# Adaptive Environmental Management for the Columbia River Channel Improvement Project:

# Annual Report for 2007


prepared by

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# 1 Introduction

The 2007 annual report documents the results of the Columbia River Channel Improvement Project (CRCIP) adaptive environmental management (AEM) Project for the Phase II construction completed as of January 31, 2007. This annual report also briefly reviews the major issues and their resolution for calendar year 2006.

Phase I construction Projects for the CRCIP were initiated in 2006. Phase I focused on channel modifications in two separate river segments: Columbia River Mile (CRM) 3 to 21 and CRM 95 to 104. Phase I, constitutes approximately 25 percent of the entire CRCIP and was anticipated to be finished in mid-February 2007. The results of adaptive management for construction completed during calendar 2006 were reported in the 2006 Annual Report for the CRCIP AEM Program.

Phase II of Project construction focused on CRM 71–91 in 2007. River Miles 27–32 are planned for 2008. The blasting zone near Pillar Rock will be avoided in the pending contract, while a blasting plan is developed for this area. Blasting is planned in 2009.

Following a brief description of the CRCIP AEM process, each monitoring action of the adaptive management effort is addressed. Summaries of the monitoring results for 2007 are provided along with comparisons of the results with AEM decision criteria. Decisions concerning adaptive management for each of the monitoring actions recorded by the Adaptive Management Team (AMT) during the assessment year are also reported.

Each annual report is developed as a stand-alone document that summarizes the activities of the AMT during the calendar year. In addition, 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 becomes available and serves as ongoing documentation of the AEM process. The workbook is reviewed by the AMT at each of the quarterly meetings.

## *1-1 CRCIP AEM Process*

The AEM process 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 U.S. Army Corps of Engineers (Corps) to explain the variances or offer a mitigation plan.

5. Based on an evaluation of the Corps 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 1.1).

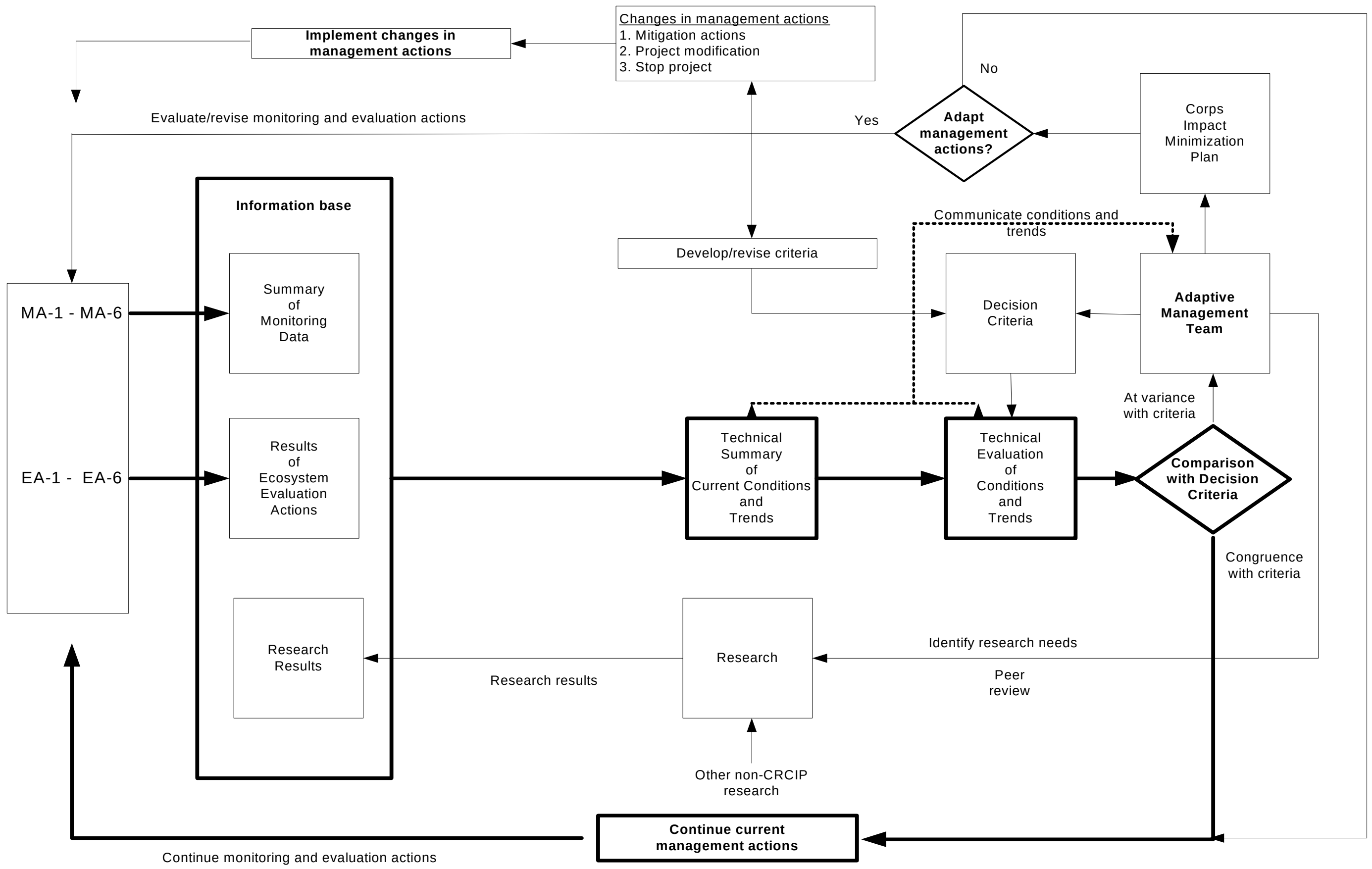



**Figure 1.1. Flowchart describing the AEM process for the CRCIP.**

# 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 calendar 2007. The results are based on analyses of verified data downloaded from the CORIE public web site. The monitoring data are obtained from four sampling stations located in the lower river and estuary: red26, tansy, grays, and cbnc3 (Figure 2.1).

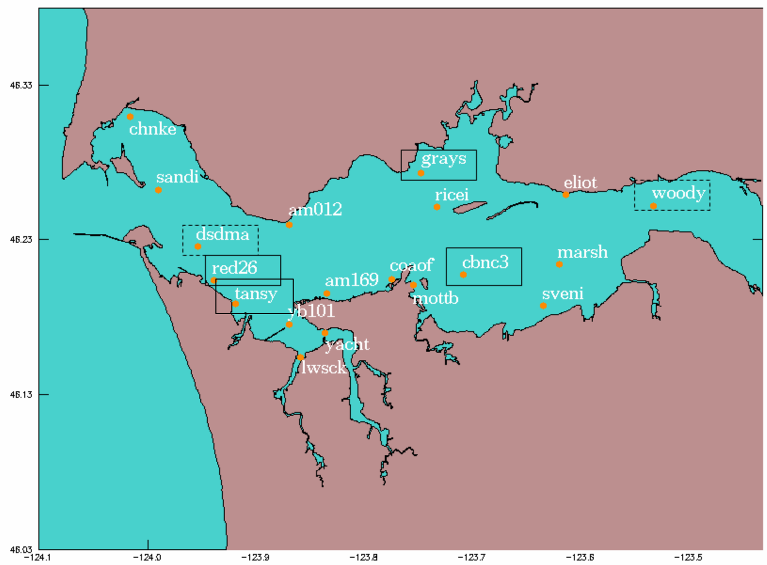



**Figure 2.1. Location of CORIE monitoring stations in the Lower Columbia River (LCR) and estuary. The four stations (red26, tansy, grays, cbnc3) indicated by the solid rectangles provide data for MA-1. The two stations indicated by the dashed rectangle provide salinity (dsdma) and temperature (woody) 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. 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 2004–2005: (1) the upper and lower 90$^{th}$ percentile criteria were defined by the 5$^{th}$ and 95$^{th}$ percentile values computed for each month, and (2) the upper and lower 60$^{th}$ percentile criteria were defined by the 20$^{th}$ and 80$^{th}$ percentile computed monthly values. These values were approved as AEM decision criteria by the AMT.

## 2-1 Depth

Depth data were only available for the grays sampling station in 2007 (Figure 2.1.1).

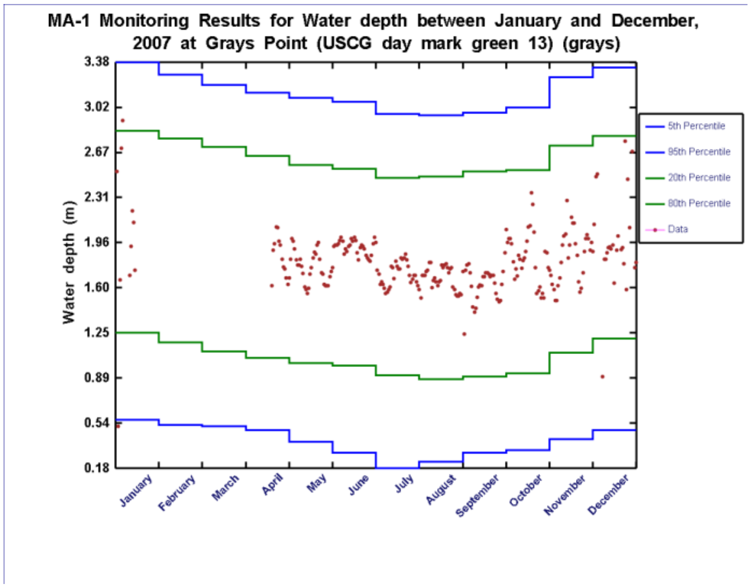



**Figure 2.1.1. Daily median values of depth for the grays sampling location for 2007 plotted in relation to the CRCIP AEM decision criteria.**

Except for two days in January and one day in December, the median daily depths lie within the 20–80$^{th}$ percentile decision criteria that were derived from the baseline data. Day 7 in December had the lowest water flow (Figure 2.4.1) in the river; consequently, Day 7 shows the lowest water depth in Figure 2.1.1, slightly below the 20$^{th}$ percentile criteria. Day 2 in January shows a water depth of just below the 5$^{th}$ percentile decision criteria. Accompanying flow for that day (Figure 2.4.1) indicated that the minimum flows in the river for the month occurred on the first two days. Within the first ten days, water depth also slightly exceeded the 80$^{th}$ percentile criteria. Investigation of the flow data revealed that the highest flow in the first 10 days occurred on day 5. Depth data were not available for much of January, February or March and part of April.

Table 2.1.1 lists the monthly median depth values calculated using the 2007 data from the grays station. All reported monthly values are within the 20–80$^{th}$ percentile range of the decision criteria derived from the 1996–2004 pre-Project data.

**Table 2.1.1. Summary of monthly median depth values (bold numbers) for grays station in relation to AEM percentile decision criteria.**

| | Monthly median depth (m) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
| | **2.2** | **-** | **-** | **1.8** | **1.8** | **1.9** | **1.7** | **1.7** | **1.7** | **1.9** | **1.9** | **2.0** |
| 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 |

## 2-2 Temperature

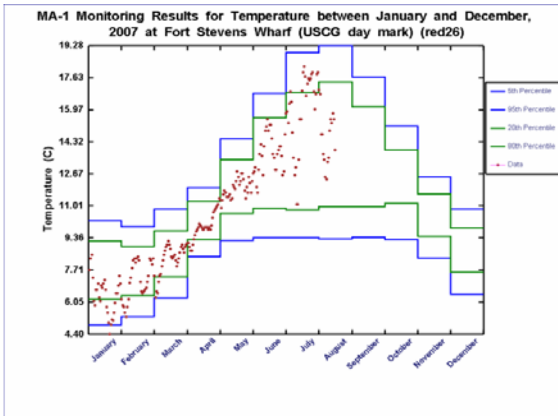
Figure 2.2.1(a,b,c,d) shows the calculated daily median temperature values for 2007 at all four CORIE stations in relation to the 60th and 90th percentile decision criteria established by the AMT. Until 2006, temperature and salinity were reported only for three stations: red26, grays, and cbnc3. In August 2007; however, the red26 monitoring station was destroyed. The tansy station was added as a surrogate for the red26 station because of its proximity to the red26 station (Figure 2.1). Figure 2.2.1(a,b) clearly indicate that the temperature data from the two stations are not only highly correlated but they have very similar values.

The values measured at red26 and tansy exhibit the greatest variation, particularly during January through March and May through September. This sampling station is located nearest the river mouth and its temperatures are variously affected by tidal mixing and river flows. The grays and cbnc3 stations are located upriver and are less influenced by tides. Except for the months of January, February, July, and November, temperature values for all four stations lie within the 60th percentile decision criteria. During July, elevated temperatures were measured at all MA-1 stations, which can be explained by the influence of increased flows of warmer river water (Figure 2.4.1). During late December and January and early February, temperatures at the red26, tansy ,and cbnc3 stations were below and outside the 20–80th percentile interval; some days recorded temperatures even below the 5th percentile criteria. River flows during these periods were higher than other days during the month (Figure 2.4.1) and produced colder temperatures at these sampling stations. In late October and November, a similar response was noted at grays, and cbnc3 stations and in late November for the tansy station. In early November, the temperatures also exceeded the 20-80th percentile intervals at both grays and cbnc3 stations presumably as the result of lower river flows (Figure 2.4.1).

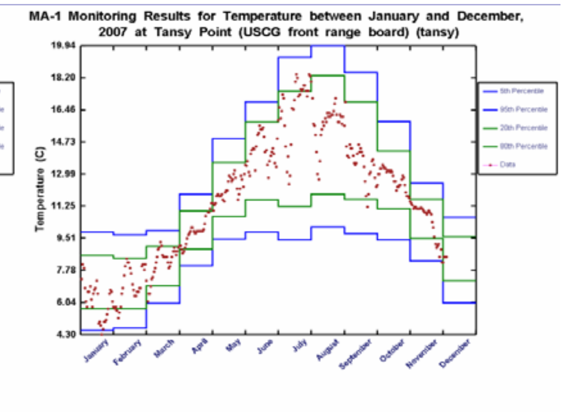
Tables 2.2.1–2.2.4 list the calculated monthly median values for 2007 and the corresponding temperature decision criteria derived from analysis of the pre-Project data (1996–2004). The monthly values for red26 and tansy are all within the 20–80th percentile values (Tables 2.2.1 and 2.2.2), even though some daily exceedances of these criteria are evident (Figure 2.2.1a). Monthly values measured at the grays and cbnc3 stations are between the 20¯80th percentile decision criteria for all but one month. The July value at grays and the November value at cbnc3 lie between the 80¯95th percentile values.

To further evaluate the potential impacts of channel modification on water temperatures, the daily median values for 2007 (red dots) were plotted against corresponding baseline (blue dots) values (1996–2004) for the upriver "woody" (Woody Island) sampling location (Figure 2.2.2). 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. However, the Team agreed that if the MA-1 results were essentially included in the baseline cluster of points then it could be concluded that the channel modifications likely did not alter the complex relationships between river flow and tidal mixing in the lower river and estuary. The 2007 monitoring results, with perhaps the exception of certain lower-temperature readings for red26, tansy, and cbnc3 appear within the baseline variations observed at all three MA-1 stations. These lower temperatures extend beyond the 1996–2004 baseline values. Yet, the pattern suggests that the values are consistent with the clustering of the baseline and 2006 values normalized to the woody station data.

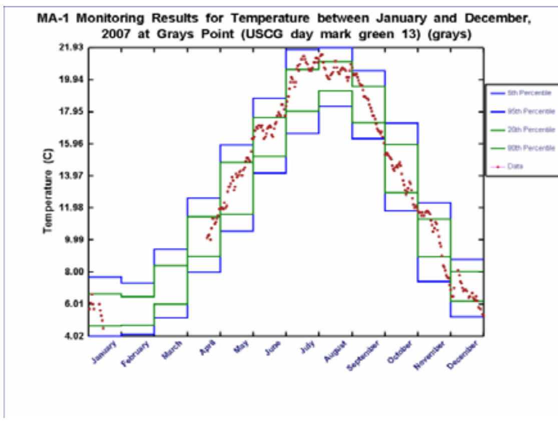
**(a)**




**(b)**




**(c)**




**(d)**

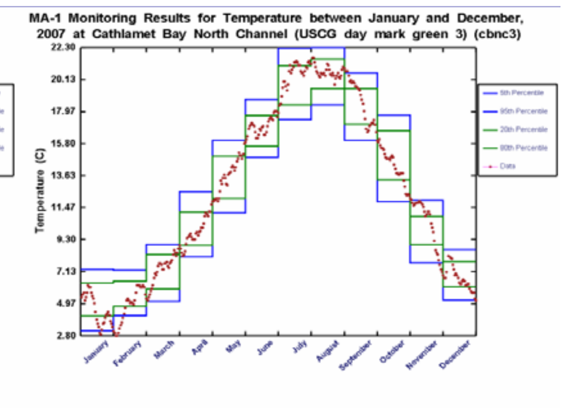



**Figure 2.2.1. Daily median values of water temperature for (a) red26, (b) tansy, (c) grays, and (d) cbnc3 sampling stations for 2007 plotted in relation to the CRCIP AEM decision criteria.**

**Table 2.2.1. Summary of monthly median temperature values (bold numbers) for red26 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 | 4.9 | 5.3 | 6.3 | 8.4 | 9.2 | 9.4 | 9.4 | 9.3 | 9.4 | 9.3 | 8.3 | 6.5 |
| 20 | 6.2 | 6.4 | 7.4 | 9.3 | 10.6 | 10.9 | 10.8 | 11.0 | 11.0 | 11.1 | 9.4 | 7.6 |
| | **6.6** | **7.5** | **8.6** | **9.9** | **11.7** | **14.0** | **16.9** | **13.8** | | | | |
| 80 | 9.2 | 8.9 | 9.7 | 11.2 | 13.4 | 15.6 | 16.9 | 17.4 | 16.1 | 13.9 | 11.6 | 9.9 |
| 95 | 10.3 | 9.9 | 10.8 | 12.0 | 14.5 | 16.8 | 18.9 | 19.3 | 17.7 | 15.1 | 12.5 | 10.8 |

**Table 2.2.2 Summary of 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 | 4.9 | 5.3 | 6.3 | 8.4 | 9.2 | 9.4 | 9.4 | 9.3 | 9.4 | 9.3 | 8.3 | 6.5 |
| 20 | 6.2 | 6.4 | 7.4 | 9.3 | 10.6 | 10.9 | 10.8 | 11.0 | 11.0 | 11.1 | 9.4 | 7.6 |
| | **6.4** | **7.1** | **8.5** | **9.9** | **12.0** | **14.4** | **17.2** | **16.1** | **13.5** | **12.7** | **10.9** | **8.5** |
| 80 | 9.2 | 8.9 | 9.7 | 11.2 | 13.4 | 15.6 | 16.9 | 17.4 | 16.1 | 13.9 | 11.6 | 9.9 |
| 95 | 10.3 | 9.9 | 10.8 | 12.0 | 14.5 | 16.8 | 18.9 | 19.3 | 17.7 | 15.1 | 12.5 | 10.8 |

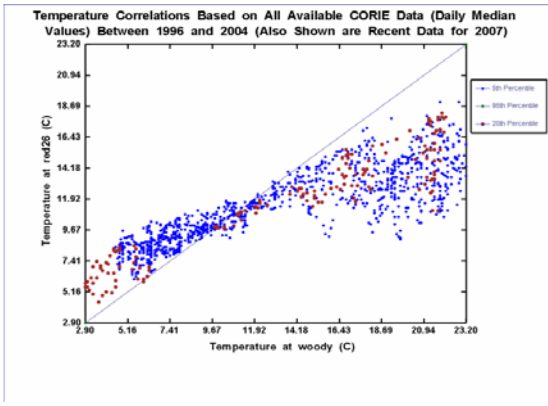
**Table 2.2.3. Summary of monthly median temperature values (bold numbers) for grays station in relation to AEM percentile decision criteria.**

| | 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 |
| 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 |
| | **5.7** | | | **11.1** | **14.0** | **17.1** | | **20.5** | **18.1** | **14.1** | **10.8** | **6.6** |
| 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 |
| | | | | | | | **20.7** | | | | | |
| 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 |

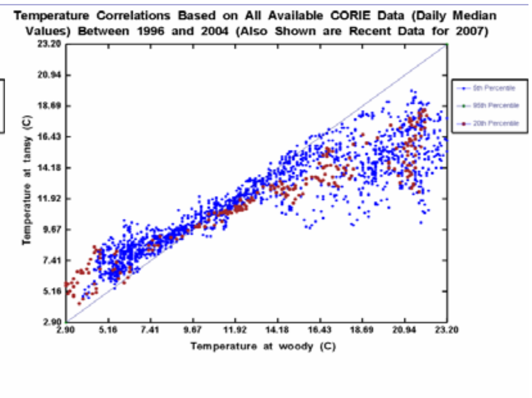
**Table 2.2.4. Summary of monthly median temperature values (bold numbers) for cnbc3 station in relation to AEM percentile decision criteria.**

| | 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** | **5.1** | **7.6** | **9.8** | **13.9** | **17.0** | **20.7** | **20.7** | **18.6** | **14.4** | | **6.4** |
| 80 | 6.4 | 6.5 | 8.3 | 11.2 | 15.0 | 17.7 | 21.1 | 21.5 | 19.5 | 16.7 | 10.9 | 7.6 |
| | | | | | | | | | | | **11.1** | |
| 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 |

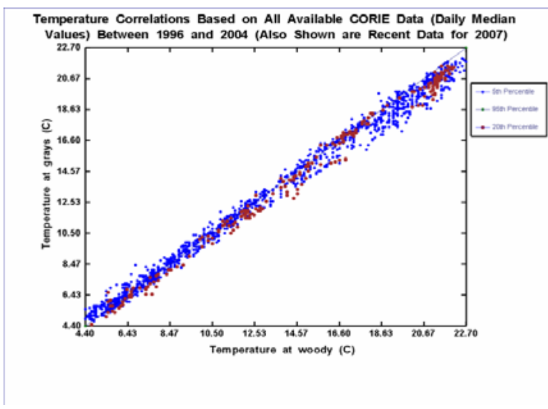
**(a)**




**(b)**




**(c)**




**(d)**

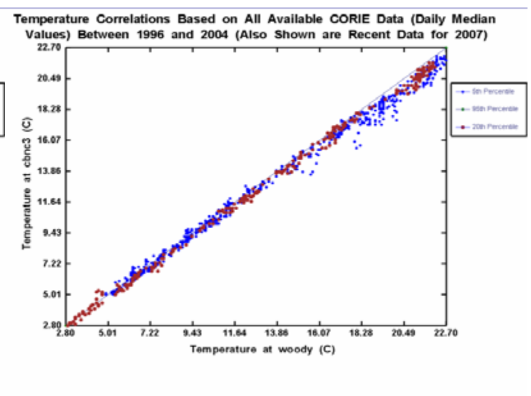



**Figure 2.2.2. Median daily water temperatures for (a) red26, (b) tansy, (c) grays, and (d) cbnc3 stations plotted for 2007 against median daily water temperatures for the 'woody' station.**

## *2-3 Salinity*

MA-1 provides an analysis of potential Project impacts on salinity. The analyses are preformed 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, which can impact habitat quality for juvenile salmon. Figure 2.3.1 (a,b,c,d) presents the daily median values of salinity measured in 2007 at the three MA-1 sampling locations. The corresponding decision criteria developed from pre-Project salinity data (i.e., 1996–2004) by the AMT are also plotted for convenient comparison with the monitoring results. Importantly, the plotted results demonstrate periods when data were not available from the monitoring stations. Data were obtained only between May and August for the tansy station. In addition, the red26 station was destroyed in August 2007.

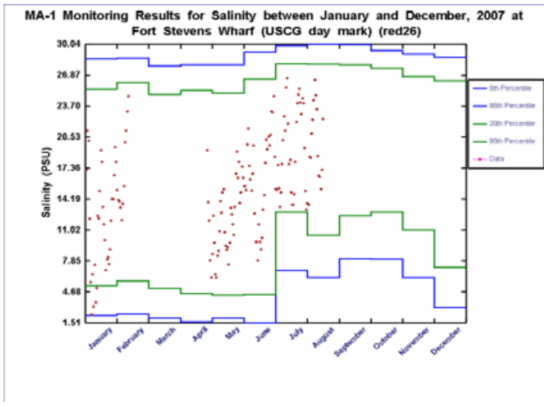
The greatest variations in salinity values were observed for red26 and tansy in 2007. These stations are strongly influenced by tidal flows (Figure 2.3.1 a,b). Despite these variations, the salinity values reported for red26 and tansy did not exceed the 5–95$^{th}$ percentile decision criteria during 2007. Four salinity values monitored in January for red26 are less than the 20$^{th}$ percentile AMT decision criteria. However, decreases in salinity are of lesser concern than salinity increases and the observed decreases can be explained by dilution of estuarine flows by higher than average river flows observed in January 2007 (Figure 2.4.1). The temporal patterns of salinity values were quite similar for red26 and tansy between April and the end of July in 2007. Importantly, none of the reported values exceeded the decision criteria during this period for either station.

Salinity values reported in 2007 for the grays and cbnc3 stations largely reinforce the observations in 2006 (Figure 2.3.1 c,d). These stations are located sufficiently upriver and their characteristically lower salinity values are determined primarily by the dominance of river flows. Circulation of more highly saline tidal waters exhibits lesser influence at these stations than observed for red26 and tansy, although tidal influence can increase salinity values at grays and cbnc3 during periods of very low river flow. For example, several daily median values of salinity exceeded the 80$^{th}$ percentile decision criteria for the grays station from late August through early November in 2007. Values reported for cbnc3 in 2007 were often less than 1 psu. However, daily six values reported during February 2007 exceeded the 90$^{th}$ percentile decision criteria for the cbnc3 station.

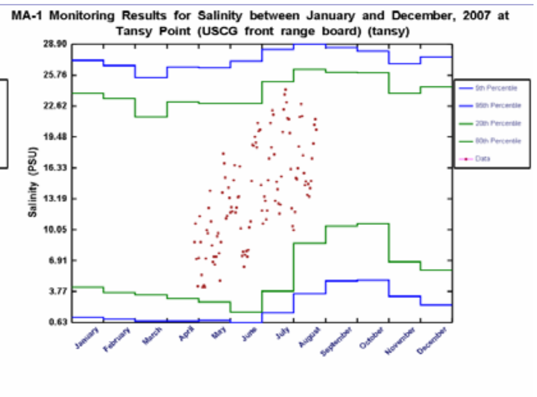
Tables 2.3.1–2.3.4 lists the monthly median salinity values and the decision criteria developed by the AMT for MA-1. The monthly values at red26 and tansy are within the 20–80$^{th}$ percentile values for all months when data were available (Tables 2.3.1 and 2.3.2). The monthly median values for grays are less than the 5$^{th}$ percentile decision criteria for April, May, June, and December. The monthly median values at grays for July through November lie within the 20–80$^{th}$ percentile decision criteria for this station. All the computed monthly median salinity values are zero for the cbnc3 station. Data were not available during July through December for cbnc3

Further evaluation of 2007 channel modifications on salinity was based on plots of MA-1 salinity values against corresponding values for the CORIE Desdemona station (dsdma). Data are not available between April and August at dsdma. As a result, correlations in salinity values for these two stations cannot be evaluated. The dsdma station is located downriver from red26 and is influenced by tidal mixing. Figure 2.3.2a illustrates the relationship between salinity values at dsdma and red26 based on pre-Project data (1996–2004, blue dots). The 2007 MA-1 salinity values for red26 are within the range of variation determined by the pre-Project data. The relationships between salinity measured at dsdma and grays or cbnc3 are less clear (Figures 2.3.2b,c). As stated, the location of these stations in comparatively shallow and upriver areas emphasizes the influence of freshwater river flows. Salinity values are often zero for these MA-1 stations. The ranges of salinity values at these stations are much less than values for the more estuarine stations of dsdma and red26. Nevertheless, the 2007 MA-1 data (red dots) were superimposed on the baseline values (blue dots) for comparison. The 2007 values are well within the range defined by the pre-Project salinity data for grays and cbnc3.

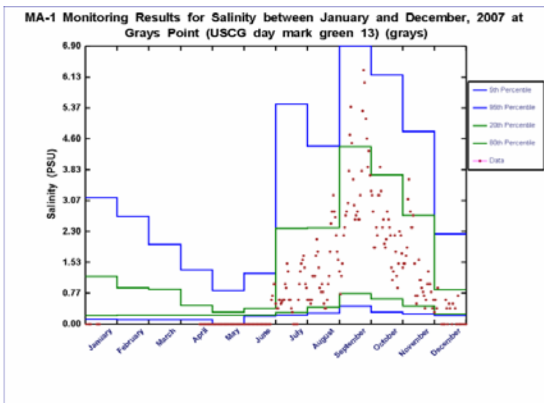
(a)




(b)




(c)




(d)

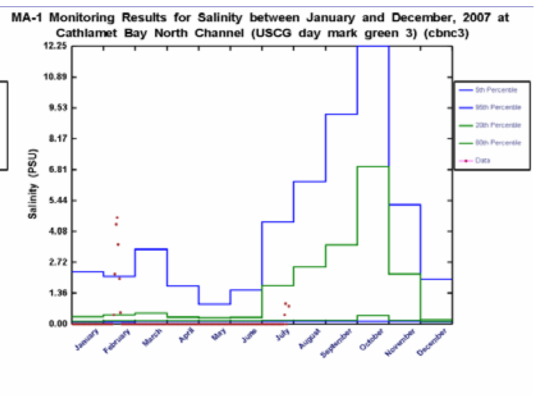



**Figure 2.3.1. Daily median values of salinity for (a) red26, (b) tansy, (c) grays, and (d) cbnc3 sampling stations for 2007 plotted in relation to the CRCIP AEM decision criteria.**

**Table 2.3.1. Summary of monthly median salinity values (bold numbers) for red26 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 | 2.3 | 2.4 | 2.0 | 1.6 | 2.0 | 1.5 | 6.9 | 6.2 | 8.1 | 8.1 | 6.2 | 3.1 |
| 20 | 5.3 | 5.8 | 5.1 | 4.5 | 4.3 | 4.4 | 12.8 | 10.5 | 12.5 | 12.8 | 11.1 | 7.2 |
| | **12.1** | **19.1** | | **10.8** | **12.4** | **17.5** | **20.8** | **21.7** | | | | |
| 80 | 25.5 | 26.1 | 24.9 | 25.3 | 25.0 | 26.5 | 28.1 | 28.0 | 27.9 | 27.6 | 26.7 | 26.3 |
| 95 | 28.5 | 28.6 | 27.8 | 27.9 | 27.9 | 29.3 | 29.9 | 30.0 | 30.0 | 29.4 | 29.0 | 28.7 |

**Table 2.3.2. Summary of 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 | 2.3 | 2.4 | 2.0 | 1.6 | 2.0 | 1.5 | 6.9 | 6.2 | 8.1 | 8.1 | 6.2 | 3.1 |
| 20 | 5.3 | 5.8 | 5.1 | 4.5 | 4.3 | 4.4 | 12.8 | 10.5 | 12.5 | 12.8 | 11.1 | 7.2 |
| | | | | **7.7** | **9.4** | **14.2** | **18.0** | **17.8** | | | | |
| 80 | 25.5 | 26.1 | 24.9 | 25.3 | 25.0 | 26.5 | 28.1 | 28.0 | 27.9 | 27.6 | 26.7 | 26.3 |
| 95 | 28.5 | 28.6 | 27.8 | 27.9 | 27.9 | 29.3 | 29.9 | 30.0 | 30.0 | 29.4 | 29.0 | 28.7 |

**Table 2.3.3. Summary of 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** |
| 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 |
| 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 |
| | | | | | | | **0.7** | **1.4** | **3.4** | **2.1** | **1.2** | |
| 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 2.3.4. Summary of 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** |
| | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | | | | | |
| 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 |
| 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)

(b)

(c)

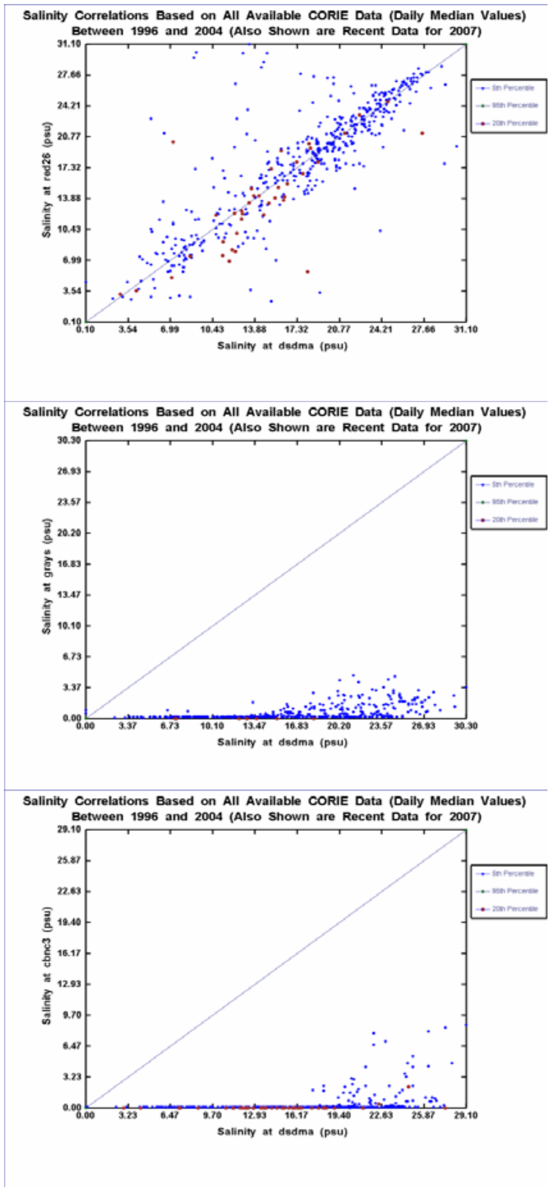



**Figure 2.3.2. Median daily salinity for (a) red26, (b) grays, and (c) cbnc3 stations plotted for 2007 in relation to median daily salinity for the "dsdma" (Desdemona) station.**

## *2-4 Columbia River Discharge*

The collation and analysis of the Bonneville Dam flow data continued through 2007 as flow data became available (Figure 2.4.1). The elevated flows in the beginning and middle of January, in the beginning of February, and towards the end of November and December also correspond to increased depths and decreased temperatures recorded at the MA-1 stations.

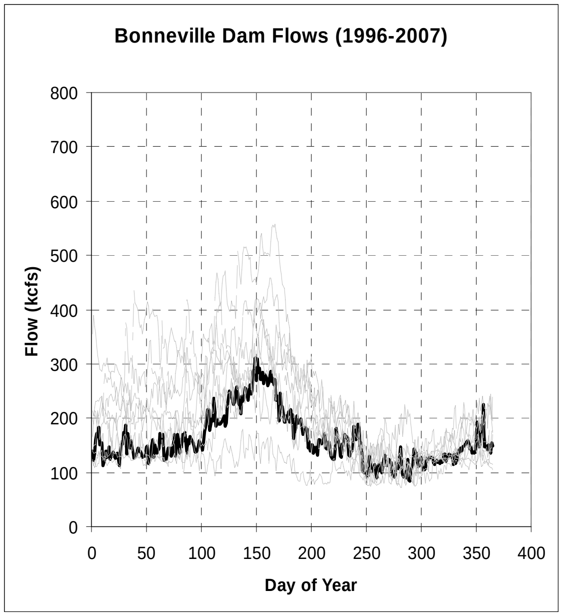



**Figure 2.4.1. Daily flow values recorded at Bonneville Dam for calendar year 2007 (solid line). Dashed lines show pre-Project (baseline) values for 1996–2004.**

The collation and analysis of the Bonneville Dam flow data continued through 2007 (Figure 2.4.1). The elevated flows in the beginning and middle of January, in the beginning of February, and towards the end of November and December also correspond to increased depths and decreased temperatures recorded at the MA-1 stations.

The Bonneville Dam flow data are consistent with the temporal changes in observations at the MA-1 stations. It is recognized that the Bonneville Dam flows are not exact predictors of water circulation at the MA-1 stations. However, the overall qualitative agreement between the patterns in recorded Bonneville flows and the MA-1 monitoring results provide a simple and compelling explanation for deviations from pre-Project conditions and exceedances of decision criteria.

## 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 2007.

**Table 2.5.1. CRCIP AEM Plan Record of AMT Decisions**

| Date | Issue | MA-1 Decisions | Comments |
|---|---|---|---|
| 16 Dec 2004 | MA-1 | Compare with different monthly confidence intervals (CI) (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 QA/QC process permits. | |
| 16 Dec 2004 | MA-1 | Make plots (analyses) available to AMT via 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 CBNCE 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 CBNCE data that were interpolated will be flagged | |
| 28 Jun 2005 | MA-1 | At the last meeting, Cathy 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 be able detect change. The Corps 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 WA-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 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 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 Consulting Engineers, Inc., (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 2006** | **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 adaptive management process (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.) | |

**Table 2.5.1. CRCIP AEM Plan Record of AMT Decisions. (Continued).**

| Date | Issue | MA-1 Decisions | Comments |
|---|---|---|---|
| **10 Jan 2007** | **MA-1 Data Analysis** | CORIE and the Corps 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. | |
| | | | |
| **11 Jul 2007** | **MA-1 CORIE Analyses** | No management decisions were required for MA-1. | |
| | | | |
| **3 Oct 2007** | **MA-1 CORIE Analysis** | Recommendations were made to examine alternative stations for red26, which has been lost from the CORIE network. Data for dsdma and tansy stations will be analyzed. | |
| | | | |

# 3 Monitoring Action 2—Dredging Volumes

## 3-1 Volumes of Dredged Materials

MA-2 provides annual dredging volumes associated with construction and operation of the 48-foot navigation channel. Volumes are reported for each dredging bar (~3-mile reaches). Adaptive management can be triggered if actual construction volumes exceed projected volumes (e.g., Table 3.1.1). In addition, the adaptive component of the proposed AEM Plan might be initiated if the volumes of dredged materials exceed the capacity for disposal. Volumes and disposal of operations and maintenance dredging are also tracked in relation to the Project. These three aspects of Project construction contribute to decision-making concerning adaptive management based on the MA-2 results.

Project construction to date has occurred at Desdemona, Flavel Bar, Upper Sands, Willow Bar, Morgan Bar, and Lower Vancouver. Thus far, actual new construction has not exceeded the projected dredging volumes at any of these locations (Table 3.1.1).

Oregon Department of Environmental Quality (ODEQ) expressed concerns regarding dredging volumes and disposal capacities. The spreadsheet that summarizes disposal for each site will be updated to address concerns regarding capacity for project dredging, including disposal to the deepwater site and Gateway.

Project construction continues to focus on CRM 21–30, 63, and 71–91 with some additional work at CRM 40–48. The Stuyvesant Phase 2 removal focused on CRM 21–30 with a total of 1,502,418 cubic yards (cys) removed. Approximately half was disposed in the Deep Water Site, while the remainder was disposed in water. The Essayons/Oregon Phase 2 construction was on CRM 91–95. Of the 954,322 cys removed, 432,792 cys were disposed at Gateway, while 521,530 cys went to Fazio. For CRM 45–48, a total of 1,312,665 cys were dredged and disposed at Brown Island, while another 167,618 cys were dredged and disposed in-water. Finally, for CRM 40–41, 190,038 cys were dredged and disposed in the Welcome Slough scour hole, 192,708 cys were removed and disposed in-water.

A contract was awarded to the Great Lakes for dredging in 2007 on selected areas in CRM 34–91. Construction by The Great Lakes was underway between September 24$^{th}$ and October 29th. Using a new dredge, the Great Lakes vessel was able to pump approximately 4 million cys of dredged materials to upland locations.

Project construction maps were presented as part of this discussion. These maps will be made available at the E2 web site (www.E2tm.com/CRCIP).

## 3-2 Disposal of Project Dredged Materials

To date, the CRCIP construction has resulted in the disposal of 1,317,978 cys to the Deep Water Site. In-water disposal accounted for 557,284 cys. Approximately 724,843 cys were rehandled materials that went to the Gateway disposal site. (This is an approximate estimate that refers to the volume contracted by the Corps. The actual amount placed at Gateway might differ.) Table 3.2.1 lists in detail the potential disposal sites, their associated capacities and amounts of dredged materials disposed of to date.

**Table 3.1.1. Comparisons of projected and actual CRCIP construction volumes for 2007.**

| Sheet ID | Chart | Bar Name | Bar Stations by River Mile | D/S River Mile | Projected Volume Above 48 ft | Projected Volume Above 45 ft | Projected New Work (48−45) Volume | Sum (48−45) Volume | Sum (48−45) Volume | Sum (48−45) Volume | Actual New Work (48−45) Volume | Actual New Work (O&M) Volume | Location of Placed Material | State | OR | WA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CL-4** | | **Lower Desdemona** | 04+20+00 | 04+00+00 | 317,100 | 222,412 | 94,688 | 317,100 | 222,412 | 94,688 | 38,894 | | DWS/IW | OR | 317,100 | |
| | | | | 05+00+00 | 550,640 | 353,916 | 196,724 | 867,740 | 576,328 | 291,412 | | | | OR | 550,640 | |
| | | | | | | | | | | | | | | | | |
| **CL-5** | | **Upper Desdemona** | 06+22+00 | 06+00+00 | 66,193 | 0 | 66,193 | 933,933 | 576,328 | 357,605 | 22,704 | 35,000 | DWS/IW | OR | 66,193 | |
| | Predicted Bar New Construction Volume = | 473,894 | | 07+00+00 | 1,039 | 0 | 1,039 | 934,972 | 576,328 | 358,644 | | | | OR | 1,039 | |
| | Actual Bar New Construction Volume = | 61,598 | | 8+00+00 | 61,140 | 8,742 | 52,398 | 996,112 | 585,070 | 411,042 | | | | OR | 61,140 | |
| | Percentage of Prediction = | 13% | | 9+00+00 | 71,593 | 8,742 | 62,851 | 1,067,705 | 593,811 | 473,894 | | | | OR | 71,593 | |
| | | | | | | | | | | | | | | | | |
| **CL-9** | | **Flavel Bar** | 10+00+00 | 10+00+00 | 379,028 | 49,732 | 329,296 | 1,446,733 | 643,543 | 803,190 | 337,154 | | DWS/IW | OR | 379,028 | |
| | Predicted Bar New Construction Volume = | 1,169,720 | | 11+00+00 | 833,973 | 298,900 | 535,074 | 2,280,706 | 942,443 | 1,338,264 | 275,367 | | DWS/IW | OR | 833,973 | |
| | Actual Bar New Construction Volume = | 716,828 | | 12+00+00 | 360,900 | 121,292 | 239,608 | 2,641,606 | 1,063,735 | 1,577,871 | 300 | 110,000 | DWS/IW | OR | 360,900 | |
| | Percentage of Prediction = | 61% | | 13+00+00 | 138,168 | 72,425 | 65,743 | 2,779,773 | 1,136,160 | 1,643,614 | 104,007 | | DWS/IW | OR | 138,168 | |
| | | | | | | | | | | | | | | | | |
| **CL-14** | | **Upper Sands** | 13+30+00 | 14+00+00 | 226,017 | 54,585 | 171,432 | 3,005,790 | 1,190,745 | 1,815,045 | 172,699 | 40,000 | DWS/IW | OR | 226,017 | |
| | Predicted Bar New Construction Volume = | 858,622 | | 15+00+00 | 323,787 | 51,945 | 271,842 | 3,329,577 | 1,242,690 | 2,086,888 | 213,913 | 70,000 | DWS/IW | OR | 323,787 | |
| | Actual Bar New Construction Volume = | 539,552 | | 16+00+00 | 354,274 | 47,557 | 306,717 | 3,683,851 | 1,290,246 | 2,393,605 | 152,940 | 90,000 | DWS/IW | OR | 354,274 | |

**Table 3.1.1. Comparisons of projected and actual CRCIP construction volumes for 2007. (Continued).**

| Sheet ID | Chart | Bar Name | Bar Station by River Mile | D/S River Mile | Projected Volume Above 48 ft | Projected Volume Above 45 ft | Projected New Work (48−45) Volume | Sum (48−45) Volume | Sum (48−45) Volume | Sum (48−45) Volume | Actual New Work (48−45) Volume | Actual New Work O&M Volume | Location of Placed Material | State | OR | WA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CL-14** | | **Upper Sands** | | | | | | | | | | | | | | |
| | Percentage of Prediction = | 63% | | 17+00+00 | 108,631 | 0 | 108,631 | 3,792,482 | 1,290,246 | 2,502,236 | | | | OR | 108,631 | |
| **CL-94** | | **Willow Bar** | 93+50+00 | 93+00+00 | 261,237 | 67,579 | 193,659 | | | | | | | WA | | 261,237 |
| | Predicted Bar New Construction Volume = | 537,183 | | 94+00+00 | 156,838 | 45,286 | 111,552 | | | | | | | OR/WA | 78,419 | 78,419 |
| | Actual Bar New Construction Volume = | 355,623 | | 95+00+00 | 78,237 | 6,356 | 71,881 | | | | 355,623 | | Rehandled Material | OR/WA | 39,118 | 39,118 |
| | Percentage of Prediction = | 66% | | 96+00+00 | 191,681 | 31,588 | 160,093 | | | | | | | OR/WA | 95,840 | 95,840 |
| **CL-97** | | **Morgan Bar** | 97+40+00 | 97+00+00 | 167,351 | 31,430 | 135,922 | | | | | | | OR/WA | 83,676 | 83,676 |
| | Predicted Bar New Construction Volume = | 191,689 | | 98+00+00 | 50,416 | 3,821 | 46,595 | | | | 33,637 | | Rehandled Material | OR/WA | 25,208 | 25,208 |
| | Actual Bar New Construction Volume = | 33,637 | | 99+00+00 | 9,172 | 0 | 9,172 | | | | | | | OR | 9,172 | |
| | Percentage of Prediction = | 18% | | 100+00+00 | 0 | 0 | 0 | | | | | | | OR | 0 | |
| **CL-102** | | **Lower Vancouver** | 101+18+00 | 101+00+00 | 87,054 | 10,311 | 76,744 | | | | | | | OR | 87,054 | |
| | Predicted Bar New Construction Volume = | 556,043 | | 102+00+00 | 84 | 0 | 84 | | | | 352,718 | | Rehandled Material | OR | 84 | |
| | Actual Bar New Construction Volume = | 352,718 | | 103+00+00 | 87,909 | 1,810 | 86,099 | | | | | | | WA | | 87,909 |
| | Percentage of Prediction = | 63% | | 104+00+00 | 393,116 | 0 | 393,116 | | | | | | | WA | | 393,116 |

**Table 3.2.1. Disposal of CRCIP dredged materials.**

| Disposal | Site | CRCIP Construction | | Projected O&M | Actual O&M | Percent | Total Estimated |
|---|---|---|---|---|---|---|---|
| Site | Location/Name | Projected Volume | Volume Placed | Volume | Volume Placed | Full | Capacity |
| **W-21.0** | Rice island | 0 | | 5,500,000 | | | 5,500,000 |
| **O-23.5** | Miller Sands | 0 | | 7,000,000 | | | NA |
| **O-27.2** | Pillar Rock Island | 0 | | 1,000,000 | | | 2,555,000 |
| **W-33.4** | Skamokawa | 0 | | varies | | | 250,000 |
| **O-34.0** | Welch island | 0 | | 400,000 | | | 446,000 |
| **O-38.3** | Tenasillahe Island | 0 | | 2,300,000 | | | 2,300,000 |
| **O-42.9** | James River | 240,000 | | 830,000 | | | 1,280,000 |
| **W-44.0** | Puget Island (Vik Prop.) | 500,000 | | 2,700,000 | | | 3,500,000 |
| **W-46.3/W-46.0** | Brown Island | 1,200,000 | 1,312,665 | 3,400,000 | | 28% | 4,700,000 |
| **O-54.0** | Port Westward | 150,000 | | 1,500,000 | | | 1,875,000 |
| **O-57.0** | Crims Island | 30,000 | | 1,100,000 | | | 1,600,000 |
| **W-59.7** | Hump Island | 400,000 | | 900,000 | | | 1,500,000 |
| **W-62.0** | Mt. Solo | 300,000 | | 2,100,000 | | | 2,500,000 |
| **W-63.5** | Reynolds Aluminum | 180,000 | | 0 | | | 500,000 |
| **O-63.5** | Lord Island Upstream | 0 | | 600,000 | | | 1,255,000 |
| **O-64.8** | Rainier Industrial | 270,000 | | 2,400,000 | | | 2,235,000 |
| **W-67.5** | International Paper | 140,000 | | 2,700,000 | | | 1,000,000 |
| **O-67.0** | Rainier Beach | 450,000 | | 2,400,000 | | | 1,095,000 |
| **W-68.7** | Howard Island | 0 | | 600,000 | | | 6,400,000 |
| **W-70.1** | Cottonwood Island | 240,000 | | 1,300,000 | | | 3,200,000 |
| **W-71.9** | Northport | 189,000 | | 1,800,000 | | | 900,000 |
| **O-75.8** | Sandy Island | 120,000 | | 860,000 | | | 1,100,000 |
| **O-77.0** | Lower Deer Island | 440,000 | | 700,000 | | | 1,498,000 |
| **W-80.0** | Martin Island Mitigation | 370,000 | | 0 | | | 550,000 |
| **W-82.0** | Martin Bar | 46,000 | | 700,000 | | | 1,500,000 |
| **O-82.6** | Reichold | 320,000 | | 2,300,000 | | | 1,285,000 |
| **O-86.2** | Sand Island | 150,000 | | 860,000 | | | 1,250,000 |
| **W-86.5** | Austin Point | 136,000 | | 1,500,000 | | | 1,645,000 |
| **O-87.8** | Railroad Corridor | 300,000 | | 0 | | | 540,000 |
| **O-91.5** | Lonestar | 900,000 | | 3,200,000 | | | 5,350,000 |
| **W-96.9** | Adjacent to Fazio | 0 | | varies | | | 475,000 |
| **W-97.1** | Fazio Sand & Gravel | 112,000 | 521,530 | 1,000,000 | | 80% | 650,000 |
| **W-101.0** | Gateway | 587,000 | 1,157,635 | 1,600,000 | | 50% | 2,300,000 |
| **O-105.0** | West Hayden Island | 600,000 | | 3,900,000 | | | 5,750,000 |
| **Total upland** | | | 1,846,783 | | | 3% | 57,433,000 |
| **DWS** | | 6,500,000 | 2,170,513 | | | 1% | 225,000,000 |
| **IW** | | | 1,925,128 | | | | |
| **Rehandled Material** | | | 2,279,575 | | | | |

**Comment [mc1]:** We may need to find a new word, don't want to use rehandle anymore

## 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 Adaptive Environmental Management Program.

**Table 3.3.1. CRCIP AEM Plan Record of AMT 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 2 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 FSEIS by 15% or more that the AMT team members would be notified. Agreement was also reached, that at the quarterly meetings, the Corps 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 percent 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 3.3.2. CRCIP AEM Plan Record of AMT Decisions.**

| 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. | |
| | | | |

# 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 will be performed annually for two years prior to construction, during construction, and three years after construction. Surveys will be performed at CRM 42, 46, 72, 75, 86, and 99. These river mile locations were identified through previous Corps analysis of locations that appeared potentially sensitive to accretion and erosion. Additional surveys will be performed 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 will determine any need for adaptive management.

## *4-1 MA-3 Decision Criteria*

In 2006, the results of pre-construction surveys (1996–2004) were used to developed consensus decision criteria to evaluate surveys performed in relation to Project construction (Table 4.1.1). The resulting depth “envelopes” define upper and lower depths that should not be exceeded as the result of construction dredging at these locations. The envelopes were calculated by subtracting the value of one standard deviation (SD) (sigma) from the minimum reported depth and adding one SD (sigma) to the maximum reported depth.

In 2007, post-construction data became available from surveys conducted in 2006. These surveys were compared with MA-3 decision criteria. There was one unexplained outlier value observed for the crossline survey at CRM 45.5.

**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** |
| 41.5south | 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 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.

**Table 4.1.2. Columbia River Cross-Line Hydrosurvey Dates**

| River Reach | RM | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Morgan Bar (MGN) | 98 to 101 | 24-Feb | N/A | 05-Jan | 12-Jan | 20-Jan | 13-Feb | 13-Feb | 07-Jan | 22-Jan | 04-Apr | 12-Jan |
| St Helens Bar (STH) | 84 to 87 | 21-Feb | 24-Feb | N/A | 19-Jan | 11-Jan | 05-Feb | 12-Feb | 14-Jan | 31-Mar | 10-May | 25-Jan |
| Kalama Bar (KLM) | 73 to 76 | 20-Feb | 12-Feb | 21-Jan | 26-Jan | 10-Jan | 31-Jan | 7-Feb | 23-Jan | 28-Apr | 24-May | 07-Feb |
| Upper Dobelbower Bar (UDB) | 70 to 73 | 20-Feb | 12-Feb | 21-Jan | 26-Jan | 06-Jan | 30-Jan | 06-Feb | 28-Jan | 29-Apr | 25-May | 07-Feb |
| Westport Bar (WST) | 45 to 48 | 20-Feb | 10-Feb | 28-Jan | 01-Feb | 26-Jan | 30-Jan | 24-Jan | 05-Feb | 17-May | 22-Jun | 31-Jan |
| Wauna and Driscoll (WAN) | 41 to 44 | 20-Feb | 06-Feb | 28-Jan | 27-Jan | 25-Jan | 29-Jan | 24-Jan | 05-Feb | 13-May | 18-May | 24-Jan |

## *4-2 AMT Decisions for MA-3*

Table 4.2.1 outlines the key AMT discussion points and decisions concerning potential effects of Project construction on channel bathymetry through calendar 2007.

**Table 4.2.1. CRCIP AEM Plan Record of AMT 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 EIS. | |
| **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 shallow water habitats. 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 Biological Opinion - 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 RM 3 to RM 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 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. | |

# 5 Monitoring Action 4—Habitat Opportunity

MA-4 will augment the estuary habitat surveys being conducted by NMFS as part of the Anadromous Fish Evaluation Program (AFEP) (Bottom and Gore 2001). The objective is to determine if changes in habitat opportunity and habitat capacity result from 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 characterizations of habitat opportunity have been provided for juvenile chinook and chum in terms of suitable water depths and current velocity. These estimates can serve as a basis for comparing post-Project estimates of habitat opportunity to determine any impacts of channel modifications on physical habitat for juvenile salmonids.

Discussions in 2007 addressed concerns expressed by NMFS that the original 2-year (2006–2008) Project construction period might well be extended. The MA-4 monitoring plan was developed under the assumption of a 2-year construction period. The projected period for Project construction is different from that used in developing the Biological Opinion and Biological Assessment.

## 5-1 MA-4 Decision Criteria

Estimates of habitat opportunity will be calculated using the post-Project bathymetry of the LCR. Pre- and post-Project comparisons may require re-calculation of pre-Project opportunity values given the availability of more recent pre-Project bathymetry than that used in the original Bottom et al. (2005) analyses. The post-construction MA-3 survey data can contribute to the calculations of habitat opportunity.

The CRCIP will fund one habitat survey conducted under the AFEP. The survey will be conducted three years following Project construction. As a result of the AFEP, there will be approximately 10-years of pre-Project habitat survey data. The results of the pre- and post-Project habitat comparisons will be evaluated in the AEM process.

Threshold values of change (i.e., decision criteria) will be defined for each habitat type as a result of the pre-Project survey data. Measures that exceed any of the decision criteria may result in adaptation to current management actions. Table 5.1.1 illustrates a template for use in evaluating results of MA-4 habitat surveys.

**Table 5.1.1. Template for evaluating changes in habitat opportunity (velocity, depth) using results from MA-4 habitat surveys.**

| LCR | Habitat Opportunity (h/month)[2] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 2007.

**Table 5.2.1. CRCIP AEM Plan Record of AMT Decisions.**

| Date | Issue | MA-4 Decisions | Comments |
|---|---|---|---|
| **16 Dec 2004** | **MA-4 Decision Criterion** | Re-evaluation of Bottom et al.(in prep.) 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 Corps proposed target year designated as three years post-construction. | |
| **5 Jul 2005** | **MA-4 Decision Criterion** | The Corps 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 Corps 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. | |

# 6 Monitoring Action 5—Sediment Contaminants

Monitoring Action 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 has initially focused on samples that were collected well before the onset of the CRCIP. More recent data will be included as they are identified and become available to the AMT.

In January of 2007, the Corps met with NMFS and USFWS to review sediment contamination data. At the April AMT Meeting, the nature of sediment contamination in reaches 3 and 4 of the Lower Columbia River was presented and discussed. In reach 3 (CRM 70–84), 13 surveys (sampling rips) were entered into sediment quality database (SEDQUAL) from1984–2003. Of the 2,526 separate chemical analyses, no samples exceeded the DMEF/SEF or NOAA threshold values. In reach 4 (CRM 56–70), 18 sampling surveys were entered into the SEDQUAL from 1987–2006. Of the 4,080 samples, PAHs exceeded DMEF/SEF and NOAA criteria at one station and NOAA criteria at a second station. The samples that exceeded the criteria were collected outside the Federal Navigation Channel and advanced maintenance areas. Other samples did not exceed criteria for metals or organic contaminants.

The SEDQUAL will be incorporated into the USDOE Environmental Information Management (EIM) system. However, the Corps will likely maintain a separate version of SEDQUAL. It was also noted that there remain gaps in the SEF benchmark values for freshwater organisms.

## *6-1 Sediment Contaminants*

No new information was presented for sediment contaminants in relation to the AEM Plan in calendar 2007. The Corps (Mark Sippola) contacted 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.

## *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 2007.

**Table 6.2.1. CRCIP AEM Plan Record of AMT Decisions.**

| Date | Issue | MA-5 Decisions | Comments |
|---|---|---|---|
| **16 Dec 2004** | **MA-5 Decision Criterion** | AMT will solicit summaries of sediment contamination data from technical group already performing this work. | |
| **16 Dec 2004** | **MA-5 Decision Criterion** | The AMT will interact with the LCREP 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 e-mailed the Corps 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 WA, OR, and ID. 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 Corps 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 Corps (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. | |

# 7 Monitoring Action 6—Fish Stranding

## *7-1 Frequency of Stranding*

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 CRCIP AEM Plan. 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 percent of the vessel passages were associated with stranding events. This frequency ranged from ~18 to 30 percent for these three 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 (RM 51)** | 3 | 17 | 17.6 |
| **Barlow Point (RM 62)** | 7 | 23 | 30.4 |
| **Sauvie Island (RM 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 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 six 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 web site (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 AMT Decisions for MA-6

Table 7.3.1 summarizes the key discussion points and decisions concerning the possible impacts of CRCIP construction on fish stranding through calendar 2007.

**Table 7.3.1. CRCIP AEM Plan Record of AMT 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** | While there are some gaps, the SEF largely addresses the sediment contaminants of interest to WA, OR, and ID. The AMT agrees that decision criteria for MA-5 should be made on the basis of the final SEF. | |
| | | | |
| **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 Apr 2007** | **MA-6 Fish Stranding** | No decisions were required for MA-6. | |

| Table 7.3.1. CRCIP AEM Plan Record of AMT Decisions. (Continued) | | | |
|---|---|---|---|
| **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. | |

# 8 Sturgeon

Criteria to protect sturgeon as part of the AEM process will address the possible CRCIP impacts on the mortality, survival, growth, movements, feeding behavior, and habitat utilization of these fish in relation to the dredging process and the disposal of dredged materials. These actions emphasize the selection of alternative sites for disposing of dredged materials if significant impacts are observed. Alternatively, the dredging schedule can be modified to minimize impacts on sturgeon.

## *8-1 Decision Criteria for Sturgeon*

The results of the Parsley and Popoff (2004) study indicated that sturgeon were not detrimentally affected by dredging operations or disposal of dredged materials. In some instances the fish did not leave areas that were being dredged. Other instances, the monitored individuals returned to dredged areas soon after dredging operations were completed.

Additional analyses are directed at concerns that modification of channel slopes and bedform might impact the quality and distribution of preferred sturgeon habitat. Preliminary analysis of the monitoring data suggests that these fish prefer steeply-sloped channels and rough channel bedform.

The AMT will determine the utility of the sturgeon habitat study results for deriving AEM criteria when it examines the final Project report. Analyses of sturgeon habitat preferences were completed in 2007; however, the project report was not delivered to the Corps. The Corps anticipates that the report will be available for AMT review and comments in early 2008.

## 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 2007.

**Table 8.2.1. CRCIP AEM Plan Record of Adaptive Management Team Decisions.**

| 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 Corps had previously indicated that additional work would be done on correlating sturgeon abundance with habitat using the existing data. | |
| 1 Sep 2005 | Sturgeon | The Corps 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. | |
| 10 Jan 2007 | Sturgeon | The Corps 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 Smelt

## 9-1 Decision Criteria for Smelt

Decision criteria concerning disposal of dredged materials on smelt were provided in the 2006 annual report for the channel deepening 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. The AMT concurred that no variances with the decision criteria for smelt were reported for 2007.

| **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 Corps 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*

The information summarized from the quarterly AMT meetings indicated that no decisions were required concerning project impacts on smelt in 2007 (Table 9.2.1).

**Table 9.2.1. CRCIP AEM Plan Record of AMT Decisions.**

| 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 Corps 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 RM 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. | |
| | | | |
| **3 Oct 2007** | **Smelt** | No decisions were required for smelt. | |

# 10 Dungeness Crab

The objectives of the AEM Plan concerning Dungeness crab are to avoid or minimize (1) entrainment mortality during dredging and (2) crab burial by disposal of dredged materials. The underlying intent is “no net loss” of these organisms as a result of channel improvement.

## *10-1 Decision Criteria for Dungeness Crab*

Entrainment studies were performed at several locations within the estuary, including the mouth of the Columbia River, 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/cy) 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+ crabs that migrate through this area during the October–November time frame.

The AMT agreed that the results of the crab entrainment studies provide useful information for evaluating the effects of Project-related dredging on crab mortality and distribution.

In 2007, the final crab entrainment and burial report was posted on E2 web site.

## 10-2 AMT Decisions regarding Dungeness Crab

Table 10.2.1 summarizes the accumulated decision and key discussion points concerning the CRCIP and potential impacts on Dungeness crab in the LCR and estuary. The principal activities during 2007 included the posting of the final report by Pearson et al. (2005b) at the E2 web site for review and comment by the AMT.

**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 Washington Department of Ecology accepted the Corps 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 web site. | |
| | | | |
| 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 web site. | |
| | | | |
| 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. | |

# 11 Sediments

## 11-1 Decision Criteria for Sediments

Discussions continued throughout 2007 concerning the development of a sediment management component for the Project AEM Process. Discussions at the January 2007 AMT Meeting were largely in response to a draft sediment document previously circulated by the Corps. By request, the exact language from each state that identifies state requirements for disposal of dredged materials was added to the draft sediment management document. NMFS requested information concerning the volume of dredged materials placed in each of the upland locations. The Corps can provide the placement volumes. However, the states sell these materials from the sites and the current inventories might not be known for each disposal location. NMFS also requested a clear description of the process for management of dredged materials. The description should address (1) disposal of dredged materials, and (2) relocation of sediments previously disposed on upland sites. The Corps indicated that such a description was in the current draft sediment document. It was also noted that materials disposed on upland sites were classified as a potentially solid waste that required additional testing before being used for beneficial purposes.

The AMT will work to complete the Project AEM Plan for sediment management during the calendar 2008 meetings.

## 11-2 Summary

Discussion of sediment management issues occurred throughout 2007 without resolution. However, given the late date for producing the 2007 annual report, it is important to note that the April 2008 quarterly meeting of the AMT was devoted to addressing the sediment issues within the context of the CRCIP authorization and the AEM Plan. Participants in the April AMT sediment workshop developed a consensus process for effectively involving the AMT in the identification and evaluation of sites for disposal of Project construction materials. Participants worked through the process and suggested alternatives for sediment disposal in relation to beneficial uses and sediment management relevant to the CRCIP AEM Program. The AMT consensus process for sediment management is described in a sediment management workshop report.

Table 11.2.1 summarizes the decisions made during 2007 concerning the relevance of Project disposal of dredged materials to regional sediment management.

**Table 11.2.1. CRCIP AEM Plan Record of AMT Decisions for Sediments.**

| Date | Issue | Sediments Decisions | Comments |
|---|---|---|---|
| **11 Jan 2006** | **Sediment Management** | The Corps 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 AEM Plan. | |
| | | | |
| **12 Apr 2006** | **Sediment Management** | The Corps agreed to further consultation with WDOE concerning the incorporation of sediment management language into the AEM Plan. | |

**Table 11.2.1. CRCIP AEM Plan Record of AMT Decisions for Sediments. (Continued).**

| | | | |
|---|---|---|---|
| **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 Corps 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. | |

# 12 Integration with 2006 AEM Results

Each annual report refers to AEM activities and conclusions in the prior year to provide continuity during the CRCIP AEM program. The following sections briefly review the 2006 AMT activities and summarize AEM monitoring results. Additional detail can be found in the notes from the quarterly AMT meetings and the AEM program workbook that are available through the project web site hosted by E2 (www.e2tm.com/CRCIP).

## *12-1 Results for Analyses of 2006 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 red26, grays, and cbnc3 are compared against these criteria. Tables 12.1.1–12.1.7 list these decision criteria and corresponding MA-1 monthly results for 2006. Detailed plots of daily median values and normalized values of temperature and salinity can be examined by downloading the corresponding files at the E2 web site site.

### Depth

Table 12.1.1 lists the monthly median depths for the grays station. All 12 monthly values are within the 20–80$^{th}$ percentile decision criteria.

### Temperature

With only three exceptions, the monthly median values of water temperature are all with the 20–80$^{th}$ percentile ranges for red26 (Table 12.1.2), grays (Table 12.1.3), and cbnc3 (Table 12.1.4). The other three monthly values show slight elevations in temperature that are between the 80–95$^{th}$ percentile decision criteria. None of the monthly median values for 2006 are outside of the 5–95$^{th}$ percentile ranges.

### Salinity

Tables 12.1.5–12.1.7 present the monthly median salinity values for red26, grays, and cbnc3. The 2006 results are quite similar to those observed in 2007. The available data for red26 are all within the 20–80$^{th}$ percentile decision criteria. The 2006 monthly median values for grays are more variable in relation to the decision criteria. However, the overall magnitudes of salinity changes are small. Similar results were obtained for cbnc3, although if there were any tendency, it was towards decreased values of salinity–again, not indicative of salinity intrusions.

**Table 12.1.1. Summary of 2006 monthly median depth values (bold numbers) for grays station in relation to AEM percentile decision criteria.**

| | Monthly median depth (m) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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 |
| | **2.3** | **2.3** | **2.3** | **2.3** | **2.2** | **2.2** | **2.1** | **2.0** | **2.0** | **2.0** | **2.6** | **2.5** |
| 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 |

**Table 12.1.2. Summary of 2006 monthly median temperature values (bold numbers) for red26 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 | 4.9 | 5.3 | 6.3 | 8.4 | 9.2 | 9.4 | 9.4 | 9.3 | 9.4 | 9.3 | 8.3 | 6.5 |
| 20 | 6.2 | 6.4 | 7.4 | 9.3 | 10.6 | 10.9 | 10.8 | 11.0 | 11.0 | 11.1 | 9.4 | 7.6 |
| | **7.8** | **7.4** | **7.5** | **10.4** | **11.4** | **14.9** | **13.7** | **12.7** | **13.4** | **11.4** | **10.5** | 8.3 |
| 80 | 9.2 | 8.9 | 9.7 | 11.2 | 13.4 | 15.6 | 16.9 | 17.4 | 16.1 | 13.9 | 11.6 | 9.9 |
| | 10.3 | 9.9 | 10.8 | 12.0 | 14.5 | 16.8 | 18.9 | 19.3 | 17.7 | 15.1 | 12.5 | 10.8 |
| 95 | 10.3 | 9.9 | 10.8 | 12.0 | 14.5 | 16.8 | 18.9 | 19.3 | 17.7 | 15.1 | 12.5 | 10.8 |

**Table 12.1.3. Summary of 2006 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 |
| 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 |
| | | | | **10.1** | **14.7** | **16.8** | | **20.2** | **18.3** | **14.9** | | **6.7** |
| 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 |
| | **6.9** | **7.1** | **8.7** | | | | **20.6** | | | | 11.6 | |
| 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 |

**Table 12.1.4. Summary of 2006 monthly median temperature values (bold numbers) for cnbc3 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 |
| | | **5.7** | **6.2** | **9.9** | **12.8** | **16.6** | **20.5** | **20.3** | **18.3** | **14.8** | **10.3** | **6.2** |
| 80 | 6.4 | 6.5 | 8.3 | 11.2 | 15.0 | 17.7 | 21.1 | 21.5 | 19.5 | 16.7 | 10.9 | 7.6 |
| 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 |

**Table 12.1.5. Summary of 2006 monthly median salinity values (bold numbers) for red26 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 | 2.3 | 2.4 | 2.0 | 1.6 | 2.0 | 1.5 | 6.9 | 6.2 | 8.1 | 8.1 | 6.2 | 3.1 |
| 20 | 5.3 | 5.8 | 5.1 | 4.5 | 4.3 | 4.4 | 12.8 | 10.5 | 12.5 | 12.8 | 11.1 | 7.2 |
| | **6.2** | **12.6** | **17.6** | **6.4** | No data | **10.1** | **20.6** | **23.1** | **27.7** | **23.5** | **16.5** | **17.8** |
| 80 | 25.5 | 26.1 | 24.9 | 25.3 | 25.0 | 26.5 | 28.1 | 28.0 | 27.9 | 27.6 | 26.7 | 26.3 |
| 95 | 28.5 | 28.6 | 27.8 | 27.9 | 27.9 | 29.3 | 29.9 | 30.0 | 30.0 | 29.4 | 29.0 | 28.7 |

**Table 12.1.6. Summary of 2006 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** |
| | | | **0.1** | **0.1** | | | | | | | | |
| 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 |
| | | | | | **0.1** | | | | | | | |
| 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 |
| | No data | | | | | | **0.4** | **1.5** | **3.2** | **2.6** | | |
| 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 12.1.7. Summary of 2006 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** | | | | | | |
| 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 |
| | | | | | No data | | | **0.5** | **1.7** | **1.4** | | |
| 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 |

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