a report was prepared by Dr. Denver Tolliver of North Dakota State University, entitled 'Analysis of the Energy, Emission, and Safety Impacts of Alternative Improvements to the Upper Mississippi River and Illinois Waterway System'. An interim final report (currently undergoing ITR and coordinating committee review) was submitted in March 2000. Based on this report and previous studies, the EIS will describe the with- and without-project impacts of a modal shift (to rail) in three major sections: emissions and fuel use, accidents and hazardous spills, and safety/noise impacts. Where possible the analysis (and EIS discussion) has included estimated costs for compliance or abatement of increased emissions, and costs for increased accidents, injuries and fatalities. Noise impacts will be discussed qualitatively. Threshold levels of emissions for EPA attainment and non-attainment areas will be discussed briefly, but detailed analysis in this area was not conducted.

PLAN FORMULATION

(a) The district should critically review utilization of mooring devices and industry self help as well as projected traffic growth under the alternative future without conditions.

Response: The study team has involved industry and OD personnel in the discussion of industry self-help (line haul boats leaving their barges to assist other waiting tows), as well as evaluated the LPMS database. This coordination, LPMS data, and environmental concerns lead to a maximum 5-percent use assumption for reasonable application of industry self-help on the UMR & IWW in the without-project condition. Additional concerns with increased use above the 5-percent level include safety, risk/liability, variability in achieving timesavings, and dependability. Note that helper boats will continue to be utilized at their existing high percentage rates for approach assists in both the future without-project and future with-project conditions in view of varying site-specific and flow conditions primarily for downbound vessels. The study assumes that mooring facilities can be placed at sites as part of the without-project condition for purposes such as safety, and avoid & minimize. However, mooring facilities placed for the purpose of gaining system efficiency are considered part of the with-project condition. The draft report will contain additional documentation and text to further explain these aspects and expected traffic growth of the without-project condition.

(b) The district should conduct a sensitivity analysis on its self-help analysis and assumptions.

Response: The current without-project formulation assumes that industry self help will be used only during those occasions when the queue of waiting tows reaches twelve (operating 6 up / 6 down). In addition, the without-project formulation further constrains the use of industry self help such that self-help lockages are not permitted to exceed five percent of total lockages. The district will perform a sensitivity analysis of industry self-help assumptions. These scenarios will be evaluated for a select list of alternatives and will be presented in the Draft Feasibility Report.

(c) The district should conduct sensitivity analysis on the timing and cost of major rehabilitations in the with and without project conditions.

Response: The district will perform a sensitivity analysis on the timing and cost of major rehabilitations in both the without-project and with-project conditions. Scenarios will separately consider alternative expenditure requirements and timing assumptions that will be developed through coordination between engineering, economics and plan formulation team members. This analysis and assumptions will be presented in the draft Feasibility Report.

(d) The district should conduct and document the sensitivity analyses prescribed in the P&G for navigation projects (Paragraph 2.6.15(d)).

Response: A traffic projection scenario reflecting most-likely traffic growth for a period of 20 years, followed by constant traffic for the remainder of the period of analysis, will be evaluated for the complete array of alternatives. A user fee scenario reflecting 100 percent recovery of project cost will be evaluated and presented in the Draft Feasibility Report. A uniform fee per ton will be applied to all potential waterway traffic in the with-project condition. The impact of the fee on transportation savings and waterway traffic will be presented. This user fee scenario will be evaluated for a select list of alternatives. These analyses will be presented in the draft Feasibility Report.

(e) The district must assure that all key inputs and outputs (delays, queues, tonnage benefits, etc.) of the formulation process are well documented and are certified by an appropriate independent technical review team.

Response: The draft Feasibility Report will document and discuss the rationale for key assumption, inputs and outputs. An introductory ITR meeting will be held with the ITR team members to quickly present the study process, assumptions, and findings, and highlight any items that have been at issue in different forums throughout the study process. Specific items will include those items mentioned in this HQ policy comment. ITR comments will be responded to and outstanding issues resolved in accordance with the QCP discussed under the Quality Management section of this memorandum.

(f) If the district plans to include Peoria and LaGrange as deferred construction, costs and benefits for such a plan must be included in the district's report.

Response: Costs and benefits (gained or foregone) associated with these sites and others will be documented in the draft report in consideration of implementation timing within a 50-year planning horizon.

(g) In order to recommend the tentatively selected plan, the reporting officers need to address other Federal, state, local, and international concerns including regional economics, risk and uncertainty, trade considerations, and environmental effects of alternative modes of transportation. The district should also compute the potential benefits foregone that could result from a delay in completion of the project.

Response: The draft report will fully discuss data, information, and evaluations of alternative plans, and the rationale for identifying the tentatively selected plan. The factors mentioned in this HQ policy comment will be considered and documented as well as a discussion of benefits foregone.

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

12 MAY 2000

CECW-PE

MEMORANDUM FOR Commander, Mississippi Valley Division, ATTN: CEMVD-PM

SUBJECT Upper Mississippi River Navigation System Study

1. References

a. CECW-PE memorandum, 16 March 00, subject: Upper Mississippi River Navigation System Study.

b. CEMVD-PM-E memorandum, 7 April 00, subject: Upper Mississippi River-Illinois Waterway System Navigation System—Responses to Policy Review Comments

2. Concur with your basic approach to responding to the policy review comments provided to you in my 16 March 00 memorandum. The following information relating to the quantification of self-help should be included in the report.

a. Describe the conditions under which industry has provided self-help in the past.

b. Describe the conditions under which industry will provide self-help in the future.

Additionally, ensure that industry understands the extent and nature of delays that are expected to occur without the project and that the industry assessment of the extent of self-help is based on that information. The enclosed tables depict the extent of delays expected for the without project condition.

3. The schedule changes up to the draft report are approved subject to the preliminary draft report being submitted to this office concurrent with the independent technical review scheduled in July. When the report is submitted, include a compliance memorandum explaining how and where in the report each of the policy issues included in references 1.a. and 1.b. was addressed in the report.

CECW-PE
SUBJECT: Upper Mississippi River Navigation System Study

4. I have no objection to resumption of suspended PED activities as long as those activities are limited to features that have clearly demonstrated near term feasibility.

FOR THE COMMANDER:

HANS A. VAN WINKLE
Major General, USA
Deputy Commander for Civil Works

Enclosure

Without Project
Mid Growth
Mid Elasticities (N=1.2 for Grain)
Self Help when Queue>=12

Location	Probability of Self Help Lockage				
	2015	2020	2030	2040	2050
UM 11	0.000	0.000	0.000	0.000	0.000
UM 12	0.000	0.000	0.000	0.000	0.000
UM 13	0.000	0.000	0.000	0.000	0.000
UM 14	0.027	0.027	0.028	0.028	0.029
UM 15	0.045	0.046	0.046	0.048	0.046
UM 16	0.039	0.040	0.041	0.042	0.042
UM 17	0.077	0.080	0.083	0.085	0.087
UM 18	0.049	0.051	0.055	0.057	0.060
UM 19	0.000	0.000	0.000	0.000	0.000
UM 20	0.367	0.393	0.435	0.470	0.508
UM 21	0.137	0.146	0.161	0.172	0.184
UM 22	0.457	0.481	0.519	0.550	0.578
UM 24	0.649	0.691	0.757	0.802	0.828
UM 25	0.296	0.317	0.349	0.372	0.384

UMR-IW
Delay (hrs)
Without Project

Lock	2000	2005	2010	2015	2020	2030	2040	2050
USA	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
LSA	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
UM01	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
UM02	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.8
UM03	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
UM04	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
UM05	1.8	1.7	1.8	1.7	1.7	1.7	1.7	1.7
UM05a	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
UM06	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9
UM07	2.0	2.0	2.1	2.0	2.0	2.0	2.0	2.0
UM08	2.2	2.2	2.2	2.2	2.2	2.1	2.1	2.1
UM09	2.2	2.2	2.2	2.2	2.1	2.1	2.1	2.1
UM10	2.0	2.0	2.0	2.0	2.0	2.0	1.9	1.9
UM11	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5
UM12	2.3	2.4	2.4	2.4	2.4	2.4	2.4	2.3
UM13	2.1	2.2	2.2	2.2	2.2	2.2	2.2	2.2
UM14	4.2	4.4	4.3	4.4	4.4	4.4	4.5	4.5
UM15	4.9	5.1	5.0	5.1	5.1	5.1	5.1	5.1
UM16	4.5	4.7	4.7	4.6	4.8	4.9	4.9	4.9
UM17	5.8	6.1	6.2	6.3	6.4	6.4	6.5	6.5
UM18	5.0	5.3	5.3	5.4	5.5	5.6	5.7	5.7
UM19	1.9	2.0	2.0	2.0	2.0	2.0	2.1	2.1
UM20	10.2	12.2	13.0	14.1	15.0	16.7	18.3	20.2
UM21	6.1	6.7	7.0	7.2	7.4	7.7	8.0	8.3
UM22	13.7	16.5	17.8	19.3	20.6	22.9	24.9	27.1
UM24	16.2	22.8	26.8	32.2	37.5	49.3	61.9	71.9
UM25	8.7	10.2	10.9	11.7	12.3	13.4	14.1	14.6
UM26	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.1
UM27	1.1	1.1	1.2	1.2	1.2	1.3	1.4	1.4
LAGRAN	3.4	4.0	4.6	5.2	6.0	8.6	13.1	18.7
PEORIA	3.5	4.1	4.8	5.6	6.6	10.3	17.6	27.4
S.R.	2.2	2.3	2.4	2.5	2.7	2.9	3.2	3.4
MARSA	3.4	3.7	3.9	4.2	4.5	5.1	5.8	6.3
DRES	1.9	1.9	2.0	2.0	2.1	2.2	2.3	2.4
BRAN	2.3	2.4	2.5	2.7	2.8	3.0	3.3	3.5
LCKPRT	2.2	2.3	2.4	2.5	2.6	2.8	3.0	3.2
O'BRIEN	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6

Attachment 3

Attachment 3

Impacts of Alternatives K and L on
Larval Fish Entrainment

29th Meeting of the NECC
June 14, 2000

Presented by

Steve Bartell

The Cadmus Group, Inc

Systemic Fish Model Results for:

Scenario K

- Mooring cells at L&D: 12,18,20,22 and 24.
- Extended Locks at L&D: 14-18, 20-25.
- New 1,200 Locks in Location 1 at PEO and LGR, leaving existing 600’ lock open

These tabular model outputs should be considered in light of the methodologies, assumptions and limits described in accompanying narrative or in previously reviewed documentation on the individual studies.

Incremental Increase in Larvae Entrained and Killed

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	866,062,016	968,246,976	1,031,310,976	1,057,464,896	17,920,100	24,424,200	36,893,100	53,179,200
Blue Catfish	48,551,672	54,591,468	58,374,200	60,134,660	0	0	0	0
Blue Sucker	19,670,900	22,371,250	24,226,360	25,606,180	0	0	0	0
Bluegill	2,189,198,592	2,467,414,784	2,656,572,160	2,749,672,704	88,083,000	115,804,000	173,128,000	254,448,000
Channel Catfish	48,712,672	54,743,668	58,359,200	59,971,460	628,540	868,550	1,259,520	1,842,840
Crappie	545,844,160	612,113,664	651,640,704	670,117,504	20,769,600	28,578,100	43,882,900	61,982,400
Flathead Catfish	33,928,928	37,907,240	40,210,600	41,069,540	417,210	580,890	838,920	1,225,720
Freshwater Drum	21,936,211,968	24,555,380,736	26,128,277,504	26,615,449,600	331,506,016	458,395,968	668,150,016	983,900,032
Goldeye	141,337,056	158,302,016	168,648,288	173,243,664	1,475,200	2,009,500	3,062,100	4,349,000
Largemouth Bass	57,878,928	65,111,620	69,340,808	71,716,736	1,672,911	2,300,075	3,373,328	4,892,058
Mooneye	108,709,744	121,826,784	129,999,912	133,656,496	1,017,600	1,429,100	2,038,600	2,862,000
Northern Pike	11,134,640	12,291,720	12,776,200	12,777,500	86,433	123,383	176,985	254,001
Paddlefish	1,311,558	1,474,970	1,566,760	1,619,810	25,987	36,710	52,800	75,120
River Carpsucker	349,906,624	394,075,872	422,298,528	437,414,688	16,833,300	23,068,500	34,509,500	49,670,500
Sauger	117,671,600	131,528,896	139,021,920	142,000,896	412,938	572,216	853,330	1,221,600
Shorthead Redhorse	2,773,744,640	3,087,072,256	3,285,433,600	3,364,530,176	35,316,700	49,086,700	71,205,000	103,884,000
Smallmouth Bass	2,983,880	3,348,260	3,552,840	3,655,890	78,785	108,560	160,798	231,399
Smallmouth Buffalo	866,062,016	968,246,976	1,031,310,976	1,057,464,896	17,920,100	24,424,200	36,893,100	53,179,200
Spotted Sucker	1,895,245,312	2,098,110,592	2,235,264,768	2,278,976,512	48,250,000	66,520,000	96,750,000	141,030,000
Sturgeon	1,088,890	1,225,416	1,308,779	1,355,058	28,394	39,430	59,590	86,950
Walleye	193,976,992	216,345,488	227,679,872	231,448,800	417,221	578,646	861,900	1,232,310
White Bass	726,778,368	811,480,768	859,324,288	877,065,344	5,515,200	7,526,500	11,565,600	16,440,400
TOTALS	**32,936,005,632**	**36,843,208,704**	**39,236,497,408**	**40,066,424,832**	**588,375,488**	**806,475,200**	**1,185,715,328**	**1,735,985,920**
		EXCLUDED FROM CONSIDERATION						
Bowfin	1,610,730	1,810,970	1,921,010	1,980,810	39,834	55,837	84,896	121,695
Carp	7,088,170,496	7,936,457,728	8,462,711,808	8,707,224,576	147,460,992	201,563,008	304,627,008	432,009,024
Emerald Shiner	7,770,158,592	8,714,120,192	9,320,748,032	9,625,568,256	387,758,016	538,004,032	785,220,032	1,137,689,984
Gizzard Shad	3,748,080,896	4,194,067,968	4,456,187,904	4,566,276,096	576,060,992	801,589,952	1,159,720,064	1,689,190,016
Shortnose Gar	20,279,770	22,508,490	23,647,540	23,897,780	90,620	122,520	181,740	266,390

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario K: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25; New 1200' Locks at Peoria and LaGrange

Incremental Percentage Entrainment

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	2.63	2.95	3.12	3.19	0.36	0.51	0.76	1.08
Blue Catfish	0.30	0.34	0.37	0.38	0.00	0.00	0.00	0.00
Blue Sucker	0.40	0.45	0.47	0.49	0.00	0.00	0.00	0.00
Bluegill	1.96	2.18	2.32	2.35	0.28	0.38	0.58	0.80
Channel Catfish	0.48	0.53	0.57	0.58	0.10	0.10	0.18	0.24
Crappie	1.39	1.55	1.64	1.68	0.20	0.31	0.46	0.60
Flathead Catfish	0.42	0.48	0.50	0.51	0.09	0.10	0.11	0.19
Freshwater Drum	2.12	2.37	2.51	2.56	0.31	0.45	0.68	0.98
Goldeye	1.45	1.63	1.73	1.77	0.10	0.13	0.19	0.29
Largemouth Bass	0.57	0.64	0.67	0.69	0.10	0.11	0.20	0.28
Mooneye	0.89	1.02	1.07	1.12	0.08	0.09	0.13	0.19
Northern Pike	0.54	0.60	0.65	0.66	0.10	0.10	0.14	0.21
Paddlefish	0.68	0.75	0.80	0.82	0.03	0.04	0.05	0.09
River Carpsucker	1.40	1.58	1.66	1.71	0.20	0.30	0.45	0.60
Sauger	1.54	1.73	1.83	1.86	0.20	0.26	0.38	0.55
Shorthead Redhorse	1.52	1.70	1.80	1.84	0.19	0.28	0.40	0.56
Smallmouth Bass	0.50	0.56	0.59	0.61	0.09	0.10	0.13	0.19
Smallmouth Buffalo	2.63	2.95	3.12	3.19	0.36	0.51	0.76	1.08
Spotted Sucker	2.50	2.79	2.96	3.02	0.14	0.17	0.26	0.40
Sturgeon	0.38	0.43	0.45	0.45	0.04	0.04	0.04	0.08
Walleye	1.47	1.65	1.76	1.79	0.20	0.26	0.39	0.56
White Bass	1.49	1.65	1.76	1.80	0.18	0.21	0.34	0.49
Average	**1.24**	**1.39**	**1.47**	**1.50**	**0.15**	**0.20**	**0.30**	**0.43**
	EXCLUDED FROM CONSIDERATION							
Bowfin	0.57	0.63	0.67	0.69	0.05	0.05	0.10	0.13
Carp	1.42	1.59	1.68	1.73	0.21	0.31	0.46	0.66
Emerald Shiner	2.07	2.31	2.45	2.51	0.32	0.49	0.70	1.00
Gizzard Shad	1.31	1.47	1.55	1.59	0.19	0.28	0.40	0.55
Shortnose Gar	0.44	0.49	0.53	0.53	0.04	0.04	0.04	0.08

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario K: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25; New 1200' Locks at Peoria and LaGrange

Incremental Equivalent Adults Lost (EAL)

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	279	312	332	340	6	8	13	18
Blue Catfish	3,104	3,529	3,802	3,939	0	0	0	0
Blue Sucker	4	5	5	6	0	0	0	0
Bluegill	9,684	10,882	11,690	12,080	410	533	790	1,153
Channel Catfish	36,923	41,992	45,198	46,797	592	834	1,226	1,810
Crappie	39,394	44,125	46,983	48,330	1,613	2,200	3,346	4,700
Flathead Catfish	6,825	7,722	8,262	8,495	118	169	249	370
Freshwater Drum	50,321	56,207	59,716	60,762	793	1,085	1,569	2,298
Goldeye	3,623	4,056	4,318	4,431	44	59	89	126
Largemouth Bass	1,686	1,914	2,056	2,133	60	85	127	188
Mooneye	7,893	8,830	9,417	9,668	83	116	164	229
Northern Pike	1,046	1,165	1,220	1,230	13	20	29	43
Paddlefish	2,013	2,279	2,442	2,529	49	70	103	147
River Carpsucker	6,595	7,404	7,917	8,181	363	493	731	1,046
Sauger	15,304	17,064	18,022	18,403	57	79	116	166
Shorthead Redhorse	13,355	14,825	15,746	16,109	191	263	379	549
Smallmouth Bass	66	75	80	83	3	4	6	8
Smallmouth Buffalo	877	979	1,042	1,067	19	26	39	57
Spotted Sucker	91,627	101,413	108,027	110,095	2,462	3,388	4,927	7,178
Sturgeon	1,907	2,183	2,362	2,459	68	100	159	238
Walleye	3,960	4,419	4,661	4,757	10	14	20	29
White Bass	66,608	74,546	79,092	80,876	598	812	1,242	1,757
TOTALS	**363,094**	**405,926**	**432,392**	**442,770**	**7,553**	**10,359**	**15,325**	**22,111**
		EXCLUDED FROM CONSIDERATION						
Bowfin	338,780	387,330	417,804	434,519	12,076	17,791	28,342	41,699
Carp	464,417	518,960	552,559	567,921	10,750	14,561	21,810	30,738
Emerald Shiner	433,123	494,722	536,697	559,624	27,123	39,356	59,701	88,765
Gizzard Shad	88,223	98,974	105,537	108,597	16,940	23,401	33,626	48,698
Shortnose Gar	49,442	55,777	59,313	60,551	336	477	742	1,120

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario K: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25; New 1200' Locks at Peoria and LaGrange

Incremental Recruitment Forgone (Individuals)

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	3,360	3,756	4,000	4,100	74	101	153	220
Blue Catfish	6,712	7,546	8,069	8,311	0	0	0	0
Blue Sucker	750	851	919	968	0	0	0	0
Bluegill	162,033	182,620	196,595	203,482	7,044	9,264	13,851	20,359
Channel Catfish	19,028	21,382	22,793	23,415	262	363	526	769
Crappie	21,345	23,933	25,473	26,191	862	1,185	1,821	2,572
Flathead Catfish	1,066	1,191	1,263	1,289	15	21	31	45
Freshwater Drum	315,349	352,980	375,593	382,548	5,075	7,016	10,229	15,064
Goldeye	40,480	45,298	48,229	49,487	475	647	988	1,403
Largemouth Bass	3,903	4,386	4,668	4,822	121	167	245	355
Mooneye	95,075	106,465	113,588	116,665	989	1,388	1,981	2,780
Northern Pike	104	115	120	120	1	1	2	3
Paddlefish	2	2	2	3	0	0	0	0
River Carpsucker	15,158	17,059	18,269	18,896	838	1,148	1,719	2,475
Sauger	6,026	6,735	7,117	7,269	22	31	46	66
Shorthead Redhorse	1,011,558	1,125,573	1,197,926	1,226,522	14,438	20,067	29,111	42,479
Smallmouth Bass	325	364	386	396	10	14	21	30
Smallmouth Buffalo	8,787	9,822	10,461	10,723	194	265	400	576
Spotted Sucker	167,076	184,958	197,034	200,863	4,483	6,178	8,988	13,103
Sturgeon	15	17	18	18	0	1	1	1
Walleye	2,603	2,903	3,055	3,105	6	8	12	17
White Bass	5,874	6,558	6,943	7,085	50	68	104	149
TOTALS	**1,886,615**	**2,104,519**	**2,242,528**	**2,296,264**	**34,961**	**47,933**	**70,229**	**102,466**
	EXCLUDED FROM CONSIDERATION							
Bowfin	682	766	811	834	20	27	42	60
Carp	2,584	2,893	3,085	3,173	61	83	125	178
Emerald Shiner	104,406,976	117,072,656	125,227,400	129,316,160	5,557,000	7,710,200	11,254,900	16,304,600
Gizzard Shad	69,941	78,236	83,083	85,076	12,051	16,768	24,263	35,337
Shortnose Gar	201,747	223,813	235,044	237,339	1,040	1,404	2,086	3,059

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario K: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25; New 1200' Locks at Peoria and LaGrange

Incremental Production Forgone (MT)

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	546,885	611,102	650,623	666,662	12,041	16,390	24,732	35,613
Blue Catfish	12,753	14,337	15,331	15,791	0	0	0	0
Blue Sucker	5,647	6,404	6,916	7,281	0	0	0	0
Bluegill	11,645	13,119	14,122	14,615	505	664	991	1,456
Channel Catfish	6,389	7,179	7,652	7,861	88	122	176	258
Crappie	15,187	17,026	18,119	18,631	612	841	1,292	1,823
Flathead Catfish	50,290	56,160	59,546	60,790	725	1,010	1,459	2,131
Freshwater Drum	5,705,267	6,380,961	6,784,864	6,906,432	90,818	125,037	181,607	266,774
Goldeye	14,600	16,331	17,381	17,828	171	232	354	502
Largemouth Bass	823	925	985	1,017	26	35	52	75
Mooneye	4,786	5,358	5,713	5,868	50	70	99	139
Northern Pike	9,627	10,625	11,039	11,029	84	120	173	248
Paddlefish	6,557	7,366	7,818	8,071	137	194	279	397
River Carpsucker	65,371	73,535	78,742	81,427	3,607	4,937	7,383	10,620
Sauger	12,020	13,430	14,189	14,491	44	61	91	131
Shorthead Redhorse	167,449	186,285	198,214	202,896	2,391	3,321	4,814	7,018
Smallmouth Bass	80	89	95	97	3	3	5	7
Smallmouth Buffalo	205,255	229,360	244,243	250,283	4,522	6,156	9,292	13,383
Spotted Sucker	54,425	60,223	64,139	65,372	1,464	2,016	2,929	4,267
Sturgeon	829	930	991	1,021	25	35	52	76
Walleye	57,739	64,376	67,730	68,814	130	180	269	384
White Bass	14,071	15,704	16,623	16,959	119	162	248	353
TOTALS	**6,967,697**	**7,790,830**	**8,285,068**	**8,443,243**	**117,561**	**161,586**	**236,296**	**345,655**
		EXCLUDED FROM CONSIDERATION						
Bowfin	0	0	0	0	0	0	0	0
Carp	9,005,095	10,078,424	10,743,598	11,050,547	210,707	287,662	434,630	615,815
Emerald Shiner	262	293	312	321	13	18	26	37
Gizzard Shad	223,755	250,209	265,627	271,939	38,376	53,329	77,089	112,170
Shortnose Gar	54	59	62	63	0	0	1	1

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario K: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25; New 1200' Locks at Peoria and LaGrange

Impact Index (EAL)
- 1000 to 5000
- 5000 to 15,000
- > 15,000

Alternative K - YR 2040

		Mississippi River					Illinois Waterway		
	Species	USA-3	4-8	9-15	16-27	Open River	Lower	Middle	Upper
1	Blue Sucker	0	0	0	5	0	0	0	0
2	Smallmouth Bass	2	6	22	47	19	2	3	1
3	Northern Pike	86	301	727	98	37	14	13	2
4	Bigmouth Buffalo	8	7	83	231	9	4	6	2
5	Smallmouth Buffalo	22	23	261	728	37	14	20	5
6	Largemouth Bass	2	171	573	1,211	463	50	76	1
7	Sturgeon	12	172	619	1,406	712	60	99	0
8	Paddlefish	39	188	652	1,447	541	61	42	0
9	Walleye	369	601	1,263	2,419	42	7	10	3
10	Blue Catfish	0	0	841	2,957	19	0	0	0
11	Goldeye	16	97	980	3,174	236	37	53	0
12	Flathead Catfish	90	714	2,405	5,039	69	85	128	37
13	River Carpsucker	10	25	980	6,796	490	264	370	97
14	Mooneye	13	44	1,823	7,468	319	101	64	0
15	Sauger	272	357	8,569	8,770	250	42	59	15
16	Bluegill	5	126	1,273	10,280	9	297	385	109
17	Shorthead Redhorse	20	41	5,211	10,450	97	138	190	50
18	Channel Catfish	353	970	7,389	36,430	245	428	624	174
19	Crappie	922	1,446	7,890	36,710	65	1,197	1,714	435
20	Freshwater Drum	318	589	14,980	43,780	204	571	784	214
21	White Bass	1,480	5,042	27,380	45,170	97	470	676	96
22	Spotted Sucker	663	711	53,200	53,090	1,693	2,046	2,881	0
	PERCENT OF TOTAL	4,702	11,631	137,121	277,706	5,652	5,888	8,197	1,241
	IMPACT (BY RIVER)	1.1%	2.7%	31.4%	63.6%	1.3%	38.4%	53.5%	8.1%
	Total Mississippi River =		436,812					Total IWW =	15,326
	Combined Total =		452,138						
	% Miss =		96.6%					% IWW =	3.4%

Systemic Fish Model Results for:

Scenario L

- Mooring cells at L&D: 12,18,20,22 and 24.
- Extended Locks at L&D: 14-18, 20-25.

These tabular model outputs should be considered in light of the methodologies, assumptions and limits described in accompanying narrative or in previously reviewed documentation on the individual studies.

Incremental Increase in Larvae Entrained and Killed

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	846,786,048	947,160,000	1,025,952,960	1,049,040,960	7,356,750	6,443,730	5,799,800	6,187,000
Blue Catfish	48,259,000	54,171,032	57,973,104	59,491,120	0	0	0	0
Blue Sucker	13,897,800	16,157,950	23,303,760	24,149,280	0	0	0	0
Bluegill	2,178,289,920	2,447,846,912	2,626,254,848	2,702,186,752	30,720,600	32,220,900	30,006,500	34,806,320
Channel Catfish	48,420,000	54,323,232	57,958,104	59,327,920	270,853	233,492	202,750	216,219
Crappie	544,062,080	609,540,608	648,392,704	665,071,552	8,559,800	7,893,410	6,905,500	6,672,960
Flathead Catfish	33,690,880	37,602,260	39,993,856	40,726,740	185,917	156,128	133,360	139,685
Freshwater Drum	21,880,436,736	24,490,381,312	26,099,247,104	26,570,608,640	139,200,000	114,651,848	109,702,000	119,509,000
Goldeye	133,356,064	149,728,000	167,455,280	171,331,680	625,390	616,605	432,482	430,546
Largemouth Bass	50,041,928	56,565,620	68,036,808	69,573,744	752,853	648,477	500,917	502,002
Mooneye	104,709,952	117,458,688	129,294,616	132,485,400	511,490	513,795	422,782	418,700
Northern Pike	10,962,050	12,104,390	12,750,780	12,734,270	43,154	41,903	35,921	35,083
Paddlefish	1,137,838	1,286,010	1,539,240	1,573,170	12,571	12,592	12,678	11,770
River Carpsucker	326,402,656	368,386,880	416,682,560	428,696,672	7,146,400	6,276,259	5,372,100	5,632,800
Sauger	116,592,992	130,340,704	138,772,320	141,591,280	178,228	157,956	133,878	133,090
Shorthead Redhorse	2,755,732,480	3,067,532,288	3,281,005,568	3,357,770,240	15,617,500	13,165,700	11,293,300	11,847,000
Smallmouth Bass	2,554,850	2,886,470	3,486,690	3,549,220	34,483	30,256	24,839	25,646
Smallmouth Buffalo	846,786,048	947,160,000	1,025,952,960	1,049,040,960	7,356,750	6,443,730	5,799,800	6,187,000
Spotted Sucker	1,875,992,320	2,076,622,720	2,229,384,960	2,269,609,472	21,956,000	18,355,100	14,558,714	14,550,000
Sturgeon	868,550	988,996	1,277,939	1,305,458	10,957	9,888	9,877	9,877
Walleye	192,898,400	215,157,296	227,430,288	231,039,184	180,371	160,099	136,021	135,233
White Bass	725,818,240	810,396,224	858,970,944	876,522,496	2,277,400	2,079,096	1,745,070	1,711,340
TOTALS	**32,737,691,648**	**36,613,795,840**	**39,141,122,048**	**39,917,432,832**	**242,997,520**	**210,110,896**	**193,228,400**	**209,161,312**
		EXCLUDED FROM CONSIDERATION						
Bowfin	1,369,030	1,548,640	1,885,500	1,920,320	15,806	14,831	13,957	12,959
Carp	7,061,032,448	7,900,917,760	8,427,715,584	8,653,109,248	64,186,000	58,664,160	45,487,136	45,946,608
Emerald Shiner	7,742,922,752	8,671,648,768	9,253,479,424	9,526,725,632	172,593,696	148,175,168	122,255,600	126,463,096
Gizzard Shad	3,715,556,864	4,151,491,072	4,419,039,232	4,510,158,336	257,604,896	218,718,416	182,676,896	190,082,976
Shortnose Gar	20,041,220	22,247,800	23,587,840	23,805,410	37,484	33,445	28,560	31,069

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario L: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25;

Incremental Percentage Entrainment

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	2.54	2.85	3.09	3.15	0.18	0.11	0.15	0.15
Blue Catfish	0.28	0.32	0.36	0.37	0.00	0.00	0.00	0.00
Blue Sucker	0.38	0.42	0.47	0.49	0.00	0.00	0.00	0.00
Bluegill	1.88	2.10	2.30	2.32	0.09	0.10	0.10	0.09
Channel Catfish	0.46	0.51	0.57	0.57	0.01	0.01	0.01	0.01
Crappie	1.35	1.50	1.63	1.67	0.09	0.06	0.09	0.09
Flathead Catfish	0.39	0.45	0.50	0.51	0.00	0.00	0.01	0.01
Freshwater Drum	2.04	2.28	2.49	2.53	0.11	0.09	0.10	0.11
Goldeye	1.35	1.52	1.71	1.75	0.05	0.04	0.03	0.03
Largemouth Bass	0.55	0.61	0.67	0.68	0.01	0.01	0.01	0.03
Mooneye	0.82	0.94	1.06	1.11	0.04	0.03	0.03	0.03
Northern Pike	0.51	0.57	0.64	0.65	0.01	0.01	0.01	0.01
Paddlefish	0.65	0.73	0.79	0.81	0.01	0.01	0.01	0.01
River Carpsucker	1.33	1.49	1.65	1.68	0.10	0.06	0.09	0.09
Sauger	1.49	1.67	1.81	1.85	0.08	0.06	0.08	0.08
Shorthead Redhorse	1.43	1.60	1.78	1.82	0.10	0.08	0.08	0.09
Smallmouth Bass	0.47	0.53	0.59	0.60	0.01	0.01	0.01	0.01
Smallmouth Buffalo	2.54	2.85	3.09	3.15	0.18	0.11	0.15	0.15
Spotted Sucker	2.39	2.66	2.94	2.98	0.06	0.05	0.04	0.04
Sturgeon	0.35	0.40	0.44	0.45	0.00	0.00	0.00	0.00
Walleye	1.42	1.59	1.74	1.77	0.08	0.06	0.08	0.08
White Bass	1.39	1.55	1.74	1.77	0.08	0.03	0.05	0.05
Average	**1.18**	**1.32**	**1.46**	**1.49**	**0.06**	**0.04**	**0.05**	**0.05**
		EXCLUDED FROM CONSIDERATION						
Bowfin	0.54	0.60	0.67	0.68	0.01	0.01	0.01	0.01
Carp	1.34	1.50	1.67	1.70	0.11	0.06	0.09	0.09
Emerald Shiner	1.98	2.22	2.43	2.48	0.14	0.11	0.11	0.14
Gizzard Shad	1.24	1.38	1.54	1.57	0.10	0.09	0.08	0.09
Shortnose Gar	0.42	0.47	0.52	0.52	0.00	0.01	0.01	0.01

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario L: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25

Incremental Equivalent Adults Lost (EAL)

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	275	307	330	338	3	2	2	2
Blue Catfish	3,089	3,505	3,776	3,896	0	0	0	0
Blue Sucker	3	4	5	5	0	0	0	0
Bluegill	9,636	10,797	11,556	11,871	144	150	139	160
Channel Catfish	36,740	41,703	44,873	46,270	251	219	192	207
Crappie	39,271	43,945	46,743	47,959	669	615	531	512
Flathead Catfish	6,788	7,669	8,215	8,419	51	44	38	41
Freshwater Drum	50,226	56,093	59,653	60,665	335	274	261	283
Goldeye	3,531	3,955	4,298	4,399	19	18	13	13
Largemouth Bass	1,522	1,729	2,023	2,080	26	23	18	18
Mooneye	7,763	8,685	9,379	9,608	42	42	34	34
Northern Pike	1,032	1,149	1,217	1,226	7	7	6	6
Paddlefish	1,819	2,062	2,403	2,467	23	24	24	23
River Carpsucker	6,387	7,170	7,833	8,051	154	135	115	120
Sauger	15,203	16,951	17,992	18,356	25	22	18	18
Shorthead Redhorse	13,314	14,779	15,729	16,083	85	71	61	63
Smallmouth Bass	59	67	79	81	1	1	1	1
Smallmouth Buffalo	863	963	1,037	1,059	8	7	6	7
Spotted Sucker	90,926	100,618	107,761	109,678	1,120	934	740	739
Sturgeon	1,667	1,914	2,318	2,390	25	23	25	25
Walleye	3,942	4,399	4,656	4,749	4	4	3	3
White Bass	66,564	74,493	79,062	80,832	247	225	187	184
TOTALS	**360,621**	**402,957**	**430,939**	**440,483**	**3,239**	**2,841**	**2,415**	**2,458**
	EXCLUDED FROM CONSIDERATION							
Bowfin	303,918	347,560	411,024	423,425	4,505	4,402	4,421	4,130
Carp	463,109	517,135	550,337	564,510	4,697	4,269	3,289	3,304
Emerald Shiner	431,700	492,374	532,738	553,665	11,656	10,297	8,717	9,325
Gizzard Shad	87,680	98,192	104,599	107,188	7,590	6,413	5,352	5,539
Shortnose Gar	49,009	55,273	59,153	60,300	134	123	105	118

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario L: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25;

Incremental Recruitment Forgone (Individuals)

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	3,301	3,691	3,981	4,069	30	27	24	26
Blue Catfish	6,677	7,494	8,014	8,224	0	0	0	0
Blue Sucker	629	719	892	925	0	0	0	0
Bluegill	161,230	181,194	194,358	199,980	2,452	2,572	2,393	2,778
Channel Catfish	18,928	21,235	22,638	23,167	113	97	85	90
Crappie	21,280	23,836	25,347	25,996	355	327	286	276
Flathead Catfish	1,061	1,184	1,256	1,279	7	6	5	5
Freshwater Drum	314,707	352,215	375,193	381,932	2,128	1,750	1,677	1,829
Goldeye	39,304	44,026	47,992	49,102	201	198	138	138
Largemouth Bass	3,487	3,931	4,590	4,694	54	47	36	36
Mooneye	93,256	104,454	113,120	115,891	497	499	411	407
Northern Pike	103	114	119	119	0	0	0	0
Paddlefish	2	2	2	2	0	0	0	0
River Carpsucker	14,612	16,449	18,071	18,587	355	311	267	280
Sauger	5,984	6,688	7,106	7,250	10	8	7	7
Shorthead Redhorse	1,008,099	1,121,737	1,196,625	1,224,528	6,370	5,361	4,609	4,840
Smallmouth Bass	294	330	380	387	4	4	3	3
Smallmouth Buffalo	8,633	9,652	10,411	10,643	80	70	63	67
Spotted Sucker	165,742	183,455	196,550	200,097	2,037	1,702	1,349	1,348
Sturgeon	13	15	17	18	0	0	0	0
Walleye	2,592	2,891	3,052	3,100	3	2	2	2
White Bass	5,870	6,553	6,940	7,081	21	19	16	15
TOTALS	1,875,806	**2,091,868**	**2,236,664**	**2,287,054**	**14,718**	**13,001**	**11,369**	**12,148**
		EXCLUDED FROM CONSIDERATION						
Bowfin	615	692	799	813	8	7	7	6
Carp	2,576	2,882	3,072	3,154	26	24	19	19
Emerald Shiner	104,053,136	116,515,376	124,329,176	127,993,816	2,470,400	2,119,019	1,749,550	1,810,513
Gizzard Shad	69,528	77,653	82,419	84,076	5,376	4,559	3,816	3,974
Shortnose Gar	200,186	222,086	234,542	236,558	428	380	325	355

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario L: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25

Incremental Production Forgone (MT)

	Mississippi River				Illinois Waterway			
Species	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**	**YR 2020**	**YR 2030**	**YR 2040**	**YR 2050**
Bigmouth Buffalo	537,280	600,504	647,507	661,729	4,940	4,317	3,887	4,147
Blue Catfish	12,686	14,238	15,227	15,624	0	0	0	0
Blue Sucker	4,735	5,414	6,715	6,961	0	0	0	0
Bluegill	11,588	13,016	13,962	14,363	176	184	172	199
Channel Catfish	6,355	7,129	7,600	7,778	38	33	28	30
Crappie	15,140	16,958	18,030	18,492	252	232	203	196
Flathead Catfish	50,029	55,808	59,242	60,309	322	270	231	243
Freshwater Drum	5,693,569	6,367,092	6,777,642	6,895,301	38,172	31,333	29,953	32,563
Goldeye	14,178	15,875	17,296	17,690	72	71	50	49
Largemouth Bass	736	829	968	990	11	10	8	8
Mooneye	4,695	5,257	5,690	5,829	25	25	21	20
Northern Pike	9,531	10,521	11,021	11,000	42	41	35	34
Paddlefish	5,878	6,625	7,697	7,865	67	67	67	62
River Carpsucker	63,016	70,907	77,887	80,095	1,528	1,338	1,147	1,204
Sauger	11,935	13,335	14,166	14,454	19	17	14	14
Shorthead Redhorse	166,876	185,651	197,998	202,567	1,055	888	763	801
Smallmouth Bass	72	81	93	95	1	1	1	1
Smallmouth Buffalo	201,651	225,385	243,073	248,432	1,855	1,622	1,460	1,558
Spotted Sucker	53,989	59,732	63,981	65,122	666	556	440	440
Sturgeon	740	835	974	995	10	9	9	9
Walleye	57,490	64,100	67,662	68,704	56	50	42	42
White Bass	14,061	15,692	16,617	16,950	49	44	37	37
TOTALS	**6,936,231**	**7,754,984**	**8,271,050**	**8,421,338**	**49,357**	**41,107**	**38,569**	**41,656**
	EXCLUDED FROM CONSIDERATION							
Bowfin	0	0	0	0	0	0	0	0
Carp	8,978,620	10,042,068	10,700,165	10,983,479	91,561	83,427	64,762	65,391
Emerald Shiner	261	291	309	318	6	5	4	4
Gizzard Shad	222,440	248,345	263,512	268,744	17,136	14,521	12,149	12,636
Shortnose Gar	53	59	62	63	0	0	0	0

These tabular outputs should be considered in context of the assumptions and limitations of the methods as described in accompanying narrative or previously reviewed documentation of the individual studies.

Scenario L: Mooring cells 12, 18, 20, 22, and 24; Extended Locks at 14-18, 20-25

Impact Index (EAL)
- 1000 to 5000
- 5000 to 15,000
- > 15,000

Alternative L - YR 2040

		Mississippi River					Illinois Waterway		
	Species	USA-3	4-8	9-15	16-27	Open River	Lower	Middle	Upper
1	Blue Sucker	0	0	0	5	2	0	0	0
2	Smallmouth Bass	2	6	22	46	16	1	0	0
3	Northern Pike	86	301	727	97	7	5	0	0
4	Bigmouth Buffalo	8	7	83	230	9	2	0	0
5	Smallmouth Buffalo	22	23	261	725	6	5	0	1
6	Largemouth Bass	2	171	573	1,193	559	18	0	0
7	Sturgeon	12	172	619	1,387	595	23	2	0
8	Paddlefish	39	188	652	1,426	459	23	2	0
9	Walleye	369	601	1,263	2,415	37	3	0	1
10	Blue Catfish	0	0	841	2,932	16	0	0	0
11	Goldeye	16	97	980	3,161	199	13	0	0
12	Flathead Catfish	90	714	2,405	4,994	56	31	0	7
13	River Carpsucker	10	25	980	6,730	408	95	0	20
14	Mooneye	13	44	1,823	7,440	273	34	0	0
15	Sauger	272	357	8,569	8,748	212	15	0	3
16	Bluegill	5	126	1,273	10,150	6	123	0	17
17	Shorthead Redhorse	20	41	5,211	10,440	80	51	0	10
18	Channel Catfish	353	970	7,389	36,120	203	159	0	33
19	Crappie	922	1,446	7,890	36,470	53	422	16	93
20	Freshwater Drum	318	589	14,980	43,730	168	218	0	43
21	White Bass	1,480	5,042	27,380	45,140	81	164	4	19
22	Spotted Sucker	663	711	53,200	52,870	1,442	740	0	0
	PERCENT OF TOTAL	4,700	11,630	137,119	276,449	4,888	2,142	25	247
	IMPACT (BY RIVER)	1.1%	2.7%	31.5%	63.6%	1.1%	88.7%	1.0%	10.2%
	Total Mississippi River =		434,786					Total IWW =	2,415
	Combined Total =		437,201						
	% Miss =		99.4%					% IWW =	0.6%

Attachment 4

Attachment 4

Impacts of Alternatives K and L on
Mussel Growth and Reproduction

29th Meeting of the NECC
June 14, 2000

Presented by

Steve Bartell

The Cadmus Group, Inc

Mussel Impact Summaries

- Detailed impacts for selected location in LaGrange Pool (maximum modeled impacts)
- Average impacts for Pools 13, 26, and LaGrange for Alternatives J, K, and L

LaGrange Cell 35L1130 – Alternative K

Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in LaGrange, Cell ID 35L1130, During Years With and Without Project for Alternative K												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	6.31	6.31	0.00	167.20	167.20	0.00	173.50	173.50	0.00	9.37	9.37	0.00
50%	3.86	3.86	0.00	108.20	108.20	0.00	112.10	112.10	0.00	5.94	5.94	0.00
90%	2.64	2.64	0.00	78.54	78.54	0.00	81.18	81.18	0.00	4.12	4.12	0.00
2020												
10%	6.28	6.30	-0.02	167.00	166.90	0.10	173.30	173.20	0.10	9.36	9.36	0.00
50%	3.56	3.65	-0.09	100.90	103.20	-2.30	104.50	106.80	-2.30	5.63	5.57	0.05
90%	2.27	2.31	-0.04	69.74	70.74	-1.00	72.02	73.04	-1.02	3.82	3.68	0.14
2030												
10%	6.30	6.30	0.00	166.80	166.80	0.00	173.10	173.10	0.00	9.35	9.35	0.00
50%	3.64	3.67	-0.03	102.80	103.40	-0.60	106.40	107.00	-0.60	5.47	5.42	0.05
90%	2.30	2.31	-0.01	70.38	70.55	-0.17	72.67	72.85	-0.18	3.59	3.57	0.03
2040												
10%	6.29	6.28	0.01	166.60	166.70	-0.10	172.80	173.00	-0.20	9.34	9.35	0.00
50%	3.62	3.50	0.12	102.30	99.31	2.99	105.90	102.80	3.10	5.31	5.23	0.08
90%	1.95	0.00	1.95	62.04	3.85	58.19	63.99	3.85	60.14	3.22	0.00	3.22
2050												
10%	6.27	6.26	0.01	166.60	166.50	0.10	172.90	172.70	0.20	9.34	9.33	0.01
50%	3.54	3.51	0.04	100.40	99.53	0.87	104.00	103.00	1.00	5.27	5.18	0.09
90%	0.00	0.00	0.00	3.67	3.61	0.06	3.67	3.61	0.06	0.00	0.00	0.00

LaGrange Cell 35L1130 – Alternative L

Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in LaGrange, Cell ID 35L1130, During Years With and Without Project for Alternative L												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	6.31	6.31	0.00	167.20	167.20	0.00	173.50	173.50	0.00	9.37	9.37	0.00
50%	3.86	3.86	0.00	108.20	108.20	0.00	112.10	112.10	0.00	5.94	5.94	0.00
90%	2.64	2.64	0.00	78.54	78.54	0.00	81.18	81.18	0.00	4.12	4.12	0.00
2020												
10%	6.28	6.29	0.00	167.00	167.00	0.00	173.30	173.30	0.00	9.36	9.36	0.00
50%	3.56	3.61	-0.04	100.90	102.00	-1.10	104.50	105.60	-1.10	5.63	5.61	0.01
90%	2.27	2.32	-0.05	69.74	70.79	-1.05	72.02	73.11	-1.09	3.82	3.81	0.01
2030												
10%	6.30	6.30	0.00	166.80	166.90	-0.10	173.10	173.20	-0.10	9.35	9.35	0.00
50%	3.64	3.65	-0.01	102.80	103.00	-0.20	106.40	106.70	-0.30	5.47	5.45	0.02
90%	2.30	2.14	0.16	70.38	66.46	3.92	72.67	68.60	4.07	3.59	3.46	0.13
2040												
10%	6.29	6.29	0.00	166.60	166.60	0.00	172.80	172.90	-0.10	9.34	9.34	0.00
50%	3.62	3.63	-0.01	102.30	102.50	-0.20	105.90	106.10	-0.20	5.31	5.33	-0.02
90%	1.95	1.97	-0.01	62.04	62.34	-0.30	63.99	64.31	-0.32	3.22	3.24	-0.02
2050												
10%	6.27	6.27	0.00	166.60	166.70	-0.10	172.90	172.90	0.00	9.34	9.34	0.00
50%	3.54	3.55	-0.01	100.40	100.60	-0.20	104.00	104.10	-0.10	5.27	5.28	-0.01
90%	0.00	0.00	0.00	3.67	3.75	-0.08	3.67	3.75	-0.08	0.00	0.00	0.00

Pool 13 Averages – Alternative J

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in Pool 13 During Years With and Without Project for Alternative J												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	3.07	3.07	0.00	79.45	79.45	0.00	82.52	82.52	0.00	4.11	4.11	0.00
50%	3.00	3.00	0.00	77.77	77.77	0.00	80.77	80.77	0.00	3.92	3.92	0.00
90%	2.84	2.84	0.00	73.94	73.94	0.00	76.78	76.78	0.00	3.56	3.56	0.00
2020												
10%	3.07	3.07	0.00	79.45	79.45	0.00	82.52	82.52	0.00	4.11	4.11	0.00
50%	2.99	2.99	0.00	77.60	77.58	0.02	80.59	80.57	0.02	3.91	3.89	0.02
90%	2.81	2.81	0.01	73.38	73.17	0.20	76.19	75.98	0.21	3.53	3.49	0.04
2030												
10%	3.07	3.07	0.00	79.44	79.44	0.00	82.51	82.51	0.00	4.11	4.11	0.00
50%	2.99	2.99	0.00	77.64	77.55	0.09	80.63	80.53	0.10	3.91	3.87	0.04
90%	2.83	2.81	0.03	73.78	73.18	0.61	76.62	75.98	0.63	3.57	3.46	0.10
2040												
10%	1.84	1.84	0.00	47.64	47.67	-0.03	49.48	49.51	-0.03	2.46	2.46	0.00
50%	3.00	2.97	0.03	77.79	77.17	0.62	80.79	80.14	0.65	3.92	3.85	0.07
90%	2.84	2.75	0.09	74.05	71.73	2.32	76.89	74.48	2.41	3.58	3.42	0.16
2050												
10%	1.84	1.84	0.00	47.67	47.66	0.01	49.52	49.50	0.01	2.46	2.46	0.00
50%	2.99	2.98	0.01	77.68	77.36	0.32	80.68	80.33	0.34	3.91	3.86	0.05
90%	2.84	2.74	0.09	74.00	71.66	2.34	76.84	74.41	2.43	3.56	3.42	0.13

Pool 13 Averages – Alternative K

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in Pool 13 During Years With and Without Project for Alternative K												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	3.07	3.07	0.00	79.45	79.45	0.00	82.52	82.52	0.00	4.11	4.11	0.00
50%	3.00	3.00	0.00	77.77	77.77	0.00	80.77	80.77	0.00	3.92	3.92	0.00
90%	2.84	2.84	0.00	73.94	73.94	0.00	76.78	76.78	0.00	3.56	3.56	0.00
2020												
10%	3.07	3.07	0.00	79.45	79.44	0.01	82.52	82.51	0.01	4.11	4.11	0.00
50%	2.99	2.97	0.02	77.60	77.12	0.47	80.59	80.10	0.49	3.91	3.86	0.05
90%	2.81	2.74	0.07	73.38	71.67	1.71	76.19	74.41	1.78	3.53	3.41	0.12
2030												
10%	3.07	3.07	0.00	79.44	79.45	0.00	82.51	82.52	-0.01	4.11	4.11	0.00
50%	2.99	2.97	0.02	77.64	77.09	0.55	80.63	80.06	0.57	3.91	3.84	0.07
90%	2.83	2.73	0.11	73.78	71.17	2.61	76.62	73.89	2.72	3.57	3.40	0.17
2040												
10%	1.84	1.84	0.00	47.64	47.65	-0.01	49.48	49.49	-0.01	2.46	2.46	0.00
50%	3.00	2.98	0.02	77.79	77.29	0.51	80.79	80.26	0.53	3.92	3.84	0.08
90%	2.84	2.71	0.13	74.05	70.92	3.13	76.89	73.63	3.26	3.58	3.39	0.19
2050												
10%	1.84	1.84	0.00	47.67	47.66	0.01	49.52	49.51	0.01	2.46	2.46	0.00
50%	2.99	2.97	0.02	77.68	77.20	0.48	80.68	80.17	0.51	3.91	3.83	0.08
90%	2.84	2.70	0.14	74.00	70.57	3.43	76.84	73.27	3.57	3.56	3.37	0.19

Pool 13 Averages – Alternative L

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in Pool 13 During Years With and Without Project for Alternative L												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	3.07	3.07	0.00	79.45	79.45	0.00	82.52	82.52	0.00	4.11	4.11	0.00
50%	3.00	3.00	0.00	77.77	77.77	0.00	80.77	80.77	0.00	3.92	3.92	0.00
90%	2.84	2.84	0.00	73.94	73.94	0.00	76.78	76.78	0.00	3.56	3.56	0.00
2020												
10%	3.07	3.07	0.00	79.44	79.44	0.00	82.51	82.51	0.00	4.11	4.11	0.00
50%	2.97	2.97	0.00	77.12	77.12	0.00	80.10	80.10	0.00	3.86	3.86	0.00
90%	2.74	2.74	0.00	71.67	71.67	0.00	74.41	74.41	0.00	3.41	3.41	0.00
2030												
10%	3.07	3.07	0.00	79.45	79.45	0.00	82.52	82.52	0.00	4.11	4.11	0.00
50%	2.97	2.97	0.00	77.09	77.09	0.00	80.06	80.06	0.00	3.84	3.84	0.00
90%	2.73	2.73	0.00	71.17	71.17	0.00	73.89	73.89	0.00	3.40	3.40	0.00
2040												
10%	1.84	1.84	0.00	47.65	47.65	0.00	49.49	49.49	0.00	2.46	2.46	0.00
50%	2.98	2.98	0.00	77.29	77.29	0.00	80.26	80.26	0.00	3.84	3.84	0.00
90%	2.71	2.71	0.00	70.92	70.92	0.00	73.63	73.63	0.00	3.39	3.39	0.00
2050												
10%	1.84	1.84	0.00	47.66	47.66	0.00	49.51	49.51	0.00	2.46	2.46	0.00
50%	2.97	2.97	0.00	77.20	77.20	0.00	80.17	80.17	0.00	3.83	3.83	0.00
90%	2.70	2.70	0.00	70.57	70.57	0.00	73.27	73.27	0.00	3.37	3.37	0.00

Pool 26 (A and B) Averages –Alternative J

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in Pool 26 (A and B) During Years With and Without Project for Alternative J												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.73	145.73	0.00	151.23	151.23	0.00	7.59	7.59	0.00
90%	5.37	5.37	0.00	142.00	142.00	0.00	147.38	147.38	0.00	7.44	7.44	0.00
2020												
10%	5.53	5.52	0.00	145.75	145.73	0.03	151.28	151.23	0.05	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.23	151.20	0.03	7.59	7.59	0.00
90%	5.36	5.34	0.02	141.80	141.38	0.42	147.18	146.73	0.45	7.43	7.41	0.02
2030												
10%	5.53	5.52	0.00	145.75	145.73	0.03	151.25	151.23	0.03	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.73	-0.03	151.25	151.25	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.75	-0.05	151.25	151.25	0.00	7.59	7.59	0.00
2040												
10%	4.14	4.14	0.00	109.28	109.28	0.00	113.43	113.40	0.03	5.69	5.69	0.00
50%	5.52	5.52	0.00	145.70	145.73	-0.03	151.23	151.25	-0.03	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.23	151.23	0.00	7.59	7.59	0.00
2050												
10%	4.14	4.14	0.00	109.30	109.30	0.00	113.43	113.43	0.00	5.69	5.69	0.00
50%	5.52	5.52	0.00	145.73	145.73	0.00	151.25	151.30	-0.05	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.75	145.70	0.05	151.28	151.25	0.03	7.59	7.59	0.00

Pool 26 (A and B) Averages –Alternative K

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in Pool 26 (A and B) During Years With and Without Project for Alternative K												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.73	145.73	0.00	151.23	151.23	0.00	7.59	7.59	0.00
90%	5.37	5.37	0.00	142.00	142.00	0.00	147.38	147.38	0.00	7.44	7.44	0.00
2020												
10%	5.53	5.52	0.01	145.75	145.70	0.05	151.28	151.23	0.05	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.73	-0.03	151.23	151.25	-0.03	7.59	7.59	0.00
90%	5.36	5.34	0.02	141.80	141.30	0.50	147.18	146.65	0.53	7.43	7.41	0.03
2030												
10%	5.53	5.52	0.00	145.75	145.73	0.03	151.25	151.25	0.00	7.59	7.59	0.00
50%	5.52	5.53	-0.01	145.70	145.75	-0.05	151.25	151.30	-0.05	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.75	-0.05	151.25	151.28	-0.03	7.59	7.59	0.00
2040												
10%	4.14	4.14	0.00	109.28	109.30	-0.03	113.43	113.45	-0.03	5.69	5.69	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.23	151.23	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.23	151.23	0.00	7.59	7.59	0.00
2050												
10%	4.14	4.14	0.00	109.30	109.28	0.03	113.43	113.43	0.00	5.69	5.69	0.00
50%	5.52	5.52	0.00	145.73	145.73	0.00	151.25	151.25	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.75	145.75	0.00	151.28	151.28	0.00	7.59	7.59	0.00

Pool 26 (A and B) Averages –Alternative L

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in Pool 26 (A and B) During Years With and Without Project for Alternative L												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.73	145.73	0.00	151.23	151.23	0.00	7.59	7.59	0.00
90%	5.37	5.37	0.00	142.00	142.00	0.00	147.38	147.38	0.00	7.44	7.44	0.00
2020												
10%	5.53	5.52	0.01	145.75	145.70	0.05	151.28	151.23	0.05	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.73	-0.03	151.23	151.25	-0.03	7.59	7.59	0.00
90%	5.36	5.34	0.02	141.80	141.30	0.50	147.18	146.65	0.53	7.43	7.41	0.03
2030												
10%	5.53	5.52	0.00	145.75	145.73	0.03	151.25	151.25	0.00	7.59	7.59	0.00
50%	5.52	5.53	-0.01	145.70	145.75	-0.05	151.25	151.28	-0.03	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.75	-0.05	151.25	151.28	-0.03	7.59	7.59	0.00
2040												
10%	4.14	4.14	0.00	109.28	109.30	-0.03	113.43	113.45	-0.03	5.69	5.69	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.23	151.23	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.23	151.23	0.00	7.59	7.59	0.00
2050												
10%	4.14	4.14	0.00	109.30	109.28	0.03	113.43	113.43	0.00	5.69	5.69	0.00
50%	5.52	5.52	0.00	145.73	145.73	0.00	151.25	151.25	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.75	145.75	0.00	151.28	151.28	0.00	7.59	7.59	0.00

LaGrange Averages –Alternative J

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in the LaGrange Pool During Years With and Without Project for Alternative J												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	6.32	6.32	0.00	167.56	167.58	-0.02	173.87	173.89	-0.02	9.38	9.39	0.00
50%	4.23	4.24	-0.01	117.18	117.40	-0.22	121.43	121.64	-0.21	6.62	6.64	-0.02
90%	2.85	2.87	-0.02	83.73	84.26	-0.52	86.59	87.13	-0.54	4.56	4.60	-0.04
2020												
10%	6.31	6.31	0.00	167.34	167.30	0.04	173.65	173.62	0.03	9.38	9.37	0.00
50%	3.90	3.95	-0.04	109.16	110.17	-1.01	113.06	114.11	-1.05	6.23	6.17	0.06
90%	2.49	2.52	-0.03	74.94	75.84	-0.90	77.43	78.36	-0.93	4.18	4.05	0.13
2030												
10%	6.31	6.31	0.00	167.25	167.21	0.04	173.55	173.54	0.01	9.37	9.37	0.00
50%	3.92	3.93	-0.01	109.59	109.80	-0.21	113.51	113.72	-0.21	6.09	6.04	0.05
90%	2.51	2.52	-0.01	75.49	75.69	-0.19	78.00	78.20	-0.21	3.97	3.94	0.03
2040												
10%	6.30	6.30	0.00	167.10	167.10	0.00	173.39	173.39	-0.01	9.37	9.37	0.00
50%	3.91	3.82	0.09	109.20	107.14	2.06	113.11	110.97	2.15	5.96	5.88	0.08
90%	2.23	1.70	0.52	67.85	53.01	14.84	70.08	54.71	15.37	3.48	2.72	0.76
2050												
10%	6.30	6.30	0.00	167.13	166.98	0.15	173.43	173.26	0.17	9.37	9.36	0.01
50%	3.85	3.76	0.09	107.84	105.77	2.07	111.69	109.53	2.16	5.92	5.80	0.12
90%	1.43	1.68	-0.25	44.92	52.30	-7.39	46.35	53.98	-7.63	2.28	2.70	-0.42

LaGrange Averages –Alternative K

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in the LaGrange Pool During Years With and Without Project for Alternative K												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	6.32	6.32	0.00	167.56	167.56	0.00	173.87	173.87	0.00	9.38	9.38	0.00
50%	4.23	4.23	0.00	117.18	117.18	0.01	121.43	121.43	0.01	6.62	6.62	0.00
90%	2.85	2.85	0.00	83.73	83.73	0.00	86.59	86.59	0.00	4.56	4.56	0.00
2020												
10%	6.31	6.31	0.00	167.34	167.30	0.04	173.65	173.62	0.03	9.38	9.37	0.00
50%	3.90	3.95	-0.04	109.16	110.17	-1.01	113.06	114.11	-1.05	6.23	6.17	0.06
90%	2.49	2.52	-0.03	74.94	75.84	-0.90	77.43	78.36	-0.93	4.18	4.05	0.13
2030												
10%	6.31	6.31	0.00	167.25	167.21	0.04	173.55	173.54	0.01	9.37	9.37	0.00
50%	3.92	3.93	-0.01	109.59	109.80	-0.21	113.51	113.72	-0.21	6.09	6.04	0.05
90%	2.51	2.52	-0.01	75.49	75.69	-0.19	78.00	78.20	-0.21	3.97	3.94	0.03
2040												
10%	6.30	6.30	0.00	167.10	167.10	0.00	173.39	173.39	-0.01	9.37	9.37	0.00
50%	3.91	3.82	0.09	109.20	107.14	2.06	113.11	110.97	2.15	5.96	5.88	0.08
90%	2.23	1.70	0.52	67.85	53.01	14.84	70.08	54.71	15.37	3.48	2.72	0.76
2050												
10%	6.30	6.30	0.00	167.13	166.97	0.17	173.43	173.24	0.19	9.37	9.36	0.01
50%	3.85	3.77	0.08	107.84	105.94	1.91	111.69	109.70	2.00	5.92	5.80	0.11
90%	1.43	1.69	-0.26	44.92	52.51	-7.59	46.35	54.19	-7.85	2.28	2.70	-0.42

LaGrange Averages –Alternative L

Average Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g) and Cumulative Reproductive Effort (kJ) for Mussels in for Mussels in all Beds in the LaGrange Pool During Years With and Without Project for Alternative L												
	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Reproductive Effort (kJ)		
2010	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.	W/O	With	Diff.
10%	6.32	6.32	0.00	167.56	167.56	0.00	173.87	173.87	0.00	9.38	9.38	0.00
50%	4.23	4.23	0.00	117.18	117.18	0.00	121.43	121.43	0.00	6.62	6.62	0.00
90%	2.85	2.85	0.00	83.73	83.73	0.00	86.59	86.59	0.00	4.56	4.56	0.00
2020												
10%	6.31	6.31	0.00	167.34	167.38	-0.04	173.65	173.69	-0.04	9.38	9.38	0.00
50%	3.90	3.93	-0.03	109.16	109.84	-0.68	113.06	113.77	-0.71	6.23	6.22	0.01
90%	2.49	2.52	-0.03	74.94	75.79	-0.84	77.43	78.31	-0.88	4.18	4.17	0.01
2030												
10%	6.31	6.31	0.00	167.25	167.22	0.03	173.55	173.53	0.02	9.37	9.37	0.00
50%	3.92	3.93	0.00	109.59	109.74	-0.15	113.51	113.66	-0.15	6.09	6.06	0.03
90%	2.51	2.41	0.10	75.49	72.93	2.56	78.00	75.34	2.66	3.97	3.84	0.13
2040												
10%	6.30	6.30	0.00	167.10	167.12	-0.02	173.39	173.43	-0.05	9.37	9.37	0.00
50%	3.91	3.90	0.01	109.20	109.01	0.19	113.11	112.90	0.21	5.96	5.96	0.00
90%	2.23	2.34	-0.11	67.85	71.24	-3.38	70.08	73.57	-3.49	3.48	3.69	-0.21
2050												
10%	6.30	6.30	0.00	167.13	167.13	0.01	173.43	173.43	0.01	9.37	9.37	0.00
50%	3.85	3.85	0.00	107.84	107.87	-0.02	111.69	111.72	-0.02	5.92	5.92	0.00
90%	1.43	1.57	-0.14	44.92	49.03	-4.11	46.35	50.60	-4.25	2.28	2.52	-0.24

Attachment 5

Attachment 5

Impacts of Alternatives J, K, and L on
Submerged Plant Growth

29th Meeting of the NECC
June 14, 2000

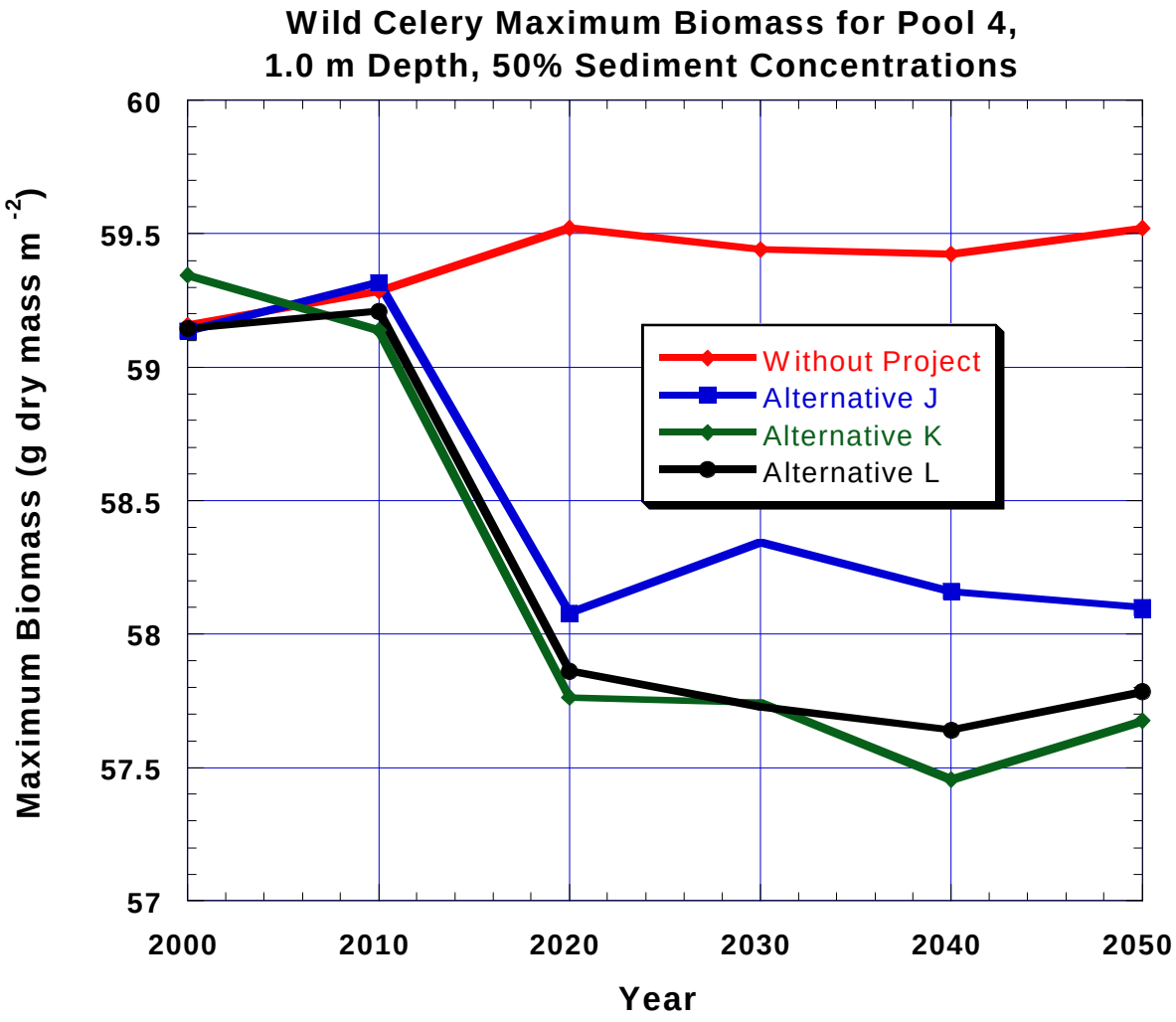
Presented by

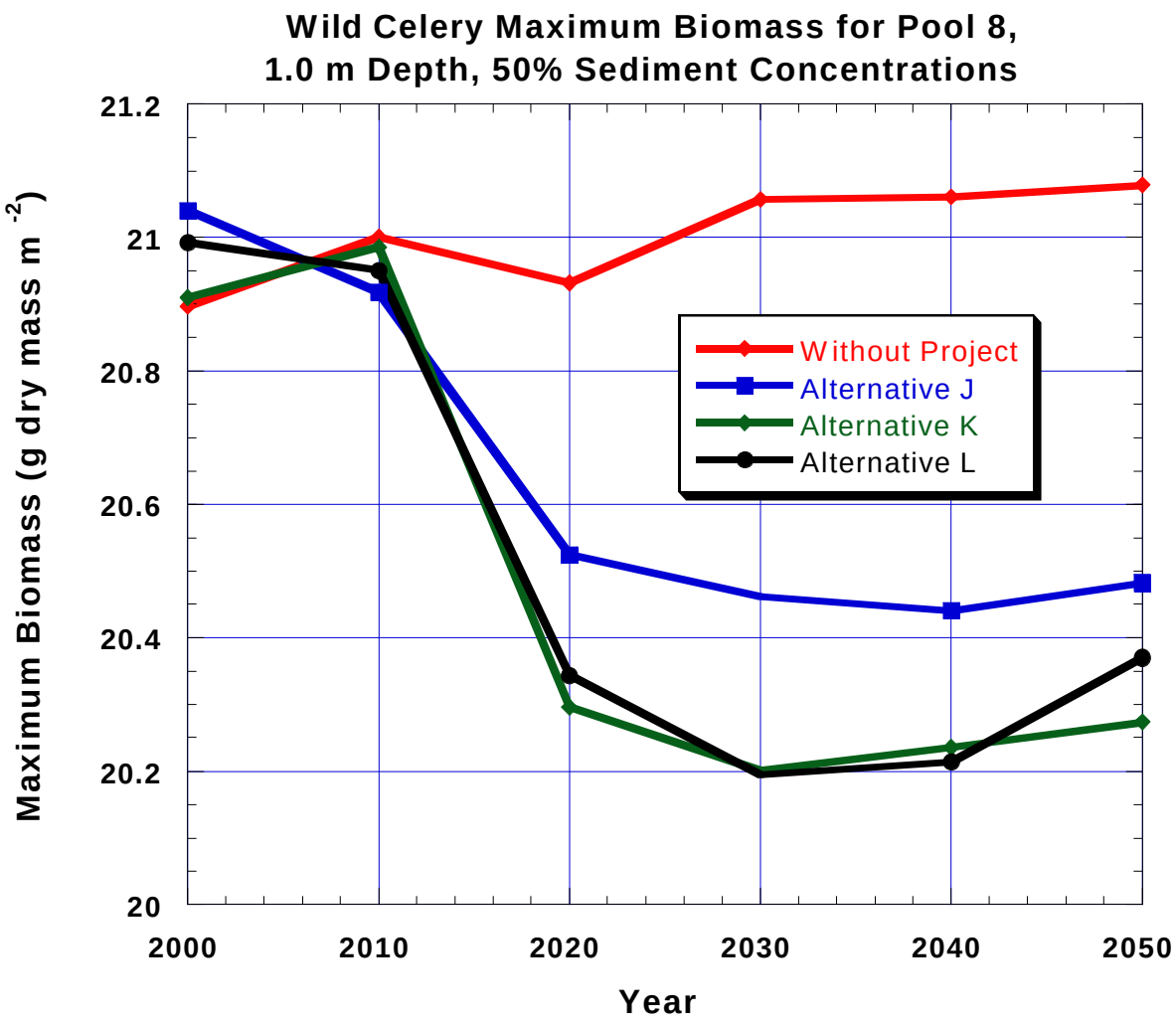
Steve Bartell

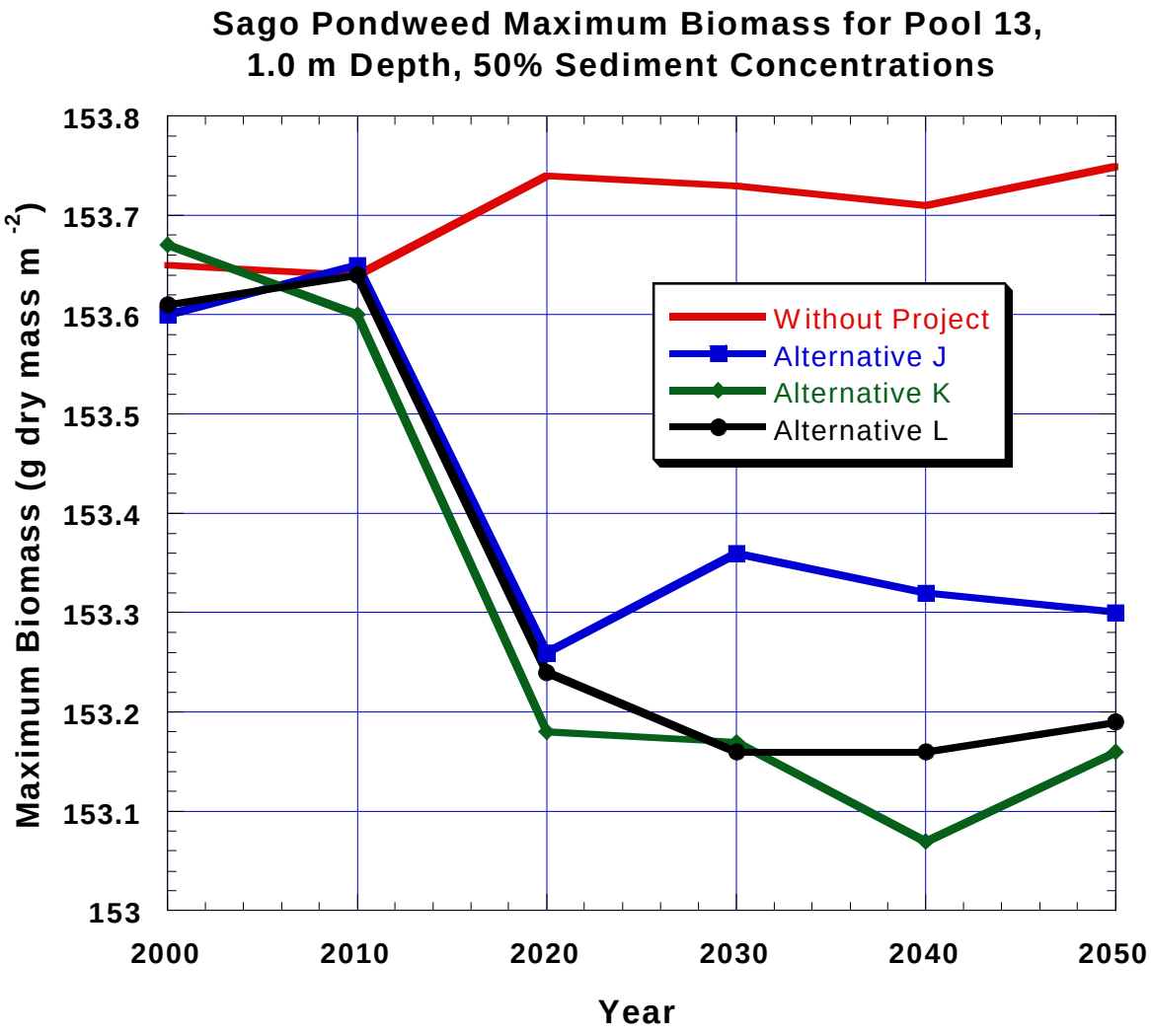
The Cadmus Group, Inc

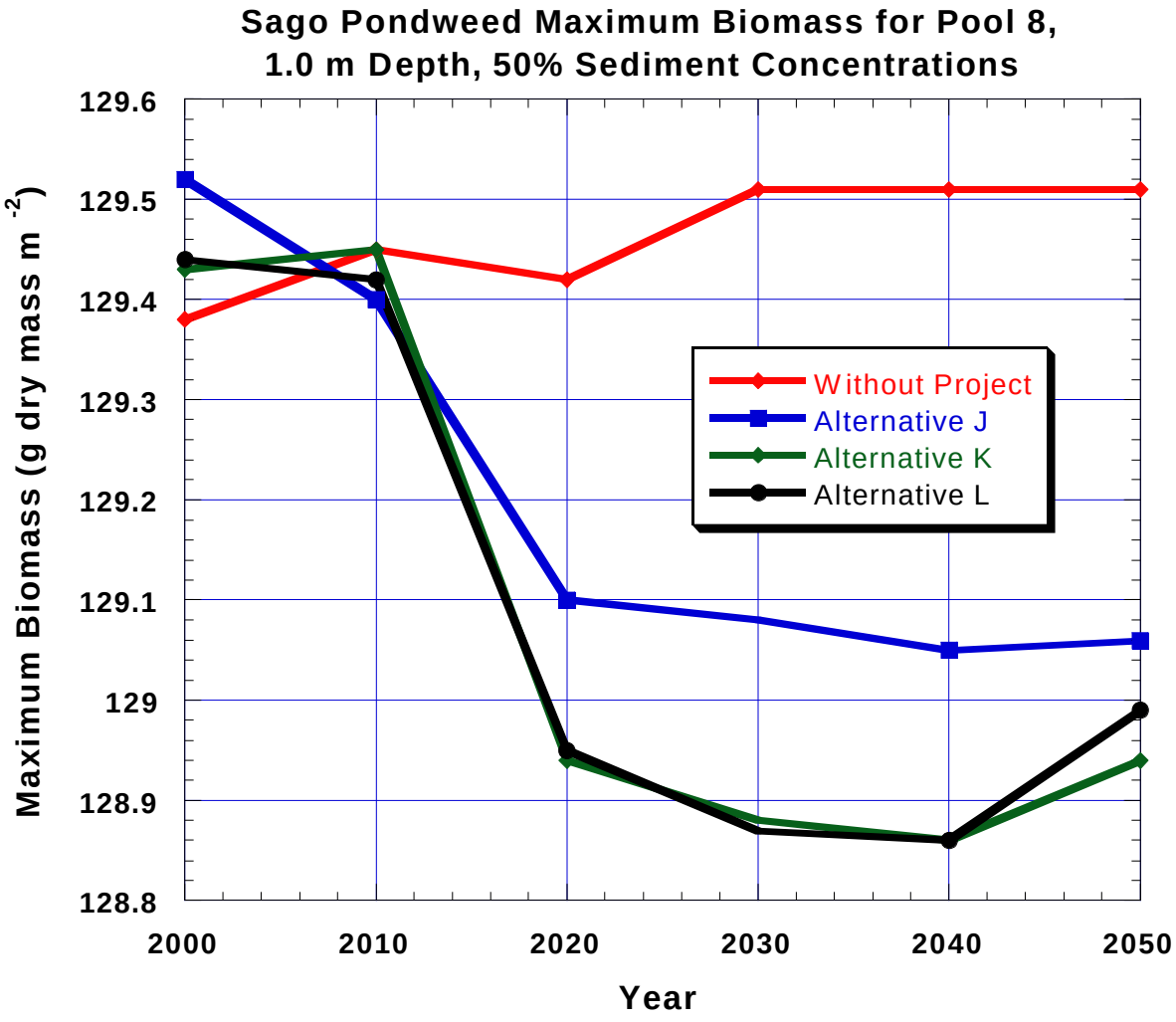
Summary of Impacts on SAV

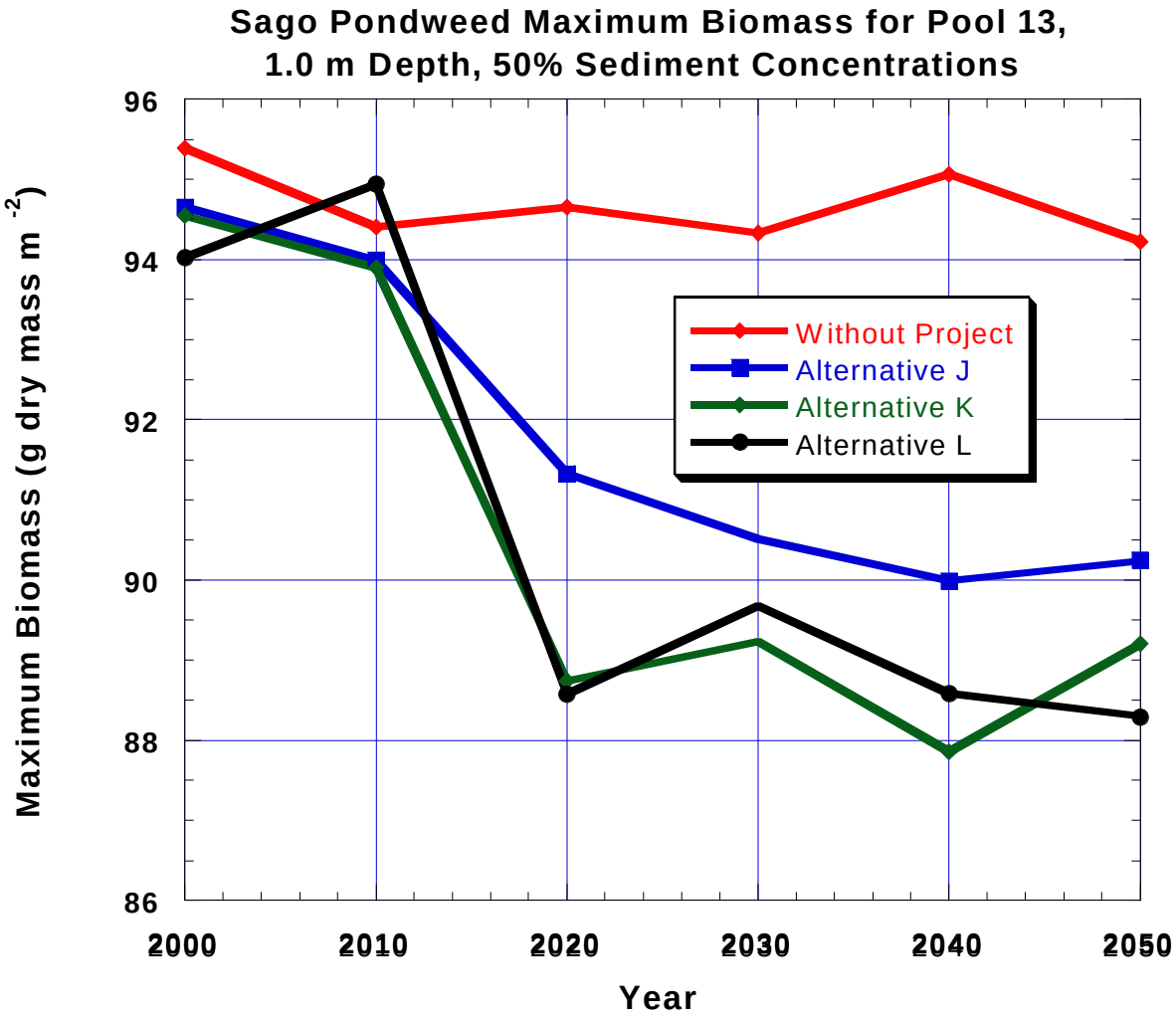
- Maximum biomass values using 50th percentile suspended sediment concentrations for 1.0 m depth
- Locations where growth decreased by at least 5%
- Probabilistic assessment of impacts on SAV growth for J, K, and L

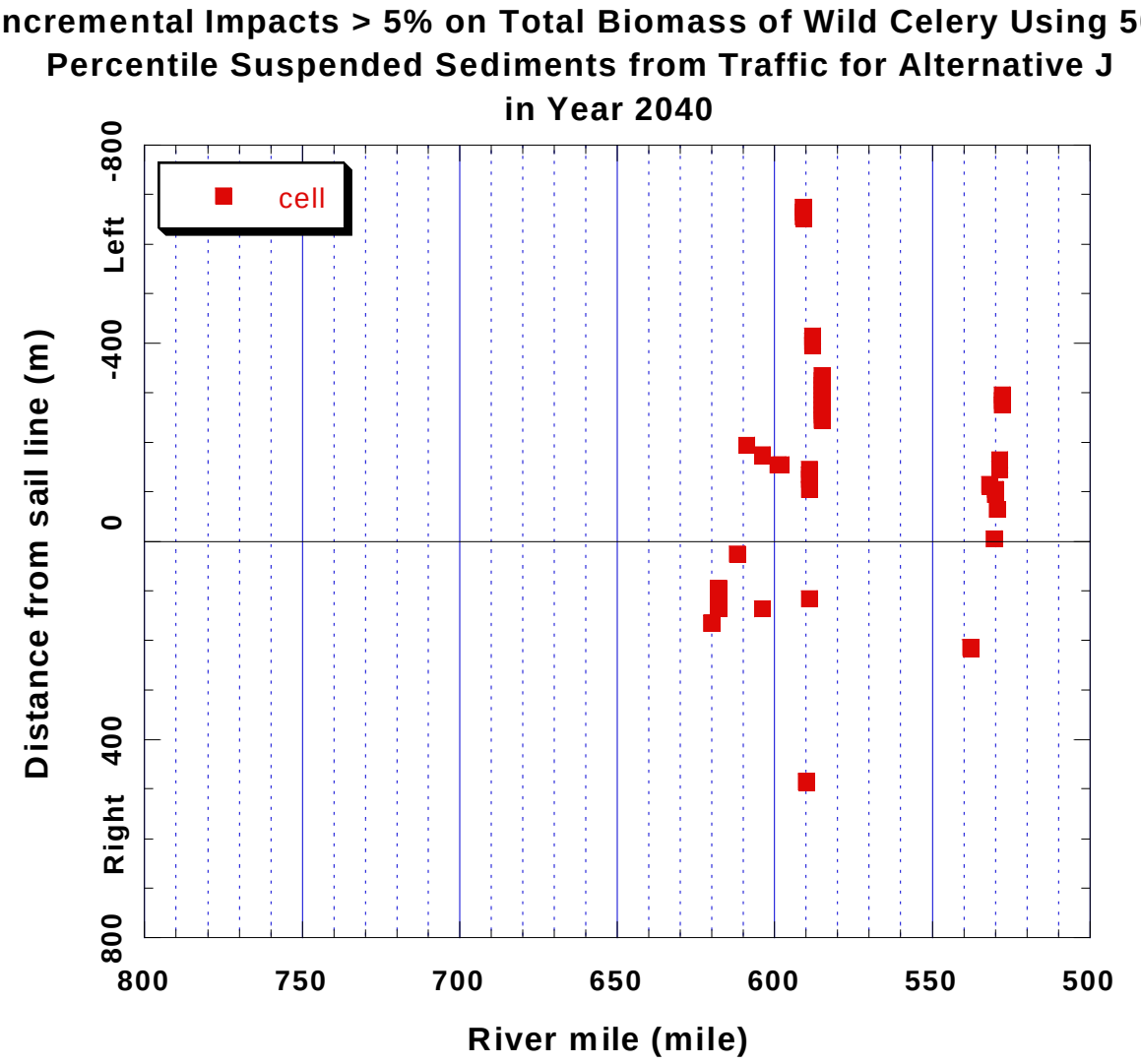

Wild Celery Maximum Biomass for Pool 4,
1.0 m Depth, 50% Sediment Concentrations
Maximum Biomass (g dry mass m -2)
60
59.5
59
58.5
58
57.5
57
2000
2010
2020
2030
2040
2050
Year
Without Project
Alternative J
Alternative K
Alternative L


Wild Celery Maximum Biomass for Pool 8,
1.0 m Depth, 50% Sediment Concentrations
Maximum Biomass (g dry mass m -2)
21.2
21
20.8
20.6
20.4
20.2
20
2000
2010
2020
2030
2040
2050
Year
Without Project
Alternative J
Alternative K
Alternative L

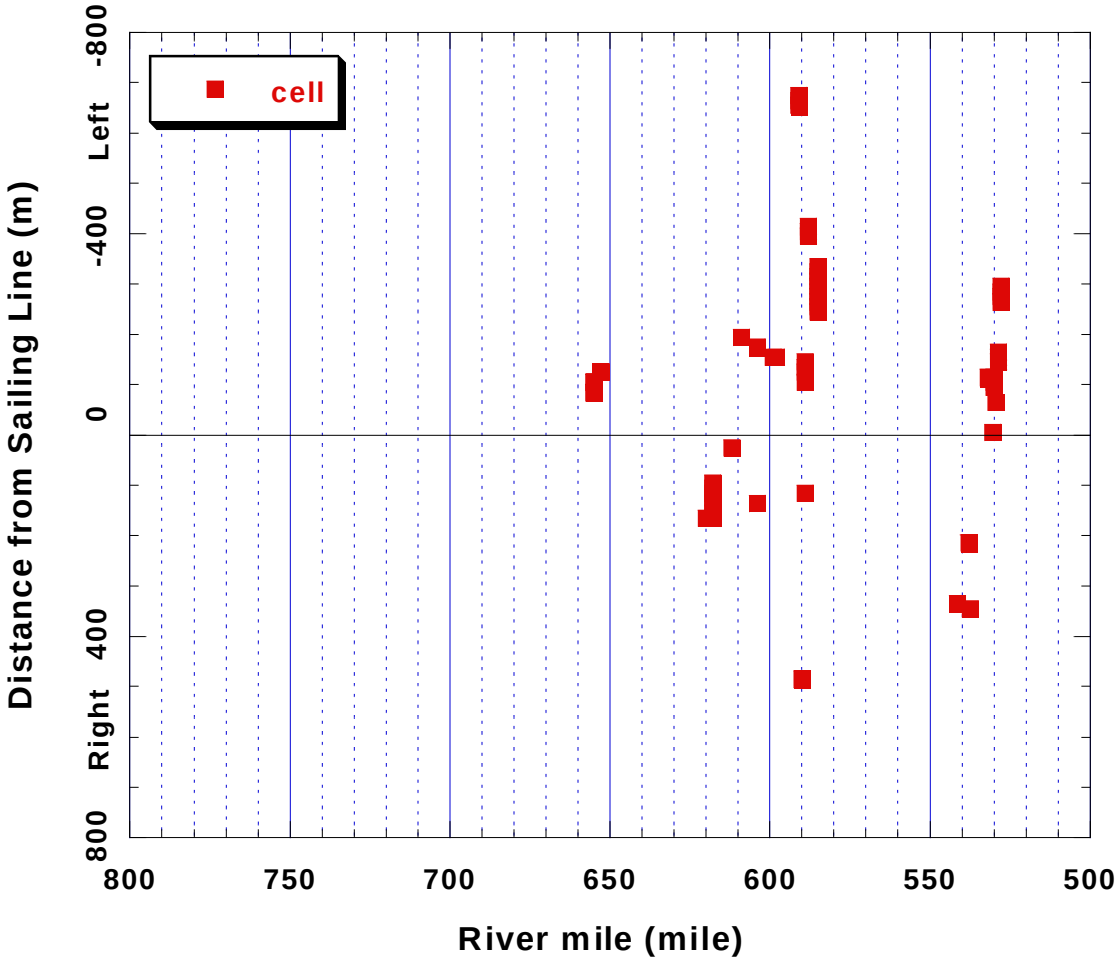

Sago Pondweed Maximum Biomass for Pool 13,
1.0 m Depth, 50% Sediment Concentrations
Maximum Biomass (g dry mass m -2)
153.8
153.7
153.6
153.5
153.4
153.3
153.2
153.1
153
2000
2010
2020
2030
2040
2050
Year
Without Project
Alternative J
Alternative K
Alternative L


Sago Pondweed Maximum Biomass for Pool 8,
1.0 m Depth, 50% Sediment Concentrations
Maximum Biomass (g dry mass m -2)
129.6
129.5
129.4
129.3
129.2
129.1
129
128.9
128.8
2000
2010
2020
2030
2040
2050
Year
Without Project
Alternative J
Alternative K
Alternative L

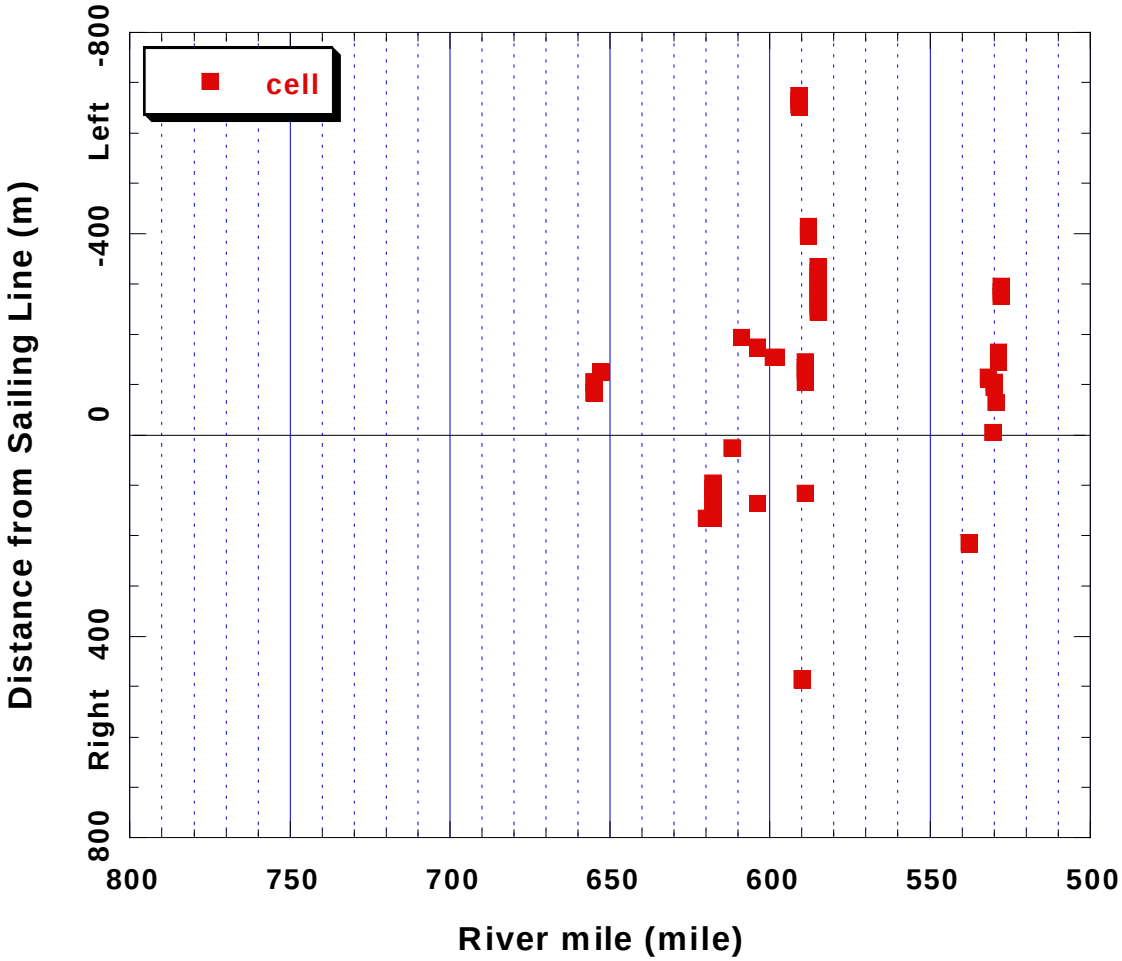

Sago Pondweed Maximum Biomass for Pool 13,
1.0 m Depth, 50% Sediment Concentrations
Maximum Biomass (g dry mass m -2)
96
94
92
90
88
86
2000
2010
2020
2030
2040
2050
Year
Without Project
Alternative J
Alternative K
Alternative L

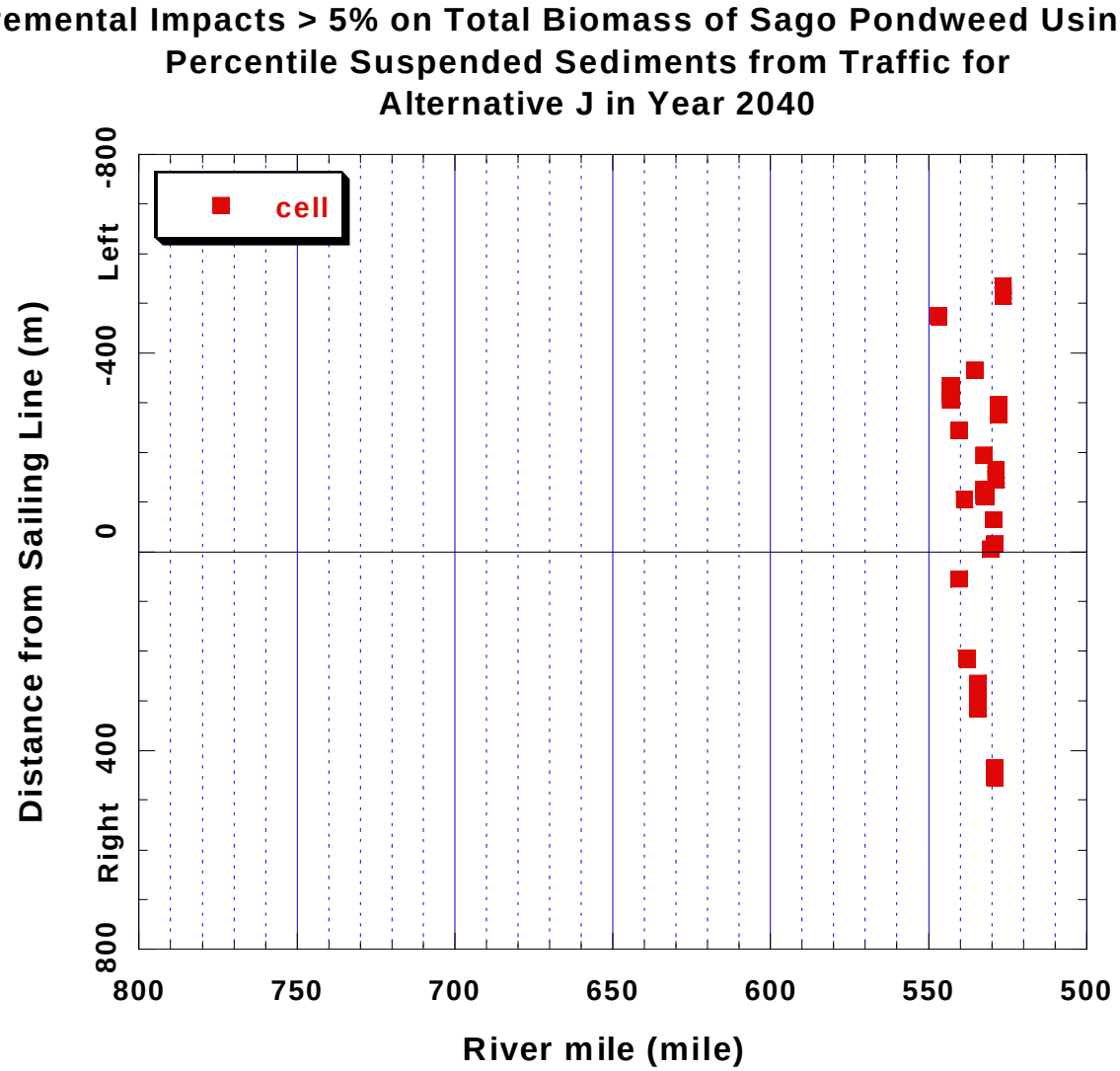

Incremental Impacts > 5% on Total Biomass of Wild Celery Using 50th Percentile Suspended Sediments from Traffic for Alternative J in Year 2040
cell
Distance from sail line (m)
-800
Left
-400
0
400
Right
800
800
750
700
650
600
550
500
River mile (mile)

Incremental Impacts > 5% on Total Biomass of Wild Celery Using 50th Percentile Suspended Sediments from Traffic for Alternative K in Year 2040

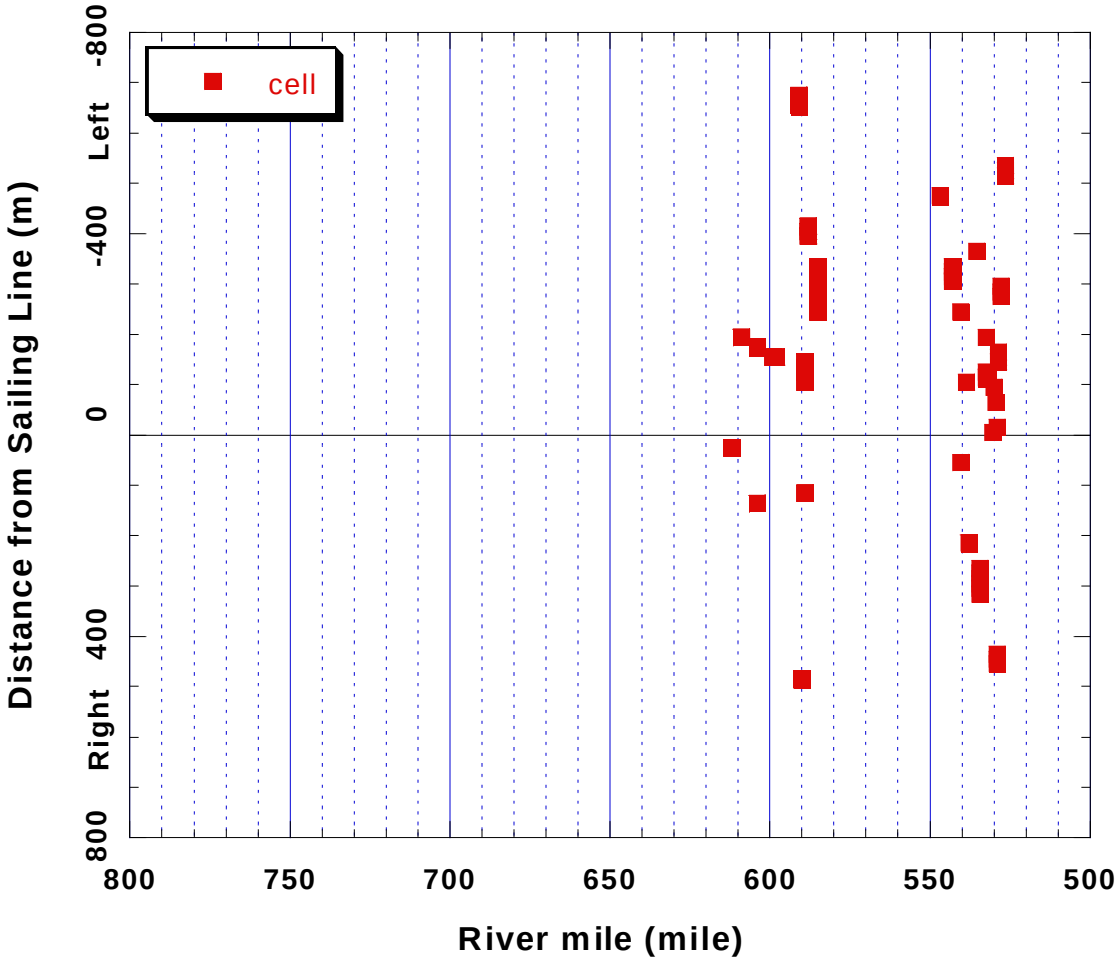


Incremental Impacts > 5% on Total Biomass of Wild Celery Using 50th Percentile Suspended Sediments from Traffic for Alternative L in Year 2040

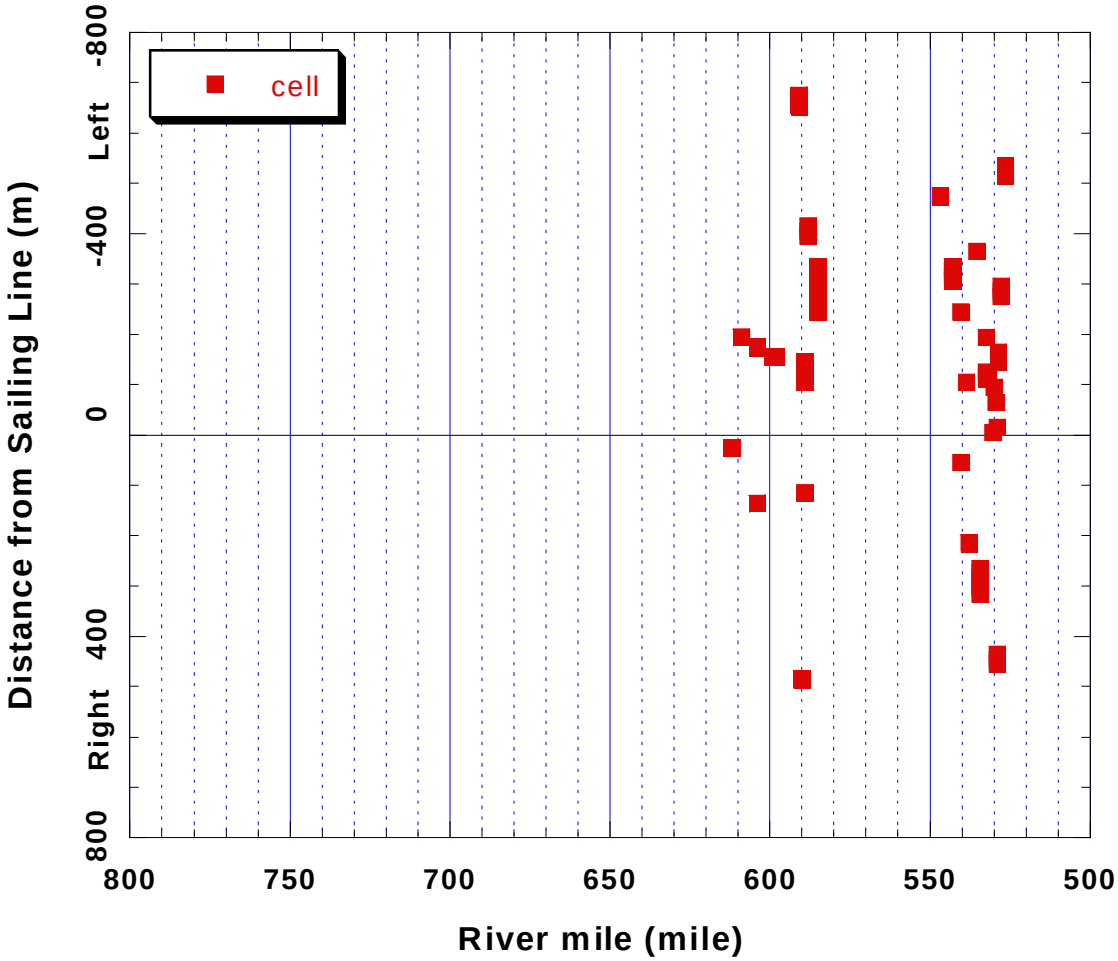


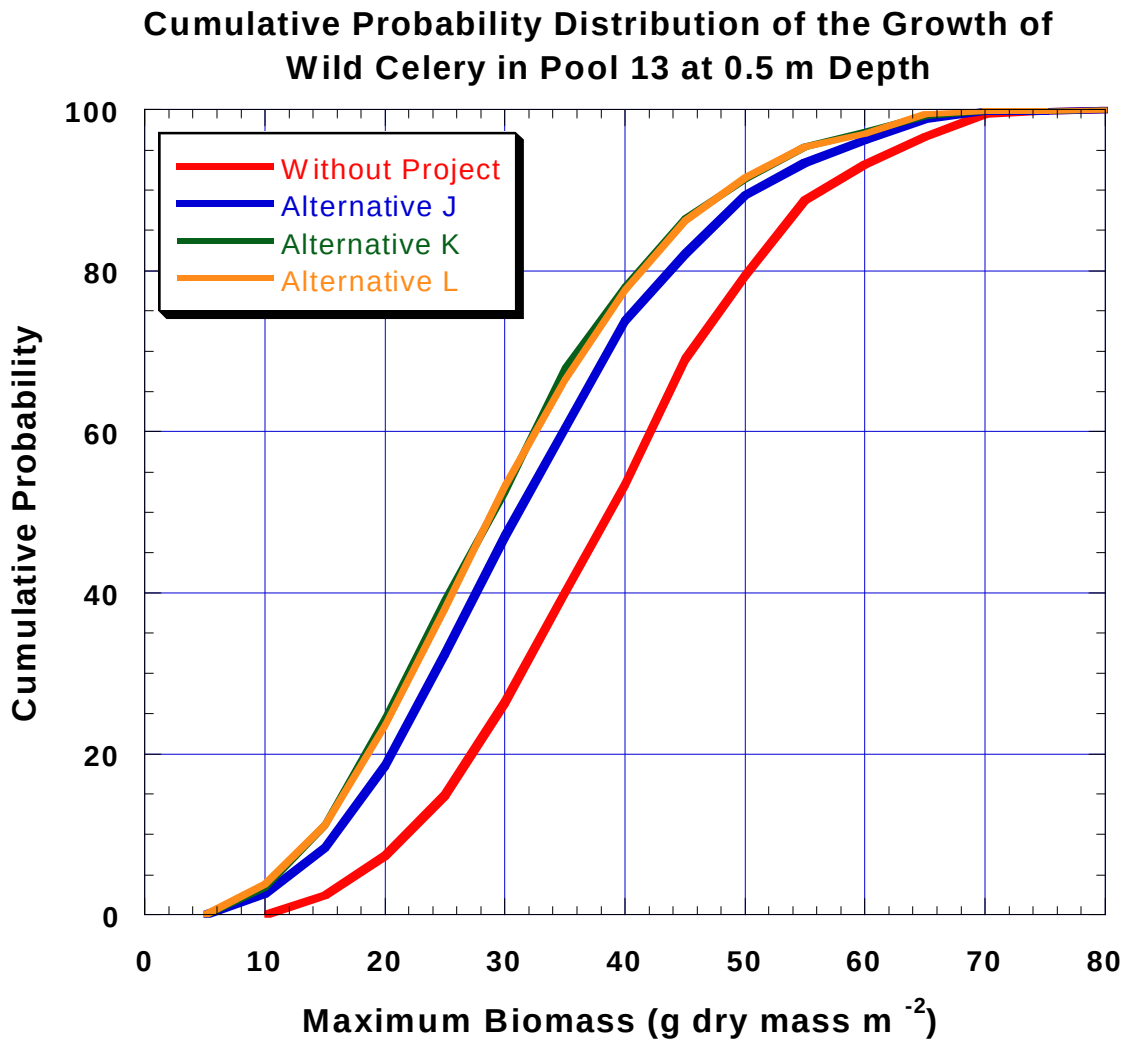

Incremental Impacts > 5% on Total Biomass of Sago Pondweed Using 50th Percentile Suspended Sediments from Traffic for Alternative J in Year 2040
cell
Distance from Sailing Line (m)
-800
Left
-400
0
400
Right
800
800
750
700
650
600
550
500
River mile (mile)

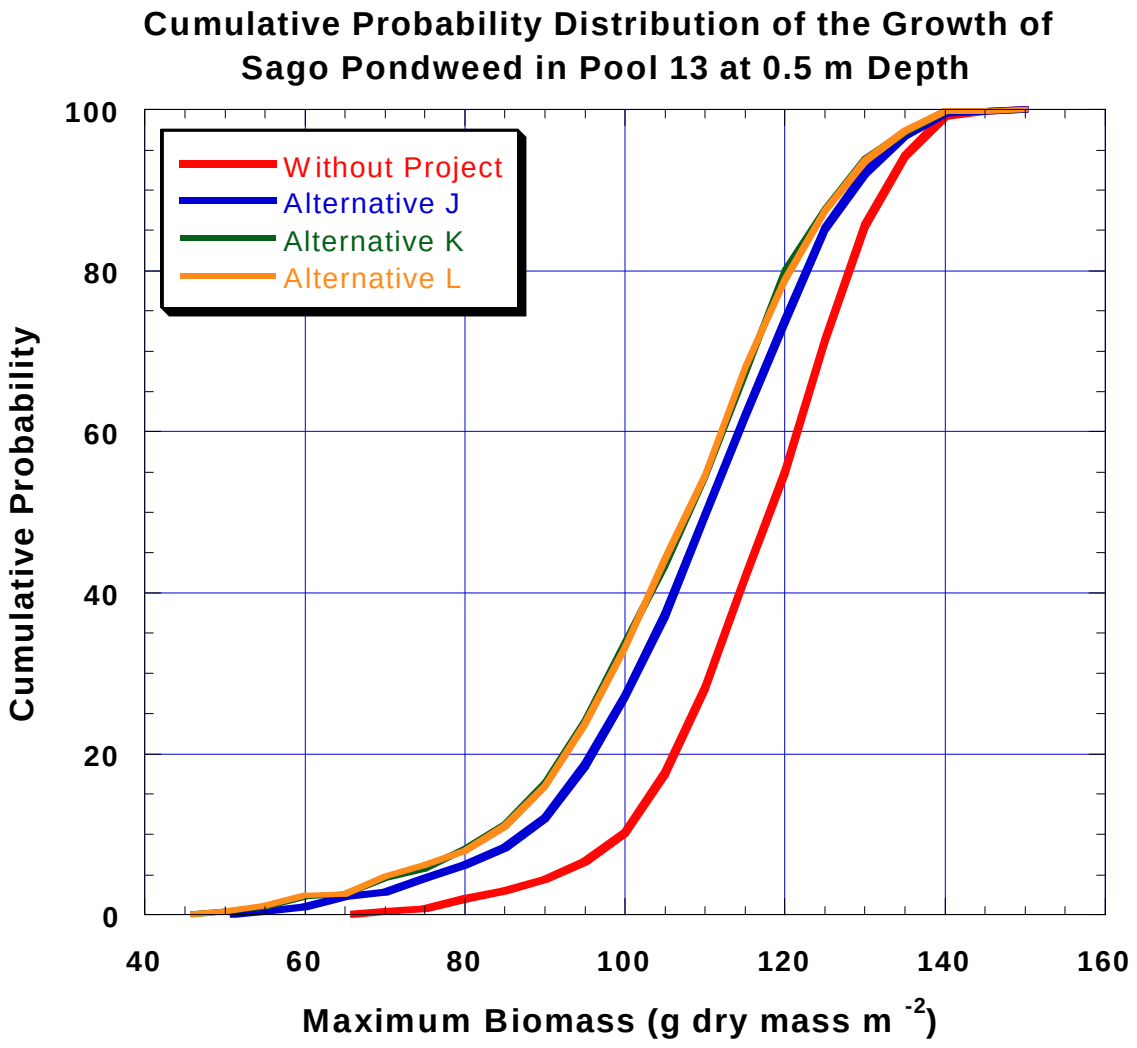
Incremental Impacts > 5% on Total Biomass of Sago Pondweed Using 50th Percentile Suspended Sediments from Traffic for Alternative K in Year 2040

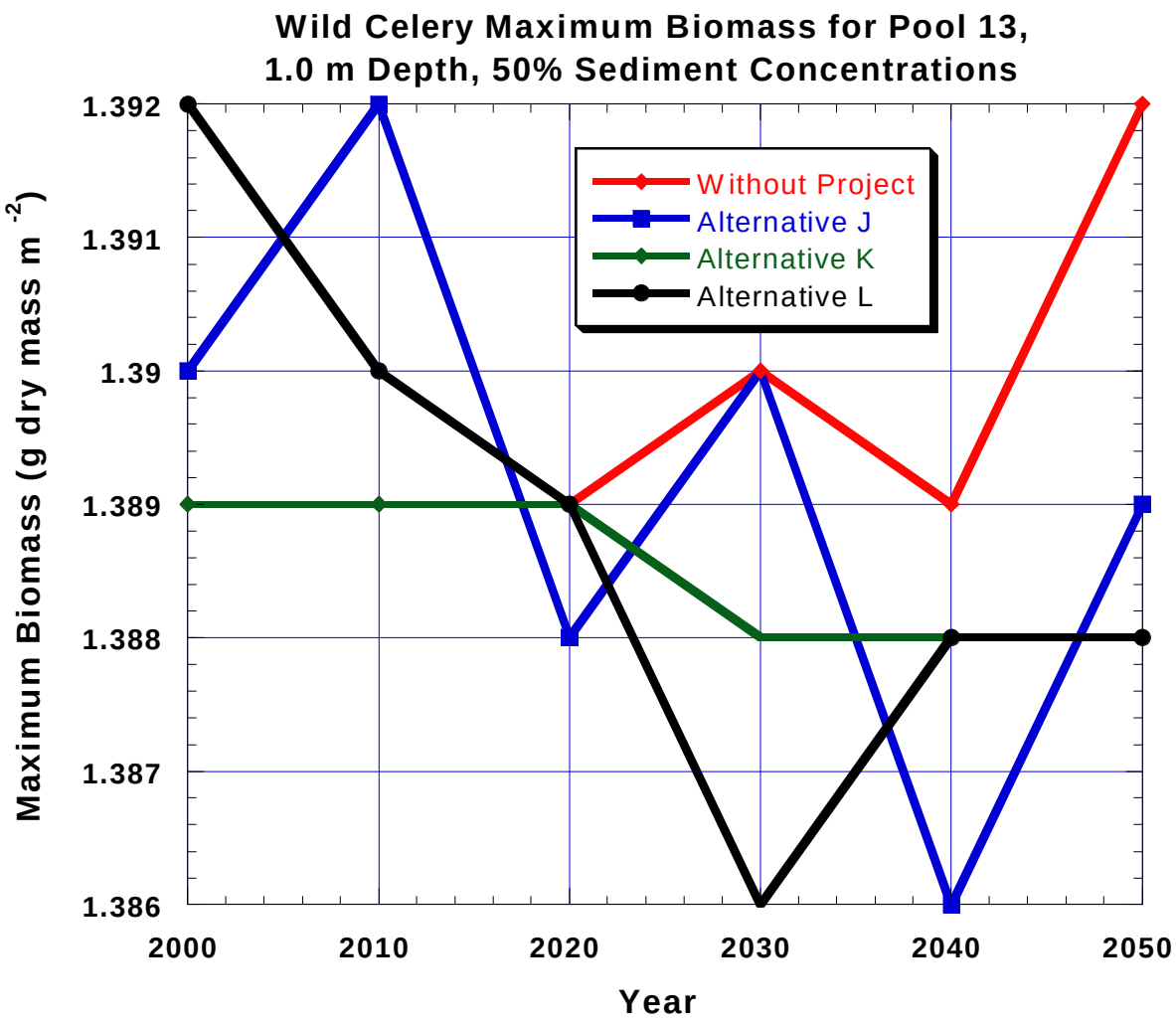


Incremental Impacts > 5% on Total Biomass of Sago Pondweed Using 50th Percentile Suspended Sediments from Traffic for Alternative L in Year 2040




Cumulative Probability Distribution of the Growth of
Wild Celery in Pool 13 at 0.5 m Depth
Without Project
Alternative J
Alternative K
Alternative L
Cumulative Probability
0
20
40
60
80
100
0
10
20
30
40
50
60
70
80
Maximum Biomass (g dry mass m -2)


Cumulative Probability Distribution of the Growth of
Sago Pondweed in Pool 13 at 0.5 m Depth
Without Project
Alternative J
Alternative K
Alternative L
Cumulative Probability
0
20
40
60
80
100
40
60
80
100
120
140
160
Maximum Biomass (g dry mass m -2)


Wild Celery Maximum Biomass for Pool 13,
1.0 m Depth, 50% Sediment Concentrations
Maximum Biomass (g dry mass m -2)
1.392
1.391
1.39
1.389
1.388
1.387
1.386
2000
2010
2020
2030
2040
2050
Year
Without Project
Alternative J
Alternative K
Alternative L

Attachment 6

Attachment 6

Risk and Uncertainty Analysis for
Selected Fish Species

29th Meeting of the NECC
June 14, 2000

Presented by

Steve Bartell

The Cadmus Group, Inc

Background: Larval Entrainment

- System reset each year (i.e., larval density)
- Entrainment mortality estimates are independent of population dynamics
- Extrapolations to EAL, RF, PF as basis for mitigation planning
- No long term impact on population, by definition…

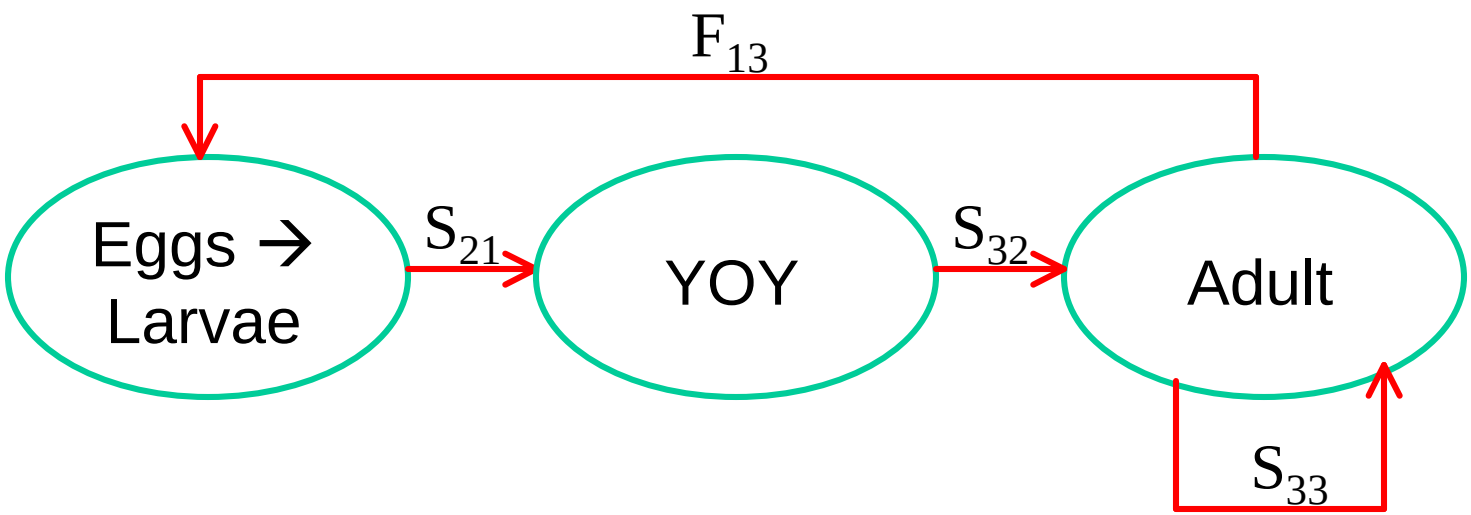
Fish Population Modeling

- Discussed in earlier considerations by the Technical Working Group for Fish
- Relies on assumption of population at equilibrium (i.e., as for EAL, RF, PF)
- Fecundity and survivorship parameters already developed for use in EAL, RF, PF
- Uses results of LEM calculations

Demographic Modeling Approach:

- Describes population as three life stages
  - Eggs/larvae, YOY, adults
- Population changes as function of survival and reproduction for each stage
- Larval entrainment added as additional mortality term, S’
- Projects population changes on yearly time scale for 50 years (i.e., 2000 – 2050)

Demographic Model for Fish Population Growth



Demographic Model for Fish Population Growth

$$\begin{bmatrix} 0 & 0 & F_{13} \\ S_{21} & 0 & 0 \\ 0 & S_{32} & S_{33} \end{bmatrix} \times \begin{bmatrix} n_1 \\ n_2 \\ n_3 \end{bmatrix}_t = \begin{bmatrix} n_1 \\ n_2 \\ n_3 \end{bmatrix}_{t+1}$$

1: Larvae
2: Young of Year
3: Adult
n_i: Number of fish
t: annual time step

F_{13}: Fecundity of Adults
S_{21}: Survivorship of Larvae to Young of Year
S_{32}: Natural Survivorship of Young of Year to Adult
S_{33}: Survivorship of Adults

Demographic Model for Fish Population Growth

$$\begin{bmatrix} 0 & 0 & F_{13} \\ S_{21} + S' & 0 & 0 \\ 0 & S_{32} & S_{33} \end{bmatrix} \times \begin{bmatrix} n_1 \\ n_2 \\ n_3 \end{bmatrix}_t = \begin{bmatrix} n_1 \\ n_2 \\ n_3 \end{bmatrix}_{t+1}$$

$$S' = - S_{21} M$$

S’ = Navigation Induced Survivorship

M = Navigation Induced Larval Mortality

Demographic Modeling: Advantages

- Establishes “feedback” between larval mortality and population dynamics
- Permits annual assessment integrated over the 50-y project duration
- Alternative to extrapolation models
  - Fewer assumptions and parameters
  - Additional check on estimated impacts on fish

Demographic Modeling: Limitations

- Three life stages used for all species
- Parameter estimates for survival and fecundity
- Initial values for larval density only
- No compensatory effects included
- Only describes population consistent with larval density and model parameters
- Population can only decline with entrainment
- Limited population data for model evaluation

Selected Species and Alternatives

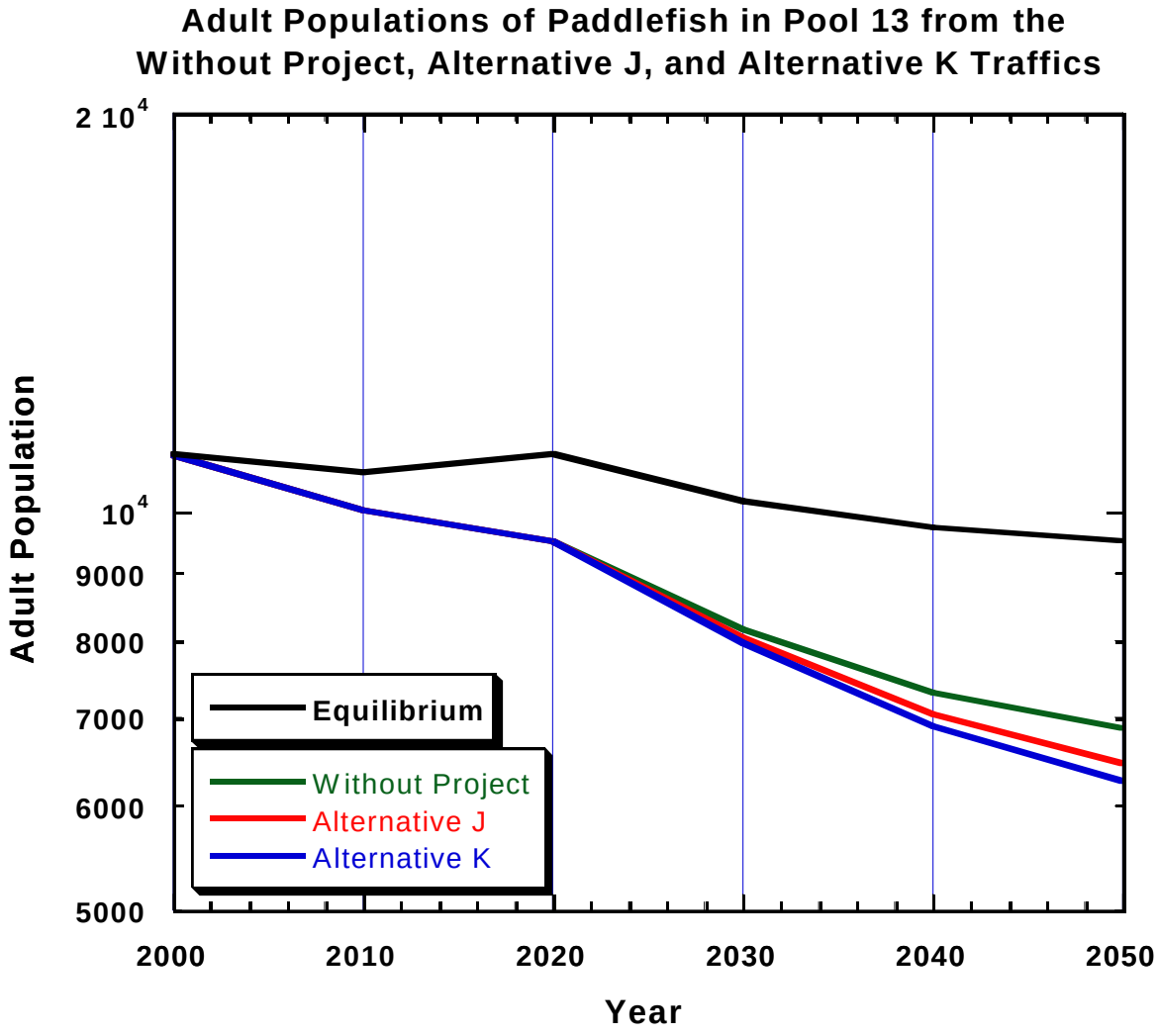
- Species
  - Paddlefish
  - Channel catfish
  - Walleye
- Alternatives J, K, and L
- Pool 13

Demographic Model for Fish Population Growth

<u>Deterministic Model: Input for Paddlefish</u>

F_{13} = 57,730 Eggs/Adult
S_{21} = 0.01085 YOY/Larvae
S_{32} = 0.0217 Adult/YOY
S_{33} = 0.02 Adult/Adult
$n_1 = 0.40/m^3$
$n_2 = 0.004/m^3$
$n_3 = 0.00009/m^3$

Without density-dependence…

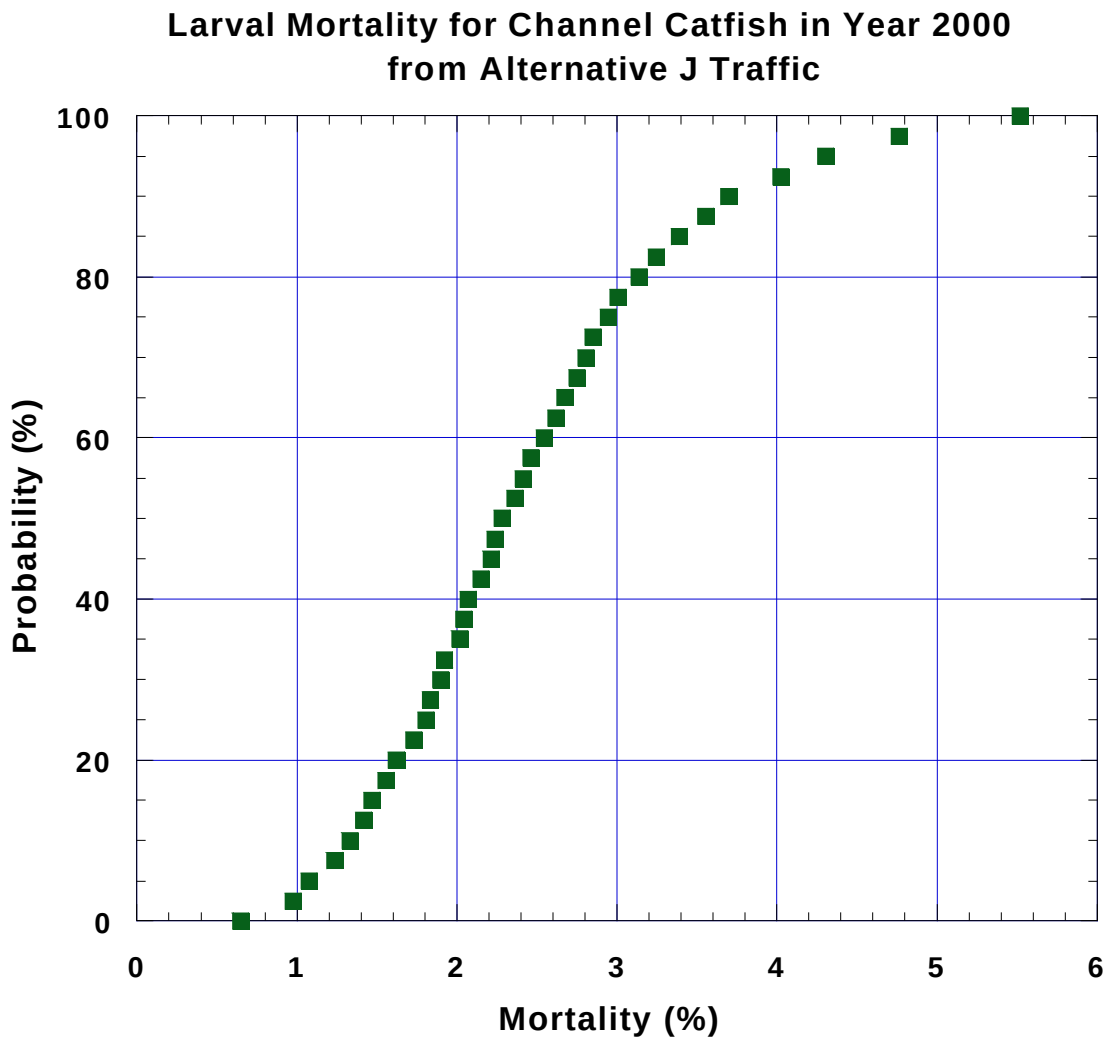


Demographic Model for Fish Population Growth

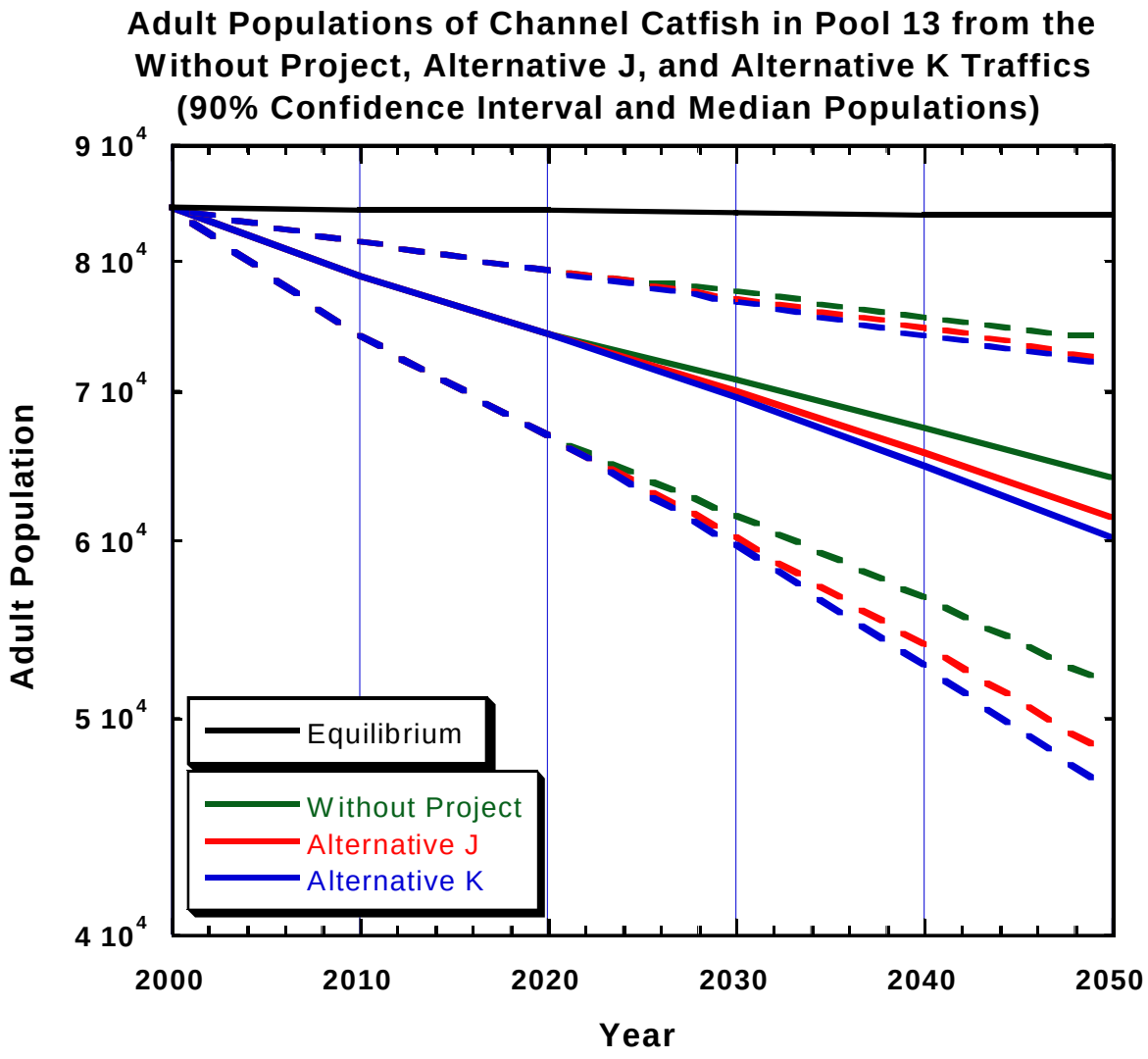
<u>Deterministic Model: Input for Channel Catfish</u>

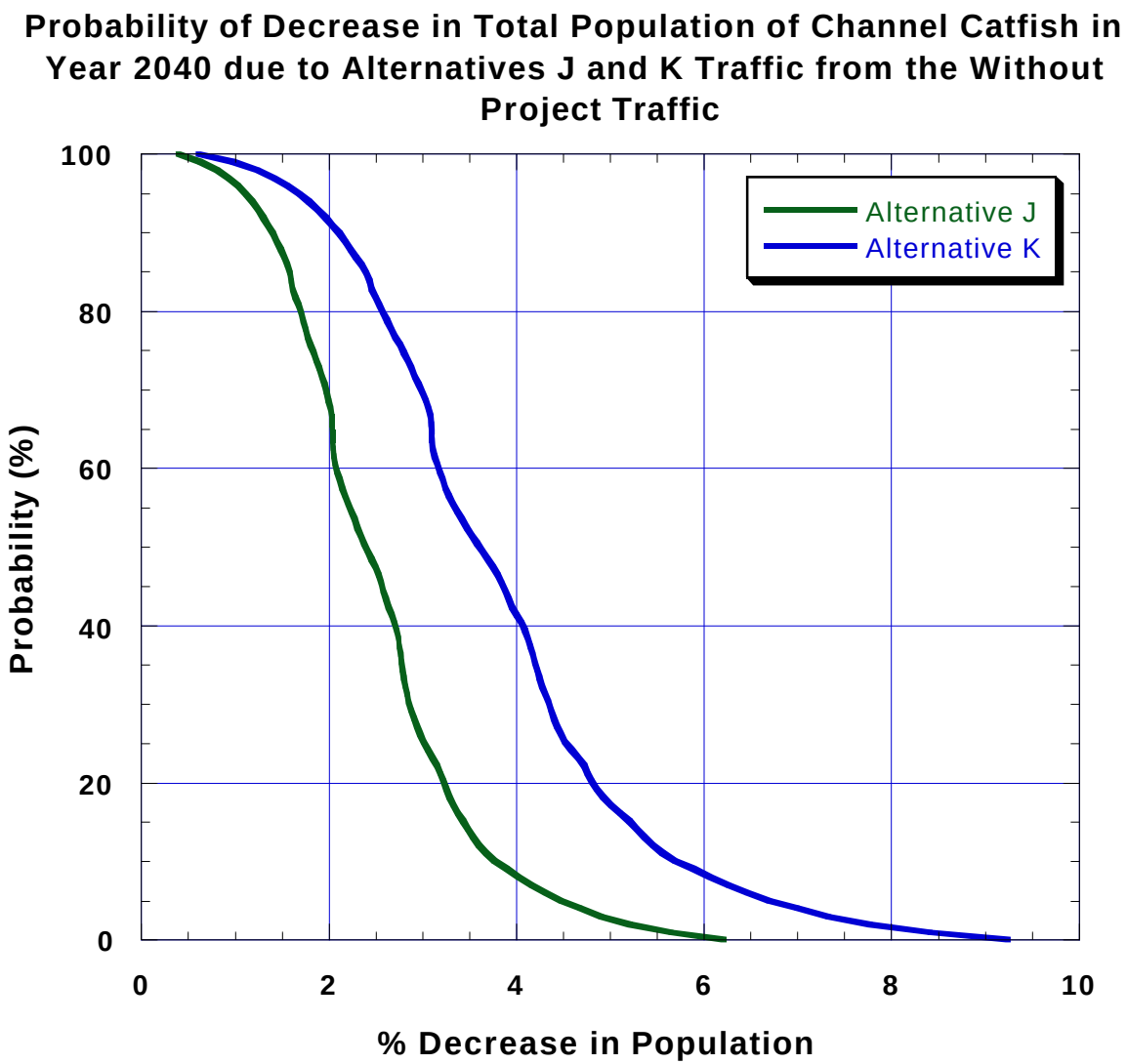
F_{13} = 1,628 Eggs/Adult
S_{21} = 0.0622 YOY/Larvae
S_{32} = 0.1244 Adult/YoY
S_{33} = 0.1 Adult/Adult
$n_1 = 0.08/m^3$
$n_2 = 0.005/m^3$
$N = \ 0.0007/m^3\ 0.0_3$
$M|_{2000,\ Alt.\ J} = 1.4\%$

Distribution of percent larval mortality



Without density-dependence…



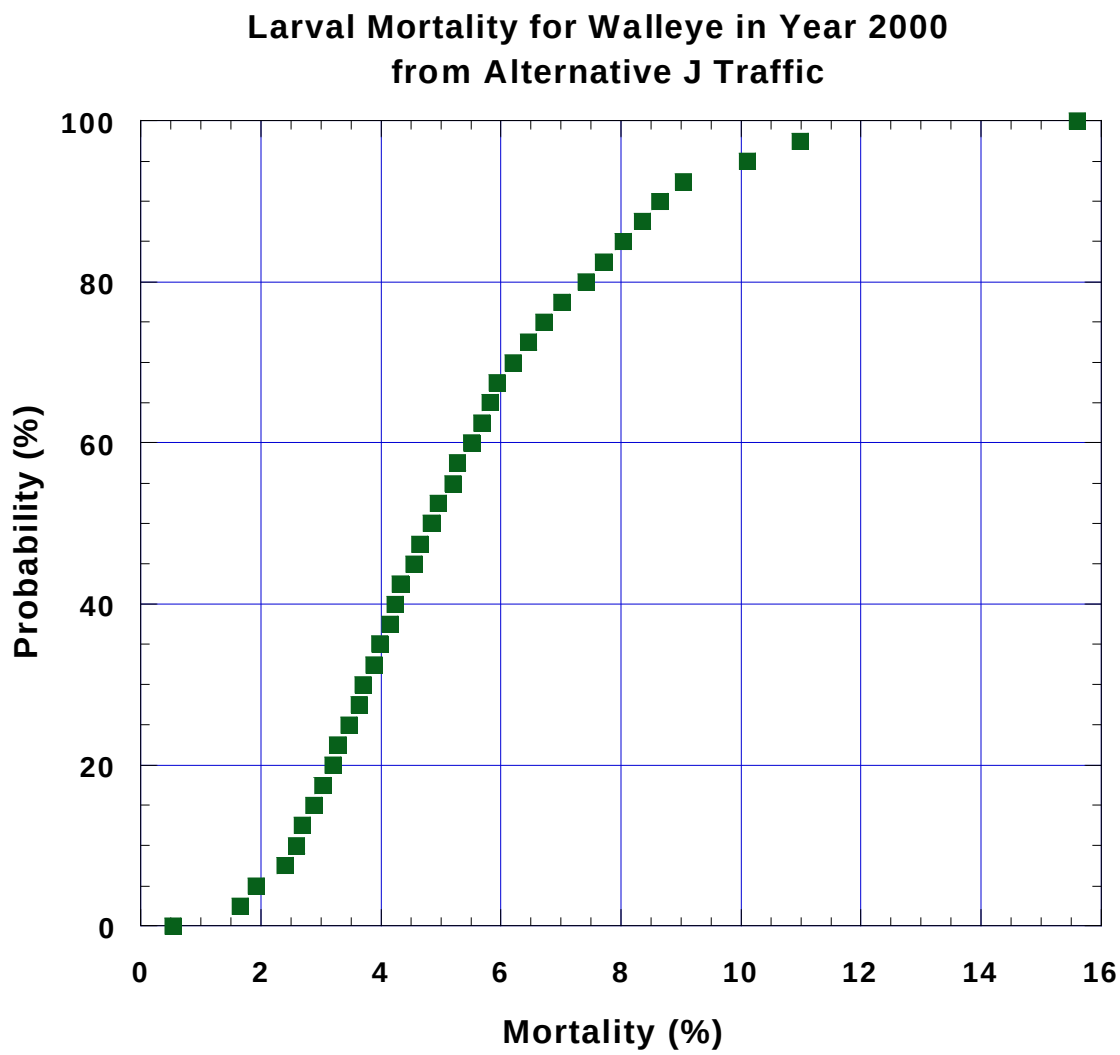

Probability of Decrease in Total Population of Channel Catfish in Year 2040 due to Alternatives J and K Traffic from the Without Project Traffic
Alternative J
Alternative K
Probability (%)
100
80
60
40
20
0
0
2
4
6
8
10
% Decrease in Population

Demographic Model for Fish Population Growth

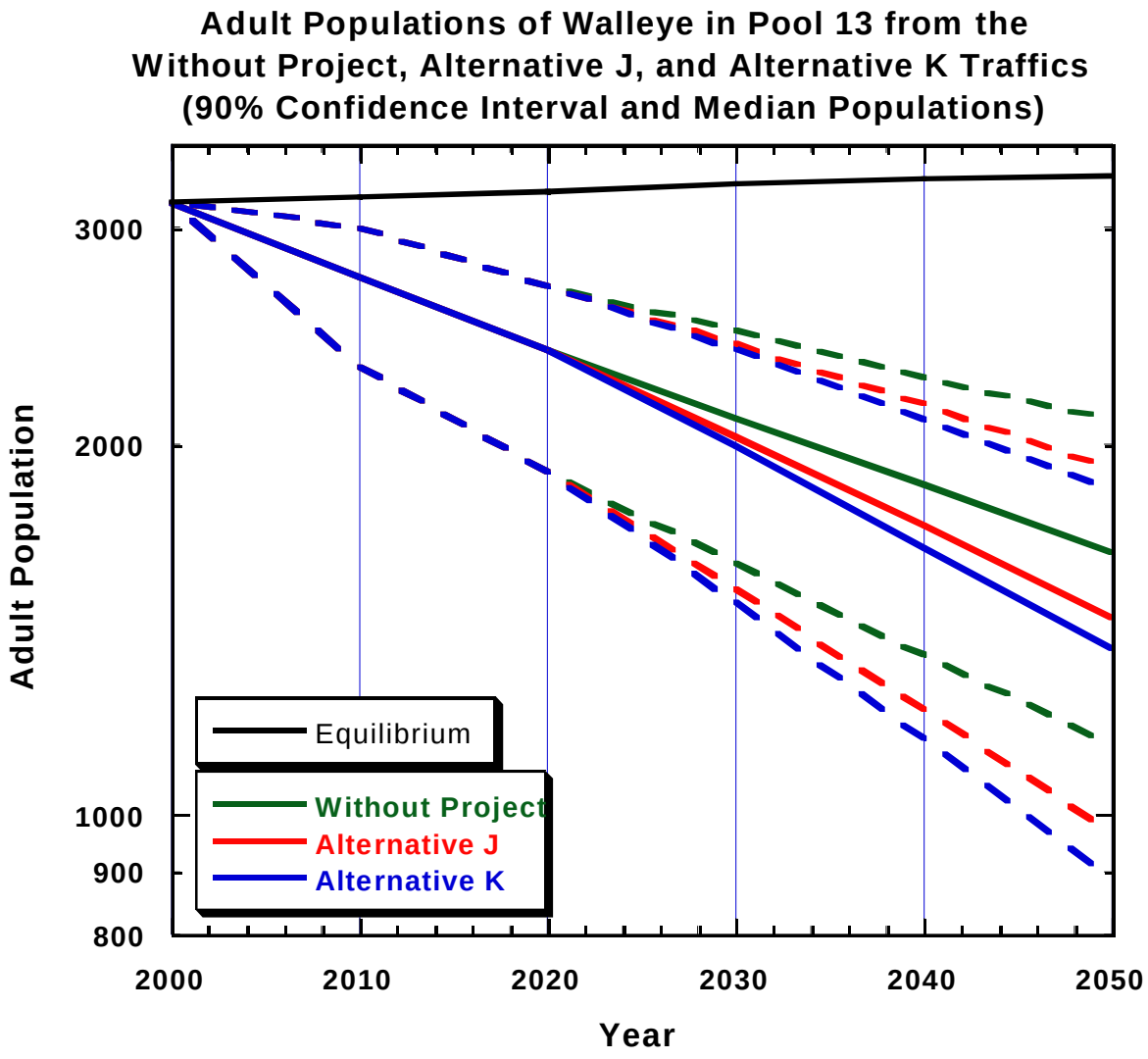
<u>Deterministic Model: Input for Walleye</u>

F_{13} = 16,160 Eggs/Adult
S_{21} = 0.005 YOY/Larvae
S_{32} = 0.15 Adult/YoY
S_{33} = 0.15 Adult/Adult
$n_1 = 0.03/m^3$
$n_2 = 0.00015/m^3$
$n_3 = 0.000026/m^3$
$M|_{2000,\ Alt.\ J} = 5.3\%$

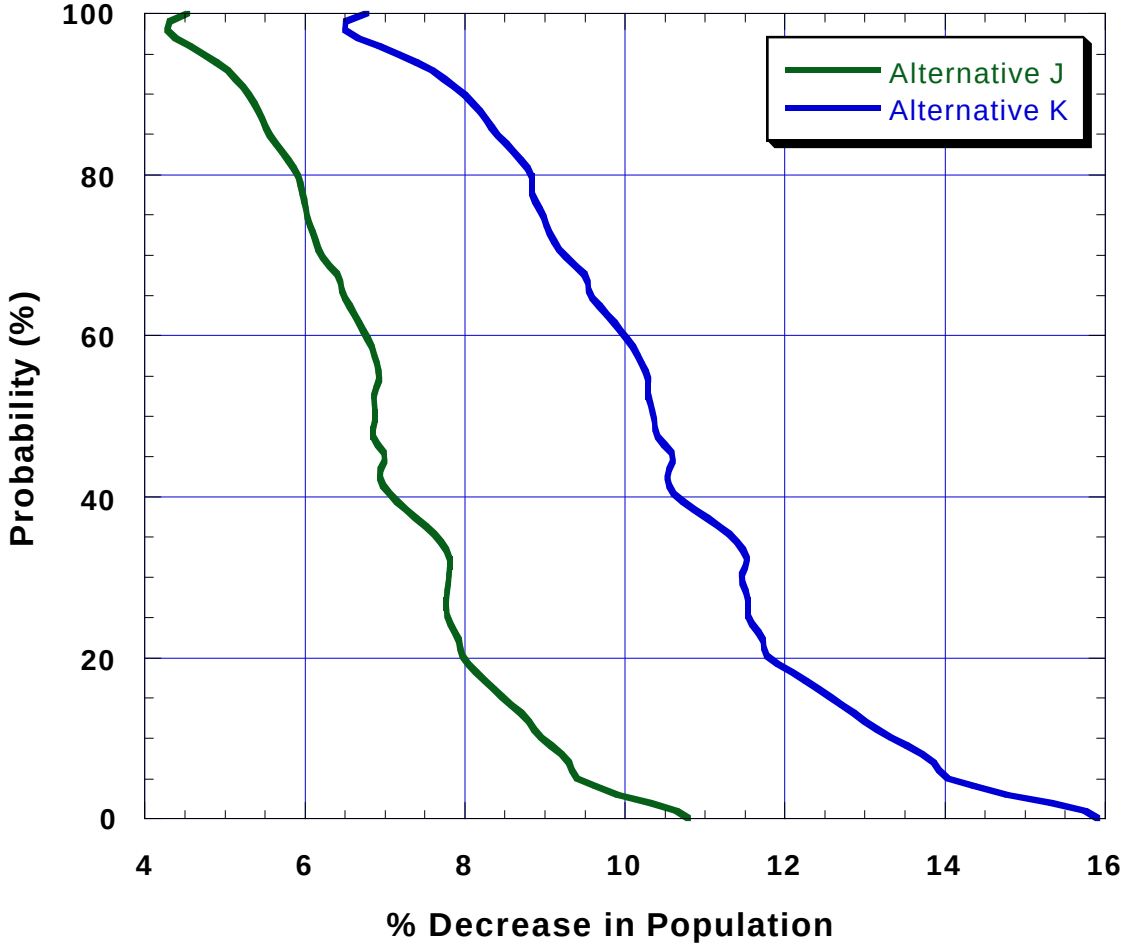
Distribution of percent larval mortality



Without density-dependence…



Probability of Decrease in Total Population of Walleye in Year 2040 due to Alternatives J and K Traffic from the Without Project Traffic



Demographic Modeling Summary

- Provides an alternative assessment of incremental impacts from larval entrainment
- Permits additional comparison of traffic alternatives
- Allows additional evaluation of previous assessments (e.g., EAL verification)
- Incorporates uncertainties in larval densities for probabilistic estimates of risk

Attachment 7

Attachment 7

Ecological Impacts of Recreational Boats

29th Meeting of the NECC
June 14, 2000

Presented by

Dan Wilcox[1] and Kevin Landwehr[2]

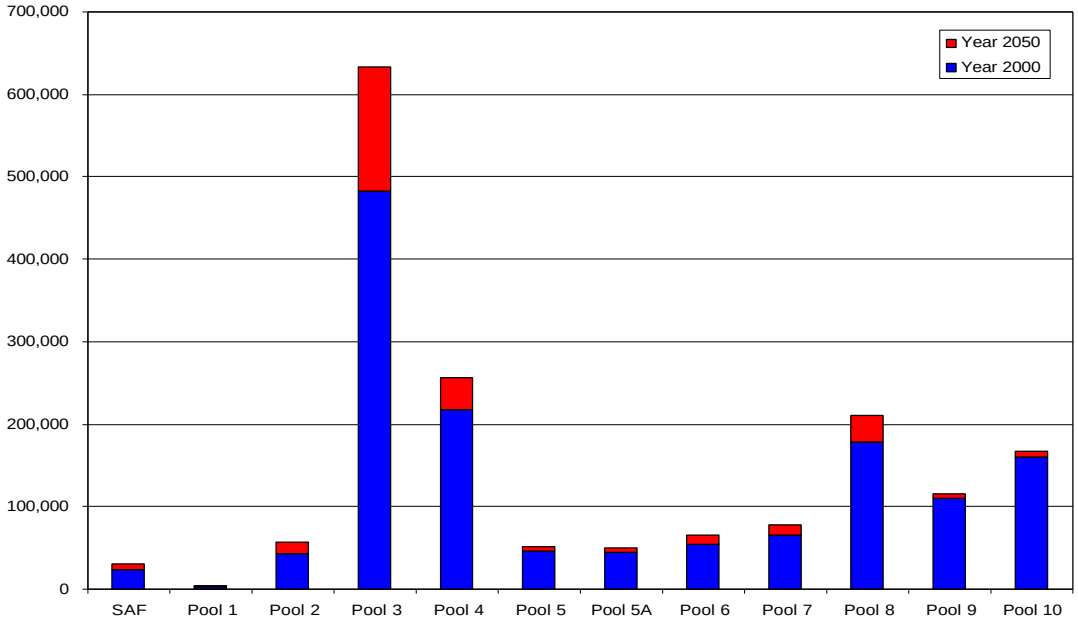
[1]Fisheries Biologist
US Army Corps of Engineers – St. Paul District

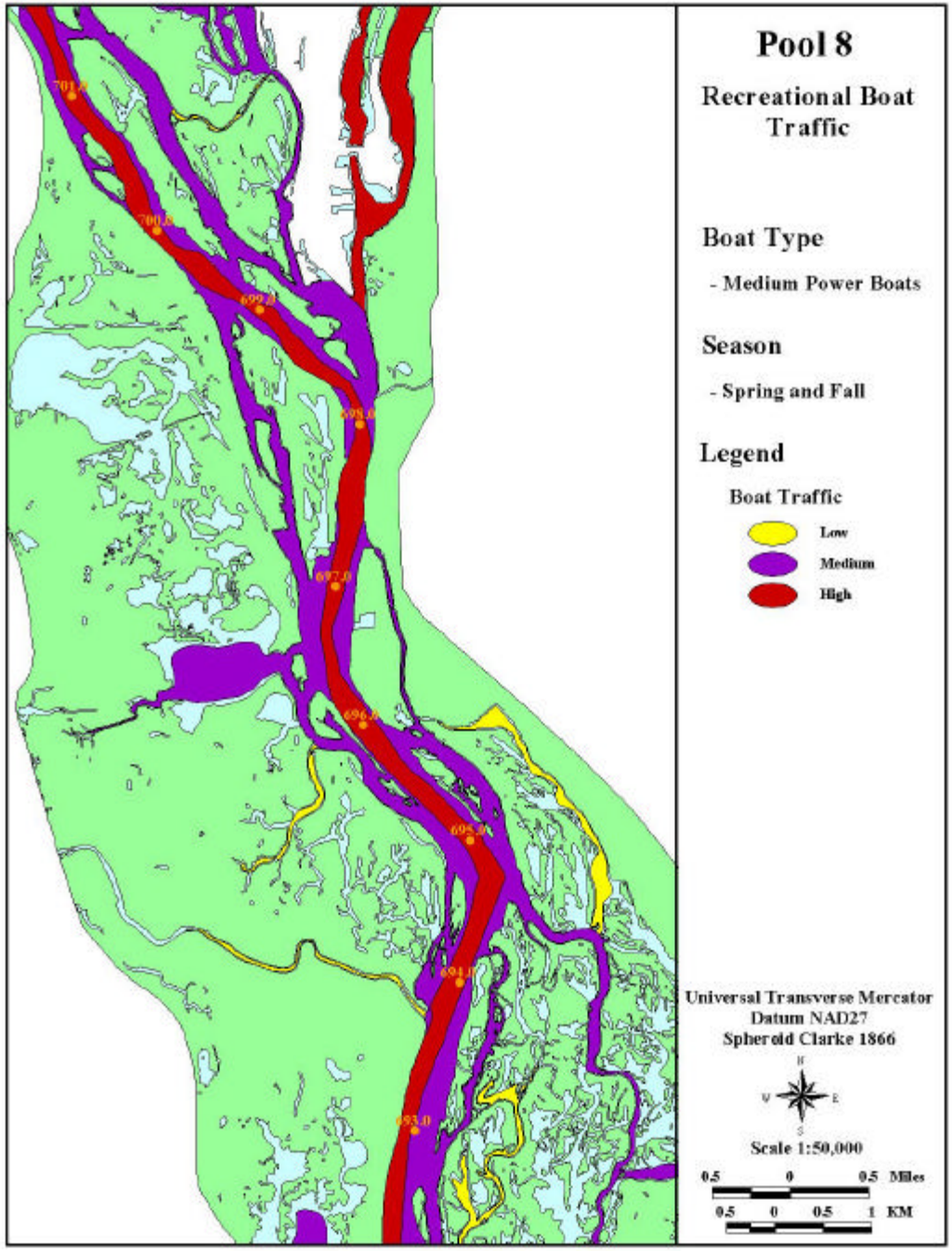
[2]Hydraulic Engineer
US Army Corps of Engineers – Rock Island District

Background:

- Estimate recreational boating intensity
  - Trips/day per pool and month
  - Allocated among different vessel types
  - Identified areas of concentrated use in pools
  - Projections of unconstrained growth 2000-2050
- Characterize wave heights for vessel types
- Calculate sediments suspended by traffic
- Estimate impacts on submerged plant growth

Total Trips Per Year for All Recreational Boating




Pool 8
Recreational Boat Traffic
Boat Type
- Medium Power Boats
Season
- Spring and Fall
Legend
Boat Traffic
Low
Medium
High
Universal Transverse Mercator
Datum NAD27
Spheroid Clarke 1866
N
W
E
S
Scale 1:50,000
0.5 0 0.5 Miles
0.5 0 0.5 1 KM

Wave heights generated by different vessel classes

Vessel type	Zone 1*	Zone 2	Zone 3
	0-30 m	30-90 m	90-150 m
Sailboats	N/A	N/A	N/A
Jet skies	8 cm	4 cm	0
Fishing boats	16 cm	8 cm	4 cm
Pontoon	8 cm	4 cm	4 cm
Medium power	24 cm	20 cm	10 cm
Large Cruisers	50 cm	40 cm	20 cm
House boats	8 cm	4 cm	4 cm

Table 7. Decrease in the Growth of Wild Celery from the Fishing Boat, Recreartional Traffic in UMR Pools 4 through 8						
Year	**Maximum Green Biomass (g dry m^{-2})**	**Green Biomass with Traffic (g dry m^{-2})**	**Percent Decrease**	**Maximum Total Biomass (g dry m^{-2})**	**Total Biomass with Traffic (g dry m^{-2})**	**Percent Decrease**
Pool: UMR04						
2000	28.29	26.77	5.37	62.58	58.76	6.1
2010	28.29	26.59	6	62.58	58.32	6.81
2020	28.29	26.45	6.52	62.58	57.95	7.41
2030	28.29	26.31	6.99	62.58	57.6	7.96
2040	28.29	26.17	7.48	62.58	57.27	8.49
2050	28.29	26	8.08	62.58	56.83	9.19
Pool: UMR08						
2000	11.08	10.61	4.27	22.4	21.2	5.34
2010	11.08	10.57	4.59	22.4	21.12	5.71
2020	11.08	10.53	4.98	22.4	21.01	6.22
2030	11.08	10.48	5.39	22.4	20.9	6.71
2040	11.08	10.44	5.77	22.4	20.79	7.18
2050	11.08	10.4	6.12	22.4	20.69	7.64

Table 13. Decrease in the Growth of Wild Celery from Large Cruiser, Recreartional Traffic in UMR Pools 4 through 8						
Year	**Maximum Green Biomass (g dry m^{-2})**	**Green Biomass with Traffic (g dry m^{-2})**	**Percent Decrease**	**Maximum Total Biomass (g dry m^{-2})**	**Total Biomass with Traffic (g dry m^{-2})**	**Percent Decrease**
Pool: UMR04						
2000	28.29	0.13	99.55	62.58	0.2	99.68
2010	28.29	0.12	99.58	62.58	0.18	99.71
2020	28.29	0.11	99.59	62.58	0.17	99.73
2030	28.29	0.11	99.61	62.58	0.16	99.75
2040	28.29	0.11	99.63	62.58	0.15	99.77
2050	28.29	0.1	99.64	62.58	0.13	99.79
Pool: UMR08						
2000	11.08	0.08	99.25	22.4	0.09	99.58
2010	11.08	0.08	99.29	22.4	0.08	99.63
2020	11.08	0.07	99.33	22.4	0.07	99.67
2030	11.08	0.07	99.36	22.4	0.06[1]	99.72
2040	11.08	0.07	99.4	22.4	0.05[1]	99.76
2050	11.08	0.06	99.43	22.4	0.05[1]	99.8
Pool: UMR13						
2000	1.39	1.38	1.14	1.4	1.38	1.47
2010	1.39	1.38	1.16	1.4	1.38	1.48
2020	1.39	1.38	1.16	1.4	1.38	1.48
2030	1.39	1.38	1.2	1.4	1.38	1.52
2040	1.39	1.38	1.2	1.4	1.38	1.54
2050	1.39	1.38	1.22	1.4	1.38	1.58

Table 25. Decrease in the Growth of Sago Pondweed from the Large Cruiser, Recreartional Traffic in UMR Pools 4 through 8						
Year	**Maximum Green Biomass (g dry m^{-2})**	**Green Biomass with Traffic (g dry m^{-2})**	**Percent Decrease**	**Maximum Total Biomass (g dry m^{-2})**	**Total Biomass with Traffic (g dry m^{-2})**	**Percent Decrease**
Pool: UMR04						
2000	107.6	19.57	81.81	154.8	29.3	81.07
2010	107.6	19.22	82.14	154.8	28.81	81.39
2020	107.6	18.85	82.48	154.8	28.29	81.73
2030	107.6	18.5	82.81	154.8	27.8	82.04
2040	107.6	18.15	83.13	154.8	27.31	82.35
2050	107.6	17.76	83.5	154.8	26.77	82.71
Pool: UMR08						
2000	87.63	25.9	70.45	130.7	36.9	71.77
2010	87.63	25.08	71.38	130.7	35.66	72.71
2020	87.63	24.3	72.27	130.7	34.96	73.25
2030	87.63	23.67	72.99	130.7	34.36	73.71
2040	87.63	23.28	73.43	130.7	33.77	74.16
2050	87.63	22.9	73.86	130.7	33.19	74.61
Pool: UMR13						
2000	68.42	55.54	18.82	109.9	77.06	29.88
2010	68.42	55.39	19.04	109.9	76.67	30.24
2020	68.42	55.22	19.29	109.9	76.23	30.64
2030	68.42	55.01	19.6	109.9	75.71	31.11
2040	68.42	54.8	19.9	109.9	75.17	31.6
2050	68.42	54.57	20.24	109.9	74.58	32.14

Summary

- Results suggest that several recreational vessel classes may impact the growth of submerged aquatic vegetation
- Additional work is being conducted to estimate the volume of water entrained by recreational vessels (~20% of commercial vessel entrainment)

Identification of Areas Subject to Bank Erosion from Waves Generated by Recreational Vessels

1. The recreational boating component of the Navigation Study identified areas on the UMRS where different classes of recreational boats operate. These areas were loaded into a series of GIS coverages containing polygons of usage intensity (high, medium and low use) for 7 different boat classes ranging from sailboats to large cruisers and houseboats. For each boating class, CHL estimated maximum wave heights based on published field data. CHL further estimated the maximum wave heights at various distances (buffers) from the usage areas. The wave height estimates were attached to the GIS polygons of usage areas, as well as to buffers representing areas 0 to 100 feet, 100 to 300 feet, and 300 to 500 feet from the usage areas.

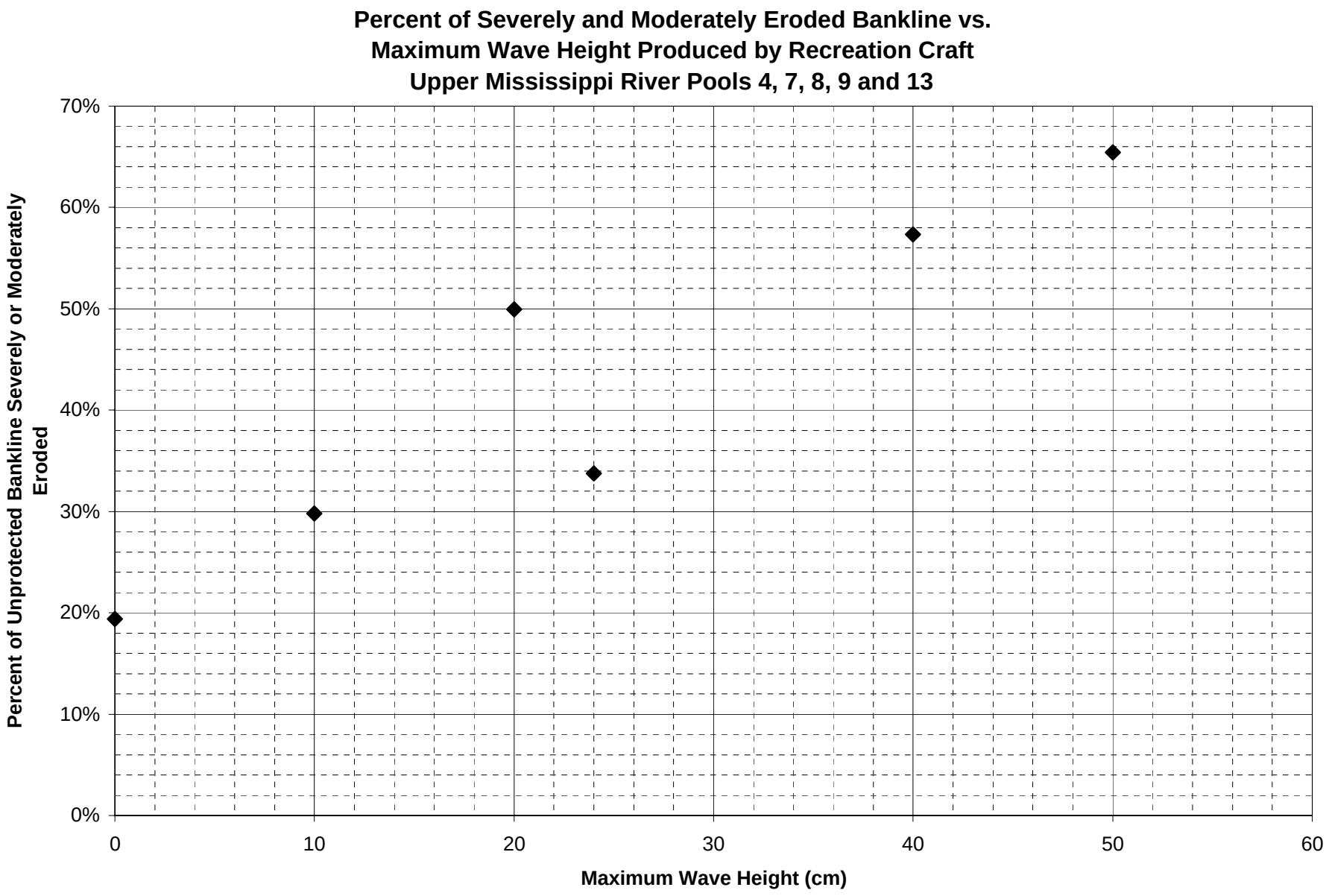
2. Actual numbers of boats operating in these usage areas were not available in the GIS database. It is my understanding that allocation of actual numbers of recreational vessels to these areas will be done at some point in the future.

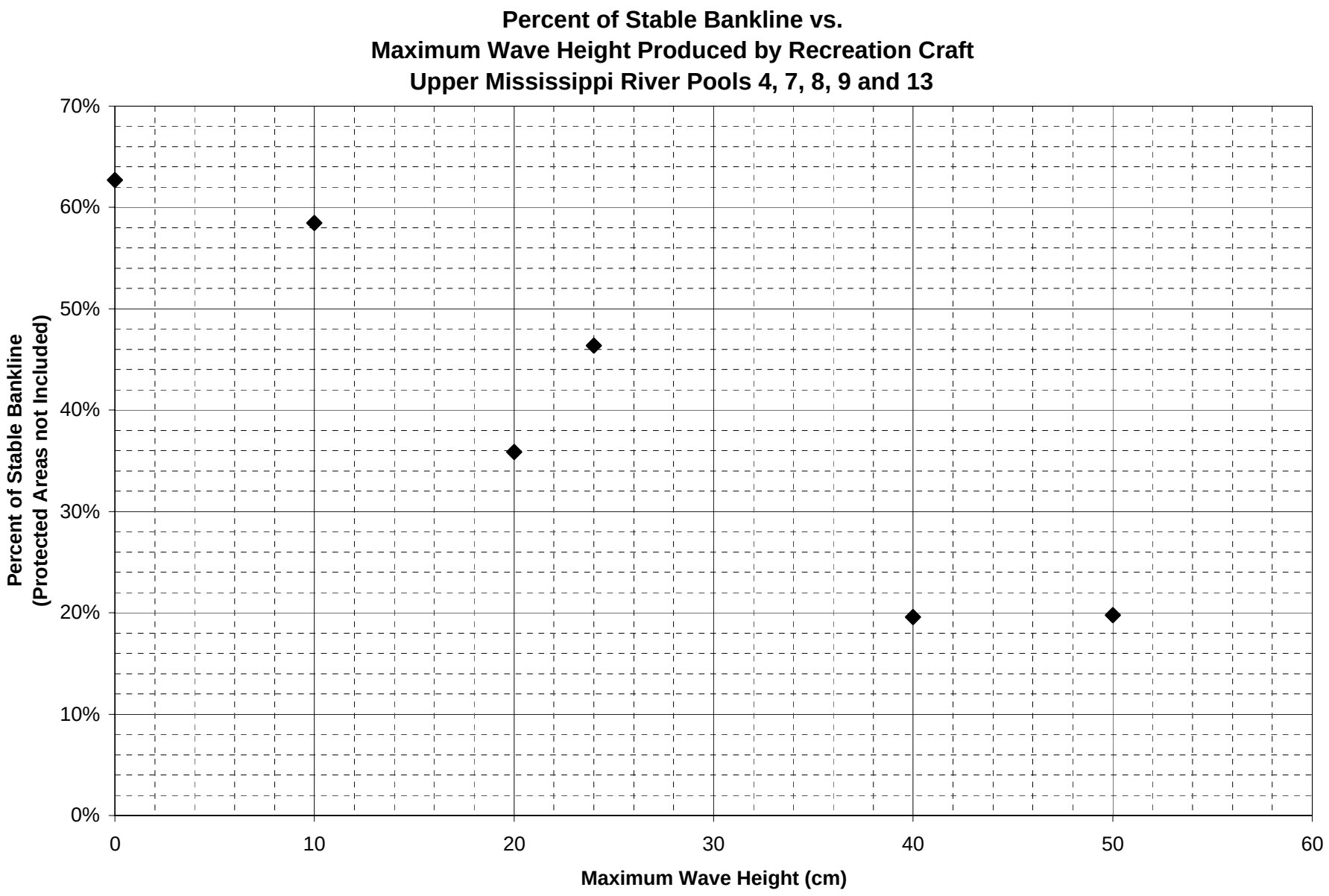
3. The Bank Erosion Study previously mapped erosion conditions as part of the 1995 field survey. Bank sections were classified as stable, protected, or as various degrees of erosion (severe, moderate, minor, intermittent, etc.). Bank conditions were only observed for the areas immediately adjacent to the main navigation channel.

4. In order to attempt to define a threshold wave height above which recreational traffic may result in bank erosion, an analysis was performed to attempt to correlate the locations of observed erosion with the estimated wave heights produced by recreation craft in those areas. Only two vessel types were identified as producing waves in excess of 20 cm, medium powerboats and large cruisers. Therefore, only these two classes of boats were considered in this analysis. Since both vessel sizes operate in some of the same areas, consideration was given only to that vessel type that produced the maximum wave height for a given area.

5. The wave heights for each boat class and boating season were attached to the bank erosion GIS coverages (using the 'identity' command within ArcInfo). The maximum wave height for each segment of the bankline was computed and plotted against the bank conditions observed during the field survey for navigation pools 4, 7, 8, 9, and 13. The two attached tables present the results of this analysis. The first compares the percentage of bankline identified as severely or moderately eroded versus the maximum wave height produced by recreation craft. The second compares the percentage of bankline identified as stable versus the maximum wave height produced by recreation craft. In both analyses, protected (naturally or artificially) banklines were eliminated from consideration. Since interpretation of the graphs can be confusing, the following statements are provided to clarify the information presented on the graphs:

- Approximately 57% of the unprotected, main channel bankline was classified as moderately or severely eroded in areas where recreation craft produce waves up to 40 cm in height.


Percent of Severely and Moderately Eroded Bankline vs.
Maximum Wave Height Produced by Recreation Craft
Upper Mississippi River Pools 4, 7, 8, 9 and 13
Percent of Unprotected Bankline Severely or Moderately Eroded
70%
60%
50%
40%
30%
20%
10%
0%
0
10
20
30
40
50
60
Maximum Wave Height (cm)


Percent of Stable Bankline vs.
Maximum Wave Height Produced by Recreation Craft
Upper Mississippi River Pools 4, 7, 8, 9 and 13
Percent of Stable Bankline
(Protected Areas not Included)
70%
60%
50%
40%
30%
20%
10%
0%
0
10
20
30
40
50
60
Maximum Wave Height (cm)

- Approximately 20% of the unprotected main channel bankline was classified as stable in areas where recreation craft produce waves up to 40 cm in height.

6. Based on the results of this analysis, there is an apparent positive relationship between wave heights generated by recreation craft and the occurrence of bank erosion along the main channel of the UMR.

7. One way to classify at-risk areas would be to use a High-Medium-Low classification scheme. This would be similar to that used in the bank erosion study (for potential commercial vessel effects) and in the backwater sedimentation study. Based on the graphed information, one possible breakdown would be:

Erosion Potential	Maximum Wave Height
High	> 35 cm
Medium	20 – 35 cm
Low	< 20 cm

In terms of boat classes, this would mean that large cruisers operating within 300 ft of the bankline would be consider high potential. Medium powerboats operating within 300 ft of the bankline or large cruisers operating 300-500 feet from the bankline would be considered medium potential. All other vessel types would be considered low potential, regardless of distance at which they are operating from the shoreline (the next highest wave height was 16 cm for fishing boats within 100 feet).

8. As a context for the results of this analysis; Nanson et al. (1994) measured erosion rates from recreational vessels on the Gordon River, Tasmania. The authors found a good relationship between wave height and erosion rates. Based on their observations, they identified a threshold of 30-35 cm for wave heights, above which unconsolidated sandy alluvium was eroded at a significant rate.