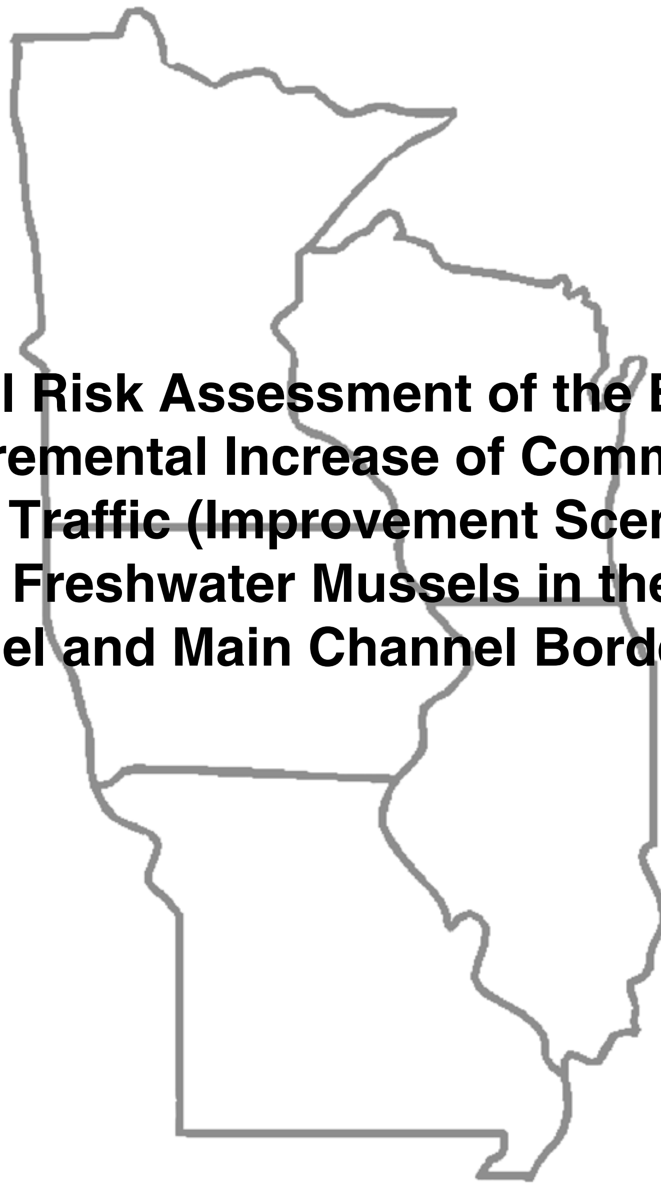
ENV Report 39

Interim Report For The Upper Mississippi River — Illinois Waterway System Navigation Study



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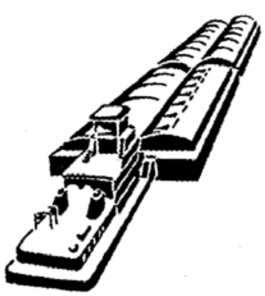

September 2003

Rock Island District
St. Louis District
St. Paul District

US Army Corps of Engineers®

Upper Mississippi River - Illinois Waterway
System Navigation Study

ENV Report 39
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Ecological Risk Assessment of the Effects of the Incremental Increase of Commercial Navigation Traffic (Improvement Scenarios 2 and 3) on Freshwater Mussels in the Main Channel and Main Channel Borders

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Interim report

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ABSTRACT: The Navigation Study Mussel Ecological Risk Assessment presents an assessment of the potential ecological risks posed by commercial traffic on freshwater mussels that live in the main channel and main channel borders of the Upper Mississippi River-Illinois Waterway (UMR-IWW) System. Backwaters were not included in this risk assessment. The assessment examines the possibility that commercial vessel-induced increases in suspended sediments might impair the growth and reproduction of freshwater mussels.

Risks to mussels posed by commercial traffic resulting from two improvement scenarios were evaluated. Scenario 2 consists of guidewall extensions at UMR Locks 20-25 to be in place by 2008, while Scenario 3 consists of guidewall extensions at UMR Locks 14-18 and lock extensions at UMR Locks 20-25 to be in place by 2012. The scenarios are presented as increases in the average daily number of vessels traversing each pool on the UMR-IWW System (i.e., tows/day).

The threeridge mussel (*Amblema plicata*) was selected to represent the freshwater mussel community in the UMR-IWW System. It is one of the most common species and is widespread throughout the UMR-IWW System. Additionally, it is one of the most important commercially harvested species.

A bioenergetics model for the threeridge mussel was developed and implemented for locations in the UMR-IWW System where mussel beds are known to occur. Freshwater mussel bed locations are included in a geographic information system (GIS) data base. For this risk assessment, selected locations included mussel beds in UMR Pools 13 and 26 and the IWW LaGrange Pool. Results of the model simulations indicated that increases in suspended sediment concentrations associated with traffic increases resulting from Scenarios 2 and 3 do not affect the growth and reproduction of threeridge mussels for five locations in Pool 13, three locations in Pool 26A, one location in Pool 26B, and fifteen locations in the LaGrange Pool.

The Navigation Study Mussel Ecological Risk Assessment was organized according to the fundamental components of the ecological risk assessment process: problem formulation, analysis (characterization of exposure and characterization of ecological effects), and risk characterization. The risk assessment methodology described in this report has been developed to assess the potential ecological impacts associated with the anticipated growth of commercial traffic navigating the UMR-IWW System for the period 2000-2050. Assessments of potential impacts on early life stages of fish, adult fish, and fish spawning habitat, as well as impacts on the breakage, growth, and reproduction of submerged aquatic plants, have concurrently been developed.

The next phase in assessing traffic impacts on mussels will be to incorporate the current methodology into a framework that characterizes risk in probabilistic terms. More detailed, probabilistic assessments will be performed for selected locations and traffic scenarios identified by the preliminary analyses. Parameters used in the calculations (e.g., suspended sediment concentrations produced by the NAVSED model, mussel growth and filtering rates) that are imprecisely known will be defined as statistical distributions. Monte Carlo simulation methods will be used to propagate these uncertainties through the model calculations to produce distributions of impacts on growth and reproduction in relation to specific traffic scenarios. These distributions of results can be used to estimate the probability of different magnitudes of impact in a manner consistent with probabilistic risk estimation.

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Preface

The work reported herein was conducted as part of the Upper Mississippi River - Illinois Waterway (UMR-IWW) System Navigation Study. The information generated for this interim effort will be considered as part of the plan formulation process for the System Navigation Study.

The UMR-IWW System Navigation Study is being conducted by the U.S. Army Engineer Districts of Rock Island, St. Louis, and St. Paul under the authority of Section 216 of the Flood Control Act of 1970. Commercial navigation traffic is increasing and, in consideration of existing system lock constraints, will result in traffic delays that will continue to grow in the future. The system navigation study scope is to examine the feasibility of navigation improvements to the Upper Mississippi River and Illinois Waterway to reduce delays to commercial navigation traffic. The study will determine the location and appropriate sequencing of potential navigation improvements on the system, prioritizing the improvements for the 50-year planning horizon from 2000 through 2050. The final product of the System Navigation Study is a Feasibility Report which is the decision document for processing to Congress.

This report was written by Steven M. Bartell, Erin M. Miller, and Kym Rouse Campbell of The Cadmus Group, Inc., and David J. Schaeffer of EcoHealth Research, Inc.

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Commander and Executive Director of ERDC was COL James R. Rowan, EN. Director was Dr. James R. Houston.

1 Introduction

Background

The Mississippi River is an integral part of American heritage, a unique resource, and the best example of a multi-purpose river in the United States. The Mississippi River, with a drainage basin of nearly 4 million km^2, is one of the largest and most productive ecosystems in the world (Holland-Bartels et al. 1990b). The river above the confluence of the Ohio River is commonly called the Upper Mississippi River (UMR) (Figure 1) and includes nearly 500,000 km^2 of watershed (Holland-Bartels et al. 1990b). The UMR, including the Illinois Waterway (IWW) and several important tributaries (Figure 1), is designated both a nationally-significant ecosystem and a nationally-significant navigation system. It is the only inland river in the United States to have such a designation. Many national wildlife refuges exist along the river corridor. The Mississippi Flyway is the migration corridor for 40% of North America's waterfowl and shorebirds, as well as an important flyway for raptors and neotropical songbirds. A total of 50 species of freshwater mussels have been recorded in the river system. In addition, the Mississippi River System is noteworthy among the world's large temperate rivers because it supports an unusually large number of fish species. Historically, at least 150 species of fish have been reported in the UMR (Gutreuter 1997).

The history of navigation on the UMR-IWW System began in the 1820s, when Congress authorized navigation improvements by the Corps of Engineers; these improvements included the removal of snags and other obstructions in several locations of the Mississippi River and the construction of a canal connecting Lake Michigan to the Illinois River (Fremling and Claflin 1984). Several navigation improvement projects, such as the excavation of rocks, closing off sloughs, construction of the 4.5-foot navigation channel, and construction of the 6-foot navigation channel, continued throughout the early 1900s (Fremling and Claflin 1984). Projects creating the current 9-foot navigation channel were authorized in the 1930s, and by 1940, most had been completed by the U.S. Army Corps of Engineers (USACOE) (Fremling and Claflin 1984). Twenty-nine locks and dams on the Mississippi and eight on the Illinois replaced rapids and falls with a series of terraced pools for commercial and recreational traffic (Figure 1). Habitats in a typical pool include a braided channel in the upper pool, a lotic area at the head of the pool, and a lentic environment above the impounding lock and dam (Van Vooren 1983). Commercial barge traffic transports a wide variety of essential

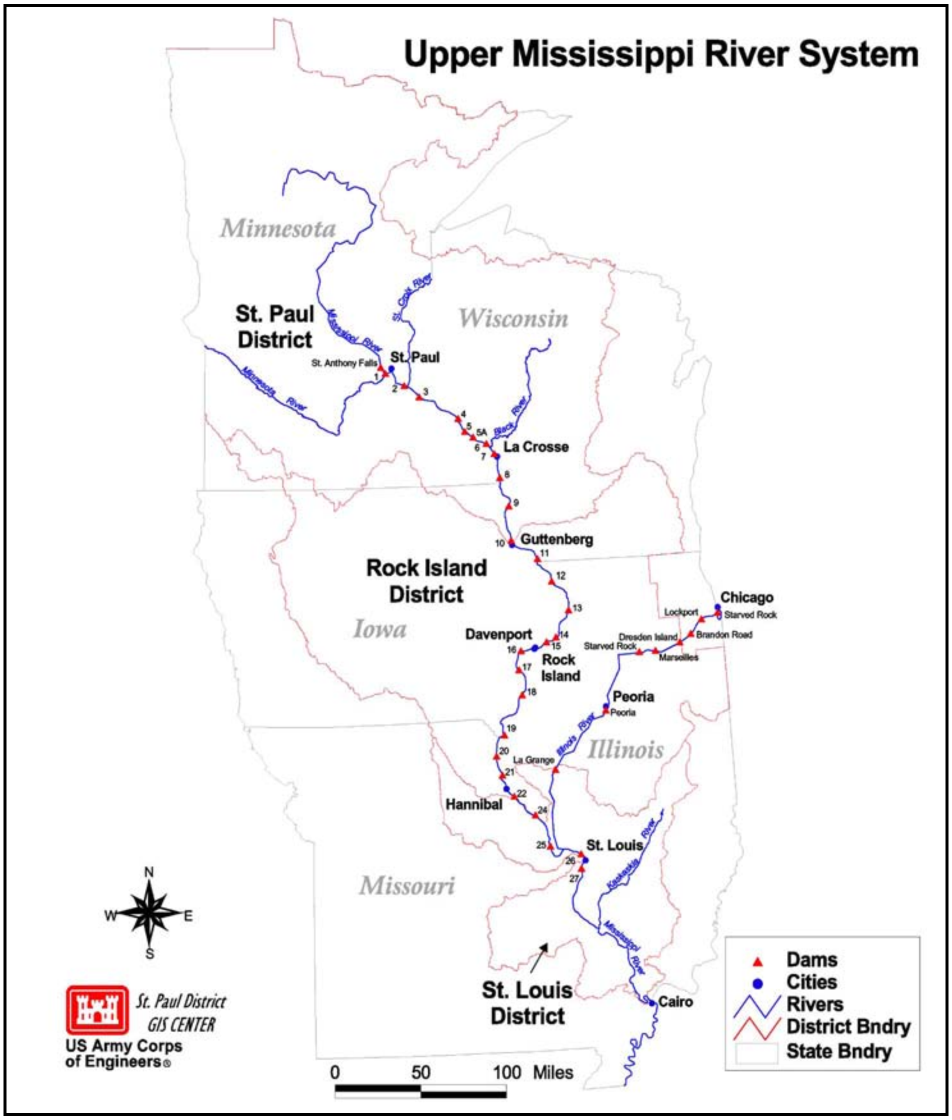

Figure 1. The Upper Mississippi River-Illinois Waterway System, the pool upstream from the dam has the same number or name as the dam

goods on the UMR-IWW System. Agricultural commodities, petroleum products, and coal are the leading cargoes, with farm products accounting for approximately half of the total tonnage shipped.

Estimates indicate that the transport of commodities on the river system could significantly increase in the future (Holland 1986, Holland-Bartels et al. 1990a). In the UMR-IWW System, a typical commercial "tow" consists of a tow boat and 15 barges with the configuration of 3 barges wide by 5 barges long (Holland 1986). Direct impacts on mussels that could result from a tow include crushing, dislodging, or burial from the physical forces produced by the commercial tows as they pass. Possible indirect impacts include the reduction in growth and/or reproduction caused by the resuspension of near shore sediments caused by tows passing throughout the growing season.

There are 297 species of freshwater mussels in the United States, the richest diversity found in the world (Turgeon et al. 1988, Helfrich et al. 1997). Most species occur in the Mississippi drainage. The high diversity of mussel species in the Mississippi drainage differs markedly with the low diversity of mussels found in North American lakes. Different mussel species are identified by the size, shape, color, and markings on their shell. In the main stem of the UMR-IWW System, about 50 species have been recorded, although only about 30 species have been documented in recent surveys (USGS 1999). Approximately 40% of the native species have been extirpated, and 20% of the remaining species in the UMR-IWW System are at risk of extinction (USGS 1999). The decrease in freshwater mussel density and diversity has occurred as a result of human-induced impacts on the UMR-IWW System. They include water pollution, dam construction, dredging, siltation, host fish kills, and harvesting. Clearly, the current status of freshwater mussels in the UMR-IWW System is precarious. Furthermore, in the United States, many species of mussels are presumed extinct (~30), are threatened or endangered (~60), or are species of concern (~70). No other widespread animal group in North America has been jeopardized to this extent (Helfrich et al. 1997).

Some mussel species are still harvested in the UMR-IWW System for use in the cultured pearl industry in Japan. However, as of this writing, the commercial harvest of mussels is essentially at a standstill due to the lack of a market resulting from the >90% mortality of pearl oysters in Japan (Scott Whitney, USACOE, Rock Island District, pers. comm.). In addition, in response to the zebra mussel (Dreissena polymorpha) invasion, the IWW remains closed to all commercial harvest (Scott Whitney, USACOE, Rock Island District, pers. comm.). The introduction of the exotic zebra mussel, which poses a severe threat to native freshwater mussels, significantly complicates the conservation of mussels in the UMR-IWW System.

Although mussels have little value as human food, they hold immense ecological value (Helfrich et al. 1997). As a vital link in the food chain, they are a major food source for valuable wildlife such as muskrat, otter, and raccoon. Young mussels are eaten by ducks, herons, and sport fish. As important natural filterers, they improve water quality by straining out suspended particles and pollutants from our rivers. Because of their filtering capacity (up to several liters/day), mussels are an integral part of the natural purification process in rivers and lakes. Freshwater mussels also have great value as indicators of environmental health. They are used as biological monitors to indicate past and present water quality conditions in rivers and lakes. Mussels are not recommended as food for humans because they accumulate and store contaminants in their tissues.

The purpose of the Navigation Study Mussel Ecological Risk Assessment is to assess the incremental impact of increased commercial navigation traffic from 2000 to 2050 (in 10-year increments) on mussels in the main channel and main channel borders of the UMR-IWW System. Backwaters were not included in this risk assessment primarily due to the absence of ambient suspended sediment data in backwaters and the difficulty of translating traffic increases to changes in suspended sediment in backwaters. This assessment evaluates the risks posed by commercial traffic resulting from two improvement scenarios. Scenario 2 consists of guidewall extensions at UMR Locks 20-25 to be in place by 2008, while Scenario 3 consists of guidewall extensions at UMR Locks 14-18 and lock extensions at UMR Locks 20-25 to be in place by 2012.

The estimated incremental impacts of increased commercial navigation traffic on mussel growth and reproduction were calculated using a bioenergetics model developed for the threeridge mussel. In addition to being an important commercial species, the threeridge mussel is common and widespread throughout the UMR-IWW System.

The U.S. Environmental Protection Agency (USEPA) Framework Ecological Risk Assessment

The assessment of potential environmental impacts caused by commercial tows on freshwater mussels in the UMR-IWW System will meet the technical requirements of the National Environmental Policy Act (NEPA), but will be conducted and organized in a manner consistent with the framework for ecological risk assessment recommended in the Guidelines for Ecological Risk Assessment developed by the USEPA (USEPA 1998). The framework was developed to promote consistent approaches to ecological risk assessment, identify key issues, and define terminology (Bartell 1996). It represents a step towards developing guidelines for incorporating ecological principles into USEPA decisions (USEPA 1998). The framework developed by the USEPA includes three components: problem formulation, analysis (characterization of exposure and characterization of ecological effects), and risk characterization (USEPA 1998).

In the problem formulation component, the disturbance or stressor is identified, the subject or ecological effects (commonly referred to as endpoints) of the risk assessment are defined, and the scope and scale of the ecological risk assessment is presented. In the characterization of exposure section, the frequency, magnitude, extent, and duration of the disturbance is described. The ecological effects consistent with the objectives of the assessment are defined and the exposure-response relationships used to translate the exposure profile into risk estimates are presented in the characterization of ecological effects phase of the assessment process. In the risk characterization section, the available information and data are integrated, the risks are estimated, and the uncertainties and their assessment implications are identified and estimated. (USEPA 1998).

2 Problem Formulation

The disturbances or stressors in the Navigation Study Mussel Ecological Risk Assessment are the physical forces associated with the incremental increase in commercial navigation traffic, specifically a commercial tow passing through the river system. The ecological effects that are the focus of this risk assessment are the decreases in mussel growth and reproduction due to the increased suspended sediment concentrations resulting from increased commercial navigation traffic. The overall approach or methodology for this risk assessment is presented in Figure 2.

Traffic projections have been developed by USACOE economists for the future (2000, 2010, 2020, 2030, 2040, and 2050) for the conditions that would occur without any major improvements to the UMR-IWW System; they are referred to as the “without-project” conditions. Future traffic projections have also been developed for various alternative improvement scenarios, one of which will ultimately become the selected National Economic Development (NED) Plan, for the years 2000-2050. Traffic that actually occurred on the river system in 1992 can be used as the baseline for comparison. In this assessment, the risks posed by commercial traffic resulting from two improvement scenarios, Scenarios 2 and 3, were evaluated.

For the purposes of this ecological risk assessment, traffic projections were broken down into tows per day by month for each pool. The physical forces resulting from all possible configurations of a passing commercial tow were calculated for the main channel of the Long Term Resource Monitoring Program (LTRMP) “trend pools” (UMR Pools 13 and 26 and the IWW La Grange Pool) using the NAVEFF model (Maynord 1998). The characteristics that define a particular vessel configuration include the direction of travel (upbound, downbound), vessel speed (slow, medium, fast), vessel size (small, medium, big), barge loads (empty, mixed, full), and propeller type (Kort nozzle, open wheel). The existing fleet data were analyzed and resulted in 108 different vessel configurations; each vessel configuration was assigned a code value (1-108) that identifies its particular combination of attributes. These fleet characteristics, developed by USACOE economists, are presumed not to change over the study period (through the year 2050). The output from the NAVEFF model was used to calculate the magnitude and duration of sediment resuspension resulting from a passing commercial tow in the sediment modeling effort (NAVSED) (Copeland et al. 1999).

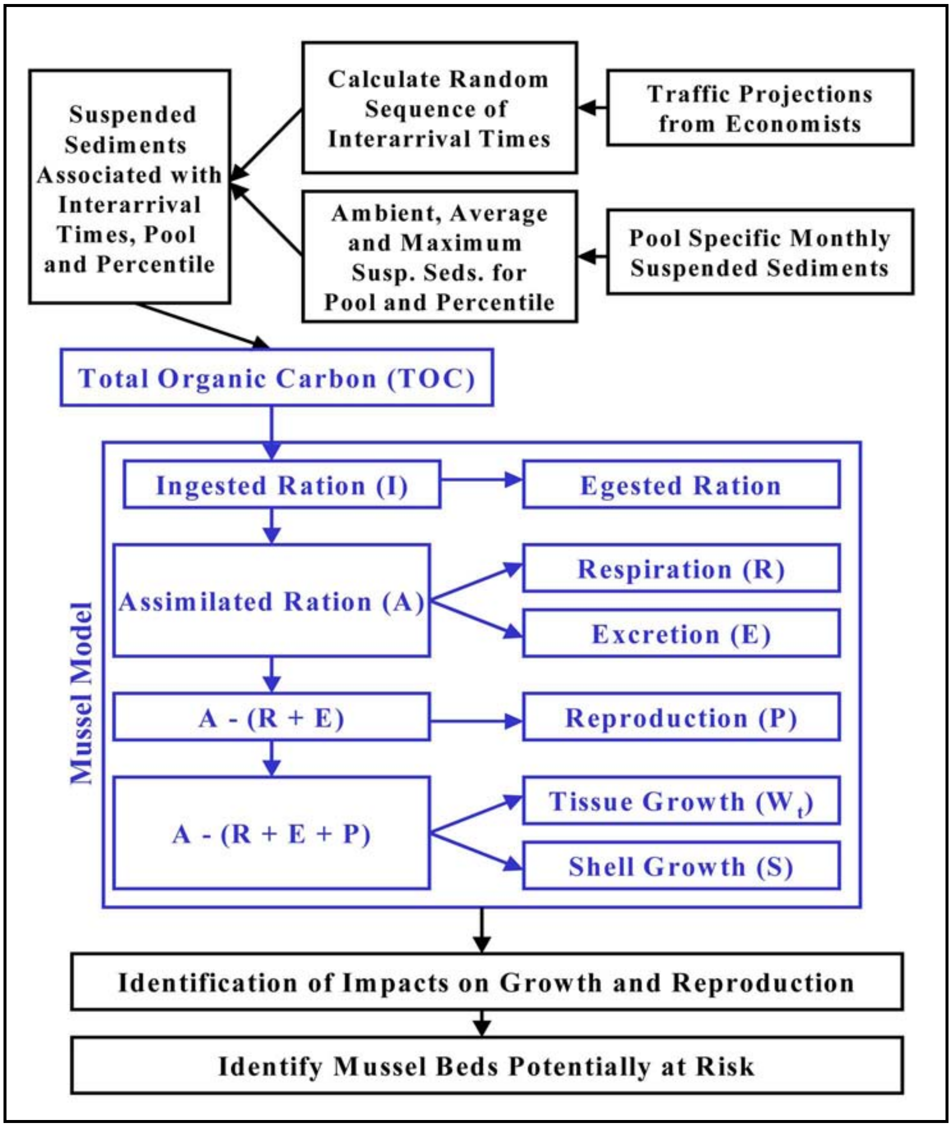

Figure 2. Schematic of the freshwater mussel risk assessment methodology

A threeridge mussel bioenergetics model was used to evaluate the potential impacts of increased commercial traffic for selected mussel beds in UMR Pools 13 and 26 and the IWW LaGrange Pool (Figure 2). Suspended sediment concentrations associated with the 108 vessel types for selected cells associated with known mussel beds in Pool 13, Pool 26, and the LaGrange Pool (in a GIS data base) were estimated using the NAVSED model. For the LTRMP trend pools, a cell is defined as 10-m wide by 0.5-mile long parallel to the sailing line. Each cell references a 3-dimensional location with a GIS data file that describes the bathymetry of the pool and is assigned a unique identification code in relation to its pool location in river miles and distance of its center point left or right of the sailing line (e.g., 135R5250 = 135 m right of the sailing line at River Mile 525.0). A time series of suspended sediment concentrations for each vessel passage and bed location within a pool was calculated using results from the NAVSED model. It was assumed that tow-induced sediment resuspension effectively diluted the organic content of the ambient total suspended solids that were ingested by the mussel. The model estimated the magnitude of reduced growth and reproduction resulting from the increase in suspended sediments associated with traffic due to Scenarios 2 and 3 (both with- and without-project conditions). The incremental difference between the with- and without-project conditions was calculated for each scenario.

3 Analysis-Characterization of Exposure

Initial Step

In order to perform this ecological risk assessment, the important initial step was to characterize the nature of the environmental stress. This step in assessing ecological risks posed to mussels by commercial traffic describes and quantifies the nature, magnitude, and extent of physical forces produced by commercial vessels navigating on the UMR-IWW System.

Payne et al. (1997) concluded that the shear stresses induced by the hulls of moving barges and pressure changes resulting from rapid displacement within the water column did not cause mussel mortality or dislocation. Increased current velocities resulting from the passage of a commercial tow did not affect mussels (Payne and Miller 1987, Payne et al. 1996). Therefore, the analysis of the potential impact resulting from increased commercial traffic was limited to the effects of increased suspended sediment concentrations on mussel growth and reproduction. This risk assessment was defined spatially by the main channel and main channel borders of the UMR-IWW System, using mussel beds in UMR Pools 13 and 26 and the IWW LaGrange Pool as typical examples.

Commercial Traffic Scenarios

Commercial traffic scenarios that define the average number of vessels which travel through each pool each day were addressed in this risk assessment. As examples, Tables 1-4 list the number of tows per day from May through September for each scenario in UMR Pool 13. The traffic intensity resulting from the 1992 baseline, Scenario 2 (with- and without-project conditions), and Scenario 3 (with- and without-project conditions) for all pools of the UMR-IWW System is presented in Appendix A.

Table 1
Traffic Intensity (Mean Tows/Day and Total for Month) for UMR Pool 13 from May-September for Scenario 2, Without-Project Conditions. IAT = Interarrival Time (h)

Year	May			June			July			August			September		
	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT
2000	9.9	306	2.4	9.2	275	2.7	10.2	316	2.4	9.2	285	2.6	7.7	230	3.1
2010	10.1	313	2.3	9.4	281	2.7	10.4	322	2.3	9.3	288	2.5	7.8	234	3.1
2020	10	310	2.3	9.3	279	2.6	10.3	319	2.4	9.3	288	2.5	7.7	230	3.1
2030	10	310	2.3	9.3	279	2.7	10.3	319	2.3	9.3	288	2.5	7.7	230	3.3
2040	10	310	2.3	9.3	279	2.7	10.2	316	2.4	9.2	285	2.5	7.7	230	3.2
2050	9.9	306	2.4	9.2	275	2.6	10.2	316	2.4	9.2	285	2.6	7.6	227	3.2

Table 2
Traffic Intensity (Mean Tows/Day and Total for Month) for UMR Pool 13 from May-September for Scenario 2, With-Project Conditions. IAT = Interarrival Time (h)

Year	May			June			July			August			September		
	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT
2000	9.9	306	2.5	9.2	275	2.6	10.2	316	2.4	9.2	285	2.5	7.7	230	3.2
2010	10.9	337	2.2	10.1	303	2.4	11.2	347	2.1	10.1	313	2.3	8.4	251	2.9
2020	10.9	337	2.1	10.2	305	2.5	11.2	347	2.1	10.1	313	2.3	8.4	251	2.9
2030	10.9	337	2.2	10.1	303	2.4	11.2	347	2.2	10.1	313	2.3	8.4	251	3.0
2040	10.9	337	2.2	10.1	303	2.5	11.2	347	2.1	10.1	313	2.3	8.4	251	3.0
2050	10.9	337	2.2	10.1	303	2.4	11.2	347	2.2	10.1	313	2.3	8.4	251	3.0

Table 3
Traffic Intensity (Mean Tows/Day and Total for Month) for UMR Pool 13 from May-September for Scenario 3, Without-Project Conditions. IAT = Interarrival Time (h)

Year	May			June			July			August			September		
	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT
2000	10.0	310	2.4	9.3	279	2.5	10.3	319	2.4	9.3	288	2.6	7.7	230	3.1
2010	10.0	310	2.4	9.3	279	2.7	10.3	319	2.3	9.3	288	2.5	7.7	230	3.1
2020	10.0	310	2.4	9.3	279	2.7	10.3	319	2.3	9.3	288	2.5	7.7	230	3.3
2030	9.9	306	2.3	9.2	275	2.7	10.2	316	2.4	9.2	285	2.5	7.7	230	3.2
2040	9.9	306	2.3	9.2	275	2.7	10.1	313	2.4	9.1	282	2.6	7.6	227	3.2
2050	9.8	303	2.5	9.1	273	2.7	10.1	313	2.4	9.1	282	2.6	7.5	225	3.2

Table 4
Traffic Intensity (Mean Tows/Day and Total for Month) for UMR Pool 13 from May-September for Scenario 3, With-Project Conditions. IAT = Interarrival Time (h)

Year	May			June			July			August			September		
	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT	Tows/ Day	Total	IAT
2000	10.0	310	2.4	9.3	279	2.7	10.3	319	2.3	9.3	288	2.5	7.7	230	3.1
2010	10.2	316	2.4	9.5	285	2.5	10.5	325	2.4	9.5	294	2.5	7.9	237	3.1
2020	12.9	399	1.9	12.0	360	2.0	13.2	409	1.8	11.9	368	2.0	9.9	296	2.4
2030	12.9	399	1.9	12.0	360	2.0	13.2	409	1.9	11.9	368	2.0	9.9	296	2.5
2040	12.9	399	1.9	12.0	360	2.0	13.2	409	1.9	11.9	368	2.0	9.9	296	2.4
2050	12.9	399	1.8	12.0	360	2.0	13.2	409	1.9	11.9	368	2.0	9.9	296	2.5

Interarrival times

The potential impacts of commercial traffic on mussel growth and reproduction were estimated as the cumulative effect of individual traffic events. To perform each assessment, a time series of vessel passages was constructed for each representative mussel bed location and traffic scenario. Each time series described a possible sequence of the specific hours throughout an entire year (i.e., 8,760 hours) in which one or more commercial vessels was projected to pass-by the selected mussel beds. An hourly time scale was used for compatibility with the hourly time-step of the mussel growth model. As the projected number of vessels/day increased, the expected time between vessel passages (i.e., the interarrival time) decreased as indicated by comparing with-project traffic values to without-project values for Scenarios 2 and 3 (Tables 1-4).

Sequences of interarrival times were developed separately for each assessment by selecting interarrival times randomly from exponential distributions developed for each traffic scenario. The shape of each distribution was defined by a single parameter, in this case, the inverse of the projected average number of vessels/day. Using the 1992 lockage records to describe seasonal traffic patterns for the UMR-IWW System, the expected daily average traffic values were estimated for each pool and month for Scenarios 2 and 3. Timelines of vessel passages were constructed for locations corresponding to selected mussel beds in Pool 4, Pool 13, and the LaGrange Pool. These time series provided realistic characterizations of increases in the frequency of vessel passages for mussel beds in relation to traffic resulting from Scenarios 2 and 3.

Suspended sediments

Each of the modeled vessel passages resulted in an increase of suspended sediment concentrations for the representative location of mussel beds addressed in this assessment. The magnitude of suspended sediments associated with each traffic “event” was a function of vessel configuration, vessel location in the navigation channel (i.e., sailing line), pool stage height, and sediment type. The exact value assigned to each event was determined from a statistical sampling and analysis of these factors.

A set of 108 commercial vessel configurations was developed by classifying each in terms of its direction (upbound, downbound), size (small, medium, large), speed (slow, medium, fast), barge load (full, empty, mixed), and propeller technology (open wheel, Kort nozzle). Specific values were assigned to each of the qualitative characteristics in relation to data obtained from the UMR-IWW System. The relative frequency of these 108 configurations was estimated for each pool and month using the 1992 lockage data (e.g., Table 5).

Vessels were assumed to navigate the middle of the navigation channel 90% of the operating conditions; the right and left edge of the navigation were each assumed to be used under 5% of operating conditions. Discharge and corresponding stage height data were analyzed for a series of sampling locations

Table 5
Relative Frequency of Different Vessel Types Observed in Pool 8 for the Month of August

Pool	Month	Direction	Size	Type	Speed	% Kort	Frequency	Relative Frequency
8	8	D	B	E	F	33.33	0.000000	0.00000000
8	8	D	B	E	M	33.33	2.647059	0.01557094
8	8	D	B	E	S	33.33	0.352886	0.00207612
8	8	D	B	L	F	40.00	0.048544	0.00028555
8	8	D	B	L	M	40.00	2.087379	0.01227870
8	8	D	B	L	S	40.00	2.864078	0.01684752
8	8	D	B	M	F	59.09	0.171206	0.00100709
8	8	D	B	M	M	59.09	10.957198	0.06445411
8	8	D	B	M	S	59.09	10.871595	0.06395056
8	8	D	M	E	F	42.86	1.991632	0.01171548
8	8	D	M	E	M	42.86	4.158996	0.02446468
8	8	D	M	E	S	42.86	0.849372	0.00499631
8	8	D	M	L	F	12.50	0.154839	0.00091082
8	8	D	M	L	M	12.50	4.438710	0.02611006
8	8	D	M	L	S	12.50	3.406452	0.02003795
8	8	D	M	M	F	20.00	0.787992	0.00463525
8	8	D	M	M	M	20.00	6.510319	0.03829599
8	8	D	M	M	S	20.00	2.701689	0.01589229
8	8	D	S	E	F	6.25	9.709402	0.05711413
8	8	D	S	E	M	6.25	4.923077	0.02895928
8	8	D	S	E	S	6.25	1.367521	0.00804424
8	8	D	S	L	F	15.38	3.734417	0.02196716
8	8	D	S	L	M	15.38	7.433604	0.04372708

(Sheet 1 of 3)

Table 5 (Continued)								
Pool	**Month**	**Direction**	**Size**	**Type**	**Speed**	**% Kort**	**Frequency**	**Relative Frequency**
8	8	D	S	L	S	15.38	1.831978	0.01077634
8	8	D	S	M	F	0.00	0.306667	0.00180392
8	8	D	S	M	M	0.00	0.493333	0.00290196
8	8	D	S	M	S	0.00	0.200000	0.00117647
8	8	U	B	E	F	75.00	0.666667	0.00392157
8	8	U	B	E	M	75.00	2.666667	0.01568628
8	8	U	B	E	S	75.00	0.666667	0.00392157
8	8	U	B	L	F	70.59	0.050296	0.00029586
8	8	U	B	L	M	70.59	7.594675	0.04467456
8	8	U	B	L	S	70.59	9.355030	0.05502959
8	8	U	B	M	F	28.57	0.395480	0.00232635
8	8	U	B	M	M	28.57	7.514124	0.04420073
8	8	U	B	M	S	28.57	6.090395	0.03582585
8	8	U	M	E	F	0.00	0.324324	0.00190779
8	8	U	M	E	M	0.00	0.459459	0.00270270
8	8	U	M	E	S	0.00	0.216216	0.00127186
8	8	U	M	L	F	37.50	0.375652	0.00220972
8	8	U	M	L	M	37.50	5.259130	0.03093606
8	8	U	M	L	S	37.50	2.365217	0.01391304
8	8	U	M	M	F	20.00	1.152263	0.00677802
8	8	U	M	M	M	20.00	6.460905	0.03800532
8	8	U	M	M	S	20.00	2.386831	0.01404018
8	8	U	S	E	F	0.00	5.302682	0.03119225
								(Sheet 2 of 3)

Table 5 (Concluded)								
Pool	Month	Direction	Size	Type	Speed	% Kort	Frequency	Relative Frequency
8	8	U	S	E	M	0.00	1.839080	0.01081812
8	8	U	S	E	S	0.00	0.858238	0.00504846
8	8	U	S	L	F	9.09	9.755656	0.05738621
8	8	U	S	L	M	9.09	10.253394	0.06031408
8	8	U	S	L	S	9.09	1.990950	0.01171147
8	8	U	S	M	F	0.00	0.369231	0.00217195
8	8	U	S	M	M	0.00	0.553846	0.00325792
8	8	U	S	M	S	0.00	0.076923	0.00045249
								(Sheet 3 of 3)

throughout the UMR-IWW System. Values corresponding to the 10^{th}, 50^{th}, and 90^{th} percentile were used to establish low, medium, and high stage heights for each pool and month. Sediment types (e.g., particle size, bulk density, organic content) were defined for each pool on the basis of field sampling and analysis.

Repeated sampling (e.g., N = 5,000) of vessel type, sailing line, and stage height provided statistical distributions of modeled physical forces that were associated with each potential traffic event. Each combination of vessel type, location, stage height, and corresponding sediment type translated into modeled estimates of near-field and far-field sediment resuspension. Distributions of suspended sediments were developed for each river mile and month.

In each assessment of potential impacts on mussel growth and reproduction, each vessel passage was assigned the same magnitude of suspended sediments. In three separate assessments per mussel bed, all events in the traffic scenarios described by the sequence of interarrival times were assigned a suspended sediment concentration equal to the 10^{th} percentile of the distribution of modeled resuspension, then the 50^{th} percentile, and the 90^{th} percentile value. Assigning all traffic events the 90^{th} percentile value of suspended sediments produced the unlikely scenario where each event approximates a nearly worse-case value of sediment resuspension; conversely, using the 10^{th} percentile values underestimated mussel exposure to increased sediment concentrations. These two assessments provided an upper and lower estimate of impacts, while using the 50^{th} percentile approximated the expected (i.e., average) impacts for each traffic scenario. In some cases where the distributions were positively skewed, the 50^{th} percentile values of suspended sediments underestimated the average values. However, given the uncertainties entering the overall modeling of sediment resuspension, it was assumed that the median value usefully characterized a typical sediment concentration for each traffic event.

4 Analysis-Characterization of Ecological Effects

Quantitative relationships between the physical forces and effects of commercial tows on freshwater mussels must be established in order to estimate the ecological risks. These stress-response relationships, which emphasize the uncertainties inherent to their development, implementation, and interpretation, provide the scientific basis for ecological risk assessment.

The Life History, Habitat, and Distribution of Freshwater Mussels in the UMR-IWW System

Freshwater mussels (Family Unionidae) are large bivalve mollusks that live in the sediments of rivers, streams, and to a lesser extent lakes (USGS 1999). Most mussel species require flowing water and coarse, gravelly substrates, whereas others survive well in silty, lake-like conditions in backwaters. Water and sediment quality are important habitat criteria (USGS 1999).

Freshwater mussels are typically found anchored in the substrate, sometimes with only their siphons exposed (USGS 1999). They draw in river water from which they filter fine organic matter such as algae, bacteria, and detritus. Mussels are long-lived, with many species living more than 10 years and some reported to live more than 100 years (Cummings and Mayer 1992, USGS 1999). Most species are sessile and move only short distances their entire life (USGS 1999). Movement can be triggered by changing water levels or other environmental conditions.

Mussels are usually found in dense aggregations called mussel beds which can be miles apart and cover large areas (USGS 1999). Mussel beds usually consist of one to five species, but up to 26 species may be found at a single bed. Selective harvest, siltation, and pollution can have different effects on individual species; therefore, a stressor may have an impact on only a portion of the community. Because they are distributed in widely-spaced clumps, site-specific impacts (e.g., spills, pollutants, dredging) can destroy the mussel fauna of large river reaches just by destroying a single bed. Both repetitive (e.g., waste discharge, harvest, dredging, sedimentation) and continuous disturbances (e.g., dams) can limit the distribution and abundance of some species by blocking fish movement, altering habitat, poisoning, or over-harvesting the population.

The freshwater mussel has a unique life cycle which includes a short parasitic stage attached to a fish (Cummings and Mayer 1992, Helfrich et al. 1997). The life cycle of a mussel can be divided into five distinct life stages (Figure 3): (1) a larva (glochidium) developing in the gills (which function as a brood chamber as well as a means for obtaining oxygen) of a female mussel; (2) a free-drifting glochidium expelled from the female mussel; (3) a parasitic glochidium attached to the gills or fins (depending on the species) of a living host fish; (4) a free-living juvenile mussel; and (5) the adult mussel. Glochidia are generally released from the female in the spring and early summer (April-July) and drift in the water seeking a suitable fish host. Timing is critical since they cannot survive long outside of the female mussel or without a host fish (a few days). Some mussels may depend only on a single fish species, while others can parasitize many different species. The glochidia attach onto the gills or fins of the host fish species (which does not affect the fish), form cysts, and remain attached for one to 25 weeks. As juveniles, they drop off the fish and begin their free-living life.

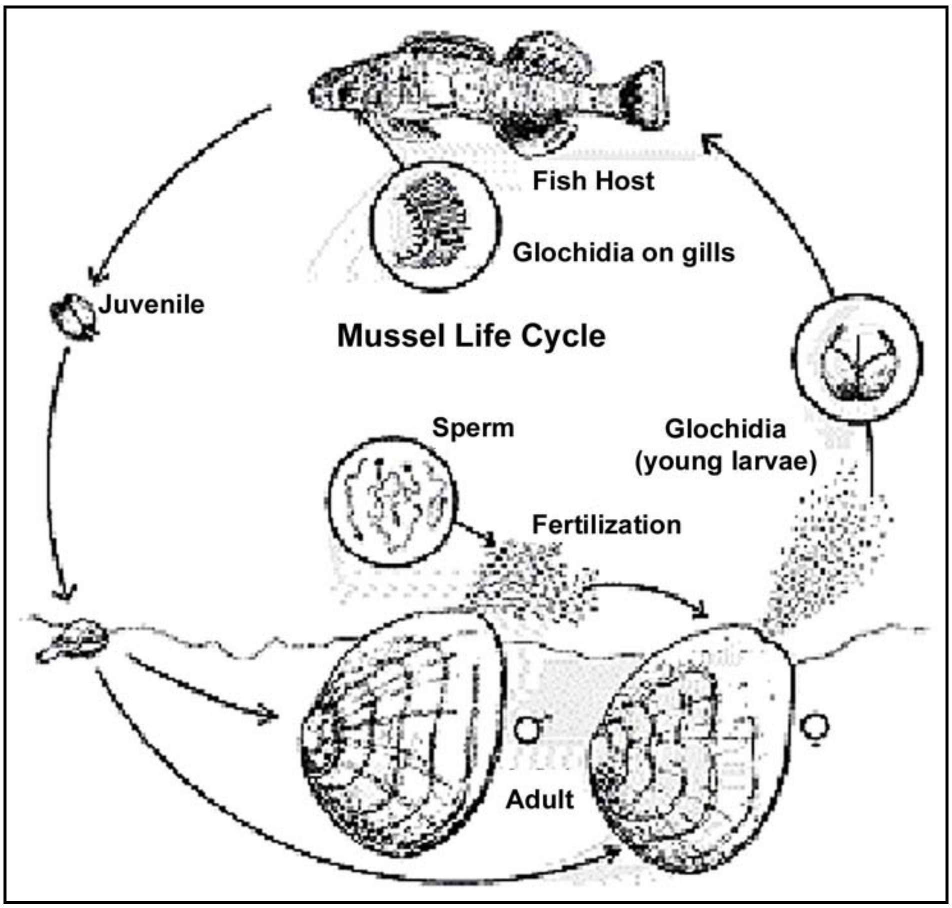

Figure 3. The life cycle of a freshwater mussel (from Helfrich et al. 1997)

The threeridge mussel is one of the most common species and is widespread throughout the UMR-IWW System (USGS 1999) (Figure 4). The glochidia of the threeridge mussel can parasitize many different fish species (Fuller 1974).

Figure 4. The threeridge mussel (*Amblema plicata*) (from Cummings and Mayer 1992)

They include the shortnose gar (*Lepisosteus platostomus*), northern pike (*Esox lucius*), highfin carpsucker (*Carpiodes velifer*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), white bass (*Morone chrysops*), rock bass (*Ambloplites rupestris*), green sunfish (*Lepomis cyanellus*), pumpkinseed (*Lepomis gibbosus*), warmouth (*Lepomis gulosus*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), and sauger (*Stizostedion canadense*).

While the threeridge mussel is not itself endangered or threatened, it was chosen as the model species for this risk assessment for the following reasons. First and foremost, threeridge is widespread and abundant throughout the UMR-IWW System. Unlike many imperiled species, threeridge is found in large numbers throughout the UMR-IWW System in both the main channel and main channel borders. Because this risk assessment is a comprehensive evaluation of the impacts of increased navigation traffic on mussels found in the entire UMR-IWW System, it was decided that the representative species should be found in all of its reaches and in the areas of focus. Next, threeridge is a rather hearty, robust mussel so that more research has been done on this species' physiological processes than on other species in the UMR-IWW System. While there currently exists a paucity of information on biological processes and physiological rates for freshwater mussels, more information exists for threeridge (albeit sparse) than for any of the other species found in the system. Additionally, because threeridge is abundant and robust, it is arguably a prime candidate as an indicator species as to the overall health of the UMR-IWW System. Finally, threeridge is one of the most important commercially-harvested species, so has economic value to the regions surrounding the UMR and the IWW.

Decreased Growth and Reproduction of Mussels

The following sections describe a growth model developed for the threeridge mussel and the results of assessing the potential impacts of two traffic scenarios on threeridge growth and reproduction.

Mussel bioenergetics model description

A bioenergetics model developed for the threeridge mussel is summarized below; this model is a modification of the bioenergetics model originally developed by Schaeffer et al. (1998). Modifications were developed in consideration of the bioenergetics model described by Bayne and Newell (1983). The conceptual model is shown in blue in Figure 2 and was adapted for our model from the flow diagram also presented in Bayne and Newell (1983). Components of the flow diagram are described in the following. Ingested ration (*I*) includes all filtered material. In this model, it is assumed that a fraction of this material is absorbed and assimilated for use by the mussel and that the remaining proportion is rejected as pseudofeces (material that is filtered by the mussel but not ingested by the mussel). Energetic gains and losses include gains obtained from the assimilated material (*A*) and losses resulting from respiration (*R*), excretion (*E*), reproduction (*P*), and shell growth (*S*). A hierarchy of energy allocation is assumed, where the costs of both respiration and excretion are met before energy is allocated to somatic or gametic growth. For sexually mature mussels, it is assumed that reproductive costs are met before energetic allocation to tissue or shell growth occurs.

Although this physiological hierarchy of allocation has not been examined for threeridge, the following has been observed. For some mollusks, reproductive onset does not occur until the cessation of somatic growth, while for others, growth continues after the age of maturity with an increasing proportion of surplus energy allocated to reproduction (Calow 1983). Animals that never allow reproduction to detract from somatic processes have been defined as *reproductively restrained*, while animals that reproduce at the expense of somatic requirements have been defined as *reproductively reckless* (Calow 1983). Calow (1983) conjectures that reproductively restrained organisms consist of those organisms subjected to environmental conditions in which survival of the offspring is not favorable as compared to that of the parents, for example intertidal marine environments in which wave action causes continuous disturbances and in which competition for space is high because space on stable substrate is limited. Reproductively reckless organisms consist of those organisms found in areas in which environmental conditions are favorable to the survival of the offspring, for example well-established freshwater systems in which space is not limited, natural disturbances are infrequent (Calow 1983), and resource availability is consistent. Because the UMR-IWW System is a well-established, fairly stable ecosystem containing mussel beds miles long, and because threeridge is one of the most abundant and robust species in the URM-IWW System, it seems reasonable to assume that threeridge follows a predominantly reproductively reckless strategy in which energy is allocated to reproduction before growth for sexually mature mussels. This assumption has been intuitively derived and has not, as of yet, been observed as the reproductive strategy for threeridge.

Mussel model formulation

The bioenergetics model was developed to simulate tissue growth, shell growth, and reproductive effort via changes in tissue and shell energy. Hourly changes in tissue and shell energy determine the total, overall growth of threeridge mussels. Equations [adapted from Schaeffer et al. (1998)] describing the energy present in tissue and shell at time *t* are given by the following:

$$dE_t/dt = A - (R + E + P + S) \qquad \text{(Eq. 1)}$$

$$dE_s/dt = S \qquad \text{(Eq. 2)}$$

where, E_t (kJ) is the tissue energy at time *t*, E_s (kJ) is the shell energy at time *t*, *A* (kJ/hour) is assimilation, *R* (kJ/hour) is respiration, *E* (kJ/hour) is excretion, *P* (kJ/hour) is reproduction, and *S* (kJ/hour) is shell growth. Tissue and shell energies are converted to tissue dry weight [W_t (g)] and shell dry weight [W_s (g)], enabling the calculation of total dry weight [W_T (g)]. The conversion equations and the total dry weight equation are:

$$W_t = E_t \times k_1 \qquad \text{(Eq. 3)}$$

$$W_s = E_s \times k_1 \qquad \text{(Eq. 4)}$$

$$W_T = W_t + W_s \qquad \text{(Eq. 5)}$$

where, k_1 is 22.5 g/kJ and is the conversion constant. Using the above equations, changes in tissue dry weight, shell dry weight, and total dry weight are calculated for an individual mussel between the ages of one and 10.

Because mussels are invertebrates, periods of activity and inactivity are primarily defined by environmental conditions. For mussels found in temperate environments, winter conditions generally lead to temporary food shortages and temperature decreases, resulting in the cessation of filtration, hence assimilation and growth. Observations made by Isely (1914) for unionids in various rivers in Oklahoma indicated that, for the threeridge mussel, virtually all growth (weight gain and shell growth) occurred between early April and late September (summer months). In addition, between late September and early April (winter months), mussels either maintained their end-of-summer-season weight or lost weight. Similar observations were made by Bayne and Worrall (1980) for the blue mussel (*Mytilus edulis*) and by Van der Schalie and Van der Schalie (1950) for unionids. Temperatures at which filtration ceased or resumed were not recorded for unionids by either Isely (1914) or Van der Schalie and Van der Schalie (1950). For zebra mussels, the lower optimal temperature for filtration was reported to be approximately 12.0°C (Schneider 1992). For pocketbook mussels (*Lampsilis ventricosa*), it was observed that mantle flap contractions increased two-fold between temperatures of 14.5°C and 22.5°C (Grier 1926). Drew Miller [USACOE, Waterways Experiment Station (WES), Vicksburg, MS, pers. comm.] indicated that for freshwater mussels in the UMR-IWW System, activity was inhibited at temperatures below 12.0 to 15.0°C and resumed above those temperatures. In addition, temperatures in the upper 30°Cs could result in the cessation of filtering. Assuming that temperature dictates mussel activity, we defined two distinctive periods: those of activity and those of inactivity. Periods of activity occur when temperatures are greater than 12.0°C and less than 36.0°C. These periods are characterized by growth in which all physiological processes (assimilation, basal and active respiration, excretion, reproduction, tissue growth, and shell growth) occur. The governing equation for energy exchange during active periods is given by Equation 1 above. Periods of inactivity are defined by temperatures below 12.0°C or above 36.0°C and are characterized by maintenance processes in which the mussel loses tissue mass. All processes except for basal respiration are assumed to be arrested during this period. Thus, all components in Equation 1 except basal respiration become zero, and the governing equation during inactive periods is $dE_t/dt = -R$. In the absence of empirical data, maximum weight loss during inactive, nonfeeding periods was assumed to be no greater than 15% of the end-of-summer-season weight, which may be an underestimate for threeridge mussels (D. Miller, USACOE, WES, Vicksburg, MS, pers. comm.). Substantially greater weight losses have been observed for some marine species (Bayne and Newell 1983).

Assimilation. Assimilation is the hourly energy gain obtained from the proportion of filtered material metabolized by the mussel. It is modeled as a function of ingestion (*I* in g/hour), where ingestion is the amount of material filtered by the mussel and is a function of filtration rate, food availability, and temperature. The equations describing ingestion and assimilation are as follows:

$$I = \begin{cases} K_a W_t^{ba} \times C \times p(t) \times f_r(T) & T \geq 12.0°C \\ 0.0 & T < 12.0°C \end{cases} \qquad \text{(Eq. 6)}$$

$$A = AE \times I \times k_a \qquad \text{(Eq. 7)}$$

where, $K_a W_t^{ba}$ is the weight-dependent filtration rate of the mussel in mL/hour, and K_a is the filtration rate in mL/g/hour of a one-gram mussel at 20°C. This value was obtained from results reported in Table 10 in Payne et al. (1997) for threeridge mussels under conditions of infrequent exposure to turbulence and suspended solids. The original value of 0.088±0.007 was expressed in terms of mg/g/hour and was converted to units used in the bioenergetics model via the conversion used by Schaeffer et al. (1998). The conversion factor used for this value was 1000 mL/5 mg, yielding a value of 19.0 mL/g/hour.

The reliance of the filtration rate on the weight of the mussel is given by b_a. We were unable to find literature values for b_a for unionid mussels. Schaeffer et al. (1998), however, reported that values for other suspension feeding mollusks ranged from 0.462-0.820 (taken from Wilbur 1983) and used these values to calibrate the growth of tissue dry weight of the modeled mussel to regression equations for tissue dry weight growth determined from tissue dry weight measurements made from ebonyshell mussels (*Fusconaia ebena*) extracted from the Lower Ohio River (Payne and Miller 1989). Calibrations performed by Schaeffer et al. (1998) found b_a to be 0.637. This value was used for our simulations.

AE represents the assimilation efficiency and is the proportion of filtered material converted to energy useable by the mussel. Schaeffer et al. (1998) set this value to 0.54, the mean value for efficiencies reported for suspension feeding mollusks by Wilbur (1983). *C* represents the total daily carbon (g/mL) available for growth from filtered material. The proportion of total suspended sediments (TSS) that is TOC was estimated to be 0.0896. This value was determined from unpublished data from the LTRMP [D. Soballe, Environmental Management Technical Center (EMTC), Upper Mississippi Science Center, Onalaska, WI, pers. comm.] for the proportions of particulate organic matter (POM) to TSS (0.28) and TOC to POM (0.32). Daily average TOC values were determined by first multiplying monthly mean, pool-specific TSS values (unpublished data from the LTRMP) by 0.0896 and then linearly interpolating these values across the respective month to obtain daily, baseline TOC values for pools 13, 26, and LaGrange under without project conditions. Underlying this determination of TOC estimates is the assumption that mussel growth is limited by ambient food concentrations in their respective environments. Thus, mussels in areas where TOC concentrations are low will tend to be smaller when compared to mussels growing in areas where TOC concentrations are higher. This trend has been observed by Whitney et al. (1997a) for unionids found throughout the IWW.

Increased sediment loads due to increased traffic on the UMR-IWW System were assumed to dilute the amount of TOC available to threeridge. The dilution (*D*) of available carbon was determined by the following equation:

$$D = TOC / (TOC + ssed) \qquad \text{(Eq. 8)}$$

where, *ssed* (g/mL) is the suspended sediments resulting from a passing tow. Final dilution of the available carbon was determined via the following equation:

$$C = TOC \times D \times fctr \qquad \text{(Eq. 9)}$$

where, *fctr* (nondimensional) is a scaling constant. For our calculations, the value of *fctr* was set to 1.0. Clearly, when *ssed* is zero, *D* is one, and the food supply is the baseline TOC available to the mussel in the without project scenario. As tow-induced suspended sediment concentrations increase, the value of D decreases and C is correspondingly diluted. For the purpose of this conservative risk assessment, it was further assumed that the sediments resuspended by passing commercial vessels comprised 100% inorganic materials (i.e., zero food quality for filter feeding organisms).

Unpublished studies on filtration activity indicate that threeridge mussels filter approximately 60% of the time (D. Miller, USACOE, WES, Vicksburg, MS, pers. comm.). Thus, *p(t)* is estimated by selecting a uniform random number between 0 and 1 at each model time step (1 h). If the random number is less than 0.6, *p(t)* is assigned a value of zero and the mussel does not filter; for random numbers equal to or greater than 0.6, p(t) is defined as 1.0 and the mussel filters during that time step. Studies performed by Payne et al. (1997) in which shell gape behavior of threeridge was monitored *in situ* in the East Channel of the Mississippi River at Prairie du Chien indicated that threeridge regularly cycles between 100% and 50% open and experiences periods of closure several times an hour for five minutes or less. This same study indicated that although some of the mussels monitored did in fact close their shells during vessel passage (commercial and pleasure), the length of time these mussels remained closed was not out of character with what they naturally experience.

$f_r(T)$ is the temperature-dependent filtration rate multiplier. Using the optimal temperature filtration range discussed previously and values reported by Schneider (1992) for the zebra mussel, filtration rate multipliers were determined via the temperature algorithm described in Thornton and Lessem (1978). Data describing the temperature dependence of filtration were not available for the threeridge mussel. Pool-specific daily water temperature values were determined by linearly interpolating average weekly values reported in data provided by Dan Wilcox (USACOE, St. Paul District, St. Paul, MN, pers. comm.) for Pools 13 and 26. Daily water temperature values for the LaGrange Pool were determined by averaging daily values reported for all years at all sites. Linear interpolation was used to fill in missing values. Data for the LaGrange Pool were provided by Clinton Beckert (USACOE, Rock Island District, Moline, IL, pers. comm.) and were taken from the EMTC database. Pool-specific daily water temperature values used in model calibrations to observed mussel growth data implied that the mussels were acclimated to the temperature regime of the pool.

The constant, k_a, converts the proportion of filtered material useable by the mussel into assimilated energy. Its value is 20.0 kJ/g (Lucas 1996.)

Respiration. Respiration is modeled as a function of basal respiration and assimilation. The equation is given by the following:

$$R = R_b + R_a \times A \qquad \text{(Eq. 10)}$$

where, R_b (kJ/hour) is the age-specific basal (or standard) metabolic rate representing costs associated with maintenance during both active and inactive periods. Basal metabolism, in the absence of food, is described by Bayne and Newell (1983) as indicating the rate of weight loss as to maintain the body in a viable condition. Estimates for R_b were determined by back-calculating from pool-specific data coupled with the 15% maximum weight loss assumption during inactive periods. It was assumed that the basal metabolic rate in effect during inactive periods held for the duration of the growing season and changed at the onset of the following year, after growth occurred. Values for R_b for unionids were not found in the literature, and the 15% maximum weight loss assumption during inactive periods may be an underestimate (D. Miller, USACOE, WES, Vicksburg, MS, pers. comm.).

R_a (dimensionless) represents the age-specific metabolic costs associated with assimilation. After age-specific values for R_b were estimated, initial estimates for R_a were determined again by back-calculating and using pool-specific data. Final model calibration was done by adjusting initial R_a estimates so that the yearly tissue dry weight values calculated by the model were within ±20.0% of yearly tissue dry weight values yielded by pool-specific regression equations (see the section on "Shell Growth" for pool-specific regression equations). Metabolic costs modeled in this way (as a function of assimilation) inherently account for respiration dependence on weight.

Excretion. Excretion is the energy loss due to the production of non-metabolized material. It is modeled as a function of the assimilation rate and is given by the following equation:

$$E = k_e \times A \qquad \text{(Eq. 11)}$$

where, k_e is the proportion of material not fully metabolized by the mussel. Values of k_e were not found in the literature for unionids. Bayne and Newell (1983), however, report that excreta comprises 1-10% of the total energy budget for the blue mussel. In the absence of data for the threeridge, it was assumed that 10% of the absorbed ration was excreted.

Reproduction. Reproductive requirements are modeled as a function of glochidial weight, glochidial numbers, and brood time. The equation is given by the following:

$$P = (G \times N \times k_p)/(B*24) \quad for \quad T \geq 21.0°C \text{ and } W_t \geq 0.9g \qquad \text{(Eq. 12)}$$

$$P = 0.0 \quad for \quad T < 21.0°C \text{ or } W_t < 0.9g$$

where, G is the weight of a single glochidia, estimated by Stein (1973) to be 1.6×10^{-7} g for the threeridge mussel. N represents the number of glochidia per brood, found to be approximately 1.71×10^5 for threeridge mussels (Stein 1973). k_p has the value 22.5 kJ/g and is the conversion constant, converting the weight of the glochidia into the energetic equivalent of reproduction. B is the brood time over which a single brood is produced and is given by Stein (1973) as 24 days.

Reproduction occurs if the threeridge mussel is sexually mature and environmental temperatures (i.e., water temperature) are suitable. Sexual maturity was assumed to depend on size. Although this assumption is not supported by documented evidence, it was reasoned that threeridge would need to reach a size large enough to accommodate brood chambers. Additionally, it was observed via field studies that the ebonyshell mussel (which is similar in size to threeridge), on average, did not develop gonadal tissue until its tissue dry weight (W_t) was approximately 0.9g (Payne and Miller 1989). Due to the lack of information for threeridge, this value was used as the minimal threshold value after which threeridge can reproduce. Suitable environmental conditions occur when temperatures are greater than or equal to 21.0°C, a value reported for threeridge mussels by Stein (1973).

Shell growth. Shell growth (S) is modeled as a function of tissue energy available from the previous time step and tissue energy available at the current time step after energy has been allocated to respiration, excretion, and reproduction. Shell growth occurs only when the tissue index is greater than the optimum tissue index, and the mussel is in an active growth period. The equation is as follows:

$$S = \begin{cases} max(0, ((Et(t) - R + E + P)) + Et(t-1))) & T \geq 12.0°C \text{ and } TI \geq OTI \\ 0.0 & T < 12.0°C \text{ or } TI < OTI \end{cases} \quad \text{(Eq. 13)}$$

where, *TI* (nondimensional) is the tissue index and is the calculated ratio of dry tissue weight to dry shell weight for the mussel at the current time step. *OTI* represents the optimum tissue index and is the ratio of the dry tissue weight to dry shell weight of the mussel calculated using the pool-specific equations given below. For Pool 13, the equations were taken from Whitney et al. (1997b) and are given by:

$$W_t = 0.0015 \times (SL^{\,2.6419}) \times 0.03 \quad \text{(Eq. 14)}$$

$$W_s = 0.0015 \times (SL^{\,2.5620}) \quad \text{(Eq. 15)}$$

$$SL = 0.0068550 \times Age^3 - 0.4318429 \times Age^2 + 9.7916577 \times Age + 3.2610581 \quad \text{(Eq. 16)}$$

where, *SL* is the length of the shell in mm, and *Age* is the age of the mussel in years. These equations and the following equations were determined by using regression plots and regression formulas calculated from tissue dry weight and shell dry weight measurements determined by weighing sampled species to the nearest 0.01g (Whitney et al. 1997b). Age of each of these sampled mussels was determined by first counting growth rings and then using a thin radial cross section of the shell and hinge ligament (Whitney et al. 1997b). Ages determined by these methods were comparable and fell within ±1 year (Whitney et al. 1997b). For Pool 26, the equations were taken from Whitney et al. (1997a) and are given below.

$$W_t = 0.00202084 \times (SL^{\,2.55148}) \times 0.03 \quad \text{(Eq. 17)}$$

$$W_s = 0.00227046 \times (SL^{\,2.4551}) \quad \text{(Eq. 18)}$$

$$SL = 0.0140520 \times Age^3 - 0.8170876 \times Age^2 + 16.2119671 \times Age - 6.1828848 \quad \text{(Eq. 19)}$$

For the LaGrange Pool, the equations were taken from Whitney et al. (1997a) and are given below.

$$W_t = 0.00202084 \times (SL^{\,2.55148}) \times 0.03 \quad \text{(Eq. 20)}$$

$$W_s = 0.00227046 \times (SL^{\,2.4551}) \quad \text{(Eq. 21)}$$

$$SL = 0.0081078 \times Age^3 - 0.5345261 \times Age^2 + 13.5837809 \times Age - 2.9339400 \quad \text{(Eq. 22)}$$

Live weight regression equations reported for mussels were used in the calculations. Drew Miller (USACOE, WES, Vicksburg, MS, pers. comm.) indicated that, on average, dry tissue weight is approximately 3.0% of live weight (wet tissue and wet shell weight) but is variable between individuals. This value was used to calculate the percentage of tissue dry weight from the live weight equations.

Mussel bioenergetics model calibration

The mussel model was calibrated in the following way. Active respiration rate values for each modeled year 1-10 were adjusted so that tissue dry weight from the model was within ±20% of the tissue dry weight values obtained for each corresponding age from the pool-specific regression equations (equations 14-22) reported by Whitney et al. (1997a and 1997b). When modeled tissue dry weight fell within these ranges, modeled shell dry weight fell within ±22% of the values obtained from the regression equations for shell dry weight in equations 14-22. Calibration results are shown in Tables 6 through 8 for both tissue dry weight (TDM) and shell dry weight (SDM) for Pools 13, 26, and the LaGrange Pool, respectively.

Table 6
Calibration Results Showing Tissue Dry Weight (TDM) and Shell Dry Weight (SDM) in Grams as Compared to Data TDM and SDM of a Mussel (Age 1 to 10) Growing in Pool 13

Age (Years)	Model TDM	Data TDM	Model SDM	Data SDM
1	0.0566	0.0552	1.673	1.484
2	0.1231	0.1241	3.505	3.256
3	0.3220	0.2848	8.831	7.285
4	0.4865	0.5112	13.29	12.85
5	1.055	1.013	28.37	24.93
6	1.298	1.272	34.47	31.11
7	1.643	1.660	43.42	40.25
8	2.025	1.932	52.88	46.64
9	2.267	2.287	59.17	54.93
10	2.983	3.016	77.43	71.83

Table 7
Calibration Results Showing Tissue Dry Weight (TDM) and Shell Dry Weight (SDM) in Grams as Compared to Data TDM and SDM of a Mussel (Age 1 to 10) Growing in Pool 26

Age (Years)	Model TDM	Data TDM	Model SDM	Data SDM
1	0.0182	0.0176	0.5940	0.5318
2	0.1780	0.1826	5.347	5.052
3	0.5480	0.5463	15.81	14.50
4	1.059	1.089	29.76	28.16
5	1.744	1.767	48.00	44.88
6	2.513	2.531	68.41	63.42
7	3.349	3.333	90.09	82.65
8	4.193	4.131	111.6	101.6
9	4.840	4.892	128.4	119.6
10	5.551	5.591	146.3	136.0

Table 8
Calibration Results Showing Tissue Dry Weight (TDM) and Shell Dry Weight (SDM) in Grams as Compared to Data TDM and SDM of a Mussel (Age 1 to 10) Growing in the LaGrange Pool

Age (Years)	Model TDM	Data TDM	Model SDM	Data SDM
1	0.0652	0.0715	2.063	2.050
2	0.2475	0.2994	7.526	8.132
3	0.6470	0.6995	18.79	18.40
4	1.233	1.261	34.53	32.43
5	1.917	1.957	53.19	49.51
6	2.774	2.760	75.71	68.92
7	3.680	3.640	99.71	89.95
8	4.577	4.567	122.7	112.0
9	5.542	5.514	147.3	134.1
10	6.419	6.461	170.1	156.3

Mussel bioenergetics model behavior

Figures 5 through 10 present the accumulation of tissue dry weight and shell dry weight, and the cumulative energetic allocations to assimilation, respiration, excretion, and reproduction over a ten year period of growth for a 1-year old mussel in Pool 13 under constant environmental conditions. Pool 13 was used as an example, but behavior for all pools is similar. For sexually mature mussels, plateaus and decreases in tissue dry weight accumulation during active periods represent periods in which the mussel's reproductive effort is highest (Figure 5). Observe that energy allocation for reproduction does not occur until approximately the fourth year for mussels in Pool 13 (Figure 6). The onset of reproduction varies by pool since the growth of mussels varies by pool (recall from the section on "Reproduction" that reproductive onset in the model occurs when tissue dry weight is greater than 0.9 g and temperature conditions are suitable). Discontinuities visible in shell dry weight accumulation during active periods also represent periods in which energy allocation to reproductive effort is highest (Figure 7). Recall that the model assumes a hierarchal allocation of energy, first to respiration and excretion, then to reproduction for sexually mature mussels, and finally to shell growth (Figure 2); this hierarchal allocation is most clearly demonstrated in Figure 7. Respiration and excretion follow assimilation as expected (Figures 8, 9, and 10).

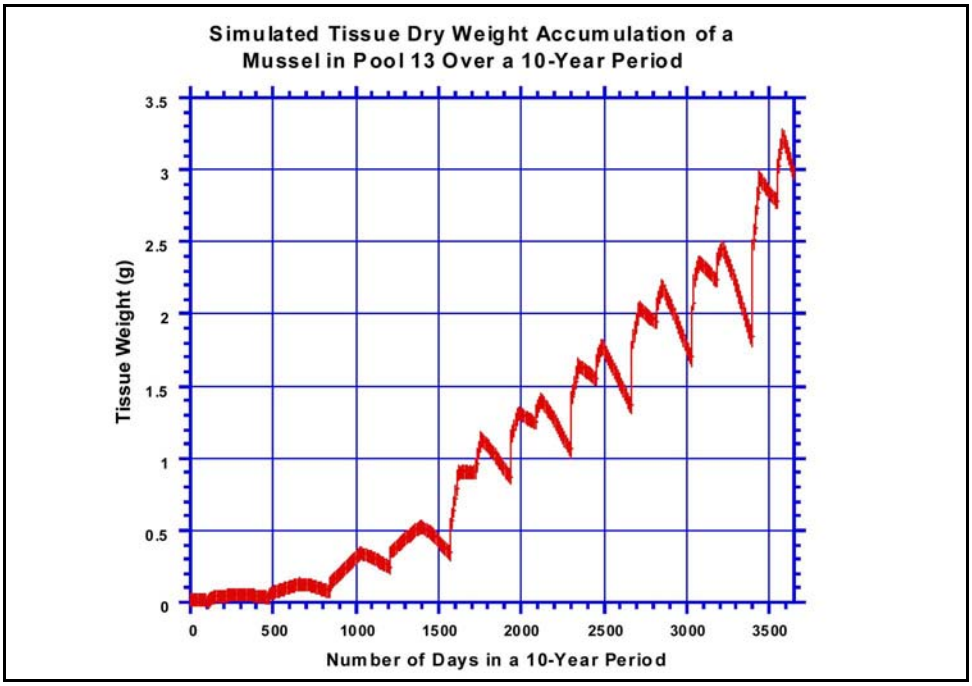

Figure 5. Simulated tissue dry weight accumulation of a threeridge mussel in Pool 13 over a 10-year period

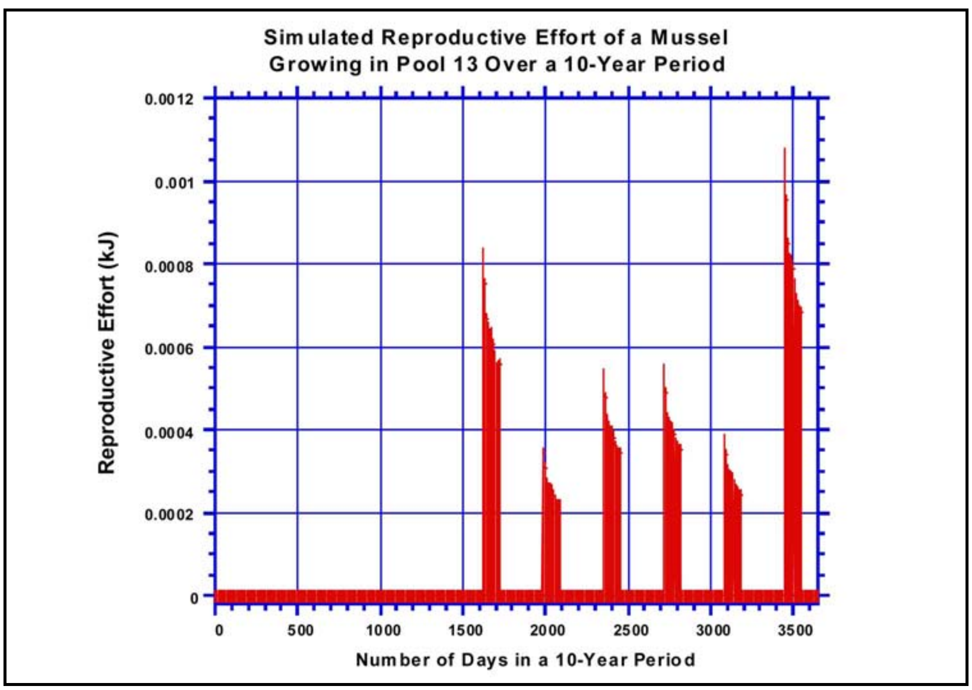

Figure 6. Simulated reproductive effort of a threeridge mussel growing in Pool 13 over a 10-year period

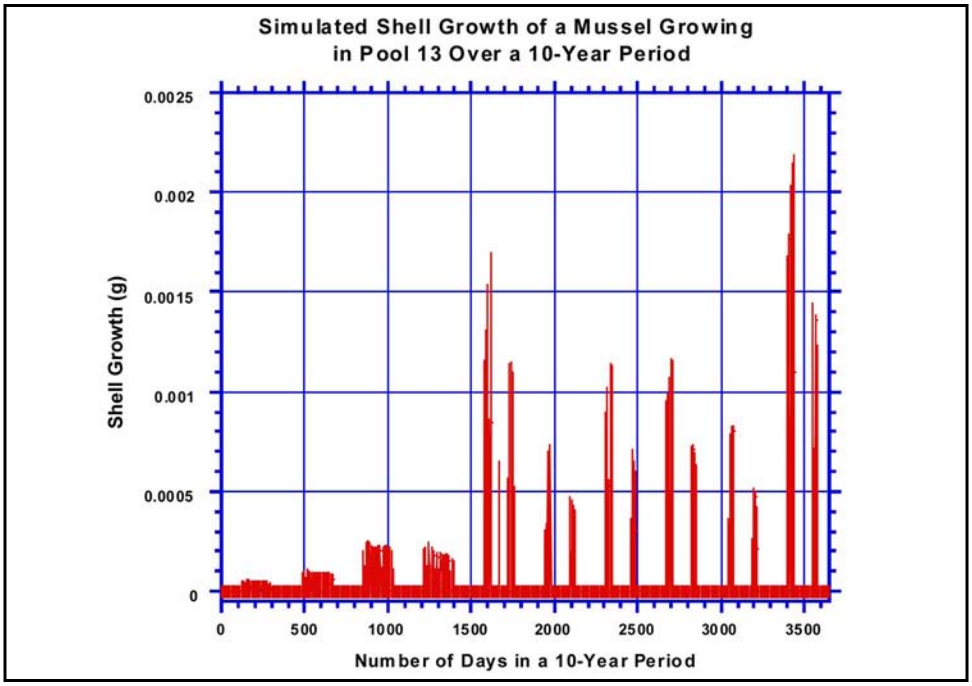

Figure 7. Simulated shell growth of a threeridge mussel growing in Pool 13 over a 10-year period

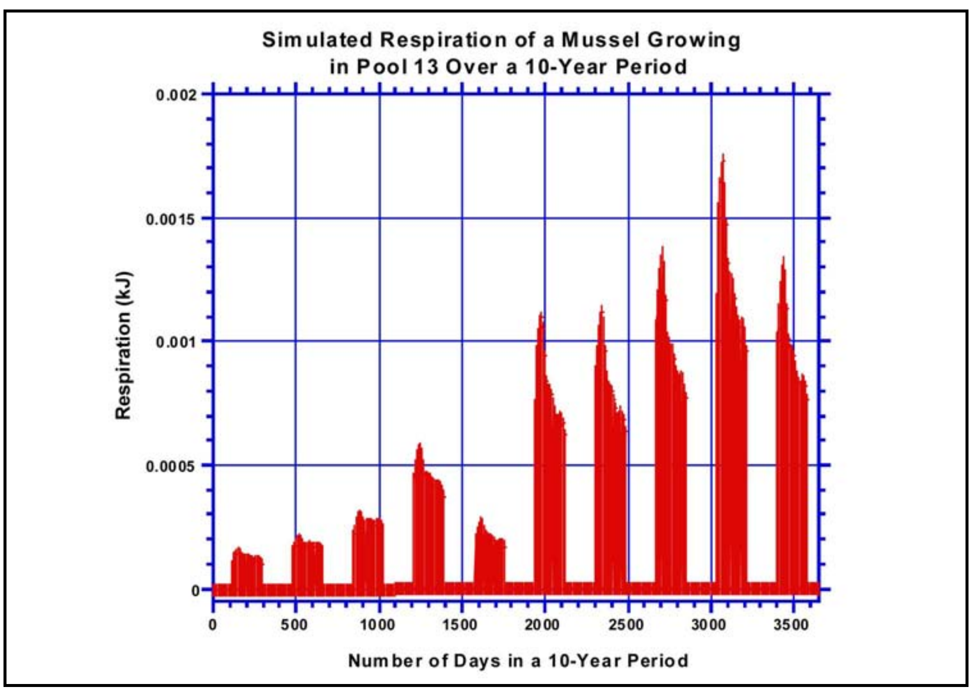

Figure 8. Simulated respiration of a threeridge mussel growing in Pool 13 over a 10-year period

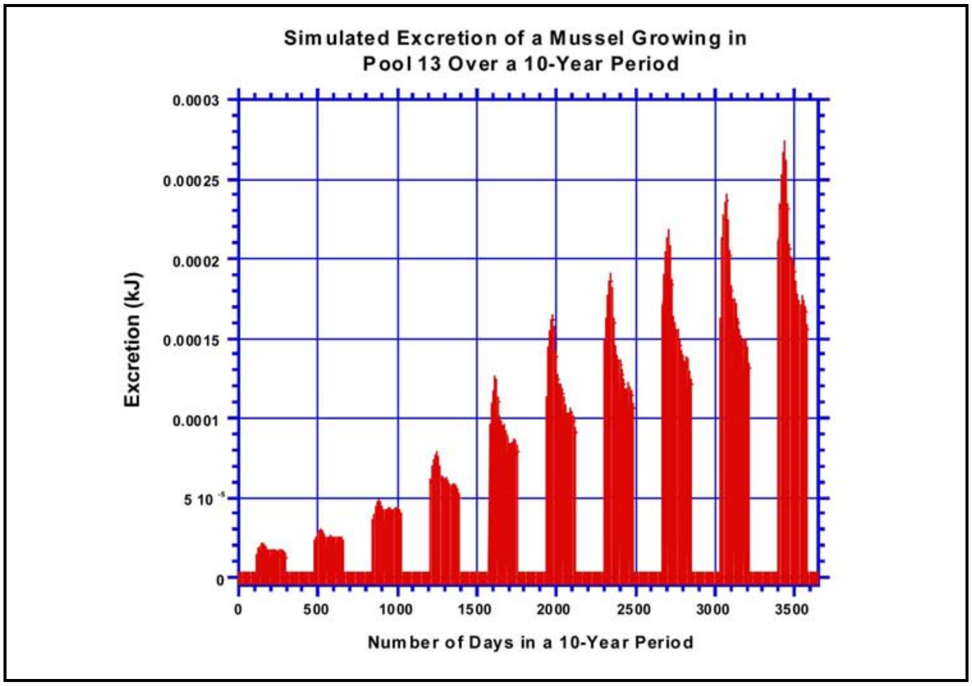

Figure 9. Simulated excretion of a threeridge mussel growing in Pool 13 over a 10-year period

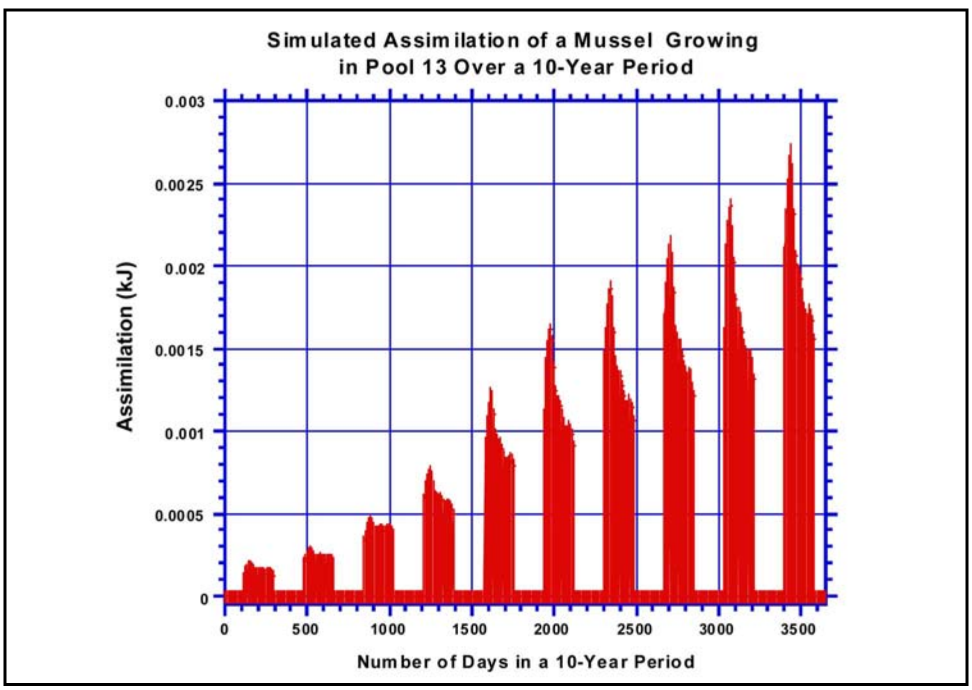

Figure 10. Simulated assimilation of a threeridge mussel growing in Pool 13 over a 10-year period

Mussel bioenergetics model assumptions and limitations

As with all models, the threeridge mussel model is limited by its assumptions and the accuracy of model paramete values. Many of the model assumptions and data limitations have been discussed previously. However, a summary list is presented as follows:

- The model presented here has been developed and parameterized (to the extent allowable by available information) for the threeridge mussel. Threeridge is a hearty, robust mussel found in abundance throughout the UMR-IWW System, and at present is not threatened or endangered. Because of this, caution is advised when extrapolating results from this model to other, perhaps more sensitive, species.

- Every attempt was made to estimate model parameters from data collected from studies performed on threeridge. However, information on physiological rates for threeridge was sufficiently sparse that values were derived from other freshwater species residing in the UMR-IWW System and in other aquatic systems. In some cases, data for marine species were used. Additionally, information for estimating some parameter values was simply not available. In such cases, we based our estimates on discussions with mussel biologists and ecologists . These informed estimates or educated guesses are labeled as "opinion in the absence of empirical data". The relative importance of these parameter values in influencing the model results has been addressed through extensive sensitivity analyses.

- For sexually mature mussels, a hierarchy of energy allocation is assumed to occur, energy being allocated first to respiration and excretion, then to reproduction, then to tissue and shell growth. Because information concerning resource allocation to reproduction is lacking for threeridge, this assumption was speculative. Under conditions of increasingly continuous disturbance (i.e., continuous sediment resuspension) during the reproductive period, the model will correspondingly allocate less energy to reproduction.

- In its current formulation, filtration rates of the mussel model are dependent only on the size of the mussel. While this is a well documented phenomena (see Bayne and Newell 1983, and Burky 1983 for a review of the literature), it has also been observed that filtration rates also depend on suspended particle concentrations and decrease or level off as suspended particle concentrations increase above some threshold (Bayne and Newell 1983, and Burky 1983). Given the current model structure, filtration and ingestion will continue even when suspended particle concentrations may rise above levels that might realistically cause threeridge to stop filtering. However, this model bias influences both the baseline simulations and simulations involving increased tow-induced sediment resuspension. The incremental impact, which is the endpoint in this assessment, will be less influenced by this bias.

- The probability (i.e., 0.6) that the mussel is filtering is constant in the current deterministic version of the model, although we have developed a distribution for this probability that is used in our Monte Carlo version of the mussel model. In field studies performed by Payne et al. (1997) it was found that considerable variability in shell gape behavior exists between individuals exposed to both commercial and pleasure boat passages. These results were obtained from a relatively small sample of mussels (six), so that generalizations as to the behavior of threeridge under periodic exposure could not be made so that this parameter contains a great deal of uncertainty. If data become available to define the probability of mussels remaining open as a function of disturbance frequency (i.e., tow passage events) , the corresponding modification can be made to the mussel growth model.

- Sexual maturity in the model is assumed to be dependent on size only. Based on the observations of Payne and Miller (1989) for the ebonyshell mussel, this value was set to 0.9g. However, the development of gonadal tissue in mussels is a complex process and is most likely dependent on internal factors specific to the individual (i.e., variation in biological processes), and external factors specific to the individual's microenvironment (ie, suspended particle concentrations and frequency of disturbance). As additional information describing sexual maturity becomes available for the threeridge or other unionid mussels, this model assumption might need to be revised.

- Acclimation to ambient suspended sediment concentrations and average temperature regimes was assumed for mussels in each pool. Underlying this assumption is the idea that mussels will grow only to the extent allowable by food concentrations in their environments.

- Sediment resuspension due to increased traffic was assumed to affect growth through dilution of the food supply. It has been observed that for some unionids if suspended sediment concentrations are sufficiently high (650.0 and 700.0 mg/L under frequent and infrequent turbulence, respectively), the filtering rate can also be affected (Aldridge et al. 1987), but that under lower suspended sediment concentrations (20.0 and 120.0 mg/L under frequent and infrequent turbulence, respectively), the decrease in the filtering rate is minimal (Payne et al. 1997). Research is currently being conducted to determine whether or not further refinements in this aspect of the model are required.

- A maximum overwinter weight loss of 15% was assumed and was used to theoretically determine age-specific basal respiration values. Drew Miller (USACOE, WES, Vicksburg, MS, pers. comm.) has indicated that overwinter weight loss experienced by threeridge mussels might exceed this value.

- Age-specific basal respiration values determined for periods of inactivity were assumed to carry over through periods of activity. This may or may not be the case since basal respiration depends on the size of the mussel.

- Active respiration was assumed to be dependent only on assimilation. It has been observed by Bayne and Newell (1983) that pseudofeces production may contribute to metabolic energy allocations. This may need to be considered in future model refinements.

- Shell length, tissue dry weight, and shell dry weight used to calculate optimum tissue index are from the same data set used to calibrate the model. This was unavoidable since an alternative data set was not available.

5 Risk Characterization

This section summarizes an initial assessment of the potential for reduced mussel growth and reproduction resulting from commercial traffic increases due to Scenarios 2 and 3 for selected mussel beds in UMR Pools 13 and 26 and the IWW LaGrange Pool.

Decreased Growth and Reproduction of Mussels

The impacts of traffic-induced sediment resuspension on mussel growth and reproduction were assessed for five locations (i.e., cells) in Pool 13 where mussel beds are known to occur, three locations in Pool 26A, one location in Pool 26B, and 15 locations in the LaGrange Pool (Table 9). The cell identification numbers are interpreted as x m to the left or right of the sailing line at River Mile x. For example in Pool 13, 65L5380 means 65 m to the left of the sailing line at River Mile 538.0. Each cell is approximately 0.81 km (i.e., 0.5 miles) in length by 10-m wide. In the LaGrange Pool, transects of cells at the same river mile were assessed to determine if differences in distances from the sailing line affected mussel impacts (Table 9). Results are presented in summary tables for the 10th, 50th, and 90th percentile sediment concentrations (Tables 10 through 57). Using the 10th, 50th, and 90th percentiles of sediment concentrations allows for a range or distribution of results instead of a fixed number.

Mussel growth and biomass

Mussel growth and biomass were measured as tissue dry weight, shell dry weight, and total dry weight (tissue dry weight + shell dry weight) (Tables 10-57). Results for the with-project conditions were subtracted from those resulting from the without-project conditions for each scenario to determine the incremental impact (termed project reduction in the summary tables) on mussels resulting from either Scenario 2 or 3. Occasionally, the project reduction results are negative numbers, indicating that the mussels are growing better in the presence of increased traffic rather than in its absence. This occurs because the interarrival times are generated randomly for each scenario. When the incremental impact is large (e.g., >20 g), this usually indicates that the mussel has died (tissue dry weight is 0.0) in either the with- or without-project scenario.

Table 9
Cells of Known Mussel Beds in UMR Pools 13 and 26 and the IWW LaGrange Pool Evaluated in This Ecological Risk Assessment

Pool	Cell Identification Number
Pool 13	65L5380
Pool 13	135R5410
Pool 13	135L5500
Pool 13	255R5540
Pool 13	15R5565
Pool 26A	225R2320
Pool 26A	175L2335
Pool 26A	155L2395
Pool 26B	235L2155
LaGrange Pool	15L1130
LaGrange Pool	35L1130
LaGrange Pool	55L1130
LaGrange Pool	15R1160
LaGrange Pool	45R1160
LaGrange Pool	85R1160
LaGrange Pool	15L1250
LaGrange Pool	35L1250
LaGrange Pool	75L1250
LaGrange Pool	15R1250
LaGrange Pool	25R1250
LaGrange Pool	45R1250
LaGrange Pool	15R1280
LaGrange Pool	45R1280
LaGrange Pool	65R1280

Table 10

Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 65L5380, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	3.07	3.07	-0.01	79.37	79.49	-0.12	82.44	82.56	-0.12	4.11	4.11	0.00
50%	3.07	3.08	0.00	79.47	79.47	0.00	82.55	82.54	0.01	4.11	4.11	0.00
90%	3.07	3.08	-0.01	79.47	79.46	0.01	82.54	82.54	0.00	4.11	4.11	-0.01
2020												
10%	3.07	3.07	0.00	79.43	79.43	0.00	82.50	82.50	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.48	79.47	0.01	82.55	82.55	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.47	79.48	-0.01	82.54	82.56	-0.02	4.11	4.11	0.00
2030												
10%	3.07	3.07	0.00	79.45	79.47	-0.02	82.52	82.55	-0.03	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.47	0.00	82.55	82.55	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.48	79.48	0.00	82.55	82.55	0.00	4.11	4.11	0.00
2040												
10%	3.07	3.07	0.00	79.43	79.47	-0.04	82.50	82.55	-0.05	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.47	0.00	82.55	82.55	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.47	79.45	0.02	82.54	82.52	0.02	4.11	4.11	0.00
2050												
10%	3.07	3.07	0.00	79.43	79.43	0.00	82.50	82.50	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.48	-0.01	82.54	82.55	-0.01	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.47	79.48	-0.01	82.54	82.56	-0.02	4.11	4.11	0.00

Table 11
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 135R5410, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	3.07	3.07	0.00	79.47	79.47	0.00	82.55	82.55	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.02	3.01	0.01	78.29	78.07	0.22	81.31	81.08	0.23	3.96	3.95	0.02
2020												
10%	3.07	3.07	0.00	79.46	79.46	0.00	82.53	82.53	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.47	0.00	82.55	82.55	0.00	4.11	4.11	0.00
90%	3.03	3.00	0.02	78.32	77.85	0.47	81.34	80.85	0.49	3.96	3.94	0.03
2030												
10%	3.07	3.07	0.00	79.47	79.46	0.01	82.54	82.53	0.01	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.50	79.47	0.03	82.57	82.55	0.02	4.11	4.11	0.00
90%	3.02	3.01	0.01	78.16	77.87	0.29	81.17	80.88	0.29	3.97	3.95	0.02
2040												
10%	3.07	3.07	0.00	79.46	79.46	0.00	82.53	82.53	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.50	79.48	0.02	82.57	82.55	0.02	4.11	4.11	0.00
90%	3.02	3.02	0.00	78.17	78.20	-0.03	81.18	81.22	-0.04	3.96	3.95	0.01
2050												
10%	3.07	3.07	0.00	79.47	79.47	0.00	82.55	82.54	0.01	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.50	-0.03	82.54	82.57	-0.03	4.11	4.11	0.00
90%	3.01	3.02	-0.01	78.11	78.11	0.00	81.12	81.13	-0.01	3.97	3.95	0.02

Table 12
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 135L5500, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	3.07	3.07	0.00	79.50	79.49	0.01	82.58	82.56	0.02	4.11	4.11	0.00
50%	3.03	3.03	0.00	78.61	78.49	0.12	81.64	81.52	0.12	4.00	3.99	0.01
90%	2.79	2.78	0.02	73.06	72.42	0.64	75.86	75.20	0.66	3.37	3.31	0.06
2020												
10%	3.07	3.07	0.00	79.45	79.48	-0.03	82.52	82.55	-0.03	4.11	4.11	0.00
50%	3.04	3.02	0.02	78.57	78.22	0.35	81.60	81.23	0.37	4.00	3.97	0.02
90%	2.81	2.72	0.08	73.19	71.17	2.02	75.99	73.89	2.10	3.38	3.27	0.11
2030												
10%	3.07	3.07	0.00	79.49	79.47	0.02	82.56	82.55	0.01	4.11	4.11	0.00
50%	3.03	3.02	0.01	78.45	78.34	0.11	81.48	81.37	0.11	3.99	3.98	0.01
90%	2.78	2.76	0.02	72.57	71.85	0.72	75.35	74.61	0.74	3.39	3.31	0.08
2040												
10%	3.07	3.08	0.00	79.48	79.49	-0.01	82.56	82.57	-0.01	4.11	4.11	0.00
50%	3.02	3.03	-0.01	78.35	78.54	-0.19	81.38	81.57	-0.19	3.99	3.98	0.01
90%	2.77	2.78	-0.01	72.37	72.57	-0.20	75.14	75.35	-0.21	3.39	3.33	0.05
2050												
10%	3.08	3.07	0.00	79.46	79.47	-0.01	82.54	82.55	-0.01	4.11	4.11	0.01
50%	3.02	3.03	-0.01	78.45	78.37	0.08	81.47	81.40	0.07	4.00	3.98	0.01
90%	2.77	2.77	0.00	72.14	72.36	-0.22	74.91	75.13	-0.22	3.40	3.31	0.09

Table 13
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 255R5540, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	3.07	3.07	0.00	79.48	79.48	0.00	82.55	82.55	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.48	79.48	0.00	82.55	82.55	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.48	79.48	0.00	82.55	82.55	0.00	4.11	4.11	0.00
2020												
10%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
2030												
10%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
2040												
10%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
2050												
10%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00

Table 14
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 15R5565, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	3.07	3.07	0.00	79.35	79.34	0.01	82.41	82.41	0.00	4.10	4.10	0.00
50%	2.78	2.77	0.01	72.45	72.15	0.30	75.23	74.91	0.32	3.29	3.23	0.06
90%	2.31	2.26	0.06	61.63	59.96	1.67	63.94	62.21	1.73	2.22	2.09	0.14
2020												
10%	3.07	3.07	0.00	79.40	79.38	0.02	82.47	82.44	0.03	4.10	4.10	0.00
50%	2.79	2.71	0.08	72.71	70.68	2.03	75.50	73.39	2.11	3.30	3.18	0.12
90%	2.34	2.15	0.19	61.91	57.58	4.33	64.24	59.73	4.51	2.25	2.00	0.25
2030												
10%	3.07	3.07	0.00	79.34	79.38	-0.04	82.40	82.45	-0.05	4.10	4.09	0.01
50%	2.77	2.73	0.04	72.28	71.41	0.87	75.06	74.14	0.92	3.31	3.22	0.08
90%	2.28	2.21	0.07	60.60	58.88	1.72	62.89	61.08	1.81	2.30	2.08	0.22
2040												
10%	3.07	3.07	0.00	79.40	79.39	0.01	82.47	82.45	0.02	4.10	4.09	0.01
50%	2.75	2.76	-0.01	72.09	72.17	-0.08	74.84	74.93	-0.09	3.31	3.24	0.07
90%	2.30	2.27	0.03	61.14	60.47	0.67	63.44	62.74	0.70	2.27	2.15	0.12
2050												
10%	3.07	3.07	0.00	79.38	79.36	0.02	82.44	82.43	0.01	4.10	4.10	0.00
50%	2.77	2.74	0.02	72.12	71.70	0.42	74.89	74.45	0.44	3.33	3.22	0.11
90%	2.26	2.28	-0.02	60.03	60.58	-0.55	62.29	62.86	-0.57	2.30	2.09	0.22

Table 15
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 65L5380, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	3.07	3.07	0.01	79.50	79.37	0.13	82.58	82.44	0.14	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.48	-0.01	82.54	82.55	-0.01	4.11	4.11	0.00
90%	3.07	3.07	-0.01	79.37	79.49	-0.12	82.44	82.56	-0.12	4.11	4.11	0.01
2020												
10%	3.07	3.07	0.00	79.43	79.43	0.00	82.50	82.50	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.47	0.00	82.55	82.55	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.01	79.50	79.37	0.13	82.57	82.44	0.13	4.11	4.11	-0.01
2030												
10%	3.07	3.07	0.00	79.43	79.47	-0.04	82.50	82.55	-0.05	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.48	79.49	-0.01	82.55	82.56	-0.01	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.47	79.47	0.00	82.54	82.54	0.00	4.11	4.11	0.00
2040												
10%	3.07	3.07	0.00	79.43	79.47	-0.04	82.50	82.54	-0.04	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.50	-0.03	82.55	82.57	-0.02	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.37	79.37	0.00	82.44	82.44	0.00	4.11	4.11	0.00
2050												
10%	3.07	3.07	0.00	79.43	79.47	-0.04	82.50	82.55	-0.05	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.48	79.47	0.01	82.55	82.55	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.50	79.47	0.03	82.57	82.55	0.02	4.11	4.11	0.00

Table 16
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 135R5410, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	3.07	3.07	0.00	79.47	79.47	0.00	82.55	82.55	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.01	3.02	-0.01	78.05	78.14	-0.09	81.06	81.16	-0.10	3.96	3.96	0.00
2020												
10%	3.07	3.07	0.00	79.47	79.46	0.01	82.55	82.53	0.02	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.50	79.47	0.03	82.57	82.54	0.03	4.11	4.11	0.00
90%	3.02	3.01	0.01	78.20	77.88	0.32	81.22	80.89	0.33	3.96	3.94	0.02
2030												
10%	3.07	3.07	0.00	79.46	79.46	0.00	82.53	82.53	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.47	79.42	0.05	82.54	82.49	0.05	4.11	4.11	0.00
90%	3.01	3.00	0.01	78.24	77.79	0.45	81.25	80.79	0.46	3.97	3.93	0.05
2040												
10%	3.07	3.07	0.00	79.46	79.46	0.00	82.53	82.53	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.50	79.48	0.02	82.57	82.55	0.02	4.11	4.11	0.00
90%	3.01	3.00	0.01	78.08	77.79	0.29	81.09	80.79	0.30	3.96	3.92	0.04
2050												
10%	3.07	3.07	0.00	79.46	79.46	0.00	82.53	82.53	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.01	79.50	79.44	0.06	82.57	82.51	0.06	4.11	4.11	0.00
90%	3.02	3.01	0.02	78.28	77.89	0.39	81.30	80.90	0.40	3.97	3.93	0.05

Table 17
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 135L5500, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	3.07	3.07	0.00	79.50	79.46	0.04	82.58	82.53	0.05	4.11	4.11	0.00
50%	3.03	3.03	0.00	78.49	78.43	0.06	81.52	81.46	0.06	3.99	3.99	0.01
90%	2.78	2.78	0.00	72.43	72.67	-0.24	75.20	75.44	-0.24	3.37	3.36	0.00
2020												
10%	3.07	3.07	0.00	79.47	79.50	-0.03	82.54	82.57	-0.03	4.11	4.10	0.00
50%	3.02	3.02	0.00	78.39	78.28	0.11	81.41	81.30	0.11	3.99	3.97	0.02
90%	2.78	2.73	0.05	72.51	71.15	1.36	75.28	73.87	1.41	3.38	3.25	0.13
2030												
10%	3.07	3.07	0.00	79.47	79.47	0.00	82.54	82.54	0.00	4.11	4.11	0.00
50%	3.03	3.02	0.01	78.46	78.19	0.27	81.49	81.21	0.28	4.00	3.96	0.04
90%	2.78	2.70	0.08	72.59	70.67	1.92	75.37	73.37	2.00	3.43	3.20	0.23
2040												
10%	3.07	3.07	0.00	79.37	79.48	-0.11	82.43	82.55	-0.12	4.11	4.11	0.00
50%	3.02	3.01	0.01	78.32	78.02	0.30	81.34	81.04	0.30	3.99	3.96	0.03
90%	2.78	2.70	0.08	72.43	70.71	1.72	75.20	73.42	1.78	3.36	3.20	0.16
2050												
10%	3.07	3.07	0.00	79.46	79.49	-0.03	82.53	82.56	-0.03	4.11	4.11	0.01
50%	3.03	3.01	0.02	78.52	78.02	0.50	81.55	81.03	0.52	4.00	3.96	0.04
90%	2.78	2.69	0.09	72.72	70.53	2.19	75.50	73.22	2.28	3.42	3.20	0.23

Table 18
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 255R5540, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	3.07	3.07	0.00	79.48	79.48	0.00	82.55	82.55	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.48	79.48	0.00	82.55	82.55	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.48	79.48	0.00	82.55	82.55	0.00	4.11	4.11	0.00
2020												
10%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
2030												
10%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
2040												
10%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
2050												
10%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
50%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00
90%	3.07	3.07	0.00	79.49	79.49	0.00	82.56	82.56	0.00	4.11	4.11	0.00

Table 19
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 13, Cell ID 15R5565, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	3.07	3.07	0.00	79.32	79.41	-0.09	82.39	82.48	-0.09	4.10	4.10	0.00
50%	2.77	2.76	0.01	72.13	72.13	0.00	74.90	74.89	0.01	3.29	3.29	0.01
90%	2.27	2.29	-0.03	60.23	61.14	-0.91	62.49	63.44	-0.95	2.23	2.24	-0.01
2020												
10%	3.07	3.07	0.00	79.37	79.38	-0.01	82.44	82.45	-0.01	4.10	4.10	0.00
50%	2.75	2.71	0.05	72.01	70.69	1.32	74.77	73.39	1.38	3.29	3.15	0.14
90%	2.27	2.12	0.16	60.45	56.59	3.86	62.73	58.71	4.02	2.27	1.95	0.32
2030												
10%	3.06	3.07	-0.01	79.18	79.36	-0.18	82.23	82.43	-0.20	4.10	4.10	0.00
50%	2.78	2.68	0.09	72.34	70.30	2.04	75.12	72.98	2.14	3.36	3.10	0.26
90%	2.29	2.02	0.27	60.66	54.33	6.33	62.94	56.35	6.59	2.36	1.83	0.54
2040												
10%	3.07	3.07	0.00	79.39	79.36	0.03	82.46	82.43	0.03	4.10	4.09	0.00
50%	2.75	2.67	0.09	71.88	69.89	1.99	74.63	72.55	2.08	3.27	3.09	0.17
90%	2.28	2.02	0.26	60.48	54.52	5.96	62.76	56.54	6.22	2.22	1.85	0.37
2050												
10%	3.07	3.07	0.00	79.35	79.37	-0.02	82.41	82.44	-0.03	4.11	4.10	0.01
50%	2.78	2.68	0.10	72.61	70.34	2.27	75.39	73.02	2.37	3.35	3.09	0.26
90%	2.30	2.03	0.26	61.25	54.70	6.55	63.55	56.73	6.82	2.34	1.83	0.51

Table 20
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 26A, Cell ID 225R2320, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
2020												
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	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.01	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2030												
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	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	-0.01	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2040												
10%	5.53	5.53	0.00	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.53	0.00	145.70	145.80	-0.10	151.20	151.30	-0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
2050												
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	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00

Table 21
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 26A, Cell ID 175L2335, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
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	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
90%	4.89	4.91	-0.02	130.30	130.70	-0.40	135.20	135.60	-0.40	6.99	6.98	0.01
2020												
10%	5.52	5.53	0.00	145.70	145.80	-0.10	151.20	151.30	-0.10	7.59	7.59	0.00
50%	5.52	5.53	0.00	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
90%	4.91	4.88	0.03	130.80	130.10	0.70	135.70	135.00	0.70	6.98	6.95	0.03
2030												
10%	5.53	5.53	0.00	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.80	-0.10	151.20	151.30	-0.10	7.59	7.59	0.00
90%	4.90	4.86	0.03	130.50	129.80	0.70	135.40	134.60	0.80	6.98	6.94	0.04
2040												
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%	5.53	5.52	0.00	145.80	145.70	0.10	151.30	151.30	0.00	7.59	7.59	0.00
90%	4.85	4.83	0.02	129.40	128.80	0.60	134.20	133.70	0.50	6.95	6.92	0.03
2050												
10%	5.52	5.53	0.00	145.70	145.80	-0.10	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.53	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
90%	4.85	4.83	0.01	129.30	129.00	0.30	134.10	133.90	0.20	6.95	6.91	0.04

Table 22
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 26A, Cell ID 155L2395, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
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	0.01	145.70	145.70	0.00	151.30	151.20	0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
2020												
10%	5.53	5.53	0.00	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.53	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
2030												
10%	5.53	5.53	0.00	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.80	-0.10	151.20	151.30	-0.10	7.59	7.59	0.00
90%	5.53	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
2040												
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	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
2050												
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	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00

Table 23
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 26A, Cell ID 225R2320, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.53	0.00	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
2020												
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	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2030												
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	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.53	5.52	0.00	145.70	145.70	0.00	151.30	151.20	0.10	7.59	7.59	0.00
2040												
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	145.70	145.80	-0.10	151.20	151.30	-0.10	7.59	7.59	0.00
90%	5.52	5.53	0.00	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
2050												
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	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00

Table 24
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 26A, Cell ID 175L2335, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
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	145.70	145.80	-0.10	151.20	151.30	-0.10	7.59	7.59	0.00
90%	4.91	4.88	0.02	130.70	130.20	0.50	135.60	135.10	0.50	6.99	6.97	0.02
2020												
10%	5.52	5.53	0.00	145.70	145.80	-0.10	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	4.88	4.80	0.08	130.30	128.10	2.20	135.10	132.90	2.20	6.97	6.87	0.10
2030												
10%	5.53	5.53	0.00	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.20	0.10	7.59	7.59	0.00
90%	4.88	4.72	0.15	130.00	126.30	3.70	134.90	131.10	3.80	6.96	6.79	0.17
2040												
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	145.70	145.80	-0.10	151.20	151.30	-0.10	7.59	7.59	0.00
90%	4.87	4.70	0.17	129.80	125.70	4.10	134.70	130.40	4.30	6.96	6.78	0.19
2050												
10%	5.52	5.53	0.00	145.70	145.80	-0.10	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	4.87	4.64	0.23	129.90	124.40	5.50	134.70	129.00	5.70	6.95	6.74	0.22

Table 25
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 26A, Cell ID 155L2395, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
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	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
2020												
10%	5.53	5.53	0.00	145.80	145.80	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
2030												
10%	5.53	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
2040												
10%	5.53	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.80	145.70	0.10	151.30	151.30	0.00	7.59	7.59	0.00
90%	5.53	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
2050												
10%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00

Table 26
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 26B, Cell ID 235L2155, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.30	151.20	0.10	7.59	7.59	0.00
2020												
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	145.70	145.70	0.00	151.30	151.30	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.01	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2030												
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%	5.53	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2040												
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%	5.53	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2050												
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	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00

Table 27
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in Pool 26B, Cell ID 235L2155, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
50%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
2020												
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	5.53	0.00	145.70	145.80	-0.10	151.20	151.30	-0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2030												
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%	5.53	5.52	0.00	145.80	145.70	0.10	151.30	151.20	0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2040												
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	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00
2050												
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	145.70	145.70	0.00	151.20	151.30	-0.10	7.59	7.59	0.00
90%	5.52	5.52	0.00	145.70	145.70	0.00	151.20	151.20	0.00	7.59	7.59	0.00

Table 28
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15L1130, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.23	6.23	0.00	165.70	165.70	0.00	171.90	171.90	0.00	9.31	9.31	0.00
50%	3.56	3.56	0.00	100.80	100.80	0.00	104.40	104.40	0.00	5.86	5.86	0.00
90%	2.68	2.68	0.00	79.55	79.55	0.00	82.23	82.23	0.00	4.38	4.38	0.00
2020												
10%	6.23	6.23	0.00	165.30	165.30	0.00	171.50	171.50	0.00	9.30	9.30	0.00
50%	3.33	3.33	0.00	95.32	95.32	0.00	98.66	98.66	0.00	5.50	5.50	0.00
90%	2.38	2.38	0.00	72.11	72.11	0.00	74.48	74.48	0.00	3.85	3.85	0.00
2030												
10%	6.21	6.21	0.00	164.90	164.90	0.00	171.20	171.20	0.00	9.28	9.28	0.00
50%	3.38	3.38	0.00	96.57	96.57	0.00	99.95	99.95	0.00	5.37	5.37	0.00
90%	2.04	2.04	0.00	64.04	64.04	0.00	66.08	66.08	0.00	3.36	3.36	0.00
2040												
10%	6.19	6.19	0.00	164.80	164.80	0.00	171.00	171.00	0.00	9.28	9.28	0.00
50%	3.24	3.24	0.00	92.98	92.98	0.00	96.22	96.22	0.00	5.19	5.19	0.00
90%	0.00	0.00	0.00	3.57	3.57	0.00	3.57	3.57	0.00	0.00	0.00	0.00
2050												
10%	6.20	6.20	0.00	164.70	164.70	0.00	170.90	170.90	0.00	9.27	9.27	0.00
50%	3.24	3.24	0.00	92.91	92.91	0.00	96.15	96.15	0.00	5.10	5.10	0.00
90%	1.80	1.80	0.00	58.41	58.41	0.00	60.21	60.21	0.00	3.06	3.06	0.00

Table 29
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 35L1130, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.32	6.32	0.00	167.30	167.30	0.00	173.60	173.60	0.00	9.37	9.37	0.00
50%	3.90	3.90	0.00	109.00	109.00	0.00	112.90	112.90	0.00	6.11	6.11	0.00
90%	2.73	2.73	0.00	81.04	81.04	0.00	83.77	83.77	0.00	4.49	4.49	0.00
2020												
10%	6.31	6.31	0.00	167.10	167.10	0.00	173.40	173.40	0.00	9.37	9.37	0.00
50%	3.74	3.74	0.00	105.20	105.20	0.00	109.00	109.00	0.00	5.78	5.78	0.00
90%	2.43	2.43	0.00	73.58	73.58	0.00	76.01	76.01	0.00	3.97	3.97	0.00
2030												
10%	6.29	6.29	0.00	167.00	167.00	0.00	173.30	173.30	0.00	9.36	9.36	0.00
50%	3.78	3.78	0.00	106.00	106.00	0.00	109.80	109.80	0.00	5.65	5.65	0.00
90%	2.18	2.18	0.00	67.58	67.58	0.00	69.76	69.76	0.00	3.53	3.53	0.00
2040												
10%	6.28	6.28	0.00	166.80	166.80	0.00	173.10	173.10	0.00	9.35	9.35	0.00
50%	3.64	3.64	0.00	102.70	102.70	0.00	106.40	106.40	0.00	5.49	5.49	0.00
90%	2.17	2.17	0.00	67.41	67.41	0.00	69.58	69.58	0.00	3.52	3.52	0.00
2050												
10%	6.28	6.28	0.00	166.80	166.80	0.00	173.00	173.00	0.00	9.35	9.35	0.00
50%	3.67	3.67	0.00	103.20	103.20	0.00	106.90	106.90	0.00	5.40	5.40	0.00
90%	1.94	1.94	0.00	61.70	61.70	0.00	63.63	63.63	0.00	3.22	3.22	0.00

Table 30
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 55L1130, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.35	6.35	0.00	168.10	168.10	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	4.44	4.44	0.00	122.00	122.00	0.00	126.40	126.40	0.00	6.79	6.79	0.00
90%	2.85	2.85	0.00	83.69	83.69	0.00	86.54	86.54	0.00	4.70	4.70	0.00
2020												
10%	6.34	6.34	0.00	168.10	168.10	0.00	174.40	174.40	0.00	9.40	9.40	0.00
50%	4.29	4.29	0.00	118.30	118.30	0.00	122.60	122.60	0.00	6.52	6.52	0.00
90%	2.55	2.55	0.00	76.51	76.51	0.00	79.06	79.06	0.00	4.21	4.21	0.00
2030												
10%	6.34	6.34	0.00	168.00	168.00	0.00	174.30	174.30	0.00	9.40	9.40	0.00
50%	4.29	4.29	0.00	118.60	118.60	0.00	122.90	122.90	0.00	6.40	6.40	0.00
90%	2.64	2.64	0.00	78.68	78.68	0.00	81.32	81.32	0.00	4.06	4.06	0.00
2040												
10%	6.34	6.34	0.00	168.00	168.00	0.00	174.30	174.30	0.00	9.40	9.40	0.00
50%	4.21	4.21	0.00	116.60	116.60	0.00	120.80	120.80	0.00	6.29	6.29	0.00
90%	2.42	2.42	0.00	73.27	73.27	0.00	75.69	75.69	0.00	3.82	3.82	0.00
2050												
10%	6.35	6.35	0.00	168.00	168.00	0.00	174.30	174.30	0.00	9.39	9.39	0.00
50%	4.20	4.20	0.00	116.00	116.00	0.00	120.20	120.20	0.00	6.20	6.20	0.00
90%	2.42	2.42	0.00	73.32	73.32	0.00	75.75	75.75	0.00	3.71	3.71	0.00

Table 31
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15R1160, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.19	6.19	0.00	164.60	164.60	0.00	170.80	170.80	0.00	9.28	9.28	0.00
50%	3.37	3.37	0.00	96.30	96.30	0.00	99.67	99.67	0.00	5.73	5.73	0.00
90%	2.69	2.69	0.00	79.85	79.85	0.00	82.54	82.54	0.00	4.44	4.44	0.00
2020												
10%	6.18	6.18	0.00	164.20	164.20	0.00	170.30	170.30	0.00	9.26	9.26	0.00
50%	3.15	3.15	0.00	90.80	90.80	0.00	93.94	93.94	0.00	5.35	5.35	0.00
90%	2.39	2.39	0.00	72.58	72.58	0.00	74.97	74.97	0.00	3.92	3.92	0.00
2030												
10%	6.18	6.18	0.00	163.80	163.80	0.00	170.00	170.00	0.00	9.24	9.24	0.00
50%	3.21	3.21	0.00	92.44	92.44	0.00	95.65	95.65	0.00	5.24	5.24	0.00
90%	2.10	2.10	0.00	65.59	65.59	0.00	67.69	67.69	0.00	3.46	3.46	0.00
2040												
10%	6.16	6.16	0.00	163.40	163.40	0.00	169.60	169.60	0.00	9.23	9.23	0.00
50%	3.05	3.05	0.00	88.41	88.41	0.00	91.46	91.46	0.00	5.05	5.05	0.00
90%	0.00	0.00	0.00	3.59	3.59	0.00	3.59	3.59	0.00	0.00	0.00	0.00
2050												
10%	6.15	6.15	0.00	163.30	163.30	0.00	169.50	169.50	0.00	9.22	9.22	0.00
50%	3.06	3.06	0.00	88.66	88.66	0.00	91.72	91.72	0.00	4.96	4.96	0.00
90%	1.86	1.86	0.00	59.69	59.69	0.00	61.55	61.55	0.00	3.14	3.14	0.00

Table 32

Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 45R1160, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.24	6.24	0.00	165.90	165.90	0.00	172.20	172.20	0.00	9.32	9.32	0.00
50%	3.49	3.49	0.00	99.16	99.16	0.00	102.70	102.70	0.00	5.89	5.89	0.00
90%	2.73	2.73	0.00	80.70	80.70	0.00	83.43	83.43	0.00	4.44	4.44	0.00
2020												
10%	6.23	6.23	0.00	165.60	165.60	0.00	171.90	171.90	0.00	9.31	9.31	0.00
50%	3.25	3.25	0.00	93.46	93.46	0.00	96.71	96.71	0.00	5.53	5.53	0.00
90%	2.42	2.42	0.00	73.28	73.28	0.00	75.69	75.69	0.00	3.92	3.92	0.00
2030												
10%	6.23	6.23	0.00	165.30	165.30	0.00	171.50	171.50	0.00	9.30	9.30	0.00
50%	3.32	3.32	0.00	95.04	95.04	0.00	98.36	98.36	0.00	5.41	5.41	0.00
90%	2.14	2.14	0.00	66.47	66.47	0.00	68.60	68.60	0.00	3.46	3.46	0.00
2040												
10%	6.22	6.22	0.00	165.10	165.10	0.00	171.30	171.30	0.00	9.29	9.29	0.00
50%	3.17	3.17	0.00	91.35	91.35	0.00	94.51	94.51	0.00	5.23	5.23	0.00
90%	0.00	0.00	0.00	3.58	3.58	0.00	3.58	3.58	0.00	0.00	0.00	0.00
2050												
10%	6.22	6.22	0.00	165.10	165.10	0.00	171.30	171.30	0.00	9.28	9.28	0.00
50%	3.18	3.18	0.00	91.51	91.51	0.00	94.69	94.69	0.00	5.15	5.15	0.00
90%	1.89	1.89	0.00	60.42	60.42	0.00	62.30	62.30	0.00	3.14	3.14	0.00

Table 33
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 85R1160, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.34	6.34	0.00	168.10	168.10	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	4.60	4.60	0.00	126.00	126.00	0.00	130.70	130.70	0.00	6.93	6.93	0.00
90%	2.92	2.92	0.00	85.38	85.38	0.00	88.30	88.30	0.00	4.80	4.80	0.00
2020												
10%	6.34	6.34	0.00	168.00	168.00	0.00	174.40	174.40	0.00	9.40	9.40	0.00
50%	4.47	4.47	0.00	122.60	122.60	0.00	127.10	127.10	0.00	6.67	6.67	0.00
90%	2.63	2.63	0.00	78.42	78.42	0.00	81.05	81.05	0.00	4.31	4.31	0.00
2030												
10%	6.35	6.35	0.00	168.10	168.10	0.00	174.40	174.40	0.00	9.40	9.40	0.00
50%	4.47	4.47	0.00	122.80	122.80	0.00	127.30	127.30	0.00	6.54	6.54	0.00
90%	2.71	2.71	0.00	80.39	80.39	0.00	83.10	83.10	0.00	4.17	4.17	0.00
2040												
10%	6.34	6.34	0.00	168.00	168.00	0.00	174.30	174.30	0.00	9.40	9.40	0.00
50%	4.31	4.31	0.00	119.10	119.10	0.00	123.40	123.40	0.00	6.41	6.41	0.00
90%	2.52	2.52	0.00	75.82	75.82	0.00	78.34	78.34	0.00	3.94	3.94	0.00
2050												
10%	6.34	6.34	0.00	167.90	167.90	0.00	174.20	174.20	0.00	9.40	9.40	0.00
50%	4.37	4.37	0.00	120.20	120.20	0.00	124.60	124.60	0.00	6.35	6.35	0.00
90%	2.52	2.52	0.00	75.48	75.48	0.00	77.99	77.99	0.00	3.83	3.83	0.00

Table 34
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15L1250, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.35	6.35	0.00	168.30	168.30	0.00	174.70	174.70	0.00	9.42	9.42	0.00
50%	4.08	4.08	0.00	113.40	113.40	0.00	117.50	117.50	0.00	6.63	6.63	0.00
90%	3.07	3.07	0.00	89.01	89.01	0.00	92.08	92.08	0.00	5.06	5.06	0.00
2020												
10%	6.34	6.34	0.00	168.20	168.20	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	3.88	3.88	0.00	108.40	108.40	0.00	112.30	112.30	0.00	6.32	6.32	0.00
90%	2.80	2.80	0.00	82.46	82.46	0.00	85.26	85.26	0.00	4.60	4.60	0.00
2030												
10%	6.34	6.34	0.00	168.30	168.30	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	3.91	3.91	0.00	109.40	109.40	0.00	113.30	113.30	0.00	6.21	6.21	0.00
90%	2.87	2.87	0.00	84.25	84.25	0.00	87.13	87.13	0.00	4.46	4.46	0.00
2040												
10%	6.35	6.35	0.00	168.20	168.20	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	3.78	3.78	0.00	106.20	106.20	0.00	110.00	110.00	0.00	6.06	6.06	0.00
90%	2.70	2.70	0.00	79.94	79.94	0.00	82.63	82.63	0.00	4.24	4.24	0.00
2050												
10%	6.33	6.33	0.00	168.20	168.20	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	3.80	3.80	0.00	106.50	106.50	0.00	110.30	110.30	0.00	5.99	5.99	0.00
90%	2.70	2.70	0.00	79.84	79.84	0.00	82.54	82.54	0.00	4.14	4.14	0.00

Table 35
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 35L1250, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.33	6.33	0.00	167.90	167.90	0.00	174.20	174.20	0.00	9.40	9.40	0.00
50%	3.92	3.92	0.00	109.60	109.60	0.00	113.50	113.50	0.00	6.47	6.47	0.00
90%	2.91	2.91	0.00	85.19	85.19	0.00	88.10	88.10	0.00	4.78	4.78	0.00
2020												
10%	6.34	6.34	0.00	167.90	167.90	0.00	174.20	174.20	0.00	9.40	9.40	0.00
50%	3.73	3.73	0.00	104.90	104.90	0.00	108.70	108.70	0.00	6.17	6.17	0.00
90%	2.62	2.62	0.00	78.01	78.01	0.00	80.63	80.63	0.00	4.29	4.29	0.00
2030												
10%	6.33	6.33	0.00	167.60	167.60	0.00	173.90	173.90	0.00	9.39	9.39	0.00
50%	3.77	3.77	0.00	106.00	106.00	0.00	109.80	109.80	0.00	6.07	6.07	0.00
90%	2.70	2.70	0.00	80.02	80.02	0.00	82.71	82.71	0.00	4.14	4.14	0.00
2040												
10%	6.33	6.33	0.00	167.60	167.60	0.00	174.00	174.00	0.00	9.39	9.39	0.00
50%	3.65	3.65	0.00	102.90	102.90	0.00	106.50	106.50	0.00	5.90	5.90	0.00
90%	2.52	2.52	0.00	75.60	75.60	0.00	78.12	78.12	0.00	3.92	3.92	0.00
2050												
10%	6.33	6.33	0.00	167.60	167.60	0.00	173.90	173.90	0.00	9.38	9.38	0.00
50%	3.65	3.65	0.00	103.00	103.00	0.00	106.70	106.70	0.00	5.82	5.82	0.00
90%	2.52	2.52	0.00	75.59	75.59	0.00	78.11	78.11	0.00	3.81	3.81	0.00

Table 36

Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 75L1250, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.36	6.36	0.00	168.90	168.90	0.00	175.20	175.20	0.00	9.43	9.43	0.00
50%	5.15	5.15	0.00	139.50	139.50	0.00	144.60	144.60	0.00	7.67	7.67	0.00
90%	3.19	3.19	0.00	91.89	91.89	0.00	95.08	95.08	0.00	5.29	5.29	0.00
2020												
10%	6.36	6.36	0.00	168.80	168.80	0.00	175.20	175.20	0.00	9.43	9.43	0.00
50%	5.02	5.02	0.00	136.00	136.00	0.00	141.00	141.00	0.00	7.46	7.46	0.00
90%	2.93	2.93	0.00	85.59	85.59	0.00	88.52	88.52	0.00	4.86	4.86	0.00
2030												
10%	6.35	6.35	0.00	168.70	168.70	0.00	175.00	175.00	0.00	9.43	9.43	0.00
50%	4.99	4.99	0.00	135.50	135.50	0.00	140.50	140.50	0.00	7.36	7.36	0.00
90%	3.01	3.01	0.00	87.49	87.49	0.00	90.50	90.50	0.00	4.73	4.73	0.00
2040												
10%	6.36	6.36	0.00	168.80	168.80	0.00	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.91	4.91	0.00	133.40	133.40	0.00	138.30	138.30	0.00	7.25	7.25	0.00
90%	2.83	2.83	0.00	83.22	83.22	0.00	86.05	86.05	0.00	4.52	4.52	0.00
2050												
10%	6.37	6.37	0.00	168.80	168.80	0.00	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.89	4.89	0.00	132.80	132.80	0.00	137.70	137.70	0.00	7.20	7.20	0.00
90%	2.85	2.85	0.00	83.46	83.46	0.00	86.31	86.31	0.00	4.43	4.43	0.00

Table 37
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15R1250, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.36	6.36	0.00	168.40	168.40	0.00	174.80	174.80	0.00	9.42	9.42	0.00
50%	4.32	4.32	0.00	119.30	119.30	0.00	123.60	123.60	0.00	6.86	6.86	0.00
90%	3.11	3.11	0.00	90.02	90.02	0.00	93.14	93.14	0.00	5.10	5.10	0.00
2020												
10%	6.34	6.34	0.00	168.40	168.40	0.00	174.70	174.70	0.00	9.42	9.42	0.00
50%	4.14	4.14	0.00	115.00	115.00	0.00	119.20	119.20	0.00	6.57	6.57	0.00
90%	2.85	2.85	0.00	83.58	83.58	0.00	86.43	86.43	0.00	4.65	4.65	0.00
2030												
10%	6.36	6.36	0.00	168.40	168.40	0.00	174.70	174.70	0.00	9.42	9.42	0.00
50%	4.15	4.15	0.00	114.90	114.90	0.00	119.10	119.10	0.00	6.45	6.45	0.00
90%	2.92	2.92	0.00	85.45	85.45	0.00	88.37	88.37	0.00	4.52	4.52	0.00
2040												
10%	6.34	6.34	0.00	168.40	168.40	0.00	174.70	174.70	0.00	9.42	9.42	0.00
50%	4.04	4.04	0.00	112.60	112.60	0.00	116.60	116.60	0.00	6.32	6.32	0.00
90%	2.73	2.73	0.00	80.86	80.86	0.00	83.59	83.59	0.00	4.29	4.29	0.00
2050												
10%	6.34	6.34	0.00	168.30	168.30	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	4.04	4.04	0.00	112.60	112.60	0.00	116.70	116.70	0.00	6.25	6.25	0.00
90%	2.75	2.75	0.00	81.01	81.01	0.00	83.76	83.76	0.00	4.19	4.19	0.00

Table 38
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 25R1250, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.33	6.33	0.00	167.90	167.90	0.00	174.20	174.20	0.00	9.40	9.40	0.00
50%	3.90	3.90	0.00	109.00	109.00	0.00	112.80	112.80	0.00	6.43	6.43	0.00
90%	2.91	2.91	0.00	85.09	85.09	0.00	88.00	88.00	0.00	4.78	4.78	0.00
2020												
10%	6.34	6.34	0.00	167.80	167.80	0.00	174.10	174.10	0.00	9.39	9.39	0.00
50%	3.71	3.71	0.00	104.40	104.40	0.00	108.10	108.10	0.00	6.12	6.12	0.00
90%	2.61	2.61	0.00	77.98	77.98	0.00	80.59	80.59	0.00	4.29	4.29	0.00
2030												
10%	6.33	6.33	0.00	167.70	167.70	0.00	174.00	174.00	0.00	9.39	9.39	0.00
50%	3.75	3.75	0.00	105.30	105.30	0.00	109.00	109.00	0.00	6.01	6.01	0.00
90%	2.70	2.70	0.00	80.29	80.29	0.00	82.99	82.99	0.00	4.16	4.16	0.00
2040												
10%	6.33	6.33	0.00	167.50	167.50	0.00	173.80	173.80	0.00	9.38	9.38	0.00
50%	3.62	3.62	0.00	102.20	102.20	0.00	105.90	105.90	0.00	5.85	5.85	0.00
90%	2.51	2.51	0.00	75.57	75.57	0.00	78.09	78.09	0.00	3.93	3.93	0.00
2050												
10%	6.33	6.33	0.00	167.40	167.40	0.00	173.80	173.80	0.00	9.38	9.38	0.00
50%	3.61	3.61	0.00	102.30	102.30	0.00	105.90	105.90	0.00	5.77	5.77	0.00
90%	2.51	2.51	0.00	75.38	75.38	0.00	77.89	77.89	0.00	3.81	3.81	0.00

Table 39
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 45R1250, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.36	6.36	0.00	168.60	168.60	0.00	174.90	174.90	0.00	9.43	9.43	0.00
50%	4.84	4.84	0.00	131.70	131.70	0.00	136.50	136.50	0.00	7.31	7.31	0.00
90%	3.04	3.04	0.00	88.25	88.25	0.00	91.29	91.29	0.00	5.03	5.03	0.00
2020												
10%	6.35	6.35	0.00	168.50	168.50	0.00	174.80	174.80	0.00	9.42	9.42	0.00
50%	4.70	4.70	0.00	128.20	128.20	0.00	132.90	132.90	0.00	7.07	7.07	0.00
90%	2.76	2.76	0.00	81.60	81.60	0.00	84.37	84.37	0.00	4.57	4.57	0.00
2030												
10%	6.36	6.36	0.00	168.40	168.40	0.00	174.80	174.80	0.00	9.42	9.42	0.00
50%	4.69	4.69	0.00	128.10	128.10	0.00	132.70	132.70	0.00	6.96	6.96	0.00
90%	2.85	2.85	0.00	83.64	83.64	0.00	86.49	86.49	0.00	4.44	4.44	0.00
2040												
10%	6.34	6.34	0.00	168.30	168.30	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	4.54	4.54	0.00	124.40	124.40	0.00	129.00	129.00	0.00	6.83	6.83	0.00
90%	2.66	2.66	0.00	79.16	79.16	0.00	81.82	81.82	0.00	4.22	4.22	0.00
2050												
10%	6.35	6.35	0.00	168.30	168.30	0.00	174.70	174.70	0.00	9.41	9.41	0.00
50%	4.54	4.54	0.00	124.80	124.80	0.00	129.30	129.30	0.00	6.76	6.76	0.00
90%	2.67	2.67	0.00	79.22	79.22	0.00	81.88	81.88	0.00	4.12	4.12	0.00

Table 40
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15R1280, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.32	6.32	0.00	167.50	167.50	0.00	173.90	173.90	0.00	9.38	9.38	0.00
50%	3.83	3.83	0.00	107.40	107.40	0.00	111.20	111.20	0.00	6.26	6.26	0.00
90%	2.88	2.88	0.00	84.49	84.49	0.00	87.37	87.37	0.00	4.73	4.73	0.00
2020												
10%	6.32	6.32	0.00	167.30	167.30	0.00	173.70	173.70	0.00	9.37	9.37	0.00
50%	3.65	3.65	0.00	102.90	102.90	0.00	106.50	106.50	0.00	5.92	5.92	0.00
90%	2.61	2.61	0.00	77.92	77.92	0.00	80.53	80.53	0.00	4.24	4.24	0.00
2030												
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%	3.69	3.69	0.00	103.90	103.90	0.00	107.60	107.60	0.00	5.81	5.81	0.00
90%	2.68	2.68	0.00	79.57	79.57	0.00	82.25	82.25	0.00	4.09	4.09	0.00
2040												
10%	6.31	6.31	0.00	167.10	167.10	0.00	173.40	173.40	0.00	9.36	9.36	0.00
50%	3.55	3.55	0.00	100.60	100.60	0.00	104.20	104.20	0.00	5.65	5.65	0.00
90%	2.48	2.48	0.00	74.80	74.80	0.00	77.28	77.28	0.00	3.86	3.86	0.00
2050												
10%	6.29	6.29	0.00	167.10	167.10	0.00	173.40	173.40	0.00	9.36	9.36	0.00
50%	3.57	3.57	0.00	100.80	100.80	0.00	104.40	104.40	0.00	5.56	5.56	0.00
90%	2.50	2.50	0.00	75.11	75.11	0.00	77.60	77.60	0.00	3.75	3.75	0.00

Table 41
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 45R1280, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.36	6.36	0.00	168.50	168.50	0.00	174.80	174.80	0.00	9.42	9.42	0.00
50%	4.67	4.67	0.00	127.70	127.70	0.00	132.40	132.40	0.00	7.08	7.08	0.00
90%	3.03	3.03	0.00	87.92	87.92	0.00	90.95	90.95	0.00	4.97	4.97	0.00
2020												
10%	6.35	6.35	0.00	168.30	168.30	0.00	174.70	174.70	0.00	9.41	9.41	0.00
50%	4.51	4.51	0.00	123.60	123.60	0.00	128.10	128.10	0.00	6.82	6.82	0.00
90%	2.75	2.75	0.00	81.29	81.29	0.00	84.05	84.05	0.00	4.51	4.51	0.00
2030												
10%	6.35	6.35	0.00	168.20	168.20	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	4.52	4.52	0.00	124.00	124.00	0.00	128.50	128.50	0.00	6.71	6.71	0.00
90%	2.83	2.83	0.00	83.17	83.17	0.00	86.00	86.00	0.00	4.37	4.37	0.00
2040												
10%	6.35	6.35	0.00	168.20	168.20	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	4.37	4.37	0.00	120.50	120.50	0.00	124.90	124.90	0.00	6.58	6.58	0.00
90%	2.64	2.64	0.00	78.71	78.71	0.00	81.35	81.35	0.00	4.15	4.15	0.00
2050												
10%	6.35	6.35	0.00	168.20	168.20	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	4.35	4.35	0.00	119.80	119.80	0.00	124.10	124.10	0.00	6.49	6.49	0.00
90%	2.64	2.64	0.00	78.63	78.63	0.00	81.27	81.27	0.00	4.04	4.04	0.00

Table 42
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 65R1280, During Years With and Without Project for Scenario 2

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.36	6.36	0.00	168.90	168.90	0.00	175.20	175.20	0.00	9.43	9.43	0.00
50%	5.10	5.10	0.00	137.90	137.90	0.00	143.00	143.00	0.00	7.69	7.69	0.00
90%	3.17	3.17	0.00	91.28	91.28	0.00	94.45	94.45	0.00	5.24	5.24	0.00
2020												
10%	6.36	6.36	0.00	168.80	168.80	0.00	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.97	4.97	0.00	134.90	134.90	0.00	139.80	139.80	0.00	7.50	7.50	0.00
90%	2.90	2.90	0.00	84.79	84.79	0.00	87.69	87.69	0.00	4.80	4.80	0.00
2030												
10%	6.36	6.36	0.00	168.70	168.70	0.00	175.00	175.00	0.00	9.43	9.43	0.00
50%	4.92	4.92	0.00	133.80	133.80	0.00	138.70	138.70	0.00	7.38	7.38	0.00
90%	2.96	2.96	0.00	86.28	86.28	0.00	89.23	89.23	0.00	4.67	4.67	0.00
2040												
10%	6.36	6.36	0.00	168.70	168.70	0.00	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.83	4.83	0.00	131.60	131.60	0.00	136.50	136.50	0.00	7.27	7.27	0.00
90%	2.80	2.80	0.00	82.37	82.37	0.00	85.16	85.16	0.00	4.46	4.46	0.00
2050												
10%	6.37	6.37	0.00	168.70	168.70	0.00	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.80	4.80	0.00	131.10	131.10	0.00	135.90	135.90	0.00	7.22	7.22	0.00
90%	2.82	2.82	0.00	82.66	82.66	0.00	85.47	85.47	0.00	4.37	4.37	0.00

Table 43
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15L1130, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.21	6.21	0.00	165.30	165.30	0.00	171.50	171.50	0.00	9.29	9.29	0.00
50%	3.41	3.41	0.00	97.13	97.13	0.00	100.50	100.50	0.00	5.50	5.50	0.00
90%	2.47	2.47	0.00	74.62	74.62	0.00	77.10	77.10	0.00	3.90	3.90	0.00
2020												
10%	6.21	6.21	0.00	164.90	165.00	-0.10	171.10	171.20	-0.10	9.29	9.29	0.00
50%	3.29	3.26	0.03	94.13	93.56	0.57	97.41	96.82	0.59	5.40	5.43	-0.04
90%	1.97	2.01	-0.05	62.29	63.61	-1.32	64.25	65.62	-1.37	3.44	3.53	-0.09
2030												
10%	6.19	6.20	-0.01	164.80	164.80	0.00	171.00	171.00	0.00	9.27	9.27	0.00
50%	3.25	3.24	0.01	93.44	93.09	0.35	96.69	96.33	0.36	5.21	5.21	0.00
90%	0.00	0.00	0.00	3.67	3.70	-0.03	3.67	3.70	-0.03	0.00	0.00	0.00
2040												
10%	6.19	6.19	0.00	164.40	164.40	0.00	170.60	170.60	0.00	9.27	9.27	0.00
50%	3.13	3.13	0.00	90.46	90.46	0.00	93.59	93.59	0.00	5.08	5.08	0.00
90%	0.00	0.00	0.00	3.59	3.59	0.00	3.59	3.59	0.00	0.00	0.00	0.00
2050												
10%	6.19	6.19	0.00	164.30	164.30	0.00	170.50	170.50	0.00	9.26	9.26	0.00
50%	3.16	3.16	0.00	91.15	91.15	0.00	94.32	94.32	0.00	4.97	4.97	0.00
90%	0.00	0.00	0.00	3.45	3.45	0.00	3.45	3.45	0.00	0.00	0.00	0.00

Table 44
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 35L1130, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
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%	3.77	3.77	0.00	105.80	105.80	0.00	109.60	109.60	0.00	5.75	5.75	0.00
90%	2.54	2.54	0.00	76.22	76.22	0.00	78.76	78.76	0.00	4.02	4.02	0.00
2020												
10%	6.30	6.29	0.01	166.80	167.00	-0.20	173.10	173.30	-0.20	9.35	9.36	-0.01
50%	3.74	3.70	0.04	105.10	104.20	0.90	108.80	107.90	0.90	5.69	5.72	-0.04
90%	2.08	2.14	-0.06	65.28	66.64	-1.36	67.37	68.78	-1.41	3.59	3.67	-0.08
2030												
10%	6.30	6.30	0.00	166.90	166.90	0.00	173.20	173.20	0.00	9.36	9.35	0.00
50%	3.66	3.63	0.03	103.30	102.50	0.80	107.00	106.20	0.80	5.49	5.48	0.01
90%	2.33	2.27	0.06	71.02	69.65	1.37	73.34	71.92	1.42	3.63	3.59	0.04
2040												
10%	6.27	6.27	0.00	166.60	166.60	0.00	172.90	172.90	0.00	9.35	9.35	0.00
50%	3.55	3.55	0.00	100.60	100.60	0.00	104.10	104.10	0.00	5.37	5.37	0.00
90%	0.00	0.00	0.00	3.63	3.63	0.00	3.63	3.63	0.00	0.00	0.00	0.00
2050												
10%	6.29	6.29	0.00	166.60	166.60	0.00	172.80	172.80	0.00	9.34	9.34	0.00
50%	3.59	3.59	0.00	101.50	101.50	0.00	105.10	105.10	0.00	5.25	5.25	0.00
90%	0.00	0.00	0.00	3.49	3.49	0.00	3.49	3.49	0.00	0.00	0.00	0.00

Table 45
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 55L1130, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.34	6.34	0.00	168.10	168.10	0.00	174.40	174.40	0.00	9.40	9.40	0.00
50%	4.33	4.33	0.00	119.50	119.50	0.00	123.80	123.80	0.00	6.49	6.49	0.00
90%	2.65	2.65	0.00	78.93	78.93	0.00	81.58	81.58	0.00	4.25	4.25	0.00
2020												
10%	6.34	6.35	-0.01	168.00	168.00	0.00	174.30	174.40	-0.10	9.40	9.40	0.00
50%	4.28	4.26	0.02	118.10	117.80	0.30	122.40	122.00	0.40	6.43	6.47	-0.03
90%	2.52	2.48	0.04	75.57	74.65	0.92	78.09	77.13	0.96	4.09	4.15	-0.06
2030												
10%	6.34	6.34	0.00	167.90	168.00	-0.10	174.30	174.30	0.00	9.39	9.39	0.00
50%	4.22	4.18	0.04	116.60	115.90	0.70	120.80	120.10	0.70	6.26	6.25	0.01
90%	2.50	2.47	0.03	75.18	74.45	0.73	77.68	76.92	0.76	3.90	3.88	0.02
2040												
10%	6.33	6.33	0.00	167.90	167.90	0.00	174.20	174.20	0.00	9.39	9.39	0.00
50%	4.13	4.13	0.00	114.60	114.60	0.00	118.70	118.70	0.00	6.19	6.19	0.00
90%	2.33	2.33	0.00	71.12	71.12	0.00	73.44	73.44	0.00	3.71	3.71	0.00
2050												
10%	6.33	6.33	0.00	167.80	167.80	0.00	174.10	174.10	0.00	9.39	9.39	0.00
50%	4.14	4.14	0.00	114.70	114.70	0.00	118.90	118.90	0.00	6.08	6.08	0.00
90%	2.29	2.29	0.00	70.20	70.20	0.00	72.49	72.49	0.00	3.53	3.53	0.00

Table 46
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15R1160, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.18	6.18	0.00	164.20	164.20	0.00	170.30	170.30	0.00	9.26	9.26	0.00
50%	3.22	3.22	0.00	92.57	92.57	0.00	95.79	95.79	0.00	5.37	5.37	0.00
90%	2.49	2.49	0.00	74.97	74.97	0.00	77.46	77.46	0.00	3.97	3.97	0.00
2020												
10%	6.14	6.17	-0.03	163.60	163.70	-0.10	169.80	169.90	-0.10	9.24	9.24	-0.01
50%	3.09	3.07	0.02	89.53	89.03	0.50	92.62	92.10	0.52	5.25	5.28	-0.04
90%	2.01	2.07	-0.06	63.52	64.83	-1.31	65.53	66.89	-1.36	3.52	3.61	-0.08
2030												
10%	6.16	6.16	0.00	163.50	163.50	0.00	169.70	169.60	0.10	9.23	9.23	0.00
50%	3.08	3.06	0.02	89.12	88.71	0.41	92.20	91.77	0.43	5.07	5.06	0.01
90%	0.00	1.83	-1.83	3.68	59.18	-55.50	3.68	61.02	-57.34	0.00	3.20	-3.20
2040												
10%	6.15	6.15	0.00	163.10	163.10	0.00	169.20	169.20	0.00	9.22	9.22	0.00
50%	2.95	2.95	0.00	86.11	86.11	0.00	89.06	89.06	0.00	4.92	4.92	0.00
90%	0.00	0.00	0.00	3.61	3.61	0.00	3.61	3.61	0.00	0.00	0.00	0.00
2050												
10%	6.14	6.14	0.00	162.90	162.90	0.00	169.00	169.00	0.00	9.21	9.21	0.00
50%	2.98	2.98	0.00	86.71	86.71	0.00	89.68	89.68	0.00	4.81	4.81	0.00
90%	0.00	0.00	0.00	3.46	3.46	0.00	3.46	3.46	0.00	0.00	0.00	0.00

Table 47
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 45R1160, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.23	6.23	0.00	165.60	165.60	0.00	171.80	171.80	0.00	9.30	9.30	0.00
50%	3.34	3.34	0.00	95.43	95.43	0.00	98.76	98.76	0.00	5.54	5.54	0.00
90%	2.52	2.52	0.00	75.75	75.75	0.00	78.27	78.27	0.00	3.97	3.97	0.00
2020												
10%	6.21	6.23	-0.02	165.20	165.30	-0.10	171.40	171.60	-0.20	9.29	9.30	-0.01
50%	3.22	3.19	0.03	92.47	91.94	0.53	95.68	95.13	0.55	5.43	5.47	-0.04
90%	2.05	2.10	-0.05	64.19	65.53	-1.34	66.24	67.62	-1.38	3.52	3.60	-0.09
2030												
10%	6.22	6.22	0.00	165.10	165.10	0.00	171.30	171.30	0.00	9.28	9.28	0.00
50%	3.18	3.17	0.01	91.65	91.31	0.34	94.83	94.47	0.36	5.25	5.24	0.00
90%	1.99	1.96	0.02	62.83	62.37	0.46	64.81	64.33	0.48	3.31	3.29	0.02
2040												
10%	6.19	6.19	0.00	164.80	164.80	0.00	171.00	171.00	0.00	9.28	9.28	0.00
50%	3.07	3.07	0.00	88.98	88.98	0.00	92.05	92.05	0.00	5.12	5.12	0.00
90%	0.00	0.00	0.00	3.61	3.61	0.00	3.61	3.61	0.00	0.00	0.00	0.00
2050												
10%	6.19	6.19	0.00	164.70	164.70	0.00	170.90	170.90	0.00	9.27	9.27	0.00
50%	3.09	3.09	0.00	89.46	89.46	0.00	92.55	92.55	0.00	5.01	5.01	0.00
90%	0.00	0.00	0.00	3.46	3.46	0.00	3.46	3.46	0.00	0.00	0.00	0.00

Table 48
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 85R1160, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.34	6.34	0.00	168.10	168.10	0.00	174.40	174.40	0.00	9.40	9.40	0.00
50%	4.50	4.50	0.00	123.40	123.40	0.00	127.90	127.90	0.00	6.64	6.64	0.00
90%	2.73	2.73	0.00	80.76	80.76	0.00	83.49	83.49	0.00	4.35	4.35	0.00
2020												
10%	6.34	6.35	-0.01	168.00	168.00	0.00	174.30	174.40	-0.10	9.40	9.40	0.00
50%	4.43	4.44	-0.01	121.70	121.90	-0.20	126.10	126.40	-0.30	6.57	6.61	-0.04
90%	2.58	2.55	0.04	77.24	76.32	0.92	79.82	78.86	0.96	4.21	4.26	-0.05
2030												
10%	6.34	6.34	0.00	168.00	168.00	0.00	174.40	174.30	0.10	9.40	9.40	0.00
50%	4.32	4.33	0.00	119.30	119.40	-0.10	123.60	123.70	-0.10	6.39	6.39	0.00
90%	2.57	2.55	0.02	76.91	76.51	0.40	79.48	79.07	0.41	4.01	3.99	0.02
2040												
10%	6.33	6.33	0.00	167.90	167.90	0.00	174.20	174.20	0.00	9.40	9.40	0.00
50%	4.29	4.29	0.00	118.60	118.60	0.00	122.90	122.90	0.00	6.35	6.35	0.00
90%	2.41	2.41	0.00	73.03	73.03	0.00	75.44	75.44	0.00	3.83	3.83	0.00
2050												
10%	6.33	6.33	0.00	167.90	167.90	0.00	174.20	174.20	0.00	9.39	9.39	0.00
50%	4.26	4.26	0.00	117.60	117.60	0.00	121.80	121.80	0.00	6.22	6.22	0.00
90%	2.43	2.43	0.00	73.55	73.55	0.00	75.98	75.98	0.00	3.67	3.67	0.00

Table 49
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15L1250, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.35	6.35	0.00	168.30	168.30	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	3.94	3.94	0.00	110.00	110.00	0.00	113.90	113.90	0.00	6.33	6.33	0.00
90%	2.88	2.88	0.00	84.47	84.47	0.00	87.36	87.36	0.00	4.63	4.63	0.00
2020												
10%	6.34	6.35	-0.01	168.30	168.30	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	3.81	3.78	0.03	107.00	106.40	0.60	110.80	110.10	0.70	6.22	6.25	-0.03
90%	2.75	2.71	0.04	81.28	80.36	0.92	84.03	83.07	0.96	4.50	4.54	-0.04
2030												
10%	6.35	6.35	0.00	168.20	168.20	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	3.83	3.79	0.04	107.40	106.50	0.90	111.20	110.30	0.90	6.09	6.08	0.01
90%	2.73	2.72	0.01	80.74	80.55	0.19	83.47	83.28	0.19	4.30	4.29	0.01
2040												
10%	6.34	6.34	0.00	168.10	168.10	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	3.69	3.69	0.00	104.00	104.00	0.00	107.70	107.70	0.00	5.98	5.98	0.00
90%	2.57	2.57	0.00	76.96	76.96	0.00	79.53	79.53	0.00	4.12	4.12	0.00
2050												
10%	6.34	6.34	0.00	168.00	168.00	0.00	174.30	174.30	0.00	9.40	9.40	0.00
50%	3.71	3.71	0.00	104.30	104.30	0.00	108.00	108.00	0.00	5.88	5.88	0.00
90%	2.63	2.63	0.00	78.31	78.31	0.00	80.94	80.94	0.00	3.99	3.99	0.00

Table 50
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 35L1250, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.34	6.34	0.00	167.80	167.80	0.00	174.10	174.10	0.00	9.39	9.39	0.00
50%	3.80	3.80	0.00	106.50	106.50	0.00	110.30	110.30	0.00	6.17	6.17	0.00
90%	2.72	2.72	0.00	80.63	80.63	0.00	83.35	83.35	0.00	4.33	4.33	0.00
2020												
10%	6.32	6.34	-0.01	167.70	167.70	0.00	174.00	174.00	0.00	9.39	9.39	0.00
50%	3.69	3.66	0.03	103.80	103.10	0.70	107.50	106.80	0.70	6.07	6.09	-0.02
90%	2.58	2.54	0.04	77.02	76.19	0.83	79.59	78.73	0.86	4.18	4.23	-0.05
2030												
10%	6.32	6.33	-0.01	167.60	167.50	0.10	173.90	173.80	0.10	9.39	9.39	0.00
50%	3.66	3.65	0.02	103.30	103.00	0.30	107.00	106.60	0.40	5.91	5.91	0.00
90%	2.57	2.55	0.02	76.90	76.35	0.55	79.47	78.90	0.57	3.99	3.97	0.02
2040												
10%	6.33	6.33	0.00	167.40	167.40	0.00	173.70	173.70	0.00	9.38	9.38	0.00
50%	3.54	3.54	0.00	100.50	100.50	0.00	104.00	104.00	0.00	5.79	5.79	0.00
90%	2.38	2.38	0.00	72.46	72.46	0.00	74.84	74.84	0.00	3.79	3.79	0.00
2050												
10%	6.32	6.32	0.00	167.40	167.40	0.00	173.70	173.70	0.00	9.38	9.38	0.00
50%	3.56	3.56	0.00	101.00	101.00	0.00	104.50	104.50	0.00	5.70	5.70	0.00
90%	2.41	2.41	0.00	73.02	73.02	0.00	75.43	75.43	0.00	3.64	3.64	0.00

Table 51
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 75L1250, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.36	6.36	0.00	168.80	168.80	0.00	175.20	175.20	0.00	9.43	9.43	0.00
50%	5.06	5.06	0.00	137.30	137.30	0.00	142.40	142.40	0.00	7.44	7.44	0.00
90%	3.02	3.02	0.00	87.63	87.63	0.00	90.65	90.65	0.00	4.88	4.88	0.00
2020												
10%	6.36	6.36	0.00	168.70	168.80	-0.10	175.10	175.10	0.00	9.43	9.43	0.00
50%	5.00	4.99	0.01	135.50	135.30	0.20	140.50	140.30	0.20	7.39	7.41	-0.02
90%	2.88	2.85	0.03	84.41	83.64	0.77	87.29	86.49	0.80	4.76	4.80	-0.04
2030												
10%	6.36	6.36	0.00	168.70	168.80	-0.10	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.93	4.88	0.05	133.90	132.70	1.20	138.80	137.60	1.20	7.24	7.23	0.01
90%	2.86	2.85	0.01	83.89	83.68	0.21	86.75	86.53	0.22	4.56	4.56	0.01
2040												
10%	6.35	6.35	0.00	168.70	168.70	0.00	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.88	4.88	0.00	132.90	132.90	0.00	137.80	137.80	0.00	7.22	7.22	0.00
90%	2.73	2.73	0.00	80.75	80.75	0.00	83.48	83.48	0.00	4.41	4.41	0.00
2050												
10%	6.36	6.36	0.00	168.70	168.70	0.00	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.84	4.84	0.00	132.10	132.10	0.00	136.90	136.90	0.00	7.12	7.12	0.00
90%	2.76	2.76	0.00	81.45	81.45	0.00	84.21	84.21	0.00	4.28	4.28	0.00

Table 52
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15R1250, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.36	6.36	0.00	168.50	168.50	0.00	174.80	174.80	0.00	9.42	9.42	0.00
50%	4.19	4.19	0.00	116.20	116.20	0.00	120.30	120.30	0.00	6.57	6.57	0.00
90%	2.93	2.93	0.00	85.55	85.55	0.00	88.48	88.48	0.00	4.68	4.68	0.00
2020												
10%	6.34	6.34	0.00	168.40	168.30	0.10	174.70	174.60	0.10	9.42	9.42	0.00
50%	4.08	4.05	0.03	113.30	112.80	0.50	117.40	116.80	0.60	6.46	6.49	-0.03
90%	2.80	2.76	0.04	82.41	81.42	0.99	85.21	84.18	1.03	4.55	4.59	-0.04
2030												
10%	6.34	6.34	0.00	168.30	168.40	-0.10	174.60	174.70	-0.10	9.42	9.42	0.00
50%	4.08	4.06	0.02	113.40	112.90	0.50	117.50	116.90	0.60	6.34	6.34	0.01
90%	2.79	2.76	0.03	82.12	81.38	0.74	84.91	84.14	0.77	4.35	4.33	0.02
2040												
10%	6.34	6.34	0.00	168.30	168.30	0.00	174.60	174.60	0.00	9.42	9.42	0.00
50%	3.95	3.95	0.00	110.20	110.20	0.00	114.20	114.20	0.00	6.24	6.24	0.00
90%	2.62	2.62	0.00	78.13	78.13	0.00	80.75	80.75	0.00	4.17	4.17	0.00
2050												
10%	6.33	6.33	0.00	168.20	168.20	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	3.96	3.96	0.00	110.60	110.60	0.00	114.60	114.60	0.00	6.13	6.13	0.00
90%	2.67	2.67	0.00	79.30	79.30	0.00	81.97	81.97	0.00	4.04	4.04	0.00

Table 53
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 25R1250, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.34	6.34	0.00	167.80	167.80	0.00	174.10	174.10	0.00	9.39	9.39	0.00
50%	3.77	3.77	0.00	105.70	105.70	0.00	109.50	109.50	0.00	6.12	6.12	0.00
90%	2.71	2.71	0.00	80.40	80.40	0.00	83.11	83.11	0.00	4.33	4.33	0.00
2020												
10%	6.33	6.33	0.00	167.50	167.60	-0.10	173.90	174.00	-0.10	9.39	9.39	0.00
50%	3.66	3.63	0.03	103.20	102.60	0.60	106.90	106.20	0.70	6.02	6.05	-0.03
90%	2.58	2.53	0.04	77.08	76.09	0.99	79.65	78.63	1.02	4.19	4.24	-0.04
2030												
10%	6.32	6.32	0.00	167.50	167.50	0.00	173.90	173.80	0.10	9.38	9.38	0.00
50%	3.64	3.62	0.03	102.80	102.30	0.50	106.40	105.90	0.50	5.86	5.86	0.00
90%	2.56	2.53	0.03	76.65	75.98	0.67	79.21	78.51	0.70	3.99	3.97	0.02
2040												
10%	6.32	6.32	0.00	167.30	167.30	0.00	173.70	173.70	0.00	9.38	9.38	0.00
50%	3.51	3.51	0.00	99.81	99.81	0.00	103.30	103.30	0.00	5.74	5.74	0.00
90%	2.38	2.38	0.00	72.47	72.47	0.00	74.85	74.85	0.00	3.80	3.80	0.00
2050												
10%	6.32	6.32	0.00	167.30	167.30	0.00	173.60	173.60	0.00	9.38	9.38	0.00
50%	3.54	3.54	0.00	100.20	100.20	0.00	103.70	103.70	0.00	5.65	5.65	0.00
90%	2.41	2.41	0.00	73.03	73.03	0.00	75.43	75.43	0.00	3.65	3.65	0.00

Table 54
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 45R1250, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.36	6.36	0.00	168.50	168.50	0.00	174.90	174.90	0.00	9.42	9.42	0.00
50%	4.71	4.71	0.00	128.50	128.50	0.00	133.20	133.20	0.00	7.04	7.04	0.00
90%	2.86	2.86	0.00	83.85	83.85	0.00	86.71	86.71	0.00	4.60	4.60	0.00
2020												
10%	6.34	6.34	0.00	168.40	168.40	0.00	174.70	174.70	0.00	9.42	9.42	0.00
50%	4.66	4.64	0.02	127.20	126.80	0.40	131.90	131.40	0.50	6.98	7.00	-0.03
90%	2.72	2.68	0.04	80.45	79.63	0.82	83.17	82.32	0.85	4.47	4.51	-0.04
2030												
10%	6.34	6.34	0.00	168.40	168.40	0.00	174.80	174.70	0.10	9.42	9.42	0.00
50%	4.56	4.52	0.04	125.00	124.10	0.90	129.50	128.60	0.90	6.81	6.80	0.01
90%	2.69	2.68	0.01	79.76	79.53	0.23	82.45	82.21	0.24	4.27	4.25	0.01
2040												
10%	6.35	6.35	0.00	168.40	168.40	0.00	174.70	174.70	0.00	9.42	9.42	0.00
50%	4.46	4.46	0.00	122.60	122.60	0.00	127.10	127.10	0.00	6.75	6.75	0.00
90%	2.54	2.54	0.00	76.30	76.30	0.00	78.84	78.84	0.00	4.10	4.10	0.00
2050												
10%	6.35	6.35	0.00	168.20	168.20	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	4.41	4.41	0.00	121.50	121.50	0.00	125.90	125.90	0.00	6.64	6.64	0.00
90%	2.59	2.59	0.00	77.46	77.46	0.00	80.05	80.05	0.00	3.96	3.96	0.00

Table 55
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 15R1280, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.33	6.33	0.00	167.40	167.40	0.00	173.80	173.80	0.00	9.38	9.38	0.00
50%	3.70	3.70	0.00	104.10	104.10	0.00	107.80	107.80	0.00	5.92	5.92	0.00
90%	2.70	2.70	0.00	79.98	79.98	0.00	82.67	82.67	0.00	4.27	4.27	0.00
2020												
10%	6.31	6.32	0.00	167.20	167.20	0.00	173.50	173.50	0.00	9.37	9.37	0.00
50%	3.61	3.57	0.04	101.90	101.10	0.80	105.60	104.70	0.90	5.82	5.85	-0.03
90%	2.57	2.53	0.04	76.85	75.79	1.06	79.42	78.31	1.11	4.13	4.18	-0.05
2030												
10%	6.31	6.31	0.00	167.10	167.10	0.00	173.50	173.40	0.10	9.36	9.36	0.00
50%	3.58	3.56	0.02	101.20	100.70	0.50	104.80	104.20	0.60	5.66	5.65	0.01
90%	2.54	2.51	0.03	76.24	75.55	0.69	78.78	78.06	0.72	3.93	3.90	0.02
2040												
10%	6.30	6.30	0.00	166.90	166.90	0.00	173.20	173.20	0.00	9.36	9.36	0.00
50%	3.46	3.46	0.00	98.36	98.36	0.00	101.80	101.80	0.00	5.54	5.54	0.00
90%	2.36	2.36	0.00	72.02	72.02	0.00	74.38	74.38	0.00	3.73	3.73	0.00
2050												
10%	6.30	6.30	0.00	166.90	166.90	0.00	173.20	173.20	0.00	9.36	9.36	0.00
50%	3.48	3.48	0.00	98.83	98.83	0.00	102.30	102.30	0.00	5.43	5.43	0.00
90%	2.36	2.36	0.00	71.80	71.80	0.00	74.15	74.15	0.00	3.57	3.57	0.00

Table 56
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 45R1280, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**	**Without Project**	**With Project**	**Project Reduction**
2010												
10%	6.35	6.35	0.00	168.30	168.30	0.00	174.60	174.60	0.00	9.41	9.41	0.00
50%	4.54	4.54	0.00	124.50	124.50	0.00	129.00	129.00	0.00	6.79	6.79	0.00
90%	2.84	2.84	0.00	83.34	83.34	0.00	86.17	86.17	0.00	4.54	4.54	0.00
2020												
10%	6.35	6.35	0.00	168.30	168.20	0.10	174.60	174.60	0.00	9.41	9.41	0.00
50%	4.46	4.44	0.02	122.50	122.20	0.30	126.90	126.60	0.30	6.71	6.75	-0.04
90%	2.70	2.67	0.03	79.98	79.21	0.77	82.68	81.87	0.81	4.40	4.45	-0.04
2030												
10%	6.35	6.35	0.00	168.30	168.30	0.00	174.70	174.60	0.10	9.41	9.41	0.00
50%	4.35	4.34	0.01	120.00	119.80	0.20	124.30	124.10	0.20	6.54	6.54	0.00
90%	2.70	2.67	0.02	79.91	79.35	0.56	82.61	82.02	0.59	4.21	4.19	0.02
2040												
10%	6.33	6.33	0.00	168.10	168.10	0.00	174.50	174.50	0.00	9.41	9.41	0.00
50%	4.35	4.35	0.00	119.90	119.90	0.00	124.20	124.20	0.00	6.50	6.50	0.00
90%	2.52	2.52	0.00	75.83	75.83	0.00	78.35	78.35	0.00	4.03	4.03	0.00
2050												
10%	6.34	6.34	0.00	168.10	168.10	0.00	174.40	174.40	0.00	9.41	9.41	0.00
50%	4.29	4.29	0.00	118.50	118.50	0.00	122.80	122.80	0.00	6.38	6.38	0.00
90%	2.57	2.57	0.00	76.92	76.92	0.00	79.49	79.49	0.00	3.89	3.89	0.00

Table 57
Tissue Dry Weight (g), Shell Dry Weight (g), Total Dry Weight (g), and Cumulative Reproductive Effort (kJ) for Mussels in the LaGrange Pool, Cell ID 65R1280, During Years With and Without Project for Scenario 3

	Tissue Dry Weight (g)			Shell Dry Weight (g)			Total Dry Weight (g)			Cumulative Reproductive Effort (kJ)		
Percent of Sediment Concentrations	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction	Without Project	With Project	Project Reduction
2010												
10%	6.36	6.36	0.00	168.80	168.80	0.00	175.20	175.20	0.00	9.43	9.43	0.00
50%	5.01	5.01	0.00	135.60	135.60	0.00	140.60	140.60	0.00	7.47	7.47	0.00
90%	2.98	2.98	0.00	86.85	86.85	0.00	89.83	89.83	0.00	4.83	4.83	0.00
2020												
10%	6.36	6.37	-0.01	168.70	168.70	0.00	175.10	175.10	0.00	9.43	9.43	0.00
50%	4.93	4.93	0.00	133.90	134.10	-0.20	138.90	139.10	-0.20	7.41	7.45	-0.04
90%	2.84	2.81	0.04	83.48	82.63	0.85	86.33	85.44	0.89	4.70	4.74	-0.04
2030												
10%	6.36	6.37	-0.01	168.70	168.70	0.00	175.10	175.00	0.10	9.43	9.43	0.00
50%	4.84	4.81	0.03	131.80	131.10	0.70	136.70	135.90	0.80	7.26	7.26	0.01
90%	2.84	2.82	0.02	83.42	82.87	0.55	86.26	85.68	0.58	4.51	4.50	0.01
2040												
10%	6.35	6.35	0.00	168.60	168.60	0.00	175.00	175.00	0.00	9.43	9.43	0.00
50%	4.81	4.81	0.00	131.20	131.20	0.00	136.00	136.00	0.00	7.24	7.24	0.00
90%	2.69	2.69	0.00	79.82	79.82	0.00	82.51	82.51	0.00	4.34	4.34	0.00
2050												
10%	6.37	6.37	0.00	168.60	168.60	0.00	175.00	175.00	0.00	9.43	9.43	0.00
50%	4.76	4.76	0.00	130.10	130.10	0.00	134.80	134.80	0.00	7.14	7.14	0.00
90%	2.74	2.74	0.00	80.91	80.91	0.00	83.64	83.64	0.00	4.22	4.22	0.00

For all mussel beds in Pool 13, Pool 26, and the LaGrange Pool, suspended sediment concentrations resulting from increased traffic due to Scenarios 2 and 3 did not significantly affect the growth of threeridge mussels. All traffic events were assigned either the 10th, 50th, or 90th percentile sediment concentrations, depending on the simulation. For the 10th and 50th percentile sediment concentrations, the project reduction for both Scenarios 2 and 3 was between 0-1 g (Tables 10-57). On occasion, impacts were higher (up to 7 g) using the 90th percentile sediment concentrations. However, as stated earlier, the chance of occurrence of the 90th percentile sediment concentrations for all vessel passages is vanishingly small.

Although there were no (or very small) differences in mussel growth between the with- and without-project conditions, differences in growth did occur among the different percentiles of sediment concentrations. Small differences can result from the interarrival times and *p(t)*. As an example, differences in the growth of a young mussel in Pool 13 (Cell ID 15R5565) over a 10-year period for Scenario 2 using the 10th, 50th, and 90th percentile sediment concentrations are presented in Figure 11. Mussel growth was highest using the 10th percentile sediment concentrations and lowest using the 90th percentile sediment concentrations (Figure 11), with a near 50% reduction in growth from the 10th to 90th percentile in the 10th year of growth.

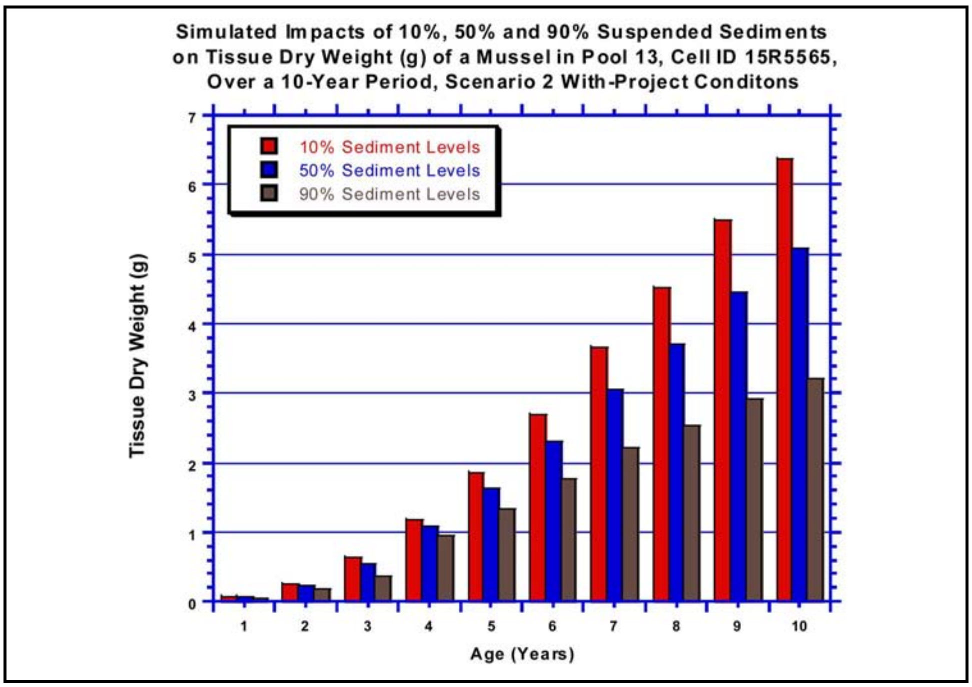

Figure 11. The simulated impacts on tissue dry weight (g) of a mussel in Pool 13 (Cell ID 15R5565) over a 10-year period using the 10th, 50th, and 90th percentile sediment concentrations for Scenario 2, with-project conditions near 50% reduction in growth from the 10th to 90th percentile in the 10th year of growth.

Differences in mussel growth were also observed between the different cells across transects in the LaGrange Pool. For example at River Mile 116.0 in the LaGrange Pool for Scenarios 2 and 3, mussel growth increased as distance from the sailing line increased (Figures 12 and 13). This occurred because mussels are exposed to higher suspended sediment concentrations closer to areas of traffic passage (i.e., closer to the sailing line).

Mussel reproduction

Mussel reproduction is presented as the cumulative reproductive effort which is the sum of the energy allocated to reproduction over each 10-year period. For all mussel beds in Pools 13 and 26 and the LaGrange Pool, suspended sediment concentrations resulting from increased traffic due to Scenarios 2 and 3 did not affect the reproduction of threeridge mussels.

Uncertainties

There are several sources of bias and imprecision associated with this initial assessment of commercial traffic on mussels in the main channel and main channel borders of the UMR-IWW System. These uncertainties are listed below.

- The mussel model was calibrated using field data from the UMR-IWW System. It is possible that mussel populations in the UMR-IWW System differ genetically from the other populations and/or possess adaptation mechanisms to other climates unknown to us. These differences may cause the UMR-IWW System populations to behave differently than other mussel model populations.

- Concentrations of potentially different suspended sediments were assumed to exert the same reduction in mussel filtering. No distinction was made between suspended sands versus suspended silts in their characteristic effects. However, the near shore algorithms for sediment resuspension were developed for the fine, cohesive sediments that are characteristic of the near-shore environment in the UMR-IWW System.

- It was assumed that the simulated impacts on threeridge mussel growth and reproduction are characteristic responses for other mussel species with similar phenology, biomass, and distribution in the UMR-IWW System.

Future revisions of the described assessment approaches will address these and other sources of bias and imprecision. Where possible, the impact of the specific sources of uncertainty on the estimated risks to mussel growth and reproduction will be quantified using methods of numerical sensitivity and uncertainty analysis.

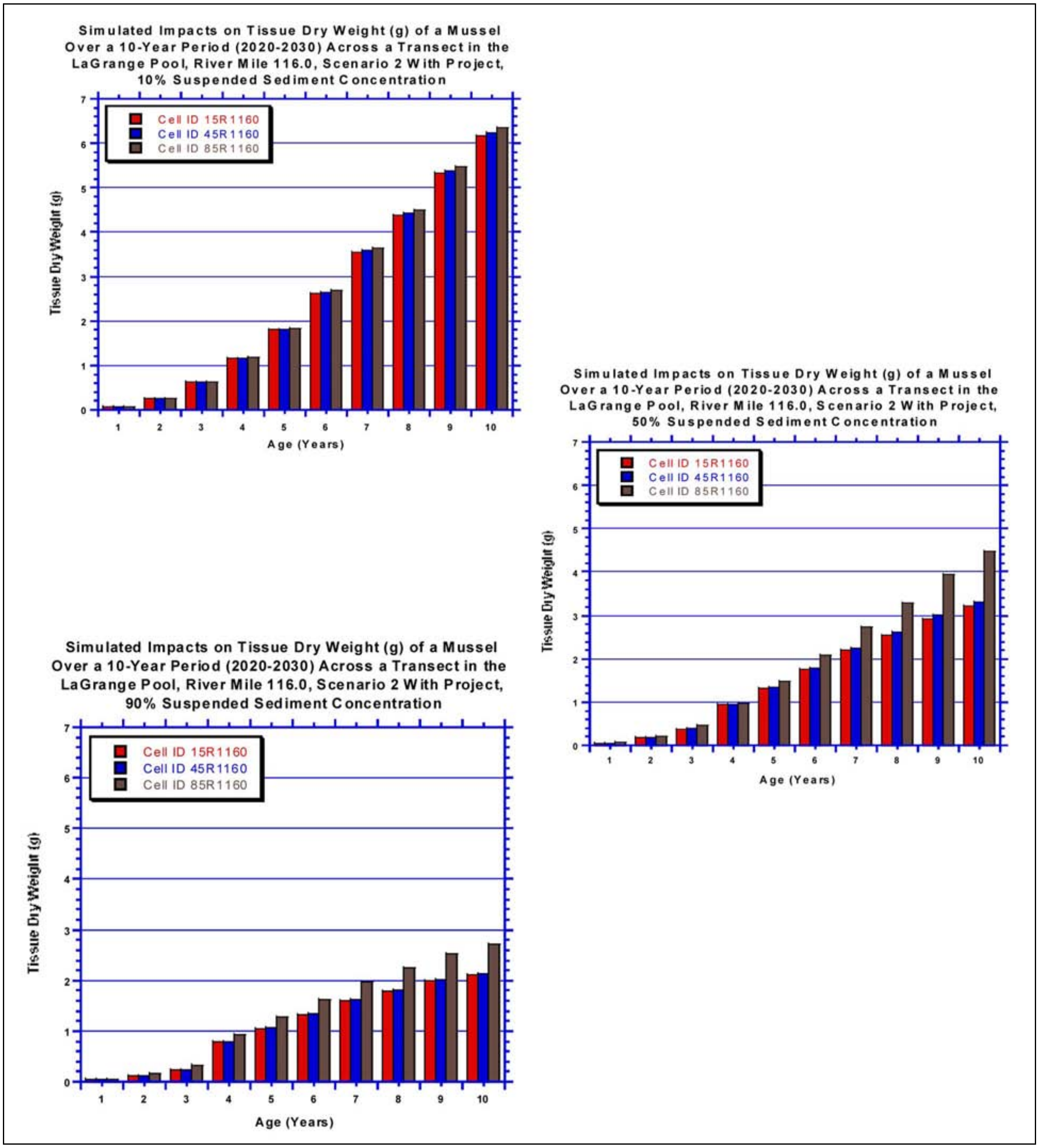

Figure 12. The simulated impacts on tissue dry weight (g) of a mussel over a 10-year period (2020-2030) across a transect in the LaGrange Pool, River Mile 116.0 using the 10th, 50th, and 90th percentile sediment concentrations for Scenario 2, with-project conditions

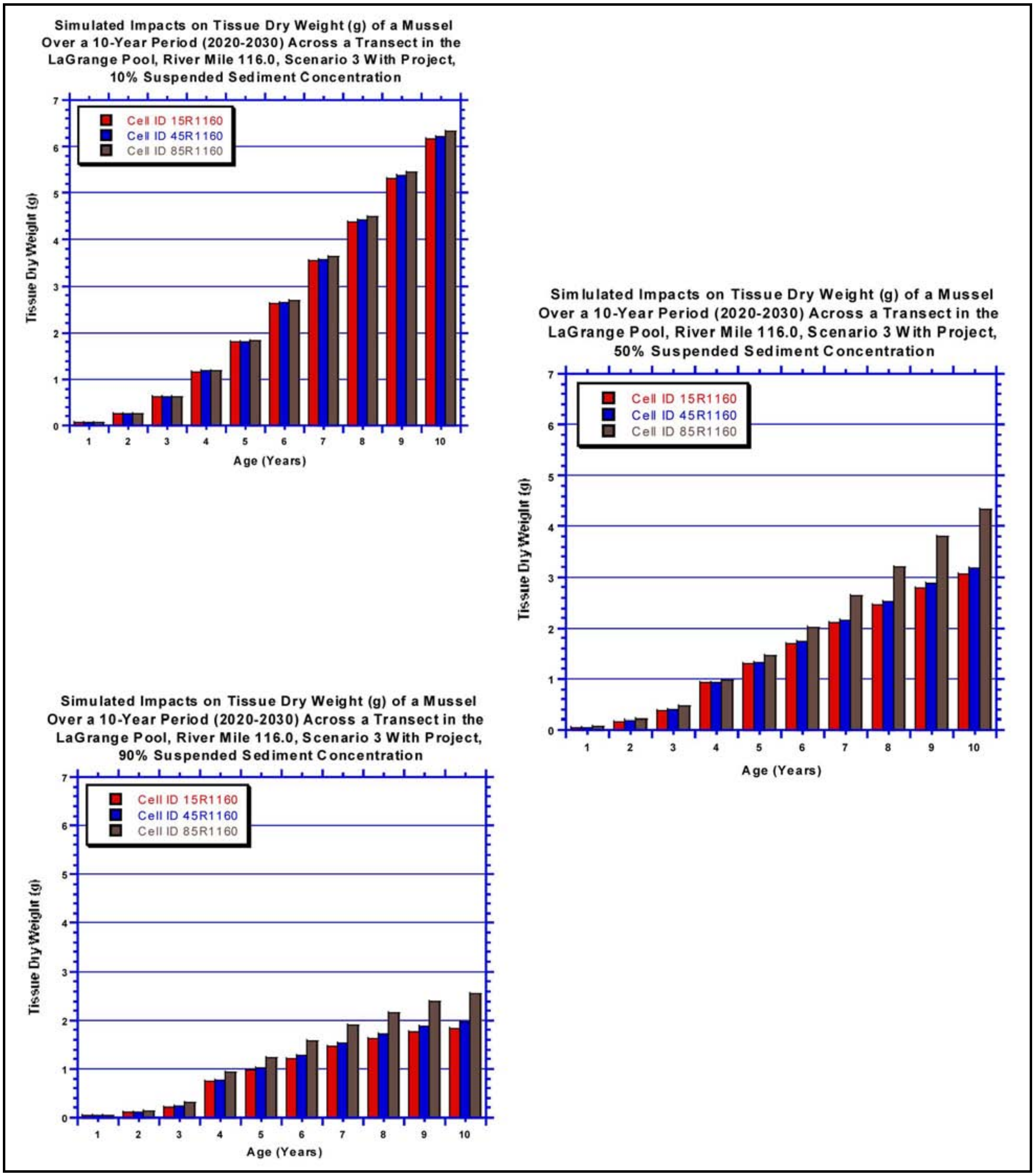

Figure 13. The simulated impacts on tissue dry weight (g) of a mussel over a 10-year period (2020-2030) across a transect in the LaGrange Pool, River Mile 116.0 using the 10th, 50th, and 90th percentile sediment concentrations for Scenario 3, with-project conditions

Probabilistic Risk Assessment

The main purposes of this preliminary assessment of hypothetical traffic scenarios were to (1) examine the efficacy of the overall approach and determine the feasibility of ecological risk assessment using the methods and models described, and (2) to estimate the magnitude of impact of increased traffic on one mussel species for selected locations within Pools 13 and 26 and the LaGrange Pool. The risk assessment described in this report represents a preliminary analysis where risks were characterized as single-value estimates or percentage changes in mussel growth and reproduction. These analyses could be expanded in spatial extent by assessing more cells per pool to identify specific locations or areas within pools that might be at risk.

The next phase in assessing traffic impacts on mussels will be to incorporate the current methodology into a framework that characterizes risk in probabilistic terms. More detailed, probabilistic assessments will be performed for selected locations and traffic scenarios identified by the preliminary analyses. Parameters used in the calculations (e.g., suspended sediment concentrations produced by the NAVSED model, mussel growth and filtering model coefficients) that are imprecisely known will be defined as statistical distributions. Monte Carlo simulation methods will be used to propagate these uncertainties through the model calculations to produce distributions of impacts on growth and reproduction in relation to specific traffic scenarios. These distributions of results can be used to estimate the probability of different magnitudes of impact in a manner consistent with probabilistic risk estimation.

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Appendix A
Traffic Intensity for the UMR-IWW System for the 1992 Baseline, Scenario 2, and Scenario 3

Table A1
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UMUSA	1992	0	0	1.3	4.3	4.7	5.1	5.2	6.2	6.5	5.9	4.1	0
	2000	0	0	1.2	4.2	4.7	5	5.1	6.1	6.4	5.9	4	0
	2010	0	0	1.3	4.3	4.8	5.1	5.3	6.3	6.6	6	4.1	0
	2020	0	0	1.3	4.4	4.9	5.2	5.4	6.4	6.7	6.1	4.2	0
	2030	0	0	1.3	4.5	5	5.4	5.5	6.6	6.9	6.3	4.3	0
	2040	0	0	1.4	4.8	5.3	5.6	5.8	6.9	7.2	6.6	4.5	0
	2050	0	0	1.5	5	5.5	5.9	6.1	7.3	7.6	7	4.8	0
UMLSA	1992	0	0	1.3	4.5	4.7	5.1	5.2	6.1	6.4	6	4.1	0
	2000	0	0	1.3	4.4	4.7	5	5.2	6.1	6.4	5.9	4.1	0
	2010	0	0	1.3	4.5	4.7	5.1	5.2	6.1	6.5	6	4.1	0
	2020	0	0	1.3	4.5	4.7	5.1	5.2	6.1	6.5	6	4.1	0
	2030	0	0	1.3	4.6	4.8	5.2	5.4	6.3	6.6	6.1	4.2	0
	2040	0	0	1.4	4.8	5	5.4	5.6	6.6	6.9	6.4	4.4	0
	2050	0	0	1.5	5	5.3	5.7	5.9	6.9	7.3	6.7	4.6	0
UM01	1992	0	0	1.3	4.5	4.7	5.1	5.3	6.1	6.5	6	4.2	0
	2000	0	0	1.3	4.4	4.6	5	5.2	5.9	6.4	5.9	4.1	0
	1992	0	0	1.3	4.5	4.7	5.1	5.3	6.1	6.5	6	4.2	0
	2020	0	0	1.3	4.6	4.8	5.2	5.3	6.1	6.6	6.1	4.2	0
	2030	0	0	1.4	4.7	4.9	5.4	5.5	6.3	6.8	6.3	4.3	0
	2040	0	0	1.5	5	5.2	5.7	5.8	6.7	7.2	6.6	4.6	0
	2050	0	0	1.5	5.3	5.5	6	6.2	7.1	7.6	7	4.9	0
UM02	1992	0	0	1.9	5	5.7	5.2	5.9	5.7	4.6	4.7	3.2	0
	2000	0	0	1.9	5.1	5.9	5.3	6	5.9	4.7	4.8	3.3	0
	2010	0	0	1.9	5	5.7	5.2	5.9	5.7	4.6	4.7	3.2	0
	2020	0	0	1.8	4.8	5.6	5	5.7	5.5	4.4	4.6	3.1	0
	2030	0	0	1.8	4.7	5.4	4.9	5.5	5.4	4.3	4.4	3	0
	2040	0	0	1.7	4.5	5.2	4.7	5.3	5.2	4.2	4.3	2.9	0
	2050	0	0	1.6	4.3	5	4.5	5.1	5	4	4.1	2.8	0
UM03	1992	0	0	2	4.8	5.7	5.3	5.8	5.7	4.6	4.7	3.1	0
	2000	0	0	2.1	4.9	5.8	5.5	6	5.9	4.7	4.8	3.2	0
	2010	0	0	2	4.8	5.7	5.4	5.8	5.7	4.6	4.7	3.1	0
	2020	0	0	1.9	4.6	5.5	5.2	5.6	5.5	4.5	4.5	3	0
	2030	0	0	1.9	4.5	5.3	5	5.5	5.4	4.3	4.4	2.9	0
	2040	0	0	1.8	4.4	5.1	4.9	5.3	5.2	4.2	4.3	2.8	0
	2050	0	0	1.7	4.2	4.9	4.7	5.1	5	4	4.1	2.7	0
UM04	1992	0	0	1.9	4.7	5.6	5.3	5.8	5.7	4.6	4.7	3.2	0
	2000	0	0	2	4.8	5.8	5.5	6	5.9	4.8	4.8	3.3	0
	2010	0	0	1.9	4.7	5.6	5.4	5.9	5.8	4.7	4.7	3.3	0
	2020	0	0	1.9	4.6	5.5	5.3	5.7	5.6	4.5	4.6	3.2	0
	2030	0	0	1.8	4.5	5.4	5.1	5.6	5.5	4.4	4.5	3.1	0
	2040	0	0	1.8	4.4	5.2	5	5.4	5.3	4.3	4.4	3	0
	2050	0	0	1.7	4.2	5	4.8	5.2	5.1	4.2	4.2	2.9	0
UM05	1992	0	0	1.9	4.6	5.6	5.2	5.6	5.6	4.6	4.6	3.1	0
	2000	0	0	1.9	4.8	5.8	5.4	5.8	5.8	4.8	4.8	3.2	0
	2010	0	0	1.9	4.7	5.6	5.3	5.7	5.7	4.7	4.7	3.2	0

Table A1 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM05	2020	0	0	1.8	4.6	5.5	5.2	5.6	5.6	4.5	4.6	3.1	0
	2030	0	0	1.8	4.5	5.4	5	5.4	5.4	4.4	4.4	3	0
	2040	0	0	1.7	4.3	5.2	4.9	5.3	5.3	4.3	4.3	2.9	0
	2050	0	0	1.7	4.2	5	4.7	5.1	5.1	4.2	4.2	2.8	0
UM05A	1992	0	0	1.9	4.6	5.6	5.4	5.7	5.6	4.5	4.6	3.1	0
	2000	0	0	1.9	4.8	5.7	5.6	5.9	5.8	4.7	4.7	3.2	0
	2010	0	0	1.9	4.7	5.6	5.5	5.8	5.7	4.6	4.6	3.1	0
	2020	0	0	1.8	4.6	5.5	5.3	5.6	5.5	4.4	4.5	3.1	0
	2030	0	0	1.8	4.4	5.4	5.2	5.5	5.4	4.3	4.4	3	0
	2040	0	0	1.7	4.3	5.2	5.1	5.3	5.3	4.2	4.3	2.9	0
	2050	0	0	1.7	4.2	5	4.9	5.2	5.1	4.1	4.1	2.8	0
UM06	1992	0	0	2.2	5.3	6.4	6.4	7	6.4	5.3	5.1	3.8	0
	2000	0	0	2.3	5.5	6.7	6.6	7.2	6.7	5.5	5.4	4	0
	2010	0	0	2.2	5.4	6.5	6.5	7.1	6.6	5.4	5.3	3.9	0
	2020	0	0	2.2	5.3	6.4	6.3	6.9	6.4	5.2	5.1	3.8	0
	2030	0	0	2.1	5.1	6.2	6.2	6.7	6.2	5.1	5	3.7	0
	2040	0	0	2	5	6	6	6.5	6	4.9	4.8	3.6	0
	2050	0	0	2	4.8	5.8	5.7	6.3	5.8	4.7	4.6	3.4	0
UM07	1992	0	0	2.1	5	6.1	6.3	6.3	6.1	5	4.9	3.5	0
	2000	0	0	2.2	5.3	6.3	6.6	6.6	6.3	5.2	5.1	3.6	0
	2010	0	0	2.2	5.2	6.2	6.5	6.5	6.2	5.1	5	3.6	0
	2020	0	0	2.1	5	6	6.3	6.3	6	5	4.9	3.5	0
	2030	0	0	2	4.9	5.9	6.1	6.1	5.9	4.8	4.7	3.4	0
	2040	0	0	2	4.7	5.7	5.9	5.9	5.7	4.7	4.6	3.3	0
	2050	0	0	1.9	4.5	5.5	5.7	5.7	5.5	4.5	4.4	3.1	0
UM08	1992	0	0	2.3	5.6	6.6	6.5	7.2	6.8	5.6	5.4	4.1	0
	2000	0	0	2.4	5.9	6.9	6.8	7.5	7.1	5.8	5.6	4.2	0
	2010	0	0	2.4	5.8	6.8	6.7	7.4	7	5.7	5.5	4.2	0
	2020	0	0	2.3	5.6	6.6	6.5	7.2	6.8	5.6	5.4	4.1	0
	2030	0	0	2.3	5.5	6.4	6.4	7	6.6	5.4	5.2	4	0
	2040	0	0	2.2	5.3	6.2	6.2	6.8	6.4	5.3	5.1	3.8	0
	2050	0	0	2.1	5.1	6	6	6.6	6.2	5.1	4.9	3.7	0
UM09	1992	0	0	2.4	5.6	6.5	6.6	7.2	6.8	5.6	5.5	4.1	0
	2000	0	0	2.5	5.8	6.8	6.8	7.5	7.1	5.8	5.7	4.2	0
	2010	0	0	2.5	5.8	6.7	6.8	7.4	7	5.7	5.6	4.2	0
	2020	0	0	2.4	5.6	6.6	6.6	7.2	6.8	5.6	5.5	4.1	0
	2030	0	0	2.4	5.5	6.4	6.5	7	6.7	5.5	5.4	4	0
	2040	0	0	2.3	5.4	6.3	6.3	6.9	6.5	5.3	5.2	3.9	0
	2050	0	0	2.2	5.2	6.1	6.1	6.7	6.3	5.2	5.1	3.8	0
UM10	1992	0	0	3.4	7.2	7.9	7.8	8.3	7.7	6.4	6.5	5.2	0.2
	2000	0	0	3.6	7.6	8.4	8.2	8.7	8.1	6.8	6.8	5.5	0.2
	2010	0	0	3.6	7.6	8.4	8.2	8.7	8.1	6.8	6.9	5.5	0.2
	2020	0	0	3.6	7.5	8.3	8.1	8.6	8	6.7	6.8	5.4	0.2
	2030	0	0	3.5	7.4	8.2	8	8.5	7.9	6.6	6.7	5.3	0.2
	2040	0	0	3.5	7.3	8	7.9	8.4	7.8	6.6	6.6	5.3	0.2

Table A1 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM10	2050	0	0	3.4	7.2	7.9	7.8	8.3	7.7	6.5	6.5	5.2	0.2
UM11	1992	0	0	3.4	7.4	8.2	8	8.4	8	6.6	6.7	5.3	0.2
	2000	0	0	3.6	7.8	8.7	8.4	8.9	8.5	7	7.1	5.7	0.2
	2010	0	0	3.6	7.8	8.7	8.4	8.9	8.5	7	7.1	5.7	0.2
	2020	0	0	3.6	7.7	8.6	8.3	8.8	8.4	6.9	7	5.6	0.2
	2030	0	0	3.5	7.6	8.5	8.2	8.7	8.3	6.8	6.9	5.5	0.2
	2040	0	0	3.5	7.5	8.4	8.1	8.6	8.2	6.7	6.8	5.4	0.2
	2050	0	0	3.4	7.4	8.3	8	8.4	8.1	6.6	6.7	5.4	0.2
UM12	1992	0	0	5.1	8.5	9.1	8.4	9.4	8.4	7	7	5.9	0.5
	2000	0	0	5.5	9.1	9.8	9.1	10	9	7.6	7.5	6.3	0.5
	2010	0	0	5.5	9.2	9.9	9.2	10.2	9.1	7.6	7.6	6.4	0.5
	2020	0	0	5.5	9.2	9.9	9.1	10.1	9.1	7.6	7.5	6.3	0.5
	2030	0	0	5.5	9.1	9.8	9.1	10.1	9.1	7.6	7.5	6.3	0.5
	2040	0	0	5.5	9.1	9.8	9	10	9	7.5	7.4	6.3	0.5
	2050	0	0	5.4	9	9.7	9	10	9	7.5	7.4	6.2	0.5
UM13	1992	0	0	5.3	8.7	9.2	8.6	9.5	8.6	7.1	7.3	6.2	0.7
	2000	0	0	5.7	9.4	9.9	9.2	10.2	9.2	7.7	7.9	6.7	0.7
	2010	0	0	5.8	9.5	10.1	9.4	10.4	9.3	7.8	8	6.8	0.8
	2020	0	0	5.8	9.5	10	9.3	10.3	9.3	7.7	7.9	6.7	0.8
	2030	0	0	5.8	9.5	10	9.3	10.3	9.3	7.7	7.9	6.7	0.8
	2040	0	0	5.8	9.4	10	9.3	10.2	9.2	7.7	7.9	6.7	0.8
	2050	0	0	5.7	9.4	9.9	9.2	10.2	9.2	7.6	7.8	6.7	0.7
UM14	1992	0	0	7.9	12.3	12.6	11.7	12.7	11.6	10	10	9.3	1.7
	2000	0	0	8.4	13.2	13.5	12.5	13.6	12.5	10.7	10.7	10	1.9
	2010	0	0	8.5	13.4	13.7	12.7	13.8	12.6	10.9	10.9	10.1	1.9
	2020	0	0	8.5	13.4	13.7	12.7	13.8	12.6	10.9	10.9	10.1	1.9
	2030	0	0	8.6	13.5	13.8	12.8	13.9	12.7	11	11	10.2	1.9
	2040	0	0	8.6	13.5	13.8	12.8	13.9	12.8	11	11	10.2	1.9
	2050	0	0	8.7	13.6	13.9	12.9	14	12.8	11.1	11.1	10.3	1.9
UM15	1992	0	0.1	8	10.9	11.1	10.5	11.2	10.4	8.8	9.9	9.4	2.2
	2000	0	0.1	8.5	11.7	11.9	11.2	12	11.1	9.4	10.6	10	2.3
	2010	0	0.1	8.6	11.8	12	11.3	12.1	11.3	9.5	10.7	10.1	2.4
	2020	0	0.1	8.6	11.8	12.1	11.3	12.2	11.3	9.5	10.8	10.2	2.4
	2030	0	0.1	8.7	11.9	12.1	11.4	12.2	11.3	9.5	10.8	10.2	2.4
	2040	0	0.1	8.7	11.9	12.2	11.4	12.3	11.4	9.6	10.8	10.2	2.4
	2050	0	0.1	8.7	12	12.2	11.5	12.3	11.4	9.6	10.9	10.3	2.4
UM16	1992	0	0	8.6	12.1	12.5	11.4	12.6	11.6	10.1	10.4	10.1	2.5
	2000	0	0	9.2	12.9	13.4	12.3	13.5	12.4	10.8	11.1	10.9	2.7
	2010	0	0	9.3	13.1	13.6	12.4	13.7	12.6	10.9	11.3	11	2.7
	2020	0	0	9.4	13.2	13.6	12.5	13.8	12.6	11	11.3	11.1	2.7
	2030	0	0	9.4	13.3	13.7	12.5	13.8	12.7	11	11.4	11.1	2.7
	2040	0	0	9.5	13.3	13.8	12.6	13.9	12.8	11.1	11.5	11.2	2.7
	2050	0	0	9.5	13.4	13.9	12.7	14	12.9	11.2	11.5	11.2	2.8
UM17	1992	0	0	8.6	11.5	12	11.1	12.1	11.2	9.3	9.4	9.2	2.4
	2000	0	0	9.2	12.3	12.8	11.9	12.9	12	10	10.1	9.9	2.6

Table A1 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM17	2010	0	0	9.3	12.5	13	12	13.2	12.2	10.1	10.3	10	2.7
	2020	0	0	9.4	12.6	13.1	12.1	13.2	12.2	10.2	10.3	10.1	2.7
	2030	0	0	9.4	12.7	13.2	12.2	13.3	12.3	10.2	10.4	10.2	2.7
	2040	0	0	9.5	12.8	13.3	12.3	13.4	12.4	10.3	10.5	10.2	2.7
	2050	0	0	9.6	12.9	13.4	12.4	13.5	12.5	10.4	10.5	10.3	2.7
UM18	1992	0	0	8.8	11.6	12.1	11.2	12.3	11.4	9.6	9.5	9.5	2.7
	2000	0	0	9.4	12.5	13	12	13.2	12.2	10.3	10.3	10.2	2.9
	2010	0	0	9.6	12.7	13.2	12.2	13.4	12.4	10.5	10.4	10.4	2.9
	2020	0	0	9.7	12.8	13.3	12.3	13.5	12.5	10.5	10.5	10.4	2.9
	2030	0	0	9.8	12.9	13.4	12.4	13.6	12.6	10.6	10.6	10.5	3
	2040	0	0	9.8	13	13.5	12.5	13.7	12.7	10.7	10.7	10.6	3
	2050	0	0	9.9	13.1	13.6	12.6	13.8	12.8	10.8	10.8	10.7	3
UM19	1992	0	0.4	9	11.9	12.3	11.4	12.5	11.5	9.8	9.7	9.8	3.1
	2000	0	0.4	9.7	12.9	13.2	12.3	13.5	12.4	10.5	10.5	10.5	3.4
	2010	0	0.4	9.9	13.1	13.5	12.6	13.8	12.7	10.8	10.7	10.7	3.4
	2020	0	0.4	10	13.2	13.6	12.7	13.9	12.8	10.9	10.8	10.8	3.5
	2030	0	0.4	10.1	13.4	13.7	12.8	14.1	12.9	11	10.9	10.9	3.5
	2040	0	0.4	10.2	13.5	13.9	13	14.2	13.1	11.1	11	11.1	3.5
	2050	0	0.4	10.3	13.6	14	13.1	14.3	13.2	11.2	11.1	11.2	3.6
UM20	1992	0.2	0.6	9.2	12.4	13.3	12.2	13.3	12.1	10.3	10.4	10.3	3.9
	2000	0.3	0.7	10	13.4	14.4	13.2	14.4	13.1	11.1	11.2	11.2	4.2
	2010	0.3	0.7	10.2	13.7	14.7	13.5	14.7	13.4	11.4	11.5	11.4	4.3
	2020	0.3	0.7	10.3	13.8	14.9	13.6	14.9	13.5	11.5	11.6	11.5	4.3
	2030	0.3	0.7	10.4	14	15	13.7	15	13.7	11.6	11.7	11.7	4.4
	2040	0.3	0.7	10.5	14.1	15.2	13.9	15.2	13.8	11.8	11.9	11.8	4.4
	2050	0.3	0.7	10.6	14.3	15.4	14	15.3	14	11.9	12	11.9	4.5
UM21	1992	1.1	1.5	9.8	12.3	12.5	11.3	12.9	12.2	10.7	10.5	10.5	4.3
	2000	1.2	1.6	10.6	13.3	13.5	12.2	13.9	13.1	11.6	11.3	11.3	4.7
	2010	1.2	1.7	10.8	13.6	13.8	12.5	14.2	13.4	11.8	11.5	11.6	4.8
	2020	1.2	1.6	10.9	13.7	13.9	12.6	14.3	13.5	11.9	11.6	11.7	4.8
	2030	1.2	1.7	11	13.8	14	12.7	14.5	13.7	12	11.7	11.8	4.9
	2040	1.2	1.7	11.1	13.9	14.2	12.8	14.6	13.8	12.1	11.9	11.9	4.9
	2050	1.2	1.7	11.2	14.1	14.3	12.9	14.7	13.9	12.2	12	12	4.9
UM22	1992	1.1	1.6	9.5	12.2	12.3	11.5	12.9	12	10.3	10.1	10.2	4.5
	2000	1.2	1.7	10.3	13.2	13.3	12.4	14	13	11.1	10.9	11	4.8
	2010	1.3	1.7	10.5	13.5	13.6	12.7	14.3	13.3	11.3	11.2	11.2	5
	2020	1.3	1.7	10.6	13.6	13.7	12.8	14.4	13.4	11.4	11.2	11.3	5
	2030	1.3	1.8	10.7	13.7	13.9	12.9	14.5	13.5	11.5	11.4	11.4	5
	2040	1.3	1.7	10.8	13.9	14	13	14.7	13.7	11.7	11.5	11.5	5.1
	2050	1.3	1.8	10.9	14	14.1	13.2	14.8	13.8	11.8	11.6	11.7	5.1
UM24	1992	1.3	2.1	9.8	12.8	12.8	11.9	13.5	12.4	10.7	10.4	10.6	4.9
	2000	1.4	2.2	10.6	13.8	13.8	12.9	14.6	13.4	11.6	11.3	11.4	5.2
	2010	1.5	2.4	10.8	14.1	14.1	13.2	14.9	13.7	11.9	11.5	11.7	5.4
	2020	1.5	2.3	10.9	14.3	14.2	13.3	15.1	13.8	12	11.7	11.8	5.4
	2030	1.5	2.4	11.1	14.4	14.4	13.5	15.2	14	12.1	11.8	11.9	5.5

Table A1 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM24	2040	1.5	2.4	11.2	14.6	14.6	13.6	15.4	14.1	12.2	11.9	12	5.5
	2050	1.5	2.5	11.3	14.7	14.7	13.8	15.5	14.3	12.4	12	12.2	5.6
UM25	1992	1.4	2.2	9.9	12.7	12.7	11.9	13.4	12.4	10.7	10.5	10.5	4.8
	2000	1.5	2.3	10.7	13.7	13.7	12.9	14.5	13.4	11.6	11.3	11.3	5.2
	2010	1.5	2.5	10.9	14	14	13.2	14.9	13.7	11.9	11.6	11.6	5.4
	2020	1.5	2.4	11	14.2	14.2	13.3	15	13.8	12	11.7	11.7	5.4
	2030	1.5	2.5	11.2	14.3	14.3	13.5	15.2	13.9	12.1	11.8	11.8	5.5
	2040	1.6	2.5	11.3	14.5	14.5	13.6	15.3	14.1	12.2	12	12	5.5
	2050	1.6	2.6	11.4	14.6	14.6	13.7	15.5	14.2	12.4	12.1	12.1	5.6
UM26A	1992	1.4	2.2	9.9	12.7	12.7	11.9	13.4	12.4	10.7	10.5	10.5	4.8
	2000	1.5	2.3	10.7	13.7	13.7	12.9	14.5	13.4	11.6	11.3	11.3	5.2
	2010	1.5	2.5	10.9	14	14	13.2	14.9	13.7	11.9	11.6	11.6	5.4
	2020	1.5	2.4	11	14.2	14.2	13.3	15	13.8	12	11.7	11.7	5.4
	2030	1.5	2.5	11.2	14.3	14.3	13.5	15.2	13.9	12.1	11.8	11.8	5.5
	2040	1.6	2.5	11.3	14.5	14.5	13.6	15.3	14.1	12.2	12	12	5.5
	2050	1.6	2.6	11.4	14.6	14.6	13.7	15.5	14.2	12.4	12.1	12.1	5.6
UM26B	1992	13.1	14.9	21.7	23.2	22.7	22	23.7	21.7	21.1	22	20.9	18.1
	2000	15	16.4	24.7	26.5	25.9	25.2	27	24.8	24.1	25.1	23.8	20.6
	2010	16.2	18.4	26.8	28.6	28	27.2	29.2	26.8	26	27.2	25.8	22.3
	2020	17.1	18.6	28.1	30.1	29.4	28.6	30.7	28.2	27.3	28.6	27.1	23.4
	2030	17.8	20.2	29.4	31.4	30.8	29.9	32.1	29.5	28.6	29.8	28.3	24.5
	2040	18.4	20.2	30.4	32.5	31.8	30.9	33.2	30.5	29.6	30.9	29.3	25.3
	2050	18.9	21.4	31.2	33.3	32.6	31.7	34	31.3	30.3	31.7	30	26
UM27	1992	18.2	20.6	25.6	28.5	28.4	26.3	28.1	25.8	25	26.5	24.5	22.4
	2000	20.8	22.7	29.3	32.6	32.4	30.1	32.1	29.4	28.5	30.2	28	25.6
	2010	22.5	25.5	31.7	35.3	35.1	32.6	34.8	31.8	30.9	32.7	30.3	27.7
	2020	23.7	25.9	33.4	37.1	37	34.3	36.6	33.5	32.5	34.4	31.9	29.2
	2030	24.8	28.1	34.9	38.9	38.7	35.9	38.4	35.1	34	36.1	33.5	30.6
	2040	25.8	28.2	36.3	40.4	40.2	37.3	39.8	36.4	35.3	37.4	34.7	31.7
	2050	26.5	30	37.3	41.5	41.4	38.4	41	37.5	36.4	38.5	35.7	32.7
ILLA	1992	9.8	10.7	9.2	8.9	8.2	7.7	8.4	8	8.4	9.2	9.1	12
	2000	11.6	12.3	10.9	10.6	9.8	9.2	10	9.5	9.9	10.9	10.8	14.2
	2010	13.1	14.3	12.3	11.9	11.1	10.4	11.3	10.7	11.2	12.3	12.2	16.1
	2020	14.2	15	13.3	12.9	12	11.2	12.2	11.6	12.1	13.3	13.2	17.4
	2030	15.1	16.5	14.2	13.7	12.7	12	13	12.3	12.9	14.1	14.1	18.5
	2040	15.8	16.6	14.8	14.3	13.3	12.5	13.5	12.8	13.5	14.7	14.7	19.3
	2050	16.1	17.6	15.1	14.6	13.6	12.8	13.9	13.1	13.8	15.1	15	19.8
ILPE	1992	10.2	11.8	10	9.7	9.5	8.9	9	9	9.3	9.6	9.9	13.2
	2000	11.8	13.2	11.5	11.2	10.9	10.3	10.4	10.4	10.7	11.1	11.4	15.3
	2010	13.2	15.3	12.9	12.5	12.2	11.5	11.7	11.7	12	12.4	12.8	17.1
	2020	14.2	15.9	13.9	13.5	13.1	12.3	12.5	12.5	12.9	13.4	13.7	18.4
	2030	15.1	17.4	14.7	14.3	13.9	13.1	13.3	13.3	13.7	14.2	14.6	19.5
	2040	15.6	17.4	15.2	14.8	14.4	13.5	13.8	13.8	14.2	14.7	15.1	20.2
	2050	15.9	18.4	15.5	15	14.7	13.8	14	14	14.4	14.9	15.4	20.5
ILSR	1992	7.3	7.9	7.9	8.2	8.1	7.6	8.2	7.5	7.6	7.8	7.9	10.1

Table A1 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
LSR	2000	8	8.4	8.6	9	8.9	8.3	9	8.2	8.4	8.6	8.7	11.1
	2010	8.8	9.6	9.5	9.9	9.8	9.2	9.9	9	9.2	9.4	9.5	12.2
	2020	9.3	9.9	10.1	10.5	10.4	9.8	10.5	9.6	9.8	10.1	10.2	13
	2030	9.9	10.8	10.7	11.2	11	10.3	11.1	10.2	10.4	10.7	10.8	13.7
	2040	10.3	10.8	11.1	11.6	11.4	10.7	11.5	10.5	10.8	11.1	11.2	14.3
	2050	10.5	11.5	11.4	11.9	11.7	11	11.8	10.8	11.1	11.3	11.5	14.6
LMA	1992	6.8	7	7.5	7.7	7.7	7.5	7.9	7.4	7.5	7.5	7.5	9.1
	2000	7.3	7.2	8.1	8.3	8.3	8	8.5	7.9	8.1	8.1	8.1	9.8
	2010	7.9	8.1	8.8	9	9	8.8	9.2	8.6	8.8	8.8	8.8	10.7
	2020	8.4	8.4	9.3	9.6	9.6	9.3	9.8	9.2	9.3	9.3	9.3	11.4
	2030	8.9	9.1	9.8	10.1	10.1	9.8	10.3	9.7	9.9	9.8	9.8	12
	2040	9.2	9.1	10.2	10.5	10.5	10.2	10.7	10	10.2	10.2	10.2	12.4
	2050	9.4	9.7	10.4	10.7	10.7	10.4	10.9	10.3	10.4	10.4	10.4	12.7
LDI	1992	5.9	6.2	7	7.7	8.1	8	8.3	7.6	8.1	8	7.4	7.7
	2000	6.2	6.3	7.4	8.1	8.5	8.3	8.7	7.9	8.5	8.3	7.8	8.1
	2010	6.7	7.1	8	8.7	9.2	9	9.5	8.6	9.2	9	8.4	8.8
	2020	7.1	7.2	8.5	9.2	9.7	9.6	10	9.1	9.7	9.6	8.9	9.3
	2030	7.5	7.9	8.9	9.7	10.2	10.1	10.6	9.6	10.2	10.1	9.4	9.8
	2040	7.8	7.9	9.3	10.1	10.6	10.5	11	10	10.6	10.5	9.8	10.2
	2050	8	8.4	9.6	10.4	11	10.8	11.3	10.3	11	10.8	10	10.5
LBR	1992	6.8	7.3	7.9	8.8	9.6	9.2	9.6	8.9	9	8.8	8.3	8.7
	2000	7.1	7.4	8.3	9.3	10.1	9.7	10.1	9.4	9.5	9.3	8.7	9.1
	2010	7.7	8.3	9	10	10.9	10.5	11	10.2	10.3	10	9.4	9.9
	2020	8.2	8.5	9.6	10.7	11.6	11.1	11.6	10.8	10.9	10.6	10	10.5
	2030	8.7	9.3	10.1	11.3	12.3	11.8	12.3	11.4	11.6	11.3	10.6	11.1
	2040	9.1	9.4	10.6	11.8	12.8	12.3	12.9	12	12.1	11.8	11	11.6
	2050	9.4	10.1	11	12.2	13.3	12.8	13.4	12.4	12.5	12.2	11.5	12
LLO	1992	6.8	7.2	7.9	8.8	9.6	9.1	9.4	8.9	8.9	8.7	8.3	8.7
	2000	7.2	7.3	8.4	9.2	10.1	9.6	9.9	9.4	9.4	9.2	8.7	9.1
	2010	7.7	8.1	9	10	11	10.4	10.7	10.2	10.1	9.9	9.4	9.9
	2020	8.2	8.3	9.6	10.6	11.6	11	11.4	10.8	10.8	10.5	10	10.5
	2030	8.7	9.1	10.1	11.2	12.3	11.7	12	11.4	11.4	11.1	10.6	11.1
	2040	9.1	9.2	10.6	11.7	12.9	12.2	12.6	11.9	11.9	11.6	11.1	11.6
	2050	9.4	9.9	11	12.1	13.3	12.6	13	12.4	12.3	12.1	11.5	12
LTOB	1992	6.4	6.8	7	8.1	8	8	7.6	8.2	8.4	7.8	7.4	7.7
	2000	7	7.1	7.7	8.9	8.8	8.7	8.3	8.9	9.2	8.6	8.1	8.3
	2010	7.6	8	8.4	9.6	9.5	9.5	9	9.7	10	9.3	8.8	9.1
	2020	8.1	8.3	9	10.3	10.2	10.2	9.7	10.4	10.7	10	9.4	9.7
	2030	8.6	9.1	9.5	10.9	10.8	10.8	10.2	11	11.3	10.6	10	10.3
	2040	9	9.1	9.9	11.4	11.3	11.2	10.7	11.5	11.8	11	10.4	10.7
	2050	9.3	9.8	10.2	11.8	11.6	11.6	11	11.8	12.2	11.3	10.7	11.1

Table A2 Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, With-Project Conditions													
Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UMUSA	1992	0	0	1.3	4.3	4.7	5.1	5.2	6.2	6.5	5.9	4.1	0
	2000	0	0	1.2	4.2	4.7	5	5.1	6.1	6.4	5.9	4	0
	2010	0	0	1.3	4.5	5	5.4	5.5	6.6	6.9	6.3	4.3	0
	2020	0	0	1.4	4.6	5.1	5.5	5.6	6.7	7	6.4	4.4	0
	2030	0	0	1.4	4.8	5.3	5.6	5.8	6.9	7.2	6.6	4.5	0
	2040	0	0	1.5	5	5.5	5.9	6.1	7.2	7.6	6.9	4.7	0
	2050	0	0	1.5	5.3	5.8	6.2	6.4	7.6	8	7.3	5	0
UMLSA	1992	0	0	1.3	4.5	4.7	5.1	5.2	6.1	6.4	6	4.1	0
	2000	0	0	1.3	4.4	4.7	5	5.2	6.1	6.4	5.9	4.1	0
	2010	0	0	1.4	4.8	5	5.4	5.5	6.5	6.9	6.3	4.4	0
	2020	0	0	1.4	4.8	5	5.4	5.6	6.5	6.9	6.4	4.4	0
	2030	0	0	1.4	4.9	5.1	5.5	5.7	6.6	7	6.5	4.5	0
	2040	0	0	1.5	5	5.3	5.7	5.9	6.9	7.3	6.7	4.6	0
	2050	0	0	1.5	5.3	5.5	6	6.2	7.2	7.6	7	4.9	0
UM01	1992	0	0	1.3	4.5	4.7	5.1	5.3	6.1	6.5	6	4.2	0
	2000	0	0	1.3	4.4	4.6	5	5.2	5.9	6.4	5.9	4.1	0
	2010	0	0	1.4	4.7	4.9	5.4	5.5	6.4	6.8	6.3	4.4	0
	2020	0	0	1.4	4.8	5	5.5	5.6	6.5	6.9	6.4	4.4	0
	2030	0	0	1.4	4.9	5.1	5.6	5.8	6.6	7.1	6.5	4.5	0
	2040	0	0	1.5	5.2	5.4	5.9	6	6.9	7.4	6.9	4.8	0
	2050	0	0	1.6	5.5	5.7	6.2	6.4	7.4	7.9	7.3	5	0
UM02	1992	0	0	1.9	5	5.7	5.2	5.9	5.7	4.6	4.7	3.2	0
	2000	0	0	1.9	5.1	5.9	5.3	6	5.9	4.7	4.8	3.3	0
	2010	0	0	2.1	5.5	6.3	5.7	6.5	6.3	5	5.2	3.5	0
	2020	0	0	2	5.4	6.2	5.6	6.3	6.1	4.9	5.1	3.4	0
	2030	0	0	2	5.2	6	5.4	6.1	6	4.8	4.9	3.3	0
	2040	0	0	1.9	5	5.8	5.2	5.9	5.8	4.6	4.8	3.2	0
	2050	0	0	1.8	4.9	5.6	5.1	5.8	5.6	4.5	4.6	3.1	0
UM03	1992	0	0	2	4.8	5.7	5.3	5.8	5.7	4.6	4.7	3.1	0
	2000	0	0	2.1	4.9	5.8	5.5	6	5.9	4.7	4.8	3.2	0
	2010	0	0	2.2	5.3	6.2	5.9	6.4	6.3	5.1	5.2	3.4	0
	2020	0	0	2.2	5.2	6.1	5.7	6.3	6.1	5	5	3.3	0
	2030	0	0	2.1	5	5.9	5.6	6.1	6	4.8	4.9	3.2	0
	2040	0	0	2	4.8	5.7	5.4	5.9	5.8	4.7	4.8	3.1	0
	2050	0	0	2	4.7	5.5	5.2	5.7	5.6	4.5	4.6	3	0
UM04	1992	0	0	1.9	4.7	5.6	5.3	5.8	5.7	4.6	4.7	3.2	0
	2000	0	0	2	4.8	5.8	5.5	6	5.9	4.8	4.8	3.3	0
	2010	0	0	2.1	5.2	6.2	5.9	6.4	6.3	5.1	5.2	3.6	0
	2020	0	0	2.1	5.1	6.1	5.8	6.3	6.2	5	5.1	3.5	0
	2030	0	0	2	5	5.9	5.7	6.2	6	4.9	5	3.4	0
	2040	0	0	2	4.9	5.8	5.5	6	5.9	4.8	4.8	3.3	0
	2050	0	0	1.9	4.7	5.6	5.4	5.8	5.7	4.6	4.7	3.2	0
UM05	1992	0	0	1.9	4.6	5.6	5.2	5.6	5.6	4.6	4.6	3.1	0
	2000	0	0	1.9	4.8	5.8	5.4	5.8	5.8	4.8	4.8	3.2	0
	2010	0	0	2.1	5.2	6.2	5.8	6.3	6.3	5.1	5.1	3.5	0

Table A2 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM05	2020	0	0	2	5.1	6.1	5.7	6.2	6.2	5	5	3.4	0
	2030	0	0	2	4.9	5.9	5.6	6	6	4.9	4.9	3.3	0
	2040	0	0	1.9	4.8	5.8	5.4	5.9	5.9	4.8	4.8	3.2	0
	2050	0	0	1.9	4.7	5.6	5.3	5.7	5.7	4.7	4.7	3.1	0
UM05A	1992	0	0	1.9	4.6	5.6	5.4	5.7	5.6	4.5	4.6	3.1	0
	2000	0	0	1.9	4.8	5.7	5.6	5.9	5.8	4.7	4.7	3.2	0
	2010	0	0	2.1	5.1	6.2	6	6.3	6.2	5	5.1	3.4	0
	2020	0	0	2	5	6.1	5.9	6.2	6.1	4.9	5	3.4	0
	2030	0	0	2	4.9	5.9	5.8	6.1	6	4.8	4.9	3.3	0
	2040	0	0	1.9	4.8	5.8	5.6	5.9	5.8	4.7	4.7	3.2	0
	2050	0	0	1.9	4.7	5.6	5.5	5.8	5.7	4.6	4.6	3.1	0
UM06	1992	0	0	2.2	5.3	6.4	6.4	7	6.4	5.3	5.1	3.8	0
	2000	0	0	2.3	5.5	6.7	6.6	7.2	6.7	5.5	5.4	4	0
	2010	0	0	2.5	6	7.2	7.2	7.8	7.2	5.9	5.8	4.3	0
	2020	0	0	2.4	5.8	7.1	7	7.7	7.1	5.8	5.7	4.2	0
	2030	0	0	2.3	5.7	6.9	6.9	7.5	6.9	5.7	5.5	4.1	0
	2040	0	0	2.3	5.5	6.7	6.7	7.3	6.7	5.5	5.4	4	0
	2050	0	0	2.2	5.4	6.5	6.4	7	6.5	5.3	5.2	3.8	0
UM07	1992	0	0	2.1	5	6.1	6.3	6.3	6.1	5	4.9	3.5	0
	2000	0	0	2.2	5.3	6.3	6.6	6.6	6.3	5.2	5.1	3.6	0
	2010	0	0	2.4	5.7	6.8	7.1	7.1	6.8	5.6	5.5	3.9	0
	2020	0	0	2.3	5.6	6.7	7	7	6.7	5.5	5.4	3.8	0
	2030	0	0	2.3	5.4	6.5	6.8	6.8	6.5	5.4	5.2	3.7	0
	2040	0	0	2.2	5.3	6.4	6.6	6.6	6.3	5.2	5.1	3.6	0
	2050	0	0	2.1	5.1	6.2	6.4	6.4	6.1	5	4.9	3.5	0
UM08	1992	0	0	2.3	5.6	6.6	6.5	7.2	6.8	5.6	5.4	4.1	0
	2000	0	0	2.4	5.9	6.9	6.8	7.5	7.1	5.8	5.6	4.2	0
	2010	0	0	2.6	6.3	7.4	7.4	8.1	7.7	6.3	6.1	4.6	0
	2020	0	0	2.6	6.2	7.3	7.2	8	7.5	6.2	6	4.5	0
	2030	0	0	2.5	6.1	7.1	7.1	7.8	7.3	6	5.8	4.4	0
	2040	0	0	2.4	5.9	6.9	6.9	7.6	7.2	5.9	5.7	4.3	0
	2050	0	0	2.4	5.7	6.7	6.7	7.4	6.9	5.7	5.5	4.1	0
UM09	1992	0	0	2.4	5.6	6.5	6.6	7.2	6.8	5.6	5.5	4.1	0
	2000	0	0	2.5	5.8	6.8	6.8	7.5	7.1	5.8	5.7	4.2	0
	2010	0	0	2.7	6.3	7.3	7.4	8	7.6	6.3	6.1	4.5	0
	2020	0	0	2.7	6.2	7.2	7.3	7.9	7.5	6.2	6	4.5	0
	2030	0	0	2.6	6.1	7.1	7.1	7.8	7.4	6	5.9	4.4	0
	2040	0	0	2.5	5.9	6.9	7	7.6	7.2	5.9	5.8	4.3	0
	2050	0	0	2.5	5.8	6.8	6.8	7.4	7	5.8	5.7	4.2	0
UM10	1992	0	0	3.4	7.2	7.9	7.8	8.3	7.7	6.4	6.5	5.2	0.2
	2000	0	0	3.6	7.6	8.4	8.2	8.7	8.1	6.8	6.8	5.5	0.2
	2010	0	0	3.9	8.2	9.1	8.9	9.5	8.8	7.4	7.4	6	0.2
	2020	0	0	3.9	8.2	9	8.9	9.4	8.8	7.4	7.4	5.9	0.2
	2030	0	0	3.9	8.1	8.9	8.8	9.3	8.7	7.3	7.3	5.8	0.2
	2040	0	0	3.8	8	8.8	8.7	9.2	8.6	7.2	7.2	5.8	0.2

Table A2 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM10	2050	0	0	3.8	7.9	8.7	8.6	9.1	8.5	7.1	7.1	5.7	0.2
	1992	0	0	3.4	7.4	8.2	8	8.4	8	6.6	6.7	5.3	0.2
UM11	2000	0	0	3.6	7.8	8.7	8.4	8.9	8.5	7	7.1	5.7	0.2
	2010	0	0	3.9	8.5	9.5	9.2	9.6	9.2	7.5	7.7	6.1	0.2
	2020	0	0	3.9	8.4	9.4	9.1	9.6	9.2	7.5	7.6	6.1	0.2
	2030	0	0	3.9	8.3	9.3	9	9.5	9.1	7.4	7.6	6	0.2
	2040	0	0	3.8	8.3	9.2	8.9	9.4	9	7.3	7.5	6	0.2
	2050	0	0	3.8	8.2	9.1	8.8	9.3	8.9	7.3	7.4	5.9	0.2
UM12	1992	0	0	5.1	8.5	9.1	8.4	9.4	8.4	7	7	5.9	0.5
	2000	0	0	5.5	9.1	9.8	9.1	10	9	7.6	7.5	6.3	0.5
	2010	0	0	6	10	10.7	9.9	11	9.9	8.3	8.2	6.9	0.6
	2020	0	0	6	10	10.7	9.9	11	9.9	8.3	8.2	6.9	0.6
	2030	0	0	6	10	10.7	9.9	11	9.9	8.3	8.2	6.9	0.6
	2040	0	0	6	9.9	10.7	9.9	11	9.8	8.2	8.1	6.9	0.6
	2050	0	0	5.9	9.9	10.6	9.8	10.9	9.8	8.2	8.1	6.8	0.6
UM13	1992	0	0	5.3	8.7	9.2	8.6	9.5	8.6	7.1	7.3	6.2	0.7
	2000	0	0	5.7	9.4	9.9	9.2	10.2	9.2	7.7	7.9	6.7	0.7
	2010	0	0	6.3	10.3	10.9	10.1	11.2	10.1	8.4	8.6	7.3	0.8
	2020	0	0	6.3	10.3	10.9	10.2	11.2	10.1	8.4	8.6	7.3	0.8
	2030	0	0	6.3	10.3	10.9	10.1	11.2	10.1	8.4	8.6	7.3	0.8
	2040	0	0	6.3	10.3	10.9	10.1	11.2	10.1	8.4	8.6	7.3	0.8
	2050	0	0	6.3	10.3	10.9	10.1	11.2	10.1	8.4	8.6	7.3	0.8
UM14	1992	0	0	7.9	12.3	12.6	11.7	12.7	11.6	10	10	9.3	1.7
	2000	0	0	8.4	13.2	13.5	12.5	13.6	12.5	10.7	10.7	10	1.9
	2010	0	0	9.2	14.4	14.7	13.6	14.8	13.5	11.7	11.7	10.9	2
	2020	0	0	9.2	14.5	14.8	13.7	14.9	13.7	11.8	11.8	11	2
	2030	0	0	9.3	14.6	14.9	13.8	15	13.8	11.9	11.9	11	2.1
	2040	0	0	9.3	14.7	15	13.9	15.1	13.8	11.9	11.9	11.1	2.1
	2050	0	0	9.4	14.7	15.1	14	15.2	13.9	12	12	11.2	2.1
UM15	1992	0	0.1	8	10.9	11.1	10.5	11.2	10.4	8.8	9.9	9.4	2.2
	2000	0	0.1	8.5	11.7	11.9	11.2	12	11.1	9.4	10.6	10	2.3
	2010	0	0.2	9.3	12.7	12.9	12.2	13.1	12.1	10.2	11.5	10.9	2.5
	2020	0	0.1	9.3	12.8	13.1	12.3	13.2	12.2	10.3	11.6	11	2.6
	2030	0	0.2	9.4	12.9	13.1	12.4	13.3	12.3	10.3	11.7	11.1	2.6
	2040	0	0.2	9.5	12.9	13.2	12.4	13.3	12.3	10.4	11.8	11.1	2.6
	2050	0	0.2	9.5	13	13.3	12.5	13.4	12.4	10.4	11.8	11.2	2.6
UM16	1992	0	0	8.6	12.1	12.5	11.4	12.6	11.6	10.1	10.4	10.1	2.5
	2000	0	0	9.2	12.9	13.4	12.3	13.5	12.4	10.8	11.1	10.9	2.7
	2010	0	0	10	14.1	14.6	13.4	14.7	13.5	11.8	12.1	11.9	2.9
	2020	0	0	10.1	14.2	14.8	13.5	14.9	13.7	11.9	12.3	12	2.9
	2030	0	0	10.2	14.4	14.9	13.6	15	13.8	12	12.4	12.1	3
	2040	0	0	10.3	14.5	15	13.7	15.1	13.9	12	12.4	12.1	3
	2050	0	0	10.3	14.5	15.1	13.8	15.2	14	12.1	12.5	12.2	3
UM17	1992	0	0	8.6	11.5	12	11.1	12.1	11.2	9.3	9.4	9.2	2.4
	2000	0	0	9.2	12.3	12.8	11.9	12.9	12	10	10.1	9.9	2.6

Table A2 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM17	2010	0	0	10	13.5	14	12.9	14.1	13.1	10.9	11	10.8	2.9
	2020	0	0	10.1	13.6	14.1	13.1	14.3	13.2	11	11.2	10.9	2.9
	2030	0	0	10.2	13.7	14.3	13.2	14.4	13.3	11.1	11.3	11	2.9
	2040	0	0	10.3	13.8	14.4	13.3	14.5	13.5	11.2	11.4	11.1	2.9
	2050	0	0	10.4	13.9	14.5	13.4	14.6	13.5	11.3	11.4	11.2	3
UM18	1992	0	0	8.8	11.6	12.1	11.2	12.3	11.4	9.6	9.5	9.5	2.7
	2000	0	0	9.4	12.5	13	12	13.2	12.2	10.3	10.3	10.2	2.9
	2010	0	0	10.3	13.6	14.2	13.1	14.4	13.3	11.2	11.2	11.1	3.1
	2020	0	0	10.5	13.8	14.3	13.3	14.6	13.5	11.4	11.3	11.3	3.2
	2030	0	0	10.6	13.9	14.5	13.4	14.7	13.6	11.5	11.5	11.4	3.2
	2040	0	0	10.7	14.1	14.6	13.5	14.9	13.8	11.6	11.6	11.5	3.2
	2050	0	0	10.8	14.2	14.8	13.7	15	13.9	11.7	11.7	11.6	3.3
UM19	1992	0	0.4	9	11.9	12.3	11.4	12.5	11.5	9.8	9.7	9.8	3.1
	2000	0	0.4	9.7	12.9	13.2	12.3	13.5	12.4	10.5	10.5	10.5	3.4
	2010	0	0.4	10.6	14.1	14.5	13.6	14.9	13.7	11.6	11.5	11.6	3.7
	2020	0	0.4	10.8	14.4	14.7	13.8	15.1	13.9	11.8	11.7	11.7	3.8
	2030	0	0.4	10.9	14.5	14.9	14	15.3	14.1	11.9	11.9	11.9	3.8
	2040	0	0.4	11.1	14.7	15.1	14.1	15.5	14.2	12.1	12	12	3.9
	2050	0	0.5	11.2	14.9	15.3	14.3	15.6	14.4	12.2	12.1	12.2	3.9
UM20	1992	0.2	0.6	9.2	12.4	13.3	12.2	13.3	12.1	10.3	10.4	10.3	3.9
	2000	0.3	0.7	10	13.4	14.4	13.2	14.4	13.1	11.1	11.2	11.2	4.2
	2010	0.3	0.7	11	14.8	15.9	14.5	15.8	14.4	12.3	12.4	12.3	4.6
	2020	0.3	0.7	11.2	15	16.1	14.7	16.1	14.7	12.5	12.6	12.5	4.7
	2030	0.3	0.8	11.3	15.2	16.3	14.9	16.3	14.9	12.6	12.8	12.7	4.8
	2040	0.3	0.8	11.5	15.4	16.5	15.1	16.5	15.1	12.8	12.9	12.8	4.8
	2050	0.3	0.8	11.6	15.6	16.7	15.3	16.7	15.2	13	13.1	13	4.9
UM21	1992	1.1	1.5	9.8	12.3	12.5	11.3	12.9	12.2	10.7	10.5	10.5	4.3
	2000	1.2	1.6	10.6	13.3	13.5	12.2	13.9	13.1	11.6	11.3	11.3	4.7
	2010	1.3	1.8	11.6	14.7	14.9	13.5	15.4	14.5	12.8	12.5	12.5	5.2
	2020	1.3	1.8	11.8	14.9	15.1	13.7	15.6	14.7	13	12.7	12.7	5.2
	2030	1.3	1.9	12	15.1	15.3	13.9	15.8	14.9	13.1	12.8	12.9	5.3
	2040	1.3	1.8	12.1	15.3	15.5	14	16	15.1	13.3	13	13	5.4
	2050	1.3	1.9	12.3	15.4	15.7	14.2	16.2	15.2	13.4	13.1	13.1	5.4
UM22	1992	1.1	1.6	9.5	12.2	12.3	11.5	12.9	12	10.3	10.1	10.2	4.5
	2000	1.2	1.7	10.3	13.2	13.3	12.4	14	13	11.1	10.9	11	4.8
	2010	1.4	1.9	11.4	14.6	14.7	13.7	15.4	14.4	12.2	12	12.1	5.3
	2020	1.4	1.9	11.6	14.8	15	13.9	15.7	14.6	12.5	12.2	12.3	5.4
	2030	1.4	1.9	11.7	15	15.2	14.1	15.9	14.8	12.6	12.4	12.5	5.5
	2040	1.4	1.9	11.9	15.2	15.4	14.3	16.1	15	12.8	12.6	12.7	5.6
	2050	1.4	2	12	15.4	15.5	14.5	16.3	15.1	12.9	12.7	12.8	5.6
UM24	1992	1.3	2.1	9.8	12.8	12.8	11.9	13.5	12.4	10.7	10.4	10.6	4.9
	2000	1.4	2.2	10.6	13.8	13.8	12.9	14.6	13.4	11.6	11.3	11.4	5.2
	2010	1.6	2.5	11.7	15.2	15.2	14.3	16.1	14.8	12.8	12.5	12.6	5.8
	2020	1.6	2.5	11.9	15.5	15.5	14.5	16.4	15.1	13	12.7	12.8	5.9
	2030	1.6	2.6	12.1	15.7	15.7	14.7	16.6	15.3	13.2	12.9	13	6

Table A2 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM24	2040	1.7	2.6	12.2	15.9	15.9	14.9	16.8	15.5	13.4	13	13.2	6.1
	2050	1.7	2.7	12.4	16.1	16.1	15.1	17	15.6	13.5	13.2	13.3	6.1
UM25	1992	1.4	2.2	9.9	12.7	12.7	11.9	13.4	12.4	10.7	10.5	10.5	4.8
	2000	1.5	2.3	10.7	13.7	13.7	12.9	14.5	13.4	11.6	11.3	11.3	5.2
	2010	1.6	2.7	11.8	15.1	15.2	14.2	16	14.7	12.8	12.5	12.5	5.8
	2020	1.7	2.6	12	15.4	15.4	14.5	16.3	15	13	12.7	12.7	5.9
	2030	1.7	2.8	12.2	15.6	15.7	14.7	16.6	15.2	13.2	12.9	12.9	6
	2040	1.7	2.7	12.3	15.8	15.8	14.9	16.8	15.4	13.4	13.1	13.1	6
	2050	1.7	2.8	12.5	16	16	15	16.9	15.6	13.5	13.2	13.2	6.1
UM26A	1992	1.4	2.2	9.9	12.7	12.7	11.9	13.4	12.4	10.7	10.5	10.5	4.8
	2000	1.5	2.3	10.7	13.7	13.7	12.9	14.5	13.4	11.6	11.3	11.3	5.2
	2010	1.6	2.7	11.8	15.1	15.2	14.2	16	14.7	12.8	12.5	12.5	5.8
	2020	1.7	2.6	12	15.4	15.4	14.5	16.3	15	13	12.7	12.7	5.9
	2030	1.7	2.8	12.2	15.6	15.7	14.7	16.6	15.2	13.2	12.9	12.9	6
	2040	1.7	2.7	12.3	15.8	15.8	14.9	16.8	15.4	13.4	13.1	13.1	6
	2050	1.7	2.8	12.5	16	16	15	16.9	15.6	13.5	13.2	13.2	6.1
UM26B	1992	13.1	14.9	21.7	23.2	22.7	22	23.7	21.7	21.1	22	20.9	18.1
	2000	15	16.4	24.7	26.5	25.9	25.2	27	24.8	24.1	25.1	23.8	20.6
	2010	16.8	19	27.7	29.6	29	28.2	30.3	27.8	27	28.2	26.7	23.1
	2020	17.7	19.4	29.2	31.2	30.6	29.7	31.9	29.3	28.4	29.7	28.1	24.3
	2030	18.5	21	30.5	32.7	32	31.1	33.4	30.6	29.7	31	29.4	25.5
	2040	19.2	20.9	31.6	33.8	33.1	32.1	34.5	31.7	30.7	32.1	30.4	26.3
	2050	19.7	22.2	32.4	34.6	33.9	33	35.4	32.5	31.5	32.9	31.2	27
UM27	1992	18.2	20.6	25.6	28.5	28.4	26.3	28.1	25.8	25	26.5	24.5	22.4
	2000	20.8	22.7	29.3	32.6	32.4	30.1	32.1	29.4	28.5	30.2	28	25.6
	2010	23.2	26.3	32.7	36.4	36.3	33.6	35.9	32.9	31.9	33.8	31.3	28.6
	2020	24.5	26.8	34.5	38.4	38.2	35.5	37.9	34.7	33.6	35.6	33	30.2
	2030	25.7	29.1	36.2	40.2	40.1	37.2	39.7	36.3	35.2	37.3	34.6	31.6
	2040	26.7	29.2	37.6	41.8	41.6	38.6	41.2	37.7	36.6	38.8	36	32.9
	2050	27.5	31.1	38.6	43	42.8	39.7	42.4	38.8	37.6	39.9	37	33.8
ILLA	1992	9.8	10.7	9.2	8.9	8.2	7.7	8.4	8	8.4	9.2	9.1	12
	2000	11.6	12.3	10.9	10.6	9.8	9.2	10	9.5	9.9	10.9	10.8	14.2
	2010	13.2	14.4	12.3	11.9	11.1	10.4	11.3	10.7	11.2	12.3	12.2	16.1
	2020	14.2	15	13.3	12.9	12	11.2	12.2	11.6	12.1	13.3	13.2	17.4
	2030	15.1	16.5	14.2	13.7	12.7	12	13	12.3	12.9	14.1	14.1	18.5
	2040	15.8	16.6	14.8	14.3	13.3	12.5	13.5	12.8	13.5	14.7	14.7	19.3
	2050	16.1	17.6	15.1	14.6	13.6	12.8	13.9	13.1	13.8	15.1	15	19.8
ILPE	1992	10.2	11.8	10	9.7	9.5	8.9	9	9	9.3	9.6	9.9	13.2
	2000	11.8	13.2	11.5	11.2	10.9	10.3	10.4	10.4	10.7	11.1	11.4	15.3
	2010	13.2	15.3	12.9	12.5	12.2	11.5	11.7	11.7	12	12.4	12.8	17.1
	2020	14.2	15.9	13.9	13.5	13.1	12.3	12.6	12.6	12.9	13.4	13.8	18.4
	2030	15.1	17.4	14.7	14.3	13.9	13.1	13.3	13.3	13.7	14.2	14.6	19.5
	2040	15.6	17.4	15.2	14.8	14.4	13.6	13.8	13.8	14.2	14.7	15.1	20.2
	2050	15.9	18.4	15.5	15	14.7	13.8	14	14	14.4	14.9	15.4	20.5
ILSR	1992	7.3	7.9	7.9	8.2	8.1	7.6	8.2	7.5	7.6	7.8	7.9	10.1

Table A2 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 2, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
ILSR	2000	8	8.4	8.6	9	8.9	8.3	9	8.2	8.4	8.6	8.7	11.1
	2010	8.8	9.6	9.5	9.9	9.8	9.2	9.9	9	9.2	9.5	9.6	12.2
	2020	9.4	9.9	10.1	10.6	10.4	9.8	10.5	9.6	9.8	10.1	10.2	13
	2030	9.9	10.8	10.7	11.2	11	10.3	11.1	10.2	10.4	10.7	10.8	13.8
	2040	10.3	10.8	11.1	11.6	11.4	10.7	11.6	10.6	10.8	11.1	11.2	14.3
	2050	10.5	11.5	11.4	11.9	11.7	11	11.8	10.8	11.1	11.3	11.5	14.6
ILMA	1992	6.8	7	7.5	7.7	7.7	7.5	7.9	7.4	7.5	7.5	7.5	9.1
	2000	7.3	7.2	8.1	8.3	8.3	8	8.5	7.9	8.1	8.1	8.1	9.8
	2010	7.9	8.2	8.8	9.1	9.1	8.8	9.2	8.7	8.8	8.8	8.8	10.7
	2020	8.4	8.4	9.4	9.6	9.6	9.3	9.8	9.2	9.4	9.3	9.4	11.4
	2030	8.9	9.1	9.9	10.1	10.1	9.8	10.3	9.7	9.9	9.8	9.9	12
	2040	9.2	9.1	10.2	10.5	10.5	10.2	10.7	10	10.2	10.2	10.2	12.4
	2050	9.4	9.7	10.4	10.7	10.7	10.4	11	10.3	10.4	10.4	10.4	12.7
ILDI	1992	5.9	6.2	7	7.7	8.1	8	8.3	7.6	8.1	8	7.4	7.7
	2000	6.2	6.3	7.4	8.1	8.5	8.3	8.7	7.9	8.5	8.3	7.8	8.1
	2010	6.7	7.1	8	8.7	9.2	9	9.5	8.6	9.2	9	8.4	8.8
	2020	7.1	7.2	8.5	9.2	9.7	9.6	10	9.1	9.7	9.6	8.9	9.3
	2030	7.5	7.9	8.9	9.7	10.3	10.1	10.6	9.6	10.3	10.1	9.4	9.8
	2040	7.8	7.9	9.3	10.1	10.7	10.5	11	10	10.7	10.5	9.8	10.2
	2050	8	8.4	9.6	10.4	11	10.8	11.3	10.3	11	10.8	10.1	10.5
ILBR	1992	6.8	7.3	7.9	8.8	9.6	9.2	9.6	8.9	9	8.8	8.3	8.7
	2000	7.1	7.4	8.3	9.3	10.1	9.7	10.1	9.4	9.5	9.3	8.7	9.1
	2010	7.7	8.3	9	10.1	10.9	10.5	11	10.2	10.3	10	9.4	9.9
	2020	8.2	8.5	9.6	10.7	11.6	11.1	11.7	10.8	10.9	10.7	10	10.5
	2030	8.7	9.3	10.1	11.3	12.3	11.8	12.3	11.5	11.6	11.3	10.6	11.1
	2040	9.1	9.4	10.6	11.8	12.8	12.3	12.9	12	12.1	11.8	11.1	11.6
	2050	9.4	10.1	11	12.3	13.3	12.8	13.4	12.4	12.5	12.2	11.5	12
ILLO	1992	6.8	7.2	7.9	8.8	9.6	9.1	9.4	8.9	8.9	8.7	8.3	8.7
	2000	7.2	7.3	8.4	9.2	10.1	9.6	9.9	9.4	9.4	9.2	8.7	9.1
	2010	7.8	8.2	9.1	10	11	10.4	10.7	10.2	10.2	9.9	9.4	9.9
	2020	8.2	8.4	9.6	10.6	11.7	11	11.4	10.8	10.8	10.5	10	10.5
	2030	8.7	9.2	10.2	11.2	12.3	11.7	12.1	11.4	11.4	11.1	10.6	11.1
	2040	9.1	9.2	10.6	11.7	12.9	12.2	12.6	11.9	11.9	11.6	11.1	11.6
	2050	9.4	9.9	11	12.1	13.4	12.7	13.1	12.4	12.4	12.1	11.5	12.1
ILTOB	1992	6.4	6.8	7	8.1	8	8	7.6	8.2	8.4	7.8	7.4	7.7
	2000	7	7.1	7.7	8.9	8.8	8.7	8.3	8.9	9.2	8.6	8.1	8.3
	2010	7.6	8	8.4	9.7	9.5	9.5	9	9.7	10	9.3	8.8	9.1
	2020	8.1	8.3	9	10.3	10.2	10.2	9.7	10.4	10.7	10	9.4	9.7
	2030	8.6	9.1	9.5	10.9	10.8	10.8	10.3	11	11.3	10.6	10	10.3
	2040	9	9.1	9.9	11.4	11.3	11.2	10.7	11.5	11.8	11	10.4	10.7
	2050	9.3	9.8	10.2	11.8	11.6	11.6	11	11.8	12.2	11.3	10.7	11.1

Table A3
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UMUSA	1992	0	0	1.3	4.3	4.7	5.1	5.2	6.2	6.5	5.9	4.1	0
	2000	0	0	1.3	4.3	4.7	5	5.2	6.2	6.5	5.9	4.1	0
	2010	0	0	1.3	4.4	4.9	5.2	5.4	6.4	6.7	6.2	4.2	0
	2020	0	0	1.4	4.7	5.2	5.5	5.7	6.8	7.1	6.5	4.4	0
	2030	0	0	1.5	5	5.5	5.9	6	7.2	7.5	6.9	4.7	0
	2040	0	0	1.6	5.3	5.8	6.3	6.5	7.7	8	7.4	5	0
	2050	0	0	1.7	5.8	6.4	6.8	7	8.4	8.7	8	5.5	0
UMLSA	1992	0	0	1.3	4.5	4.7	5.1	5.2	6.1	6.4	6	4.1	0
	2000	0	0	1.3	4.5	4.7	5	5.2	6.1	6.4	5.9	4.1	0
	2010	0	0	1.3	4.5	4.7	5.1	5.3	6.2	6.5	6	4.2	0
	2020	0	0	1.4	4.7	4.9	5.3	5.5	6.4	6.8	6.3	4.3	0
	2030	0	0	1.5	5	5.2	5.6	5.8	6.8	7.2	6.6	4.6	0
	2040	0	0	1.5	5.3	5.6	6	6.2	7.2	7.6	7.1	4.9	0
	2050	0	0	1.7	5.8	6	6.5	6.7	7.9	8.3	7.7	5.3	0
UM01	1992	0	0	1.3	4.5	4.7	5.1	5.3	6.1	6.5	6	4.2	0
	2000	0	0	1.3	4.4	4.6	5.1	5.2	6	6.4	5.9	4.1	0
	2010	0	0	1.4	4.6	4.8	5.2	5.4	6.2	6.6	6.1	4.2	0
	2020	0	0	1.4	4.8	5.1	5.5	5.7	6.5	7	6.5	4.5	0
	2030	0	0	1.5	5.2	5.4	5.9	6.1	7	7.5	6.9	4.8	0
	2040	0	0	1.6	5.6	5.8	6.4	6.6	7.5	8.1	7.5	5.2	0
	2050	0	0	1.8	6.1	6.4	6.9	7.2	8.2	8.8	8.1	5.6	0
UM02	1992	0	0	1.9	5	5.7	5.2	5.9	5.7	4.6	4.7	3.2	0
	2000	0	0	1.9	5.1	5.8	5.3	6	5.8	4.6	4.8	3.2	0
	2010	0	0	1.8	4.8	5.5	5	5.6	5.5	4.4	4.5	3.1	0
	2020	0	0	1.7	4.6	5.3	4.8	5.4	5.3	4.2	4.4	2.9	0
	2030	0	0	1.7	4.4	5.1	4.6	5.2	5	4	4.2	2.8	0
	2040	0	0	1.6	4.1	4.8	4.3	4.9	4.8	3.8	3.9	2.7	0
	2050	0	0	1.5	4	4.6	4.1	4.7	4.5	3.6	3.7	2.5	0
UM03	1992	0	0	2	4.8	5.7	5.3	5.8	5.7	4.6	4.7	3.1	0
	2000	0	0	2	4.9	5.8	5.4	5.9	5.8	4.7	4.8	3.1	0
	2010	0	0	1.9	4.6	5.4	5.1	5.6	5.5	4.4	4.5	3	0
	2020	0	0	1.8	4.4	5.2	4.9	5.4	5.3	4.3	4.3	2.8	0
	2030	0	0	1.8	4.2	5	4.7	5.1	5	4.1	4.1	2.7	0
	2040	0	0	1.7	4	4.7	4.4	4.8	4.7	3.8	3.9	2.6	0
	2050	0	0	1.6	3.8	4.5	4.2	4.6	4.5	3.7	3.7	2.4	0
UM04	1992	0	0	1.9	4.7	5.6	5.3	5.8	5.7	4.6	4.7	3.2	0
	2000	0	0	2	4.8	5.7	5.5	5.9	5.8	4.7	4.8	3.3	0
	2010	0	0	1.9	4.6	5.5	5.2	5.7	5.6	4.5	4.6	3.1	0
	2020	0	0	1.8	4.4	5.3	5.1	5.5	5.4	4.4	4.4	3	0
	2030	0	0	1.7	4.3	5.1	4.9	5.3	5.2	4.2	4.2	2.9	0
	2040	0	0	1.7	4.1	4.8	4.6	5	4.9	4	4	2.8	0
	2050	0	0	1.6	3.9	4.6	4.5	4.8	4.7	3.8	3.9	2.7	0
UM05	1992	0	0	1.9	4.6	5.6	5.2	5.6	5.6	4.6	4.6	3.1	0
	2000	0	0	1.9	4.8	5.7	5.4	5.8	5.8	4.7	4.7	3.2	0
	2010	0	0	1.8	4.5	5.5	5.1	5.5	5.5	4.5	4.5	3	0

Table A3 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM05	2020	0	0	1.8	4.4	5.3	5	5.4	5.4	4.4	4.4	2.9	0
	2030	0	0	1.7	4.2	5.1	4.8	5.2	5.2	4.2	4.2	2.8	0
	2040	0	0	1.6	4	4.8	4.6	4.9	4.9	4	4	2.7	0
	2050	0	0	1.6	3.9	4.7	4.4	4.7	4.7	3.9	3.9	2.6	0
UM05A	1992	0	0	1.9	4.6	5.6	5.4	5.7	5.6	4.5	4.6	3.1	0
	2000	0	0	1.9	4.7	5.7	5.6	5.8	5.8	4.6	4.7	3.2	0
	2010	0	0	1.8	4.5	5.4	5.3	5.6	5.5	4.4	4.5	3	0
	2020	0	0	1.8	4.4	5.3	5.1	5.4	5.3	4.3	4.3	2.9	0
	2030	0	0	1.7	4.2	5.1	4.9	5.2	5.1	4.1	4.2	2.8	0
	2040	0	0	1.6	4	4.8	4.7	5	4.9	3.9	4	2.7	0
	2050	0	0	1.6	3.9	4.7	4.5	4.8	4.7	3.8	3.8	2.6	0
UM06	1992	0	0	2.2	5.3	6.4	6.4	7	6.4	5.3	5.1	3.8	0
	2000	0	0	2.3	5.5	6.6	6.6	7.2	6.6	5.5	5.3	3.9	0
	2010	0	0	2.2	5.2	6.3	6.3	6.9	6.3	5.2	5.1	3.7	0
	2020	0	0	2.1	5	6.1	6.1	6.6	6.1	5	4.9	3.6	0
	2030	0	0	2	4.8	5.8	5.8	6.3	5.8	4.8	4.7	3.5	0
	2040	0	0	1.9	4.6	5.5	5.5	6	5.5	4.5	4.4	3.3	0
	2050	0	0	1.8	4.3	5.2	5.2	5.7	5.3	4.3	4.2	3.1	0
UM07	1992	0	0	2.1	5	6.1	6.3	6.3	6.1	5	4.9	3.5	0
	2000	0	0	2.2	5.2	6.3	6.5	6.5	6.3	5.2	5	3.6	0
	2010	0	0	2.1	5	6	6.2	6.2	6	4.9	4.8	3.4	0
	2020	0	0	2	4.8	5.8	6	6	5.8	4.7	4.6	3.3	0
	2030	0	0	1.9	4.6	5.5	5.7	5.8	5.5	4.5	4.4	3.2	0
	2040	0	0	1.8	4.3	5.2	5.4	5.4	5.2	4.3	4.2	3	0
	2050	0	0	1.7	4.1	5	5.2	5.2	5	4.1	4	2.9	0
UM08	1992	0	0	2.3	5.6	6.6	6.5	7.2	6.8	5.6	5.4	4.1	0
	2000	0	0	2.4	5.8	6.8	6.8	7.4	7	5.8	5.6	4.2	0
	2010	0	0	2.3	5.6	6.5	6.5	7.1	6.7	5.5	5.3	4	0
	2020	0	0	2.2	5.4	6.3	6.3	6.9	6.5	5.4	5.2	3.9	0
	2030	0	0	2.1	5.2	6.1	6	6.6	6.3	5.1	5	3.7	0
	2040	0	0	2	4.9	5.8	5.7	6.3	5.9	4.9	4.7	3.5	0
	2050	0	0	1.9	4.7	5.5	5.5	6	5.7	4.7	4.5	3.4	0
UM09	1992	0	0	2.4	5.6	6.5	6.6	7.2	6.8	5.6	5.5	4.1	0
	2000	0	0	2.5	5.8	6.8	6.8	7.4	7	5.8	5.7	4.2	0
	2010	0	0	2.4	5.6	6.5	6.6	7.2	6.8	5.6	5.4	4	0
	2020	0	0	2.3	5.4	6.3	6.4	6.9	6.6	5.4	5.3	3.9	0
	2030	0	0	2.3	5.2	6.1	6.2	6.7	6.4	5.2	5.1	3.8	0
	2040	0	0	2.2	5	5.9	5.9	6.5	6.1	5	4.9	3.6	0
	2050	0	0	2.1	4.9	5.7	5.7	6.3	5.9	4.9	4.8	3.5	0
UM10	1992	0	0	3.4	7.2	7.9	7.8	8.3	7.7	6.4	6.5	5.2	0.2
	2000	0	0	3.6	7.6	8.4	8.2	8.7	8.1	6.8	6.9	5.5	0.2
	2010	0	0	3.6	7.5	8.2	8.1	8.6	8	6.7	6.7	5.4	0.2
	2020	0	0	3.5	7.3	8.1	7.9	8.5	7.9	6.6	6.6	5.3	0.2
	2030	0	0	3.4	7.2	8	7.8	8.3	7.7	6.5	6.5	5.2	0.2
	2040	0	0	3.4	7	7.8	7.6	8.1	7.5	6.3	6.4	5.1	0.2

Table A3 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM10	2050	0	0	3.3	6.9	7.6	7.5	8	7.4	6.2	6.2	5	0.2
UM11	1992	0	0	3.4	7.4	8.2	8	8.4	8	6.6	6.7	5.3	0.2
	2000	0	0	3.6	7.8	8.7	8.4	8.9	8.5	7	7.1	5.7	0.2
	2010	0	0	3.6	7.7	8.6	8.3	8.7	8.4	6.8	7	5.6	0.2
	2020	0	0	3.5	7.6	8.4	8.2	8.6	8.2	6.7	6.9	5.5	0.2
	2030	0	0	3.4	7.5	8.3	8	8.5	8.1	6.6	6.7	5.4	0.2
	2040	0	0	3.4	7.3	8.1	7.9	8.3	7.9	6.5	6.6	5.3	0.2
	2050	0	0	3.3	7.2	8	7.7	8.1	7.8	6.4	6.5	5.2	0.2
UM12	1992	0	0	5.1	8.5	9.1	8.4	9.4	8.4	7	7	5.9	0.5
	2000	0	0	5.5	9.2	9.8	9.1	10.1	9.1	7.6	7.5	6.3	0.5
	2010	0	0	5.5	9.2	9.8	9.1	10.1	9.1	7.6	7.5	6.3	0.5
	2020	0	0	5.5	9.1	9.8	9.1	10	9	7.6	7.5	6.3	0.5
	2030	0	0	5.4	9.1	9.7	9	10	9	7.5	7.4	6.2	0.5
	2040	0	0	5.4	9	9.6	8.9	9.9	8.9	7.4	7.4	6.2	0.5
	2050	0	0	5.3	8.9	9.6	8.9	9.8	8.8	7.4	7.3	6.1	0.5
UM13	1992	0	0	5.3	8.7	9.2	8.6	9.5	8.6	7.1	7.3	6.2	0.7
	2000	0	0	5.8	9.4	10	9.3	10.3	9.3	7.7	7.9	6.7	0.8
	2010	0	0	5.8	9.5	10	9.3	10.3	9.3	7.7	7.9	6.7	0.8
	2020	0	0	5.8	9.4	10	9.3	10.3	9.3	7.7	7.9	6.7	0.8
	2030	0	0	5.7	9.4	9.9	9.2	10.2	9.2	7.7	7.8	6.7	0.7
	2040	0	0	5.7	9.3	9.9	9.2	10.1	9.1	7.6	7.8	6.6	0.7
	2050	0	0	5.7	9.3	9.8	9.1	10.1	9.1	7.5	7.7	6.6	0.7
UM14	1992	0	0	7.9	12.3	12.6	11.7	12.7	11.6	10	10	9.3	1.7
	2000	0	0	8.5	13.3	13.6	12.6	13.7	12.5	10.8	10.8	10	1.9
	2010	0	0	8.5	13.4	13.7	12.7	13.8	12.7	10.9	10.9	10.2	1.9
	2020	0	0	8.6	13.5	13.8	12.8	13.9	12.7	11	11	10.2	1.9
	2030	0	0	8.7	13.6	13.9	12.9	14	12.8	11	11.1	10.3	1.9
	2040	0	0	8.7	13.6	13.9	12.9	14.1	12.9	11.1	11.1	10.3	1.9
	2050	0	0	8.7	13.7	14	13	14.1	12.9	11.1	11.1	10.4	1.9
UM15	1992	0	0.1	8	10.9	11.1	10.5	11.2	10.4	8.8	9.9	9.4	2.2
	2000	0	0.1	8.6	11.7	11.9	11.2	12.1	11.2	9.4	10.7	10.1	2.4
	2010	0	0.1	8.6	11.8	12.1	11.4	12.2	11.3	9.5	10.8	10.2	2.4
	2020	0	0.1	8.7	11.9	12.1	11.4	12.3	11.4	9.6	10.8	10.2	2.4
	2030	0	0.1	8.7	12	12.2	11.5	12.3	11.4	9.6	10.9	10.3	2.4
	2040	0	0.1	8.8	12	12.2	11.5	12.4	11.4	9.6	10.9	10.3	2.4
	2050	0	0.1	8.8	12	12.3	11.5	12.4	11.5	9.6	10.9	10.3	2.4
UM16	1992	0	0	8.6	12.1	12.5	11.4	12.6	11.6	10.1	10.4	10.1	2.5
	2000	0	0	9.3	13	13.5	12.3	13.6	12.5	10.8	11.2	10.9	2.7
	2010	0	0	9.4	13.2	13.7	12.5	13.8	12.7	11	11.4	11.1	2.7
	2020	0	0	9.5	13.3	13.8	12.6	13.9	12.8	11.1	11.4	11.2	2.7
	2030	0	0	9.5	13.4	13.9	12.7	14	12.8	11.1	11.5	11.2	2.7
	2040	0	0	9.6	13.4	13.9	12.7	14	12.9	11.2	11.6	11.3	2.8
	2050	0	0	9.6	13.5	14	12.8	14.1	12.9	11.2	11.6	11.3	2.8
UM17	1992	0	0	8.6	11.5	12	11.1	12.1	11.2	9.3	9.4	9.2	2.4
	2000	0	0	9.2	12.4	12.9	11.9	13	12.1	10	10.2	9.9	2.6

Table A3 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM17	2010	0	0	9.4	12.6	13.1	12.1	13.2	12.3	10.2	10.3	10.1	2.7
	2020	0	0	9.5	12.7	13.2	12.2	13.4	12.4	10.3	10.4	10.2	2.7
	2030	0	0	9.6	12.8	13.3	12.3	13.5	12.5	10.4	10.5	10.3	2.7
	2040	0	0	9.6	12.9	13.4	12.4	13.6	12.6	10.4	10.6	10.4	2.7
	2050	0	0	9.7	13	13.5	12.5	13.6	12.6	10.5	10.6	10.4	2.8
UM18	1992	0	0	8.8	11.6	12.1	11.2	12.3	11.4	9.6	9.5	9.5	2.7
	2000	0	0	9.5	12.5	13.1	12.1	13.3	12.3	10.4	10.3	10.3	2.9
	2010	0	0	9.7	12.8	13.3	12.3	13.5	12.5	10.6	10.5	10.5	2.9
	2020	0	0	9.8	12.9	13.4	12.4	13.7	12.7	10.7	10.6	10.6	3
	2030	0	0	9.9	13	13.6	12.6	13.8	12.8	10.8	10.7	10.7	3
	2040	0	0	10	13.2	13.7	12.7	13.9	12.9	10.9	10.8	10.8	3
	2050	0	0	10	13.2	13.8	12.7	14	13	10.9	10.9	10.8	3
UM19	1992	0	0.4	9	11.9	12.3	11.4	12.5	11.5	9.8	9.7	9.8	3.1
	2000	0	0.4	9.7	13	13.3	12.4	13.6	12.5	10.6	10.6	10.6	3.4
	2010	0	0.4	10	13.3	13.6	12.7	14	12.8	10.9	10.9	10.9	3.5
	2020	0	0.4	10.1	13.5	13.8	12.9	14.1	13	11	11	11	3.5
	2030	0	0.4	10.2	13.6	14	13.1	14.3	13.2	11.2	11.1	11.1	3.6
	2040	0	0.4	10.3	13.8	14.1	13.2	14.5	13.3	11.3	11.2	11.3	3.6
	2050	0	0.4	10.4	13.9	14.3	13.3	14.6	13.4	11.4	11.3	11.4	3.6
UM20	1992	0.2	0.6	9.2	12.4	13.3	12.2	13.3	12.1	10.3	10.4	10.3	3.9
	2000	0.3	0.7	10.1	13.5	14.5	13.3	14.5	13.2	11.2	11.4	11.3	4.2
	2010	0.3	0.7	10.3	13.9	14.9	13.6	14.9	13.6	11.5	11.7	11.6	4.4
	2020	0.3	0.7	10.5	14.1	15.1	13.8	15.1	13.8	11.7	11.8	11.7	4.4
	2030	0.3	0.7	10.6	14.3	15.3	14	15.3	13.9	11.9	12	11.9	4.5
	2040	0.3	0.7	10.7	14.4	15.5	14.2	15.5	14.1	12	12.1	12	4.5
	2050	0.3	0.7	10.8	14.6	15.6	14.3	15.6	14.2	12.1	12.2	12.1	4.6
UM21	1992	1.1	1.5	9.8	12.3	12.5	11.3	12.9	12.2	10.7	10.5	10.5	4.3
	2000	1.2	1.6	10.6	13.4	13.6	12.3	14	13.2	11.7	11.4	11.4	4.7
	2010	1.2	1.7	10.9	13.7	13.9	12.6	14.4	13.6	11.9	11.7	11.7	4.8
	2020	1.2	1.7	11	13.9	14.1	12.8	14.5	13.7	12.1	11.8	11.8	4.9
	2030	1.2	1.7	11.2	14	14.3	12.9	14.7	13.9	12.2	11.9	12	4.9
	2040	1.2	1.7	11.3	14.2	14.4	13	14.9	14	12.4	12.1	12.1	5
	2050	1.2	1.8	11.4	14.3	14.6	13.2	15	14.2	12.5	12.2	12.2	5
UM22	1992	1.1	1.6	9.5	12.2	12.3	11.5	12.9	12	10.3	10.1	10.2	4.5
	2000	1.2	1.7	10.4	13.3	13.5	12.5	14.1	13.1	11.2	11	11.1	4.9
	2010	1.3	1.8	10.7	13.6	13.8	12.8	14.4	13.4	11.5	11.3	11.4	5
	2020	1.3	1.7	10.8	13.8	14	13	14.6	13.6	11.6	11.4	11.5	5.1
	2030	1.3	1.8	10.9	14	14.1	13.1	14.8	13.8	11.7	11.5	11.6	5.1
	2040	1.3	1.8	11	14.1	14.3	13.3	15	13.9	11.9	11.7	11.8	5.2
	2050	1.3	1.9	11.1	14.3	14.4	13.4	15.1	14.1	12	11.8	11.9	5.2
UM24	1992	1.3	2.1	9.8	12.8	12.8	11.9	13.5	12.4	10.7	10.4	10.6	4.9
	2000	1.5	2.2	10.7	13.9	13.9	13	14.7	13.5	11.7	11.4	11.5	5.3
	2010	1.5	2.4	11	14.3	14.3	13.4	15.1	13.9	12	11.7	11.8	5.4
	2020	1.5	2.3	11.1	14.5	14.5	13.6	15.3	14.1	12.2	11.9	12	5.5
	2030	1.5	2.5	11.3	14.7	14.7	13.7	15.5	14.3	12.3	12	12.1	5.6

Table A3 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM24	2040	1.6	2.4	11.4	14.9	14.8	13.9	15.7	14.4	12.5	12.1	12.3	5.6
	2050	1.6	2.5	11.5	15	15	14	15.8	14.6	12.6	12.3	12.4	5.7
UM25	1992	1.4	2.2	9.9	12.7	12.7	11.9	13.4	12.4	10.7	10.5	10.5	4.8
	2000	1.5	2.4	10.8	13.8	13.9	13	14.7	13.5	11.7	11.4	11.4	5.3
	2010	1.5	2.5	11.1	14.2	14.2	13.3	15.1	13.8	12	11.7	11.7	5.4
	2020	1.6	2.4	11.2	14.4	14.4	13.5	15.3	14	12.2	11.9	11.9	5.5
	2030	1.6	2.6	11.4	14.6	14.6	13.7	15.4	14.2	12.3	12	12	5.6
	2040	1.6	2.5	11.5	14.7	14.8	13.9	15.6	14.4	12.5	12.2	12.2	5.6
	2050	1.6	2.6	11.6	14.9	14.9	14	15.8	14.5	12.6	12.3	12.3	5.7
UM26A	1992	1.4	2.2	9.9	12.7	12.7	11.9	13.4	12.4	10.7	10.5	10.5	4.8
	2000	1.5	2.4	10.8	13.8	13.9	13	14.7	13.5	11.7	11.4	11.4	5.3
	2010	1.5	2.5	11.1	14.2	14.2	13.3	15.1	13.8	12	11.7	11.7	5.4
	2020	1.6	2.4	11.2	14.4	14.4	13.5	15.3	14	12.2	11.9	11.9	5.5
	2030	1.6	2.6	11.4	14.6	14.6	13.7	15.4	14.2	12.3	12	12	5.6
	2040	1.6	2.5	11.5	14.7	14.8	13.9	15.6	14.4	12.5	12.2	12.2	5.6
	2050	1.6	2.6	11.6	14.9	14.9	14	15.8	14.5	12.6	12.3	12.3	5.7
UM26B	1992	13.1	14.9	21.7	23.2	22.7	22	23.7	21.7	21.1	22	20.9	18.1
	2000	15.5	16.9	25.6	27.3	26.7	26	27.9	25.6	24.8	25.9	24.6	21.3
	2010	17.3	19.6	28.5	30.4	29.8	29	31.1	28.6	27.7	28.9	27.4	23.7
	2020	18.2	19.9	30	32	31.4	30.5	32.7	30.1	29.1	30.4	28.9	25
	2030	18.8	21.3	31	33.1	32.4	31.5	33.8	31.1	30.1	31.5	29.8	25.8
	2040	19.3	21.1	31.9	34.1	33.4	32.4	34.8	32	31	32.4	30.7	26.6
	2050	19.7	22.3	32.5	34.8	34.1	33.1	35.5	32.6	31.6	33	31.3	27.1
UM27	1992	18.2	20.6	25.6	28.5	28.4	26.3	28.1	25.8	25	26.5	24.5	22.4
	2000	21.5	23.5	30.2	33.7	33.5	31.1	33.2	30.4	29.5	31.2	29	26.5
	2010	24	27.2	33.8	37.6	37.5	34.7	37.1	34	32.9	34.9	32.4	29.6
	2020	25.3	27.7	35.7	39.7	39.5	36.7	39.2	35.9	34.8	36.8	34.2	31.2
	2030	26.3	29.8	37.1	41.3	41.1	38.1	40.7	37.2	36.1	38.3	35.5	32.4
	2040	27.2	29.8	38.3	42.7	42.5	39.4	42.1	38.5	37.3	39.6	36.7	33.5
	2050	28	31.6	39.4	43.8	43.6	40.4	43.2	39.5	38.3	40.6	37.7	34.4
ILLA	1992	9.8	10.7	9.2	8.9	8.2	7.7	8.4	8	8.4	9.2	9.1	12
	2000	12.2	12.9	11.5	11.1	10.3	9.7	10.5	10	10.5	11.4	11.4	15
	2010	14.5	15.8	13.6	13.1	12.2	11.4	12.4	11.8	12.4	13.5	13.5	17.7
	2020	15.5	16.3	14.5	14	13	12.2	13.3	12.6	13.2	14.5	14.4	19
	2030	16	17.5	15	14.5	13.5	12.7	13.8	13.1	13.7	15	14.9	19.6
	2040	16.4	17.3	15.4	14.9	13.8	13	14.1	13.4	14	15.3	15.3	20.1
	2050	16.6	18.2	15.6	15.1	14	13.2	14.3	13.5	14.2	15.5	15.5	20.4
ILPE	1992	10.2	11.8	10	9.7	9.5	8.9	9	9	9.3	9.6	9.9	13.2
	2000	12.4	13.8	12.1	11.7	11.4	10.8	10.9	10.9	11.2	11.6	12	16
	2010	14.5	16.7	14.1	13.7	13.4	12.6	12.8	12.8	13.1	13.6	14	18.7
	2020	15.4	17.1	15	14.5	14.2	13.3	13.6	13.6	13.9	14.5	14.9	19.8
	2030	15.8	18.3	15.4	15	14.6	13.7	14	14	14.4	14.9	15.3	20.4
	2040	16.1	18	15.7	15.2	14.9	14	14.2	14.2	14.6	15.1	15.6	20.8
	2050	16.3	18.8	15.9	15.4	15.1	14.1	14.4	14.4	14.8	15.3	15.8	21
ILSR	1992	7.3	7.9	7.9	8.2	8.1	7.6	8.2	7.5	7.6	7.8	7.9	10.1

Table A3 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, Without-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
LSR	2000	8.3	8.7	9	9.3	9.2	8.7	9.3	8.5	8.7	8.9	9	11.5
	2010	9.5	10.4	10.3	10.7	10.6	9.9	10.7	9.8	10	10.2	10.4	13.2
	2020	10.1	10.7	10.9	11.4	11.3	10.5	11.4	10.4	10.6	10.9	11	14
	2030	10.5	11.4	11.3	11.8	11.7	10.9	11.8	10.8	11	11.3	11.4	14.5
	2040	10.8	11.4	11.7	12.1	12	11.2	12.1	11.1	11.3	11.6	11.7	15
	2050	11	12	11.9	12.4	12.3	11.5	12.4	11.3	11.6	11.9	12	15.3
LMA	1992	6.8	7	7.5	7.7	7.7	7.5	7.9	7.4	7.5	7.5	7.5	9.1
	2000	7.5	7.5	8.4	8.6	8.6	8.3	8.8	8.2	8.4	8.3	8.4	10.2
	2010	8.6	8.8	9.5	9.8	9.8	9.5	10	9.3	9.5	9.5	9.5	11.5
	2020	9.1	9	10	10.3	10.3	10	10.5	9.9	10	10	10	12.2
	2030	9.4	9.6	10.4	10.7	10.7	10.3	10.9	10.2	10.4	10.4	10.4	12.6
	2040	9.6	9.5	10.7	11	11	10.6	11.2	10.5	10.7	10.6	10.7	13
	2050	9.8	10.1	10.9	11.2	11.2	10.9	11.4	10.7	10.9	10.9	10.9	13.3
LDI	1992	5.9	6.2	7	7.7	8.1	8	8.3	7.6	8.1	8	7.4	7.7
	2000	6.4	6.5	7.6	8.3	8.8	8.6	9	8.2	8.8	8.6	8	8.4
	2010	7.2	7.6	8.6	9.4	9.9	9.7	10.2	9.2	9.9	9.7	9	9.4
	2020	7.7	7.8	9.1	9.9	10.5	10.3	10.8	9.8	10.5	10.3	9.6	10
	2030	8	8.4	9.5	10.3	10.9	10.7	11.2	10.2	10.9	10.7	10	10.4
	2040	8.3	8.4	9.8	10.7	11.3	11.1	11.6	10.6	11.3	11.1	10.3	10.8
	2050	8.5	8.9	10.1	11	11.6	11.4	12	10.9	11.6	11.4	10.6	11.1
LBR	1992	6.8	7.3	7.9	8.8	9.6	9.2	9.6	8.9	9	8.8	8.3	8.7
	2000	7.4	7.6	8.6	9.6	10.4	10	10.5	9.7	9.8	9.6	9	9.4
	2010	8.3	8.9	9.7	10.8	11.8	11.3	11.8	11	11.1	10.8	10.1	10.7
	2020	8.9	9.2	10.4	11.6	12.6	12.1	12.6	11.7	11.8	11.6	10.8	11.4
	2030	9.3	10	10.9	12.1	13.2	12.6	13.2	12.3	12.4	12.1	11.4	11.9
	2040	9.8	10.1	11.4	12.7	13.8	13.2	13.9	12.9	13	12.7	11.9	12.5
	2050	10.1	10.8	11.8	13.2	14.3	13.7	14.4	13.3	13.5	13.1	12.3	12.9
LLO	1992	6.8	7.2	7.9	8.8	9.6	9.1	9.4	8.9	8.9	8.7	8.3	8.7
	2000	7.4	7.5	8.6	9.5	10.5	9.9	10.2	9.7	9.7	9.5	9	9.5
	2010	8.4	8.8	9.8	10.7	11.8	11.2	11.6	11	10.9	10.7	10.2	10.7
	2020	8.9	9.1	10.4	11.5	12.6	12	12.3	11.7	11.7	11.4	10.8	11.4
	2030	9.3	9.8	10.9	12	13.2	12.5	12.9	12.3	12.2	12	11.4	11.9
	2040	9.8	9.9	11.4	12.6	13.8	13.1	13.5	12.8	12.8	12.5	11.9	12.5
	2050	10.1	10.6	11.8	13	14.3	13.6	14	13.3	13.3	13	12.3	12.9
LTOB	1992	6.4	6.8	7	8.1	8	8	7.6	8.2	8.4	7.8	7.4	7.7
	2000	7.2	7.4	8	9.2	9.1	9	8.6	9.2	9.5	8.9	8.4	8.6
	2010	8.3	8.7	9.1	10.5	10.4	10.3	9.8	10.6	10.9	10.1	9.6	9.9
	2020	8.8	9	9.7	11.2	11.1	11	10.5	11.2	11.6	10.8	10.2	10.5
	2030	9.2	9.7	10.1	11.7	11.5	11.5	10.9	11.7	12.1	11.3	10.6	11
	2040	9.5	9.7	10.5	12.1	12	11.9	11.3	12.2	12.5	11.7	11	11.4
	2050	9.8	10.4	10.8	12.5	12.4	12.3	11.7	12.6	12.9	12.1	11.4	11.8

Table A4
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UMUSA	1992	0	0	1.3	4.3	4.7	5.1	5.2	6.2	6.5	5.9	4.1	0
	2000	0	0	1.3	4.3	4.7	5	5.2	6.2	6.5	5.9	4.1	0
	2010	0	0	1.3	4.5	5	5.3	5.5	6.5	6.8	6.3	4.3	0
	2020	0	0	1.6	5.4	5.9	6.3	6.5	7.8	8.1	7.4	5.1	0
	2030	0	0	1.7	5.6	6.2	6.7	6.9	8.2	8.5	7.8	5.4	0
	2040	0	0	1.8	6	6.6	7.1	7.3	8.7	9.1	8.3	5.7	0
	2050	0	0	1.8	6.3	6.9	7.4	7.7	9.1	9.5	8.7	6	0
UMLSA	1992	0	0	1.3	4.5	4.7	5.1	5.2	6.1	6.4	6	4.1	0
	2000	0	0	1.3	4.5	4.7	5	5.2	6.1	6.4	5.9	4.1	0
	2010	0	0	1.3	4.6	4.8	5.2	5.4	6.3	6.6	6.2	4.2	0
	2020	0	0	1.6	5.6	5.8	6.3	6.5	7.6	8	7.4	5.1	0
	2030	0	0	1.7	5.7	6	6.5	6.7	7.8	8.3	7.7	5.3	0
	2040	0	0	1.8	6	6.3	6.8	7	8.2	8.7	8	5.5	0
	2050	0	0	1.8	6.3	6.6	7.2	7.4	8.6	9.1	8.4	5.8	0
UM01	1992	0	0	1.3	4.5	4.7	5.1	5.3	6.1	6.5	6	4.2	0
	2000	0	0	1.3	4.4	4.6	5.1	5.2	6	6.4	5.9	4.1	0
	2010	0	0	1.4	4.7	4.9	5.3	5.5	6.3	6.7	6.2	4.3	0
	2020	0	0	1.6	5.5	5.8	6.3	6.5	7.4	8	7.3	5.1	0
	2030	0	0	1.7	5.8	6.1	6.6	6.8	7.8	8.4	7.7	5.3	0
	2040	0	0	1.8	6.2	6.4	7	7.2	8.3	8.9	8.2	5.7	0
	2050	0	0	1.9	6.6	6.8	7.5	7.7	8.8	9.5	8.7	6	0
UM02	1992	0	0	1.9	5	5.7	5.2	5.9	5.7	4.6	4.7	3.2	0
	2000	0	0	1.9	5.1	5.8	5.3	6	5.8	4.6	4.8	3.2	0
	2010	0	0	1.8	4.9	5.6	5.1	5.8	5.6	4.5	4.6	3.1	0
	2020	0	0	2.4	6.3	7.2	6.5	7.4	7.2	5.8	5.9	4	0
	2030	0	0	2.3	6.1	7	6.3	7.2	7	5.6	5.7	3.9	0
	2040	0	0	2.2	5.9	6.7	6.1	6.9	6.7	5.4	5.5	3.8	0
	2050	0	0	2.1	5.7	6.5	5.9	6.7	6.5	5.2	5.4	3.6	0
UM03	1992	0	0	2	4.8	5.7	5.3	5.8	5.7	4.6	4.7	3.1	0
	2000	0	0	2	4.9	5.8	5.4	5.9	5.8	4.7	4.8	3.1	0
	2010	0	0	2	4.7	5.6	5.3	5.7	5.6	4.5	4.6	3	0
	2020	0	0	2.5	6	7.1	6.7	7.3	7.2	5.8	5.9	3.9	0
	2030	0	0	2.4	5.8	6.9	6.5	7.1	7	5.6	5.7	3.7	0
	2040	0	0	2.4	5.6	6.7	6.3	6.8	6.7	5.4	5.5	3.6	0
	2050	0	0	2.3	5.4	6.4	6.1	6.6	6.5	5.2	5.3	3.5	0
UM04	1992	0	0	1.9	4.7	5.6	5.3	5.8	5.7	4.6	4.7	3.2	0
	2000	0	0	2	4.8	5.7	5.5	5.9	5.8	4.7	4.8	3.3	0
	2010	0	0	1.9	4.7	5.6	5.4	5.8	5.7	4.6	4.7	3.2	0
	2020	0	0	2.4	6	7.1	6.8	7.4	7.3	5.9	6	4.1	0
	2030	0	0	2.4	5.8	6.9	6.6	7.2	7.1	5.7	5.8	4	0
	2040	0	0	2.3	5.7	6.7	6.4	7	6.9	5.6	5.6	3.9	0
	2050	0	0	2.2	5.5	6.5	6.3	6.8	6.7	5.4	5.5	3.8	0
UM05	1992	0	0	1.9	4.6	5.6	5.2	5.6	5.6	4.6	4.6	3.1	0
	2000	0	0	1.9	4.8	5.7	5.4	5.8	5.8	4.7	4.7	3.2	0
	2010	0	0	1.9	4.6	5.6	5.3	5.7	5.7	4.6	4.6	3.1	0

Table A4 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM05	2020	0	0	2.4	5.9	7.1	6.7	7.2	7.2	5.9	5.9	4	0
	2030	0	0	2.3	5.8	6.9	6.5	7	7	5.7	5.7	3.9	0
	2040	0	0	2.2	5.6	6.7	6.3	6.8	6.8	5.6	5.6	3.8	0
	2050	0	0	2.2	5.4	6.5	6.2	6.6	6.6	5.4	5.4	3.7	0
UM05A	1992	0	0	1.9	4.6	5.6	5.4	5.7	5.6	4.5	4.6	3.1	0
	2000	0	0	1.9	4.7	5.7	5.6	5.8	5.8	4.6	4.7	3.2	0
	2010	0	0	1.9	4.6	5.6	5.4	5.7	5.6	4.5	4.6	3.1	0
	2020	0	0	2.4	5.9	7.1	6.9	7.3	7.2	5.7	5.8	3.9	0
	2030	0	0	2.3	5.7	6.9	6.7	7.1	7	5.6	5.7	3.9	0
	2040	0	0	2.3	5.6	6.7	6.6	6.9	6.8	5.4	5.5	3.7	0
	2050	0	0	2.2	5.4	6.5	6.4	6.7	6.6	5.3	5.4	3.6	0
UM06	1992	0	0	2.2	5.3	6.4	6.4	7	6.4	5.3	5.1	3.8	0
	2000	0	0	2.3	5.5	6.6	6.6	7.2	6.6	5.5	5.3	3.9	0
	2010	0	0	2.2	5.4	6.5	6.4	7	6.5	5.3	5.2	3.8	0
	2020	0	0	2.8	6.9	8.3	8.3	9	8.3	6.8	6.7	4.9	0
	2030	0	0	2.8	6.7	8.1	8	8.8	8.1	6.7	6.5	4.8	0
	2040	0	0	2.7	6.5	7.8	7.8	8.5	7.8	6.4	6.3	4.6	0
	2050	0	0	2.6	6.3	7.6	7.5	8.2	7.6	6.2	6.1	4.5	0
UM07	1992	0	0	2.1	5	6.1	6.3	6.3	6.1	5	4.9	3.5	0
	2000	0	0	2.2	5.2	6.3	6.5	6.5	6.3	5.2	5	3.6	0
	2010	0	0	2.1	5.1	6.1	6.4	6.4	6.1	5	4.9	3.5	0
	2020	0	0	2.7	6.5	7.9	8.2	8.2	7.8	6.5	6.3	4.5	0
	2030	0	0	2.7	6.4	7.7	8	8	7.6	6.3	6.2	4.4	0
	2040	0	0	2.6	6.2	7.4	7.7	7.7	7.4	6.1	6	4.3	0
	2050	0	0	2.5	6	7.2	7.5	7.5	7.2	5.9	5.8	4.1	0
UM08	1992	0	0	2.3	5.6	6.6	6.5	7.2	6.8	5.6	5.4	4.1	0
	2000	0	0	2.4	5.8	6.8	6.8	7.4	7	5.8	5.6	4.2	0
	2010	0	0	2.4	5.7	6.7	6.6	7.3	6.9	5.7	5.5	4.1	0
	2020	0	0	3	7.3	8.6	8.5	9.3	8.8	7.3	7	5.3	0
	2030	0	0	2.9	7.1	8.3	8.3	9.1	8.6	7.1	6.8	5.1	0
	2040	0	0	2.9	6.9	8.1	8	8.9	8.4	6.9	6.6	5	0
	2050	0	0	2.8	6.7	7.9	7.8	8.6	8.1	6.7	6.4	4.9	0
UM09	1992	0	0	2.4	5.6	6.5	6.6	7.2	6.8	5.6	5.5	4.1	0
	2000	0	0	2.5	5.8	6.8	6.8	7.4	7	5.8	5.7	4.2	0
	2010	0	0	2.5	5.7	6.7	6.7	7.3	6.9	5.7	5.6	4.1	0
	2020	0	0	3.1	7.2	8.4	8.5	9.2	8.8	7.2	7	5.2	0
	2030	0	0	3	7.1	8.3	8.3	9.1	8.6	7	6.9	5.1	0
	2040	0	0	3	6.9	8.1	8.1	8.9	8.4	6.9	6.7	5	0
	2050	0	0	2.9	6.7	7.9	7.9	8.7	8.2	6.7	6.6	4.9	0
UM10	1992	0	0	3.4	7.2	7.9	7.8	8.3	7.7	6.4	6.5	5.2	0.2
	2000	0	0	3.6	7.6	8.4	8.2	8.7	8.1	6.8	6.9	5.5	0.2
	2010	0	0	3.6	7.6	8.4	8.2	8.8	8.2	6.8	6.9	5.5	0.2
	2020	0	0	4.6	9.6	10.6	10.4	11.1	10.3	8.6	8.7	6.9	0.2
	2030	0	0	4.5	9.5	10.5	10.3	11	10.2	8.6	8.6	6.9	0.2
	2040	0	0	4.5	9.4	10.4	10.2	10.9	10.1	8.5	8.5	6.8	0.2

Table A4 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM10	2050	0	0	4.4	9.3	10.3	10.1	10.7	10	8.4	8.4	6.7	0.2
UM11	1992	0	0	3.4	7.4	8.2	8	8.4	8	6.6	6.7	5.3	0.2
	2000	0	0	3.6	7.8	8.7	8.4	8.9	8.5	7	7.1	5.7	0.2
	2010	0	0	3.6	7.9	8.7	8.5	8.9	8.5	7	7.1	5.7	0.2
	2020	0	0	4.6	9.9	11	10.7	11.2	10.7	8.8	8.9	7.1	0.2
	2030	0	0	4.5	9.8	10.9	10.6	11.1	10.7	8.7	8.9	7.1	0.2
	2040	0	0	4.5	9.7	10.8	10.5	11	10.6	8.6	8.8	7	0.2
	2050	0	0	4.4	9.6	10.7	10.4	10.9	10.4	8.5	8.7	6.9	0.2
UM12	1992	0	0	5.1	8.5	9.1	8.4	9.4	8.4	7	7	5.9	0.5
	2000	0	0	5.5	9.2	9.8	9.1	10.1	9.1	7.6	7.5	6.3	0.5
	2010	0	0	5.6	9.3	10	9.3	10.3	9.3	7.8	7.7	6.5	0.5
	2020	0	0	7.1	11.7	12.6	11.7	12.9	11.6	9.7	9.6	8.1	0.7
	2030	0	0	7.1	11.8	12.6	11.7	13	11.6	9.7	9.6	8.1	0.7
	2040	0	0	7	11.7	12.6	11.7	12.9	11.6	9.7	9.6	8.1	0.7
	2050	0	0	7	11.7	12.6	11.6	12.9	11.6	9.7	9.6	8.1	0.7
UM13	1992	0	0	5.3	8.7	9.2	8.6	9.5	8.6	7.1	7.3	6.2	0.7
	2000	0	0	5.8	9.4	10	9.3	10.3	9.3	7.7	7.9	6.7	0.8
	2010	0	0	5.9	9.7	10.2	9.5	10.5	9.5	7.9	8.1	6.9	0.8
	2020	0	0	7.4	12.1	12.9	12	13.2	11.9	9.9	10.2	8.6	1
	2030	0	0	7.5	12.2	12.9	12	13.2	11.9	9.9	10.2	8.7	1
	2040	0	0	7.4	12.2	12.9	12	13.2	11.9	9.9	10.2	8.6	1
	2050	0	0	7.4	12.1	12.9	12	13.2	11.9	9.9	10.2	8.6	1
UM14	1992	0	0	7.9	12.3	12.6	11.7	12.7	11.6	10	10	9.3	1.7
	2000	0	0	8.5	13.3	13.6	12.6	13.7	12.5	10.8	10.8	10	1.9
	2010	0	0	8.7	13.7	14	12.9	14.1	12.9	11.1	11.1	10.3	1.9
	2020	0	0	10.9	17.1	17.5	16.2	17.6	16.1	13.9	13.9	12.9	2.4
	2030	0	0	11	17.3	17.7	16.4	17.8	16.3	14.1	14.1	13.1	2.4
	2040	0	0	11.1	17.4	17.8	16.5	18	16.4	14.2	14.2	13.2	2.5
	2050	0	0	11.2	17.5	17.9	16.6	18.1	16.6	14.3	14.3	13.3	2.5
UM15	1992	0	0.1	8	10.9	11.1	10.5	11.2	10.4	8.8	9.9	9.4	2.2
	2000	0	0.1	8.6	11.7	11.9	11.2	12.1	11.2	9.4	10.7	10.1	2.4
	2010	0	0.1	8.8	12.1	12.3	11.6	12.4	11.5	9.7	11	10.4	2.4
	2020	0	0.2	11	15.1	15.4	14.5	15.5	14.4	12.1	13.7	13	3
	2030	0	0.2	11.1	15.2	15.5	14.6	15.7	14.5	12.2	13.9	13.1	3.1
	2040	0	0.2	11.2	15.4	15.7	14.7	15.8	14.7	12.3	14	13.2	3.1
	2050	0	0.2	11.3	15.5	15.8	14.8	15.9	14.7	12.4	14	13.3	3.1
UM16	1992	0	0	8.6	12.1	12.5	11.4	12.6	11.6	10.1	10.4	10.1	2.5
	2000	0	0	9.3	13	13.5	12.3	13.6	12.5	10.8	11.2	10.9	2.7
	2010	0	0	9.6	13.4	13.9	12.7	14	12.9	11.2	11.6	11.3	2.8
	2020	0	0	12	16.8	17.4	15.9	17.6	16.2	14	14.5	14.1	3.5
	2030	0	0	12.1	17.1	17.7	16.1	17.8	16.4	14.2	14.7	14.3	3.5
	2040	0	0	12.3	17.2	17.9	16.3	18	16.6	14.4	14.8	14.5	3.5
	2050	0	0	12.3	17.4	18	16.4	18.1	16.7	14.5	14.9	14.6	3.6
UM17	1992	0	0	8.6	11.5	12	11.1	12.1	11.2	9.3	9.4	9.2	2.4
	2000	0	0	9.2	12.4	12.9	11.9	13	12.1	10	10.2	9.9	2.6

Table A4 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM17	2010	0	0	9.6	12.8	13.4	12.4	13.5	12.5	10.4	10.5	10.3	2.7
	2020	0	0	12	16.1	16.7	15.5	16.9	15.6	13	13.2	12.9	3.4
	2030	0	0	12.2	16.3	17	15.7	17.2	15.9	13.2	13.4	13.1	3.5
	2040	0	0	12.3	16.6	17.2	15.9	17.4	16.1	13.4	13.6	13.3	3.5
	2050	0	0	12.4	16.7	17.4	16.1	17.5	16.2	13.5	13.7	13.4	3.5
UM18	1992	0	0	8.8	11.6	12.1	11.2	12.3	11.4	9.6	9.5	9.5	2.7
	2000	0	0	9.5	12.5	13.1	12.1	13.3	12.3	10.4	10.3	10.3	2.9
	2010	0	0	9.9	13	13.5	12.5	13.8	12.8	10.8	10.7	10.6	3
	2020	0	0	12.4	16.4	17	15.8	17.3	16	13.5	13.5	13.4	3.8
	2030	0	0	12.6	16.7	17.3	16	17.6	16.3	13.8	13.7	13.6	3.8
	2040	0	0	12.8	16.9	17.6	16.3	17.9	16.6	14	13.9	13.8	3.9
	2050	0	0	13	17.1	17.8	16.5	18.1	16.7	14.1	14.1	14	3.9
UM19	1992	0	0.4	9	11.9	12.3	11.4	12.5	11.5	9.8	9.7	9.8	3.1
	2000	0	0.4	9.7	13	13.3	12.4	13.6	12.5	10.6	10.6	10.6	3.4
	2010	0	0.4	10.2	13.5	13.9	13	14.2	13.1	11.1	11	11.1	3.5
	2020	0	0.5	13	17.3	17.8	16.6	18.2	16.7	14.2	14.1	14.2	4.5
	2030	0	0.5	13.4	17.8	18.3	17.1	18.7	17.2	14.6	14.5	14.5	4.7
	2040	0	0.5	13.7	18.2	18.7	17.5	19.2	17.6	14.9	14.9	14.9	4.8
	2050	0	0.6	14	18.6	19.1	17.8	19.5	18	15.2	15.2	15.2	4.9
UM20	1992	0.2	0.6	9.2	12.4	13.3	12.2	13.3	12.1	10.3	10.4	10.3	3.9
	2000	0.3	0.7	10.1	13.5	14.5	13.3	14.5	13.2	11.2	11.4	11.3	4.2
	2010	0.3	0.7	10.5	14.1	15.2	13.9	15.2	13.8	11.7	11.9	11.8	4.4
	2020	0.3	0.9	13.5	18.1	19.5	17.8	19.5	17.7	15.1	15.2	15.1	5.7
	2030	0.4	0.9	13.9	18.7	20.1	18.3	20	18.3	15.5	15.7	15.5	5.9
	2040	0.4	0.9	14.3	19.2	20.6	18.8	20.6	18.8	16	16.1	16	6
	2050	0.4	1	14.6	19.6	21.1	19.2	21	19.2	16.3	16.4	16.3	6.1
UM21	1992	1.1	1.5	9.8	12.3	12.5	11.3	12.9	12.2	10.7	10.5	10.5	4.3
	2000	1.2	1.6	10.6	13.4	13.6	12.3	14	13.2	11.7	11.4	11.4	4.7
	2010	1.2	1.7	11.1	14	14.2	12.8	14.7	13.8	12.2	11.9	11.9	4.9
	2020	1.6	2.2	14.4	18.1	18.4	16.7	19	17.9	15.8	15.4	15.5	6.4
	2030	1.6	2.3	14.9	18.7	19	17.2	19.6	18.5	16.3	15.9	16	6.6
	2040	1.7	2.3	15.3	19.3	19.6	17.8	20.2	19.1	16.8	16.4	16.5	6.8
	2050	1.7	2.4	15.7	19.8	20.1	18.2	20.7	19.6	17.2	16.8	16.9	7
UM22	1992	1.1	1.6	9.5	12.2	12.3	11.5	12.9	12	10.3	10.1	10.2	4.5
	2000	1.2	1.7	10.4	13.3	13.5	12.5	14.1	13.1	11.2	11	11.1	4.9
	2010	1.3	1.8	10.9	13.9	14	13.1	14.7	13.7	11.7	11.5	11.6	5.1
	2020	1.7	2.3	14.1	18.1	18.3	17	19.1	17.8	15.2	14.9	15	6.6
	2030	1.7	2.4	14.6	18.7	18.9	17.6	19.8	18.4	15.7	15.4	15.6	6.9
	2040	1.8	2.4	15.1	19.3	19.5	18.2	20.4	19	16.2	16	16.1	7.1
	2050	1.9	2.6	15.5	19.8	20	18.6	21	19.5	16.6	16.4	16.5	7.3
UM24	1992	1.3	2.1	9.8	12.8	12.8	11.9	13.5	12.4	10.7	10.4	10.6	4.9
	2000	1.5	2.2	10.7	13.9	13.9	13	14.7	13.5	11.7	11.4	11.5	5.3
	2010	1.5	2.4	11.1	14.5	14.5	13.6	15.3	14.1	12.2	11.9	12	5.5
	2020	2	3.1	14.5	18.9	18.9	17.7	20	18.4	15.9	15.5	15.6	7.2
	2030	2.1	3.3	15	19.6	19.6	18.3	20.7	19	16.5	16	16.2	7.4

Table A4 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
UM24	2040	2.1	3.3	15.6	20.3	20.3	19	21.4	19.7	17.1	16.6	16.8	7.7
	2050	2.2	3.5	16	20.8	20.8	19.5	22	20.2	17.5	17	17.2	7.9
UM25	1992	1.4	2.2	9.9	12.7	12.7	11.9	13.4	12.4	10.7	10.5	10.5	4.8
	2000	1.5	2.4	10.8	13.8	13.9	13	14.7	13.5	11.7	11.4	11.4	5.3
	2010	1.6	2.5	11.2	14.4	14.4	13.5	15.3	14	12.2	11.9	11.9	5.5
	2020	2	3.2	14.6	18.8	18.8	17.7	19.9	18.3	15.9	15.5	15.5	7.2
	2030	2.1	3.4	15.2	19.5	19.5	18.3	20.6	19	16.5	16.1	16.1	7.4
	2040	2.2	3.4	15.7	20.1	20.2	18.9	21.3	19.6	17	16.6	16.6	7.7
	2050	2.2	3.6	16.1	20.7	20.7	19.4	21.9	20.2	17.5	17.1	17.1	7.9
UM26A	1992	1.4	2.2	9.9	12.7	12.7	11.9	13.4	12.4	10.7	10.5	10.5	4.8
	2000	1.5	2.4	10.8	13.8	13.9	13	14.7	13.5	11.7	11.4	11.4	5.3
	2010	1.6	2.5	11.2	14.4	14.4	13.5	15.3	14	12.2	11.9	11.9	5.5
	2020	2	3.2	14.6	18.8	18.8	17.7	19.9	18.3	15.9	15.5	15.5	7.2
	2030	2.1	3.4	15.2	19.5	19.5	18.3	20.6	19	16.5	16.1	16.1	7.4
	2040	2.2	3.4	15.7	20.1	20.2	18.9	21.3	19.6	17	16.6	16.6	7.7
	2050	2.2	3.6	16.1	20.7	20.7	19.4	21.9	20.2	17.5	17.1	17.1	7.9
UM26B	1992	13.1	14.9	21.7	23.2	22.7	22	23.7	21.7	21.1	22	20.9	18
	2000	15.5	16.9	25.6	27.3	26.7	26	27.9	25.6	24.8	25.9	24.6	21
	2010	17.4	19.7	28.7	30.7	30	29.2	31.3	28.8	27.9	29.1	27.6	24
	2020	20.5	22.4	33.8	36.1	35.4	34.4	36.9	33.9	32.9	34.3	32.6	28
	2030	21.4	24.2	35.2	37.7	36.9	35.9	38.5	35.4	34.3	35.8	34	29
	2040	22.2	24.2	36.5	39.1	38.3	37.2	39.9	36.7	35.5	37.1	35.2	31
	2050	22.8	25.8	37.5	40.1	39.3	38.2	41	37.7	36.5	38.1	36.2	31
UM27	1992	18.2	20.6	25.6	28.5	28.4	26.3	28.1	25.8	25	26.5	24.5	22
	2000	21.5	23.5	30.2	33.7	33.5	31.1	33.2	30.4	29.5	31.2	29	27
	2010	24.2	27.4	34	37.9	37.7	35	37.4	34.2	33.1	35.1	32.6	30
	2020	28.3	30.9	39.8	44.3	44.1	40.9	43.7	40	38.7	41.1	38.1	35
	2030	29.6	33.5	41.6	46.3	46.1	42.7	45.7	41.8	40.5	42.9	39.8	36
	2040	30.8	33.6	43.3	48.2	48	44.5	47.5	43.5	42.2	44.7	41.5	38
	2050	31.7	35.9	44.7	49.7	49.5	45.9	49	44.9	43.5	46.1	42.8	39
ILLA	1992	9.8	10.7	9.2	8.9	8.2	7.7	8.4	8	8.4	9.2	9.1	12
	2000	12.2	12.9	11.5	11.1	10.3	9.7	10.5	10	10.5	11.4	11.4	15
	2010	14.5	15.8	13.5	13.1	12.2	11.4	12.4	11.8	12.4	13.5	13.5	18
	2020	15.5	16.3	14.5	14	13	12.3	13.3	12.6	13.2	14.5	14.4	19
	2030	16.1	17.5	15	14.5	13.5	12.7	13.8	13.1	13.7	15	14.9	20
	2040	16.4	17.3	15.4	14.9	13.8	13	14.1	13.4	14	15.3	15.3	20
	2050	16.6	18.2	15.6	15.1	14	13.2	14.3	13.5	14.2	15.5	15.5	20
ILPE	1992	10.2	11.8	10	9.7	9.5	8.9	9	9	9.3	9.6	9.9	13
	2000	12.4	13.8	12.1	11.7	11.4	10.8	10.9	10.9	11.2	11.6	12	16
	2010	14.5	16.7	14.1	13.7	13.4	12.5	12.8	12.8	13.1	13.6	14	19
	2020	15.4	17.2	15	14.6	14.2	13.4	13.6	13.6	14	14.5	14.9	20
	2030	15.8	18.3	15.4	15	14.6	13.7	14	14	14.4	14.9	15.3	20
	2040	16.1	18	15.7	15.3	14.9	14	14.2	14.2	14.6	15.1	15.6	21
	2050	16.3	18.8	15.9	15.4	15.1	14.2	14.4	14.4	14.8	15.3	15.8	21
ILSR	1992	7.3	7.9	7.9	8.2	8.1	7.6	8.2	7.5	7.6	7.8	7.9	10

Table A4 (cont.)
Traffic Intensity (Mean Vessels/Day) for the UMR-IWW System for Scenario 3, With-Project Conditions

Pool	Year	Jan	Feb	Mar	Apr	May	Jun	Jly	Aug	Sep	Oct	Nov	Dec
LSR	2000	8.3	8.7	9	9.3	9.2	8.7	9.3	8.5	8.7	8.9	9	12
	2010	9.5	10.4	10.3	10.7	10.6	9.9	10.7	9.8	10	10.2	10.3	13
	2020	10.1	10.7	11	11.4	11.3	10.6	11.4	10.4	10.6	10.9	11	14
	2030	10.5	11.5	11.4	11.8	11.7	11	11.8	10.8	11	11.3	11.4	15
	2040	10.8	11.4	11.7	12.2	12	11.3	12.2	11.1	11.3	11.6	11.8	15
	2050	11	12.1	12	12.5	12.3	11.5	12.4	11.4	11.6	11.9	12	15
LMA	1992	6.8	7	7.5	7.7	7.7	7.5	7.9	7.4	7.5	7.5	7.5	9.1
	2000	7.5	7.5	8.4	8.6	8.6	8.3	8.8	8.2	8.4	8.3	8.4	10
	2010	8.6	8.8	9.5	9.7	9.7	9.4	9.9	9.3	9.5	9.5	9.5	12
	2020	9.1	9	10.1	10.4	10.4	10.1	10.6	9.9	10.1	10.1	10.1	12
	2030	9.4	9.6	10.4	10.7	10.7	10.4	10.9	10.2	10.4	10.4	10.4	13
	2040	9.7	9.6	10.7	11	11	10.7	11.2	10.5	10.7	10.7	10.7	13
	2050	9.9	10.1	11	11.3	11.3	10.9	11.5	10.8	11	10.9	11	13
LDI	1992	5.9	6.2	7	7.7	8.1	8	8.3	7.6	8.1	8	7.4	7.7
	2000	6.4	6.5	7.6	8.3	8.8	8.6	9	8.2	8.8	8.6	8	8.4
	2010	7.2	7.6	8.6	9.4	9.8	9.7	10.2	9.2	9.8	9.7	9	9.4
	2020	7.7	7.8	9.2	10	10.5	10.4	10.8	9.9	10.5	10.4	9.6	10
	2030	8	8.4	9.5	10.4	11	10.8	11.3	10.3	10.9	10.8	10	10
	2040	8.3	8.4	9.9	10.8	11.4	11.2	11.7	10.6	11.4	11.2	10.4	11
	2050	8.6	9	10.2	11.1	11.7	11.5	12.1	11	11.7	11.5	10.7	11
LBR	1992	6.8	7.3	7.9	8.8	9.6	9.2	9.6	8.9	9	8.8	8.3	8.7
	2000	7.4	7.6	8.6	9.6	10.4	10	10.5	9.7	9.8	9.6	9	9.4
	2010	8.3	8.9	9.7	10.8	11.8	11.3	11.8	11	11.1	10.8	10.1	11
	2020	8.9	9.2	10.4	11.6	12.6	12.1	12.7	11.8	11.9	11.6	10.9	11
	2030	9.4	10	10.9	12.2	13.2	12.7	13.3	12.4	12.5	12.2	11.4	12
	2040	9.8	10.1	11.4	12.8	13.9	13.3	13.9	12.9	13.1	12.7	11.9	13
	2050	10.2	10.9	11.9	13.3	14.4	13.8	14.5	13.4	13.6	13.2	12.4	13
LLO	1992	6.8	7.2	7.9	8.8	9.6	9.1	9.4	8.9	8.9	8.7	8.3	8.7
	2000	7.4	7.5	8.6	9.5	10.5	9.9	10.2	9.7	9.7	9.5	9	9.5
	2010	8.3	8.8	9.7	10.7	11.8	11.2	11.6	11	10.9	10.7	10.2	11
	2020	9	9.1	10.5	11.5	12.7	12	12.4	11.7	11.7	11.5	10.9	11
	2030	9.4	9.9	11	12.1	13.3	12.6	13	12.3	12.3	12	11.4	12
	2040	9.8	10	11.5	12.6	13.9	13.2	13.6	12.9	12.9	12.6	12	13
	2050	10.2	10.7	11.9	13.1	14.4	13.7	14.1	13.4	13.4	13	12.4	13
LTOB	1992	6.4	6.8	7	8.1	8	8	7.6	8.2	8.4	7.8	7.4	7.7
	2000	7.2	7.4	8	9.2	9.1	9	8.6	9.2	9.5	8.9	8.4	8.6
	2010	8.3	8.7	9.1	10.5	10.4	10.3	9.8	10.6	10.9	10.1	9.6	9.9
	2020	8.8	9	9.7	11.2	11.1	11	10.5	11.3	11.6	10.8	10.2	11
	2030	9.2	9.7	10.1	11.7	11.5	11.5	10.9	11.7	12.1	11.3	10.6	11
	2040	9.5	9.7	10.5	12.1	12	11.9	11.4	12.2	12.5	11.7	11	11
	2050	9.8	10.4	10.8	12.5	12.4	12.3	11.7	12.6	12.9	12.1	11.4	12

Appendix B
Mussel Bioenergetics Model Initial Conditions and Parameters

Mussel Bioenergetics Model Initial Conditions

Pool-specific initial conditions for tissue energy, tissue dry weight, shell energy, shell dry weight and shell length were calculated via the following equations. We assumed mussels to be one year of age.

Pool 13

$$SL_0 = 0.0068550 \times Age^3 - 0.4318429 \times Age^2 + 9.7916577 \times Age + 3.2610581, \quad Age = 1$$

$$Wt_0 = 0.0015 \times (SL_0{}^{2.6419}) \times 0.03$$

$$Ws_0 = 0.0015 \times (SL_0{}^{2.5620})$$

$$Et_0 = Wt_0 \times 22.5$$

$$Es_0 = Ws_0 \times 22.5$$

Pool 26

$$SL_0 = 0.0140520 \times Age^3 - 0.8170876 \times Age^2 + 16.2119671 \times Age - 6.1828848, \quad Age = 1$$

$$Wt_0 = 0.00202084 \times (SL_0{}^{2.55148}) \times 0.03$$

$$Ws_0 = 0.00227046 \times (SL_0{}^{2.4551})$$

$$Et_0 = Wt_0 \times 22.5$$

$$Es_0 = Ws_0 \times 22.5$$

LaGrange Pool

$$SL_0 = 0.0081078 \times Age^3 - 0.5345261 \times Age^2 + 13.5837809 \times Age - 2.9339400, \quad Age = 1$$

$$Wt_0 = 0.00202084 \times (SL_0{}^{2.55148}) \times 0.03$$

$$Ws_0 = 0.00227046 \times (SL_0{}^{2.4551})$$

$$Et_0 = Wt_0 \times 22.5$$

$$Es_0 = Ws_0 \times 22.5$$

Table B1 **Model Parameters for the Threeridge Mussel for Pool 13 in the UMR-IWW System**				
Paramete r	**Definition**	**Value**	**Units**	**Reference**
Et_0	Initial tissue energy	0.5625	kJ	Calculated from initial conditions
Wt_0	Initial tissue dry weight	0.0250	g/dry weight	Calculated from initial conditions
Es_0	Initial shell energy	22.612	kJ	Calculated from initial conditions
Ws_0	Initial shell dry weight	1.005	g/dry weight	Calculated from initial conditions
SL_0	Initial shell length	12.627	mm	Whitney et al. 1997a
K_a	Filtration rate at 20°C	19.0	mL/g/hour	Payne et al. 1997
b_a	b_a in filtering rate equation	0.637	nondimension	Schaeffer et al. 1998
AE	Assimilation efficiency	0.54	nondimension	Schaeffer et al. 1998
k_a	Conversion constant – food to energy	20.0	kJ/g dry	Lucas 1996
G	Weight of a single glochidia	1.60E-7	g	Stein 1973
N	Number of glochidia/brood	1.71E+	nondimension	Stein 1973
B	Brood time	24.0	days	Stein 1973
k_p	Conversion constant – glochidia to energy	22.5	kJ/g	Schaeffer et al. 1998
k_e	Proportion of assimilated material that is	0.10	nondimension	Professional judgement

Table B2
Model Parameters for the Threeridge Mussel for Pool 26 in the UMR-IWW System

Paramete r	Definition	Value	Units	Reference
Et_0	Initial tissue energy	0.2703	kJ	Calculated from initial conditions
Wt_0	Initial tissue dry weight	0.0120	g/dry weight	Calculated from initial conditions
Es_0	Initial shell energy	11.952	kJ	Calculated from initial conditions
Ws_0	Initial shell dry weight	0.5312	g/dry weight	Calculated from initial conditions
SL_0	Initial shell length	9.2260	mm	Whitney et al. 1997b
K_a	Filtration rate at 20°C	19.0	mL/g/hour	Payne et al. 1997
b_a	$b_{a.}$ in filtering rate equation	0.637	nondimension	Schaeffer et al. 1998
AE	Assimilation efficiency	0.54	nondimension	Schaeffer et al. 1998
k_a	Conversion constant – food to energy	20.0	kJ/g dry	Lucas 1996
G	Weight of a single glochidia	1.60E-7	g	Stein 1973
N	Number of glochidia/brood	1.71E+	nondimension	Stein 1973
B	Brood time	24.0	days	Stein 1973
k_p	Conversion constant – glochidia to energy	22.5	kJ/g	Schaeffer et al. 1998
k_e	Proportion of assimilated material that is	0.10	nondimension	Professional judgement

Table B3
Model Parameters for the Threeridge Mussel for the LaGrange Pool in the UMR-IWW System

Paramete r	Definition	Value	Units	Reference
Et_0	Initial tissue energy	1.1002	kJ	Calculated from initial conditions
Wt_0	Initial tissue dry weight	0.0489	g/dry weight	Calculated from initial conditions
Es_0	Initial shell energy	46.125	kJ	Calculated from initial conditions
Ws_0	Initial shell dry weight	2.05	g/dry weight	Calculated from initial conditions
SL_0	Initial shell length	15.99	mm	Whitney et al. 1997b
K_a	Filtration rate at 20°C	19.0	mL/g/hour	Payne et al. 1997
b_a	b_a in filtering rate equation	0.637	nondimension	Schaeffer et al. 1998
AE	Assimilation efficiency	0.54	nondimension	Schaeffer et al. 1998
k_a	Conversion constant – food to energy	20.0	kJ/g dry	Lucas 1996
G	Weight of a single glochidia	1.60E-7	g	Stein 1973
N	Number of glochidia/brood	1.71E+	nondimension	Stein 1973
B	Brood time	24.0	days	Stein 1973
k_p	Conversion constant – glochidia to energy	22.5	kJ/g	Schaeffer et al. 1998
k_e	Proportion of assimilated material that is	0.10	nondimension	Professional judgement

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14. ABSTRACT

The Navigation Study Mussel Ecological Risk Assessment presents an assessment of the potential ecological risks posed by commercial traffic on freshwater mussels that live in the main channel and main channel borders of the Upper Mississippi River-Illinois Waterway (UMR-IWW) System. Backwaters were not included in this risk assessment. The assessment examines the possibility that commercial vessel-induced increases in suspended sediments might impair the growth and reproduction of freshwater mussels.

Risks to mussels posed by commercial traffic resulting from two improvement scenarios were evaluated. Scenario 2 consists of guidewall extensions at UMR Locks 20-25 to be in place by 2008, while Scenario 3 consists of guidewall extensions at UMR Locks 14-18 and lock extensions at UMR Locks 20-25 to be in place by 2012. The scenarios are presented as increases in the average daily number of vessels traversing each pool on the UMR-IWW System (i.e., tows/day).

The threeridge mussel (*Amblema plicata*) was selected to represent the freshwater mussel community in the UMR-IWW System. It is one of the most common species and is widespread throughout the UMR-IWW System. Additionally, it is one of the most important commercially harvested species.

(Continued)

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14. ABSTRACT (Concluded).

A bioenergetics model for the threeridge mussel was developed and implemented for locations in the UMR-IWW System where mussel beds are known to occur. Freshwater mussel bed locations are included in a geographic information system (GIS) data base. For this risk assessment, selected locations included mussel beds in UMR Pools 13 and 26 and the IWW LaGrange Pool. Results of the model simulations indicated that increases in suspended sediment concentrations associated with traffic increases resulting from Scenarios 2 and 3 do not affect the growth and reproduction of threeridge mussels for five locations in Pool 13, three locations in Pool 26A, one location in Pool 26B, and fifteen locations in the LaGrange Pool.

The Navigation Study Mussel Ecological Risk Assessment was organized according to the fundamental components of the ecological risk assessment process: problem formulation, analysis (characterization of exposure and characterization of ecological effects), and risk characterization. The risk assessment methodology described in this report has been developed to assess the potential ecological impacts associated with the anticipated growth of commercial traffic navigating the UMR-IWW System for the period 2000-2050. Assessments of potential impacts on early life stages of fish, adult fish, and fish spawning habitat, as well as impacts on the breakage, growth, and reproduction of submerged aquatic plants, have concurrently been developed.

The next phase in assessing traffic impacts on mussels will be to incorporate the current methodology into a framework that characterizes risk in probabilistic terms. More detailed, probabilistic assessments will be performed for selected locations and traffic scenarios identified by the preliminary analyses. Parameters used in the calculations (e.g., suspended sediment concentrations produced by the NAVSED model, mussel growth and filtering rates) that are imprecisely known will be defined as statistical distributions. Monte Carlo simulation methods will be used to propagate these uncertainties through the model calculations to produce distributions of impacts on growth and reproduction in relation to specific traffic scenarios. These distributions of results can be used to estimate the probability of different magnitudes of impact in a manner consistent with probabilistic risk estimation.

15. SUBJECT TERMS (Concluded)

Ecological risk assessment
Impacts of commercial navigation on mussel growth and reproduction
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