The stream surveys conducted in late June 2005 are not sufficient in themselves to determine if salmonids in the *Selendang Ayu* spill area were injured, or not, by the oil that washed into the freshwater streams in early December 2004. The necessary comparative data from previous years combined with other sites to determine if the coho salmon and Dolly Varden char observed in these streams were at reduced or unimpacted densities are not available. Pink salmon juveniles probably would have migrated to sea before June 2005, especially because the winter of 2004-2005 was reported as unusually warm, which would have accelerated time to hatching and alevin development, so there may have been some mortality to juvenile pink salmon that would not be observed during the June 2005 survey. It is possible that fish in the oiled streams could have suffered sub-lethal adverse effects, such as impaired development, growth, reproduction, long-term survival, or site-return from exposure to non-lethal concentrations of oil.

**Determination**

The observations made during the winter and June surveys, together with information coming from the Unified Command, are sufficient to make the determination that some level of injury did occur to at least some of the resources and habitats examined in the intertidal, subtidal and anadromous stream surveys as a result of the *Selendang Ayu* oil spill, including from the clean-up operations that took place following the spill. The most evident injuries are those caused by the response - removal of oiled sediments or burning of wrack from the shoreline with its associated fauna - and those to habitats, such as the oiled vegetation and heavily oiled shoreline of some salmonid streams. Some of the impacts to algal species in and around those being actively cleaned during the June 2005 survey may have resulted from remobilized oil. These impacts could have continued throughout the clean-up operations in the rest of the summer. At Spray Cape, there appears to have been a lack of herbivores, possibly a result of the spill, and resulting bloom of ephemeral green algae. There were also observations of dead eulachon, which could potentially be a result of exposure to oil from the *Selendang Ayu*.

Much of the most apparent and likely injury appears to be the result of response actions taken during warmer weather at some of the most heavily oiled areas. Biota in these areas and those nearby were exposed to remobilized oil, and some injury is likely to have resulted from that exposure- such as the apparent oil-related injuries to some algal species. While not observable in our surveys, there is also likely to have been sub-lethal effects to some biota within the areas most affected by the spill. However, the magnitude of likely injury resulting from the *Selendang Ayu* incident is relatively moderate, except perhaps at the most heavily oiled areas and those in the vicinity of oil remobilized during the cleanup operations in the spring and summer of 2005. The total length of shoreline where oil was observed to be present is approximately twenty miles, so some degree of injury to these habitats and biota likely occurred over a large area. The observations made during the winter and June surveys, together with information obtained from the response efforts, and what can be reasonably inferred from experience with the effects of similarly-sized spills in similar environments and the scientific literature indicate that an as yet undetermined amount of restoration will be needed to address the injury to natural resources and services in the intertidal, subtidal, and anadromous stream habitats.

Contact John Kern at john.kern@noaa.gov for more information

**Figure 1. SCAT survey map showing most of the area surveyed in the studies described in this report.** Chernofski Harbor is about 20 km southwest of “ALM” (Alimuda Bay) at lower left.



**Figure 2. Detailed map of SCAT segments (1 of 6)**



**Figure 2. Detailed map of SCAT segments (2 of 6)**



**Figure 2. Detailed map of SCAT segments (3 of 6)**



**Figure 2. Detailed map of SCAT segments (4 of 6)**



**Figure 2. Detailed map of SCAT segments (5 of 6)**



**Figure 2. Detailed map of SCAT segments (6 of 6)**



**Table 1**. *Selendang Ayu* oil spill segments surveyed in June 2005.

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Segment** | **Date** | **Segment** |
| 6/2/2005 | ALM 8 | 6/9/052 | UDE3 |
|  | ALM 7 |  | UDE1 |
|  | ALM 6 |  | VLC9 |
|  | ALM10 |  | VLC10 |
|  | CFS 19 |  |  |
|  | CFS 20 | 6/19/2005 | SKN 3 |
| 6/3/2005 | KMK 30 |  | SKN 4 |
|  | PMS 7 |  | SKN 7 |
|  | PMS 10 |  | SKN 6 |
| 6/4/2005 | SPR 11 |  | PMS 16 |
|  | SPR12 | 6/20/2005 | HMP 12 |
|  | SKS 4 |  | HMP 9 |
|  | SKS 6 |  | PTN 3 |
| 6/5/2005 | CNB9 |  | PTS 11 |
|  | CNB10 | 6/21/2005 | MKS 4 |
|  | PTN2 |  | MKS 5 |
|  | PTN3 |  | MKS 6 |
| 6/6/2005 | HMP7 |  | SPR 2 |
|  | HMP6 |  | SPR 3 |
|  | HMP10 |  | UDW 1 |
|  | HMP11 | 6/22/2005 | SKN 14 |
|  | HMP5 |  | SKN 10 |
| 6/7/2005 | SKN8 |  | SKN 11 |
|  | SKN9 |  | SKN 7 |
|  | SKN11 |  | PMS 20 |
|  | SKN12 | 6/23/2005 | HMP 11 |
|  | SKN14 |  | HMP 13 |
|  | SKN15 |  |  |
| 6/8/2005 | SKS 18 |  |  |
|  | SKS 14 |  |  |
|  | SKS 15 |  |  |
|  | SKS 16 |  |  |
|  | SKS 17 |  |  |

**Table 2.** Examples of mature perennial biota found on rocky shores in the spill area, June 2005.

|  |  |
| --- | --- |
| **Invertebrates** | **Common name category** |
| *Henricia* | starfish |
| *Katharina* | chiton |
| *Littorina* *sitkana* | snail |
| *Lottia digitalis* | limpet |
| *Lottia pelta* | limpet |
| *Nucella emarginata* | snail |
| *Calliostoma ligatum.* | snail |
| *Balanus glandula* | barnacle |
| *Semibalanus cariosus* | barnacle |
| *Mytilus trossulus* | mussel |
|  |  |
| **Marine algae** |  |
| *Laminaria* | kelp |
| *Alaria* | kelp |
| *Cymathere* | kelp |
| *Fucus* | rockweed |
| *Hedophyllum* | kelp |
| *Neorhodomela larix* | red alga |
| *Petrocelis* | tar-spot alga |
| *Agarum (or* possibly *Thalassiophyllum)* | kelp |
| The individuals of these species were large enough that they were probably present in the spill area before 8 December 2004, when the *Selendang Ayu* wrecked at Spray Cape. | |

**Table 3.** Summary of clean up methods by segment. Segments in bold type were locations not treated due to safety concerns. Does not include segments which had no observable oil (NOO) in winter (2004-2005) and which had a No Further Treatment (NFT) recommendation in spring (2005). When more than one oiling category is used for a segment, the highest was put in this table.

| **SEGMENT NAME** | **WINTER OILING CAT.** | **SPRING OILING CAT.** | **SPRING**  **CLEAN-UP?** | **MANUAL CLEAN-UP** | **MECH. REMOVAL** | **MECH. TILL** | **BERM RELOC-ATION** | **OPEN BURN** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ALM03 | NOO | MODERATE | YES | X |  |  |  |  |
| ALM09 | NOO | MODERATE |  |  |  |  |  |  |
| AND01 | LIGHT | LIGHT | NFT |  |  |  |  |  |
| AND06 | LIGHT | LIGHT | YES | X |  |  |  |  |
| AND07 | NOO | HEAVY | NFT |  |  |  |  |  |
| AND08 | NOO | HEAVY | YES | X |  |  |  |  |
| ASP07 | NOO | LIGHT | YES | X |  |  |  |  |
| ASP14 | NOO | MODERATE | YES | X |  |  |  |  |
| ASP15 | NOO | LIGHT | YES | X |  |  |  |  |
| ASP16 | NOO | LIGHT | YES | X |  |  |  |  |
| BCK07 | NOO | HEAVY | YES | X |  |  |  |  |
| BCK09 | HEAVY | MODERATE | YES | X |  |  |  |  |
| BCK11 |  | HEAVY | YES | X |  |  |  |  |
| CBE21 | HEAVY | NOO | NFT |  |  |  |  |  |
| CNB01 | NOO | MODERATE | YES | X |  |  |  |  |
| CNB10 | NOO | LIGHT | YES | X |  |  |  |  |
| CNB11 | NOO | LIGHT | YES | X |  |  |  |  |
| CNB14 | NOO | LIGHT | YES | X |  |  |  |  |
| CNB15 | NOO | LIGHT | YES | X |  |  |  |  |
| CNB17 | NOO | MODERATE | YES | X |  |  |  |  |
| CNB19 | MODERATE | LIGHT | NFT |  |  |  |  |  |
| CNB20 | MODERATE | HEAVY | YES | X |  |  |  |  |
| CNB21 | HEAVY | HEAVY | YES | X |  |  |  |  |
| HMP02 | NOO | HEAVY | YES |  |  |  |  |  |
| HMP03 | NOO | HEAVY | YES |  |  |  |  |  |
| HMP05 | HEAVY | HEAVY | YES | X |  |  |  |  |
| HMP06 | HEAVY | HEAVY | YES | X |  |  |  |  |
| HMP07 | HEAVY | HEAVY | YES | X | X | X |  |  |
| HMP08 | HEAVY | LIGHT | YES | X |  |  |  |  |
| HMP10 | HEAVY | HEAVY | YES | X |  |  |  |  |
| HMP11 | HEAVY | HEAVY | YES | X | X | X |  | X |
| HMP12 | HEAVY | HEAVY | YES | X | X | X | X |  |
| HMP13 | HEAVY | HEAVY | YES | X |  |  |  |  |
| KFP01 | NOO | HEAVY | YES | X |  |  |  |  |
| KFP02 | NOO | HEAVY | YES | X |  |  |  |  |
| KFP03 | NOO | HEAVY | YES | X |  |  |  |  |
| KFP04 | NOO | VERY LIGHT | X | X |  |  |  |  |
| KFP05 | LIGHT | VERY LIGHT | NFT |  |  |  |  |  |
| KFP07 | LIGHT | VERY LIGHT | NFT |  |  |  |  |  |
| KFP08 | NOO | HEAVY | YES | X |  |  |  | X |
| KFP09 | MODERATE | HEAVY | YES | X |  |  |  |  |
| KFP10 | NOO | HEAVY | YES | X |  |  |  |  |
| KMK02 | NOO | HEAVY | YES | X |  |  |  |  |
| KMK06 | MODERATE | MODERATE |  |  |  |  |  |  |
| KMK07 | MODERATE | HEAVY | YES | X |  | X |  |  |
| KMK08 | HEAVY | NOO | NO |  |  |  |  |  |
| KMK09 | HEAVY | HEAVY | YES | X |  |  |  |  |
| KMK11 | HEAVY | LIGHT | YES | X |  |  |  |  |
| KMK15 | NOO | LIGHT | YES | X |  |  |  |  |
| KMK26 | NOO | HEAVY | YES | X |  |  |  |  |
| KMK27 | MODERATE | HEAVY | YES | X |  |  |  |  |
| KMK28 | HEAVY | HEAVY | YES | X |  |  |  |  |
| KMK29 | HEAVY | LIGHT | NFT |  |  |  |  |  |
| KMK30 | HEAVY | HEAVY | YES | X |  |  |  |  |
| KMK32 | NOO | MODERATE | YES | X |  |  |  |  |
| KSB01 | NOO | MODERATE | YES | X |  |  |  |  |
| KSB02 | MODERATE | HEAVY | YES | X |  |  |  |  |
| KSB03 | NOO | HEAVY | YES | X |  |  |  |  |
| KSB08 | MODERATE | MODERATE | YES | X |  |  |  |  |
| KSB10 | HEAVY | MODERATE | YES | X |  |  |  |  |
| KSB15 | NOO | LIGHT | YES | X |  |  |  |  |
| KTS19 |  | LIGHT | YES | X |  |  |  |  |
| MKS01 | HEAVY | HEAVY | YES | X | X | X |  | X |
| MKS02 | HEAVY | HEAVY | YES | X | X | X |  |  |
| MKS03 | HEAVY | LIGHT | YES | X |  |  |  |  |
| MKS04 | HEAVY | NOO | NFT |  |  |  |  |  |
| MKS05 | HEAVY | HEAVY | YES | X |  |  |  |  |
| MKS06 | HEAVY | HEAVY | YES | X |  |  |  |  |
| MKS07 | LIGHT | HEAVY | YES | X |  |  |  |  |
| MKS08 | LIGHT | NOO | NFT |  |  |  |  |  |
| MKS09 | HEAVY | HEAVY | YES | X |  |  |  |  |
| MKS10 | HEAVY | NOO | NFT |  |  |  |  |  |
| MKS11 | HEAVY | HEAVY | YES | X |  |  |  |  |
| MKS12 | NOO | HEAVY | YES | X |  |  |  |  |
| **MKS13** | NOO | HEAVY | NFT |  |  |  |  |  |
| **MKS14** | NOO | HEAVY | NFT |  |  |  |  |  |
| **MKS15** | NOO | HEAVY | NFT |  |  |  |  |  |
| **MKS16** | NOO | HEAVY | NFT |  |  |  |  |  |
| **MKS17** | NOO | HEAVY | NFT |  |  |  |  |  |
| **MKS18** | NOO | HEAVY | NFT |  |  |  |  |  |
| NGE07 | LIGHT | LIGHT | YES | X |  |  |  |  |
| NGW01 | LIGHT | LIGHT | NFT |  |  |  |  |  |
| NGW02 | MODERATE | LIGHT | YES | X |  |  |  |  |
| NGW03 | MODERATE | LIGHT | YES | X |  |  |  |  |
| NGW04 | LIGHT | LIGHT | NFT |  |  |  |  |  |
| NGW05 | LIGHT | LIGHT | NFT |  |  |  |  |  |
| NGW06 | LIGHT | LIGHT | NFT |  |  |  |  |  |
| NGW07 | LIGHT | LIGHT |  |  |  |  |  |  |
| PMN02 | HEAVY | NOO | NFT |  |  |  |  |  |
| PMN10 | LIGHT | NOO | NFT |  |  |  |  |  |
| PMN12 | LIGHT | LIGHT | NFT |  |  |  |  |  |
| PMN13 | NOO | VERY LIGHT | NFT |  |  |  |  |  |
| PMN15 | NOO | MODERATE | YES | X |  |  |  |  |
| PMN16 | NOO | MODERATE | YES | X |  |  |  |  |
| PMN24 | LIGHT | NOO | NFT |  |  |  |  |  |
| PMN25 | LIGHT | NOO | NFT |  |  |  |  |  |
| PMN28 | NOO | HEAVY | YES | X |  |  |  |  |
| PMS05 | LIGHT | LIGHT |  |  |  |  |  |  |
| PMS06 | LIGHT | MODERATE | YES | X |  |  |  |  |
| PMS10 | MODERATE | MODERATE | YES | X |  |  |  |  |
| PMS11 | LIGHT | LIGHT |  |  |  |  |  |  |
| PTN01 | MODERATE | LIGHT | NFT |  |  |  |  |  |
| PTN02 | NOO | HEAVY | YES | X |  |  |  |  |
| PTN03 | HEAVY | HEAVY | YES | X |  |  |  |  |
| PTN04 | HEAVY | HEAVY | YES | X |  |  |  |  |
| PTN10 | LIGHT | HEAVY | YES | X |  |  |  |  |
| PTS01 | LIGHT | HEAVY | YES | X |  |  |  |  |
| PTS03 | LIGHT | NOO | NFT |  |  |  |  |  |
| PTS04 | LIGHT | NOO | NFT |  |  |  |  |  |
| PTS05 | MODERATE | MODERATE | NFT |  |  |  |  |  |
| PTS06 | NOO | NOO | NO |  |  |  |  |  |
| PTS07 | MODERATE | LIGHT | NFT |  |  |  |  |  |
| PTS08 | MODERATE | NOO | NFT |  |  |  |  |  |
| PTS10 |  | MODERATE | NFT |  |  |  |  |  |
| SKN04 | NOO | LIGHT | YES | X |  |  |  |  |
| SKN05 | HEAVY | HEAVY | YES | X |  | X | X | X |
| SKN06 | NOO | MODERATE | YES | X |  |  | X |  |
| SKN08 | HEAVY | MODERATE | YES | X |  |  |  | X |
| SKN11 | HEAVY | HEAVY | YES | X | X | X |  | X |
| SKN12 | LIGHT | HEAVY | YES | X |  |  |  |  |
| SKN13 | HEAVY | MODERATE | YES | X |  |  |  |  |
| SKN14 | HEAVY | HEAVY | YES | X |  |  |  |  |
| SKN15 | HEAVY | HEAVY | YES | X |  |  |  | X |
| SKS01 | NOO | HEAVY | YES | X |  |  |  |  |
| SKS02 | NOO | HEAVY | YES | X |  |  |  |  |
| SKS03 | NOO | HEAVY | YES | X |  |  |  |  |
| SKS04 | MODERATE | HEAVY | YES | X | X | X | X |  |
| SKS06 | HEAVY | HEAVY | YES | X |  |  |  |  |
| SKS10 | NOO | HEAVY | YES | X |  |  |  |  |
| SKS11 | NOO | HEAVY | YES | X |  |  |  |  |
| SKS12 | NOO | LIGHT | YES | X |  |  |  |  |
| SKS13 | NOO | MODERATE | YES | X |  |  |  |  |
| SKS14 | NOO | MODERATE | YES | X |  |  |  |  |
| SKS15 | NOO | HEAVY | YES | X |  |  |  |  |
| SKS16 | NOO | HEAVY | YES | X |  |  |  |  |
| SKS17 | NOO | MODERATE | YES | X |  |  |  |  |
| SKS18 | HEAVY | HEAVY | YES | X | X | X |  |  |
| SMB06 |  | HEAVY | YES | X |  |  |  |  |
| SPR01 | NOO | MODERATE | YES | X |  |  |  |  |
| SPR02 | HEAVY | MODERATE | YES | X |  |  |  |  |
| SPR03 | NOO | LIGHT | YES | X |  |  |  |  |
| SPR04 | HEAVY | MODERATE | YES | X |  |  |  |  |
| SPR05 | HEAVY | NOO | NFT |  |  |  |  |  |
| SPR07 |  | MODERATE | YES | X |  |  |  |  |
| SPR09 |  | MODERATE | YES | X |  |  |  |  |
| SPR10 |  | LIGHT | YES | X |  |  |  |  |
| SPR11 | LIGHT | HEAVY | YES | X |  |  |  |  |
| SPR12 |  | HEAVY | YES | X |  |  |  |  |
| UDE16 | LIGHT | LIGHT | YES | X |  |  |  |  |
| WDE03 | MODERATE |  |  |  |  |  |  |  |
| UDW01 | NOO | HEAVY | YES | X |  |  |  |  |
| UDW04 | NOO | LIGHT | YES | X |  |  |  |  |
| UNK03 |  | LIGHT | YES | X |  |  |  |  |
| VLC01 |  | HEAVY | YES | X |  |  |  |  |
| VLC10a |  | LIGHT | YES | X |  |  |  |  |

**Table 4.** Summary of observations pertinent to oil remobilization made in the Selendang Ayu spill area from June 2005 onwards.

|  |  |
| --- | --- |
| **DATES** | **OBSERVATIONS** |
| 20-23 June 2005: | NOAA survey teams documented remobilized oil from beach cleaning operations in Skan Bay (SKN10-11) and probably from beach cleaning operations in Hump Back Bay (~HMP10-12). |
| August-September 2005 | Scott Arnold, Alaska Department of Health and Social Services, reported elevated levels of total PAHs in blue mussels from various locations in Skan Bay, but not in other nearby bays |
| ~September 2005: | Mark Carls reported increase of oil in PEMD samplers at Skan Bay (SKN-14). |
| 21 October 2005 | Unnamed observer in civilian aircraft reported what appeared to be a sheen around thevessel. Coast Guard reported oil from Selendang in water and onshore around wreck (Spray Cape) and Skan Bay. |
| 24 October 2005 | Coast Guard reported seeing sheen and emulsified oil coming from the stern of the *Selendang Ayu*. |
| 25 October 2005 | Coast Guard observed a rainbow sheen burping up from around 350 yards from the vessel. |
| 1 December 2005: | Coast Guard/ADEC reported sheening from the vessel (POLREP 104). |
| 1 December 2005 | Dan Magone reported oil on about 200 feet of shoreline near the Selendang; “grass has distinctive droopy look….” |
| 3 December 2005 | Dan Magone reported “ribbon of oil sheen” in inner bay of “Lower Skan Bay”. |
| Feb or March 2006(?) | Seaduck crews reported sticky oil blobs on beach and oiled scaup. |

**Table 5.** Final Status of 2005 Non-End Point Segments

| **SEGMENT** | **SEGMENT LENGTH (km)** | **OILED LENGTH (km)** | **FINAL STATUS** | **DATE of STATUS DETERMINATION** |
| --- | --- | --- | --- | --- |
| BCK11 | 0.951 | 0.08 | End Point Reached | 6/8/06 |
| HMP06 | 0.463 | 0.08 | Natural Recovery | 6/6/06 |
| HMP11b | 0.300 | 0.12 | End Point Reached | 6/6/06 |
| KFP01 | 1.494 | 0.635 | Natural Recovery | 6/13/06 |
| KFP02 | 0.536 | 0.38 | End Point Reached | 6/12/06 |
| KFP03 | 0.239 | 0.03 | End Point Reached | 6/12/06 |
| KFP10a | 1.102 | 0.36 | End Point Reached | 6/12/06 |
| KMK26 | 0.265 | 0.02 | End Point Reached | 6/4/06 |
| KMK30 | 1.839 | 0.04 | End Point Reached | 6/4/06 |
| MKS13 | 1.507 | 0.02 | End Point Reached | 6/4/06 |
| MKS14 | 0.688 | 0.14 | Natural Recovery | 6/4/06 |
| MKS16 | 0.681 | 0.265 | Natural Recovery | 6/4/06 |
| MKS17 | 1.294 | 0.08 | End Point Reached | 6/4/06 |
| SKN05 | 0.676 | 0.6 | End Point Reached | 6/5/06 |
| SKN06 | 1.854 | 0.02 | End Point Reached | 6/5/06 |
| SKN08 | 0.128 | 0.082 | End Point Reached | 6/5/06 |
| SKN11 | 0.210 | 0.24 | End Point Reached | 6/5/06q |
| SKN12 | 1.172 | 0.025 | End Point Reached | 6/5/06 |
| SKN15 | 2.610 | 2.073 | Natural Recovery | 6/12/06 |
| SKS03 | 0.865 | 0.122 | Natural Recovery | 6/8/06 |
| SKS04 | 0.235 | 0.235 | End Point Reached | 6/8/06 |
| SKS06 | 0.439 | 0.04 | End Point Reached | 6/8/06 |
| SKS11c | 0.045 | 0.08 | End Point Reached | 6/12/06 |
| SKS18d,e,g | 3.610 | 0.354 | End Point Reached | 6/12/06 |
| SPR11a | 1.210 | 0.1 | Natural Recovery | 6/8/06 |
| SPR12 | 0.593 | 0.2 | End Point Reached | 6/8/06 |

**Table 6.** Locations of anadromous fish streams surveyed in June 2005.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Incident Command Segment Code** | **General Location Name** | **Site of Auke Bay Hydrocarbon Monitoring Stations** |
| 1. | MKS 5 | Makushin Bay South (Glacier Valley Creek) | X |
| 2. | HMP 9 | Humpback Bay |  |
| 3. | HMP12 | Humpback Bay |  |
| 4. | PTN 3 | Portage Bay North |  |
| 5. | PTS 10 | Portage Bay South |  |
| 6. | SKN 4 | Skan North | X |
| 7. | SKN 14 | Skan North | X |
| 8. | SPR 3 | Spray Cape |  |
| 9. | PMN 20/21 | Pumicestone North | X |
| 10. | PMS 16 | Pumicestone South | X |

**Photo of Dry Tilling to Expose Buried Oil at HMP-12 (2 December 2005)**



(photo taken by ADEC)