CHEMICAL AND BIOLOGICAL MEASURES OF
SEDIMENT QUALITY AND TISSUE BIOACCUMULATION
IN THE NORTH COAST REGION
FINAL REPORT

October, 1998

California State Water Resources Control Board

California Regional Water Quality Control Board, North Coast Region

California Department of Fish and Game
Marine Pollution Studies Laboratory

Moss Landing Marine Laboratories

University of California, Santa Cruz
Table 15. Station summary of chemistry, toxicity and benthic community results (** not used in station evaluations due to water quality exceedances, SV= screening values, see text for complete descriptions).

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station</th>
<th>Sediment Chemistry Exceed.</th>
<th>Tissue Chemistry Tox</th>
<th>Repeat Single Tox</th>
<th>Tox Benthics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10028.0</td>
<td>PORTO BODEGA MARINA</td>
<td>ERMQ=0.35, 3 PEI exceedances</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Limpets in top 95% of the state</td>
</tr>
<tr>
<td>14001.0</td>
<td>EUREKA WATERFRONT- II STREET</td>
<td>ERMQ=0.243, PEI=0.528</td>
<td>X</td>
<td>&gt;EPA SV for PCBs &amp; MW value for CU</td>
<td>Undegraded</td>
<td>LMW PAHs in top 95% of the state</td>
</tr>
<tr>
<td>14001.0</td>
<td>EUREKA WATERFRONT J STREET</td>
<td>PEI exceedances</td>
<td>X</td>
<td>&gt;EPA SV for PAHs &amp; MW values for CU &amp; Hg</td>
<td>Undegraded</td>
<td>LMW PAHs in top 95% of the state</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station</th>
<th>Sediment Chemistry Exceed.</th>
<th>Tissue Chemistry Tox</th>
<th>Repeat Single Tox</th>
<th>Tox Benthics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10001.0</td>
<td>H. BAY-COAL/OIL/GAS PLANT</td>
<td>PEI=0.482</td>
<td>X</td>
<td>Undegraded</td>
<td>Limpets in top 90% of the state</td>
<td></td>
</tr>
<tr>
<td>10007.0</td>
<td>BODEGA-SPUD POINT MARINA</td>
<td>Transiitional Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10007.0</td>
<td>BODEGA-SPUD POINT MARINA</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10017.0</td>
<td>ARCATA BAY-EUREKA SL.</td>
<td>Transition</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10023.0</td>
<td>H. BAY EUREKA STORM 23</td>
<td>Undegraded</td>
<td>X</td>
<td>Undegraded</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10040.0</td>
<td>UNCONTAMINATED SITE-33D</td>
<td>Transition</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10016.0</td>
<td>ARCATA BAY-JOLLY GIANT SL.</td>
<td>Transition</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10018.0</td>
<td>H. BAY-UNION OIL PLANT</td>
<td>Undegraded</td>
<td>X</td>
<td>Undegraded</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10021.0</td>
<td>H. BAY-CHEVRON TERMINAL</td>
<td>Undegraded</td>
<td>X</td>
<td>Undegraded</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>14004.0</td>
<td>DAVENPORT MARINE</td>
<td>Undegraded</td>
<td>X</td>
<td>Undegraded</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
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<tr>
<td>14006.0</td>
<td>H. BAY-JAHLBERK SHORELINE</td>
<td>Undegraded</td>
<td>X</td>
<td>Undegraded</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station</th>
<th>Sediment Chemistry Exceed.</th>
<th>Tissue Chemistry Tox</th>
<th>Repeat Single Tox</th>
<th>Tox Benthics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10004.0</td>
<td>ARCATA BAY-MCDANIEL SL.</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10020.0</td>
<td>H. BAY-OLD PAC. LUMBER SITE</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10032.0</td>
<td>MOUTH OF ESTERO DE SAN ANTONIO</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station</th>
<th>Sediment Chemistry Exceed.</th>
<th>Tissue Chemistry Tox</th>
<th>Repeat Single Tox</th>
<th>Tox Benthics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10030.0</td>
<td>ESTERO AMERICANO-VALLY FORD</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10030.0</td>
<td>ESTERO DE SAN ANTONIO-VALLY F</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10039.0</td>
<td>UNCONTAMINATED SITE-33C</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10041.0</td>
<td>SALMON CREEK-34L</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station</th>
<th>Sediment Chemistry Exceed.</th>
<th>Tissue Chemistry Tox</th>
<th>Repeat Single Tox</th>
<th>Tox Benthics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10005.0</td>
<td>RUSSIAN RIVER MOUTH SWM 280.0</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10015.0</td>
<td>ARCATA BAY-MAD RIVER SL.</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10024.0</td>
<td>H. BAY FIELDS LANDING</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10031.0</td>
<td>MOUTH OF ESTERO AMERICANO</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
<tr>
<td>10036.0</td>
<td>SOUTHPORT CHANNEL-33B</td>
<td>Toxic</td>
<td>X</td>
<td>X</td>
<td>Undegraded</td>
<td>Toxic in both amphipod and SDI tests</td>
</tr>
</tbody>
</table>
Table 14. Sample summary of toxicity, sediment chemistry exceedances, benthic indices results. Only those bioassay protocols which showed toxicity are listed. Complete results are listed in the appendices (shaded survival indicates samples which were toxic; n/a indicates no chemical analyses).

<table>
<thead>
<tr>
<th>Station number</th>
<th>Station</th>
<th>Date</th>
<th>% B. survival</th>
<th>S. toxicity</th>
<th>M. edulis*</th>
<th>ERV or PEL</th>
<th>Benthic indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>100040</td>
<td>ARCATA BAY-SAN JUAN SL</td>
<td>11/20/92</td>
<td>0.58</td>
<td>36</td>
<td>66</td>
<td>CY, N</td>
<td>0.112</td>
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<tr>
<td>100050</td>
<td>RUSSIAN RIVER SOUTHWEST 2000</td>
<td>2/25/93</td>
<td>48.0</td>
<td>0.99</td>
<td>92</td>
<td>NT (0.009)</td>
<td>n/a</td>
</tr>
<tr>
<td>100060</td>
<td>BODGDA BAY-MASON'S MARINA</td>
<td>6/14/94</td>
<td>97.7</td>
<td>3.44</td>
<td>51</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100070</td>
<td>BODGDA BAY-MASON'S MARINA REP1</td>
<td>6/14/94</td>
<td>94.1</td>
<td>3.50</td>
<td>52</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100080</td>
<td>BODGDA BAY-MASON'S MARINA REP2</td>
<td>6/14/94</td>
<td>98.5</td>
<td>3.58</td>
<td>75</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100090</td>
<td>BODGDA BAY-MASON'S MARINA</td>
<td>12/6/94</td>
<td>3.34</td>
<td>57</td>
<td>NT</td>
<td>Ni</td>
<td>0.165</td>
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<tr>
<td>100100</td>
<td>BODGDA BAY-SPOON POINT MARINA</td>
<td>2/25/93</td>
<td>27.0</td>
<td>1.00</td>
<td>89</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>100110</td>
<td>BODGDA BAY-SPOON POINT MARINA REP1</td>
<td>6/13/94</td>
<td>19.8</td>
<td>0.43</td>
<td>86</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100120</td>
<td>BODGDA BAY-SPOON POINT MARINA REP2</td>
<td>6/13/94</td>
<td>17.3</td>
<td>0.48</td>
<td>75</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100130</td>
<td>BODGDA BAY-SPOON POINT MARINA</td>
<td>6/13/94</td>
<td>15.2</td>
<td>0.35</td>
<td>91</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100140</td>
<td>BODGDA BAY-SPOON POINT MARINA</td>
<td>12/3/96</td>
<td>16.7</td>
<td>0.64</td>
<td>56</td>
<td>T</td>
<td>Cr</td>
</tr>
<tr>
<td>100150</td>
<td>ARCATA BAY-MAD RIVER SL</td>
<td>11/20/92</td>
<td>60.0</td>
<td>0.65</td>
<td>81</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100160</td>
<td>ARCATA BAY-DILLY GRANT SL</td>
<td>11/20/92</td>
<td>61.0</td>
<td>0.75</td>
<td>78</td>
<td>Cr, Ni</td>
<td>0.157</td>
</tr>
<tr>
<td>100170</td>
<td>ARCATA BAY-EUREKA SL</td>
<td>4/18/96</td>
<td>79.5</td>
<td>2.68</td>
<td>89</td>
<td>Cr, Ni</td>
<td>0.127</td>
</tr>
<tr>
<td>100180</td>
<td>H BAY-UNION OIL PLANT</td>
<td>6/24/96</td>
<td>21.4</td>
<td>1.17</td>
<td>81</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100190</td>
<td>H BAY-CAL-UGAS PLANT</td>
<td>11/29/92</td>
<td>72.0</td>
<td>0.65</td>
<td>82</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>100200</td>
<td>H BAY-CAL-CAS PLANT</td>
<td>4/17/96</td>
<td>43.1</td>
<td>0.53</td>
<td>94</td>
<td>Cr, Ni, MNP2</td>
<td>0.143</td>
</tr>
<tr>
<td>100210</td>
<td>H BAY-OLD PAL. LUMBER SITE</td>
<td>11/29/92</td>
<td>93.0</td>
<td>0.70</td>
<td>30</td>
<td>CY, Ni</td>
<td>0.181</td>
</tr>
<tr>
<td>100220</td>
<td>H BAY-OLD PAL. LUMBER SITE</td>
<td>2/15/95</td>
<td>93.0</td>
<td>0.70</td>
<td>30</td>
<td>Cr, Ni, MNP2</td>
<td>0.177</td>
</tr>
<tr>
<td>100230</td>
<td>H BAY-CHEVRON TERMINAL</td>
<td>11/29/92</td>
<td>93.0</td>
<td>0.70</td>
<td>3</td>
<td>Cr, Ni</td>
<td>0.114</td>
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<tr>
<td>100240</td>
<td>H BAY-CHEVRON TERMINAL</td>
<td>4/17/96</td>
<td>79.9</td>
<td>1.18</td>
<td>86</td>
<td>Cr, Ni, MNP2</td>
<td>0.122</td>
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<tr>
<td>100250</td>
<td>H BAY-HABKSTON SL</td>
<td>11/29/92</td>
<td>93.0</td>
<td>0.70</td>
<td>80</td>
<td>Cr, Ni</td>
<td>0.077</td>
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</tbody>
</table>

* (interstitial seawater ammonia values for M. edulis (mg/L))
IV. CONCLUSIONS

Sediment quality guideline values were used for comparison with chemical concentrations found within the North Coast Region. Chromium, nickel, PAHs, and lindane were found most often to exceed ERM or PEL guideline values. Due to relatively low chemical concentrations within the region, ERL and TEL guideline values also were used to provide a more relevant comparison to the chemical composition of the North Coast Region. Copper, mercury, and zinc were found most often to exceed ERL and TEL guideline values. Although ERL and TEL values are considerably lower than ERM and PEL guidelines, multiple exceedances of ERL and TEL guidelines may indicate possible impacts on the relatively pristine environment of the North Coast Region.

The upper 90th percentiles, for sediment quotient ranges, for the North Coast Region were ERMQ>0.201 and PELQ>0.422. These values are significantly lower than other summary quotient values calculated for the state (i.e., San Diego 90th percentile ERMQ>0.85 and PELQ>1.29). Nevertheless, this is to be expected because the North Coast is not as heavily populated or industrialized as much of California. It should be noted that lower summary quotient values should not be used to infer that chemical pollution does not exist at discrete stations within the region. It should be noted that in contrast to the mitigation approach employed in more urban/industrial coastal regions, prevention and prohibition are the primary approaches employed in the protection of the relatively unpolluted coastal resources of California's North Coast. Therefore, any anthropogenic pollution is of great concern.

Tissue samples were collected from 10 stations and were analyzed for a variety of chemicals. Samples included both resident and transplanted mussels, oysters, crabs and polychaete worms. When applicable, relevant SMWP data were reviewed for chemical contamination and provided supplemental information about stations. In general, measured tissue concentrations of organic contaminants, such as pesticides, BTEX and TPH, were below detection limits, indicating relatively low levels of tissue contamination in the North Coast Region. However, some trace metals were detected in patterns similar to those found in sediments. Metals that were detected in both sediments and tissues included chromium, nickel, copper, and mercury.

Toxicity within the region was examined using a variety of bioassays. Twenty-nine of 31 stations sampled were tested using solid phase amphipod survival tests. Of these stations, 9 were toxic at least once using either *Eohaustorius* or *Rhepoxynius*; amphipod survival ranged from 38-99%. Stations shown to be toxic were scattered along the northern section of the Eureka waterfront, at the northern most station in Arcata Bay, and at the three marinas in Bodega Bay. All samples that were toxic, and had synoptic chemical analysis performed on them, had at least one ERM or PEL exceedance and at least 3 ERL or TEL exceedances. However, multiple regression analysis of data from throughout the region showed no significant relationships between amphipod toxicity and chemical concentrations.
Benthic community structure within the North Coast Region was analyzed using a Relative Benthic Index. The low and high ranges of the index indicate the relative "health" of a station compared to other stations within the data set and was used to classify stations as degraded, transitional and undegraded. The RBI for the North Coast ranged between 0.4 and 0.9 and none were classified as degraded. Nine stations were classified as having transitional benthic communities. These stations were scattered throughout the study area, particularly in Bodega Bay. The three undegraded stations were located on the central portion of the Eureka Waterfront. Due to the relatively low pollution levels in this region, and the small benthic community sample, size specific patterns or relationship between sediment chemistry and RBI values were not found.

Five stations, Porto Bodega Marina, Mason's Marina, H Street, J Street, and Humboldt Bay Coal, Gas and Oil Plant were distinguished as stations of concern or interest for the region. These stations exhibited greater level impacts of toxicity, greater chemical concentrations, or biological impacts compared to the remaining 31 stations analyzed in the region, and correspond with issues of regional concern.