Adaptive Environmental Management for the Columbia River Channel Improvement Project:

Annual Report for 2013–2014
and
Final Project Report

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List of Acronyms and Abbreviations

AEM	Adaptive Environmental Management
AFEP	Anadromous Fish Evaluation Program
AMP	adaptive management process
AMT	Adaptive Management Team
BiOp	Biological Opinion
CORIE	Columbia River Environment
CMOP	Center for Coastal Margin Observation and Prediction
CRCIP	Columbia River Channel Improvement Project
CRM	Columbia River Mile
CZMA	Coastal Zone Management Act
DLCD	Department of Land and Conservation Development
E2	E2 Consulting Engineers, Inc.
FTP	file transfer protocol
LCR	Lower Columbia River
LCREP	Lower Columbia River Estuary Partnership
MA	Monitoring Action
MCR	mouth of the Columbia River
NMFS	National Marine Fishery Service
NOAA	National Oceanic and Atmospheric Administration
O&M	operations and maintenance
OCMP	Oregon Coastal Management Program
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OHSU	Oregon Health and Science University
PRG	Project Review Group
psu	practical salinity unit
QA/QC	quality assurance/quality control
RFP	request for proposal
SD	standard deviation
SEF	Sediment Evaluation Framework
SIL	salinity intrusion length
SHO	salmon habitat opportunity
SWH	shallow water habitat
UDB	Upper Dobelbower
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WDOE	Washington Department of Ecology
woody	Woody Island
WST	Westport
YOY	young of the year

1 Introduction

This 2013–2014 report continues the series of annual reports produced for the Adaptive Environmental Management (AEM) Program for the Columbia River Channel Improvement Project (CRCIP). The first annual report was developed for the calendar year 2006, which was the first full year of Project construction and implementation of the CRCIP AEM Program. Subsequent annual reports were produced for calendar years 2007–2012. The 2013–2014 annual report documents the activities and results of Project construction and ecosystem restoration and mitigation activities completed through the conclusion of the AEM Program.

Each CRCIP AEM Annual Report is developed as a separate stand-alone document for the convenience of the reader. Therefore, the previously developed background materials that describe the adaptive management process (AMP) for the CRCIP AEM Program are presented in each annual report. There is considerable redundancy among the annual reports. Again, this is intentional to save the reader from having to consult each previous annual report for important background materials developed as part of the CRCIP AEM Program.

To provide a degree of continuity from year-to-year, the 2013–2014 annual report also briefly reviews the major AEM results and decisions for calendar year 2012. The results for Monitoring Action (MA)-1 for 2012 are presented for convenient comparison with the 2013 results. In addition, each of the monitoring activities includes a continuous summary of decisions made during the course of the CRCIP AEM Program. However, the details of the 2012 AEM activities are described more fully in the 2012 CRCIP AEM Program annual report.

The 2013–2014 annual report has been expanded in scope to also serve as a final report for the CRCIP AEM Program. The report is intended to briefly review the development of the project goals and objectives and state the corresponding outcomes of the AEM process. Beginning in 2003 and continuing for more than a decade, the AEM Program remains as one of the few formal adaptive management efforts implemented by the USACE. This final project report documents this successful effort.

1-1 CRCIP Construction and Operations & Maintenance

The CRCIP navigation channel construction began in June 2005 and was completed in November 2010. The Project transitioned into the long-term operations and maintenance (O&M) phase in 2011. The AEM Program continued into the first few years of the O&M phase to evaluate post-construction monitoring results, which are discussed throughout the 2013–2014 report.

Columbia River peak flows in 2013 and 2014, while not as great as 2011 and 2012, remained high compared to average flows. Widespread shoaling continued to impact O&M of the navigation channel. Annual maintenance dredging quantities remain within anticipated estimates.

All of the monitoring and management components of the Project AEM Program have been completed. The process and resolution of each program component is summarized in this final report.

1-2 Ecosystem Restoration and Mitigation

Ecosystem restoration and mitigation continued as important components of the CRCIP during 2013 and 2014. These activities primarily served as sources of additional information for more comprehensive evaluation of the Project by the Adaptive Management Team (AMT). However, restoration and mitigation activities associated with the Project did not enter directly into the decision-making aspects of the AEM Program. Correspondingly, formal decision criteria were not developed to evaluate the restoration or mitigation activities within the framework of the CRCIP AEM Program.

The principal mitigation activities in 2013 and 2014 included the continued restoration of native riparian vegetation and/or wetlands at the Chumbley, Cottonwood, and Webb sites. The plantings at the Chumbley site continue to thrive. To facilitate the restoration of native plants, invasive vegetation removal was completed in 2013 and 2014, as well as mowing in 2014. Mowing and spraying invasive vegetation to protect the new plantings on Cottonwood Island was completed in 2013 and 2014. Restored areas at the Webb site were mowed in the early summer and late fall in 2013 and 2014. Continuing maintenance plans at Webb involve repairs to the wetland berm and future evaluations to ensure successful management of flows. The mitigation activities for flows and depths at the Webb site were designed in part to enhance overwintering foraging habitat for migratory waterfowl.

1-3 Annual Report Structure

By design, the CRCIP AEM Annual Reports have been similar in structure throughout the AEM Program. Following a brief description of the overall CRCIP AEM process, each MA of the adaptive management effort is addressed. Summaries of the monitoring results for the current assessment year (e.g., 2013) are provided along with comparisons of the results to the AEM decision criteria. Decisions reached by the AMT concerning adaptive management for each of the MAs during the assessment year are tabulated in each annual report.

Detailed accounts of the actions of the AMT, minutes of the quarterly AMT meetings, and additional supporting information are documented in the CRCIP AEM Workbook. The workbook is updated as additional monitoring data become available. The workbook provides ongoing documentation of the AEM process throughout the AEM Program. The workbook is reviewed by the AMT at each of the quarterly meetings. An electronic working version of the workbook is available to the AMT at the website (www.e2tm.com/CRCIP) hosted by E2 Consulting Engineers, Inc. (E2).

1-4 CRCIP AEM Process

The AEM process developed for the CRCIP includes the following steps for adaptively managing the environmental resources of concern in relation to channel deepening (Bartell 2004):

1. Results of the ongoing monitoring programs are summarized and reported quarterly to the AMT.

2. The AMT evaluates monitoring results in relation to the consensus management decision criteria (see Appendix D in Bartell 2004).

3. If none of the decision criteria are exceeded, the AEM process can continue with the current monitoring programs until the next evaluation (i.e., Step 1).

4. If decision criteria are exceeded, the AMT can request the United States Army Corps of Engineers (USACE) to explain the variances or offer a mitigation plan.

5. Based on an evaluation of the USACE submission, the AMT may (a) determine that there is no justification for changing the current management practices, or (b) recommend changes to the current management practices and/or modifications to the decision criteria.

6. Following resolution of the proposed adaptive management actions and possible revisions to monitoring and criteria recommended by the AMT, the AEM process cycles back to analysis and review of new data and information at the next quarterly meeting.

The steps in the above described AEM process are schematically illustrated in the following AEM plan flowchart (Figure 1-4.1).

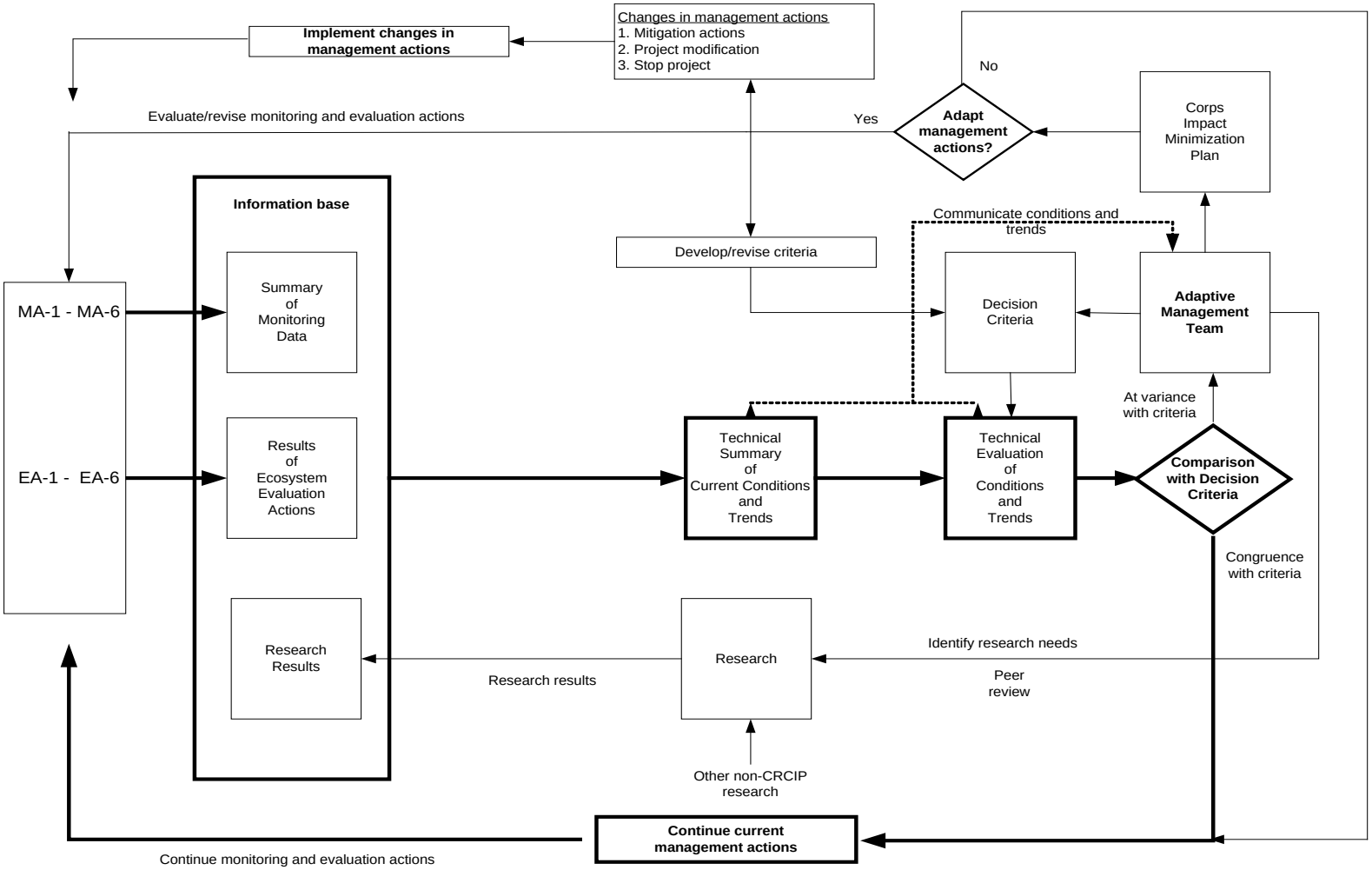


Figure 1-4.1. Flowchart describing the AEM process for the CRCIP.

1-5 AEM Program Summary and Conclusion

The AEM Program continued into the first few years of the O&M phase to evaluate post-construction monitoring results. The following AMT consensus decisions regarding the continued implementation of the CRCIP adaptive management program resulted from AMT discussions that continued throughout 2013 and subsequently to the conclusion of the AEM Program in 2014:

- MA-1: concluded that changes to physical parameters as a result of CRCIP are minor and occur in proximity to the navigation channel. The statistical analysis of depth, temperature, and salinity monitoring results for the selected Columbia River Environment (CORIE) stations began in 2003 and continued through December 2013. At the January 2014 meeting, the AMT members reached consensus that the CRCIP had no measurable impact on the monitored parameters during or subsequent to channel modification and therefore the MA-1 activities have been completed as part of the AEM Program.

- MA-2: concluded that CRCIP dredging volumes did not exceed planned placement capacity. Projected and actual project construction total dredging and placement volumes were evaluated in 2010. The primary reasons for differences in dredging volume were changes made to improve accounting definitions of new and maintenance work. Placement at upland sites did not exceed projected volumes. As a result, at the July 2010 meeting, AMT members agreed that they had no concerns and reached consensus that MA-2 requirements have been completed as part of the AEM Program. Annual dredging and placement volumes will continue to be reported in accordance with project O&M requirements (No change from 2011).

- MA-3: concluded that river bottom side-slope adjustments caused by CRCIP dredging occurred as expected (intermittently adjacent to the navigation channel). The results of the annual crossline bathymetric surveys were presented and discussed by the AMT beginning in 2007 and continuing through 2013. Overall variances in local accretion or erosion compared to the pre-Project decision criteria were determined to be consistent with the natural sediment dynamics of the Lower Columbia River (LCR). The AMT concluded at the November 2013 meeting that the construction and operation of the Project channel improvements had no significant impacts on the sediment dynamics described by the crossline surveys and that the MA-3 requirements had been completed for the AEM Program.

- MA-4: concluded that modeling results did not indicate a significant change to shallow water habitat or salmon habitat opportunity as a result of CRCIP. Initially, this monitoring action was to compare results of ongoing juvenile salmon habitat estuary studies for time periods before and after CRCIP construction; however, the studies changed focus during CRCIP so an alternative approach to MA-4 was required. During 2013 and 2014, Drs. Antonio Baptista [Oregon Health and Science University (OHSU)] and Daniel Bottom [National Oceanic and Atmospheric Administration (NOAA)] recalculated juvenile salmon habitat opportunity (SHO) and shallow water habitat (SWH) using revised and updated models, data, and bathymetry. The results of the revised

calculations indicated that CRCIP modifications to the LCR and estuary would have minimal impacts on SHO or SWH. The AMT reached consensus during 2014 discussions of the model results and concluded that AEM Program requirements for MA-4 had been completed.

- MA-5: concluded that CRCIP dredging would not expose aquatic organisms to toxic contaminants. At the July 2011 meeting, sediment evaluation results were presented to the AMT. The Project Review Group determined that all material from the project channel is suitable for unconfined aquatic placement. The AMT reached consensus that AEM Program requirements for MA-5 had been completed. The next testing is required after 10 years (in 2018) during the O&M phase for compliance with Sediment Evaluation Framework (SEF) (No change from 2011).

- MA-6: concluded that modeling results did not indicate an increase in fish stranding as a result of CRCIP. Initially, this monitoring action was to compare results of fish stranding field studies before and after CRCIP construction. The pre-construction field study was completed; however, post-Project stranding modeling and analysis by Dr. Walter Pearson (Peapod Research) (2011) indicated that the planned repeat post-construction field study would not likely have sufficient statistical power to determine changes in stranding probability as a result of CRCIP. During 2013, a formal peer review of the Dr. Walter Pearson (Peapod Research) (2011) post-Project stranding analysis was completed by the United States Geological Survey (USGS). The USGS confirmed Dr. Pearson's conclusions and also indicated that the pre-project studies, while competently performed, were constrained by statistical power and posed technical challenges in designing post-project studies. Based on the results of the USGS review, the AMT concluded that post-Project stranding studies would not be required. The AMT reached consensus at the April 2013 meeting that the AEM Program requirements for MA-6 had been completed.

- Bank to Bank Survey: the post-construction survey two years after construction required by Washington Department of Ecology (WDOE) was completed in 2012. The bathymetry changes observed within the LCR estuary between 2004 and 2012 (before and after construction) were evaluated by USACE. The report provided to the AMT in 2014 concluded that changes are not attributed to CRCIP and, therefore, the requirement has been met in its entirety. The requirement to complete another bank-to-bank bathymetric survey five years after the State of Washington's required survey from the 2005 National Marine Fishery Service (NMFS) Biological Opinion was superseded by the 2012 Biological Opinion which did not contain the requirement.

- Sediment Management: this program component addressed concerns about potential impacts to valued coastal zone habitats caused by placement of dredged material from CRCIP. Nearshore sites were given priority over estuarine and deepwater ocean placement. The USACE regional sediment management program will continue into the O&M phase [Jarod Norton (USACE)] (No change from 2011).

- Sturgeon: this program component addressed concerns about potential CRCIP impacts to sturgeon. Studies were completed to describe the behavioral response of tagged white

sturgeon to dredging activities and develop a model that predicts sturgeon habitat quality based on descriptions of channel physical characteristics. The study findings did not indicate that CRCIP would result in adverse effects to sturgeon. Green sturgeon tagging and detection was performed by USGS in 2010 with funding from O&M. The sturgeon component of the AEM Program is considered completed.

- Crab: this program component addressed concerns about potential CRCIP impacts to Dungeness crab. This requirement is completed by compliance with Oregon and Washington's 401 requirements and Oregon Department of Land and Conservation Development's (DLCD) Coastal Zone Consistency Determination (No change from 2011).

- Smelt: this program component addressed concerns about potential CRCIP impacts to smelt (Eulachon). USACE consulted with NMFS and project effects to Eulachon (now listed under the Endangered Species Act) are fully evaluated in the 2012 Biological Opinion. The assessment of potential CRCIP impacts on smelt has been completed.

The AMT recognizes that these current consensus decisions define the final disposition of the CRCIP AEM Program.

2 Monitoring Action 1—Physical, Chemical Data

The following figures and tables summarize the MA-1 results of monitoring depth, temperature, and salinity values in relation to channel improvements for the calendar year 2013, which was the final year of monitoring. The results are based on analyses of verified data downloaded from the CORIE public website (www.ccalmr.ogi.edu/CORIE). Note that the CORIE stations have become integrated as part of the Center for Coastal Margin Observation and Prediction (CMOP). Data can now be retrieved from the CMOP observation network (www.stccmop.org/datamart/observation_network). The AEM Program monitoring data are obtained from three sampling stations located in the lower river and estuary: tansy, grays, and cbnc3 (Figure 2-1).

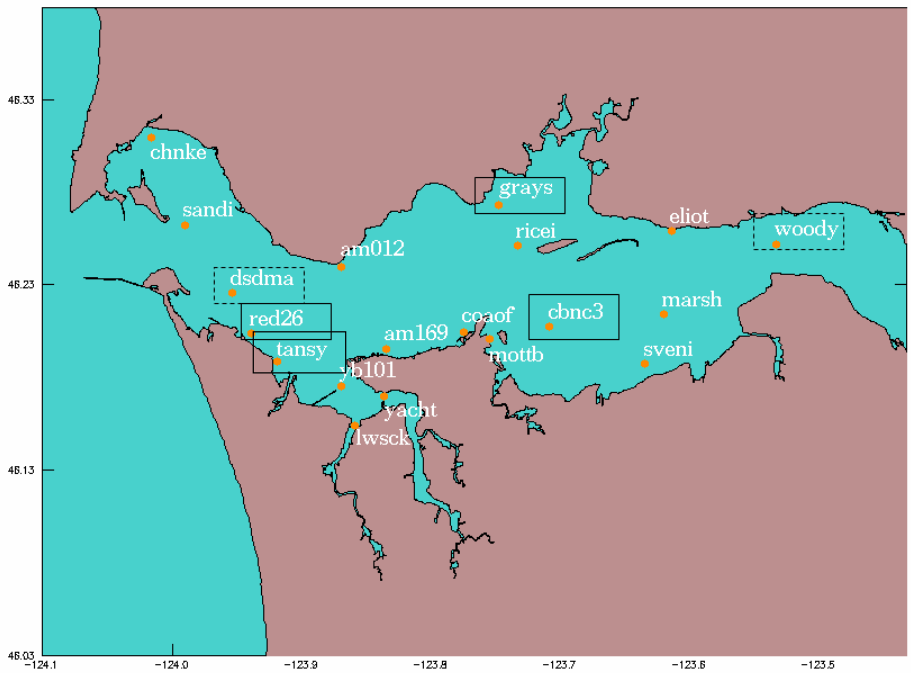


Figure 2-1. Location of CORIE monitoring stations in the LCR and estuary. The three stations (tansy, grays, and cbnc3) indicated by the solid rectangles provide data for MA-1. The two stations indicated by the dashed rectangle provide salinity (dsdma) and temperature [Woody Island (woody)] data used in normalization of the data collected at the three MA-1 stations.

CORIE monitoring data collected from 1996–2004 provided the pre-Project (baseline) physical chemical data (i.e., depth, water temperature, and salinity). Decision criteria were defined for depth, temperature, and salinity through analyses of these data. Two sets of criteria were defined during the development of the AEM plan in calendar years 2004–2005: (1) the upper and lower bounds of the 90% confidence interval were defined by the 5th and 95th percentile values computed for each month, and (2) the upper and lower bounds of the 60% confidence interval

were defined by the 20th and 80th percentile computed monthly values. These values were approved as AEM decision criteria by the CRCIP AMT.

The available data for 2013 reflect the operational status of the CORIE (or CMOP) stations required for the MA-1 analyses. The following CORIE data were available for analysis for calendar year 2013:

- grays: temperature, salinity and depth (January through December 2013);
- tansy: temperature and salinity (January through December 2013);
- woody: temperature (January through December 2013);
- cbnc3: temperature and salinity (reconstructed January through December 2013); and
- dsdma: salinity (September through December 2013).

Reconstructing Data for cbnc3

Water temperature and salinity data were obtained for cbnc3 during April, May, and June of 2013 at depths of 6.9 and 9.0 meters. Shyam Nair (E2) calculated the correlations between data sampled at the two different depths. The correlation for water temperature was 0.9998. The correlation for salinity was 0.9657. Based on these analyses, it was possible to use the correlations to fill in missing temperature and salinity data at 6.9 m depth using available data at 9.0 m depth for cbnc3. These interpolated data were used in the MA-1 analysis of temperature and salinity for cbnc3 for 2013.

2-1 Depth

As in previous years (2006–2012), water depth data were only available for the grays sampling station in 2013 (Figure 2-1.1).

Depth data were available for the grays station through December 2013. Similar to previous years of monitoring, the daily values for 2013 are nearly centered within the 20th–80th percentile decision criteria.

Table 2-1.1 lists the monthly median depth values calculated using the 2013 data from the grays station. All reported 2013 monthly values were within the 20th–80th percentile range of the decision criteria derived from the 1996–2004 pre-Project data.

The median depth values computed from the continuous monitoring data obtained for the grays station during 2013 have been plotted with values developed using data collected during the pre-construction “baseline” years (1996–2004), corresponding values computed during Project construction (2005–2010), and post-construction monitoring (2010–2013). Simple inspection of the results illustrated in Figure 2-1.2 suggests that the median depth values associated with the CRCIP AEM monitoring (2005–2013) are not different from the baseline depths for the grays station. The central tendency values fluctuate around ~2 m during the entire period. High and low values for 2005–2013 lie within ranges of extreme values computed for the baseline years. Based on the analysis of extensive monitoring results (i.e., 2005–2013), the AMT concluded that

the CRCIP construction and operations have had no measurable impact on the depth values at the grays station compared to baseline.

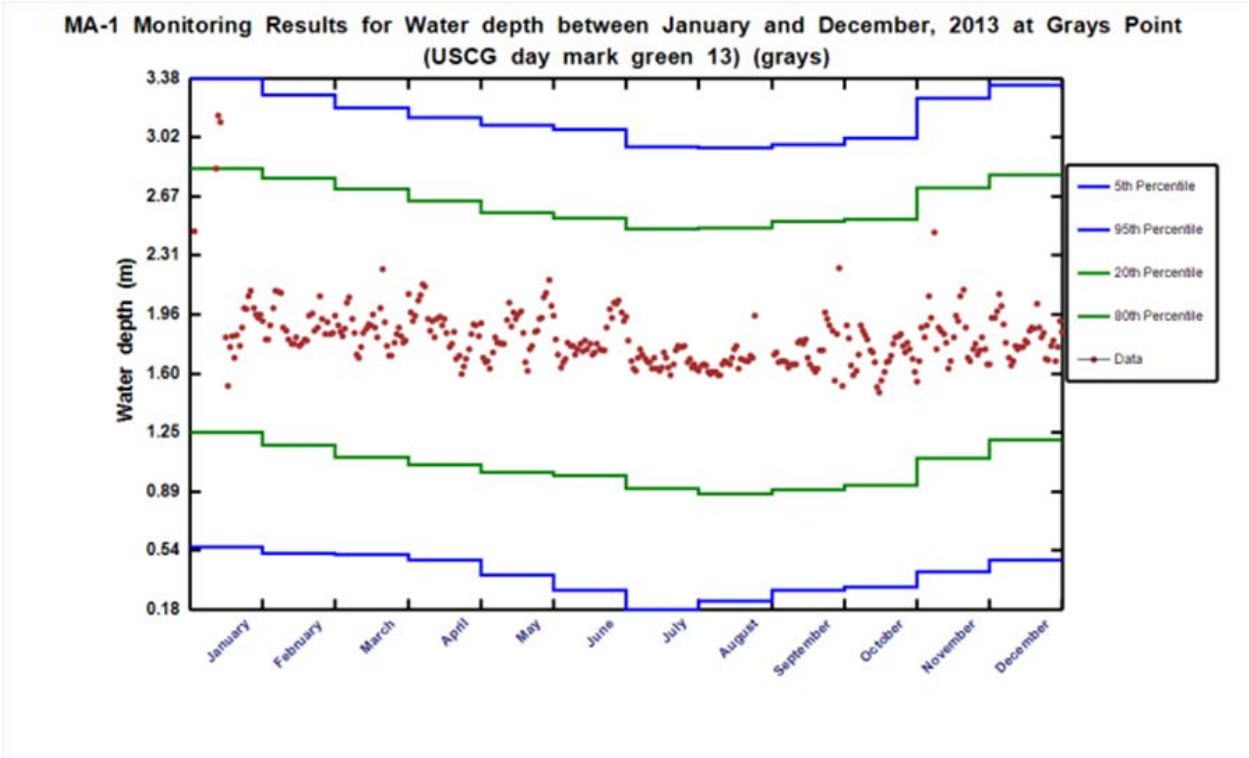


Figure 2-1.1. Daily median values of depth for the grays sampling location for 2013 plotted in relation to the CRCIP AEM decision criteria.

Table 2-1.1. Summary of 2013 Monthly Median Depth Values (bold numbers) for grays Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Depth Meters											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	0.6	0.5	0.5	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.4	0.5
20	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.9	1.1	1.2
	2.0	**1.9**	**1.9**	**1.9**	**1.9**	**1.8**	**1.7**	**1.7**	**1.8**	**1.7**	**1.8**	**1.8**
80	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.7	2.8
95	3.4	3.3	3.2	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.3	3.3

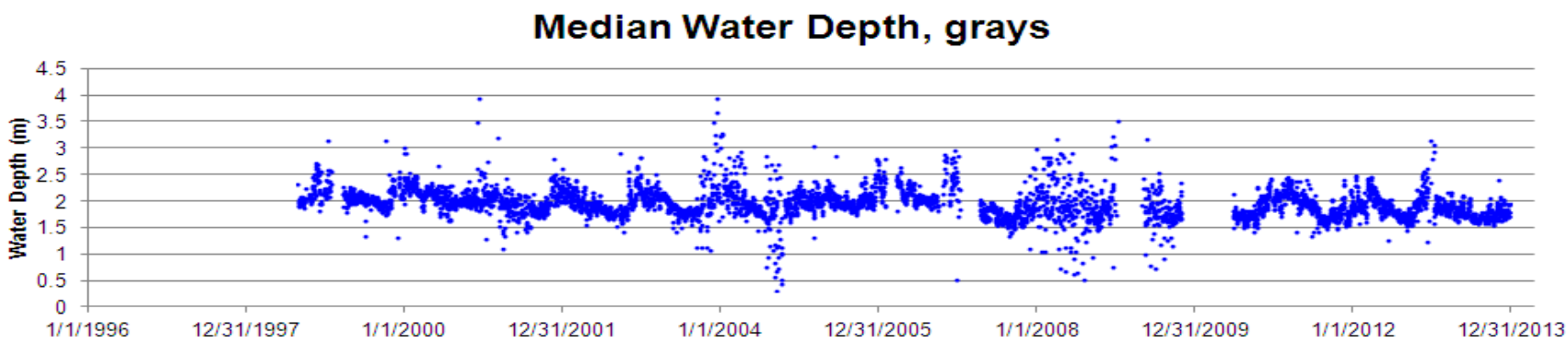


Figure 2-1.2. Time series of median water depths computed for the grays CORIE (or CMOP) station. Baseline monthly AEM decision criteria were derived using median depths for 1996–2004. The CRCIP construction period span from 2005–2010. Post-construction AEM monitoring continues through 2013.

2-2 Temperature

Figure 2-2.1(a,b,c) shows the daily median water temperature values calculated for 2013 for the three CORIE stations: tansy, grays, and cbnc3. The daily values are plotted in relation to the monthly percentile decision criteria established prior to the Project construction by the AMT. These decision criteria were estimated using CORIE data from 1996–2004 (i.e., pre-Project).

Daily median water temperature values calculated for the tansy station during January–March 2013 were generally within the 20th and 80th percentile decision criteria (Figure 2-2.1a). However, temperatures were lower in mid-January and ranged between the 5th and 20th percentile decision criteria, but subsequently returned to mid-range values for the remainder of the monitoring period. The daily median water temperature values for April–August 2013 were generally within the 80th and 95th percentile decision criteria. Temperatures were elevated during this time period, although the majority of the values for July and August were between the 20th and 80th decision criteria. Values calculated for the tansy station for the September–October 2013 period were generally within the 80th and 95th percentile decision criteria for September and the first half of October. Temperatures appeared somewhat elevated during this time. The values for the remainder of October were between the 20th and 80th decision criteria. Temperature values for the tansy station for November 2013 were generally within the 20th–80th percentile decision criteria. Values in late November and most of December 2013 were typically within the 5th and 20th percentile decision criteria or lower than the 5th percentile value. Lower water temperatures during this period appeared to largely reflect colder weather characteristic of the Northwest during December 2013.

For January–March 2013, daily median values of water temperature computed for the grays station demonstrated a temporal pattern similar to the tansy station (Figure 2-2.1b). With the exception of mid-January, when temperatures were generally lower and between the 5th and 20th percentile .decision criteria, daily median values were within the 20th and 80th percentile decision criteria. However, daily values for the last week in March ranged between the 80th and 95th percentiles, with several values exceeding the 95th percentile values at the end of March. For April–August 2013, daily median values for the grays station demonstrated a temporal pattern similar to the tansy station, although somewhat less elevated than tansy. Temperature values at grays were generally within the 20th and 80th percentile decision criteria. However, daily values for the first week in June ranged between the 5th and 20th percentiles; values in the last week of June were within the 80th and 95th percentile criteria. Values for the second half of August were similarly within the 80th and 95th percentile criteria. For the September–October 2013 period, daily median values of water temperature for the grays station were similar in pattern to the tansy station, although somewhat less elevated than tansy. Temperature values at grays were generally within the 20th and 80th percentile decision criteria. However, daily values for the first half of September slightly exceeded the 95th percentiles. Daily median values for the grays station showed a temporal pattern similar to the tansy station in November and December 2013. Temperature values at grays were generally within the 20th and 80th percentile decision criteria in November. However, daily values for most of December were less than the 5th percentile decision value.

Temperature values for cbnc3 were reconstructed for January through December 2013 using the previously described correlation (Figure 2-2.1c). The overall seasonal pattern of temperatures computed for cbnc3 was similar to the tansy and grays stations. Temperatures were generally within the 20th–80th decision values for the January–August period, with the exception of lower than average values for late January and warmer temperatures for August and early September. The daily median values for early September, similar to the grays station, somewhat exceeded the 95th percentile decision criteria. However, computed values for the remainder of September and early October returned to within the 20th–80th percentile range. The daily median values for November, similar to the grays station, were generally within the 20th and 80th percentile decision criteria. However, computed values for the first half of December were less than the 5th percentile value. Temperatures varied within the 5th and 20th percentile decision criteria for the second half of December.

Tables 2-2.1–2-2.3 list the calculated monthly average median values for 2013 and the corresponding temperature decision criteria derived from analysis of the pre-Project data (1996–2004). The monthly averaged median temperature values for tansy were within the 5th–20th decision criteria for January (Table 2-2.1). The February–April values were within the 20th–80th decision criteria. The May, June, and July values were within the 80th–95th criteria. The August, October, and November values were within the 20th–80th percentile decision criteria. The monthly averaged median temperature value for September was within the 80th–95th decision criteria. The December 2013 monthly value was within the 5th–20th percentile decision criteria.

The monthly averaged median temperature values computed for grays were within the 20th–80th percentile decision criteria for the February–August and October–November time periods during 2013 (Table 2-2.2). The monthly value for January was within the 5th–20th decision criteria. The value for September was within the 80th–95th percentile decision criteria. The December 2013 monthly average value for grays was equal to the 5th percentile decision criteria.

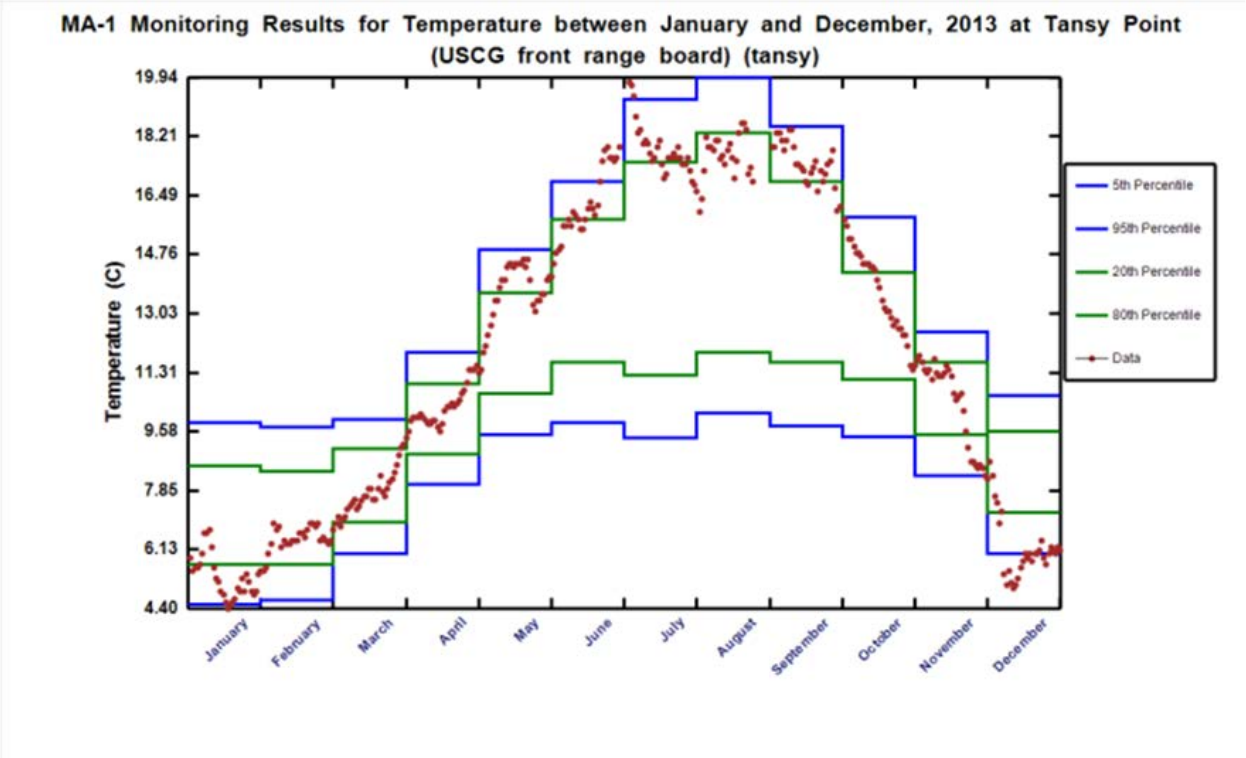
The monthly averaged median temperature values for cbnc3 were within the 20th–80th decision criteria for all months in 2013 except September (Table 2-2.3). The September 2013 value was within the 80th–95th percentile decision criteria.

To further evaluate the potential impacts of channel modification on water temperatures, the daily median values for 2013 were plotted against corresponding baseline values (1996–2004) for the upriver woody sampling location [Figure 2-2.2(a,b,c)]. Water temperatures at woody are primarily determined by river flows. Explicit decision criteria were not formulated by the AMT to evaluate the nature of the MA-1 temperature values relative to the woody baseline data. Normalized temperature plots were developed for the tansy, grays and cbnc3 stations. Inspection of the normalized temperature plots for January–March 2013 indicated several outlier points in comparison with the clusters of points defined by the pre-construction data. The lower daily median temperatures computed for mid-January for tansy, grays, and woody produced points on the normalized plots that were slightly outside the pre-Project cluster (i.e., 1996–2004), but consistent in the overall pattern defined by the pre-Project normalization. The plotted daily 2013 values of temperature for the tansy, grays, and cbnc3 stations were within the corresponding clusters of normalized temperature points defined by the pre-Project data [Figure 2-2.2 (a,b,c)].

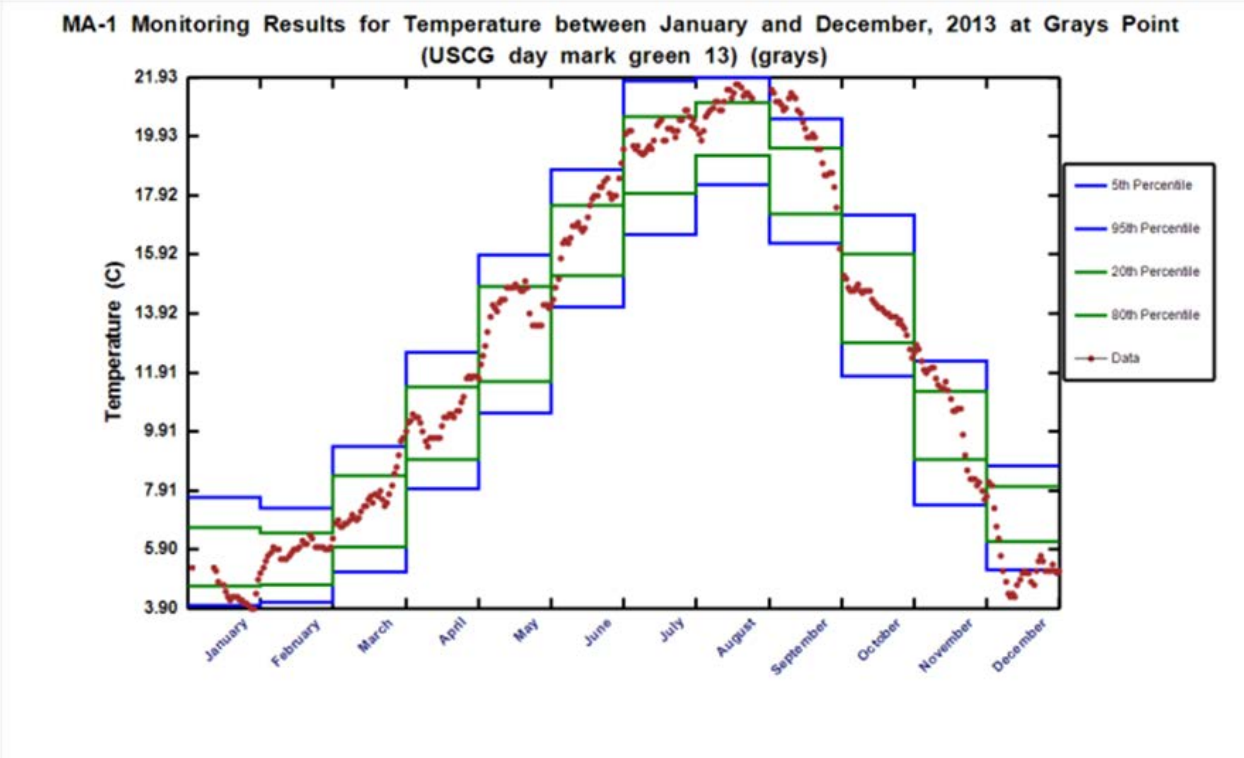
Figure 2-2.3 (a,b,c,d) places the annual temperature values for tansy, grays, and cbnc3 in a longer-term context. The daily median temperature values are plotted as a function of time from 1996–2013. Data from 1996–2004 were used to derive the monthly pre-Project decision criteria used in the AEM Process. Data after 2004 correspond to the period of construction (2005–2010) and post construction monitoring (2010–2013). Longer-term data are also provided for the woody station. Data gaps are also evident in the Figure 2-2.3 plots. The longer-term plots hint at longer-term fluctuations in temperature. For example, the data for tansy (Figure 2-2.3a) suggest slightly cooler summer maximum temperatures and warmer winter minimum temperatures from 1998–2006 with subsequent increases to near 1997 values during 2007–2013. Such longer-term fluctuations are less evident for the grays, cbnc3, and woody stations. Examining the data in a longer-term context further suggests that the Project had no measurable impact on water temperatures in the LCR and estuary.

Analysis of the post-Project construction CORIE data available through December 2013 continues to suggest that the channel improvements did not have any measurable impact on water temperatures recorded at the MA-1 stations.

(a)


MA-1 Monitoring Results for Temperature between January and December, 2013 at Tansy Point
(USCG front range board) (tansy)
Temperature (C)
19.94
18.21
16.49
14.76
13.03
11.31
9.58
7.85
6.13
4.40
January
February
March
April
May
June
July
August
September
October
November
December
5th Percentile
95th Percentile
20th Percentile
80th Percentile
Data

(b)


MA-1 Monitoring Results for Temperature between January and December, 2013 at Grays Point
(USCG day mark green 13) (grays)
Temperature (C)
21.93
19.93
17.92
15.92
13.92
11.91
9.91
7.91
5.90
3.90
January
February
March
April
May
June
July
August
September
October
November
December
5th Percentile
95th Percentile
20th Percentile
80th Percentile
Data

(c)

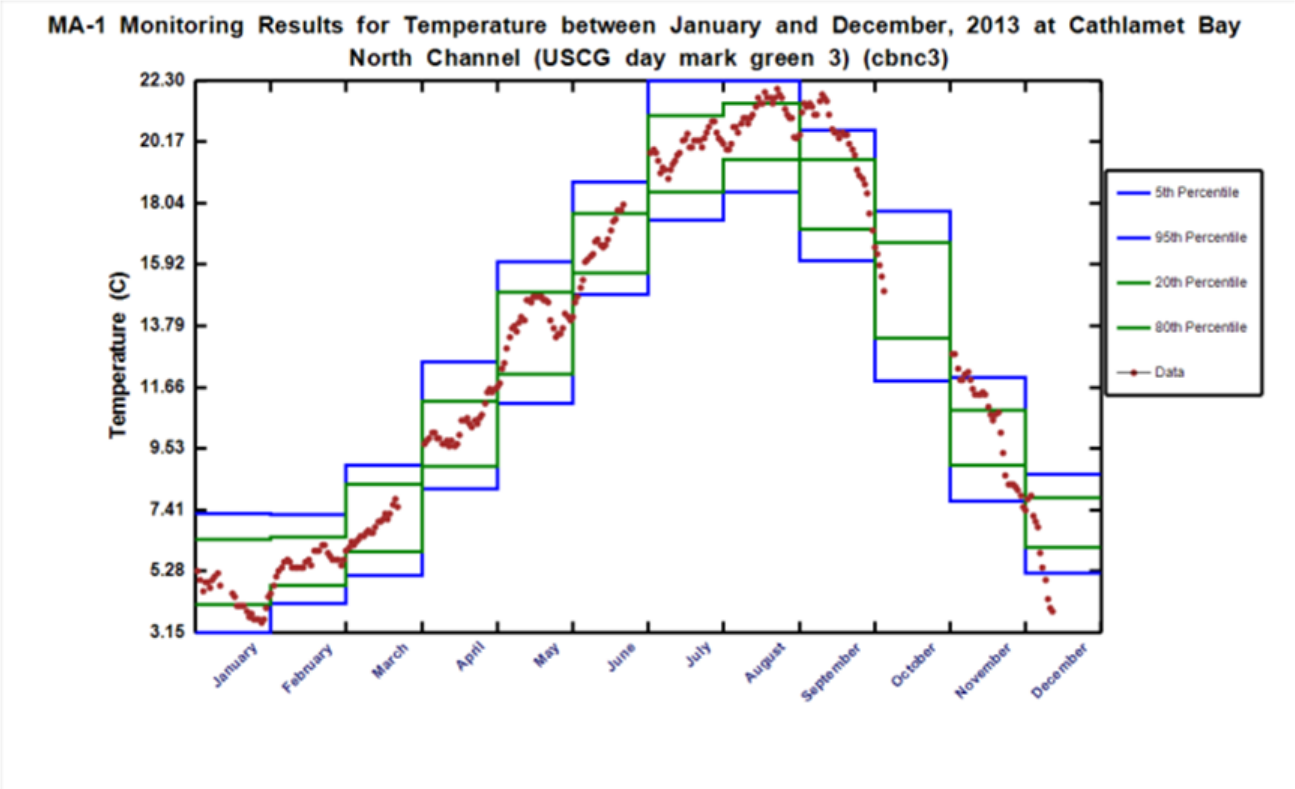


Figure 2-2.1. Daily median values of water temperature for (a) tansy, (b) grays, and (c) cbnc3 sampling stations for 2013 plotted in relation to the CRCIP AEM decision criteria. Interpolated temperature data are plotted for cbnc3.

Table 2-2.1. Summary of 2013 Monthly Median Temperature Values (bold numbers) for tansy Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Temperature C											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	4.5	4.6	6.0	7.0	9.5	9.8	9.4	10.1	9.8	9.4	8.3	6.0
	5.5											**6.2**
20	5.7	5.7	6.9	8.9	10.7	11.6	11.2	11.9	11.6	11.1	9.5	7.2
		6.6	**7.8**	**10.2**	**No data**			**17.6**		**13.9**	**10.6**	
80	8.9	8.4	9.1	11.0	13.6	15.8	17.5	18.3	16.9	14.2	11.6	9.6
					13.7	**16.0**	**18.0**		**17.4**			
95	9.8	9.7	9.9	11.9	14.9	16.9	19.3	19.9	18.5	15.8	12.5	10.6

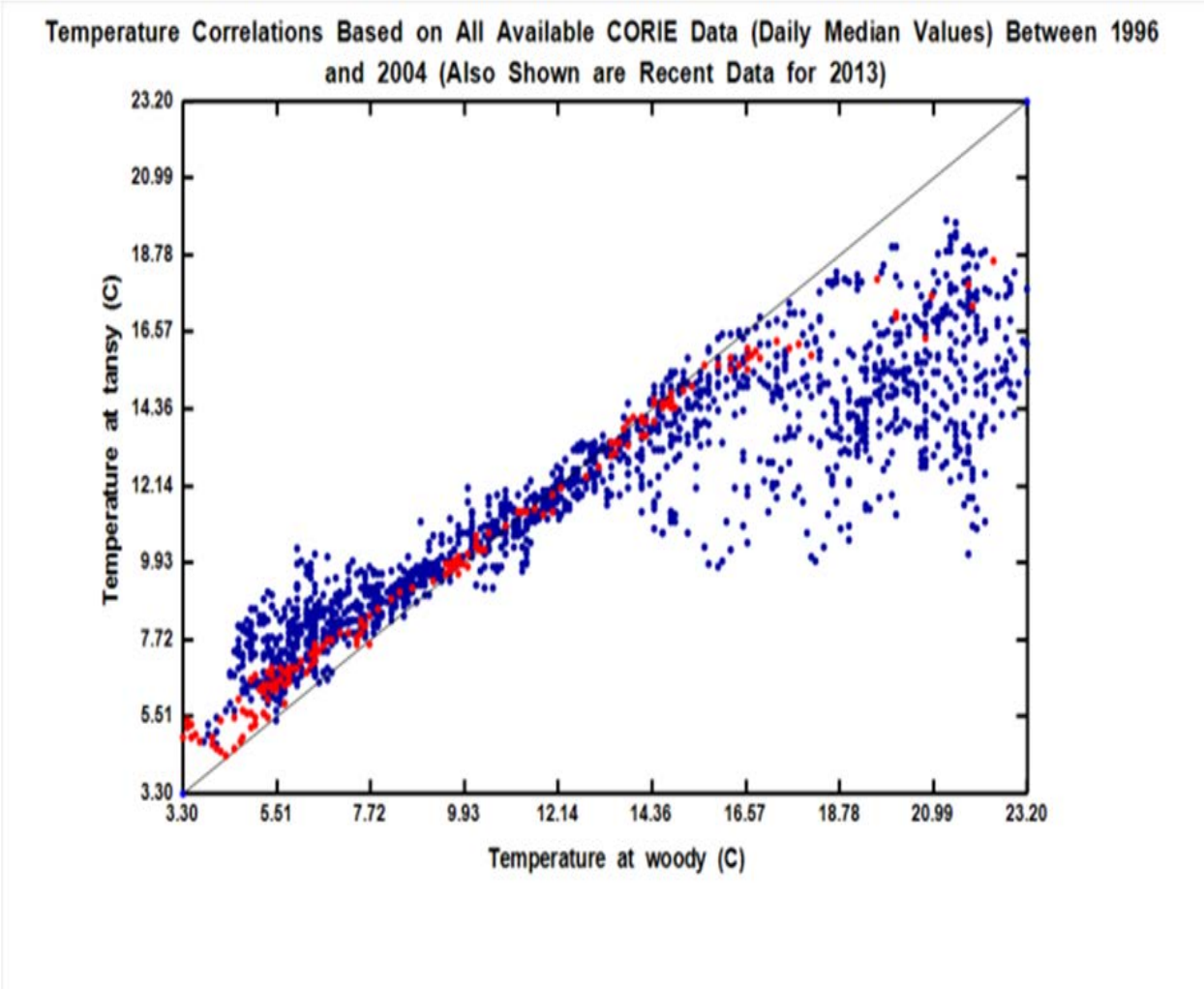
Table 2-2.2. Summary of 2013 Monthly Median Temperature Values (bold numbers) for grays Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Temperature C											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
												5.2
5	4.0	4.1	5.2	8.0	10.5	14.1	16.6	18.3	16.3	11.8	7.4	5.2
	4.3											
20	4.7	4.7	6.0	9.0	11.6	15.2	18.0	19.3	17.3	12.9	9.0	6.2
		5.9	**7.4**	**10.4**	**14.2**	**17.5**	**20.0**	**21.0**		**14.1**	**10.8**	
80	6.6	6.5	8.4	11.4	14.8	17.6	20.6	21.1	19.5	15.9	11.3	8.0
									20.1			
95	7.7	7.3	9.4	12.6	15.9	18.8	21.8	21.9	20.5	17.3	12.3	8.8

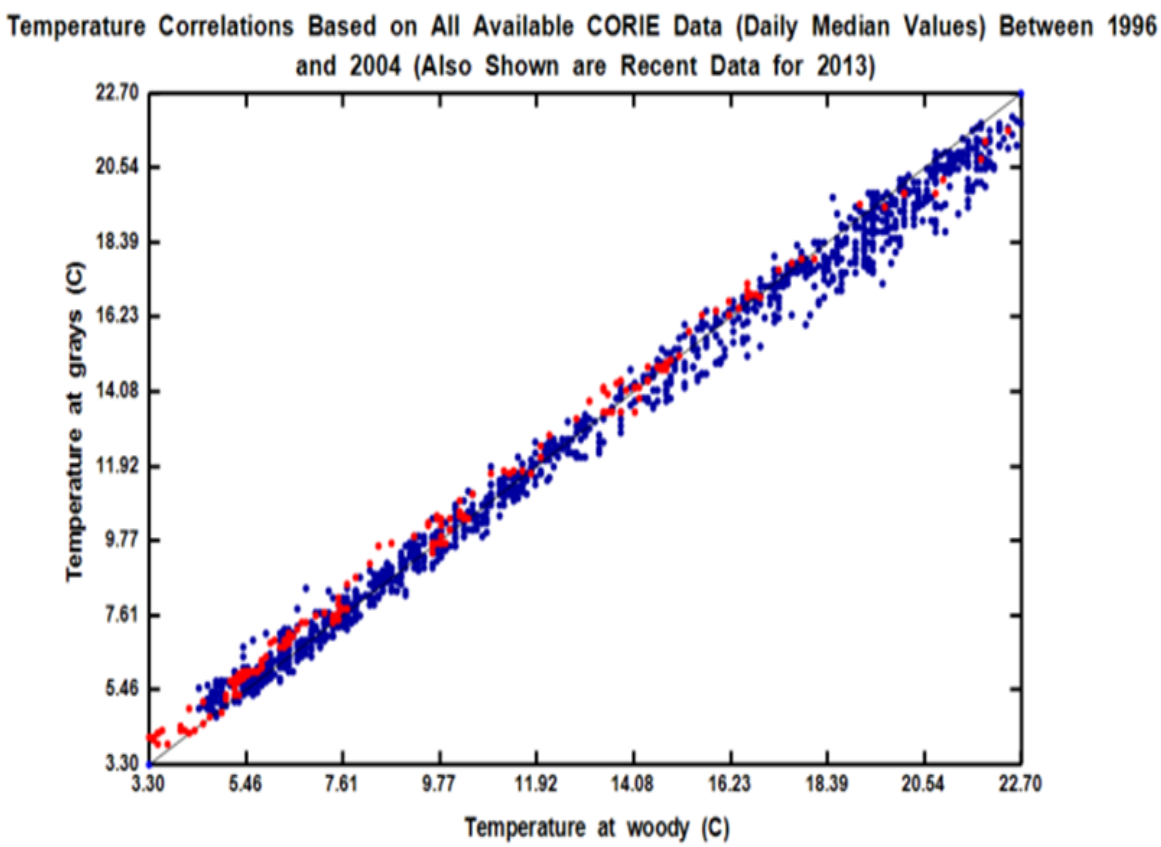
Table 2-2.3. Summary of 2013 Monthly Median Temperature Values (bold numbers) for cbnc3 Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Temperature C											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	3.2	4.2	5.1	8.1	11.1	14.9	17.4	18.4	16.0	11.9	7.7	5.2
20	4.1	4.8	6.0	8.9	12.1	15.6	18.4	19.5	17.1	13.4	9.0	6.1
	4.3	**5.6**	**6.8**	**10.2**	**14.0**	**16.6**	**20.1**	**21.1**		**15.7**	**10.9**	**6.3**
80	6.4	6.5	8.3	11.2	15.0	17.7	21.1	21.5	19.5	16.7	10.9	7.8
									20.4			
95	7.3	7.2	9.0	12.6	16.0	18.8	22.3	22.3	20.6	17.8	12.0	8.6

(a)


Temperature Correlations Based on All Available CORIE Data (Daily Median Values) Between 1996 and 2004 (Also Shown are Recent Data for 2013)
Temperature at tansy (C)
Temperature at woody (C)
23.20
20.99
18.78
16.57
14.36
12.14
9.93
7.72
5.51
3.30
3.30
5.51
7.72
9.93
12.14
14.36
16.57
18.78
20.99
23.20

(b)


Temperature Correlations Based on All Available CORIE Data (Daily Median Values) Between 1996 and 2004 (Also Shown are Recent Data for 2013)
Temperature at grays (C)
Temperature at woody (C)
22.70
20.54
18.39
16.23
14.08
11.92
9.77
7.61
5.46
3.30
3.30
5.46
7.61
9.77
11.92
14.08
16.23
18.39
20.54
22.70

(c)

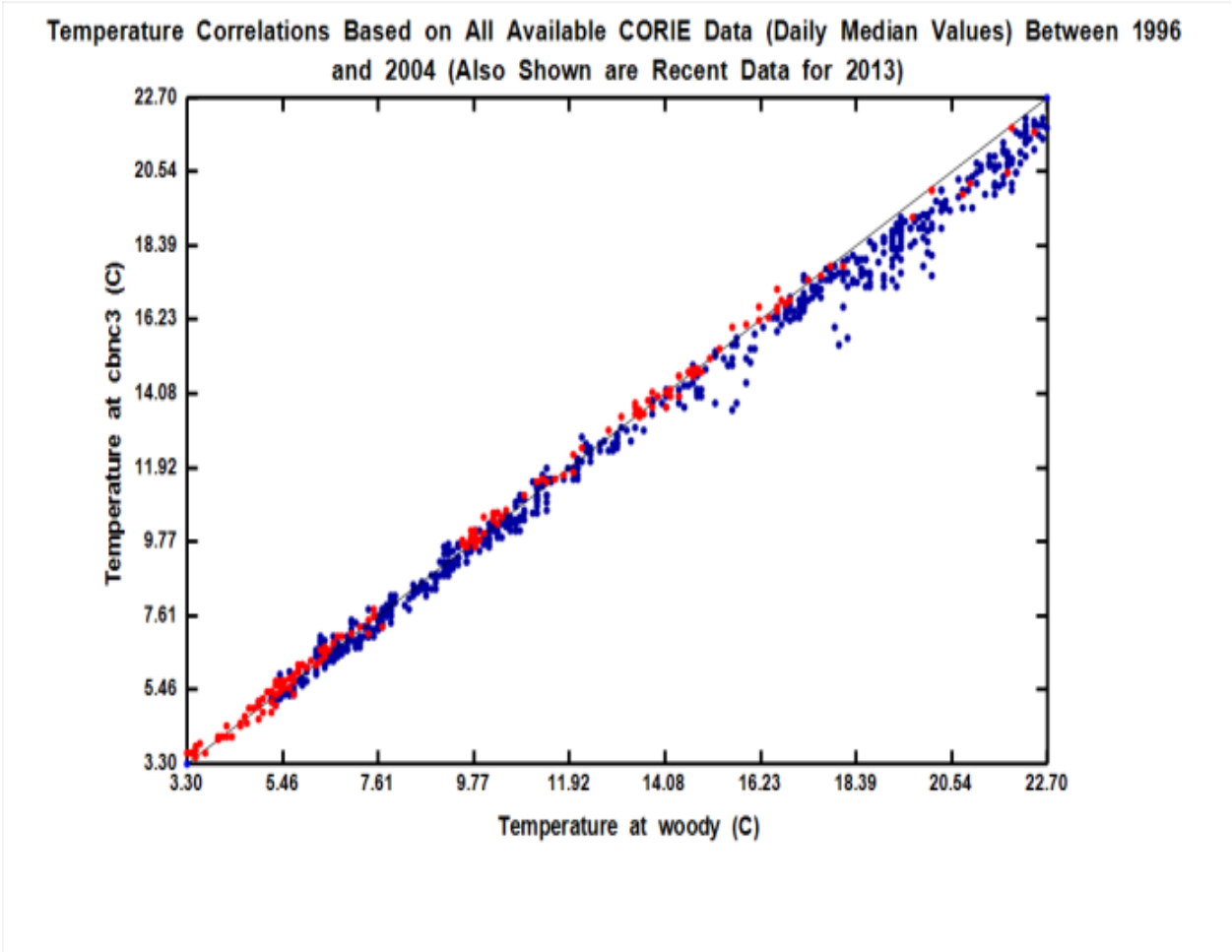
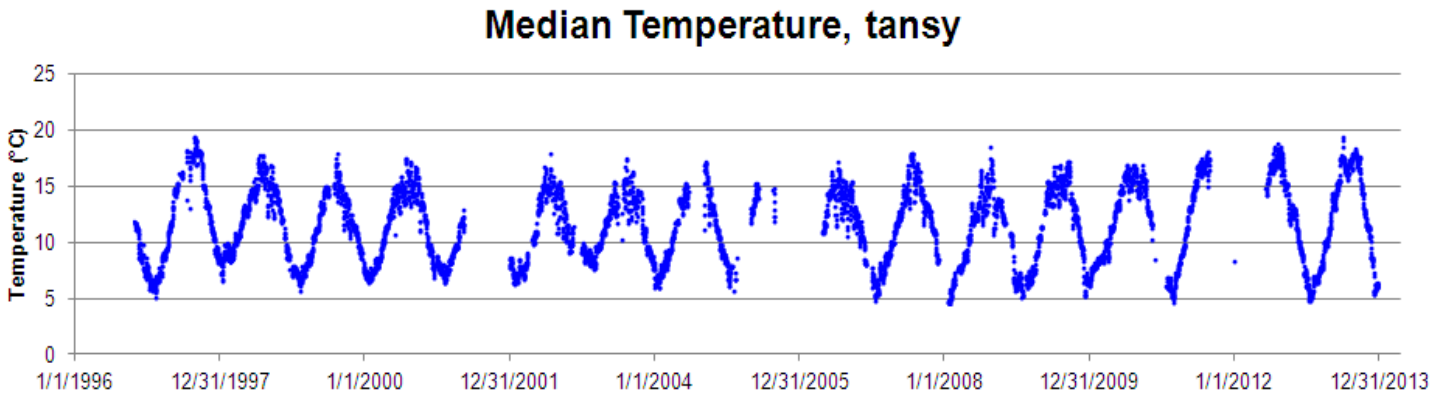
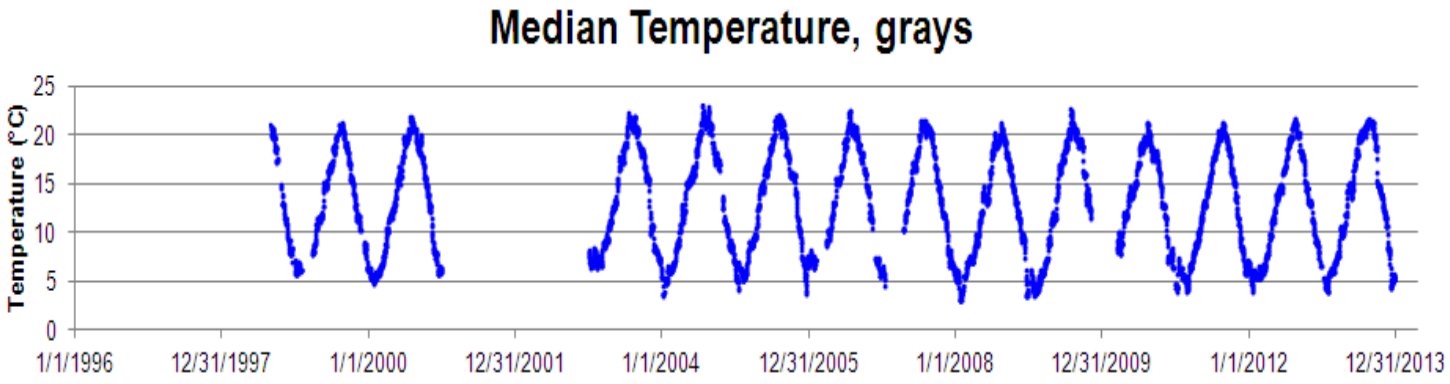


Figure 2-2.2. Median daily water temperatures for (a) tansy (b) grays, and (c) cbnc3 stations plotted for 2013 against median daily water temperatures for the "woody" station. Interpolated temperature data are plotted for cbnc3.

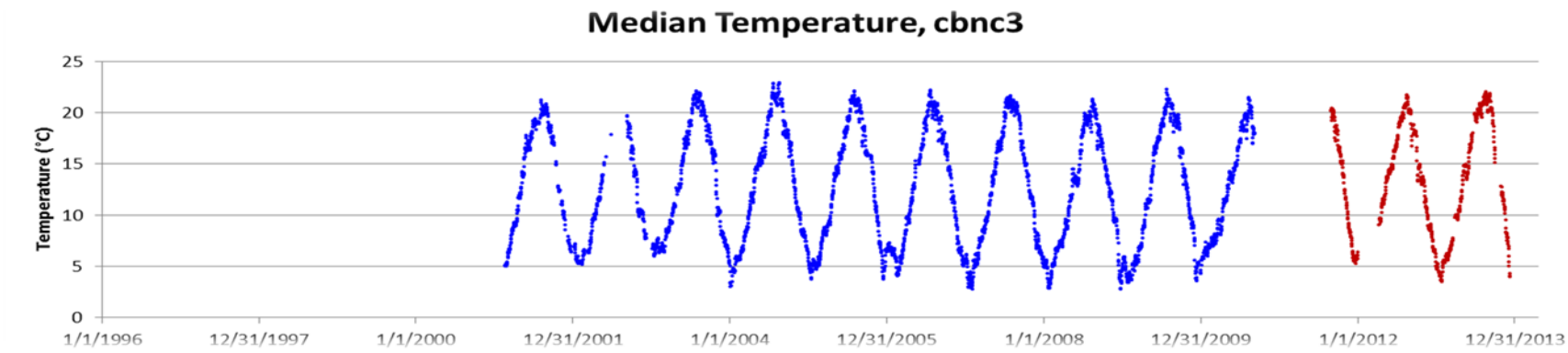
(a)


Median Temperature, tansy
Temperature (°C)
25
20
15
10
5
0
1/1/1996
12/31/1997
1/1/2000
12/31/2001
1/1/2004
12/31/2005
1/1/2008
12/31/2009
1/1/2012
12/31/2013

(b)


Median Temperature, grays
Temperature (°C)
25
20
15
10
5
0
1/1/1996
12/31/1997
1/1/2000
12/31/2001
1/1/2004
12/31/2005
1/1/2008
12/31/2009
1/1/2012
12/31/2013

(c)



(d)

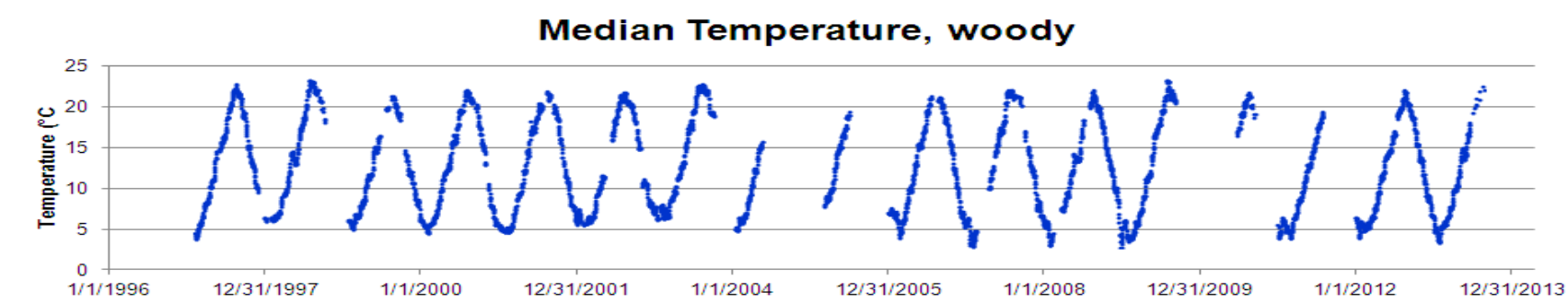


Figure 2-2.3. Long term plots of daily median water temperatures for CRCIP AEM CORIE (or CMOP) monitoring stations: (a) tansy, (b) grays, (c) cbnc3, and (d) woody. Interpolated temperatures for cbnc3 are plotted in red.

2-3 Salinity

MA-1 includes an analysis of potential Project construction impacts on salinity values in the LCR and estuary. The analyses are based on the CORIE data and performed and presented in a manner analogous to those previously presented for water temperatures. The issue of concern for salinity is that channel modifications might increase the likelihood of salt water intrusions and elevate salinity values, which can impact habitat quality for juvenile salmon. Figure 2-3.1 (a,b,c) presents the daily median values of salinity computed from data reported in 2013 at the MA-1 sampling locations: tansy, grays, and cbnc3.

The January–March 2013 daily median salinity values computed using data available for the tansy station were generally at the lower range of values defined by the 20th–80th percentile decision criteria (Figure 2-3.1a). Several daily median values were less than the 20th percentile criteria values for mid-January and early February. Similar to the January–March 2013 period, the April–August daily median salinity values were generally at the lower range of values defined by the 20th–80th percentile decision criteria. However, many of the daily median values were less than the 20th percentile criteria values for April and May. The monthly averaged daily median values of salinity for the tansy station were within the 20th–80th percentile decision criteria for April, June, July, and August 2013. The May monthly average value was equal to the 20th percentile decision criterion (2.7 psu). The September–October daily median salinity values computed using data available for the tansy station ranged from approximately 4 to 21 psu. While highly variable, the median values were generally within the 20th–80th percentile decision criteria for these two months. However, many of the daily median values for early October were between the 5th and 20th percentile criteria values. The November–December daily median salinity values for the tansy station were generally within the 20th–80th percentile decision criteria for these two months. However, several of the daily median values for these two months were between the 5th and 20th percentile criteria values. Daily median salinity values for the tansy station did not exceed the 5th or 95th percentile decision criteria during 2013.

Daily median values calculated for salinity data available from January–March 2013 for the grays station were mainly distributed between the 5th and 20th percentile decision criteria or less than the 5th percentile value (Figure 2-3.1b). These comparatively higher salinity values at the grays station at the end of January and February appear consistent with corresponding LCR flows reported during these periods in 2013. Daily median values calculated for April through mid-July 2013 for the grays station were mainly distributed between the 5th and 20th percentile decision criteria. Values for later in July and throughout August were within the 20th–80th percentile decision criteria. Daily median values for September and October 2013 for the grays station were mainly distributed between the 20th and 80th percentile decision criteria. Values for early October were within the 5th–20th percentile decision criteria. Daily median values calculated for November–December 2013 for the grays station were highly variable and ranged from near zero to ~4.6 psu. The values were mainly distributed between the 20th and 80th percentile decision criteria for these two months. Several values for November and late December were within the 80th–95th percentile decision criteria. Daily median salinity values for the grays station did not exceed the 5th or 95th percentile decision criteria during 2013.

Daily median values of salinity computed from the reconstructed cbnc3 data were generally within the 5th–20th percentile decision criteria from January through July in 2013 (Figure 2-3.1c).

The August–October daily median salinity values computed using data available for the cbnc3 station ranged from approximately 0.1 to 6 practical salinity units (psu). The median values were generally within the 20th–80th percentile decision criteria for these three months. The November–December daily median salinity values computed using data available for the cbnc3 station ranged from approximately 0.1 to 7 psu. The median values were generally within the 5th–20th percentile decision criteria for these two months. Daily median salinity values for the cbnc3 station did not exceed the 5th or 95th percentile decision criteria during 2013.

Salinity data were available for the dsdma station only during September–December in 2013. Normalized salinity plots were developed using corresponding salinity values for tansy (Figure 2-3.2a), grays (Figure 2-3.2b) and cbnc3 (Figure 2-3.2c) stations. Inspection of the normalized temperature plots for 2013 indicated that the comparisons were consistent in the overall pattern defined by the pre-Project (1996–2004) normalization.

Tables 2-3.1–2-3.3 list the monthly median salinity values calculated for 2013 and the decision criteria developed by the AMT for MA-1. The monthly daily median values of salinity for the tansy station were within the 20th–80th percentile decision criteria for all months except May (Table 2-3.1). The monthly value for May was equal to the 20th percentile decision value (2.7 psu). Monthly median salinity values for the grays station were equal to the 20th percentile decision value (0.3 psu) for January, March, and July 2013 (Table 2-3.2). Monthly values for grays were equal to the 5th percentile decision value (0.2 psu) for February, April, May, and June. Monthly values for July–December were within the 20th–80th percentile decision values. Monthly median values for the cbnc3 station were 0.1 psu for all months in 2013 except August and September, which is less than the 5th percentile decision value (0.2 psu) (Table 2-3.3). The August monthly value was equal to the 5th percentile (0.2 psu), while the September monthly media was within the 20th–80th percentile decision values.

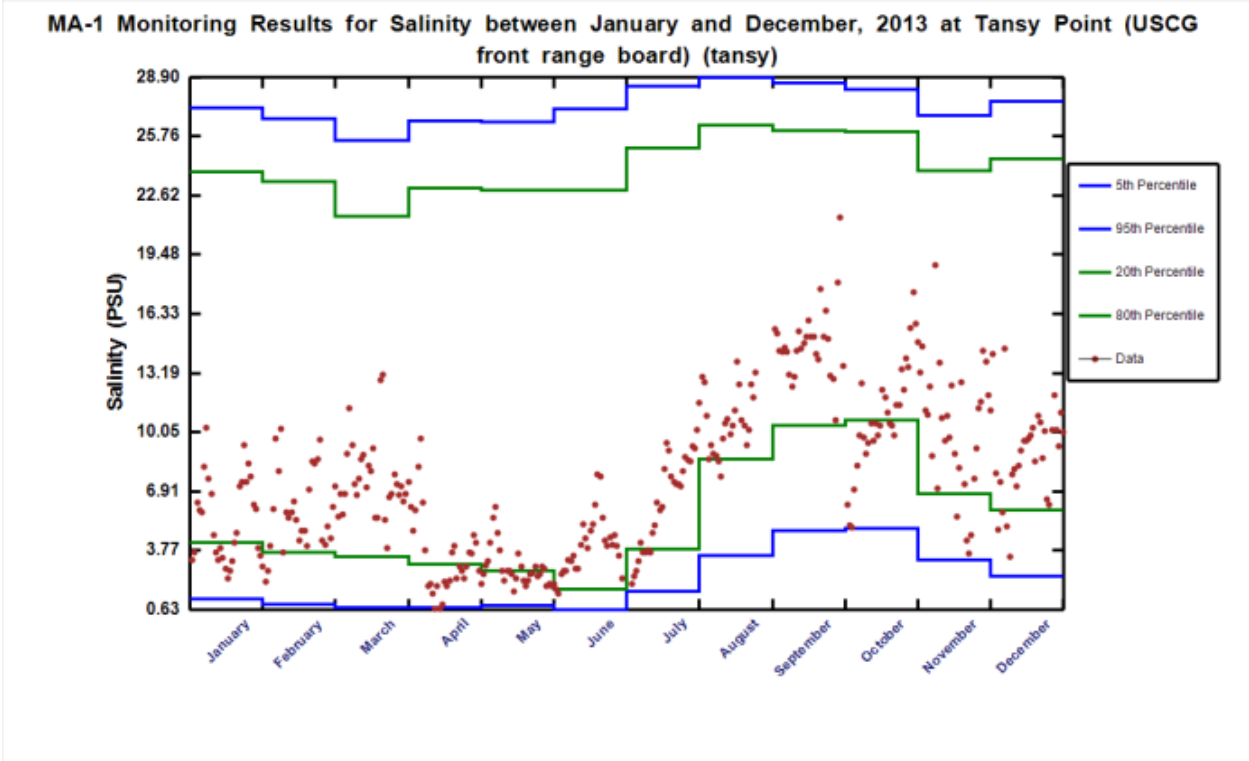
Longer-term time series plots of salinity were developed using available data for tansy, grays, cbnc3, and dsdma (Figure 2-3.3). The time series for tansy (Figure 2-3.3) suggests a trend of decreasing salinity values for the period of 2009–2013, although data are missing for much of 2011. However, the trend of decreasing salinities, if real, does not raise the issue of salinity intrusion (i.e., an increasing trend), which was the endpoint of concern for salinity in the design of the AEM Program.

The time series for the grays station (Figure 2-3.3) shows year-to-year variability in the range of salinity values. However, upon inspection, there seems to be no trend for salinity values at the grays station.

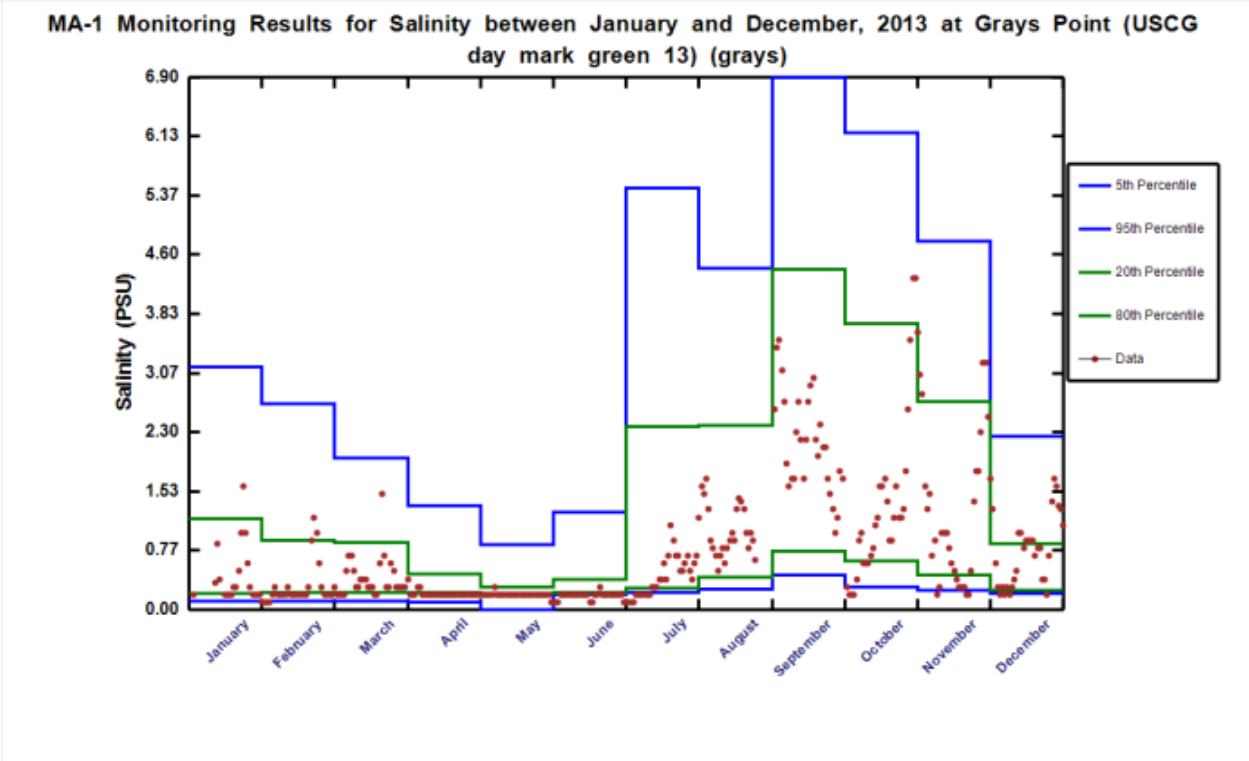
The highest salinity values for cbnc3 in 2009 appear 2–4 psu higher than corresponding values reported for other years (Figure 2-3.3). However, subsequent values plotted for 2013 are within the ranges observed for 2004–2007. There seems to be no compelling evidence for a trend of increasing salinity values for cbnc3.

The longer-term time series plot of salinity for the dsdma station illustrates the gaps in available data used to develop the normalized salinity plots for MA-1 (Figure 2-3.3). The available data do not appear to demonstrate a trend over the plotted time period.

(a)


MA-1 Monitoring Results for Salinity between January and December, 2013 at Tansy Point (USCG front range board) (tansy)
Salinity (PSU)
28.90
25.76
22.62
19.48
16.33
13.19
10.05
6.91
3.77
0.63
January
February
March
April
May
June
July
August
September
October
November
December
5th Percentile
95th Percentile
20th Percentile
80th Percentile
Data

(b)


MA-1 Monitoring Results for Salinity between January and December, 2013 at Grays Point (USCG day mark green 13) (grays)
Salinity (PSU)
6.90
6.13
5.37
4.60
3.83
3.07
2.30
1.53
0.77
0.00
January
February
March
April
May
June
July
August
September
October
November
December
5th Percentile
95th Percentile
20th Percentile
80th Percentile
Data

(c)

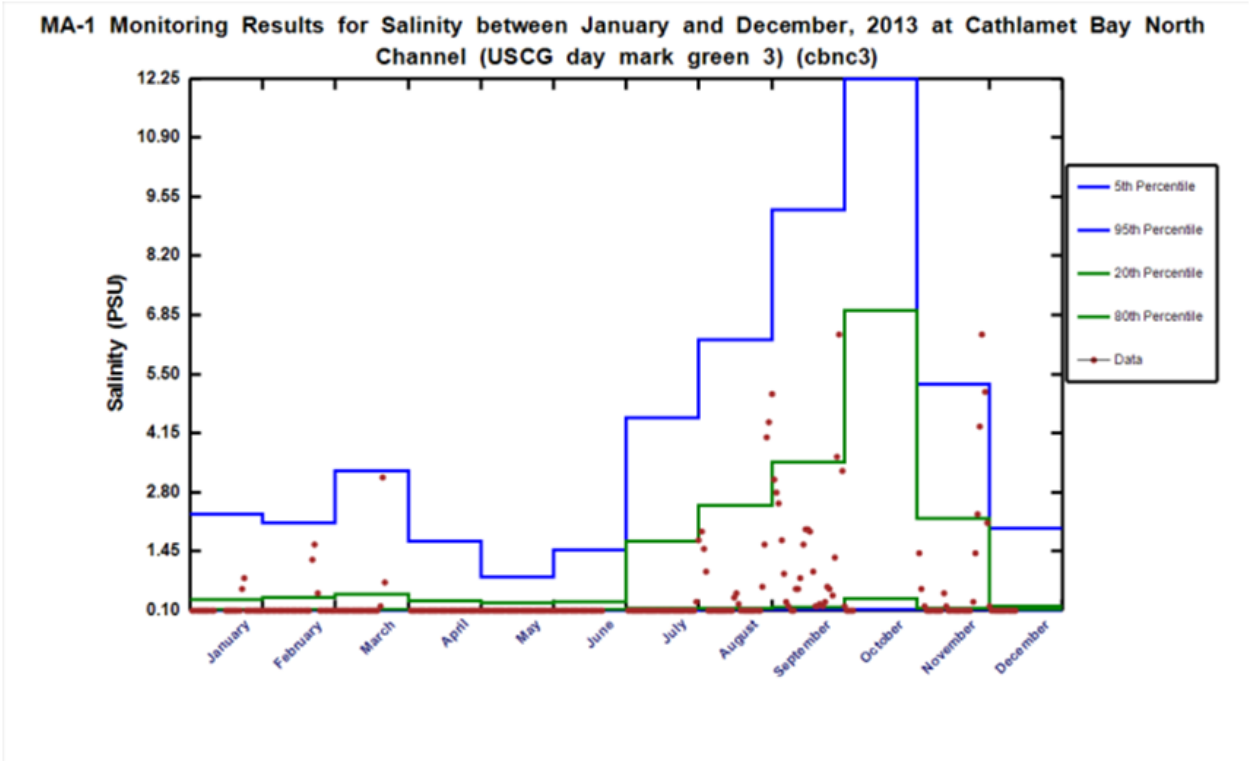
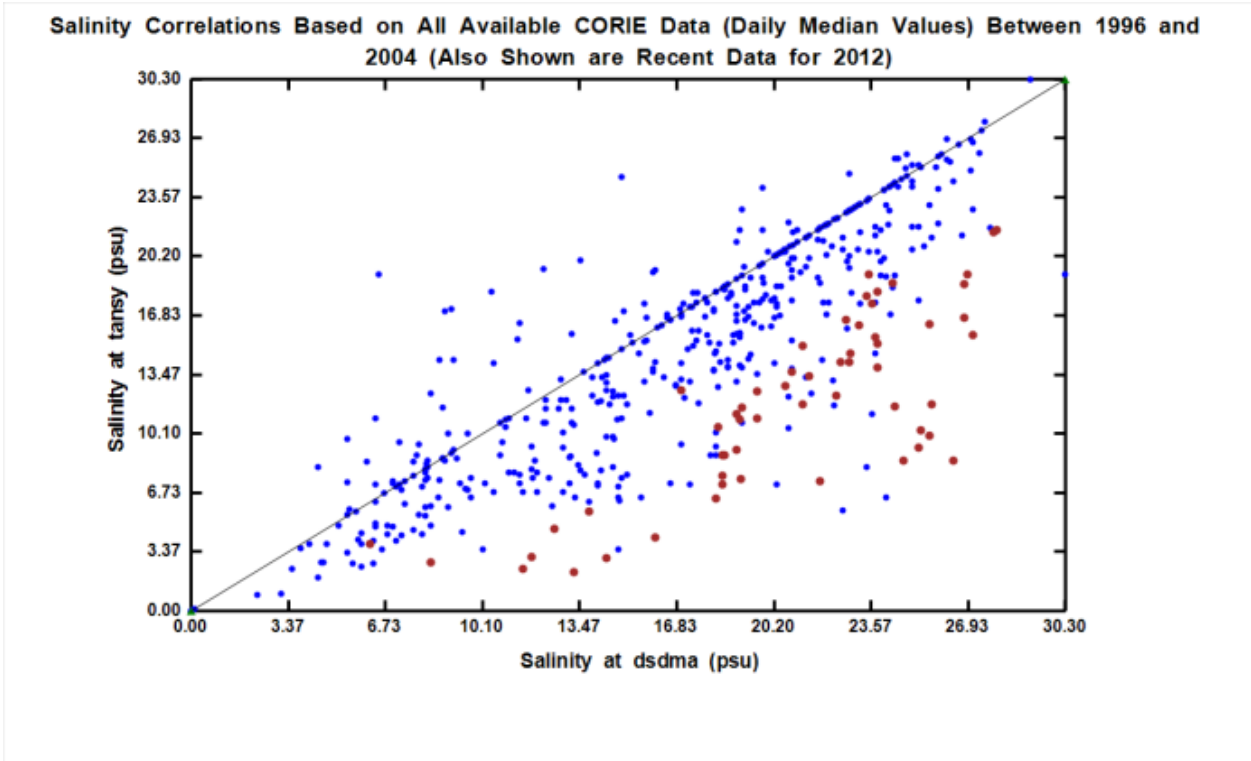
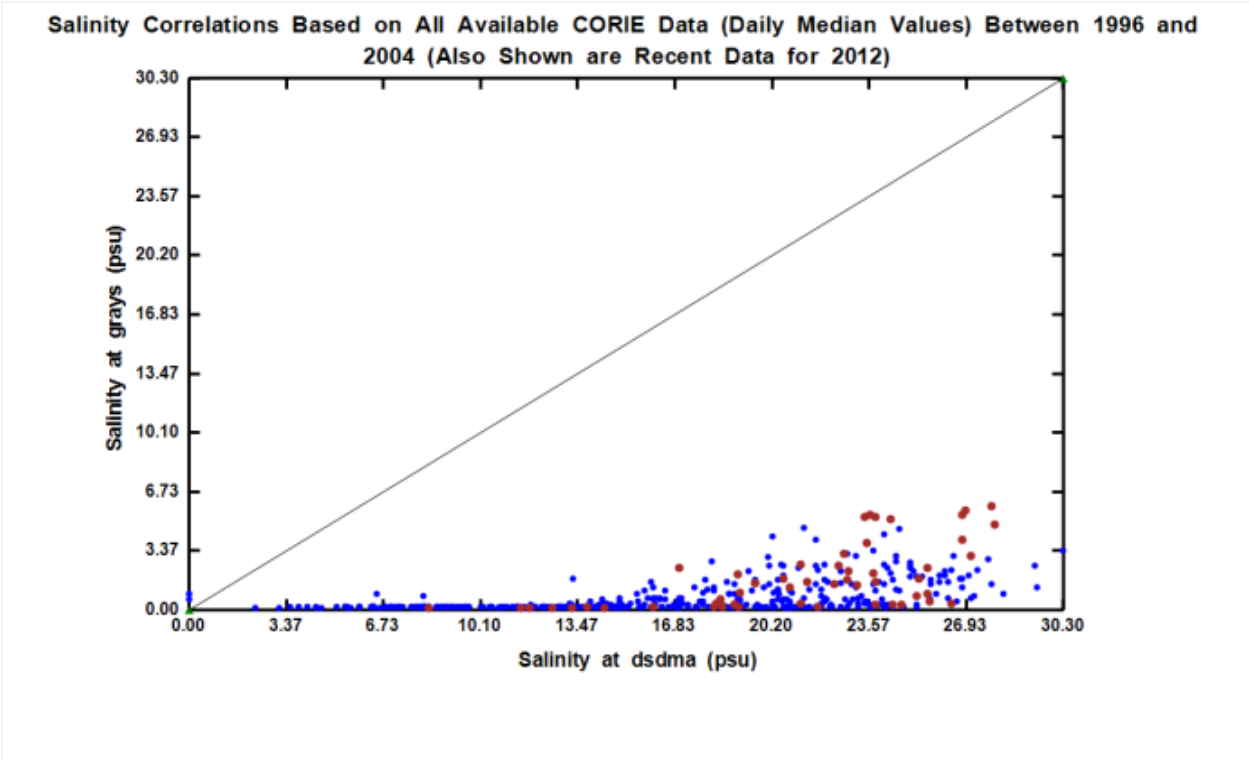


Figure 2-3.1. Daily median values of salinity for (a) tansy, (b) grays, and (c) cbnc3 sampling stations for 2013 plotted in relation to the CRCIP AEM decision criteria. Interpolated salinity data are plotted for cbnc3.

(a)


Salinity Correlations Based on All Available CORIE Data (Daily Median Values) Between 1996 and 2004 (Also Shown are Recent Data for 2012)
Salinity at tansy (psu)
Salinity at dsdma (psu)
0.00
3.37
6.73
10.10
13.47
16.83
20.20
23.57
26.93
30.30

(b)


Salinity Correlations Based on All Available CORIE Data (Daily Median Values) Between 1996 and 2004 (Also Shown are Recent Data for 2012)
Salinity at grays (psu)
Salinity at dsdma (psu)
0.00
3.37
6.73
10.10
13.47
16.83
20.20
23.57
26.93
30.30

(c)

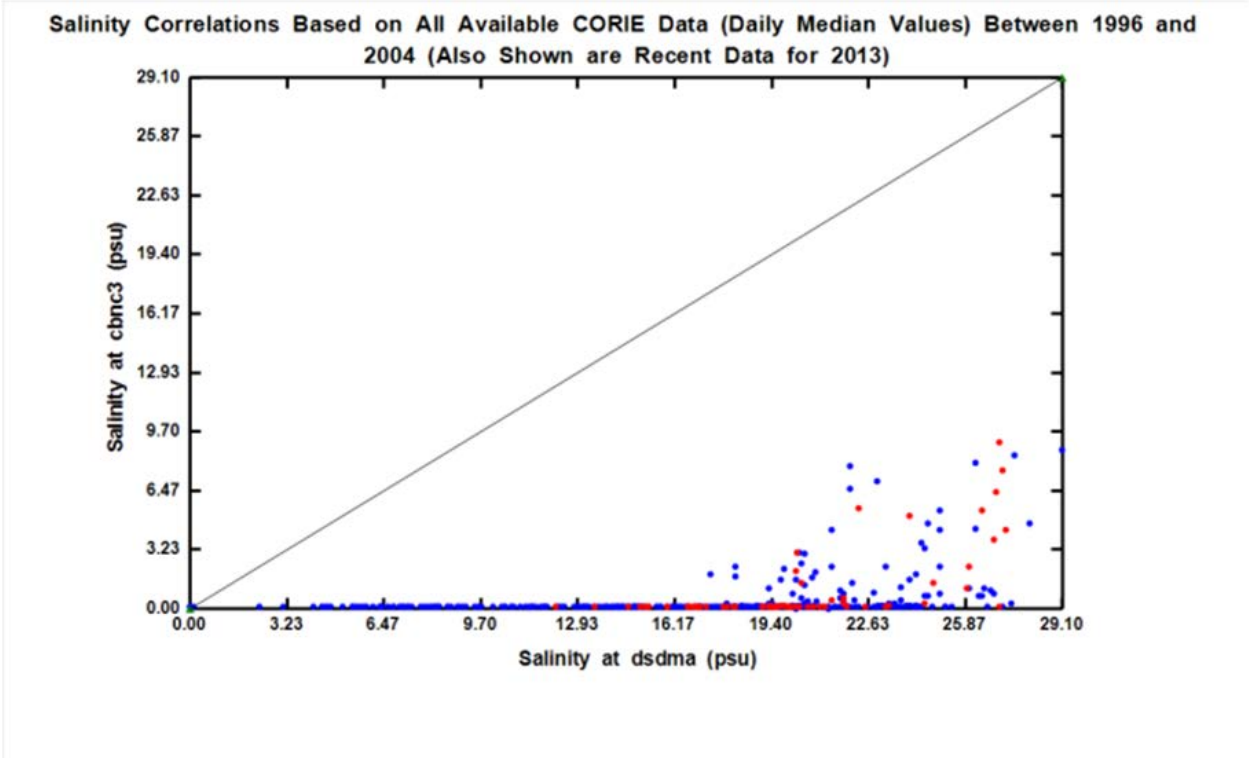


Figure 2-3.2. Daily median values of salinity for (a) tansy, (b) grays, and cbnc3 sampling stations for 2013 plotted in relation to values for the dsdma station. Interpolated salinity data are plotted for cbnc3.

Table 2-3.1. Summary of 2012 Monthly Median Salinity Values (bold numbers) for tansy Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	1.2	0.9	0.7	0.7	0.9	0.4	1.6	3.5	4.8	5.9	3.3	2.4
					2.7							
20	4.2	3.7	3.4	3.0	2.7	1.7	3.8	8.7	10.4	10.7	6.8	5.9
	5.5	**6.0**	**7.4**	**3.2**	**No data**	**4.0**	**6.6**	**10.6**	**14.4**	**11.3**	**10.4**	**9.0**
80	23.9	23.4	21.5	23.0	22.9	22.9	24.1	26.3	26.0	26.0	23.9	24.6
95	27.3	26.7	25.5	26.6	26.5	27.2	28.4	28.9	28.6	28.0	26.9	27.6

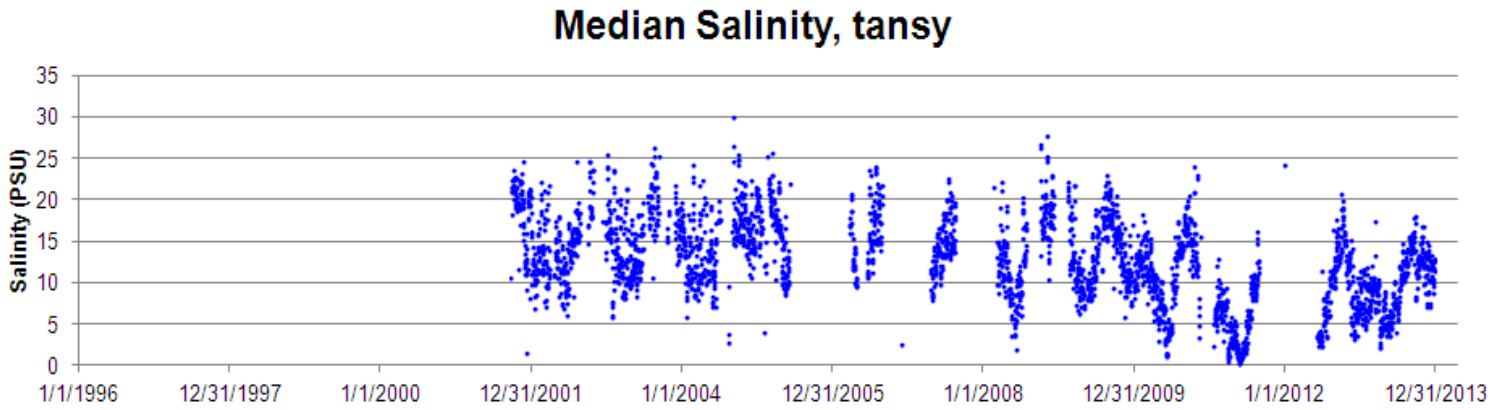
Table 2-3.2. Summary of 2012 Monthly Median Salinity Values (bold numbers) for grays Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	0.2	0.2	0.2	0.2	0.0	0.2	0.3	0.3	0.5	0.4	0.3	0.3
		0.2		**0.2**	**0.2**	**0.2**						
20	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.8	0.7	0.5	0.3
	0.3		**0.3**				**0.3**	**1.1**	**2.0**	**1.1**	**1.0**	**0.6**
80	1.2	0.8	0.8	0.7	0.7	0.7	2.4	2.4	4.4	3.7	2.7	0.8
95	3.1	2.7	2.0	1.4	0.8	1.3	5.5	4.4	6.9	6.2	4.8	2.2

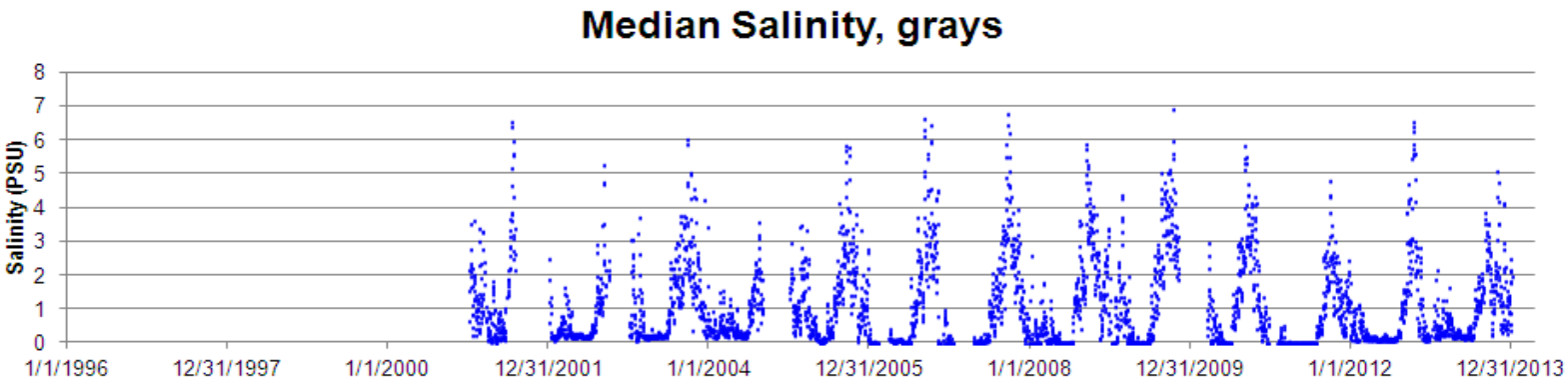
Table 2-3.3. Summary of 2012 Monthly Median Salinity Values (bold numbers) for cbnc3 Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
	0.1	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**			**0.1**	**0.1**	**0.1**
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.2	0.2
								0.2	**1.0**			
80	0.7	0.7	0.7	0.7	0.7	0.7	1.7	2.5	3.5	7.0	2.2	0.7
95	2.3	2.1	3.3	1.7	0.9	1.5	4.5	6.3	9.3	12.3	5.3	2.0

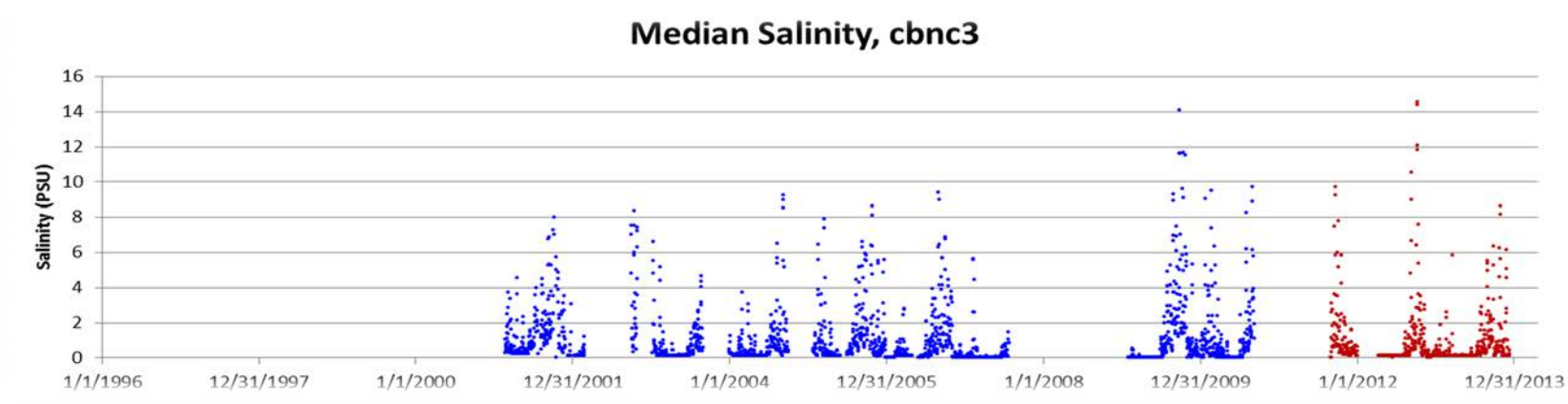
(a)


Median Salinity, tansy
Salinity (PSU)
35
30
25
20
15
10
5
0
1/1/1996
12/31/1997
1/1/2000
12/31/2001
1/1/2004
12/31/2005
1/1/2008
12/31/2009
1/1/2012
12/31/2013

(b)


Median Salinity, grays
Salinity (PSU)
8
7
6
5
4
3
2
1
0
1/1/1996
12/31/1997
1/1/2000
12/31/2001
1/1/2004
12/31/2005
1/1/2008
12/31/2009
1/1/2012
12/31/2013

(c)



(d)

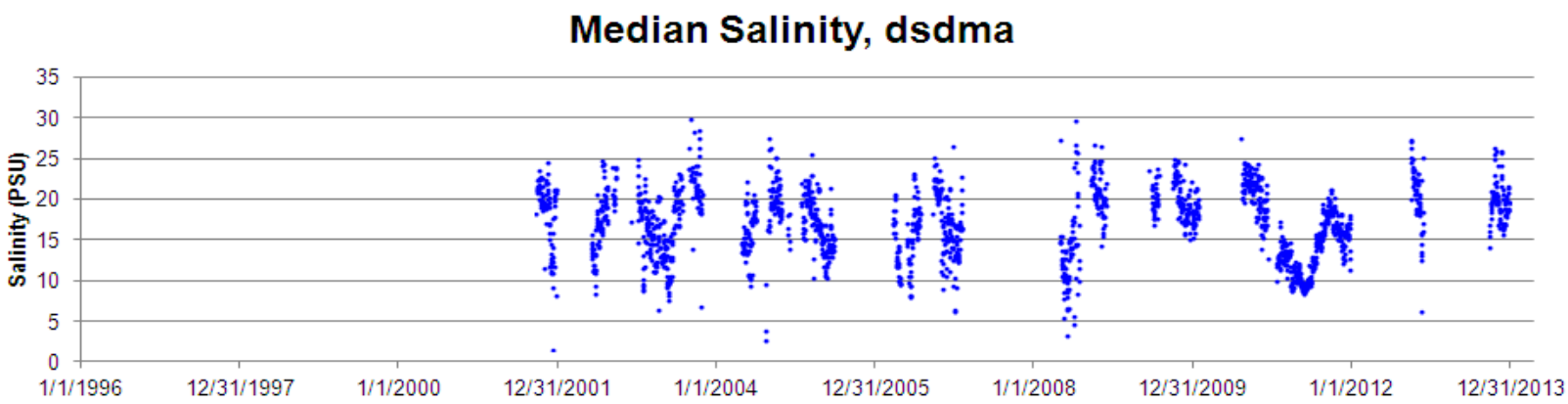


Figure 2-3.3. Long term plot of daily median salinity values from CRCIP AEM CORIE (or CMOP) stations: (a) tansy, (b) grays, (c) cbnc3, and (d) dsdma. Interpolated salinities for cbnc3 are plotted in red.

2-4 Columbia River Discharge

As with preceding years, Bonneville Dam discharge data were obtained and analyzed in 2013 (Figure 2-4.1). These data have been used to help understand the potential sources of outlier values of temperature and salinity observed at the MA-1 stations during the AEM Program. Depending on the time of year, higher than average releases at Bonneville can reduce salinity values and influence water temperatures at the MA-1 stations. Similarly, lower than average flows can result in increased salinity values. The seasonal pattern for 2013 indicated lower than typical (e.g., mean, median) flows compared to pre-Project years (1996–2004) during January and February (e.g., ~days 1–90). These lower flows were followed by a rapid increase to a spring and summer period of higher than average flows compared to the pre-Project years. The higher flows persisted until approximately the end of August. The fall and early winter periods of 2013 are characterized by a combination of lower than average flows, followed by mid-range (typical) flows, and culminating with lower than average flows through December. These lower flows might account for the higher than average salinity values during these periods in 2013 for the grays and cbnc3 stations.

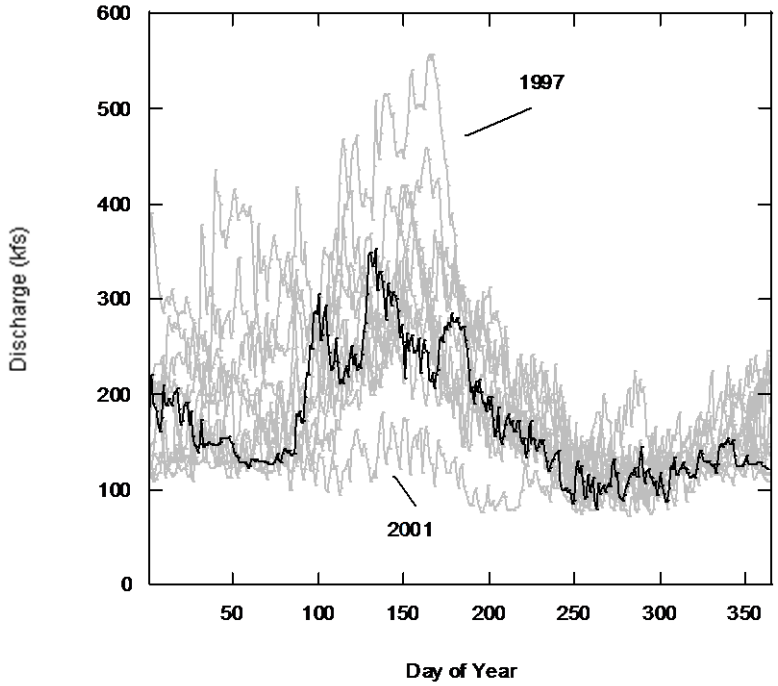


Figure 2-4.1. Daily flow values recorded at Bonneville Dam for calendar year 2013 (solid black line). Light gray lines show pre-Project (baseline) values for 1996–2004. (Data: Columbia Basin Fishery Agencies and Tribes http://www.fpc.org/river/flowspill/FlowSpill.asp).

2-5 AMT Decisions for MA-1

Table 2-5.1 summarizes the key discussions and decisions made by the AMT during the course of the quarterly meetings in relation to MA-1 monitoring and MA-1 monitoring results through calendar year 2013.

Table 2-5.1. CRCIP AEM Plan Record of AMT MA-1 Decisions.

Date	Issue	MA-1 Decisions	Comments
16 Dec 2004	**MA-1**	Compare with different monthly confidence intervals (e.g., 70, 80, 90 percentiles).	
16 Dec 2004	**MA-1**	Develop plots of daily mean values against the CI.	
16 Dec 2004	**MA-1**	Add state water quality standards (e.g., temperature for Washington and Oregon).	
16 Dec 2004	**MA-1**	Produce plots in "real time" as data quality assurance/quality control (QA/QC) process permits.	
16 Dec 2004	**MA-1**	Make plots (analyses) available to AMT via file transfer protocol (FTP) site-daily values posted every 1–5 days.	
16 Dec 2004	**MA-1**	At the end of each month, calculate monthly average and compare to the monthly CI values	
16 Dec 2004	**MA-1**	Meet monthly during construction phase to evaluate consensus on criteria.	
14 Jun 2005	**MA-1**	The team tentatively agreed to the water elevation decision criteria. The Science Center http://www.nwr.noaa.gov/ should have the opportunity to review the proposed criteria.	
21 Jun 2005	**MA-1**	Concerns were expressed that cbnc3 had incomplete data and that the Marsh station would provide better data. The cbnc3 station was selected because of the location (channel into Cathlamet Bay) and would be a good indicator of changes that could affect the bay. The Marsh station is too far upstream and would likely not show any changes in salinity or temperature from the deepening. The cnbc3 location is also important for connectivity and conductivity. NMFS agreed with the stated rationale for the selection of cbnc3.	
28 Jun 2005	**MA-1**	The team discussed the desire by WDOE and Oregon Department of Environmental Quality (ODEQ) to substitute cbnc3 for one of the other close proximity CORIE stations (e.g., Marsh), because of the limited historical data availability and it's susceptibility to bio-fouling. However, the change was not agreed to by the AMT and as a result the cbnc3 data that were interpolated will be flagged.	
28 Jun 2005	**MA-1**	At the last meeting, Cathy Tortorici (NMFS) was going to talk to the Science Center about the water elevation decision criteria. She stated that she was waiting for an e-mail back from Ed Castillas. She stated that Ed talked with Antonio Baptista who stated that the evaluation criteria were too broad and we would not to be able detect change. The USACE agreed to have a conference call between Steve Bartell, Antonio Baptista and Shyam Nair to discuss these concerns.	
28 Jun 2005	**MA-1**	Sample sizes will be added to the MA-1 tables. The numbers in the tables will be revised and presented to the 10th decimal point. Corrections to the salinity calculations (i.e., binning errors) will be included in the revised tables. Any reference to real-time data needs to be taken out of the decision criteria document. WDOE and ODEQ also requested that the depth at which each CORIE station is monitored is included in each data table provided to the AMT.	

Table 2-5.1. CRCIP AEM Plan Record of AMT MA-1 Decisions. (Continued).

Date	Issue	MA-1 Decisions	Comments
22 Aug 2005	**MA-1**	There was discussion of the normalization of daily median water temperature data for selected CORIE stations to daily median water temperature data for the "woody" sampling location. Temperature values at the woody station are largely determined by river flows. These normalizations have been summarized by simply plotting the data from selected stations against the woody data. Deviations from a linear relationship suggest increasing influence of ocean water on temperature. The suggestion is that alterations in circulation within the estuary due to channel modifications might be indicated by changes in the relations summarized in the plots.	
31 Aug 2005	**MA-1 Decision Criteria**	All agencies concurred on the triggers for MA-1. Two trigger tables will be developed showing triggers values set between the 5th–90th percentile and the 20th–80th percentile. Median daily water temperature values for the three MA-1 CORIE stations will also be plotted against corresponding values for the woody station. The data will be evaluated quarterly for the first year and/or after each contract for channel modifications starting October 12, 2005. These data will be reviewed and summarized annually.	
31 Aug 2005	**MA-1 Decision Criteria**	The group also agreed that if one of the stations being used breaks down, one of the other stations close to the unavailable station will be used as a surrogate, if possible.	
1 Sep 2005	**MA-1 Data Analysis**	E2 (Steve Bartell) will be responsible for analyzing and summarizing the MA-1 data.	
12 Oct 2005	**MA-1 Data Analysis**	Based on the results for depth, temperature, and salinity presented at the AMT meeting, the AMT concluded that adaptive management would not be initiated.	
12 Oct 2005	**MA-1 Data Analysis**	The AMT requested that normalized salinity plots be developed by E2 for the three MA-1 monitoring stations.	
11 Jan 2006	**MA-1 Salinity Plots**	E2 developed salinity plots for the three MA-1 stations and several candidate reference stations. After examining the results of these plots, the AMT agreed that the Desdemona station appeared to provide the best relationship between values of median daily salinity. The AMT concluded that these kinds of normalized salinity plots should become part of the AMP and used in the same way as the normalized temperature plots.	
12 Apr 2006	**MA-1 Data Analysis**	Based on the results for depth, temperature, and salinity presented at the AMT meeting, the AMT concluded that adaptive management would not be initiated.	
12 Apr 2006	**Columbia River flow data**	The AMT requested that summaries of flow data be provided to assist in the interpretation of depth, temperature, and salinity data.	
12 Apr 2006	**MA-1 Current Velocity Data**	The AMT asked that the availability of current velocity data be reexamined in relation to MA-1 assessments of changes in physical habitat that might be associated with the CRCIP construction.	
11 Oct 2006	**MA-1 Data Analysis**	The AMT requested that the MA-1 analyses be performed in a timely manner. (This is largely determined by the availability of the data provided by CORIE.)	
10 Jan 2007	**MA-1 Data Analysis**	CORIE and the USACE have agreed that the verified MA-1 data will be available for public download and analyses 30 days after the end of a sampled month. This will essentially introduce a one-month time lag in the reporting of the CORIE analyses to the AMT.	
11 Apr 2007	**MA-1 CORIE Analyses**	Several January and February temperature and salinity values will be examined in relation to river flows and local climate data.	

Table 2-5.1. CRCIP AEM Plan Record of AMT MA-1 Decisions. (Continued).

Date	Issue	MA-1 Decisions	Comments
11 Jul 2007	**MA-1 CORIE Analyses**	No management decisions were required for MA-1.	
9 Jan 2008	**MA-1 CORIE Analyses**	Analysis of salinity data for tansy station suggests that tansy can be substituted for red26 (which is out of service). Salinity outlier values for cbnc3 in January 2008 will be examined in relation to local climate and river flow data.	
29 Apr 2008	**MA-1 CORIE Analyses**	No decisions were made in relation to the CORIE analysis.	
9 Jul 2008	**MA-1 CORIE Analyses**	No decisions were made in relation to the CORIE analysis.	
8 Oct 2008	**MA-1 CORIE Analyses**	E2 will explore possible reasons to explain the variations in temperature observed in late May and early June.	
14 Jan 2009	**MA-1 CORIE Analyses**	No decisions were made concerning the MA-1 results at the January 2010 meeting.	
8 Apr 2009	**MA-1 CORIE Analyses**	The AMT decided to continue using publicly available CORIE data that have been through the CORIE (QA/QC) process.	
8 Jul 2009	**MA-1 CORIE Analyses**	Monitoring results for depth, temperature, and salinity were within the monthly decision criteria for MA-1.	
18 Nov 2009	**MA-1 CORIE Analyses**	Monitoring results for depth, temperature, and salinity were within the monthly decision criteria for MA-1.	
18 Nov 2009	**MA-1 CORIE Analyses**	The AMT decided by consensus that MA-1 monitoring activities should continue according to the terms and conditions specified in the BiOp.	
20 Jan 2010	**MA-1 CORIE Analyses**	No decisions were made concerning the MA-1 results reported at the January 20 meeting. E2 will follow up on obtaining additional temperature data not currently reported for the grays station.	
14 Apr 2010	**MA-1 CORIE Analyses**	No decisions were made concerning the MA-1 results reported at the April 14 th meeting.	
14 Jul 2010	**MA-1 CORIE Analyses**	No decisions were made concerning the MA-1 results reported at the July 14 th meeting.	
13 Oct 2010	**MA-1 CORIE Analyses**	No decisions were made concerning the MA-1 results reported at the October 13th meeting.	
12 Jan 2011	**MA-1 CORIE Analyses**	The January 2011 AMT meeting was cancelled.	
13 Apr 2011	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the January–March 2011 period.	
13 Jul 2011	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the April–July 2011 period.	
12 Oct 2011	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the August–October 2011 period.	
13 Jul 2011	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the April–July 2011 period.	

Table 2-5.1. CRCIP AEM Plan Record of AMT MA-1 Decisions. (Continued).

Date	Issue	MA-1 Decisions	Comments
11 Jan 2012	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for 2011.	
11 Apr 2012	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the January–March 2012 period.	
11 Jul 2012	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the April–June 2012 period.	
10 Oct 2012	**MA-1 CORIE Analyses**	October AMT Meeting cancelled.	
9 Jan 2013	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for 2012.	
10 Apr 2013	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the January–March 2013 period.	
12 Sep 2013	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the April–August 2013 period.	
13 Nov 2013	**MA-1 CORIE Analyses**	The AMT concluded that there were no discernible impacts of the Project on measured values of temperature or salinity for the September–October 2013 period.	
22 Jan 2014	**MA-1 CORIE Analyses**	The AMT reached consensus that the Project had not measurably changed the monitored temperature and salinity values. The AMT concluded that the MA-1 requirements have been completed in relation to the CRCIP AEM Program.	

3 Monitoring Action 2—Dredging Volumes

MA-2 tracks and reports annual dredging and placement volumes associated with construction and maintenance of the 43-foot navigation channel. MA-2 results were evaluated after construction and are considered completed for the AEM Program.

3-1 Volumes of Dredged Materials

Post-construction volumes of materials dredged as part of the O&M activities are not included in the CRCIP AEM Program. The 2013 O&M volumes are therefore not reported in the 2013 AEM Annual Report. The USACE continues to provide this information as part of its O&M reporting procedures. The reporting of dredged materials in support of the AEM Program is considered complete.

3-2 Disposal of Project Dredged Materials

During Project construction, detailed summaries of the disposal of Project dredged materials were provided in the previous AEM Program Annual Reports. The intent was to review the reported disposal of construction materials in relation to pre-Project approved locations and evaluate the amounts disposed in relation to the estimated capacity of the disposal locations. With the project now in the O&M phase, these summaries of the disposal of dredged materials are no longer included in the AEM Annual Reports. The review of dredged materials disposal has been completed for the AEM Program.

3-3 AMT Decisions for MA-2

Table 3-3.1 lists the decisions made by the AMT in relation to project construction, dredging volumes, and dredged material disposal during the course of the quarterly meetings of the CRCIP AEM Program through 2013. Although MA-2 activities have transitioned into O&M, the table of decisions has been included for continuity in AEM reporting. This format also readily permits addition of any future issues that might develop concerning MA-2 and the AEM Program.

Table 3-3.1. CRCIP AEM Plan Record of AMT MA-2 Decisions.

Date	Issue	MA-2 Decisions	Comments
16 Dec 2004	**MA-2 Decision Criterion**	Compare actual dredging volumes with predicted volumes.	
16 Dec 2004	**MA-2 Decision Criterion**	Annual O&M dredging volumes plus construction volumes.	
16 Dec 2004	**MA-2 Decision Criterion**	Develop plots of predicted vs. actual dredged volumes for the contracted river mile segments; show percentages (e.g., 5, 10, 15, etc.) of possible exceedance.	
16 Dec 2004	**MA-2 Decision Criterion**	Develop similar summaries for dredge disposal.	
16 Dec 2004	**MA-2 Decision Criterion**	Communicate summaries, plots, etc., to the AMT within two months after each contract is completed.	
16 Dec 2004	**MA-2 Decision Criterion**	Trigger for other disposal options (e.g., in-water vs. upland), if larger than predicted volumes are dredged.	
5 Jul 2005	**MA-2 Decision Criterion**	Initial consensus was for reporting the results of dredging on a contract basis, although Washington expressed continued interest in a bar-by-bar summary as well as a summary by contract.	
5 Jul 2005	**MA-2 Decision Criterion**	The AMT achieved consensus that the decision criteria for MA-2 would derive from comparisons between estimated and actual dredging volumes, as summarized and presented in the March annual AMT meeting.	
1 Sept 2005	**MA-2 Decision Criterion**	All agencies concurred that if the dredging volumes exceed the projected amounts in the CRCIP Final Supplemental Environmental Impact Statement by 15% or more that the AMT members would be notified. Agreement was also reached, that at the quarterly meetings, the USACE would provide: dredging volumes updates for CRCIP construction and O&M, estimated amounts would be compared with actual amounts placed at individual upland sites and that volumes would be provide by bar and river mile.	
12 Oct 2005	**MA-2 Decision Criterion**	The AMT decision criteria refer to bar-by-bar summary of projected and actual dredging volumes. The spreadsheet currently provides a summary based on river miles. The spreadsheet will be modified to include additional rows that provide the bar-by-bar summaries. The location of disposal sites for Project dredging should also be included in the reporting for MA-2.	
11 Jan 2005	**MA-2 Decision Criterion**	It has proved difficult to determine the original source or relevance of the 15% proposed exceedance value. Therefore, following discussion, the AMT reached consensus to abandon the 15% decision criterion and simply compare projected dredging volumes to actual volumes.	
12 Apr 2006	**MA-2 Reporting**	The AMT made recommendations concerning the format of reporting dredging and disposal of dredged materials. A revised reporting template will be presented to the AMT at the next quarterly meeting.	

Table 3-3.1. CRCIP AEM Plan Record of AMT MA-2 Decisions. (Continued).

Date	Issue	MA-2 Decisions	Comments
10 Jan 2007	**MA-2 Project Construction**	The form and content of the MA-2 spreadsheet summary for the AEM Workbook were accepted by the AMT.	
11 Apr 2007	**MA-2 Dredging Summary**	The spreadsheet summary of disposal will be updated to address concerns regarding disposal capacity.	
11 Jul 2007	**MA-2 Dredging Summary**	MA-2 spreadsheets were updated to address capacity for disposal, especially in the deep ocean areas and Gateway.	
3 Oct 2007	**MA-2 Dredging Summary**	The MA-2 dredging summary tables in the AEM Project Workbook will be updated to include recent construction and disposal of dredged materials.	
9 Jan 2008	**MA-2 Dredging Summary**	Spreadsheet summaries of dredging volumes and disposal locations will be updated upon completion of the year's dredging.	
29 Apr 2008	**MA-2 Dredging Summary**	No decisions were made concerning Project dredging for MA-2.	
9 Jul 2008	**MA-2 Dredging Summary**	Disposal of Project dredged materials will be updated and summarized for the October AMT meeting.	
8 Oct 2008	**MA-2 Dredging Summary**	The summary for disposal at Northport will be revised to reflect that it is actually two disposal sites. Disposal capacity has not been exceeded.	
14 Jan 2009	**MA-2 Dredging Summary**	The upland disposal summary table was modified to show that the Northport site includes two disposal locations.	
8 Apr 2009	**MA-2 Dredging Summary**	Upland disposal has not exceeded capacity for any of the disposal locations used thus far in the CRCIP construction.	
8 Jul 2009	**MA-2 Dredging Summary**	No new information was presented for MA-2. However, the AMT will continue to be informed concerning monitoring plans being developed for rock removal as part of the CRCIP construction.	
18 Nov 2009	**MA-2 Dredging Summary**	No new information was presented for MA-2.	
20 Jan 2010	**MA-2 Dredging Summary**	MA-2 monitoring and assessment activities will transition into the post-Project O&M phase for reporting.	
14 Apr 2010	**MA-2 Dredging Summary**	MA-2 monitoring and assessment activities will transition into the post-Project O&M phase for reporting.	
14 Jul 2010	**MA-2 Dredging Summary**	Revisions will be made to the annual reports for 2007 and 2008 to clarify the in-water disposal at the Fazio site, previously reported incorrectly as upland disposal. AMT had no concerns and reached consensus that MA-2 requirements have been completed as part of the AEM Program. Annual dredging and placement volumes will continue to be reported in accordance with project O&M requirements.	
13 Oct 2010	**MA-2 Dredging Summary**	No new information was presented concerning MA-2.	
12 Jan 2011	**MA-2 Dredging Summary**	The January AMT meeting was cancelled.	
13 Apr 2011	**MA-2 Dredging Summary**	The final MA-2 spreadsheet summaries have been included in the 2010 Annual Report for the CRCIP AEM Program.	

4 Monitoring Action 3—Crossline Surveys

MA-3 examines accretion/erosion and changes in bathymetry of the main channel in relation to the channel deepening. Crossline surveys were performed annually for two years prior to construction, during construction, and three years after construction. The 2013 results represent the final of three post-construction surveys. Annual surveys are performed at Columbia River mile (CRM) 42, 46, 72, 75, 86, and 99. These river mile locations were identified through pre-construction USACE analysis of locations that appeared potentially sensitive to accretion and erosion. Additional surveys are performed annually at 0.5 miles up-river and 0.5 miles down-river from each of the selected CRM locations. Comparisons of survey results obtained during and after construction (year 2005+) with the MA-3 decision criteria determine any need for adaptive management.

4-1 MA-3 Decision Criteria

The results of the 2013 crossline surveys were presented at the September 2013 AMT meeting (Figure 4-1.1). The 2013 post-construction surveys were performed on the following dates:

- Wauna Driscoll (CRM 41.5–42.5) –May 7, 2013,
- Westport (WST) Bar (CRM 45.5–46.5) –May 8, 2013,
- Upper Dobelbower (UDB) (CRM 71.5–72.5) –March 20, 2013,
- Kalama Bar (CRM 74.5–75.5) –March 20, 2013,
- St. Helens Bar (CRM 85.5–86.5) –January 28, 2013, and
- Morgan Bar (CRM 98.5–99.5) –January 30, 2013.

Based on comparisons with the depth “envelopes” estimated from pre-construction surveys, the results of the 2013 post-construction surveys indicated erosion exceedances on the Washington side of the navigation channel at Morgan Bar (CRM 98.5 and 99.5), on the Oregon side at St. Helens Bar (CRM 86.5),on the Oregon side at Kalama Bar (CRM 75.0), on the Washington side at Kalama (CRM 75.5), on the Oregon side at UDB (CRM 71.5), on the Oregon side at WST Bar (CRM 45.5) and both Oregon and Washington sides at WST (CRM 46.0), and on the Washington side of Wauna Driscoll (CRM 41.5).

The 2013 survey results showed accretion exceedances on the Oregon side at Wauna Driscoll (CRM 41.5), on both the Oregon and Washington sides at WST Bar (CRM 45.5), on the Washington side at UDB (CRM 72.5), on the Oregon side at St. Helens Bar (CRM 85.5), and on the Washington side at Morgan Bar (CRM 98.5).

The erosion variance at CRM 41.5 (Wauna Driscoll) seemed unusually high compared to recent previous years (2007–2012). At the same time, this 2013 exceedance did not seem substantial when viewed in relation to the entire variance envelope for CRM 41.5, which was calculated using data from 1996–2006. Therefore, crossline surveys were plotted for all available years for CRM 41.5 for review and discussion at the October AMT meeting.

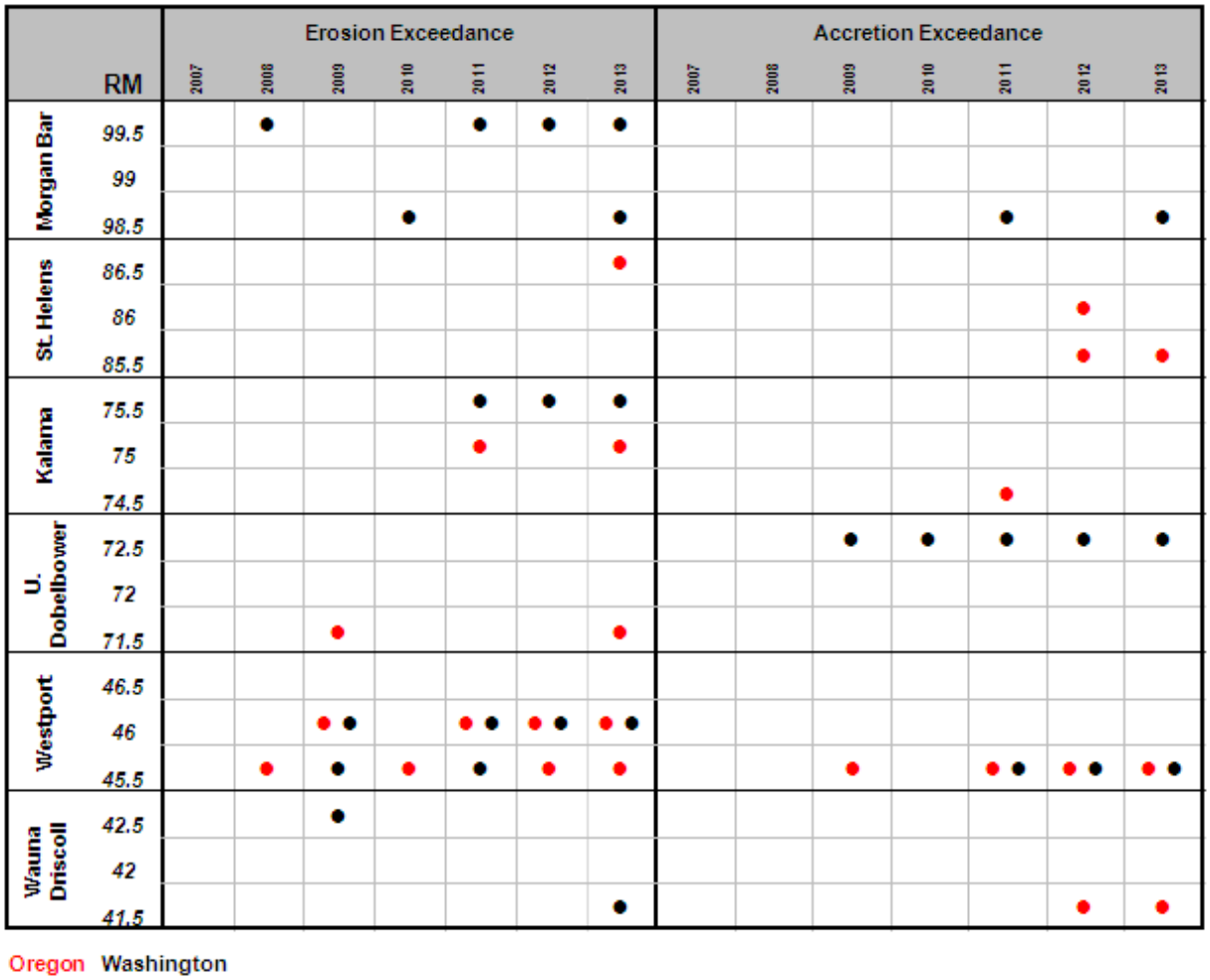


Figure 4-1.1. Summary of erosion and accretion exceedances for MA-3 crossline surveys through 2013. Red dots identify the Oregon side of the navigation channel; black dots refer to the Washington side.

The USACE provided an analysis for CRM 41.5 based on data from 1981–2013 (Figure 4-1.2). Following discussion, the AMT concluded that the erosion reported for 2013 was not related to MA-3, but rather a result of bedload (sand wave) movement, consistent with the dynamic nature of this river reach, potentially exacerbated by high flows.

There was consensus among the AMT members that no further actions were required concerning MA-3. The primary intention of MA-3 was to monitor the potential impacts of CRCIP construction and operation on channel erosion and accretion, specifically side-slope adjustments adjacent to the navigation channel. The results of the MA-3 monitoring and analysis indicate that the Project has not altered the pre-construction patterns of sediment dynamics within the LCR and estuary.

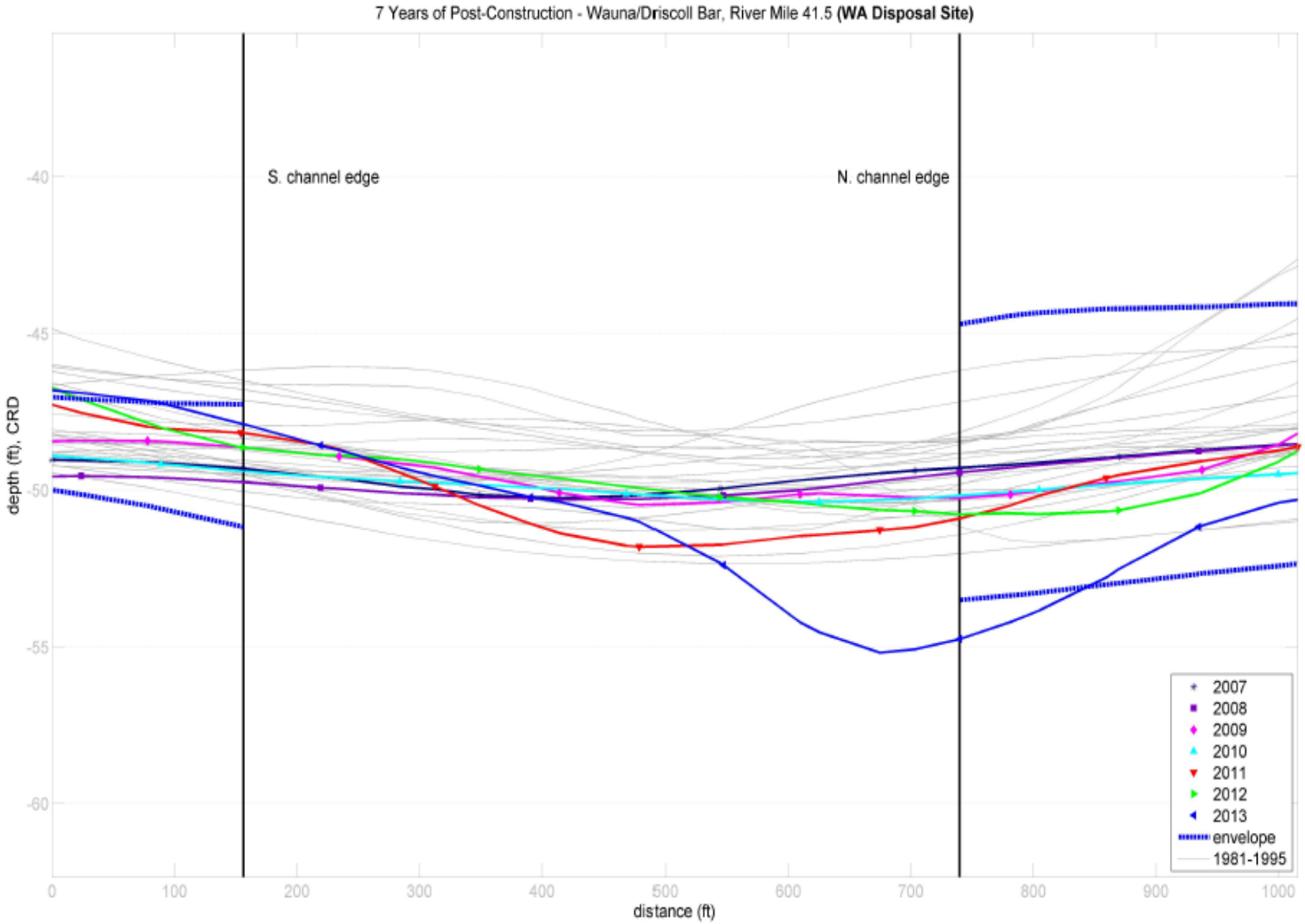


Figure 4-1.2. Illustration of crossline survey results for 1981–1995 and 2007–2013 and decision "envelope" at CRM 41.5.

Table 4-1.1. Adaptive Management Depth Envelopes for MA-3 Crossline Surveys.

	Pre-construction Depth Values (ft)			AEM Envelope Depth (ft)	
CRM	**Minimum**	**Maximum**	**Sigma[1]**	**Upper**	**Lower**
41.5 South	47.94	50.48	0.69	47.25	51.17
North	46.17	52.02	1.48	44.69	53.50
42.0	51.38	55.60	1.48	49.90	57.08
	43.58	48.74	1.64	41.94	50.38
42.5	47.17	54.54	2.71	44.46	57.25
	41.90	44.95	1.07	40.83	46.02
45.5	44.98	47.13	0.71	44.27	47.84
	40.71	44.31	1.20	39.51	45.51
46.0	46.53	52.64	1.67	44.86	54.31
	40.46	46.72	1.93	38.53	48.65
46.5	42.41	47.83	1.55	40.86	49.38
	41.43	46.83	1.45	39.98	48.28
71.5	40.75	46.79	1.61	39.14	48.40
	45.10	50.98	1.73	43.37	52.71
72.0	47.30	53.48	1.93	45.37	55.41
	44.37	50.44	2.13	42.24	52.57
72.5	61.39	77.15	4.40	56.99	81.55
	60.71	69.81	2.46	58.25	72.27
74.5	43.32	46.25	0.95	42.37	47.20
	52.33	59.04	1.85	50.48	60.89
75.0	42.17	47.14	1.60	40.57	48.74
	42.44	47.90	1.49	40.95	49.39
75.5	41.92	46.86	1.51	40.41	48.37
	45.84	49.54	1.29	44.55	50.83
85.5	42.18	46.55	1.46	40.72	48.01
	43.92	49.88	1.69	42.23	51.57
86.0	41.11	46.70	1.63	39.48	48.33
	46.78	55.77	2.68	44.10	58.45
86.5	39.64	44.42	1.50	38.14	45.92
	45.35	49.66	1.65	43.70	51.31
98.5	49.43	52.69	1.21	48.22	53.90
	43.15	46.94	1.26	41.89	48.20
99.0	50.35	54.55	1.25	49.10	55.80
	43.76	48.81	1.65	42.11	50.46
99.5	48.65	49.92	0.46	48.19	50.38
	45.13	47.36	0.77	44.36	48.13

[1]One standard deviation (SD) of mean depth based on analysis of pre-Project surveys.

Table 4-1.2 lists the locations and dates of the crossline survey data used in developing the MA-3 decision criteria and the dates of the post-construction surveys conducted through 2013.

Table 4-1.2. Columbia River Cross-Line Hydrosurvey Dates.

	Morgan Bar	St. Helens Bar	Kalama Bar	UDB	WST Bar	Wauna/Driscoll
Year	CRM 98–101	CRM 84–87	CRM 73–76	CRM 70–73	CRM 45–48	CRM 41–44
1996	24-Feb	21-Feb	20-Feb	20-Feb	20-Feb	20-Feb
1997	-	24-Feb	12-Feb	12-Feb	10-Feb	6-Feb
1998	5-Jan	-	21-Jan	21-Jan	28-Jan	28-Jan
1999	12-Jan	19-Jan	26-Jan	26-Jan	1-Feb	27-Jan
2000	20-Jan	11-Jan	10-Jan	6-Jan	26-Jan	25-Jan
2001	13-Feb	5-Feb	31-Jan	30-Jan	30-Jan	29-Jan
2002	13-Feb	12-Feb	7-Feb	6-Feb	24-Jan	24-Jan
2003	7-Jan	14-Jan	23-Jan	28-Jan	5-Feb	5-Feb
2004	22-Jan	31-Mar	28-Apr	29-Apr	17-May	13-May
2005	4-Apr	10-May	24-May	25-May	22-Jun	18-May
2006	12-Jan	25-Jan	7-Feb	7-Feb	31-Jan	24-Jan
2007	12-Feb	14-Feb	21-Feb	22-Mar	27-Mar[a]	26-Mar
2008	27-Mar	10-Apr	8-Apr	8-Apr	1-May	2-Apr
2010	12-Feb	26-Feb	5-Mar	10-Mar	2-Feb	27-Jan
2011	25-Jan	3-Feb	18-Feb	18-Feb	24-Feb	10-Feb
2012	2-Apr	16-May	8-May	18-Apr	24-Apr	24-Apr
2013	30-Jan	28-Jan	20-Mar	20-Mar	8-May	7-May

[a]Dates blue indicate post-construction surveys.

4-2 AMT Decisions for MA-3

Table 4-2.1 briefly summarizes the key AMT discussion points and decisions concerning potential effects of Project construction on channel bathymetry through calendar 2012.

Table 4-2.1. CRCIP AEM Plan Record of AMT MA-3 Decisions.

Date	Issue	MA-3 Decisions	Comments
16 Dec 2004	**MA-3 Decision Criterion**	Develop plots that compare pre-construction variations in side slopes with post-construction slopes using results of crossline surveys; show percentages (e.g., 5, 10, 15, etc.) of measured changes in side slopes.	
16 Dec 2004	**MA-3 Decision Criterion**	Focus on six locations identified in the Environmental Impact Statement.	
16 Dec 2004	**MA-3 Decision Criterion**	Use recorded dredging volumes to identify other possible locations for impacts on slopes. O&M dredging volumes that substantially exceed predicted values might indicate locations of increased side slope adjustments.	
16 Dec 2004	**MA-3 Decision Criterion**	Communicate summaries, plots, etc., to the AMT 2 years prior, 2 years during, and 3 years after construction is completed.	
16 Dec 2004	**MA-3 Decision Criterion**	Trigger for adaptive management if larger than predicted changes in side slope adjustment are observed.	
9 Aug 2005	**MA-3 Decision Criterion**	Crossline data are available at approximately 500-foot intervals throughout the navigable river. The results also summarized the minimum, maximum, and SD for surveyed depths at the southern and northern edges of the navigation channel. An envelope defined by the minimum + 1 SD and the maximum +1 SD was also plotted for each of the cross sections.	
9 Aug 2005	**MA-3 Decision Criterion**	Concerns were expressed that the selected few locations did not provide a sufficient description of potential impacts of channel dredging on slide slope adjustments and corresponding potential impacts on SWHs. Requests were made to include two additional cross sections, upriver and downriver, to the locations currently included in the MA-3 design. Inclusion of more cross sections at other selected river miles into the MA-3 effort was also desired by several AMT members.	
9 Aug 2005	**MA-3 Decision Criterion**	Concerns were raised about the number of years included in the analysis. The years represent different flow conditions, for example, with 1996–97 being years with comparatively higher flows, and 2001 being an example of a low flow year. The surveys are part of an ongoing activity in support of navigation the CRCIP was funding several surveys in relation to the time periods outlined in the terms and conditions of the BiOp - i.e., 2 years before, 2 years during, and 2 years after project construction.	
1 Sept 2005	**MA-3 Decision Criterion**	The consensus AMT decision criteria for MA-3 are defined as an "envelope" calculated as the minimum surveyed depth + 1 SD and the maximum depth + 1 SD. The envelope is defined across the channel for each survey with particular emphasis on the northern and southern boundaries of the navigation channel.	
1 Sept 2005	**MA-3 Decision Criterion**	All agencies concurred that the crossline survey results will be reviewed for exceedances and will reported yearly after the cross line surveys are completed. The MA-3 will examine accretion/erosion and changes in bathymetry of the main channel in relation to the channel deepening. Surveys will be conducted annually for two years prior to construction (by individual contract), two years during construction, and three years after construction. Crossline surveys will be conducted within a December–February time period to coincide with the end of the dredging season. Surveys will be conducted along the navigation channel from CRM 3 to CRM 106. Statistical analyses will produce estimates of mean and median depth at each sampled location across the channel; minimum and maximum values as well as SD and coefficients of variation will also be determined.	

Table 4-2.1. CRCIP AEM Plan Record of AMT MA-3 Decisions. Continued

Date	Issue	MA-3 Decisions	Comments
11 Jan 2006	**MA-3 Decision Criterion**	The AMT agreed that the "envelope" calculations for side slope adjustments would serve as initial decision criteria for MA-3. The AMT requested that the O'Brien-Michalsen' plots be incorporated as part of the AEM Plan implementation.	
10 Jan 2007	**MA-3 Crossline Surveys**	Additional pre-construction crossline survey data were used to revise the decision "envelopes" for MA-3.	
11 Apr 2007	**MA-3 Crossline Surveys**	An outlier value in reference to the decision "envelopes" at CRM 45.5 will be examined.	
11 Jul 2007	**MA-3 Crossline Surveys**	No new information was reported for MA-3.	
3 Oct 2007	**MA-3 Crossline Surveys**	No new information was available for MA-3.	
9 Jan 2008	**MA-3 Crossline Surveys**	No new information was available for MA-3.	
29 Apr 2008	**MA-3 Crossline Surveys**	No new information was available for MA-3.	
9 Jul 2008	**MA-3 Crossline Surveys**	Available 2008 survey results will be summarized and presented at the October AMT meeting.	
8 Oct 2008	**MA-3 Crossline Surveys**	The 2008 surveys suggest two possible values that lie outside the decision envelopes on the Washington side at CRM 75 and 42.5. The 2008 survey also shows that an outlier observed in 2007 at CRM 45.5 had returned to conditions within the envelope decision criteria. The AMT will continue to review future crossline survey results for these locations.	
14 Jan 2009	**MA-3 Decision Criterion**	No new information was presented regarding MA-3.	
8 Apr 2009	**MA-3 Decision Criterion**	No new information was presented for MA-3 at the April 2009 meeting.	
8 Jul 2009	**MA-3 Crossline Surveys**	No new information was presented for MA-3 at the July 2009 meeting.	
18 Nov 2009	**MA-3 Crossline Surveys**	No new information was presented for MA-3 at the November 2009 meeting.	
20 Jan 2010	**MA-3 Crossline Surveys**	MA-3 activities will continue for three years post-Project construction.	
14 Apr 2010	**MA-3 Crossline Surveys**	MA-3 activities will continue for three years post-Project construction.	
14 Jul 2010	**MA-3 Crossline Surveys**	The USACE will determine if crossline surveys are available for 2009.	
13 Oct 2010	**MA-3 Crossline Surveys**	Results of the 2009 MA-3 surveys were reported at the October 13th meeting. No decisions were made in relation to adaptive management.	

Table 4-2.1. CRCIP AEM Plan Record of AMT MA-3 Decisions. Continued

Date	Issue	MA-3 Decisions	Comments
12 Jan 2011	**MA-3 Crossline Surveys**	No AMT meeting was held in January 2011.	
13 Apr 2011	**MA-3 Crossline Surveys**	No new information for MA-3 was available for the April AMT meeting.	
13 Jul 2011	**MA-3 Crossline Surveys**	No new information for MA-3 was available for the July AMT meeting.	
12 Oct 2011	**MA-3 Crossline Surveys**	Results of the 2010 MA-3 surveys were reported at the October 12 meeting. No decisions were made in relation to adaptive management.	
11 Jan 2012	**MA-3 Crossline Surveys**	No new information for MA-3 was available for the January AMT meeting.	
11 Apr 2012	**MA-3 Crossline Surveys**	No new information for MA-3 was available for the April AMT meeting.	
11 Jul 2012	**MA-3 Crossline Surveys**	No new information for MA-3 was available for the July AMT meeting.	
10 Oct 2012	**MA-3 Crossline Surveys**	The October AMT meeting was cancelled.	
9 Jan 2013	**MA-3 Crossline Surveys**	No new information was presented for MA-3.	
10 Apr 2013	**MA-3 Crossline Surveys**	No new information was presented for MA-3.	
12 Sept 2013	**MA-3 Crossline Surveys**	Based on results of 2013 crossline surveys presented at the September meeting, the AMT requested additional analysis of all existing crossline survey results for CRM 41.5 (Wauna/Driscoll Bar).	
13 Nov 2013	**MA-3 Crossline Surveys**	A review of available crossline survey results from CRM 41.5 suggested that the variances with the envelope decision criteria reported at the September meeting was the result of natural sediment dynamics and not related to Project construction or O&M activities. The AMT reached consensus that CRCIP has not altered the pre-construction patterns of sediment dynamics within the LCR and estuary and no further analysis will be required.	

5 Monitoring Action 4—Habitat Opportunity

The original AEM plan for MA-4 was to augment the estuary habitat surveys that were being conducted by NMFS as part of the Anadromous Fish Evaluation Program (AFEP) (Bottom and Gore 2001). The MA-4 activity was originally scheduled to be completed three years after the Project construction was completed. However, the AFEP ended during the course of the AEM Program, which necessitated that the AMT adapt its plan in addressing MA-4 objectives.

The original MA-4 objective was to determine if changes in habitat opportunity and habitat capacity resulted from Project modifications to the channel. Habitat opportunity is defined as the number of hours within a 30-day (720-hour) month, wherein values of physical habitat criteria are consistent with criteria developed for juvenile salmonids (Bottom et al. 2001). Pre-construction calculations of habitat opportunity have been provided for juvenile Chinook and chum based on habitat descriptors of suitable water depths and current velocity. These pre-Project estimates can serve as a basis for comparing post-Project estimates of habitat opportunity in characterizing any impacts of channel modifications on the availability of desired physical habitat for juvenile salmonids.

As the result of discussions during 2011–2012, the AMT meetings reached consensus to address MA-4 objectives by having Drs. Antonio Baptista (OHSU) and Dan Bottom (NOAA) provide updated estimates of juvenile SHO and SWH in relation to the CRCIP channel modifications. Differences between pre- and post-Project values of SHO and SWH are intended to help the AMT evaluate impacts in relation to the MA-4 objectives. The modeling process would also include (1) detailed evaluation of model results (QA/QC), (2) performing a more detailed analysis of the model results attributable to the CRCIP, and (3) generation of a final report.

The AMT provided specific guidance for summarization of the modeling results to best support efforts in evaluating the results in relation to MA-4 objectives. The AMT requested that the initial model analysis and summary of model results to emphasize calculated values of (1) SWH and SHO. The team also recommended focus on the results of Option B (i.e., the difference between 2003 bank-to-bank bathymetry and 2012 channel bathymetry imposed on 2003 bank-to-bank bathymetry) to describe changes directly attributable to CRCIP. The AMT requested that the percentage differences in SWH and SHO for the conditions defined by model Option B be used as the fundamental measure in the recommended analysis of model results. The AMT also requested that tables of summary statistics (i.e., mean, median, minimum, maximum, standard deviation, and range) of Option B model results be developed for these specific model outputs.

Several additional topics concerning the MA-4 analysis and summarization included:

1. the potential implications of using option B bathymetry all the way to Bonneville,
2. the model depth criteria used to define SWH compared to the commonly used 20 foot regulatory value,
3. explanation or specification of model reliability (i.e., general model validation) to help the AMT in evaluating the tabular summaries of the percent differences in relation to MA-4 objectives, and

4. model sensitivity to values and assumptions used in developing the simulations, particularly for Option B.

The AMT additionally recommended that any assumptions or caveats underlying the analysis, summary, and presentation of the model results be documented and included with the tabular summaries.

5-1 MA-4 Decision Criteria

Formal decision criteria were not developed for MA-4 during the AEM planning process. Early discussions among the AMT addressed possible summaries of changes in opportunity or habitat in the form of Table 5-1.1. However, further deliberations by the AMT during 2013 supplanted Table 5-1.1 with tabular summaries more specifically tailored to support decision-making in relation to MA-4 objectives.

Dr. Antonio Baptista provided results for four circulation-derived metrics: (1) plume volume, (2) salinity intrusion length, (3) SWH, and (4) SHO. The latter three metrics are of primary importance in evaluating MA-4 objectives. The results were calculated using the 2003 (pre-construction) and 2012 (post-construction) bank-to-bank bathymetry data. The potential impacts were also calculated by imposing the 2012 bathymetry directly on the 2003 data (with unrelated effects "filtered out"). Results for these two approaches for evaluating changes in bathymetry were simulated for years 1999, 2001, 2011, and 2012. These results have been summarized for eight (A–H) geographic river reaches that describe the Lower Columbia River and estuary. Reach A includes the mouth of the Columbia River, while reach H extends to the Bonneville Dam.

The results for plume volume were not of primary interest to the AMT in assessing pre- and post-project changes in juvenile salmon habitat. Nevertheless, the results are briefly outlined as follows. Model results for plume volume showed differences between the 2003 and 2012 bathymetry scenarios on the order of ±20% and are characterized by large seasonal and inter-annual variability. Changes in plume volume directly attributable to the CRCIP appear on the order of ±2%. However, plume values attributable to the Project that exceed 2% are evident in the first quarter of 2012. These results are currently under investigation.

Model results for salinity intrusion length (SIL) differ substantially for the 2003 and 2012 bathymetry data. Overall modeled changes in SIL are on the order of ±10%, and exhibit large seasonal and inter-annual variability. However, changes in SIL directly attributable to the CRCIP appear on the order of ±1%. The overall results suggest a small net decrease in SIL. In contrast, the pre-Project concerns of the AMT were that channel modifications might increase salinity intrusions into the Lower River and estuary and potentially reduce habitat quality and availability for juvenile salmonids. The model results are not consistent with significant increases in salinity intrusion.

SWH is concentrated mainly in the lower estuary (reaches A–C) and downstream of the confluence with the Willamette (reach F). Changes in modeled SWH in these lower reaches are not dramatically affected by changes in the 2003 and 2012 bathymetry, although modeled SWH

in reach A increases consistently between the 2003 and 2012 bathymetry scenarios. SWH is more strongly influenced between 2003 and 2012 in the upper reaches; reach H shows the most significant differences (±). Model results for SWH are strongly influenced by variations in river discharge for reaches C–H. In contrast, modeled SWH in reaches A and B are less sensitive to variations in discharge.

The model results for SHO were measurably different between the 2003 and 2012 bathymetry scenarios. However, the changes were minimally associated with the CRCIP channel modifications. The modeled increases in SWH for reach A between 2003 and 2012 bathymetry translated into corresponding increases in SHO for this reach. Some of the increase in SHO for reach A resulted from modeled reductions in the salinity intrusion lengths. Reaches D, G, and H exhibited the largest changes in SHO among the modeled reaches. Reaches B and C demonstrated essentially no change in SHO between the 2003 and 2012 bathymetry.

Dr. Bottom reviewed the physical modeling results relative to sensitive times, locations, and stocks of juvenile salmon. Juvenile salmon utilize different habitats within the estuary depending on individual fish size: larger individuals appear to use the main channel, while smaller fish remain in SWH. Larger fish also spend less time in the estuary before entering the ocean. Importantly, Bottom identified potentially sensitive areas as reach B in the oligohaline transition zone used by lower Columbia River stocks and reaches F, G, and H in the tidal transition used by interior stocks. Potentially sensitive time periods include the spring peak in juvenile abundance and the summer/fall seasonal transition when flows are low, temperatures are high, and late migrants are correspondingly stressed. Bottom concluded from the Baptista modeling results that bathymetric changes from the CRCIP would most directly have affected deeper habitats favored by yearlings and large sub-yearlings. However, the modeled changes in habitat opportunity were minor for most reaches and time periods except for reach H, where the simulation results suggested comparatively greater possible impacts.

Examinations of the model results indicated that the larger changes in SHO were all in areas where the model accuracy and reliability were questionable. Therefore, the changes do not reflect actual system behavior, and are likely model artifacts. The current model results indicate minimal CRCIP impacts to SHO. The AMT agreed that there were minimal concerns and that the MA-4 requirements had been usefully addressed by the modeling. However, the AMT recommended one last simulation using a recalibrated model that fixed the standing wave error near Beacon Rock.

To address the concerns stated by the AMT, Dr. Baptista and his colleagues revised the model to improve its treatment of the bottom boundary layer in the estuary. The modification also improved model performance in calculating water elevation in the upper reaches of the river. The following results of the simulation using the revised model have been summarized from final modeling report (Seaton et al. 2014):

- Modeled post-CRCIP salinity intrusion lengths and salt volume mainly decrease in comparison to pre-Project conditions. Intrusion lengths decrease by approximately 1%. Salt volumes decrease by approximately 2%. Nearly all the model results suggest changes on the order of 5% or less.

- Simulated plume volume increased compared to pre-CRCIP conditions. The modeled increases were mainly less than 5%.
- Modeled shallow water habitat suggested both increases and decreases. The upstream reaches were more susceptible to change than the estuary. However, most of the changes were less than 5% compared to pre-CRCIP habitat conditions.
- Simulated changes in salmon habitat opportunity indicated both increases and decreases compared to pre-CRCIP opportunity. Changes were reach-specific and affected mainly by salinity changes in the lower reaches and water elevations in the upper reaches. However, the modeled changes were small, mainly less than 5% compared to pre-Project conditions.

The Seaton et al. (2014) final modeling report has been uploaded to the E2 CRCIP website under the MA-4 reporting section of the electronic workbook.

The final report has been reviewed by members of the AMT. Prior to the October 7, 2014, final meeting, the AMT reached consensus that the objectives for MA-4 had been met and that no further action is necessary for MA-4.

Table 5-1.1. Template for Evaluating Changes in Habitat Opportunity (Velocity, Depth) using Results from MA-4 Habitat Surveys.

	Habitat Opportunity (h/month)[2]											
LCR	Pre-construction[3]			Post-construction[5]			Percent change			Decision criteria (%-change)[6]		
Region[1]	Velocity	Depth	Combined	Velocity	Depth	Combined	Velocity	Depth	Combined	Velocity	Depth	Combined
1	580 - 620[4]	125 - 160										
2	275 - 310	~50										
3	590 - 610	210 - 240										
4	350 - 550	190 - 210	140 - 180									
5	390 - 500	155 - 180										
6	50 - 490	10 - 90										

[1] Regions defined by Bottom et al. (2005)

Region 1	Baker Bay
Region 2	Lower mainstem
Region 3	Youngs Bay
Region 4	Cathlamet Bay
Region 5	Grays Bay
Region 6	Upper estuary

[2] Calculated for 30-d (720 h) month

[3] Results reported in Bottom et al. (2005)

[4] Ranges reflect seasonal variations in river discharge

[5] Post-Project values of habitat opportunity will be estimated using the same methodology as Bottom et al. (2005) and bathymetry data revised in relation to channel deepening

[6] MA-4 decision criteria have yet to be defined by the Adaptive Management Team

5-2 AMT Decisions for MA-4

Table 5-2.1 outlines the key discussion and decisions regarding potential CRCIP impacts on habitat through calendar 2012 of the AEM Program.

Table 5-2.1. CRCIP AEM Plan Record of AMT MA-4 Decisions.

Date	Issue	MA-4 Decisions	Comments
16 Dec 2004	**MA-4 Decision Criterion**	Re-evaluation of Bottom et al. (2005) calculations of habitat opportunity.	
16 Dec 2004	**MA-4 Decision Criterion**	Detailed survey to be conducted 3 years after project construction.	
16 Dec 2004	**MA-4 Decision Criterion**	Presentation of ongoing studies (Science Center) that are further elaborating salmonid utilization of the lower river and estuary.	
5 Jul 2005	**MA-4 Decision Criterion**	The Channel Improvement Project will fund one of the 10 years and include support for in-depth analysis of the data obtained during this study. Discussion continues concerning which one of the 10 years will be funded by the CRCIP. It was proposed to select the year corresponding to 3 years after Project completion.	
5 Jul 2005	**MA-4 Decision Criterion**	NOAA Fisheries (C. Tortorici) expressed an interest in selecting the year of Project funding for the more intensive studies to be supported by MA-4. The NOAA emphasis resides in ensuring that the intensive study is performed. NOAA was silent concerning the USACE proposed target year designated as three years post-construction.	
5 Jul 2005	**MA-4 Decision Criterion**	The USACE noted that additional discussion is needed to come to an agreement on identifying the post-construction year selected for MA-4. This should be a topic of future AMT meetings until resolved.	
1 Sep 2005	**MA-4 Decision Criterion**	The agencies concurred that setting triggers at this time would be premature and that this MA would be reviewed quarterly. It was also agreed that either NOAA or the USACE would report the study findings at the yearly AFEP meeting.	
10 Jan 2007	**MA-4 Habitat Surveys**	The AMT made no new decisions concerning MA-4.	
11 Apr 2007	**MA-4 Habitat Surveys**	No decisions were required for MA-4.	
11 Jul 2007	**MA-4 Habitat Surveys**	No new information was reported for MA-4.	
3 Oct 2007	**MA-4 Habitat Surveys**	No new information was reported for MA-4.	
9 Jan 2008	**MA-4 Habitat Surveys**	No new information was available for MA-4.	
29 Apr 2008	**MA-4 Habitat Surveys**	No new information was available for MA-4.	
9 Jul 2008	**MA-4 Habitat Surveys**	No new information was available for MA-4.	
8 Oct 2008	**MA-4 Habitat Surveys**	No decisions were made for MA-4 at the October 2008 meeting.	
14 Jan 2009	**MA-4 Habitat Surveys**	No new information was available for MA-4.	

Table 5-2.1. CRCIP AEM Plan Record of AMT MA-4 Decisions. (Continued).

Date	Issue	MA-4 Decisions	Comments
8 Apr 2009	**MA-4 Habitat Surveys**	No new information was presented for MA-4 at the April 2009 meeting.	
8 Jul 2009	**MA-4 Habitat Surveys**	No new information was presented for MA-4 at the July 2009 meeting.	
18 Nov 2009	**MA-4 Habitat Surveys**	No new information was presented for MA-4 at the November 2009 meeting.	
20 Jan 2010	**MA-4 Habitat Surveys**	No new information was presented for MA-4 at the January 2010 meeting. MA-4 will be discussed at the April 201 0AMT meeting.	
14 Apr 2010	**MA-4 Habitat Surveys**	The USACE will support studies to evaluate habitat utilization by Evolution Significant Units in the lower river and estuary. A submitted research proposal for MA-4 related work will be discussed at the July 201 0AMT meeting.	
14 Jul 2010	**MA-4 Habitat Surveys**	Discussions concerning post-construction MA-4 activities will continue at upcoming AMT meetings.	
13 Oct 2010	**MA-4 Habitat Surveys**	Discussion of MA-4 activities was re-scheduled for the January 2011 AMT meeting.	
12 Jan 2011	**MA-4 Habitat Surveys**	No AMT meeting was held in January 2011.	
13 April 2011	**MA-4 Habitat Surveys**	No decisions were made in relation to MA-4 at the April AMT meeting. Discussion will continue at the July meeting.	
13 Jul 2011	**MA-4 Habitat Surveys**	The AMT discussed several approaches to address MA-4 objectives. Bartell will develop and present a "strawman" proposal at the October AMT. This draft proposal will include the main points of the July discussion.	
12 Oct 2011	**MA-4 Habitat Surveys**	Bartell presented a draft proposal including several technical approaches aimed at meeting MA-4 objectives. The AMT agreed to further discuss the proposal at the January 2012 AMT meeting.	
11 Jan 2012	**MA-4 Habitat Surveys**	The AMT agreed to solicit a proposal from Dr. Antonio Baptista to repeat the modeling of juvenile salmonid habitat opportunity.	
11 Apr 2012	**MA-4 Habitat Surveys**	There was no quorum at the April 2012 AMT meeting. No decisions were reached concerning MA-4.	
11 Jul 2012	**MA-4 Habitat Surveys**	The AMT agreed to invite Drs. Baptista and Bottom to the October AMT meeting to discuss their proposal for MA-4 activities.	
11 Oct 2012	**MA-4 Habitat Surveys**	The October AMT meeting was cancelled.	
14 Dec 2012	**MA-4 Habitat Surveys**	The MA-4 proposal by Drs. Baptista and Bottom was approved by the AMT through written communications outside of a formal AMT meeting.	
9 Jan 2013	**MA-4 Habitat Surveys**	Dr. Baptista will provide preliminary modeling results for habitat opportunity and SWH habitat prior to the April 2013 AMT meeting.	
10 Apr 2013	**MA-4 Habitat Surveys**	Baptista and his colleagues will continue with refinements to the model and present an update on model results at the July 2013 AMT meeting.	
12 Sep 2013	**MA-4 Habitat Surveys**	Dr. Baptista stated that the next steps in the modeling process would include (1) completion of the 1999 simulations, (2) detailed evaluation of model results (QA/QC), (3) perform a more detailed analysis of the model results attributable to the CRCIP, and (4) generate a final report.	

Table 5-2.1. CRCIP AEM Plan Record of AMT MA-4 Decisions. (Continued).

Date	Issue	MA-4 Decisions	Comment
13 Nov 2013	**MA-4 Habitat Surveys**	The AMT recommended focusing on the results of Option B (using the difference between 2003 bank-to-bank bathymetry and 2012 channel bathymetry imposed on 2003 bank-to-bank bathymetry to define changes directly attributable to CRCIP) simulations for all modeled years: 1999, 2001, 2011, and 2012. The AMT also requested the initial model analysis and summary of model results to include only the calculated values of SWH and SHO. The AMT requested that the percentage differences in SWH and SHO be used as the fundamental measure in the analysis of model results. The AMT requested that tables of summary statistics (i.e., mean, median, minimum, maximum, SD, and range) be developed for these specific model outputs. The AMT suggested that tables of model results should be developed separately for months March through September and that the monthly model results should be developed separately for all modeled reaches (A–H). The AMT recommended that any assumptions or caveats underlying the analysis, summary, and presentation of the model results be documented and included with the tabular summaries.	
22 Jan 2014	**MA-4 Habitat Surveys**	The AMT agreed that there were minimal concerns and that the MA-4 requirements had been usefully addressed by the modeling. However, the AMT recommended one last simulation using a recalibrated model that fixed the standing wave error near Beacon Rock. If there are greater than anticipated changes in the recalibrated simulation results, the AMT may reconsider its decision.	
7 Oct 2014	**MA-4 Habitat Surveys**	The draft report (which included results of the modeling requested by the AMT in the January 2014 meeting) was reviewed by the AMT from July to August 2014. Based on the cumulative modeling in the report, the modeled differences do not suggest a significant change between pre- and post- CRCIP shallow water habitat or salmon habitat opportunity. The report findings were consistent with the results presented and discussed at the January AMT meeting and final consensus was received by email from AMT to complete MA-4.	

6 Monitoring Action 5—Sediment Contaminants

MA-5 addresses the potential for existing sediment contaminants to be suspended by dredging activities. This action includes the collation and evaluation of existing data that describe sediment contaminants in the LCR and estuary. Given limitations in available data, MA-5 initially focused on samples that were collected well before the onset of the CRCIP. Comprehensive sediment testing was completed in 2008 and the results of the Project Review Group (PRG) review was presented to the AMT in 2011.

The CRCIP construction requirements for MA-5 have been completed. The assessment of sediment contaminants will continue as part of routine Project O&M, however the O&M sediment assessments are not included in the CRCIP AEM Program.

6-1 Sediment Contaminants

The 2013 Annual Report simply underscores the 2010 findings of the PRG that the sediments from CRM 3 through CRM 106.5 ranked as “very low” according to the 2010 SEF for the Pacific Northwest. According to the PRG review, the sediment quality data reported for this area in the Sediment Quality Evaluation Report are sufficient for ten years. As a result of this review process, additional sediment testing will not be required until 2018.

The PRG report has been uploaded to the E2 CRCIP website and located in the MA-5 reporting link for the electronic version of the AEM Workbook.

6.2 AMT Decisions for MA-5

Table 6-2.1 summarizes the important AMT discussion points and decisions concerning the possible impacts of Project construction on redistribution of sediment contaminants through calendar 2013.

Table 6-2.1. CRCIP AEM Plan Record of AMT MA-5 Decisions.

Date	Issue	MA-5 Decisions	Comments
16 Dec 2004	**MA-5 Decision Criterion**	AMT will solicit summaries of sediment contamination data from the technical group already performing this work.	
16 Dec 2004	**MA-5 Decision Criterion**	The AMT will interact with the LCR and Estuary Program to acquire additional data and information concerning chemical contaminants in the lower river and estuary.	
1 Sep 2005	**MA-5 Decision Criterion**	WDOE agreed to verify whether they would be housing the system. (Update: WDOE emailed the USACE on September 6, stating that WDOE "…will always maintain the SEDQUAL system as for their purposes so it will always be available to use of the AMT.)	
1 Sep 2005	**MA-5 Decision Criterion**	As for the triggers, the team discussed using the new SEF as triggers for sediment quality upon approval and adoption of the SEF.	
12 Oct 2005	**MA-5 Decision Criterion**	While there are some gaps, the SEF largely addresses the sediment contaminants of interest to Washington, Oregon, and Idaho. The AMT agrees that decision criteria for MA-5 should be made on the basis of the final SEF.	
12 Apr 2006	**MA-5 Reporting**	The AMT agreed that the SEDQUAL input template was adequate to describe newly obtained sediment contaminants data.	
10 Jan 2007	**MA-5 Sediment Contaminants**	The USACE will convene a meeting to review available sediment contaminant data.	
11 Apr 2007	**MA-5 Sediment Contaminants**	No decisions were required for MA-5.	
11 Jul 2007	**MA-5 Sediment Contaminants**	No new information was reported for MA-5.	
3 Oct 2007	**MA-5 Sediment Contaminants**	The USACE (Mark Sippola) will be contacting ODEQ to provide sediment toxic chemical information for the base period and optional work that was awarded to the Great Lakes. The AMT also discussed tracking in the decision summary the areas that ODEQ has approved for dredging.	
9 Jan 2008	**MA-5 Sediment Contaminants**	ODEQ has provided a summary of river miles that have been approved for dredging. This information will be summarized in a spreadsheet and posted at the E2 CRCIP website (Folder: MA-5 Sediment Quality).	
29 Apr 2008	**MA-5 Sediment Contaminants**	No decisions were made concerning MA-5.	
9 Jul 2008	**MA-5 Sediment Contaminants**	No new information was available concerning MA-5.	
8 Oct 2008	**MA-5 Sediment Contaminants**	Results of sediment testing from CRM 3-106.5 will be presented at the January 2010 AMT meeting.	

Table 6-2.1. CRCIP AEM Plan Record of AMT MA-5 Decisions. (Continued).

Date	Issue	MA-5 Decisions	Comments
14 Jan 2009	**MA-5 Decision Criterion**	No decisions were made regarding MA-5 monitoring activities.	
8 Apr 2009	**MA-5 Decision Criterion**	Based on chemical analysis of 23 samples from the Columbia River navigation channel, dredged sediments were judged as suitable for in-water placement.	
8 Jul 2009	**MA-5 Decision Criterion**	No new information was presented for MA-5 at the July 2009 meeting.	
18 Nov 2009	**MA-5 Decision Criterion**	No new information was presented for MA-5 at the November 2009 meeting.	
20 Jan 2010	**MA-5 Decision Criterion**	MA-5 activities will transition into the O&M phase for compliance with the SEF.	
14 Apr 2010	**MA-5 Decision Criterion**	MA-5 activities will transition into the O&M phase for compliance with the SEF.	
14 Jul 2010	**MA-5 Decision Criterion**	MA-5 has been completed for the CRCIP AEM Program. Sediment contaminant activities will transition into the O&M phase of channel improvement. The SEF PRG will be requested to review previous sediment findings concerning disposal of dredge materials.	
13 Oct 2010	**MA-5 Decision Criterion**	The PRG verified that sediments from CRM 3 through CRM 106.5 will not require further testing for ten years, with the exception of one sample from CRM 100.7 that will require testing in five years. The USACE plans to re-sample and test this location in 2011.	
12 Jan 2011	**MA-5 Decision Criterion**	January 2011 AMT meeting was cancelled.	
13 April 2011	**MA-5 Decision Criterion**	No decisions were made in relation to MA-5 at the April 2011 AMT meeting.	
13 Jul 2011	**MA-5 Decision Criterion**	The report from the PRG determined that materials from CRM 3–106.5 were suitable for unconfined aquatic placement. The AMT reached consensus that AEM Program requirements for MA-5 had been completed. The next testing will occur in 2018.	

7 Monitoring Action 6—Fish Stranding

The evaluation of the potential changes in fish stranding in relation to Project construction was originally planned to be based on a before-and-after comparison of field studies, similar in concept to MA-4. However, in 2011 the AMT agreed that there was insufficient justification for simply repeating the post-Project stranding studies as originally proposed, because the study designs lack sufficient statistical power to detect the anticipated magnitudes of change in the probabilities of fish stranding. Dr. Walter Pearson's (Pearson 2011) statistical analysis of likely changes in the probability of fish stranding for post-construction navigation scenarios estimated that additional years of study and millions of dollars would be required to collect sufficient samples to provide the necessary statistical power. To help assess the reliability of Pearson's analysis in addressing MA-6 concerns, the AMT requested that Dr. Pearson's statistical modeling of fish stranding undergo a rigorous external peer-review. This review was initiated in 2012 by the USGS Western Fisheries Research Center (Cook, WA).

The principal effort for MA-6 during 2013 was completion of the external peer review of the Pearson (2011) model and analysis, as described in Section 7-3. Importantly, the AMT was able to reach consensus, based mainly on the peer review, that the post-Project stranding studies should not be performed and that the objectives of the fish stranding component of the CRCIP AEM Program had been met (Section 7-4).

7-1 Frequency of Stranding

The following sections are identical to the 2010 annual report, which are provided for the convenience of the reader. The proposed decision criteria for fish stranding are based on a comparison of pre- and post-Project numbers of stranded fish. An increase in the number of stranded fish following channel improvements could initiate the adaptive components of the AEM Program for the CRCIP. Table 7-1.1 summarizes the results of intensive field studies aimed at understanding the potential for fish stranding by commercial navigation in the Columbia River and estuary (Pearson et al. 2005a). On average across all three locations, approximately 26% of the vessel passages were associated with stranding events. This frequency ranged from ~18 to 30% for these 3 locations. If corresponding post-Project stranding frequencies are statistically greater than the values summarized in Table 7-1.1, the adaptive components of the AEM Plan could be invoked to determine the likely cause for the measured increase.

Table 7-1.1. Frequency of Fish Stranding Events at Study Sites (Pearson et al. 2005a).

Sites	Stranding Events	Total Passages	Frequency (%)
County Line Park (CRM 51)	3	17	17.6
Barlow Point (CRM 62)	7	23	30.4
Sauvie Island (CRM 97)	4	14	28.6
Overall frequency: 25.9% Chi square: p=0.64			

7-2 Susceptibility to Stranding

In addition to potentially changing the frequency of fish stranding events, channel modifications in the Columbia River and estuary might alter the susceptibility of different fish species to stranding. Pearson et al. (2005a) estimated the relative percentage of 11 species commonly collected in the locations of the stranding studies (Table 7-2.1). The results of seining indicated that the relative abundance of fish subject to stranding was dominated by the three-spine stickleback, peamouth, American shad, and age 0+ Chinook salmon. The relative abundances of these species among the stranded fish were also calculated. Dividing the relative frequency of stranding by the relative abundance produced a ratio that defines the susceptibility for each of the 11 species (Table 7-2.1). Ratios greater than 1.0 indicate greater susceptibility to stranding. That is, the species is proportionally over-represented among the stranded fish compared to its relative availability. In contrast, susceptibility ratios less than 1.0 indicate some ability of the species to reduce its likelihood of stranding.

Bass (fry) were the most susceptible of the 11 species to stranding by commercial vessel passage. Sunfish (bluegill), crappie, and age 0+ Chinook were also susceptible. The remaining species demonstrated some capability to avoid stranding. The susceptibility ratios can also serve as decision criteria for fish stranding in the AEM Plan. Potential modifications in fish habitat and changes in fish behavior associated with channel modifications could increase the local availability or susceptibility of these (or other) species. If post-Project susceptibility ratios increase significantly compared to those reported in Table 7-2.1, the adaptive components of the AEM Plan should be followed to determine the likely reason for the increases.

Table 7-2.1. Relative Susceptibility of Different Fish Species to Stranding (Pearson et al. 2005a).

Species	Percent Stranded	Percent Seined	Susceptibility Ratio
Chinook salmon (0+)	30.1	12.5	2.4
Three-spin stickleback	25.9	28.7	0.9
Peamouth	5.7	22.3	0.3
Banded killifish	10.6	12.3	0.9
Bass (fry)	16.0	0.2	80.0
American shad	8.2	20.1	0.4
Yellow perch	0.8	1.7	0.5
Mountain whitefish	0.6	0	0
Starry flounder	0.8	2.0	0.4
Crappie	0.4	0.1	4.0
Sunfish/bluegill	0.8	0.1	8.0

The pre-construction evaluation of fish stranding was completed in 2007 and the final report has been posted to the E2 Project website (www.e2tm.com/CRCIP). The form and content of these tables of decision criteria have been accepted by the AMT. The above decision criteria have been included in the AEM Workbook.

7-3 Post-Construction Probability of Stranding

In 2013, Toby Kock, John Plumb, and Noah Adams (USGS–Cook, WA) completed their peer review of Dr. Walter Pearson's statistical model and analysis of post-construction fish stranding (Pearson 2011). This formal review began during 2012 following identification and development of the peer-review issues by the AMT. The reviewers were asked to (1) examine the overall structure of the statistical model, (2) evaluate the estimated model parameter values in relation to the underlying data, and (3) characterize the results of the navigation scenarios analyzed by Pearson. In addition, the AMT requested that reviewers consider possible alternative model formulations and search the technical literature for other similar analyses of fish stranding. The AMT intended to use the results of the peer-review as a basis for evaluating post-construction activities (e.g., additional stranding studies) for MA-6 in relation to the AEM Plan.

During the course of 2013, Kock and his colleagues reported on the progress of their review activities. At the January AMT meeting, the investigators stated that the Pearson (2011) analysis was well-written, organized, transparent, and scientifically defensible. Kock and his colleagues emphasized that limitations and uncertainties associated with the 2004–2005 data used to develop the Pearson model were important components in estimating fish stranding probabilities. For example, many of the data used in the Pearson analysis were collected on a single day. Additionally, the data were collected mainly during the period of rising tides. Resulting collinearities and strong correlations among the underlying data can introduce instability in estimated parameters of the statistical model. An initial recommendation supported by the review was that any future studies should focus on expanding the LCR wake stranding data set. The reviewers also indicated that other statistical model formulations might provide additional insights concerning juvenile fish stranding, but also understood that other model structures would require more data that were not likely available.

At the April 2013 AMT meeting, Toby Koch briefly summarized the results and conclusions of reviewing the empirical modeling and analysis of fish stranding performed by Pearson. Kock concluded that there were no significant technical shortcomings in the work provided by Dr. Pearson. Dr. Pearson agreed with the USGS review of his empirical stranding model and scenario analysis. He further suggested that year-to-year variations in river flows and fish abundance likely outweigh the effects of channel deepening in determining the magnitudes of fish stranding in the LCR and estuary. Shyam Nair also pointed out that continued modifications of the commercial navigation fleet since 2010 define a dynamic baseline which could complicate the assessment of any changes in stranding resulting from channel deepening. Koch also emphasized that fish stranding on the LCR and estuary remains an incompletely understood phenomenon. Koch suggested that more complex simulation modeling might provide additional insights into the stranding process and help characterize the potential magnitudes of fish stranding mortalities in the LCR and estuary. Pearson supported the idea that more complex simulation models might increase the precision associated with the current empirical assessment. However, increases in accuracy would depend more on evaluation of the model results with additional field observations. Pearson's power analysis of his statistical model indicated that 300–400 additional ship passage events would be needed to provide sufficient data to quantify changes in stranding. This would take 3–4 years of study and funding resources that were not likely to be available. Correspondingly, the AMT determined that it was not within the scope of

the CRCIP AEM Program to develop such a comprehensive description of fish stranding. As an alternative, the AMT proposed to monitor the results of multi-agency fish stranding workshops scheduled for 2013. The anticipated workshops are directed towards developing a more comprehensive understanding and assessment of fish stranding in the LCR and estuary.

Multi-Agency Fish Stranding Workshop Summary

Greg Smith (USACE) and Jeff Fisher (NMFS) summarized the 2013 multi-agency fish stranding workshop. Led primarily by NMFS, interested stakeholder agencies have organized to discuss and further understand fish stranding by commercial navigation on the Columbia River. The results of the MA-6 fish stranding studies have been part of the discussion. NMFS is particularly interested in understanding the system-wide implications of stranding. However, the MA-6 effort examined only three beaches known to be susceptible to fish stranding. Minimally, all beaches of interest should be classified as high, medium, and low in terms of stranding potential. The workshop stakeholders understand the need and the difficulty of assessing the cumulative impacts of stranding on fish population dynamics. Age-0 fish, especially Columbia River chum, appear particularly vulnerable. Current indications are that 50,000 fish might be stranded each year on the Columbia River. This value is likely a substantial underestimate. Fish stranding is of continued and increasing interest because commercial shipping on the Columbia is anticipated to increase by 900-1,000 vessels/year. The workshop identified two possible courses of future action in relation to stranding: (1) additional verification studies to further characterize the stranding process, and (2) modification of beaches to reduce stranding (e.g., beneficial uses of dredged materials). NMFS and other workshop participants are exploring the use of collaborative funding mechanisms [e.g., request for proposal (RFP), grants, etc.] to comprehensively address fish stranding on the Columbia River.

7-4 AMT Decisions for MA-6

Based on extensive discussion, analysis and peer-review since Project completion in 2010, the AMT reached consensus at the April 2013 AMT that post-Project studies of fish stranding need not be performed and that the objectives of the fish stranding component of the CRCIP AEM Program had been met.

Table 7-4.1 summarizes the key discussion points and decisions concerning the possible impacts of CRCIP construction on fish stranding through calendar 2013 for the AEM Program.

Table 7-4.1. CRCIP AEM Plan Record of AMT MA-6 Decisions.

Date	Issue	MA-6 Decisions	Comments
16 Dec 2004	**MA-6 Decision Criterion**	Studies of fish stranding will continue in 2005.	
16 Dec 2004	**MA-6 Decision Criterion**	Need to examine the statistical model to identify the factors and interaction terms that can be effectively incorporated into the AEM process.	
16 Dec 2004	**MA-6 Decision Criterion**	Revisit decision criteria after studies are completed (approx. November–December 2005).	
1 Sep 2005	**MA-6 Decision Criterion**	Post-construction studies of stranding will be performed and the results will be compared to pre-construction stranding study results.	
12 Oct 2005	**MA-6 Decision Criterion**	No decisions was made concerning fish stranding at the October 2005 AMT meeting.	
12 Apr 2006	**MA-6 Reporting**	The AMT suggested that tables describing fish stranding be modified to focus on species of concern (i.e., salmonids).	
10 Jan 2007	**MA-6 Fish Stranding**	The final report of the pre-construction evaluation of fish stranding has been completed and will be posted to the E2 FTP site.	
11 Jul 2007	**MA-6 Fish Stranding**	No new information was provided for MA-6.	
3 Oct 2007	**MA-6 Fish Stranding**	No new information was provided for MA-6.	
9 Jan 2008	**MA-6 Fish Stranding**	No new information was provided for MA-6.	
29 Apr 2008	**MA-6 Fish Stranding**	No new information was provided for MA-6.	
9 Jul 2008	**MA-6 Fish Stranding**	No new information was provided for MA-6.	
8 Oct 2008	**MA-6 Fish Stranding**	No decisions were made for MA-6 at the October 2008 meeting.	
14 Jan 2009	**MA-6 Fish Stranding**	No new information was presented regarding MA-6.	
8 Apr 2009	**MA-6 Fish Stranding**	No new information was presented for MA-6 at the April 2009 meeting.	
8 Jul 2009	**MA-6 Fish Stranding**	No new information was presented for MA-6 at the July 2009 meeting.	
18 Nov 2009	**MA-6 Fish Stranding**	The AMT requested that the post-construction (Phase 2) fish stranding studies be performed as originally specified in the BiOp.	
20 Jan 2010	**MA-6 Fish Stranding**	Post-Project construction studies will be performed in March 2012–2013.	
14 Apr 2010	**MA-6 Fish Stranding**	Post-Project construction studies will be performed in March 2012 and March 2013. Additional discussion concerning the design of the studies is planned for the July 2010 AMT meeting.	
14 Jul 2010	**MA-6 Fish Stranding**	Dr. Walter Pearson has been contracted to evaluate the efficacy of post-construction experiments for fish stranding. Dr. Pearson will present initial results of his analysis at the October 2010 AMT meeting.	
13 Oct 2010	**MA-6 Fish Stranding**	Dr. Pearson presented the results of his analysis of the probability of fish stranding in the post-Project channel for several scenarios of commercial navigation. The AMT will review the report prepared by Dr. Pearson for discussion at the January 2011 AMT meeting.	
12 Jan 2011	**MA-6 Fish Stranding**	No AMT meeting was held in January 2011.	

Table 7-4.1. CRCIP AEM Plan Record of AMT MA-6 Decisions. Continued.

Date	Issue	MA-6 Decisions	Comments
13 Apr 2011	**MA-6 Fish Stranding**	The AMT does not intend to accept Dr. Pearson's results as justification for not performing post-Project stranding studies. The studies remain part of the terms and conditions in the BiOp. However, the results of Pearson's analysis might be used to carefully design a subset of the originally stipulated follow-up studies to verify the empirical model and draw inferences concerning the effects of channel modification on fish stranding.	
13 Jul 2011	**MA-6 Fish Stranding**	The AMT did not arrive at a consensus process for resolving MA-6 during the July meeting. The USACE agreed to have some internal meetings to discuss possible approaches prior to the October AMT meeting.	
12 Oct 2011	**MA-6 Fish Stranding**	The AMT agreed that there was insufficient justification for performing the post-construction stranding studies. The AMT recommended that Dr. Pearson's analysis undergo an external peer review. The results of this review will be used by the AMT to develop recommendations for completing the requirements of MA-6.	
11 Jan 2012	**MA-6 Fish Stranding**	Bartell was requested to draft a RFP for peer-review of Dr. Pearson's analysis for discussion at the April AMT meeting.	
11 Apr 2012	**MA-6 Fish Stranding**	There was no quorum at the April AMT meeting. No decisions were made concerning MA-6 activities.	
11 Jul 2012	**MA-6 Fish Stranding**	The peer review of the Pearson analysis will be performed by technical staff at the USGS Western Fisheries Research Center, Cook, WA.	
10 Oct 2012	**MA-6 Fish Stranding**	The October AMT meeting was cancelled.	
9 Jan 2013	**MA-6 Fish Stranding**	No decisions were required for MA-6.	
10 Apr 2013	**MA-6 Fish Stranding**	The AMT reached consensus that post-Project stranding studies need not be performed and that MA-6 has been completed for the AEM Program.	

8 Sturgeon

The sturgeon component of the AEM Program is considered completed for the CRCIP project. No new information concerning project impacts on sturgeon was presented or discussed during 2013.

8-1 Decision Criteria for Sturgeon

In the original CRCIP AEM Plan, decision criteria for sturgeon were based on the potential impacts of dredging and disposal of dredged materials on sturgeon behavior (e.g., foraging, and habitat selection). The two reports that summarize the studies of dredging activities have been essentially finalized. The first study describes the behavioral response of tagged white sturgeon to dredging activities. The second study developed a model that predicts sturgeon habitat quality based on descriptions of channel physical characteristics. The resulting reports have been previously posted on the E2 CRCIP website.

8-2 AMT Decisions regarding Sturgeon

Table 8-2.1 summarizes the key discussion points and decisions concerning the possible impacts of Project construction on sturgeon through calendar year 2013 for the AEM Program. Although the sturgeon component of the CRCIP AEM Program has been completed, the table of AMT decisions has been included for continuity in reporting.

Table 8-2.1. CRCIP AEM Plan Record of AMT Decisions for Sturgeon.

Date	Issue	Sturgeon Decisions	Comments
16 Dec 2004	**Sturgeon**	Slope characteristics will be further analyzed to identify categories of slope and bed form using existing data. Results will be used to guide dredging and dredge disposal.	
16 Dec 2004	**Sturgeon**	Awaiting completion of report (due mid-January 2005).	
16 Dec 2004	**Sturgeon**	Mitigation strategy to be developed during January.	
16 Dec 2004	**Sturgeon**	Ongoing studies will look at disposal impacts.	
5 Jul 2005	**Sturgeon**	Previous monitoring studies of tagged sturgeon suggest minimal or no impacts of dredging or disposal of dredged materials on these fish. Additional analyses of the data are awaited to determine the nature of bottom type (flat or presence of structure) that seem important to sturgeon in the lower river and estuary. With the exception of a desire for additional studies by Washington (L. Randall), there is general consensus among the AMT that sturgeon can be removed from further consideration in relation to implementing the Project AEM Plan.	
1 Sep 2005	**Sturgeon**	At the July 5, 2005, weekly AMT meeting, the AMT agreed that previous monitoring studies of tagged sturgeon suggested minimal or no impacts due to dredging or disposal of dredged materials and that adaptive management will be required only if dredging activities alter habitat. The USACE had previously indicated that additional work would be done on correlating sturgeon abundance with habitat using the existing data.	
1 Sep 2005	**Sturgeon**	The USACE at the current meeting had concerns with funding stating that the work plan for this study was stopped and the study plan was not finalized. The agencies also requested that any study plans for this work be reviewed by all agencies.	

Table 8-2.1. CRCIP AEM Plan Record of AMT Decisions for Sturgeon. Continued.

Date	Issue	Sturgeon Decisions	Comments
10 Jan 2007	**Sturgeon**	The USACE will check the status of the sturgeon habitat analysis.	
11 Apr 2007	**Sturgeon**	No decisions were required for sturgeon.	
11 Jul 2007	**Sturgeon**	The habitat analysis report for sturgeon has not yet been completed.	
3 Oct 2007	**Sturgeon**	It is anticipated that the USGS will finalize the sturgeon report in time for the January 2008 AMT meeting. If the report is available in time, the results will be discussed at the meeting.	
9 Jan 2008	**Sturgeon**	The report describing habitat analysis for sturgeon should be available for the April 2008 AMT meeting.	
29 Apr 2008	**Sturgeon**	Oregon Department of Fish and Wildlife (ODFW) had some remaining issues and requested time at a future meeting to discuss them with the original investigators, who will be contacted concerning availability.	
9 Jul 2008	**Sturgeon**	The sturgeon habitat analysis and model developed by Parsley and Hatten will be posted to the E2 CRCIP website.	
8 Oct 2008	**Sturgeon**	No decisions were made for sturgeon at the October 2008 meeting.	
14 Jan 2009	**Sturgeon**	No new information was available for sturgeon at the January 2009 meeting.	
8 Apr 2009	**Sturgeon**	Finalization of the sturgeon report was re-scheduled for the July 2009 AMT meeting.	
8 Jul 2009	**Sturgeon**	The two reports that summarize the responses of sturgeon to dredging have been finalized.	
18 Nov 2009	**Sturgeon**	No new information was available concerning sturgeon for the November 2009 meeting.	
20 Jan 2010	**Sturgeon**	A green sturgeon study program is underway as part of the CRCIP O&M phase.	
14 Apr 2010	**Sturgeon**	A green sturgeon study program is underway as part of the CRCIP O&M phase. The sturgeon component of the AEM Program has been completed.	

9 Smelt

The assessment of potential CRCIP impacts on smelt (Eulachon) has been completed in relation to Project construction and the AEM Program. Criteria to protect smelt as part of the AEM process addressed the possible CRCIP impacts on the survival, movements, and habitat utilization of these fish in relation to the dredging process. Water Quality Certificates dated 2008 from the states of Oregon and Washington prohibit in-water disposal between the 8th and 20th weeks of the year (out migration) between CRM 35 and CRM 75. Since then, smelt have been listed under the Endangered Species Act and a NMFS BiOp for O&M was received in 2012. The BiOp contains terms and conditions for the protection of smelt.

9-1 Decision Criteria for Smelt

Decision criteria concerning effects of disposal of dredged materials on smelt were provided in the 2006 annual report for the CRCIP AEM Plan (Table 9-1.1). The criteria are essentially compliance or non-compliance with state requirements for disposal of dredged materials during smelt migration.

Table 9-1.1. Compliance Measures Offered as Decision Criteria for Smelt in Implementation of the CRCIP AEM Plan.

Washington
In-water disposal of dredged material will not occur in areas shallower than 43-feet between CRM 35 and CRM 75 along the Washington shoreline. These areas are defined by depths determined in the pre-construction bank-to-bank bathymetry supplemented by additional channel bathymetry.
Washington, Oregon
In-water disposal will not occur during the period of peak Eulachon out migration (between the 8th and 20th weeks of the year) from the identified spawning areas (CRM 35–CRM 75). If in-water disposal is essential during the period of peak out migration, then the USACE shall further study the potential for Eulachon losses as a result of dredged material disposal impacts. Appropriate mitigation measures shall be developed based on the study outcomes, as determined through an AMP.

9-2 AMT Decisions regarding Smelt

Because the smelt component of the CRCIP AEM Program has been completed, no decisions were required on the part of the AMT concerning project impacts on smelt during 2013 (Table 9-2.1). However, the decision table for smelt is included in the 2013 report for continuity.

Table 9-2.1. CRCIP AEM Plan Record of AMT Decisions for Smelt.

Date	Issue	Smelt Decisions	Comments
16 Dec 2004	**Smelt**	Regularly report compliance with state issues concerning flow-lane disposal.	
16 Dec 2004	**Smelt**	If flow-lane disposal becomes necessary, the abundance of smelt and time of peak out-migration will be documented by the USACE and provided to the AMT to determine timing and guidance for dredge disposal.	
28 Jun 2005	**Smelt**	The team agreed that dredging will occur between CRM 35–75 between August 1 and September 30.	
10 Jan 2007	**Smelt**	No issues or decisions concerning smelt were raised at the January 10, 2007, AMT meeting.	
11 Apr 2007	**Smelt**	No decisions were required for smelt.	
11 Jul 2007	**Smelt**	No decisions were required for smelt.	

Table 9-2.1. CRCIP AEM Plan Record of AMT Decisions for Smelt. (Continued).

Date	Issue	Smelt Decisions	Comments
3 Oct 2007	**Smelt**	No decisions were required for smelt.	
9 Jan 2008	**Smelt**	No new information was provided for smelt, although there was some discussion and recognition concerning smelt in the diet of sturgeon.	
29 Apr 2008	**Smelt**	No new information was available regarding smelt.	
9 Jul 2008	**Smelt**	No new information was available regarding smelt.	
8 Oct 2008	**Smelt**	No decisions were made for smelt at the October 2008 meeting.	
14 Jan 2009	**Smelt**	The AMT was informed that smelt might be listed as an endangered species during the spring of 2009.	
8 Apr 2009	**Smelt**	NMFS indicated that smelt would not likely be listed prior to the Project rock removal planned for the November–December 2009 and January–February 2010 in-water work window.	
8 Jul 2009	**Smelt**	It seems unlikely that smelt will be listed before completion of Project construction.	
18 Nov 2009	**Smelt**	No new information was available regarding smelt.	
20 Jan 2010	**Smelt**	The O&M phase of adaptive management will need to address the inclusion of smelt. Conditions may be placed on smelt in relation to an anticipated O&M BiOp due from NMFS in April or May of 2011.	
14 Apr 2010	**Smelt**	No new information was available regarding smelt.	
14 Jul 2010	**Smelt**	No new information was available regarding smelt.	
13 Oct 2010	**Smelt**	No new information was available regarding smelt.	
12 Jan 2011	**Smelt**	The January 2011 AMT meeting was cancelled.	
13 Apr 2011	**Smelt**	No new information was available regarding smelt.	
13 Jul 2011	**Smelt**	No new information was available regarding smelt.	
13 Oct 2011	**Smelt**	No new information was available regarding smelt.	
11 Jan 2012	**Smelt**	No new information was available regarding smelt.	
11 Apr 2012	**Smelt**	No new information was available regarding smelt.	
11 Jul 2012	**Smelt**	No new information was available regarding smelt.	
10 Oct 2012	**Smelt**	The October 2012 AMT meeting was cancelled.	
9 Jan 2013	**Smelt**	No new information was available for smelt. O&M BiOp containing evaluation of project effects to smelt has been received. The smelt component of the AEM Program has been completed.	

10 Dungeness Crab

In 2010, the CRCIP completed its obligations under Oregon and Washington's 401 requirements and DLCD's Coastal Zone Consistency Determination in relation to Dungeness crab. The following sections are reproduced from the 2010 annual report for the reader's convenience.

The original objectives of the AEM Plan concerning Dungeness crab were to avoid or minimize (1) entrainment mortality during dredging and (2) crab burial by disposal of dredged materials. The underlying intent was "no net loss" of these organisms as a result of channel improvement. Two studies were performed prior to Project construction to assess the potential impacts on crabs. Phase I studies addressed the physical forces associated with dredging on crabs. Phase II studies focused on the response of crabs to burial in experimental tanks. Phase III studies were proposed to examine crab burial under field conditions. However, it is logistically very difficult to perform the necessary experiments under field conditions and Phase III studies were not conducted in relation to the AEM Program for the CRCIP.

10-1 Decision Criteria for Dungeness Crab

As indicated in previous CRCIP AEM Annual Reports, entrainment studies were performed at several locations within the estuary, including the mouth of the Columbia River (MCR), Desdemona Shoals, Upper Sands, Miller Sands, and Flavel Bar (Pearson et al. 2005b). Estimated crab entrainment rates varied by location, age-class, and year. Entrainment rates decreased progressively upriver from the mouth of the estuary, presumably in relation to the reduced abundance of crabs (Table 10-1.1).

Table 10-1.1. Crab Entrainment Rates (crabs/cubic yards) Estimated for 2004 (Pearson et al. 2005b).

Location	Age 0+	Age 1+	Age 2+	Age 3+	All
MCR All	0.0572	0.0028	0.0210	0.0128	0.0937
MCR-1	0.0535	0.0023	0.0147	0.0179	0.0883
MCR-2	0.0445	0.0022	0.0341	0.0126	0.0934
MCR-3	0.0760	0.0042	0.0137	0.0067	0.1007
Desdemona	0.0139	0	0.0035	0.0065	0.0239
Flavel Bar	0	0.0031	0.0035	0.0046	0.0112

Pearson et al. (2005b) recommended actions to mitigate the potential impacts of Project dredging on Dungeness crabs. One, understanding of seasonal patterns of salinity values throughout the lower river and estuary could be used to schedule dredging operations when salinity values are low (<16 psu) and crabs are correspondingly less abundant. Additionally, disposal of dredged materials should be avoided at the North Jetty Site thus reducing potential impacts on 1+ crab that migrate through this area during the October–November time frame.

The AMT had previously agreed that the results of the crab entrainment studies provided useful information for evaluating the effects of Project-related dredging on crab mortality and distribution. However, during 2008, the AMT was informed that several issues of potential concern to the ODFW remained with regard to crab entrainment and burial. ODFW raised the need for additional information concerning dredging impacts on young of the year (YOY) and age 1+ crabs.

The remaining issues concerning crab were further pointed out by the ODFW during the calendar year 2010. These issues concerned the potential impacts of dredging and disposal of dredged materials on crabs. While the ODFW recognized the value of the Phase I and Phase II studies of crab entrainment and burial, the agency remained concerned about the comparative lack of information for YOY and smaller sized individuals. Previously proposed Phase III studies were to extend the laboratory entrainment and burial studies to field conditions. However, the logistical challenges posed by field conditions in further studying potential impacts on crabs have precluded the Phase III studies. ODFW requested additional studies that describe the spatial-temporal variability in the distribution and abundance of crabs in areas potentially impacted by dredging or the in-water disposal of dredged materials.

The USACE underscored the difficulties of studying crab burial under field conditions and indicated that, as a result, Phase III studies would not likely be performed. In addition, the recent commercial harvests do not indicate that the crab populations are declining. Surveys of crabs following dredging and disposal indicate that crabs inhabit and utilize the newly deposited dredged materials. Despite the remaining issues and data gaps, ODFW indicated that no additional actions seemed necessary on the part of the AMT.

Nevertheless, ODFW asked for confirmation that the Oregon Coastal Management Program (OCMP) crab conditions [II.a.(i)–(iv)] would apply to O&M following the completion of the Channel Improvement Project construction. These conditions primarily address activities to minimize crab entrainment and burial (e.g., use of the crab distribution model to schedule dredging and disposal), restrictions on dredging and flow lane disposal below CRM 17 during periods of high crab abundance, and a crab mitigation strategy. The opinion of the ODFW was that the conditions have been satisfied in relation to Project construction, but indicated that the final OCMP provisions apply to maintenance activities, as well as construction.

ODFW cautioned that although there is an ongoing and continuing AMP, state decisions [i.e., 401 and Coastal Zone Management Act (CZMA)] are requirements that must be met by the USACE. This caution refers not only to crabs, but also to the sediment issues referred to previously (i.e., MA-3 and MA-4 above). It was noted, however, that the new 401 water quality certification does not identify crabs, although the sediment monitoring requirements are retained in the current CZMA.

10-2 AMT Decisions regarding Dungeness Crab

Table 10-2.1 summarizes the accumulated decision and key discussion points through calendar year 2013 concerning the CRCIP and potential impacts on Dungeness crab in the LCR and estuary. The Dungeness crab component of the CRCIP AEM Program has been completed. However, the decision table has been included for continuity in reporting results of the AMT meetings.

Table 10-2.1. CRCIP AEM Plan Record of AMT Decisions for Crab.

Date	Issue	Crab Decisions	Comments
1 Sep 2004	**Crab**	The draft crab mitigation strategy document was sent out for review by the AMT on June 21, 2005. The agencies had no feedback on the document but considered it to be a living document that could potentially change as new information on crabs was obtained. They also indicated that additional information should be obtained on the distribution and abundance of 1+ crab at Desdemona shoal.	
12 Apr 2006	**Crab**	The AMT agreed that reporting on crab entrainment would mainly take the form of including new data that became available during the course of the Project.	
12 Apr 2006	**Crab**	The WDOE accepted the USACE crab mitigation plan subject to the collection of additional data in 2007 at the Desdemona sampling location.	
11 Oct 2006	**Crab**	The final version of the Pearson et al. (2005b) report on crab entrainment will be posted at the E2 Project website.	
10 Jan 2007	**Crab**	DLCD and ODFW indicated some remaining issues concerning project impacts on Dungeness crab. Conversations will occur separately outside the context of the AMT.	
11 Apr 2007	**Crab**	Final crab entrainment and burial report was posted to the E2 website.	
11 Jul 2007	**Crab**	The final report was posted for review on the E2 FTP site.	
3 Oct 2007	**Crab**	Awaiting possible comments from ODFW on crab report.	
9 Jan 2008	**Crab**	Dale Blanton will check to see if ODFW has any remaining issues regarding the crab study report. He will report at the July 2008 AMT meeting.	
29 Apr 2008	**Crab**	No decisions were made concerning crab.	
9 Jul 2008	**Crab**	ODFW indicated that there were some unresolved issues to be discussed concerning potential dredging impacts on crab. ODFW will summarize these issues at the October AMT meeting. There was also recognition of possible dredging conflicts between the time period for outmigration of juvenile salmonids and movement of Age 1+ crab.	
8 Oct 2008	**Crab**	No decisions were made for crab at the October 2008 meeting.	
14 Jan 2009	**Crab**	ODFW indicated that there were some remaining concerns regarding dredging and disposal for crabs, but no actions of the AMT were required.	
8 Apr 2009	**Crab**	ODFW requested confirmation that OCMP crab conditions [II.a(i)–(iv)] would apply to O&M following completion of the CRCIP construction.	
8 Jul 2009	**Crab**	No new information was presented concerning crab at the July 2009 meeting.	
18 Nov 2009	**Crab**	No new information was presented concerning crab at the November 2009 meeting.	
20 Jan 2010	**Crab**	The CRCIP completed requirements concerning crab by compliance with Oregon and Washington 401 requirements and the Oregon DLCD Coastal Zone Consistency Determination.	

11 Sediments

Given that the Project construction was completed in November 2010, the sediment management activities have moved to the O&M phase and Jarod Norton (USACE) will be the USACE contact for this work. The sediment management component of the CRCIP AEM Program is considered complete.

11-1 Summary of Decisions

Table 11-1.1 summarizes the decisions made through 2013 regarding the relevance of Project disposal of dredged materials to regional sediment management. While the sediment management component is considered complete, the decision table has been included for continuity in AEM reporting.

Table 11-1.1. CRCIP AEM Plan Record of AMT Decisions for Sediments.

Date	Issue	Sediments Decisions	Comments
11 Jan 2006	**Sediment Management**	The USACE and E2 agreed to collaborate with WDOE in the development of language concerning sediments (i.e., management of disposal of dredged materials) for incorporation into the Project of the AEM Plan.	
12 Apr 2006	**Sediment Management**	The USACE agreed to further consultation with WDOE concerning the incorporation of sediment management language into the AEM Plan.	
10 Jan 2007	**Sediment Management**	The AMT requested that the exact state language be incorporated into documentation of the sediment management component of the AEM. The USACE will continue to work with the AMT on achieving consensus regarding sediment management in relation to the Project.	
11 Apr 2007	**Sediment Management**	No decisions were required for sediment management. Discussion was deferred to the July AMT meeting.	
11 Jul 2007	**Sediment Management**	Discussions of sediment management were rescheduled for the October AMT meeting.	
3 Oct 2007	**Sediment Management**	Discussions of sediment management will continue at the January 2008 AMT meeting.	
9 Jan 2008	**Sediment Management**	The April 2008 AMT meeting will focus on conceptual models and approaches to regional sediment management. E2 will propose a "strawman" conceptual model in advance of the April meeting.	
29 Apr 2008	**Sediment Management**	The April AMT meeting developed an initial process for sediment management in relation to Project construction. The process has been summarized in a draft sediment management workshop report.	
9 Jul 2008	**Sediment Management**	Sediment management will likely occur under LCR channel operation and maintenance. The AMT agreed to look more broadly across USACE projects for opportunities in regional sediment management. The future of sediment management in relation to CRCIP AEM Program will be addressed at the October AMT meeting.	

Table 11-1.1. CRCIP AEM Plan Record of AMT Decisions for Sediments. Continued.

Date	Issue	Sediments Decisions	Comments
8 Oct 2008	**Sediment Management**	The 2008 AMT sediment management workshop report was approved as final.	
14 Jan 2009	**Sediment Management**	The AMT expressed a desire that the CRCIP Sediment Management Plan be communicated to regional sediment management activities underway.	
8 Apr 2009	**Sediment Management**	Mike Ott (USACE) will replace Doris McKillip (USACE) with regard to future AMT discussions of regional sediment management.	
8 Jul 2009	**Sediment Management**	The USACE reinforced its intentions of looking for beneficial uses of Project construction dredged materials. This interest will continue into the O&M activities.	
18 Nov 2009	**Sediment Management**	Sediment management (i.e., beach nourishment) was discussed in relation to post-construction fish stranding studies. A decision was made to go forward with the Phase 2 fish stranding studies.	
20 Jan 2010	**Sediment Management**	No new information was presented in relation to sediment management.	
14 Apr 2010	**Sediment Management**	No new information was presented in relation to sediment management.	
14 Jul 2010	**Sediment Management**	No new information was presented in relation to sediment management.	
13 Oct 2010	**Sediment Management**	No new information was presented in relation to sediment management. The sediment management component of the AEM Program has been completed. The USACE regional sediment management program will continue into the O&M phase.	

12 Integration with 2012 AEM Results

Each annual report refers to AEM activities and conclusions in the prior year to provide continuity during the AEM Program for the CRCIP. The following sections briefly review the 2012 AMT activities and summarize AEM monitoring results with emphasis on MA-1 results. Additional details can be found in the notes from the quarterly AMT meetings and the AEM Program Workbook that are available through the project website hosted by E2 (www.e2tm.com/CRCIP).

12-1 Results for Analyses of 2012 Data for MA-1

The primary MA-1 decision criteria are the monthly percentile values for depth, temperature, and salinity. Monthly median values calculated from the CORIE data for tansy and grays are compared against these criteria. Tables 12-1.1–12-1.5 list these decision criteria and corresponding MA-1 monthly results for 2012. Detailed plots of daily median values and normalized values of temperature and salinity can be examined by downloading the corresponding files at the E2 website. No data were available at 6.9 m depth from cbnc3 in 2012 while a new station in cbnc3 was recording data at 9.0 m depth. Availability of data from both stations in 2013 (Section 2) allowed reconstruction of temperature and salinity data for 2012 using correlational analyses as described in Section 2. Figures 2-2.3(c) and 2-3.3(c) show the reconstructed temperature and salinity data for 2012 for the cnbc3 station in red, which indicate that the profiles of salinity and temperature for 2012 are consistent with long-term trends at cbnc3. Therefore, the other tables and figures for cbnc3 in the 2012 Annual report were not reconstructed.

Depth

As in previous years (2006–2011), depth data were only available for the grays sampling station in 2012. Depth data were available for the grays station except for November and December 2012. The daily values are nearly centered within the 20th–80th percentile decision criteria during this period.

Table 12-1.1 lists the monthly median depth values calculated using the 2012 data from the grays station. All reported 2012 monthly values were within the 20th–80th percentile range of the decision criteria derived from the 1996–2004 pre-Project data.

Table 12.1.1. Summary of 2012 Monthly Median Depth Values (bold numbers) for grays Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Depth Meters											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	0.6	0.5	0.5	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.4	0.5
20	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.9	1.1	1.2
	2.0	**1.9**	**2.2**	**2.1**	**1.9**	**1.9**	**1.8**	**1.7**	**1.7**	**1.8**	**2.1**	**2.3**
80	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.7	2.8
95	3.4	3.3	3.2	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.3	3.3

Temperature

Tables 12-1.2–12-1.3 list the calculated monthly median values for 2012 and the corresponding temperature decision criteria derived from analysis of the pre-Project data (1996–2004). Despite the above mentioned variances in the daily temperature data, the spreadsheet summaries of monthly average temperatures used in the AEM decision-making process were nearly all within the decision criteria for both tansy and grays stations for the months with available data. The monthly summary of the additional July 2012 temperature data confirmed that, except for March, values were within the 20th–80th percentile decision criteria for the tansy station (Table 12-1.2). The March monthly value for tansy of 6.8°C was just slightly less than the 20th percentile decision criterion of 6.9°C. The average monthly value for July (17.2°C) was very near the 80th percentile value of 17.5°C.

Monthly summaries for grays also showed values that were within the 20th–80th percentile criteria for January–March and May (Table 12-1.3). Monthly temperature values were cooler in April and June, but still within the 5th–20th percentile decision criteria. The July monthly average value was equal to the 20th percentile decision value (18.0°C).

The overall conclusion from the MA-1 analysis of water temperatures was that no discernible impacts of Project construction were evident based on the CORIE monitoring data available for 2012.

Table 12.1.2. Summary of 2012 Monthly Median Temperature Values (bold numbers) for tansy Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Temperature C											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	4.5	4.6	6.0	7.0	9.5	9.8	9.4	10.1	9.8	9.4	8.3	6.0
20	5.7	5.7	6.9	8.9	10.7	11.6	11.2	11.9	11.6	11.1	9.5	7.2
	8.4		**No data**	**No data**	**No data**	**15.7**		**18.3**	**15.7**	**12.6**	**11.2**	**8.4**
80	8.9	8.4	9.1	11.0	13.6	15.8	17.5	18.3	16.9	14.2	11.6	9.6
							17.6					
95	9.8	9.7	9.9	11.9	14.9	16.9	19.3	19.9	18.5	15.8	12.5	10.6

Table 12.1.3. Summary of 2012 Monthly Median Temperature Values (bold numbers) for grays Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Temperature C											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	4.0	4.1	5.2	8.0	10.5	14.1	16.6	18.3	16.3	11.8	7.4	5.2
						14.9						
20	4.7	4.7	6.0	9.0	11.6	15.2	18.0	19.3	17.3	12.9	9.0	6.2
	5.6	**5.6**	**6.4**	**9.5**	**13.3**		**18.8**	**20.7**	**18.4**	**14.4**	**11.0**	
80	6.6	6.5	8.4	11.4	14.8	17.6	20.6	21.1	19.5	15.9	11.3	8.0
												8.6
95	7.7	7.3	9.4	12.6	15.9	18.8	21.8	21.9	20.5	17.3	12.3	8.8

Salinity

MA-1 importantly includes an analysis of potential Project construction impacts on salinity values in the LCR and estuary. The analyses are based on the CORIE data and performed and presented in a manner analogous to those previously presented for water temperatures. The issue of concern for salinity is that channel modifications might increase the likelihood of salt water intrusions and elevate salinity values, which can impact habitat quality for juvenile salmon.

Tables 12-1.4–12-1.5 list the monthly median salinity values calculated for 2012 and the decision criteria developed by the AMT for MA-1. Despite the variations in the daily median values, the 2012 monthly average salinity values for tansy were within the 20th–80th percentile decision criteria for January, September, October, and November (Table 12-1.4). The June, July, August, and December monthly average values were within the 5th–20th percentile criteria.

The 2012 average monthly values for the grays station did not suggest any issues concerning saltwater intrusion in relation to Project construction (Table 12-1.5). Monthly average values were less than the 20th percentile criteria for all months except September and October. The monthly values for September and October were within the 20th–80th percentile decision criteria.

The MA-1 monitored salinity results for 2012 are consistent with those of the temperature data analysis and further suggest that the Project construction had produced no measurable impact on salinity at these three station locations in the LCR and estuary.

Table 12.1.4. Summary of 2011 Monthly Median Salinity Values (bold numbers) for tansy Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	1.2	0.9	0.7	0.7	0.9	0.4	1.6	3.5	4.8	5.9	3.3	2.4
					2.7	**0.6**	**2.8**	**8.1**				
20	4.2	3.7	3.4	3.0	2.7	1.7	3.8	8.7	10.4	10.7	6.8	5.9
	5.5	**6.0**	**7.4**	**3.2**		**4.0**	**6.6**	**10.6**	**14.4**	**11.3**	**10.4**	**9.0**
80	23.9	23.4	21.5	23.0	22.9	22.9	24.1	26.3	26.0	26.0	23.9	24.6
95	27.3	26.7	25.5	26.6	26.5	27.2	28.4	28.9	28.6	28.0	26.9	27.6

Table 12.1.5. Summary of 2011 Monthly Median Salinity Values (bold numbers) for grays Station in Relation to AEM Percentile Decision Criteria.

	Monthly Median Salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
	0.0	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**					**0**
5	0.2	0.2	0.2	0.2	0.0	0.2	0.3	0.3	0.5	0.4	0.3	0.3
								0.4			**0.4**	
20	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.8	0.7	0.5	0.3
									1.8	**1.5**		
80	1.2	0.8	0.8	0.7	0.7	0.7	2.4	2.4	4.4	3.7	2.7	0.8
95	3.1	2.7	2.0	1.4	0.8	1.3	5.5	4.4	6.9	6.2	4.8	2.2

13 Epilogue

The 2013–2014 annual report marks the final installment of the CRCIP Adaptive Environmental Management Program. Importantly, as described in the previous sections of this report, the AEM Program was able to fulfill all of the adaptive management requirements specified at the outset of the program, now more than a decade ago. These requirements crossed multiple jurisdictions and involved several different regulatory frameworks. The overall success of this organized and long-term effort suggests that the CRCIP AEM Program might help guide the design and implementation of future adaptive environmental management programs undertaken by the participating agencies, or other organizations with similar interests or obligations. Given its comparative uniqueness, it seems only fitting to summarize key aspects that contributed to the success, as well as those issues that challenged the AEM Program.

The definitive mandate for adaptive management prescribed in the Biological Opinion provided an overarching strategic benefit in the design and implementation of the AEM Program. The participating agencies understood the directive and minimal time and effort were lost in debating the need and merits of adaptive management in relation to channel improvement. The AEM Program enjoyed high-level management support of the participating agencies. The continued recognition of the imperative stated in the BiOp undoubtedly contributed to sustaining the program through more than 10 years of agency participation. Perhaps just as important, the directives for adaptive management laid out in the BiOp also specified a timeframe, namely, the program would end three years after completion of project construction. Agencies considering the implementation of organized adaptive management efforts are often uncomfortable with the potential open-ended nature of such programs. Having a well-defined ending point no doubt helped garner overall program acceptance and secure long-term commitment to participation by the agencies. Of no less strategic value was the sustained congressional support of the CRCIP, which helped ensure adequate funding for the AEM Program throughout its period of performance.

The CRCIP AEM Program also benefitted from the substantial efforts in developing the Biological Assessments that provided a comprehensive technical basis for identifying the key issues addressed in the BiOp. Most, if not all, of these technical concerns addressed by the monitoring actions in the AEM Program had been the subject of intensive investigation and analysis prior to the publication of the BiOP. As a result of these pre-Project efforts in research and assessment, the anticipated impacts of the channel modification had been fairly well described. For example, the AEM Plan included an appendix that outlined a previously developed conceptual model for juvenile salmon growth survival, and ocean entry. This model helped guide the AMT in developing decision criteria for several monitoring actions (e.g., MA-1 and MA-4). In a sense, the AEM Program was developed as an organized evaluation of the previously projected impacts of the CRCIP on the resources of concern (e.g., juvenile salmonids, smelt, sturgeon, Dungeness crab) and their supporting habitats. The emphasis of the AEM Program was on avoiding, minimizing, and mitigating potential risks posed by channel modifications. This kind of adaptive management challenge differs, for example, from programs aimed at restoring depleted populations to some naturally self-sustaining size, where relationships between available management actions and anticipated population responses might be poorly characterized, highly uncertain, or entirely unknown. However, despite possible differences in management objectives, much of the CRCIP AEM Program organization and

methods of implementation might prove useful to agencies engaged in starting up their own adaptive management programs. Representatives of the AEM Program made presentations at six professional conferences, which helped to publicize the adaptive management efforts underway on the Lower Columbia River and estuary. In addition, the Corps project team manager and the independent AEM facilitator helped author a technical guide for adaptive management intended for use throughout the USACE.

Having offered the CRCIP AEM Program as a potentially useful model, it is important to point out that this effort was not developed independently. Formal adaptive management programs have existed at least since the 1980's and the initial task at hand was to review previous efforts and use them to guide our own program development. The Glen Canyon Dam adaptive management program was recognized as perhaps the most comprehensive and formal program ongoing. Its overall structure and components were used to help develop the initial draft AEM Plan. The challenge was to define a program sufficiently organized to accomplish the adaptive management objectives outlined in the BiOp, while avoiding a degree of formalism that might impede progress. To address this challenge, the development of the AEM Plan was undertaken as the initial activity of the parties involved. Acting in the capacity of what became formally defined as the CRCIP AMT, the participating agencies collaborated in developing an AEM Plan based on building consensus, while addressing the varied individual agency responsibilities. More than producing a workable plan, the process helped develop mutual trust among the participants – a trust that sustained throughout and contributed largely to the success of the program. As an additional benefit, it is anticipated that trusting relationships created during the AEM Program will carry over to future actions involving the participating agencies.

Using the Glen Canyon adaptive management program as a guide, the AMT developed an AEM Plan that importantly (1) defined the set of management decisions that the participants were empowered to make; (2) included quantitative decision criteria for individual monitoring actions; (3) described a process for evaluating monitoring results in relation to the decision criteria and making decisions; (4) emphasized documentation of the entire adaptive management process, including all AMT decisions; and (5) provided flexibility to adapt the Plan during its implementation, as necessary. The Plan also provided for securing additional external technical information, data, and analysis to support the individual components (i.e., monitoring actions) of the AEM Program. The take home message is that new programs do not have to be developed from scratch. There are examples of effective adaptive management programs, including the CRCIP model, to help formulate new initiatives in adaptive management.

The AEM Plan set the stage for implementation of adaptive management. Implementation of the Plan was effectively enabled because it was “owned” by the AMT. Members of the AMT were selected on the basis of their technical understanding of the issues central to the CRCIP and their ability to speak on behalf of their agency. These two attributes contributed competence and efficiency in implementing the Plan. In addition, the AMT members were familiar with other relevant programs (e.g., LCREP) and activities ongoing in the Lower Columbia River and estuary. This knowledge and experience contributed to the discussions of individual components of the AEM Program and permitted consideration of the program within a larger-scale or regional context. Familiarity with other related activities extended the reach of the AEM Program by providing the opportunity for other programs to observe possible implications of

USACE channel modifications. To date, potential deleterious effects of the construction and operation of the modified channel have not been reported by others (e.g., LCREP) to the AMT.

Implementation of the program was greatly facilitated by the lead agency (USACE) providing valued team management oversight and consistent and reliable logistical support for the AMT meetings throughout the 10+ years. The USACE also contributed importantly to the success of the program by (1) providing data and analysis for several of the monitoring actions (e.g., MA-2, MA-3, MA-5), (2) providing contractual support for external analysis and modeling (e.g., MA-4 and MA-6), and (3) sustaining the participation of independent contractors to help develop and co-facilitate the AEM Program. The participating agencies (e.g., Sponsor Ports, NMFS, FWS, states of Oregon and Washington) were importantly no less committed to the program and sustained their participation and valued contributions throughout, but the USACE ownership of the program helped sustain the momentum needed to complete the 10+ year effort.

The development and implementation of the AEM Program benefited from the guidance and participation of independent contractors well-versed in adaptive environmental management and skilled and experienced in the specific technical issues central to the CRCIP. Without a vested interest in the outcome, the independent contractors were able to help facilitate the adaptive management process without attempting to influence the outcomes of AMT deliberations – other than insisting that some outcome be eventually obtained for each of the monitoring actions. By adopting a consensus-based approach to conducting the program, it proved perhaps less important that the independent facilitator had minimal formal training in meeting facilitation. Rather, the role of the independent facilitator was more in keeping the varied discussions on track in relation to the AEM Plan from a scientific perspective. The independent facilitator, in addition to providing program logistics and documentation, helped to focus the discussion on the issues at hand and provided technical input concerning specific monitoring actions when requested by the AMT. However, the program decisions were made solely by the participating agencies.

Having a well-defined timeframe benefitted the AEM Program in several ways. As indicated previously, identifying a stopping point as 3 years post-construction undoubtedly helped gain support from the participating agencies, which might reasonably question commitment to a potentially open ended program. The endpoint also provided the lead agency with flexibility in completing construction, which proved valuable given variations in construction funding experienced during the CRCIP. Getting the program underway in 2003 with construction scheduled to begin in 2005 provided critical time for developing the AEM Plan, completing pre-Project studies (e.g., potential entrainment effects on crabs, pre-construction fish stranding, and potential impacts on sturgeon), and deriving initial decision criteria for the monitoring actions. Agreeing to regularly scheduled quarterly AMT meetings kept the adaptive management efforts on track, provided a timetable for pre- and post-meeting technical support and documentation, and contributed to reliable participation by AMT members, who all had other duties, responsibilities, and correspondingly busy schedules. Regularly scheduled meetings put familiar faces around the table to conduct the business of adaptive management as laid out in the Plan. This initial period was critical in setting the tone for interactions among the AMT participants; members learned to listen to, respect, and work productively with one another, without sacrificing the integrity and importance of their respective agency perspectives and responsibilities.

Transparency and documentation were central to the overall effectiveness of the AEM Program. A draft agenda was provided to the AMT for review and comment in advance of each quarterly meeting. Supporting documents, presentations, data, and analyses were similarly provided in advance. Meeting notes were provided to the AMT subsequent to each meeting for review, revision, and approval. Annual reports, such as this one, were developed to summarize the activities of the AMT, including any formal decisions, for each calendar year throughout the program. Draft or working versions of the documentation were readily accessible to members of the AMT through a password-protected website hosted by the contractors. Approved, final versions of AEM Program documents were made publicly available at the USACE Portland District website.

Executing the AEM Program required evaluations of monitoring actions that were disparate in time scales. Although reported quarterly, the monitoring of temperature and salinity for selected locations (MA-1) was essentially continuous. Cross-section surveys (e.g., MA-3) were performed and reported annually. Evaluations of shallow water habitat (MA-4) and fish stranding (MA-6) were based on pre- and post-Project construction comparisons. Regulation of in-water disposal in relation to smelt migration and meeting state 401 Water Quality Certification requirements were essentially compliance-level (not adaptive) monitoring actions incorporated into the AEM Program for convenience and efficiency. The ability to meaningfully address these varied monitoring actions benefited from the technical expertise of the AMT members and the opportunity to obtain additional external technical inputs (e.g., fish stranding analysis and peer review, juvenile salmon habitat modeling) as needed.

The preceding paragraphs might connote an overall well-planned and smoothly operating program. To a large extent this proved to be the case. However, there were significant challenges along the way, which should come as no surprise for such a complex and long-term effort in formal adaptive management. Working across all the monitoring actions to derive scientifically defensible and consensus decision criteria dominated much of the AMT activity between 2003 and 2005. Revisions to the 2003 draft AEM Plan were also ongoing; the final Plan, including the decision criteria, was approved by the AMT in 2005. During the CRCIP construction phase, several topics occupied the AMT for upwards of a year each. For example, much discussion and debate early on addressed the risks and benefits posed by disposal of construction materials at previously approved deepwater locations off the Oregon coast or upland locations along the river. Concerns with deepwater disposal focused on impacts to Dungeness crabs and other valued benthic organisms. Several participating agencies suggested that the AEM Program should be responsible for developing and encumbering the costs of a regional sediment management plan for the Lower Columbia River and estuary. After more than a year of rigorous debate, the AMT reached consensus that the AEM Program should strive towards beneficial uses of CRCIP construction materials (e.g., beach nourishment) wherever possible, but also agreed that a regional sediment management plan was beyond the scope of the AEM Program. The last two years of construction (2009-2010) saw much of the attention of the AMT shift to evaluation of a biological monitoring plan for rock removal required to complete construction. This evaluation included a field trip to witness one of the rock removal (i.e., underwater blasting) events.

Two other significant challenges to the AMT were post-construction activities for MA-4 (shallow water habitats) and MA-6 (fish stranding) specified in the BiOp and therefore included

in the AEM Plan. The original plan was for the USACE to fund, upon completion of CRCIP construction, an additional shallow water habitat survey performed as part of the AFEP. However, performing an additional survey was not recommended by the lead researcher, who was no longer working on this specific topic. The AMT had to develop an alternative approach to meet the requirements of MA-4. The flexibility to alter the AEM Plan was written into the Plan in anticipation of these kinds of events. As detailed in the annual reports for 2012 and 2013, the AMT reached consensus on addressing the MA-4 requirements through computer simulation of pre- and post-construction characteristics of juvenile salmonid habitat. External consultants were contracted for this work. Based on the model results, the AMT concluded that possible changes in juvenile salmonid habitat quality and availability projected by the model were well-within the bounds of model accuracy. The AMT was able to use the modeling results to arrive at a consensus decision that the CRCIP posed negligible impacts on juvenile salmonid habitat in the Lower Columbia River and estuary. This importantly resolved the MA-4 requirements.

Resolution of the MA-6 fish stranding requirements proved similarly challenging, but for a different reason. It was technically feasible to repeat the pre-construction fish stranding studies and thereby meet the MA-6 requirements. However, an in-depth analysis of the projected changes in fish stranding probabilities post-construction indicated that the pre-Project studies, while competently performed, posed technical challenges in designing post-Project studies. The constraining issue was the statistical power of the pre-Project studies. Again, using the modeling expertise of an external contractor combined with an independent peer review provided the AMT with sufficient understanding to reconsider the post-Project studies. The AMT consensus was that post-construction studies of fish stranding with sufficient statistical power to draw strong inferences concerning any changes in stranding probability would be prohibitively expensive and time consuming. As an alternative approach to meeting the requirements for MA-6, the AMT suggested that the USACE make beneficial use of construction materials to reduce the likelihood of fish stranding on beaches where stranding has been often observed. The USACE also agreed to participate in multi-agency discussions of fish stranding in the Columbia River, which had begun during the AMT deliberation of MA-6 post-construction studies and to consider future research opportunities. This was not an easy decision and several AMT members expressed concerns that the program was not meeting the MA-6 requirements to the fullest extent possible. There was some frustration that the potential statistical problems were not identified and addressed by the pre-Project stranding studies. MA-6 was resolved with a degree of discomfort, but consensus was achieved.

There were some difficulties in obtaining the water temperature, salinity, and depth data from the CORIE in a timely manner to permit analysis and presentation at the quarterly AMT meetings. Having the continuous monitoring system largely in place was an advantage in meeting the requirements of MA-1. However, the logistical challenges experienced by CORIE in maintaining a complex network of monitoring stations resulted in some longer term delays in securing data and resulted in some data gaps for stations used by the AEM Program.

The final year of the program experienced some wane of enthusiasm among the participating agencies. Tenures on the AMT shortened. Perhaps this resulted in part from the success of the program in documenting the outcomes of the CRCIP, which were consistent with those anticipated in the environmental compliance documents (e.g., BiOp, 401 WQC, etc.). New or

unforeseen impacts of the Project were not observed during the monitoring period – namely that nothing adverse happened in relation to channel modification during or following construction. As the requirements of individual monitoring actions were fulfilled and actions were removed from further consideration, meeting agendas diminished in scope, and participation by the AMT decreased somewhat commensurately. The major remaining issues, MA-4 and MA-6, had been resolved. Yet despite the somewhat sporadic participation, in the end, the program remained consistent with its Plan. For example, MA-1 was continued through the end of 2013, 3-years post-construction, even though years of previous monitoring and analysis suggested no measurable alterations in temperature or salinity in relation to channel modification.

The important point is that the AMT was able to stay largely on track, overcome the varied challenges and distractions, adapt its Plan and process as necessary, and complete the AEM Program by meeting the requirements outlined in the BiOp and articulated in the AEM Plan. The long-term performance and successful completion of the AEM Program demonstrates that it is possible to design and conduct complex adaptive environmental management programs across multiple participating agencies. Future similar programs can benefit from the lessons learned during the course of the CRCIP AEM Program, as well as other well-documented adaptive management efforts (e.g., Glen Canyon). The major obstacle to overcome is simply the will to commit to the process. Once committed, develop a mutually acceptable and workable plan – with a focus on defining sufficient organization, while avoiding unnecessary counterproductive and undue formality. Then, build trust, persevere, and work the plan. The CRCIP AEM Program proved that it is possible.

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