

**A Toxicity Evaluation of
Marine Sediment Samples Collected from
Outer Cook Inlet and the Shelikof Strait**

(Collected June 29-July 5, 1998)

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1. INTRODUCTION

Under contract to Applied Marine Sciences, Pacific Eco-Risk Laboratories performed sediment toxicity testing on 7 marine sediment samples, collected from the Outer Cook Inlet and Shelikof Strait during the period of June 29-July 5, 1998. These sediment toxicity evaluations consisted of performing the U.S. EPA's 10-day estuarine amphipod survival test with the amphipod *Ampelisca abdita*.

This report describes the performance and results of these sediment tests.

2. SEDIMENT TOXICITY TESTING

The methods used in conducting these tests followed the guidelines established by the EPA manual "Methods for measuring the toxicity of sediment-associated contaminants with estuarine and marine amphipods" (EPA-600/R-94/025, U.S. EPA, Env. Research Laboratory, Narragansett, RI).

2.1 RECEIPT AND HANDLING OF THE SEDIMENT SAMPLES

During the period of June 29-July 5, 1998, grab samples of marine sediments of approximately 2 L volume were collected from each of 8 sites within the Outer Cook Inlet and Shelikof Strait; these samples were collected into 2 L high-density polyethylene bottles, and were then shipped, via overnight delivery, to the testing laboratory in Martinez, CA, where they were received on July 7, 1998. Upon receipt, the sediment samples were stored at 4°C until used to set-up the test replicates for the sediment toxicity tests on July 13, 1998.

2.2 TEST ORGANISMS

The *Ampelisca abdita* (along with the home sediment from which these organisms were collected) used in these tests were obtained from a commercial supplier (John Brezina and Associates, Dillon Beach, CA).

2.3. SEDIMENT TOXICITY TESTING PROCEDURES

There were 4 replicates for each site. Each replicate consisted of a 1 L glass beaker to which approximately 175 mL (approximately 2 cm depth) of sediment was added (each sediment sample was homogenized prior to loading of the test replicate containers). Test replicates were similarly established for the 'home' sediment Control treatment, which consisted of the same fine-grained sediment from which the test organisms were originally collected. An additional 'reference' Control, consisting of sediment collected

from Aialik Bay (a “pristine” site near the sites of concern), was also tested; this ‘reference’ sediment was autoclaved for 30 minutes prior to use in this test. The overlying water consisted of 0.45-um filtered seawater (collected from the U.C. Bodega Bay Marine Laboratory) diluted to a salinity of 30 ppt with reverse-osmosis, de-ionized water; approximately 800 mL of this water was carefully poured into each test replicate so as to minimize disturbance of the sediment. These test replicates were then placed in a temperature-controlled water bath at 20°C under continuous illumination from fluorescent lighting. Each test replicate was gently aerated.

The following day (July 14, 1998), routine water qualities (temperature, pH, dissolved oxygen (D.O.), and salinity) were determined for the overlying water in each test replicate. Then, the tests were initiated with the random allocation of 20 randomly-selected *Ampelisca* into each replicate container (aeration was shut off until the amphipods re-buried themselves, approximately 1 hr after their introduction). Each day, for the next 10 days, the temperature, pH, D.O., and salinity of the overlying water were measured in one test replicate for each treatment. On Days 2 and 8, a small sample of the overlying water was collected from each replicate for each treatment, composited, and analyzed to determine the total ammonia.

After 10 days exposure, routine water qualities (temperature, pH, dissolved oxygen (D.O.), and salinity) were again determined for each test replicate. Then, the contents of each replicate beaker were sieved and examined, and the surviving amphipods were collected and counted. The resulting % survival data for the 7 site sediments were statistically compared to both the ‘home’ sediment Control and the ‘reference’ sediment Control using the Tox-Calc statistical software (TidePool Scientific, McKinleyville, CA); for these evaluations, an “ecologically significant difference” was defined as a statistically significant difference and a $\geq 20\%$ reduction in survival relative to the Control. The results of these tests are summarized in Section 3.

3. RESULTS

The results of the toxicity evaluation of these sediments are summarized below in Table 1. Briefly, there was 100% survival of the amphipods in the ‘home’ sediment Control and 91.25% survival in the ‘reference’ sediment Control. There was not less than 90% survival in any of the 7 site sediments, indicating that none of these sediment exhibited an “ecologically significant difference” from either of the the Controls. The results of the statistical comparisons of the 7 site sediments with the two Control sediments are summarized below:

Sample “Z0F1” - There was 92.5% survival in the sediment designated “Z0F1” which was statistically less than survival in the ‘home’ Control, but not statistically different from the ‘reference’ Control;

Sample “Z0F6” - There was 90% survival in the sediment designated “Z0F6” which was statistically less than survival in the ‘home’ Control, but not statistically different from the ‘reference’ Control;

Sample “Z2F1” - There was 93.75% survival in the sediment designated “Z2F1” which was not statistically different from either the ‘home’ Control or the ‘reference’ Control;

Sample “Z3F1” - There was 95% survival in the sediment designated “Z3F1” which was statistically less than survival in the ‘home’ Control, but not statistically different from the ‘reference’ Control;

Sample “Z3F2” - There was 91.25% survival in the sediment designated “Z3F2” which was statistically less than survival in the ‘home’ Control, but not statistically different from the ‘reference’ Control;

Sample “Z3R11” - There was 95% survival in the sediment designated “Z3R11” which was not statistically different from either the ‘home’ Control or the ‘reference’ Control;

Sample “Z3R14” - There was 95% survival in the sediment designated “Z3R14” which was statistically less than survival in the ‘home’ Control, but not statistically different from the ‘reference’ Control.

Copies of the statistical analysis summaries for each of these tests are provided in Appendix A. Copies of the test data sheets are provided in Appendix B. A QA/QC summary is provided in Appendix C.

Table 1. Percent survival of <i>Ampelisca abdita</i> in the test sediments.					
Sediment Site	% Survival in Test Replicates				Overall Mean % Survival
	Rep A	Rep B	Rep C	Rep D	
“Home” Sediment Control	100	100	100	100	100
“Reference” Sediment Control	90	90	90	95	91.25
Z0F1 *	100	95	85	90	92.5
Z0F6 *	90	85	95	90	90
Z2F1	95	85	95	100	93.75
Z3F1 *	95	90	100	95	95
Z3F2 *	95	85	90	95	91.25
Z3R11	100	90	90	100	95
Z3R14 *	95	100	90	95	95

* statistical analysis indicates that amphipod survival at this site was significantly less than the ‘home’ sediment Control at $p < 0.05$.

Appendix A

Summary of Statistical Analyses Toxicity Evaluation of Sediment Samples Collected from the Outer Cook Inlet and Shelikof Strait

(samples collected June 29-July 5, 1998)

Ten Day Amphipod Survival Test-Proportion Survived

Start Date: 7/14/08	Test ID: 2087	Sample ID:	Reference
End Date: 7/24/98	Lab ID: CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:	Protocol: ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:			

Conc-%	1	2	3	4
Control	1.0000	1.0000	1.0000	1.0000
100	0.9000	0.9000	0.9000	0.9500

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root					Rank Sum	1-Tailed Critical
			Mean	Min	Max	CV%	N		
Control	1.0000	1.0000	1.4594	1.4588	1.4615	0.093	4		
100	0.9125	0.9125	1.2731	1.2490	1.3453	3.780	4	10.00	11.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution ($p \leq 0.01$)	0.7165	0.749	2.0343	4.8845
F-Test indicates unequal variances ($p = 7.58E-05$)	1260.1	47.468		
Hypothesis Test (1-tail, 0.05)				
Wilcoxon Two-Sample Test indicates significant differences				

Ten Day Amphipod Survival Test-Proportion Survived					
Start Date:	7/14/98	Test ID:	2079	Sample ID:	Z0F1
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:					
Conc-%	1	2	3	4	
Control	1.0000	1.0000	1.0000	1.0000	
100	1.0000	0.9500	0.8500	0.9000	

Transform: Arcsin Square Root										
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	1-Tailed Critical	MSD
Control	1.0000	1.0000	1.4594	1.4588	1.4615	0.093	4			
*100	0.9250	0.9250	1.3065	1.1731	1.4588	9.455	4	2.475	2.353	0.0090

Auxiliary Tests					Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)					0.9071	0.749	0.3665	2.0479
F-Test indicates unequal variances ($p = 4.48E-06$)					8305.8	47.468		
Hypothesis Test (1-tail, 0.05)								
Heteroscedastic t Test indicates significant differences								

Ten Day Amphipod Survival Test-Proportion Survived

Start Date:	7/14/98	Test ID:	2079	Sample ID:	Z0F1
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:	vs. Reference				

Conc-%	1	2	3	4
Reference	0.9000	0.9000	0.9000	0.9500
100	1.0000	0.9500	0.8500	0.9000

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root				N	t-Stat	1-Tailed	
			Mean	Min	Max	CV%			Critical	MSD
Reference	0.9125	1.0000	1.2731	1.2490	1.3453	3.780	4			
100	0.9250	1.0137	1.3065	1.1731	1.4588	9.455	4	-0.504	1.943	0.0085

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.9589	0.749	0.394	0.5093
F-Test indicates equal variances ($p = 0.16$)	6.5913	47.468		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates no significant differences				

Ten Day Amphipod Survival Test-Proportion Survived					
Start Date:	7/14/98	Test ID:	2081	Sample ID:	Z0FG
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:					
Conc-%	1	2	3	4	
Control	1.0000	1.0000	1.0000	1.0000	
100	0.9000	0.8500	0.9500	0.9000	

Transform: Arcsin Square Root								1-Tailed		
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Control	1.0000	1.0000	1.4594	1.4588	1.4615	0.093	4			
*100	0.9000	0.9000	1.2541	1.1731	1.3453	5.625	4	5.820	2.353	0.0029

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.7699	0.749	0.4361	3.5511
F-Test indicates unequal variances ($p = 2.41E-05$)	2707.9	47.468		
Hypothesis Test (1-tail, 0.05)				
Heteroscedastic t Test indicates significant differences				

Ten Day Amphipod Survival Test-Proportion Survived

Start Date:	7/14/98	Test ID:	2081	Sample ID:	Z0F6
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:	vs. Reference				

Conc-%	1	2	3	4
Reference	0.9000	0.9000	0.9000	0.9500
100	0.9000	0.8500	0.9500	0.9000

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root					t-Stat	1-Tailed	
			Mean	Min	Max	CV%	N		Critical	MSD
Reference	0.9125	1.0000	1.2731	1.2490	1.3453	3.780	4	0.445	1.943	0.0035
100	0.9000	0.9863	1.2541	1.1731	1.3453	5.625	4			

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.8837	0.749	0.6105	0.027
F-Test indicates equal variances ($p = 0.55$)	2.1489	47.468		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates no significant differences				

Ten Day Amphipod Survival Test-Proportion Survived					
Start Date:	7/14/98	Test ID:	2080	Sample ID:	Z2F1
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:					
Conc-%	1	2	3	4	
Control	1.0000	1.0000	1.0000	1.0000	
100	0.9500	0.8500	0.9500	1.0000	

		Transform: Arcsin Square Root							1-Tailed		
Conc-%		Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
HOME	Control	1.0000	1.0000	1.4594	1.4588	1.4615	0.093	4			
	100	0.9375	0.9375	1.3306	1.1731	1.4588	8.857	4	2.186	2.353	0.0082

Auxiliary Tests		Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)		0.7825	0.749	-0.7451	3.6661
F-Test indicates unequal variances ($p = 5.17E-06$)		7558.2	47.468		
Hypothesis Test (1-tail, 0.05)					
Heteroscedastic t Test indicates no significant differences					

Ten Day Amphipod Survival Test-Proportion Survived

Start Date: 7/14/98	Test ID: 2080	Sample ID: Z2F1	
End Date: 7/24/98	Lab ID: CAPER-Pacific Eco-Risk Lab	Sample Type: MS-Marine Sediment	
Sample Date:	Protocol: ASTM 87	Test Species: AM-Ampelisca abdita	
Comments: vs. Reference			

Conc-%	1	2	3	4
Reference	0.9000	0.9000	0.9000	0.9500
100	0.9500	0.8500	0.9500	1.0000

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root				N	1-Tailed		
	Mean	N-Mean	Mean	Min	Max	CV%		t-Stat	Critical	MSD
Reference	0.9125	1.0000	1.2731	1.2490	1.3453	3.780	4			
100	0.9375	1.0274	1.3306	1.1731	1.4588	8.857	4	-0.903	1.943	0.0079

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.9268	0.749	-0.4814	1.5946
F-Test indicates equal variances ($p = 0.18$)	5.998	47.468		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates no significant differences				

Ten Day Amphipod Survival Test-Proportion Survived					
Start Date:	7/14/98	Test ID:	2083	Sample ID:	Z3F1
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:					
Conc-%	1	2	3	4	
Control	1.0000	1.0000	1.0000	1.0000	
100	0.9500	0.9000	1.0000	0.9500	

		Transform: Arcsin Square Root							1-Tailed		
Conc-%		Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
H&M	Control	1.0000	1.0000	1.4594	1.4588	1.4615	0.093	4			
	*100	0.9500	0.9500	1.3496	1.2490	1.4588	6.354	4	2.561	2.353	0.0043

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.7606	0.749	0.3059	3.5239
F-Test indicates unequal variances ($p = 1.34E-05$)	4002.7	47.468		
Hypothesis Test (1-tail, 0.05)				
Heteroscedastic t Test indicates significant differences				

Ten Day Amphipod Survival Test-Proportion Survived					
Start Date:	7/14/98	Test ID:	2083	Sample ID:	Z071
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:	vs. Reference				
Conc-%	1	2	3	4	
Reference	0.9000	0.9000	0.9000	0.9500	
100	0.9500	0.9000	1.0000	0.9500	

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root					t-Stat	1-Tailed	
			Mean	Min	Max	CV%	N		Critical	MSD
Reference	0.9125	1.0000	1.2731	1.2490	1.3453	3.780	4			
100	0.9500	1.0411	1.3496	1.2490	1.4588	6.354	4	-1.556	1.943	0.0047

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.9037	0.749	0.4416	0.5371
F-Test indicates equal variances ($p = 0.37$)	3.1764	47.468		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates no significant differences				

Ten Day Amphipod Survival Test-Proportion Survived

Start Date:	7/14/98	Test ID:	2085	Sample ID:	Z3F2
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:					

Conc-%	1	2	3	4
Control	1.0000	1.0000	1.0000	1.0000
100	0.9500	0.8500	0.9000	0.9500

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root					t-Stat	1-Tailed	
			Mean	Min	Max	CV%	N		Critical	MSD
H&M&E Control	1.0000	1.0000	1.4594	1.4588	1.4615	0.093	4	4.343	2.353	0.0041
*100	0.9125	0.9125	1.2782	1.1731	1.3453	6.530	4			

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.8736	0.749	-0.6778	1.3754
F-Test indicates unequal variances ($p = 1.45E-05$)	3790.9	47.468		
Hypothesis Test (1-tail, 0.05)				
Heteroscedastic t Test indicates significant differences				

Ten Day Amphipod Survival Test-Proportion Survived					
Start Date:	7/14/98	Test ID:	2085	Sample ID:	Z3F2
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:	vs. Reference				
Conc-%	1	2	3	4	
Reference	0.9000	0.9000	0.9000	0.9500	
100	0.9500	0.8500	0.9000	0.9500	

Transform: Arcsin Square Root								1-Tailed		
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Reference	0.9125	1.0000	1.2731	1.2490	1.3453	3.780	4			
100	0.9125	1.0000	1.2782	1.1731	1.3453	6.530	4	-0.105	1.943	0.0045

Auxiliary Tests		Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)		0.8475	0.749	-0.1871	-0.7534
F-Test indicates equal variances ($p = 0.39$)		3.0084	47.468		
Hypothesis Test (1-tail, 0.05)					
Homoscedastic t Test indicates no significant differences					

Ten Day Amphipod Survival Test-Proportion Survived

Start Date: 7/14/98	Test ID: 2084	Sample ID: Z3R11	
End Date: 7/24/98	Lab ID: CAPER-Pacific Eco-Risk Lab	Sample Type: MS-Marine Sediment	
Sample Date:	Protocol: ASTM 87	Test Species: AM-Ampelisca abdita	
Comments:			

Conc-%	1	2	3	4
Control	1.0000	1.0000	1.0000	1.0000
100	1.0000	0.9000	0.9000	1.0000

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root				N	t-Stat	1-Tailed		MSD
			Mean	Min	Max	CV%			Critical		
Control	1.0000	1.0000	1.4594	1.4588	1.4615	0.093	4				
100	0.9500	0.9500	1.3539	1.2490	1.4588	8.943	4	1.743	2.353	0.0086	

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.8534	0.749	#####	-0.7011
F-Test indicates unequal variances ($p = 4.76E-06$)	7978.4	47.468		
Hypothesis Test (1-tail, 0.05)				
Heteroscedastic t Test indicates no significant differences				

Ten Day Amphipod Survival Test-Proportion Survived					
Start Date:	7/14/98	Test ID:	2084	Sample ID:	Z3R11
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:	vs. Reference				
Conc-%	1	2	3	4	
Reference	0.9000	0.9000	0.9000	0.9500	
100	1.0000	0.9000	0.9000	1.0000	

Transform: Arcsin Square Root								1-Tailed		
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Reference	0.9125	1.0000	1.2731	1.2490	1.3453	3.780	4			
100	0.9500	1.0411	1.3539	1.2490	1.4588	8.943	4	-1.240	1.943	0.0082

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.8663	0.749	0.1026	-1.5853
F-Test indicates equal variances ($p = 0.16$)	6.3315	47.468		
Hypothesis Test (1-tail, 0.05)				
Homoscedastic t Test indicates no significant differences				

Ten Day Amphipod Survival Test-Proportion Survived

Start Date: 7/14/98	Test ID: 2082	Sample ID: Z3R14	
End Date: 7/24/98	Lab ID: CAPER-Pacific Eco-Risk Lab	Sample Type: MS-Marine Sediment	
Sample Date:	Protocol: ASTM 87	Test Species: AM-Ampelisca abdita	
Comments:			

Conc-%	1	2	3	4
Control	1.0000	1.0000	1.0000	1.0000
100	0.9500	1.0000	0.9000	0.9500

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root					t-Stat	1-Tailed	
			Mean	Min	Max	CV%	N		Critical	MSD
H ₂ O ₂ Control	1.0000	1.0000	1.4594	1.4588	1.4615	0.093	4			
*100	0.9500	0.9500	1.3496	1.2490	1.4588	6.354	4	2.561	2.353	0.0043

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)	0.7606	0.749	0.3059	3.5239
F-Test indicates unequal variances ($p = 1.34E-05$)	4002.7	47.468		
Hypothesis Test (1-tail, 0.05)				
Heteroscedastic t Test indicates significant differences				

Ten Day Amphipod Survival Test-Proportion Survived

Start Date:	7/14/98	Test ID:	2082	Sample ID:	Z3R14
End Date:	7/24/98	Lab ID:	CAPER-Pacific Eco-Risk Lab	Sample Type:	MS-Marine Sediment
Sample Date:		Protocol:	ASTM 87	Test Species:	AM-Ampelisca abdita
Comments:	vs. Reference				

Conc-%	1	2	3	4
Reference	0.9000	0.9000	0.9000	0.9500
100	0.9500	1.0000	0.9000	0.9500

Conc-%	Mean	N-Mean	Transform: Arcsin Square Root					t-Stat	1-Tailed	
			Mean	Min	Max	CV%	N		Critical	MSD
Reference	0.9125	1.0000	1.2731	1.2490	1.3453	3.780	4			
100	0.9500	1.0411	1.3496	1.2490	1.4588	6.354	4	-1.556	1.943	0.0047

Auxiliary Tests

Shapiro-Wilk's Test indicates normal distribution ($p > 0.01$)
 F-Test indicates equal variances ($p = 0.37$)

Statistic

Critical

Skew

Kurt

0.9037

0.749

0.4416

0.5371

3.1764

47.468

Hypothesis Test (1-tail, 0.05)

Homoscedastic t Test indicates no significant differences

Appendix B

Test Data Sheets for the Toxicity Evaluation of Sediment Samples Collected from the Outer Cook Inlet and Shelikof Strait

(samples collected June 29-July 5, 1998)

10 Day Marine/Estuarine Sediment Toxicity Test Data

Date (Day 0) 7/14/98 Client AMS Project # 2079-2085, 2087
 Species A. abdita Organism Age/Size 3-5 mm Sample # NA

Date	Treatment Replicate	Sample I.D.: <u>Control</u>				Sample I.D.:				Sign-Off (Initials)
		pH	D.O.	Salinity	Temp.	pH	D.O.	Salinity	Temp.	
Day 0	Rep A	8.07	7.2	29.4	20.4					7-14-98 ke Time: 1730
	Rep B	7.99	6.8	29.7	20.4					
	Rep C	8.00	7.0	29.6	20.5					
	Rep D	8.08	7.0	29.5	20.5					
Day 1	Rep A	8.00 ^{DT}	7.3 ^{DT}	29.6 ^{DT}	20.6					7-15-98 DT
Day 2	Rep B	8.02	7.2	29.9	20.5					7-16-98 DT
Day 3	Rep C	8.08	6.9	30.2	20.7					7-16-98 ke
Day 4	Rep D	8.11	6.9	30.8	20.8					7-18-98 ke
Day 5	Rep A	8.17	7.6	29.2	20.5					7-19-98 DT
Day 6	Rep B	8.25	7.2	29.7	20.8					7-20-98 DT
Day 7	Rep C	8.20	7.8	30.2	20.6					7-21-98 DT
Day 8	Rep D	8.26	7.2	31.3	20.7					7-22-98 DT
Day 9	Rep A	8.31	6.3	30.1	20.5					7-23-98 ke/DT
Day 10	Rep A	8.45	7.4	30.4	20.5					7-24-98 Int/ke Time: 1600 am
	Rep B	8.53	7.4	30.7	20.5					
	Rep C	8.52	7.4	31.1	20.5					
	Rep D	8.52	7.4	32.1	20.5					
# of live organisms at end of test (Day 10)		Rep A	Rep B	Rep C	Rep D	Rep A	Rep B	Rep C	Rep D	
		20	21 [#]	20	20					

21[#] 7/24/98

10 Day Marine/Estuarine Sediment Toxicity Test Data

Date (Day 0) 7/14/98 Client AMS Project # 2084/2080
 Species A. abdita Organism Age/Size 3-5 mm Mature Sample # 7331^K729
0/9

Date	Treatment Replicate	Sample I.D.: <u>E3R11</u>				Sample I.D.: <u>E2F1</u>				Sign-Off (Initials)
		pH	D.O.	Salinity	Temp.	pH	D.O.	Salinity	Temp.	
Day 0	Rep A	8.12	7.4	29.8	20.5	8.13	7.5	29.7	20.5	7-14-98 ke Time:
	Rep B	8.10	7.2	30.1	20.5	8.12	7.4	29.8	20.5	
	Rep C	8.11	7.2	29.9	20.5	8.12	7.4	30.0	20.5	
	Rep D	8.13	7.2	29.6	20.5	8.14	7.3	29.6	20.5	
Day 1	Rep A	8.02	7.4	30.2	^{20.6 DT} 20.5	8.02	7.1	30.1	20.5	7-15-98 DT
Day 2	Rep B	7.92	7.1	30.7	20.5	7.94	7.3	30.7	20.5	7-16-98 DT
Day 3	Rep C	7.98	6.9	31.1	20.7	7.96	7.0	31.5	20.7	7-17-98 ke
Day 4	Rep D	8.05	7.3	31.7	20.8	8.09	7.1	32.1	20.8	7-18-98 ke
Day 5	Rep A	8.11	7.8	29.3	20.6	8.11	7.7	28.7	20.5	7-19-98 DT
Day 6	Rep B	8.05	7.0	29.5	20.8	8.22	7.2	29.3	20.8	7-20-98 DT
Day 7	Rep C	8.09	8.0	29.8	20.7	8.26	8.0	30.6	20.6	7-21-98 DT
Day 8	Rep D	8.12	7.5	30.8	20.4	8.22	7.5	31.1	20.7	7-22-98 DT
Day 9	Rep A	8.05	6.3	30.2	^{20.6} 20.5	8.13	6.4	29.5	20.1	7-23-98 DT
Day 10	Rep A	8.19	7.3	30.3	20.2	8.24	7.1	29.7	20.4	7-24-98 ke (10) Time: 3:00 P.M.
	Rep B	8.18	7.3	30.7	20.3	8.28	7.2	30.1	20.5	
	Rep C	8.19	7.3	30.4	20.4	8.31	7.3	31.3	20.5	
	Rep D	8.18	7.2	31.6	20.4	8.28	7.2	31.9	20.4	
# of live organisms at end of test (Day 10)		Rep A	Rep B	Rep C	Rep D	Rep A	Rep B	Rep C	Rep D	
		20	14	18	20	19	17	19	20	

10 Day Marine/Estuarine Sediment Toxicity Test Data

Date (Day 0) 7/14/98 Client AMS Project # 2083/2082Species A. abdita Organism Age/Size No Mixture Sample # 732/731

Date	Treatment Replicate	Sample I.D.: Z3F1				Sample I.D.: Z3R14				Sign-Off (Initials)
		pH	D.O.	Salinity	Temp.	pH	D.O.	Salinity	Temp.	
Day 0	Rep A	8.12	7.4	29.8	20.5	8.12	7.2	29.9	20.5	7-14-98 W Time:
	Rep B	8.10	7.4	29.6	20.5	8.12	7.2	29.8	20.5	
	Rep C	8.11	7.3	29.8	20.5	8.14	7.2	29.8	20.5	
	Rep D	8.12	7.3	29.6	20.5	8.14	7.2	29.9	20.5	
Day 1	Rep A	8.01	7.0	30.2	20.6	8.00	7.2	30.2	20.6	7-15-98 DT
Day 2	Rep B	7.94	7.3	30.5	20.5	7.97	7.4	30.7	20.5	7-16-98 DT
Day 3	Rep C	7.96	6.9	31.2	20.7	7.88	6.7	31.4	20.7	7-17-98 ke
Day 4	Rep D	8.11	7.1	32.2	20.8	7.99	6.9	32.3	20.8	7-18-98 ke
Day 5	Rep A	8.12	7.6	30.7	20.5	8.01	7.4	29.3	20.6	7-19-98 DT
Day 6	Rep B	8.14	7.1	29.7	20.8	8.14	7.1	29.8	20.8	7-20-98 DT
Day 7	Rep C	8.13	7.8	30.2	20.6	7.99	7.8	31.0	20.6	7-21-98 DT
Day 8	Rep D	8.14	7.4	31.7	20.8	8.08	7.4	31.4	20.8	7-22-98 DT
Day 9	Rep A	8.15	6.4	31.4	20.1	8.08	6.3	30.3	20.1	7-23-98 W/DT
Day 10	Rep A	8.26	7.4	31.6	20.5	8.23	7.3	30.6	20.5	7-24-98 W Time:
	Rep B	8.06	7.6	30.6	20.5	8.20	7.2	30.8	20.5	
	Rep C	8.29	7.1	30.9	20.5	8.19	7.2	31.9	20.4	
	Rep D	8.24	7.2	32.5	20.4	8.12	7.1	32.2	20.4	
# of live organisms at end of test (Day 10)		Rep A	Rep B	Rep C	Rep D	Rep A	Rep B	Rep C	Rep D	2:30 W
		19	18	20	19	19	20	18	19	

10 Day Marine/Estuarine Sediment Toxicity Test Data

Date (Day 0) 7/14/98 Client AMS Project # 2081/2087
 Species A. abdita Organism Age/Size No. 3.5 mm Sample # 730/736
278

Date	Treatment Replicate	Sample I.D.:				Sample I.D.:				Sign-Off (Initials)
		ZOF6				Ref				
		pH	D.O.	Salinity	Temp.	pH	D.O.	Salinity	Temp.	
Day 0	Rep A	8.15	7.4	29.6	20.6	8.08	7.1	29.6	20.5	7-14-98 KE Time:
	Rep B	8.16	7.3	29.6	20.5	8.09	7.1	29.6	20.5	
	Rep C	8.15	7.3	29.6	20.4	8.06	7.1	29.9	20.5	
	Rep D	8.15	7.3	29.6 ⁸	20.4	8.09	7.1	29.4	20.5	
Day 1	Rep A	8.06	7.4	30.0	20.6	8.02	7.4	30.1	20.6	7-15-98 DT
Day 2	Rep B	8.01	7.2	30.3	20.5	7.96	7.3	30.2	20.5	7-16-98 DT
Day 3	Rep C	7.91	6.5	30.7	20.7	7.88	6.8	31.1	20.6	7-17-98
Day 4	Rep D	8.14	7.1	32.1	20.8	8.09	7.1	31.9	20.8	7-18-98 KE
Day 5	Rep A	8.20	7.7	29.9	20.5	8.13	7.4	30.1	20.5	7-19-98 DT
Day 6	Rep B	8.34	7.4	29.5	20.8	8.13	7.2	29.7	20.8	7-20-98 DT
Day 7	Rep C	8.45	8.0	29.9	20.6	7.97	7.9	30.4	20.6	7-21-98 DT
Day 8	Rep D	8.31	7.3	31.1	20.6	8.11	7.4	32.3	20.6	7-22-98 DT
Day 9	Rep A	8.17	6.3	31.2	20.5	8.05	6.2	31.3	20.5	7-23-98 DT
Day 10	Rep A	8.33	7.4	31.6	20.4	8.23	7.4	31.6	20.4	7-24-98 KE Time:
	Rep B	8.40	7.4	30.7	20.5	8.18	7.5	30.6	20.5	
	Rep C	8.53	7.5	30.7	20.5	8.14	7.3	31.1	20.5	
	Rep D	8.42	7.5	32.0	20.4	8.07	6.9	33.2	20.5	
# of live organisms at end of test (Day 10)		Rep A	Rep B	Rep C	Rep D	Rep A	Rep B	Rep C	Rep D	1000 ^{KE} am 1100
		18	17	19	18	18	18	18	19	

Appendix C

QA/QC Summary

METHODS QA/QC SUMMARY

The methods used in conducting these tests followed the guidelines established by the EPA manual "Methods for measuring the toxicity of sediment-associated contaminants with estuarine and marine amphipods" (EPA-600/R-94/025, U.S. EPA, Env. Research Laboratory, Narragansett, RI). The following methodological QA/QC criteria were met at test initiation and validate the results obtained:

- Adult organisms, 3-5 mm and no mature males or females) were used at test initiation; all organisms were from the same source.
- Tests were started two weeks after collection of the first sediment sample, which is within the recommended sample holding time.
- Test chambers were identical and contained the same amount of sediment and overlying water.
- All instruments used for routine measurements of chemical and physical characteristics were calibrated each day according to the instrument manufacturer's instructions.

RESULTS QA/QC SUMMARY

The following required QA/QC criteria were met during the performance of these tests and validate the results obtained:

- The percentage survival of amphipods in both of the control sediments was greater than the acceptability criteria of 90%.
- Water quality conditions in the overlying water were all within the tolerance limits of the test species.
- The time-weighted average of daily temperature readings was within $\pm 1^{\circ}\text{C}$ of the desired temperature and the instantaneous temperature was always within $\pm 3^{\circ}\text{C}$ of the desired temperature.
- Data used in statistical analyses and reported in Table 1 of the toxicity test report were independently reviewed and 'signed-off on' for accuracy.

Table A3. Overlying Water Total Ammonia Concentrations for the Test Sediments.		
Sediment Site	Total Ammonia (mg/L NH ₃ -N)	
	Day 2	Day 8
'Home' Sediment Control	2.32	< 0.10
'Reference' Sediment Control	0.54	1.75
Z0F1	0.51	< 0.10
Z0F6	0.33	< 0.10
Z2F1	0.35	< 0.10
Z3F1	0.40	< 0.10
Z3F2	0.14	< 0.10
Z3R11	0.19	< 0.10
Z3R14	0.17	< 0.10