

ALASKA LEGISLATURE COMMITTEE FILES 1993-1994 8672

3055 HOUSE RESOURCES

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME
DIVISION OF ADMINISTRATION

11/24/92
FPS6003F

SUMMARY OSIAI EMPLOYMENT PAYMENT --- RSA 1821000
JULY 1991 - JUNE 1992

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COLLOCATION CODE	PCN	NAME	JOB CLASS	JOB TITLE	LOCATION CODE	LOCATION	GROSS AMOUNT	TRANSACTION AMOUNT
11822501	11N175	LANDEEN, PAMELA R	P6112	FISH & WILDLIFE TECHNICIAN I	DWA	CORDOVA	4325.72	5273.00
	11N185	ROSEN, KELLY T	P1792	RESEARCH ANALYST I	DWA	CORDOVA	122.55	139.16
	11N186	ALLEN, JANE M	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	69.83	75.99
	11N229	MILLER, MATTHEW G	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	1302.67	1472.65
	11N868	RICH, CECIL F	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	717.26	808.93
	11N916	DECKER, KARL E	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	11832.09	15712.68
	111365	MCCRACKEN, BETSY W	P6160	FISHERY BIOLOGIST I	EBA	ANCHORAGE	4405.20	5958.91
	111394	HALEY, BETH E	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	3375.19	5041.79
	111552	GILMAN, JEAN M	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	12333.08	18182.97
	111658	ATKINSON, DARYL J	P6112	FISH & WILDLIFE TECHNICIAN I	DWA	CORDOVA	191.97	274.89
	117019	WILCOCK, JOHN A	P6162	FISHERY BIOLOGIST III	DWA	CORDOVA	27323.76	37144.95
	117023	CHALK, KENNETH H	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	1900.83	2500.96
	117044	BIGGS, EVELYN D	P6161	FISHERY BIOLOGIST II	DWA	CORDOVA	45339.81	61829.92
	117057	MILLER, MATTHEW G	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	5190.79	6920.75
	TOTAL COLLOCATION CODE 11822501 :							118430.75
11822651	11N196	VARTAN, KENNETH K	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	565.41	627.17
	11N207	KINZER, VERA	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	3394.25	4617.60
	11N534	STACK, CECILIA T	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	348.30	574.06
	11N916	BECKER, KARL E	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	3577.58	4237.89
	11N918	SANDY, WILLIAM B	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	6283.88	8010.08
	111346	URBAN, JOSEPH D	P6160	FISHERY BIOLOGIST I	DWA	CORDOVA	6155.65	8375.78
	111961	URBAN, JOSEPH D	P6160	FISHERY BIOLOGIST I	CAA	KODIAK	0.00	0.73
	111970	TROWBRIDGE, CHARLES E	P6161	FISHERY BIOLOGIST II	DWA	CORDOVA	4155.96	5710.51
	117020	TROWBRIDGE, CHARLES E	P6161	FISHERY BIOLOGIST II	DWA	CORDOVA	7963.74	11007.05
	117085	VINING, IVAN W	P6135	BIOMETRICIAN I	EBA	ANCHORAGE	1570.50	2368.60
	TOTAL COLLOCATION CODE 11822651 :							34015.27
11822702	114137	BEGICH, ROBERT N	P6160	FISHERY BIOLOGIST I	EBA	ANCHORAGE	2553.00	3645.29
	117057	MILLER, MATTHEW G	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	6540.33	11729.82
TOTAL COLLOCATION CODE 11822702 :							11093.33	15375.11
11823205	11N193	PORTER, BOYD	P6113	FISH & WILDLIFE TECHNICIAN II	EBA	ANCHORAGE	3109.85	3474.38
	111393	BROWNING, JAMES B	P6160	FISHERY BIOLOGIST I	IGD	SOLDOTNA	1764.34	2269.44
	112196	KOENEN, KIANA K	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	1556.64	2034.65
	117027	FARO, JAMES B	P6143	WILDLIFE BIOLOGIST III	DRD	SOLDOTNA	70514.04	93825.99

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COLLOCATION CODE	PCN	NAME	JOB CLASS	JOB TITLE	LOCATION CODE	LOCATION	GROSS AMOUNT	TRANSACTION AMOUNT
11823205	117071	VANDENBOSCH, DAVID P	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	23476.09	30905.76
TOTAL COLLOCATION CODE 11823205 :							100420.96	132510.22
11823235	112073	TAYLOR, WILLIAM P, JR	P6143	WILDLIFE BIOLOGIST III	EBA	ANCHORAGE	2440.66	2440.66
	117071	VANDENBOSCH, DAVID P	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	13133.60	17556.87
TOTAL COLLOCATION CODE 11823235 :							15574.26	19997.53
11823255	112125	MCALLISTER, DENNIS C	P6116	FISH & WILDLIFE TECHNICIAN V	EBA	ANCHORAGE	165.41	216.71
TOTAL COLLOCATION CODE 11823255 :							165.41	216.71
11823402	11N173	WEISS, BILLIE J	P6112	FISH & WILDLIFE TECHNICIAN I	DWA	CORDOVA	114.50	137.64
	11N220	SAIGET, DAVID	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	4213.49	5121.32
	11N225	HECKART, ALAN G	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	5379.43	6734.31
	11N229	MILLER, MATTHEW G	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	1433.65	1433.65
	114038	HEPLER, KELLY R	P6162	FISHERY BIOLOGIST III	EBA	ANCHORAGE	36085.75	49238.27
	114124	CAPPIELLO, THOMAS A	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	2203.12	2192.50
	114159	SWEET, DANA E	P6160	FISHERY BIOLOGIST I	ECF	PALMER	1535.71	2100.08
	114207	BERNARD, DAVID R	P6138	BIOMETRICIAN IV	EBA	ANCHORAGE	17237.50	23307.28
	114208	HOFFMANN, ANDREW G	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	26414.77	36756.02
	117057	MILLER, MATTHEW G	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	2372.69	3647.20
	117064	HOFFMANN, ANDREW G	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	2454.26	2454.26
TOTAL COLLOCATION CODE 11823402 :							99444.87	134161.53
11823422	111674	MONACO, CRAIG D	P6113	FISH & WILDLIFE TECHNICIAN II	DAA	DILLINGHAM	1240.68	1597.61
	114122	HECKART, ALAN G	P6113	FISH & WILDLIFE TECHNICIAN II	EBA	ANCHORAGE	1729.80	2181.15
	114124	CAPPIELLO, THOMAS A	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	2449.69	3486.12
	114208	HOFFMANN, ANDREW G	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	6998.00	9614.10
	117057	MILLER, MATTHEW G	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	3964.03	5813.42
	117068	MCCARRON, SUZANNE H	P6160	FISHERY BIOLOGIST I	EBA	ANCHORAGE	5106.00	7234.42
TOTAL COLLOCATION CODE 11823422 :							21496.20	29926.82

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COLLOCATION CODE	PCN	NAME	JOB CLASS	JOB TITLE	LOCATION CODE	LOCATION	GROSS AMOUNT	TRANSACTION AMOUNT
11823505	11N226	GUSTIN, RICHARD L	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	7957.28	10484.43
	117069	HASTINGS, CHARLIE W	P6115	FISH & WILDLIFE TECHNICIAN IV	EBA	ANCHORAGE	8880.76	12052.64
	117074	SYDER, JONATHAN L	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	2873.15	3661.94
TOTAL COLLOCATION CODE 11823505 :							19711.19	26199.01
11823511	111417	ROCHE, PATRICIA A	F6160	FISHERY BIOLOGIST I	CAA	KODIAK	50.00	50.00
	117018	SWANTON, CHARLES O	F6161	FISHERY BIOLOGIST II	CAA	KODIAK	1711.99	2547.19
TOTAL COLLOCATION CODE 11823511 :							1761.99	2597.19
11823561	111418	PILLIFANT, LAURA L	F6160	FISHERY BIOLOGIST I	CAA	KODIAK	155.35	193.88
	117018	SWANTON, CHARLES O	F6161	FISHERY BIOLOGIST II	CAA	KODIAK	3424.00	4338.78
TOTAL COLLOCATION CODE 11823561 :							3579.35	4532.66
11823605	11N193	PORTER, BOYD	F6113	FISH & WILDLIFE TECHNICIAN II	EBA	ANCHORAGE	7030.35	8626.05
	111393	BROWNING, JAMES B	F6160	FISHERY BIOLOGIST I	D0D	SOLDOTNA	11538.76	15302.61
	117063	LEWIS, JONATHAN P	F6142	WILDLIFE BIOLOGIST II	EBA	ANCHORAGE	29650.94	40671.33
	117073	BOWEN, SUZAN D	F6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	10050.55	14465.10
	117086	CALKINS, DONALD E	F6144	WILDLIFE BIOLOGIST IV	EBA	ANCHORAGE	9903.50	53689.71
TOTAL COLLOCATION CODE 11823605 :							98174.10	132754.80
11823655	112113	LOWRY, LLOYD F	F6143	WILDLIFE BIOLOGIST III	JFA	FAIRBANKS	4459.97	6116.95
	112115	FROST, KATHRYN J	F6143	WILDLIFE BIOLOGIST III	JBA	FAIRBANKS	16684.00	22567.08
	112125	MCALLISTER, DENNIS C	F6116	FISH & WILDLIFE TECHNICIAN V	EBA	ANCHORAGE	1127.80	1478.54
TOTAL COLLOCATION CODE 11823655 :							22271.77	30127.67
11823701	11N534	STACK, CECILIA T	F6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	1358.30	2255.19
	11N921	TUCCIO, MARIA TS	F6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	2778.50	3535.96
	11N922	COBBETT, NICHOLAS J	F6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	3996.48	4897.92
	111649	JOHNSON, J D	F6160	FISHERY BIOLOGIST I	DWA	CORDOVA	29409.53	41448.12
	111649	MCCRACKEN, BETSY W	F6160	FISHERY BIOLOGIST I	DWA	CORDOVA	944.15	1112.00

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11823701	111970	TROWBRIDGE, CHARLES E	P6161	FISHERY BIOLOGIST II	DWA	CORDOVA	6892.36	9560.63
TOTAL COLLOCATION CODE 11823701 :							45379.32	62809.82
11824050	11M015	SHELLEY, SAVANAH	P6951	STUDENT INTERN I	AWA	JUNEAU	138.90	138.90
	11M030	WINDOM, MONICA M	P1202	ACCOUNTING CLERK II	AWA	JUNEAU	2786.46	3103.83
	11M084	MATHIS, LARRY A	P1123	CLERK TYPIST III	AWA	JUNEAU	4965.87	5388.00
	11N348	DILBECK, MICHELLE M	P6951	STUDENT INTERN I	AWA	JUNEAU	2361.40	2611.43
	11N493	HOCKER, CAROL L	P6955	COLLEGE INTERN II	AWA	JUNEAU	1309.03	1407.39
	11N624	FITZSIMONDS, RONALD L	P6951	STUDENT INTERN I	AWA	JUNEAU	1030.18	1133.81
	11N625	MCPHETRES, WENDY K	P6954	COLLEGE INTERN I	AWA	JUNEAU	3109.70	3404.85
	11N774	SMITH, SARAH E	P6954	COLLEGE INTERN I	AWA	JUNEAU	1408.53	1559.71
	11N849	MAYFIELD, COURTNEY M	P6954	COLLEGE INTERN I	AWA	JUNEAU	3499.35	3780.48
	11N880	GREEK, MELINA L	P6954	COLLEGE INTERN I	AWA	JUNEAU	579.82	642.34
	110054	ERICKSON, JEAN M	P1123	CLERK TYPIST III	AWA	JUNEAU	735.08	814.30
	110205	MARQUARDT, TUULA K	P1292	INTERNAL AUDITOR III	AWA	JUNEAU	1665.51	2354.15
	110212	DURAN, JOSETTE M	P1912	ADMINISTRATIVE ASSISTANT I	AWA	JUNEAU	15031.88	21660.08
	110215	RANSOM, CARMELA F	P1211	ACCOUNTING TECHNICIAN II	AWA	JUNEAU	2830.00	4029.11
	110219	CHILDRESS, JENIFER L	P1210	ACCOUNTING TECHNICIAN I	AWA	JUNEAU	6476.86	9479.71
	110225	OSTROWSKI, STANLEY	P1203	ACCOUNTING CLERK III	AWA	JUNEAU	4505.06	6549.46
	110234	LEAMER, VICTOR A	P1311	SUPPLY TECHNICIAN II	AWA	JUNEAU	1196.01	1750.63
	110243	DALE, MARK A	P1205	ACCOUNTANT II	AWA	JUNEAU	1610.54	2254.83
	110245	KUNZ, STEPHEN F	P1123	CLERK TYPIST III	AWA	JUNEAU	5494.49	7954.82
	110270	BAPTISTE, MARGARET M	P1463	PROGRAM BUDGET ANAL III	AWA	JUNEAU	17097.30	23254.23
	110274	HOBBS, JULIE A	P1403	PERSONNEL ASSISTANT I	AWA	JUNEAU	9257.90	13424.40
	110285	RADACH, KIRK A	P1612	DATA PROCESSING TECHNICIAN II	AWA	JUNEAU	10291.84	14517.50
	110286	BURTON, MARYLOU D	P1293	INTERNAL AUDITOR IV	AWA	JUNEAU	4164.00	5642.11
	110291	NICOLLS, CONSTANCE	P1403	PERSONNEL ASSISTANT I	AWA	JUNEAU	9501.40	13927.23
	110606	KENNEDY, VALERIE J	P1123	CLERK TYPIST III	JBA	FAIRBANKS	1901.64	2836.69
	117060	EVANS, LEDA D	P1108	CLERK V	EBA	ANCHORAGE	11496.51	16836.47
	117060	GOODWIN, ELIZABETH	P1403	PERSONNEL ASSISTANT I	EBA	ANCHORAGE	2315.00	3385.79
	117081	JONES, BONNIE J	P1106	CLERK III	CAA	KODIAK	2297.52	3536.27
	117081	JONES, BONNIE J	P1106	CLERK III	CAA	KODIAK	5292.04	7880.60
	117089	CLEMETSON, TODD A	P1123	CLERK TYPIST III	AWA	JUNEAU	1655.29	1757.12
	117089	ERICKSON, JEAN M	P1123	CLERK TYPIST III	AWA	JUNEAU	209.63	264.58
	117089	JAMES-LEE, EUNICE E	P1123	CLERK TYPIST III	AWA	JUNEAU	2159.53	3773.23
	117104	KUNZ, STEPHEN F	P1123	CLERK TYPIST III	AWA	JUNEAU	100.33	100.33
	117107	EVANS, LEDA D	P1123	CLERK TYPIST III	EBA	ANCHORAGE	5580.69	8280.69
	117107	JOHNSON, JANICE R	P1123	CLERK TYPIST III	EBA	ANCHORAGE	8255.42	12081.31
	117108	BOWE, SHEILA M	P1912	ADMINISTRATIVE ASSISTANT I	EBA	ANCHORAGE	15174.00	21512.42
	117109	PETERSON, KAREN M	P1107	CLERK IV	DWA	CORDOVA	19464.01	28177.92
	117111	COLRUD, CORRINE	P1203	ACCOUNTING CLERK III	EBA	ANCHORAGE	17664.45	25722.93
	117112	RANDALL, STEPHANIE	P1403	PERSONNEL ASSISTANT I	AWA	JUNEAU	16808.81	24298.76

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COLLOCATION CODE	PCN	NAME	JOB CLASS	JOB TITLE	LOCATION CODE	LOCATION	GROSS AMOUNT	TRANSACTION AMOUNT
11824050	117112	RIGGINS, EMILY E	F1403	PERSONNEL ASSISTANT I	AWA	JUNEAU	0.00	28.21
TOTAL COLLOCATION CODE 11824050 :							221421.98	311256.?
11824051	111271	BUE, BRIAN G	P6136	BIOMETRICIAN II	EBA	ANCHORAGE	40721.61	55852.12
	111365	MCCRACKEN, BETSY W	P6160	FISHERY BIOLOGIST I	EBA	ANCHORAGE	5531.50	8223.32
	111395	BAKER, TIMOTHY T	P6135	BIOMETRICIAN I	EBA	ANCHORAGE	34296.38	47707.77
	117072	EVANS, DAVID G	P6135	BIOMETRICIAN I	EBA	ANCHORAGE	25236.98	35227.71
	117085	VINING, IVAN W	P6135	BIOMETRICIAN I	EBA	ANCHORAGE	21098.12	29234.04
TOTAL COLLOCATION CODE 11824051 :							126884.59	176246.66
11824052	117012	HANSEN, PATRICIA A	P6136	BIOMETRICIAN II	EBA	ANCHORAGE	28856.60	40026.63
TOTAL COLLOCATION CODE 11824052 :							28856.60	40026.63
11824053	11N471	SIMMONS, JAMIE E	P6955	COLLEGE INTERN II	EBA	ANCHORAGE	19778.13	21691.55
	115200	FABISZEWSKI, DON E	P9554	STOREKEEPER WG IV	EBA	ANCHORAGE	3524.19	4864.91
	117030	HASBROUCK, JAMES J	P6136	BIOMETRICIAN II	EBA	ANCHORAGE	31938.50	44056.18
	117082	JEAN, YVETTE D	P1123	CLERK TYPIST III	EBA	ANCHORAGE	22862.62	33886.32
TOTAL COLLOCATION CODE 11824053 :							78103.44	104498.96
11824055	112125	MCALLISTER, DENNIS C	P6116	FISH & WILDLIFE TECHNICIAN V	EBA	ANCHORAGE	270.67	346.93
	112196	KOENEN, KIANA K	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	1825.28	2715.56
TOTAL COLLOCATION CODE 11824055 :							2095.95	3062.49
11824059	11K033	BLUMENSHINE, TREVA A	P6951	STUDENT INTERN I	AWA	JUNEAU	148.16	161.29
	11M017	CLEMETSON, TODD A	P6954	COLLEGE INTERN I	AWA	JUNEAU	8543.26	9319.01
	11M084	MATHIS, LARRY A	P1123	CLERK TYPIST III	AWA	JUNEAU	0.00	615.45
	11N493	HOCKER, CAROL L	P6955	COLLEGE INTERN II	AWA	JUNEAU	232.20	257.64
	11N618	KEHRER, MARGARET A	P6959	GRADUATE INTERN II	AWA	JUNEAU	1680.57	1836.23
	11N849	MAYFIELD, COURTNEY M	P6955	COLLEGE INTERN II	AWA	JUNEAU	853.37	945.35
	11N946	TWAIT, PAUL B	P6954	COLLEGE INTERN I	EBA	ANCHORAGE	5415.31	5950.41

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11824059	110276	LAROCQUE, DIANE C	P3570	LIBRARY ASSISTANT I	AWA	JUNEAU	5233.80	7597.94
	114150	KOENEN, KIANA K	P6114	FISH & WILDLIFE TECHNICIAN III	ECF	PALMER	109.60	109.60
	116028	SUNDBERG, KIMBAL A	P6168	HABITAT BIOLOGIST IV	EBA	ANCHORAGE	2461.31	3335.05
	116041	SWENSON, CHRISTOPHER	P6166	HABITAT BIOLOGIST II	EDA	ANCHORAGE	1521.12	2117.36
	116137	HUGHES, DEAN W	P6166	HABITAT BIOLOGIST II	EBA	ANCHORAGE	0.00	802.81
	117001	MONTAGUE, J JEROME	X0823	DIVISION DIRECTOR	AWA	JUNEAU	43505.00	58779.16
	117002	DEAN, MICHAEL R	X0825	DEPUTY DIRECTOR	AWA	JUNEAU	41323.00	55166.90
	117003	FRAKER, MARK A	X0907	WILDLIFE/HABITAT PROGRAM M	EBA	ANCHORAGE	44771.70	60084.30
	117003	NDWLN, ROY A	X0907	WILDLIFE/HABITAT PROGRAM M	EBA	ANCHORAGE	9850.80	13411.04
	117004	SULLIVAN, JOSEPH R	X0913	FISHERY PROGRAM MANAGER	EBA	ANCHORAGE	42199.00	57092.67
	117021	SULLIVAN, JOSEPH R	X0908	FISHERY MANAGER	EBA	ANCHORAGE	11840.31	15988.71
	117023	CHALK, KENNETH H	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	3042.00	4234.41
	117064	HUGHES, DEAN W	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	21103.20	29129.81
	117078	JOSEPH, VENITA F	P1151	SECRETARY I	AWA	JUNEAU	16661.07	23884.32
	117078	WELLARD, MONICA J	P1151	SECRETARY I	AWA	JUNEAU	5919.25	8656.05
	117089	CLEMETSON, TODD A	P1123	CLERK TYPIST III	AWA	JUNEAU	1682.51	1872.38
	117094	KEHRER, MARGARET A	P4229	PROJECT ASSISTANT	AWA	JUNEAU	27188.13	37710.29
	117095	MICHAEL, ROBIN D.T.	F3571	LIBRARY ASSISTANT II	EBA	ANCHORAGE	17262.00	24931.55
	117104	MATHIS, LARRY A	P1123	CLERK TYPIST III	AWA	JUNEAU	2878.82	3421.31
	117107	JOHNSON, JANICE R	P1123	CLERK TYPIST III	EBA	ANCHORAGE	5189.63	7155.28
	117108	BOWE, SHEILA M	P1912	ADMINISTRATIVE ASSISTANT I	EBA	ANCHORAGE	9154.17	13016.15
	117111	JOHNSON, JANICE R	P1203	ACCOUNTING CLERK III	EBA	ANCHORAGE	0.00	516.15
TOTAL COLLOCATION CODE 11824059 :							329769.29	448098.62
11824071	11N796	HOVEN, LINDA A	P9655	BOAT OFFICER I	AWA	JUNEAU	15066.79	17756.96
	11N797	VINCENT, STUART A	P9656	BOAT OFFICER II	AWA	JUNEAU	23960.19	28206.88
	111102	FORREST, CRAIG MK	P9655	BOAT OFFICER I	CYB	HOMER	1851.63	2252.29
TOTAL COLLOCATION CODE 11824071 :							40878.61	48216.13
11824753	111328	COFSKE, JAMES P	P6160	FISHERY BIOLOGIST I	CAA	KODIAK	2592.02	3094.86
	111391	GLICK, WILLIAM J	P6160	FISHERY BIOLOGIST I	DDQ	SOLDOTNA	10076.19	14457.99
	115187	SHIELDS, PATRICK A	P6160	FISHERY BIOLOGIST I	DDQ	SOLDOTNA	1365.50	1730.41
	115296	CIALEK, DENISE M	P6114	FISH & WILDLIFE TECHNICIAN III	DDQ	SOLDOTNA	18408.21	26249.50
	115342	HELMINSKI, ALOYSIUS D	P6113	FISH & WILDLIFE TECHNICIAN II	DDQ	KASLOF	5593.50	8320.73
	115357	EDMUNDSON, JOHN M	P6160	FISHERY BIOLOGIST I	DDQ	SOLDOTNA	5282.58	7491.51
	117045	HONNOLD, STEVEN G	P6161	FISHERY BIOLOGIST II	CAA	KODIAK	19888.89	27753.26
TOTAL COLLOCATION CODE 11824753 :							63206.89	89098.26

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11824859	11N618	KEHRER, MARGARET A	P6955	GRADUATE INTERN II	AWA	JUNEAU	4542.67	5032.38
TOTAL COLLOCATION CODE 11824859 :							4542.67	5032.38
11825051	111328	COFSKE, JAMES P	P6160	FISHERY BIOLOGIST I	DQD	SOLDOTNA	762.36	1030.29
	111333	DAVIS, RANDALL Z	P6160	FISHERY BIOLOGIST I	DQD	SOLDOTNA	7218.34	10325.52
	111374	BRANNEN-PEZZENT, JENN	P6113	FISH & WILDLIFE TECHNICIAN II	DGD	SOLDOTNA	6072.93	8473.42
	111381	WESTERMAN, DAVID L	P6160	FISHERY BIOLOGIST I	DQD	SOLDOTNA	12752.91	17859.94
	111391	GLICK, WILLIAM J	P6160	FISHERY BIOLOGIST I	DGD	SOLDOTNA	2473.85	3500.01
	111393	BROWNING, JAMES B	P6160	FISHERY BIOLOGIST I	DQD	SOLDOTNA	3164.17	4371.90
	111406	BELIVEAU, DENNIS H	P6113	FISH & WILDLIFE TECHNICIAN II	DQD	SOLDOTNA	6895.37	9925.91
	111418	PILLIFANT, LAURA L	P6160	FISHERY BIOLOGIST I	CAA	KODIAK	6703.02	9552.78
	111514	MORIN, PHILLIP R	P6113	FISH & WILDLIFE TECHNICIAN II	DQD	SOLDOTNA	243.29	314.88
	111518	DERNING, KERRI B	P6113	FISH & WILDLIFE TECHNICIAN II	DQD	SOLDOTNA	4107.91	6002.42
	111536	SHOWALTER, JENNIFER F	P6113	FISH & WILDLIFE TECHNICIAN II	DQD	SOLDOTNA	1653.99	2478.40
	111615	STANLEY, TRENNIS B	P6112	FISH & WILDLIFE TECHNICIAN I	DQD	SOLDOTNA	2931.58	4477.25
	111621	WALKER, STANLEY C	P6114	FISH & WILDLIFE TECHNICIAN III	DQD	SOLDOTNA	96.41	157.70
	111642	SCHLENKER, MARK W	P6114	FISH & WILDLIFE TECHNICIAN III	DQD	SOLDOTNA	10485.00	14831.69
	111820	LAMB DIN, MORRIS A	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	1872.44	2747.01
	115266	TODD, GARY L	P6160	FISHERY BIOLOGIST I	DGD	SOLDOTNA	1570.50	2023.45
TOTAL COLLOCATION CODE 11825051 :							69004.07	98072.57
11825101	11M154	POPE, JONATHAN R	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	3300.50	3596.42
	11M155	BOWERS, FORREST R	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	1501.21	1609.96
	11M155	SALMON, DANIEL J	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	3854.15	4197.58
	11M156	BRIGHENTI JR, JAMES M	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	2737.70	2981.08
	11M157	GLAMANN, DAVID A	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	2828.06	3079.20
	11N210	CAMPBELL, RODNEY D	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	0.00	923.45
	11N833	CARTMELL, BRAM	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	3676.35	3958.97
	11N834	HICKS, CHRISTIAN	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	5004.55	5418.54
	11N835	MARX, SCOTT O	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	4674.06	5052.42
	11N837	GIEGERICH, TERRY D	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	4162.29	4627.97
	111118	SCOTT, LESLIE D	P6160	FISHERY BIOLOGIST I	CAA	KODIAK	4691.29	6421.90
	111413	CAMPBELL, RUDNEY D	P6160	FISHERY BIOLOGIST I	CAA	KODIAK	7965.85	9881.97
	111417	ROCHE, PATRICIA A	P6160	FISHERY BIOLOGIST I	CAA	KODIAK	3225.08	4857.29
	111521	LARRISON, MARK F	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	1526.28	2314.93
	111594	MCINTOSH, BRUCE C	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	4156.35	5956.26
	111597	KAPLAN, DAVID F	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	3659.98	4561.97
	111598	PEARSON, THOMAS W	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	870.51	1119.66
	111601	BOWERS, FORREST R	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	0.00	78.35

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11825101	111601	PEARSON, THOMAS W	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	3356.30	4774.04
	111825	PHILLIPS, KIMBERLY	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	5173.65	7284.08
	111827	PITCHER, DONALD C	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	6512.50	8978.27
	111836	BOUWENS, KENNETH A	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	5010.36	7086.02
	111842	WADLE, JEFF A	P6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	5317.69	7473.39
	115266	TODD, GARY L	P6160	FISHERY BIOLOGIST I	DQD	SOLDOTNA	942.30	1193.35
	115342	HELMINSKI, ALOYSIUS D	P6113	FISH & WILDLIFE TECHNICIAN II	DQH	KASILOF	497.75	636.77
	117018	SWANTON, CHARLES O	P6161	FISHERY BIOLOGIST II	CAE	KODIAK	1712.00	2207.05
TOTAL COLLOCATION CODE 11825101 :							86356.76	110270.89
11825151	111888	WIBLE, KEITH	P6113	FISH & WILDLIFE TECHNICIAN II	DQD	SOLDOTNA	735.67	803.05
	111326	LEHTINEN, MARION Y	P6113	FISH & WILDLIFE TECHNICIAN II	DQD	SOLDOTNA	900.54	1522.76
	111328	COFSKE, JAMES P	P6160	FISHERY BIOLOGIST I	DQD	SOLDOTNA	2544.20	3599.32
	111333	DAVIS, RANDALL Z	P6160	FISHERY BIOLOGIST I	DQD	SOLDOTNA	6197.22	8602.75
	111514	MORIN, PHILLIP R	P6113	FISH & WILDLIFE TECHNICIAN II	DQD	SOLDOTNA	1928.13	2825.75
	111843	RUDGE, KIMBERLY K	P6114	FISH & WILDLIFE TECHNICIAN III	DQD	SOLDOTNA	1269.72	1990.94
TOTAL COLLOCATION CODE 11825151 :							13575.48	19344.57
11825159	111085	QUINTO, ROBERT F	P6951	STUDENT INTERN I	AWA	JUNEAU	833.40	904.91
	116060	THOMPSON, FREDERICK	P6167	HABITAT BIOLOGIST III	EBA	ANCHORAGE	267.39	365.29
	117023	CHALK, KENNETH H	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	6989.80	9822.91
	117095	MICHAEL, ROBIN D.T.	P3571	LIBRARY ASSISTANT II	EBA	ANCHORAGE	6426.00	8909.00
	57R1	MIDDLETON, KENNETH R	R0000		EBA	ANCHORAGE	10298.58	13171.53
TOTAL COLLOCATION CODE 11825159 :							24815.17	33173.64
11825308	116007	MUHLBERG, GAY A	P6167	HABITAT BIOLOGIST III	EBA	ANCHORAGE	122.79	155.51
	116008	WILLIS, ROBERTA M	P6167	HABITAT BIOLOGIST III	EBA	ANCHORAGE	675.40	1008.71
	116010	OTT, ALVIN G	P6164	FISH & GAME REGIONAL SUPERVISOR	JBA	FAIRBANKS	1405.95	1815.54
	116027	DOLEZAL, CLAUDE W	P6167	HABITAT BIOLOGIST III	EBA	ANCHORAGE	364.64	461.36
	116036	GILLELAND, CEVIN L	P6167	HABITAT BIOLOGIST III	EBA	ANCHORAGE	1484.07	1977.53
	116041	SWENSON, CHRISTOPHER	P6166	HABITAT BIOLOGIST II	EBA	ANCHORAGE	1331.55	1812.82
	116048	GNATH, DENNIS G	P6166	HABITAT BIOLOGIST II	EBA	ANCHORAGE	928.97	1287.28
	116060	THOMPSON, FREDERICK	P6167	HABITAT BIOLOGIST III	EBA	ANCHORAGE	4561.03	6196.03
	116061	POST, ROGER A	P6167	HABITAT BIOLOGIST III	JBA	FAIRBANKS	202.73	256.42
	116064	SLATER, CLAUDIA L	P6167	HABITAT BIOLOGIST III	EBA	ANCHORAGE	9900.09	13517.54
	116087	WALLIS, FRANCIS R	P1624	ANALYST/PROGRAMMER IV	EBA	ANCHORAGE	124.77	157.77

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11825308	116102	WINTERS, JACK F, JR	F6166	HABITAT BIOLOGIST II	JBA	FAIRBANKS	6808.83	9613.37
	116104	BRNA, PHILIP J	F6164	FISH & GAME REGIONAL SUPERVISOR	EBA	ANCHORAGE	4714.66	6296.11
	116110	ROZEN, CELIA M	P3574	LIBRARIAN II	EBA	ANCHORAGE	110.28	165.24
	116136	WIEDMER, MICHAEL	F6166	HABITAT BIOLOGIST II	EBA	ANCHORAGE	169.75	238.97
	116138	ALBERT, STEVEN W	F6167	HABITAT BIOLOGIST III	EBA	ANCHORAGE	154.64	205.18
TOTAL COLLOCATION CODE 11825308 :							33059.15	45165.38
11825429	111652	NEFF, CORT B	F6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	829.51	1061.73
	111676	SCHWENZFEIER, MARY C	F6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	2270.41	3228.10
	115243	DICKSON, MARK S	F6114	FISH & WILDLIFE TECHNICIAN III	CYB	HOMER	6208.11	8731.68
	115268	BALLAND, D THOMAS	F6160	FISHERY BIOLOGIST I	CYB	HOMER	1570.50	1988.90
	115269	BOYLE, LAWRENCE R	F6160	FISHERY BIOLOGIST I	CYB	HOMER	8091.74	10908.49
	115274	CARPENTER, GREG S	F6160	FISHERY BIOLOGIST I	DWA	CORDOVA	2929.00	4156.25
	115362	HOLMAN, MICHAEL K	F6113	FISH & WILDLIFE TECHNICIAN II	CYB	HOMER	993.10	1261.31
	116041	SWENSON, CHRISTOPHER	F6166	HABITAT BIOLOGIST II	EBA	ANCHORAGE	2281.71	3272.66
	117001	MONTAGUE, J JEROME	X0823	DIVISION DIRECTOR	AWA	JUNEAU	22600.00	29958.25
	117002	DEAN, MICHAEL R	X0825	DEPUTY DIRECTOR	AWA	JUNEAU	21370.80	28297.10
	117009	FRAKER, MARK A	X0985	RESTORATION PROGRAM MANAGER	EBA	ANCHORAGE	2542.00	3594.82
	117009	SENNER, STAN EY E	X0985	RESTORATION PROGRAM MANAGER	EBA	ANCHORAGE	53171.22	71436.53
	117023	CHALK, KENNE, H H	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	1521.00	2310.39
	117045	HONNOLD, STEVEN G	F6161	FISHERY BIOLOGIST II	CAA	KODIAK	9596.06	13280.39
	117068	MCCARRON, SUZANNE H	F6160	FISHERY BIOLOGIST I	EBA	ANCHORAGE	26555.09	37739.65
	117601	CROWE, THOMAS W	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	5235.78	7057.49
TOTAL COLLOCATION CODE 11825429 :							167766.03	228283.74
11825435	112115	FROST, KATHRYN J	P6143	WILDLIFE BIOLOGIST III	JBA	FAIRBANKS	6450.00	8918.85
TOTAL COLLOCATION CODE 11825435 :							6450.00	8918.85
11825439	112075	LENART, ELIZABETH	P6115	FISH & WILDLIFE TECHNICIAN IV	JBA	FAIRBANKS	2565.00	3688.81
	112081	MCCARTHY, LAURA A	P1107	CLERK IV	JBA	FAIRBANKS	1133.50	1800.58
	112113	LOWRY, LLOYD F	P6143	WILDLIFE BIOLOGIST III	JBA	FAIRBANKS	4460.00	6116.99
	112115	FROST, KATHRYN J	P6143	WILDLIFE BIOLOGIST III	JBA	FAIRBANKS	10492.00	14116.07
	112137	DELONG, ROBERT A	P1623	ANALYST/PROGRAMMER III	JBA	FAIRBANKS	3267.00	4518.43
TOTAL COLLOCATION CODE 11825439 :							21917.50	30240.88

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11825445	11M190	COEN, CLAUDIA E	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	6625.54	7206.76
	11M191	EAST, MICHAEL W	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	5214.91	5670.85
	11M192	LIVINGSTON, LARRY	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	8830.98	10076.09
	11M193	HILL, DOUGLAS D	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	8505.35	10116.39
	11M194	PETRULA, MICHAEL J	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	8456.45	9676.64
	11N226	GUSTIN, RICHARD L	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	12208.76	14982.93
	112196	KOENEN, KIANA K	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	56.67	56.67
	115278	LIVINGSTON, LARRY	P6113	FISH & WILDLIFE TECHNICIAN II	DWH	KASLOF	-9.04	-9.04
	117029	PATTEN, SAMUEL M, JR	P6143	WILDLIFE BIOLOGIST III	EBA	ANCHORAGE	16149.59	21316.83
	117069	HASTINGS, CHARLIE W	P6115	FISH & WILDLIFE TECHNICIAN IV	EBA	ANCHORAGE	12984.81	17462.01
	117070	CROWLEY, DAVID W	P6115	FISH & WILDLIFE TECHNICIAN IV	DWA	CORDOVA	12544.72	16896.01
	117601	CROWE, THOMAS W	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	13599.01	18196.03
TOTAL COLLOCATION CODE 11825445 :							105167.75	131648.17
11825449	117029	PATTEN, SAMUEL M, JR	P6143	WILDLIFE BIOLOGIST III	EBA	ANCHORAGE	40024.07	54138.31
	117070	CROWLEY, DAVID W	P6115	FISH & WILDLIFE TECHNICIAN IV	DWA	CORDOVA	35795.79	49151.22
	117074	SYDER, JONATHAN L	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	9114.90	12316.26
	117601	CROWE, THOMAS W	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	14055.87	18959.09
TOTAL COLLOCATION CODE 11825449 :							98990.63	134564.88
11825459	11N165	SAIGET, DAVID	P6112	FISH & WILDLIFE TECHNICIAN I	DWA	CORDOVA	0.00	571.32
	11N166	KEOWN, SARAH L	P6112	FISH & WILDLIFE TECHNICIAN I	DWA	CORDOVA	8030.57	10201.72
	11N169	MITTELSTADT, KONRAD W	P6112	FISH & WILDLIFE TECHNICIAN I	DWA	CORDOVA	5033.17	6443.99
	11N220	SAIGET, DAVID	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	8978.69	10699.18
	11N221	MOTIS, TIMOTHY J	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	3737.26	4598.92
	111365	MCCRACKEN, BETSY W	P6160	FISHERY BIOLOGIST I	EBA	ANCHORAGE	2901.14	4065.13
	114141	HREBAR, ANTHONY E	P6113	FISH & WILDLIFE TECHNICIAN II	ECF	PALMER	1892.49	2573.45
	114157	ROMBERG, WILLIAM J	P6114	FISH & WILDLIFE TECHNICIAN III	DSA	SEWARD	1559.67	2310.39
	114208	HOFFMANN, ANDREW G	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	12240.50	17056.32
	115244	STARKEY, DIANE P	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	624.22	798.39
	115278	LIVINGSTON, LARRY	P6113	FISH & WILDLIFE TECHNICIAN II	HCE	GLENALLEN	1194.87	1531.49
TOTAL COLLOCATION CODE 11825459 :							46198.58	60850.30
11825471	11N186	ALLEN, JANE M	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	2182.61	2806.98
	11N192	PETERS, EZEKIEL D	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	160.25	178.79
	11N205	PAAVO, ERIC S	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	589.72	656.36

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11825471	11N208	WOLTERS, GEORGE J	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	716.24	796.12
	11N209	SNELL, PETER J	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	576.90	642.19
	11N220	NORRIS, JOHN S	F6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	2538.38	2801.62
	11N221	MILLER, ALBERT W	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	1342.59	1486.96
	11N223	RAMOS, AMADO T	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	2021.36	2611.00
	11N225	COMERFORD, JOHN P	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	1749.59	1938.95
	11N227	SADDLER, PENELOPE L	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	2390.86	3038.61
	11N228	SPEER, NANCY J	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	2773.03	3453.30
	11N231	WHITTON, KELLIE S	F6160	FISHERY BIOLOGIST I	DWA	CORDOVA	732.48	814.22
	11N232	DUNBAR, ROGER D	F6160	FISHERY BIOLOGIST I	DWA	CORDOVA	9607.86	11627.92
	11N233	SMITH, JODI L	F6160	FISHERY BIOLOGIST I	DWA	CORDOVA	4481.10	5320.21
	11N241	CRAIG, ANDREW K	F6160	FISHERY BIOLOGIST I	DWA	CORDOVA	3932.63	4743.26
	11N536	MOONEY, DELANA L	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	1187.85	1316.07
	11N547	RAMOS, AMADO T	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	5467.17	6506.09
	11N866	BUCHANAN, JOHN D	P6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	5266.19	6573.88
	11N867	WILSON, KRISTI A	F6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	1332.45	1475.65
	11N868	ESTASSI, SAMIA	F6114	FISH & WILDLIFE TECHNICIAN III	DWA	CORDOVA	838.52	931.31
	111571	VARTAN, KENNETH K	F6112	FISH & WILDLIFE TECHNICIAN I	DWA	CORDOVA	1077.35	1367.31
	117043	SHARP, DANIEL G, JR	F6161	FISHERY BIOLOGIST II	DWA	CORDOVA	8083.50	11371.95
TOTAL COLLOCATION CODE 11825471 :							59048.63	72458.75
11825479	11N196	VARTAN, KENNETH K	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	2837.14	3592.85
	11N232	DUNBAR, ROGER D	P6160	FISHERY BIOLOGIST I	DWA	CORDOVA	19950.64	23955.29
	11N546	PETERS, EZEKIEL O	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	2778.74	3269.54
	11N547	RAMOS, AMADO T	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	10647.36	13806.47
	11N915	HOLMES, CHRISTINE E	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	1692.24	2300.26
	111496	DUNBAR, ROGER D	P6113	FISH & WILDLIFE TECHNICIAN II	CKC	KING SALMON	0.00	564.15
	117043	SHARP, DANIEL G, JR	P6161	FISHERY BIOLOGIST II	DWA	CORDOVA	12355.84	16732.65
TOTAL COLLOCATION CODE 11825479 :							50261.96	64221.21
11825483	11N185	ROSEN, KELLY T	P1792	RESEARCH ANALYST I	DWA	CORDOVA	24.51	30.49
	11N233	SMITH, JODI L	P6160	FISHERY BIOLOGIST I	DWA	CORDOVA	1547.80	2099.76
	112072	CLAPSADDLE, AGNES S	P1109	FIELD OFFICE ASSISTANT	DWA	CORDOVA	2061.92	2995.93
	115125	WHITE, LORNE E	P6162	FISHERY BIOLOGIST III	CAA	KODIAK	2926.92	4081.41
	115243	DICKSON, MARK S	F6114	FISH & WILDLIFE TECHNICIAN III	CYB	HOMER	1276.50	2000.23
	115274	CARPENTER, GREG S	P6160	FISHERY BIOLOGIST I	DWA	CORDOVA	1230.79	1941.65
	115340	WEIMER, SCOTT R	F6113	FISH & WILDLIFE TECHNICIAN II	CAA	KODIAK	3104.41	4703.04
	117045	HONNOLD, STEVEN G	P6161	FISHERY BIOLOGIST II	CAA	KODIAK	1658.00	2483.29
TOTAL COLLOCATION CODE 11825483 :							13830.85	20335.80

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STATE OF ALASKA
DEPARTMENT OF FISH AND GAME
DIVISION OF ADMINISTRATION

11/24/92
FPS6003P

SUMMARY OSIAR EMPLOYMENT PAYMENT --- RSA 1821000
JULY 1991 - JUNE 1992

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COLLOCATION CODE	FCN	NAME	JOB CLASS	JOB TITLE	LOCATION CODE	LOCATION	GROSS AMOUNT	TRANSACTION AMOUNT
11825489	11N 33	SMITH, JODI L	P6160	FISHERY BIOLOGIST I	DWA	CORDOVA	8292.72	9941.52
	11N546	PETERS, EZEKIEL O	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	2379.71	2925.37
	111652	NEFF, CORT B	P6114	FISH & WILDLIFE TECHNICIAN III	CAA	KODIAK	3217.91	4442.34
	111676	SCHWENZFEIER, MARY C	P6113	FISH & WILDLIFE TECHNICIAN II	DWA	CORDOVA	1021.73	1221.22
	115243	DICKSON, MARK S	P6114	FISH & WILDLIFE TECHNICIAN III	CYB	HOMER	4531.58	6114.04
	115269	BOYLE, LAWRENCE R	P6160	FISHERY BIOLOGIST I	CYB	HOMER	778.26	994.79
	115274	CARPENTER, GREG S	P6160	FISHERY BIOLOGIST I	DWA	CORDOVA	20849.46	29060.78
	117045	HONNOLD, STEVEN G	P6161	FISHERY BIOLOGIST II	CAA	KODIAK	6874.00	9466.00
TOTAL COLLOCATION CODE 11825489 :							47945.37	64166.06
11825701	11N185	ROSEN, KELLY T	P1792	RESEARCH ANALYST I	DWA	CORDOVA	22514.36	28637.68
	117033	SIMONSON, BRUCE P	P1624	ANALYST/PROGRAMMER IV	AWA	JUNEAU	31904.18	43744.61
	117034	LOVELADY, MURIEL J	P1621	ANALYST/PROGRAMMER I	AWA	JUNEAU	29736.83	42642.49
	117036	SAVIKKO, KURT E	P3605	PUBLICATIONS TECHNICIAN	AWA	JUNEAU	32789.00	46527.35
TOTAL COLLOCATION CODE 11825701 :							116944.37	161552.13
11825751	111928	GEIGER, HAROLD J	P6136	BIOMETRICIAN II	AWA	JUNEAU	2209.00	2842.65
	117011	GATES, RICHARD B	P6135	BIOMETRICIAN I	AWA	JUNEAU	36163.40	50609.36
TOTAL COLLOCATION CODE 11825751 :							38372.40	53452.01
11825761	111916	CRANE, PENELOPE A	P6161	FISHERY BIOLOGIST II	EBA	ANCHORAGE	8793.00	12287.24
	111964	SEEB, LISA W	P6163	FISHERY BIOLOGIST IV	EBA	ANCHORAGE	9665.00	13379.33
	117011	GATES, RICHARD B	P6135	BIOMETRICIAN I	EBA	ANCHORAGE	2172.10	3004.80
	117607	FISH, JAMES T	P6114	FISH & WILDLIFE TECHNICIAN III	EBA	ANCHORAGE	1060.50	1729.13
TOTAL COLLOCATION CODE 11825761 :							21690.60	30400.50

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME
DIVISION OF ADMINISTRATION

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SUMMARY OSIAR EMPLOYMENT PAYMENT TOTALS --- RSA 1821000
JULY 1991 - JUNE 1992

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COLLOCATION CODE	PCN	NAME	JOB CLASS	JOB TITLE	LOCATION CODE	LOCATION	GROSS AMOUNT	TRANSACTION AMOUNT
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TOTAL GROSS AMOUNT: 3819112.08

TOTAL TRANS AMOUNT: 5029198.16

TOTAL JUL 91 - JUN 92 TRANSACTIONS PROCESSED: 33298

REPORT DATA IS TAKEN FROM DEPARTMENT OF ADMINISTRATION, DIVISION OF FINANCE'S LABOR DISTRIBUTION DETAIL FILE FOR CALENDAR YEAR 1991 AND 1992.

LOCATION AND JOB TITLE INFORMATION ARE OBTAINED FROM DEPARTMENT OF FISH & GAME'S FAB-TABLE FILE.

DATA SELECTION CRITERIA:

PAY PERIODS SELECTED: 14 - 24 OF 1991
PAY PERIODS SELECTED: 01 - 13 OF 1992

RSA 1821000 IS BASED ON: COLLOCATION CODES 11820000 - 11829999

GROSS AMOUNT IS BASED ON: ETV CODES E001 - E413

TRANSACTION AMOUNT IS BASED ON: ALL ETV CODES

STATE OF ALASKA

Rep. Bill Williams
WALTER J. HICKEL, GOVERNOR

DEPT. OF ENVIRONMENTAL CONSERVATION

OFFICE OF THE COMMISSIONER
410 WILLOUGHBY AVENUE, SUITE 105
JUNEAU, AK 99801-1795

Phone: (907) 465-5000
Fax: (907) 465-5070

January 21, 1993

JAN 20 1993

The Honorable Ramona Barnes
Speaker, Alaska House of Representatives
State Capitol, Room 208
Juneau, AK 99801

For Hand Delivery

Dear Representative Barnes:

Today I am transmitting to you the fiscal year 1992 Annual Report on the Oil and Hazardous Substance Release Response Fund (Response Fund) pursuant to AS 46.08.060.

This year, we were able to obtain a significant increase in information from other agencies that are authorized to expend Response Fund dollars. This success is in part due to new reporting requirements written into the Reimbursable Service Agreements between DEC and these other agencies.

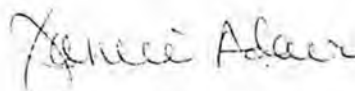
In addition, we are continually striving to take actions which improve management of the Response Fund. A draft manual of Proposed Cost Recovery Policy and Procedures has been developed by the Division of Information and Administrative Services and will be available within ninety days. In the FY92 Report you will also find an estimated value for equipment purchased with Response Fund dollars, listed by department. A copy of the inventory databases are available by contacting the Department. This response gear inventory tracking database is an important component of our spill response capability.

Last year, in my transmittal letter, I mentioned that the spill reserve had dipped below \$12 million. Currently, considering the FY 94 budget proposals, the spill reserve is just over \$22 million, considerably closer to the \$30 million we believe it should be. However, I urge the Legislature to closely scrutinize and evaluate any additional proposals which would impact this reserve account. A stable spill reserve account is vital to the State's response capability in the event of another major spill incident.

The Honorable Ramona Barnes
January 21, 1993
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Please contact me if you would like additional information or have any questions regarding the Response Fund and its management. Thank you.

Sincerely,



for John A. Sandor
Commissioner

CMU\rb (ASDIR\RFAR.MEM)

Enclosure: FY92 Response Fund Annual Report

cc: All Representatives w/enclosure

Sorted by Region, by Company

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plant title	Company	Address	City	ST	Zipcode	Region
Alaska Pulp Corporation	Alaska Pulp Corporation	4600 Sawmill Creek Road	Sitka	AK	99835-9801	1
Anderes Oil Company CALLAPOOYA	Anderes Oil Company Boyer Towing, Inc.	900 Stedman Street 7318 4th Avenue, South	Ketchikan Seattle	AK WA	99901 98108	1 1
XOOTZNAHOO	Boyer Towing, Inc.	7318 4th Avenue, South	Seattle	WA	98108	1
Brix Maritime Barging, Inc.	Brix Maritime Barging, Inc.	P.O. Box 3505	Seattle	WA	98124	1
Delta Western Yakutat Bulk Plant	Delta Western, Inc.	P.O. Box 29	Yakutat	AK	99689	1
Delta Western Juneau Bulk Plant	Delta Western, Inc.	449 Willoughby Avenue	Juneau	AK	99801	1
Ketchikan Pulp Company	Ketchikan Pulp Company	P.O. Box 6600	Ketchikan	AK	99901	1
KFP Petroleum Tank Farm	Klukwan Forest Products	P.O. Box 34659	Juneau	AK	99803	1
ALASKAN SPIRIT CHILKAT WARRIOR	Maritime North, Ltd. North Pacific Expediting	P.O. Box 435 1541-A South 92nd Place	Skagway Seattle	AK WA	99840 98108	1 1
ANNAHOOTZ	Samson Tug & Barge, Inc.	P.O. Box 559	Sitka	AK	99835	1
Sitka Fuels Bulk Transfer Facility	Sitka Fuels, Inc.	P.O. Box 1947	Sitka	AK	99835	1
Totem Oil Bulk Plant	Totem Oil Products Supply, Inc.	P.O. Box 355	Haines	AK	99827	1
Unocal Juneau/ Taku Oil Sales	Union Oil Company of California	P.O. Box 769	Juneau	AK	99802	1
Unocal Ketchikan Bulk Plant	Union Oil Company of California	P.O. Box 7660	Ketchikan	AK	99901	1
West Coast Shipping	West Coast Shipping	P.O. Box 4258	Los Angeles	CA	90051-2258	1
White Pass Sitka Bulk Plant	White Pass Alaska	P.O. Box 418	Sitka	AK	99835	1
White Pass Petersburg Bulk Plant	White Pass Alaska	P.O. Box 769	Petersburg	AK	99833	1

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plant title	Company	Address	City	ST	Zipcode	Region
White Pass Ketchikan Bulk Plant	White Pass Alaska	P.O. Box 7398	Ketchikan	AK	99901	1
White Pass Skagway Bulk Plant	White Pass Alaska	P.O. Box 435	Skagway	AK	99840	1
White Pass Haines Bulk Plant	White Pass Alaska	P.O. Box 590	Haines	AK	99827	1
FRANK H. BROWN	White Pass Transportation, Ltd.	P.O. Box 86190	North Vancouver	BC	V7L 4J9	1
Alaska Marine Charters	Alaska Marine Charters, Inc.	106 110th Place S.E.	Bellevue	WA	98004	2
Anchorage Fueling & Service Co./Butler Aviation	Anchorage Fueling and Service Co.			AK	995	2
Anchorage Municipal Light & Power #2	Anchorage Municipal Light and Power					2
ARCO Sunfish #1/North Forelands-Exploration Well	Arco Alaska	P.O. BOX 100360	Anchorage	AK	99510-0360	2
Bering Sea Fisheries	Bering Sea Fisheries	Winter-4413 - 83 Ave. S.E.	Everett, WA 98025			2
Bethel Fuel Sales	Bethel Fuel Sales, Inc.	P.O. Box 266	Bethel	AK	99559	2
Bethel Fuel Sales	Bethel Fuel Sales, Inc., Bethel Ak					2
Chevron Marine Companies-Cook Inlet	Chevron Shipping Company	P.O. Box 7000	San Francisco	CA	94120-7000	2
Chevron Anchorage Terminal	Chevron U.S.A. Inc		Anchorage	AK	995	2
Chevron Anchorage Terminal	Chevron U.S.A. Inc	P.O.Box 101580	Anchorage	AK	99510	2
Kustatan Exploration Well	Chevron U.S.A. Inc.					2
St. Paul Bulk Fuel Storage Facility	City of St. Paul	P.O. Box 29	St. Paul Island	AK	99660	2

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Planttitle	Company	Address	City	SI	Zipcode	Region
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Cook Inlet Pipeline Co.	Cook Inlet Pipeline Co.	P.O. Box 191009	Anchorage	AK	99519	2
Crowley Marine Services-Captains Bay Tank Farm	Crowley Marine Services, Inc.			AK	99-0-	2
Crowley Marine Services-Captains Bay Tank Farm	Crowley Marine Services, Inc.	P.O. Box 2287	Seattle	WA	98111-2287	2
Crowley Barges	Crowley Maritime					2
Daitoh Trading Company Vessels - Cook Inlet	Daitoh Trading Co. Tokoyo					2
U.S. Defense Fuels-Whittier Terminal	Defense Logistics Agency, Defense Fuels	Cameron Station	Alexandria	VA	22304-6160	2
Delta Western - Dillingham Bulk Plant	Delta Western Barge Lines					2
Delta Western Barges	Delta Western Barge Lines					2
Delta Western Naknek	Delta Western Barge Lines	P.O. Box 70438	Seattle	WA	98017	2
Delta Western-Dutch Harbor Tank Farm	Delta Western Barge Lines, Seattle					2
Delta Western - Dillingham Bulk Plant	Delta Western, Seattle, WA					2
Flyums Barge Service	Flyums Barge Service					2
Forty Niner Transportation, Inc. (FNT)	FNT, Inc. (aka Petro Marine)	1600 A street, Suite 308	Anchorage	AK	99501	2
Forty Niner B-340	Forty Niner Transportation, Inc.					2
Forty-Niner, B-180	Forty-Niner Transportation					2
Foss Maritime Barges	Foss Maritime	660 West Ewing Street	Seattle	WA	98119	2
Kenai Pipeline Company	Kenai Pipe Line Co., Kenai, AK	P.O. Box 5555	Kenai	AK	99611	2

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plant title	Company	Address	City	ST	Zipcode	Region
Kenai Pipe Line Company Terminal	Kenai Pipe Line Company	P.O. Box 5555	Kenai	AK	99611	2
Kipnuk Fuel Services	Kipnuk Fuel Services, Kipnik, AK					2
Kodiak Oil Sales Bulk Plant	Kodiak Oil Sales, Inc					2
Mapco Charter Vessels - Cook Inlet	Mapco Alaska Petroleum	1076 Ocean Dock Road	Anchorage	ak	99501-4100	2
MAPCO Anchorage Terminal	MAPCO Alaska Petroleum, Inc.					2
MAPCO Anchorage Terminal	MAPCO Petroleum Company		Anchorage	AK	995	2
Marathon LNG -Polar Alaska/S.S. Arctic Tokyo	Marathon Oil Co. Houston, TX					2
Marathon Vessel- M/S Scotland	Marathon Oil Company	539 South Main Street	Findlay	OH	45840	2
Marathon Facilities-Cook Inlet	Marathon Oil Company, Anc	P.O. Box 190168	Anchorage	AK	99519	2
Moody Sea Lighterage	Moody Sea Lighterage					2
Naknek Electric	Naknek Electric Assc., Naknek, AK	P.O. Box 118	Naknek	AK	99633	2
Nushagak Electric-Dillingham	Nushagak Electric Co-Op, Inc, Dillingham					2
Nushagak Electric-Dillingham	Nushagak Electric Co-Op, Inc. Dillingham					2
Ocean Marine Services Vessels-Cook Inlet	Ocean Marine Services, Inc.	570 Kirkland Way, Suite 200	Kirkland	WA	99635	2
Ocean Ships, Inc.	Ocean Ships, Inc.					2
Offshore Systems-Port Lekanoff Facility	Offshore Systems, Inc. Captains Bay AK					2
Orca Oil Company Bulk Plant Operations	Orca Oil Company, Inc., Cordova					2
Peter Pan Seafoods - King Cove	Peter Pan Seafoods, Inc., Seattle					2

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Planttitle	Company	Address	City	ST	Zipcode	Region
Petro-Marine Resoff Dock	Petro Marine Services	1600 A Street, Suite 307	Anchorage	AK	99501	2
Petro Marine Services - Kodiak Bulk Plant	Petro Marine Services			AK		2
Shoreside	Petro Marine Services	P.O. Box 1189	Seward	AK	99664	2
Petroleum-Seward Marine Industrial Ctr.						2
Petro Marine- Ballyhoo Bulk Plant	Petro Marine Services, Anc					2
Petro Marine-Westward Seafoods, Captains Bay	Petro Marine Services, ANC					2
Petro Marine - Resoff Dock	Petro Marine Services, Inc					2
Phillips Tyonek Platform Drilling Program	Phillips Petroleum Company	P.O. Drawer 66	Kenai	AK	99611	2
Reeve Aleutian Airways; Frosty Fuel-Cold Bay	Reeve Aleutian Airways, Inc.	4700 W. International Airport Road	Anchorage	AK	99502-1091	2
SEACOR Marine- M/V Mustang Island	SEACOR Marine Inc.	P.O. Box 2291	Morgan City	LA	70381	2
Shell Cook Inlet Middle Ground Shoal	Shell Western E&P, Inc.	601 West 5th Ave.	Anchorage	AK	99501	2
Shoreside	Shoreside Petroleum, Inc., Seward	P.O. Box 1189	Seward	AK	99664	2
Petroleum-Harbor Bulk Plant-Seward						2
Signature Service Co. (Butler Oil Co)	Signature Service ???		Anchorage	AK	995	2
Silver Bay Logging, Inc.-M/V Silver Bay III	Silver Bay Logging, Inc.	P.O. Box 509	Kodiak	AK	99615	2
Smith Lighterage Co.	Smith Lightering Company					2
St George Delta Fuel Company	St George Delta Fuel Company	4000 Old Seward Highway, Suite 302	Anchorage	AK	99503	2

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plant title	Company	Address	City	ST	Zipcode	Region
West McArthur River Unit Drilling and Production	Stewart Petroleum Company	3111 "C" Street	Anchorage	AK	99503	2
Terminal Oil Sales-Homer	Terminal Oil Sales, Inc.	4755 Homer Spit Road	Homer	AK	99603	2
Terminal Oil Sales -Homer	Terminal Oil Sales, Inc., Homer, AK 99603	4755 Homer Spit Road	Homer	AK	99603	2
Tesoro Alaska Kenai Refinery	Tesoro Alaska Petroleum	P.O. Box 3690	Kenai	AK	99611-3690	2
Tescro Alaska Anchorage Terminal	Tesoro Alaska Petroleum					2
Tesoro Alaska Valdez Terminal	Tesoro Alaska Petroleum	P.O. Box 3690	Kenai	AK	99611-3690	2
Tesoro Cook Inlet Vessel Operations	Tesoro Alaska Petroleum Company	P.O. Box 3690	Kenai	AK	99611-3690	2
Tesoro Charter Vessels - Cook Inlet	Tesoro Alaska Petroleum Company	P.O. Box 3690	Kenai	AK	99611-3690	2
Texaco Anchorage Terminal	Texaco Refining & Marketing Inc. Seattle	1601 Tidewater Road	Anchorage	AK	99501	2
Texaco Anchorage Terminal	Texaco Refining & Marketing, Inc.	P.O. Box 34041	Seattle	WA	98124-1041	2
Tidewater Pacific Vessels-CI	Tidewater Pacific, Inc.	1440 Canal Street	New Orleans	LA	70112	2
Trident Seafoods - Sandpoint	Trident Seafoods Corp, Sand Point, Ak					2
Trident Seafoods - Akutan	Trident Seafoods, Inc.					2
U.S. Army- Fort Richardson	U.S. Army	6th Infantry Div(Lgt), APVR-DE-PSE	Fort Richardson	AK	99505	2
U.S. Defense Fuels-Anchorage Terminal & Pipeline	U.S. Defense Logistics Agency-DFSC	Cameron Station, DFSC-FQ	Alexandria	VA	22304-6160	2
U.S. Navy - Adak	U.S. Naval Air Station	PSC 486, Box 1201	FPD Seattle	WA	98791	2

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Planttitle	Company	Address	City	ST	Zipcode	Region
U.S. Navy Amchitka	U.S. Navy Fleet Surveillance Spt Cmd,					2
U.S. Navy-Military Sealift Command Vessels	U.S. Navy, Washington, D.C.	Commander Military Sealift Command	Washington	DC	203908-510	2
U.S.A.F.-King Salmon Airport	U.S.A.F., 11th Aircraft Control Wing	6900 9th Street, Suite 301	Elmendorf AFB	AK	99506-2270	2
U.S.A.F., Shemya AFB	U.S.A.F., 11th Aircraft Control Wing	6900 9th Street, Suite 301	Elmendorf AFB	AK	99506-2270	2
U.S.A.F.-Elmendorf AFB	U.S.A.F.-21st Tactical Fighter Wing, EAFB	22-040 Maple Street	Elmendorf AFB	AK	99506-3240	2
U.S.C.G Kodiak	U.S.C.G., Kodiak	USCG Port Center, P.O. Box 14	Kodiak	AK	99619	2
Unocal Cook Inlet Production Facilities	Union Oil Company of California	P.O. Box 190247	Anchorage	AK	99519-0247	2
Swanson River Field Production	Unocal North American Oil & Gas Division	P.O. Box 190247	Anchorage	AK	99519-0247	2
West Coast Shipping-Cook Inlet	West Coast Shipping Company	P.O. Box 4258	Los Angeles	CA	90051-2258	2
Delta Western Naknek	Western Pioneer dba Delta Western					2
Tesoro Anchorage Terminal						2
City of Galena Power Plant Tank Farm	City of Galena	P.O. BOX 149	GALENA	AK	99741	3
Red Dog Mine Project	Cominco-Red Dog	P.O. BOX 1230	KOTZEBUE	AK	99752	3
Ft. Wainwright Tank Farm	Defense Fuel (Region FBKS)	6920 12th St.	ELMENDORF AFB	AK	99506-2570	3
Eskimo's, Inc. Wainwright	Eskimo's, Inc.	P.O. Box 536	Barrow	AK	99723	3
Block B Tank Farm	Eskimos Inc.	P.O. BOX 536	BARROW	AK	99723	3
Golden Valley Electric North Pole Plant	Golden Valley Electric Association	BOX 71249	FAIRBANKS	AK	99707	3
Kotzebue Electric Association	Kotzebue Electric	BOX 44	KOTZEBUE	AK	99752	3

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plant title	Company	Address	City	ST	Zipcode	Region
Mapco Petroleum Inc. Airport facility	Mapco	1100 H&H LANE	NORTH POLE	AK	99705	3
North Pole Refinery Mapco	Mapco	1100 H&H LANE	NORTH POLE	AK	99705	3
Nenana Fuel Company	Mapco	2090 VAN HORN ROAD	FAIRBANKS	AK	99701	3
Nome Joint Utility	Nome Joint Utility	BOX 70	NOME	AK	99762	3
Wainwright Fuel Storage	North Slope Borough	P.O. Box 69	Barrow	AK	99723	3
Barrow Oil Terminal	North Slope Borough	P.O. Box 69	Barrow	AK	99723	3
Pt. Hope Fuel Storage	North Slope Borough	P.O. Box 69	Barrow	AK	99723	3
Northern Transportation	Northern Transportation	P.O. BOX 250	HAY RIVER, CANADA, NWT		XOE ORO	3
PAFS-Nome Bulk Plant	Pacific Alaska Fuel Services	BOX 700	NOME	AK	99762	3
PAFS-Kotzebue Bulk Plant	Pacific Alaska Fuel Services	P.O. BOX 261	KOTZEBUE	AK	99752	3
Petro Star	Petro Star Inc.	BOX 56239	NORTH POLE	AK	99705	3
Chevron Fairbanks Bulk Plant	Saupe Chevron	P.O. Box 510	Fairbanks	AK	99707	3
Tesoro Airport Facility	Tesoro-Alaska Petroleum	P.O. BOX 60722	FAIRBANKS	AK	99706	3
Eielson AFB	U. S. Air Force	343 CES/DEV,2250 CENTRAL AVE SUITE #1	EIELSON AFB	AK	99702	3
BAR - Main	U.S. Air Force	GE GOV SERVICES 32156 CEDAR AVE., BLDG 32-156	ELMENDORF	AK	99506-3060	3
Galena AFB	U.S. Air Force	5072 CSS/DED, APO	SEATTLE	WA	98723-5000	3
Tin City	U.S. Air Force	GE GOV. SERVICES, BLDG 32-156	ELMENDORF AFB	AK	99506-5000	3
Cape Lisburne ACWS	U.S. Air Force	GE GOV SERVICES, BLDG 32-156	ELMENDORF AFB	AK	99506-5000	3
Fort Wainwright Facility	U.S. Army	DEH-ENVIRONMENTAL OFFICE	FT RICHARDSON	AK	99505-5500	3
Fort Greely Army Base	U.S. Army	DIRECTORATE OF ENGINEERING & HOUSING	FT GREELY	AK	98733-5500	3

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plant title	Company	Address	City	ST	Zipcode	Region
UIC Fuel Terminal	Ukpeagvik Inupiat Corporation	5300 "A" STREET	ANCHORAGE	AK	99518	3
U.N.C.	Unalakleet Native Corporation					3
Yutana Barge Lines	Yutana Barge Lines	P.O. BOX 00220	HEMANA	AK	99760	3
Yukon Fuel Company (GZ)	Yutana Barge Lines	P.O. BOX 89	FT YUKON	AK	99740	3
St. Michael Bulk Plant	Yutana Barge Lines	P.O. BOX 110	ST. MICHAEL	AK	99659	3
Trans Alaska Pipeline Valdez Marine Terminal	Alyeska Pipeline Service Co.	P.O. Box 300	Valdez	AK	99686	4
Trans Alaska Pipeline Valdez Marine Terminal	Alyeska Pipeline Service Co.	P.O. Box 300	Valdez	AK	99686	4
Alyeska Trans Alaska Pipeline	Alyeska Pipeline Service Co.	1835 South Bragaw Street	Anchorage	AK	99512	4
Alyeska Trans Alaska Pipeline	Alyeska Pipeline Service Co.	1835 South Bragaw Street	Anchorage	AK	99512	4
Amerada Hess Corporation - Marine	Amerada Hess					4
Amerada Hess Corporation - Marine	Amerada Hess					4
Amerada Hess Barrier Islands Exploration Program	Amerada Hess Corporation	1201 Louisiana, Suite 700	Houston	TX	77002	4
Amerada Hess Jones Island Exploration Program	Amerada Hess Corporation	1201 Louisiana, Suite 700	Houston	TX	77002	4
American Trading Transportation-Chesapeake Trader	American Trading Transportation Co. Inc					4
American Trading Transportation-Chesapeake Trader	American Trading Transportation Co. Inc					4
American Trading Transportator American Trader	American Trading Transportation Co. Inc.					4

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plantitle	Company	Address	City	ST	Zipcode	Region
American Trading Transportation- American Trader	American Trading Transportation Co. Inc.					4
Amoco Galahad	Amoco Production Co.	P.O. Box 100779	Anchorage	AK	99510-0779	4
Amoco Galahad	Amoco Production Co.	P.O. Box 100779	Anchorage	AK	99510-0779	4
ARCO Cabot Prospect	ARCO Alaska Inc.	P.O. Box 100360	Anchorage	AK	99510-0360	4
ARCO Prudhoe Bay & Lisburne Units	ARCO Alaska Inc.	P.O. Box 100360	Anchorage	AK	99510-0360	4
Arco Fireweed Prospect	Arco Alaska Inc.	P.O. Box 100360	Anchorage	AK	99510-0360	4
ARCO Prudhoe Bay & Lisburne Units	ARCO Alaska Inc.	P.O. Box 100360	Anchorage	AK	99510-0360	4
Arco Fireweed Prospect	Arco Alaska Inc.	P.O. Box 100360	Anchorage	AK	99510-0360	4
ARCO Cabot Prospect	ARCO Alaska Inc.	P.O. Box 100360	Anchorage	AK	99510-0360	4
ARCO Kuvlum Prospect	ARCO Alaska, Inc.	P.O. Box 100360	Anchorage	AK	99510-0360	4
ARCO Kuparuk Field and Pipeline	ARCO Alaska, Inc.	P.O. Box 196105	Anchorage	AK	99510-6105	4
ARCO Kuvlum Prospect	ARCO Alaska, Inc.	P.O. Box 100360	Anchorage	AK	99510-0360	4
ARCO Kuparuk Field and Pipeline	ARCO Alaska, Inc.	P.O. Box 196105	Anchorage	AK	99510-6105	4
Arco Marine - Prince William Sound	Arco Marine, Inc.					4
Arco Marine - Prince William Sound	Arco Marine, Inc.					4
BPX Endicott	BP Exploration (Alaska) Inc.	P. O. Box 196612	Anchorage	AK	99519-6612	4
BPX Prudhoe Bay Unit	BP Exploration (Alaska) Inc.	P.O. 196612	Anchorage	AK	99519-6612	4
BPX Endicott	BP Exploration (Alaska) Inc.	P. O. Box 196612	Anchorage	AK	99519-6612	4
BPX Sag Delta Well #12	BP Exploration (Alaska) Inc.	P.O. Box 196612	Anchorage	AK	99519-6612	4
BPX Pt. Barrow	BP Exploration (Alaska) Inc.	P.O. Box 196612	Anchorage	AK	99519-6612	4
BPX Prudhoe Bay Unit	BP Exploration (Alaska) Inc.	P.O. 196612	Anchorage	AK	99519-6612	4

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plantitle	Company	Address	City	ST	Zipcode	Region
BPX Kuparuk Uplands	BP Exploration (Alaska) Incorporated	P.O. Box 196612	Anchorage	AK	99519-6612	4
BPX Kuparuk Uplands	BP Exploration (Alaska) Incorporated	P.O. Box 196612	Anchorage	AK	99519-6612	4
T/V OVERSEAS BOSTON.	Cambridge Tankers Corp.					4
T/V OVERSEAS BOSTON.	Cambridge Tankers Corp.					4
Chevron Shipping Company	Chevron Shipping Company					4
Chevron Shipping Company	Chevron Shipping Company					4
Chevron Canvasback Prospect	Chevron USA	P.O. Box 107839	Anchorage	AK	99510-7839	4
Chevron Canvasback Prospect	Chevron USA	P.O. Box 107839	Anchorage	AK	99510-7839	4
Conoco Badami Exploration Project	Conoco Inc.	3201 C Street, Suite 200	Anchorage, AK	AK	99503-3999	4
Conoco Milne Point	Conoco Inc.	3201 C Street, Suite 200	Anchorage	AK	99503-3999	4
Conoco Badami Exploration Project	Conoco Inc.	3201 C Street, Suite 200	Anchorage, AK	AK	99503-3999	4
Conoco Sequoia Exploration Project	Conoco Inc.	3201 C Street, Suite 200	Anchorage	AK	99503-3999	4
Conoco Milne Point	Conoco Inc.	3201 C Street, Suite 200	Anchorage	AK	99503-3999	4
Conoco Sequoia Exploration Project	Conoco Inc.	3201 C Street, Suite 200	Anchorage	AK	99503-3999	4
Exxon Thetis Island #1 Exploratory Well	Exxon Exploration Company	P.O. Box 196601	Anchorage	AK	99510-6601	4
Exxon Shipping Company	Exxon Shipping Company					4
Exxon Shipping Company	Exxon Shipping Company					4
T/V OVERSEAS CHICAGO	First Shipmor Associates					4

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
 OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Planttitle	Company	Address	City	ST	Zipcode	Region
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T/V OVERSEAS CHICAGO	First Shipmor Associates					4
T/V WESTERN LION	First United Shipping					4
T/V WESTERN LION	First United Shipping					4
T/V OVERSEAS WASHINGTON	FOURTH SHIPHOR ASSOCIATES					4
T/V OVERSEAS WASHINGTON	FOURTH SHIPHOR ASSOCIATES					4
T/V OVERSEAS ALASKA	Intercontinental Bulk Tank Corp.					4
T/V OVERSEAS ALASKA	Intercontinental Bulk Tank Corp.					4
Interocean Management Corp.	Interocean Management Corp.					4
Interocean Management Corp.	Interocean Management Corp.					4
T/V SOUTHERN LION	INTEROCEAN TANKER CORPORATION					4
T/V SOUTHERN LION	INTEROCEAN TANKER CORPORATION					4
T/V OVERSEAS JUNEAU	Juneau Tanker Corp.					4
T/V OVERSEAS JUNEAU	Juneau Tanker Corp.					4
Keystone Shipping Company	Keystone Shipping Co.					4
Keystone Shipping Company	Keystone Shipping Co.					4
MARINE TRANSPORT LINES	Marine Transport Lines, Inc.					4
MARINE TRANSPORT LINES	Marine Transport Lines, Inc.					4
T/V OMI COLUMBIA	OMI CHALLENGER TRANSPORT, INC.					4
T/V OMI COLUMBIA	OMI CHALLENGER TRANSPORT, INC.					4

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

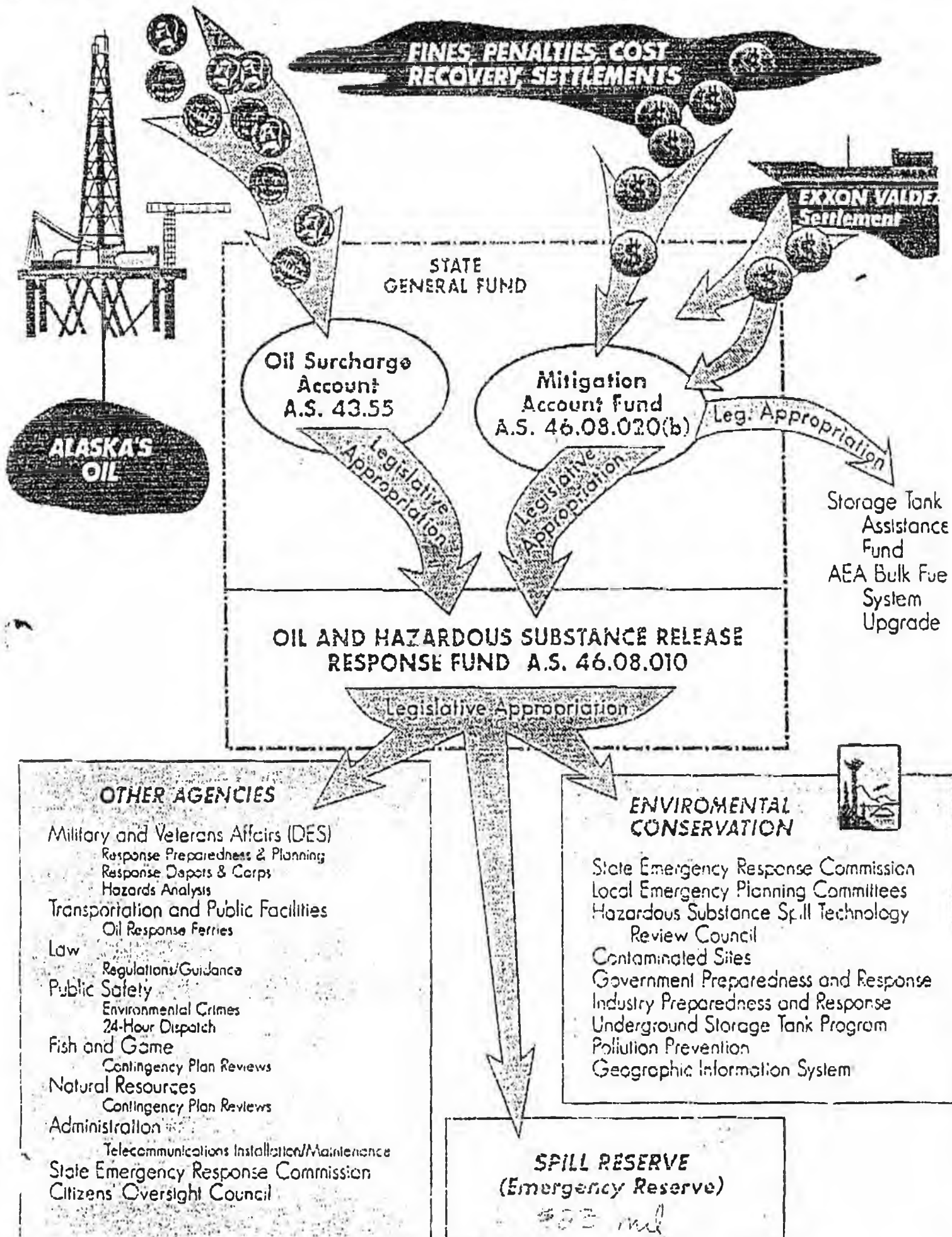
03/23/93

Plant title	Company	Address	City	ST	Zipcode	Region
T/V OVERSEAS ARCTIC	OVERSEAS BULK TANK CORPORATION					4
T/V OVERSEAS ARCTIC	OVERSEAS BULK TANK CORPORATION					4
PETRO STAR TANK FARM & BARGE LOADING FACILITY	PETRO STAR JOINT VENTURE	P.O. BOX 3389	VALDEZ	AK	99686	4
PETRO STAR TANK FARM & BARGE LOADING FACILITY	PETRO STAR JOINT VENTURE	P.O. BOX 3389	VALDEZ	AK	99686	4
PETRO STAR VALDEZ REFINERY	PETRO STAR JOINT VENTURE	P.O. BOX 3389	VALDEZ	AK	99686	4
PETRO STAR VALDEZ REFINERY	PETRO STAR JOINT VENTURE	P.O. BOX 3389	VALDEZ	AK	99686	4
PETRO STAR VALDEZ REFINERY	PETRO STAR VALDEZ JOINT VENTURE	P.O. BOX 3389	VALDEZ	AK	99686	4
PETRO STAR VALDEZ TANK FARM & BARGE LOADING FACILITY	PETRO STAR VALDEZ JOINT VENTURE	P.O. BOX 3389	VALDEZ	AK	99686	4
T/V OVERSEAS PHILADELPHIA	PHILADELPHIA TANKER CORPORATION					4
T/V OVERSEAS PHILADELPHIA	PHILADELPHIA TANKER CORPORATION					4
T/V OVERSEAS OHIO	Second Shipmor Associates					4
T/V OVERSEAS OHIO	Second Shipmor Associates					4
T/V NORTHERN LION	Second United Shipping					4
T/V NORTHERN LION	Second United Shipping					4
Texaco Chukchi Sea	Texaco Producing Inc.	550 West Seventh Avenue	Anchorage	AK	99501	4
Texaco Chukchi Sea	Texaco Producing Inc.	550 West Seventh Avenue	Anchorage	AK	99501	4
T/V OVERSEAS NEW YORK	Third Shipmor Associates					4
T/V OVERSEAS NEW YORK	Third Shipmor Associates					4

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
 OIL DISCHARGE PREVENTION AND CONTINGENCY PLANS

03/23/93

Plantitle	Company	Address	City	ST	Zipcode	Region
T/V EASTERN LION	Third United Shipping					4
T/V EASTERN LION	Third United Shipping					4
TRINIDAD CORPORATION	TRINIDAD CORPORATION					4
TRINIDAD CORPORATION	TRINIDAD CORPORATION					4
Unocal Alpenglow Exploration Drilling Program	Unocal Corporation	P.O. Box 190247	Anchorage	AK	99519	4
Unocal Alpenglow Exploration Drilling Program	Unocal Corporation	P.O. Box 190247	Anchorage	AK	99519	4



Oil and Hazardous Substance Prevention and Response Fund		g:\spar\hearings\238projA.xls					
Revision Date: 04/14/93	FY94	FY95	FY96	FY97	FY98	FY99	FY2000
Balance Forward Catastrophic Response Account		30,573.3	45,873.3	50,000.0	50,000.0	50,000.0	50,000.0
Balance Forward Contingency and Abatement Account		6,055.2	2,228.2	.0	.0	.0	.0
Revenue from .03 Surcharge		15,300.0	4,126.7	.0	.0	.0	.0
Revenue from .02 Surcharge		10,200.0	9,840.0	9,040.0	8,240.0	7,560.0	6,800.0
Catastrophic Mitigation Account		.0	.0	.0	.0	.0	.0
Contingency/Abatement Mitigation Account		300.0	300.0	600.0	900.0	1,000.0	1,000.0
TOTAL AVAILABLE IN FUND	50,955.5	62,428.5	62,368.2	59,340.0	59,140.0	58,560.0	57,800.0
DISTRIBUTION BETWEEN ACCOUNTS							
Catastrophic Response Account	30,573.3	45,873.3	50,000.0	50,000.0	50,000.0	50,000.0	50,000.0
Contingency and Abatement Account	20,382.2	16,555.2	12,368.2	9,640.0	9,140.0	8,560.0	7,800.0
TOTAL IN ACCOUNTS	50,955.5	62,428.5	62,368.2	59,640.0	59,140.0	58,560.0	57,800.0
PROJECTED EXPENDITURES							
SPAR Director's Office	1,098.8	1,098.8	1,098.8	1,098.8	1,098.8	1,098.8	1,098.8
Industry Preparedness Program	2,346.0	2,346.0	2,346.0	2,346.0	2,346.0	2,346.0	2,346.0
Government Preparedness and Response Program	4,040.7	4,040.7	4,040.7	4,040.7	4,040.7	4,040.7	4,040.7
Contaminated Sites Program	2,852.1	2,852.1	2,852.1	2,852.1	2,852.1	2,852.1	2,852.1
Underground Storage Tank Program	75.9	75.9	75.9	75.9	75.9	75.9	75.9
Division of Information and Administrative Services	740.6	740.6	740.6	740.6	740.6	740.6	740.6
Division of Environmental Quality	303.5	303.5	303.5	303.5	303.5	303.5	303.5
Response Fund Administration (Other Agencies)							
Fish and Game	190.7	190.7	190.7	190.7	190.7	190.7	190.7
Natural Resources	108.0	108.0	108.0	108.0	108.0	108.0	108.0
Law	1,360.2	1,360.2	1,360.2	1,360.2	1,360.2	1,360.2	1,360.2
Labor	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Community and Regional Affairs	13.5	13.5	13.5	13.5	13.5	13.5	13.5
Health and Social Services	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Public Safety	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Legislative Affairs	.0	.0	.0	.0	.0	.0	.0
DOT/Pf	6.5	6.5	6.5	6.5	6.5	6.5	6.5
DMVA	611.0	611.0	611.0	611.0	611.0	611.0	611.0
Administration	.0	.0	.0	.0	.0	.0	.0
University of Alaska	.0	.0	.0	.0	.0	.0	.0
Capital Budget							
Response Ferry	.0	.0	.0	.0	.0	.0	.0
State Owned Site Cleanup	.0	.0	.0	.0	.0	.0	.0
SIJB TOTAL PROJECTED EXPENDITURES	13,827.0	13,827.0	13,827.0	13,827.0	13,827.0	13,827.0	13,827.0
Non Catastrophic Response (available)	6,555.2	2,728.2	-1,458.8	-4,187.0	-4,687.0	-5,267.0	-6,027.0
Non Catastrophic Response (expended)	500.0	500.0	500.0	500.0	500.0	500.0	500.0
TOTAL	20,382.2	16,555.2	12,368.2	9,640.0	9,140.0	8,560.0	7,800.0
Assumptions:							
Bill is effective 7/1, thus Ferry and R and D will not be funded in FY 94.							
FY94 available balance will be allocated 60% to catastrophic and 40% to contingency and abatement.							
FY94 authorized is based on the House scenario.							
None of the funding for Contaminated Sites is used for restoration.							
Contingency and Abatement Mitigation Account will receive funding from cost recovery, fines, settlements and penalties for Non Catastrophic Response.							
Cost recovery will begin to increase based on enhanced procedures and efforts in FY97.							
State Owned Sites must be cleaned up using General Funds							
Average annual expenditures for non catastrophic response will be 500.0.							

Books

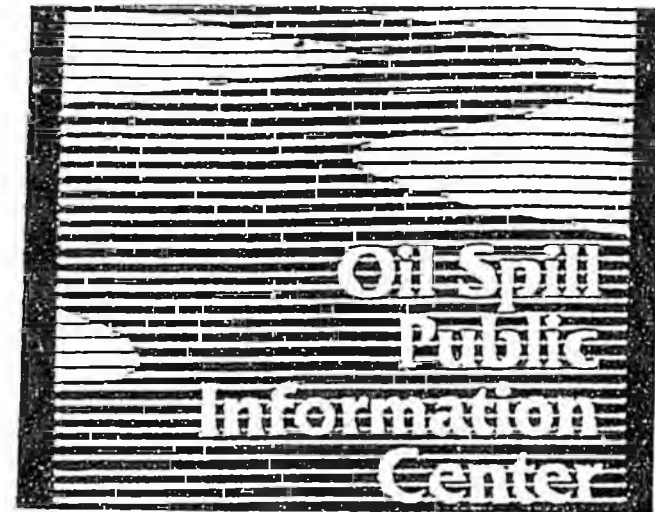
Technical Reports

Audiotapes

Videotapes

Slides

Maps



Oil Spill Public Information Center

645 G street
Anchorage, Alaska 99501

(907) 278-8008
(907) 276-7178 Fax
800-478-7745 In Alaska
800-283-7745 Outside Alaska

The Oil Spill Public Information Center (OSPIC) provides public access to information on the *Exxon Valdez* oil spill. Located in Anchorage, Alaska, the OSPIC welcomes requests from patrons around the world.

The OSPIC's Origin On March 24, 1989, the tanker *Exxon Valdez* spilled almost 11 million gallons of oil into Prince William Sound. Cleanup, damage assessment, and restoration efforts that followed continue to generate large amounts of scientific and economic information.

Recognizing the value of this information to the public, the U.S. Department of Justice established the Oil Spill Public Information Center. Administration of the OSPIC currently falls under the auspices of the *Exxon Valdez* Oil Spill Trustee Council, a six member panel representing three Federal and three State of Alaska agencies.

Resources and Services The OSPIC collection includes information for numerous disciplines of the natural and social sciences, economics, and law. Visitors to the OSPIC will find technical reports, books, maps, audio and videotapes, slides, and computerized databases.

To serve users from outside the Anchorage area, the OSPIC's professional library staff has established systems for sharing information by telephone, fax, mail, or interlibrary loan. In addition, the OSPIC is a contributing member of the Western Library Network (WLN). Through WLN, the OSPIC's resources are made available throughout the United States, Canada, and other countries.

Special Collections Included in the OSPIC's reference and circulating collection are the following special collections:

Natural Resource Damage Assessment Studies - The OSPIC serves as a repository for these interim and final reports.

Newspaper Clippings - This comprehensive collection of newspaper articles pertaining to the *Exxon Valdez* oil spill is indexed in an inhouse database and in WLN's PolarPak.

Shoreline Evaluations - Produced by multi-agency teams, these reports detail oiling conditions and cleanup recommendations.

Trustee Council Public Record - The OSPIC serves as a repository for documents produced for and by the Trustee Council, including meeting transcripts, budgets, and public comments.

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The Magazine of the Alaska Department of Fish and Game

ALASKA'S WILDLIFE

Volume 25, No. 1
\$5.00

The
Exxon Valdez
Oil Spill

What Have We Learned?



Special Issue



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Walter J. Hickel, Governor

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Ron Somerville, Deputy Commissioner
Chuck Meacham, Deputy Commissioner

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Cheryl Hull, Assist. Editor/Business Manager
John B. Hyde, Photography Editor

COVER: Although oil is no longer visible from a distance on shorelines such as these in Lower Herring Bay, it can still be found under the surface (inset photo, May 1992) in some previously oiled areas.

ALASKA'S WILDLIFE

The Magazine of the Alaska Department of Fish and Game
Volume 25, No. 1 January-February 1993

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From the New Editor...

I feel privileged to begin my new job as editor of *Alaska's Wildlife* with this issue, devoted exclusively to the scientific work related to the March 1989 Exxon Valdez oil spill.

Normally, scientific findings are first published in professional journals where they undergo outside peer review to ensure credibility and accuracy. However, it is usually a long time before information submitted to professional journals filters out to the public. For several reasons, the department and other trustee agencies decided to release some of the oil spill findings in this issue of *Alaska's Wildlife*. First, when the legal settlement removed strict confidentiality on oil spill research, the department realized that it would be difficult to sequester the findings until the scientific publication process was complete. Second, this research has already undergone extensive internal peer review. Third, the world has waited for over three years to hear from scientists about the effects of the oil spill on Alaska's natural resources, and the department wanted to ensure that the most accurate and current information is released. Some of the information presented is preliminary, and conclusions could change with further analysis and interpretation.

The issue was conceived by Jerome Montague and Michelle Sydeman, and publication has required extensive cooperation between Trustee agencies, scientists, and legal counsel of the Departments of Law and Justice. Within the Department of Fish and Game, we have received enormous help from reviewers in many sections and at all levels. Perhaps more than any issue in our history, this one represents a department-wide effort.


Lynn Wallen

EDITORIAL

Throughout history, catastrophic events have caused rapid, sometimes beneficial, changes in philosophy and brought out the best in human endeavor and spirit. This has been particularly true of ecological disasters. At the close of the 19th century, in the span of one lifetime, Americans had deforested an area of our country the size of Europe. The future of our forests looked bleak. In response, Congress passed an act in 1891 which started the federal forest reserves, an ineffective stop-gap effort. The unresolved problem inspired Gifford Pinchot to develop a philosophy of conservation (meaning wise use) that now directs the activities of most biological resource agencies. Theodore Roosevelt changed the forest reserves into a National Forest System in 1905, creating in the process the U.S. Forest Service. He put Pinchot at its head and charged it with scientific forest management and multiple use. The Chugach National Forest in the Prince William Sound area was created in this process.

In the 1930s, a drastic reduction in the nation's wildlife, which resulted from unscientific management of wildlife or no management at all, and the ecological horror of the "dust bowl" years, inspired the creation of the new field of scientific wildlife management by Aldo Leopold. The proliferation of the pesticide DDT and its disastrous effects on an ecosystem's food chain prompted Rachel Carson to write *Silent Spring* in 1962, a book credited with propelling concern about the environment into the world-wide movement that is still growing today.

In 1989, the grounding of the *TV Exxon Valdez* resulted in the largest oil spill in U.S. history. This catastrophe in the nation's most pristine temperate marine ecosystem was another milestone in environmental history, and, like earlier environmental disasters, is resulting in change. The *Exxon Valdez* Trustees and the scientists and managers serving them have conducted the most comprehensive research into the effects of an oil spill ever undertaken: a \$100 million effort spanning three years. The result, in a nutshell, is that we are rewriting the book on the effects of oil. We want to ensure that no

one will have to relearn what was learned here. This issue of *Alaska's Wildlife*, dedicated to presenting some of the research findings, is one of the ways Trustee agencies are beginning to provide this information to the public.

The oil spill has been, and continues to be, a media event extraordinaire. Consequently, the words *Exxon Valdez* are infamous throughout the world. Yet because the investigations conducted by the Trustees have been litigation-sensitive, official scientific inquiry had to be conducted with severe restrictions on dissemination of information. Scientists generally prefer to do their research openly with a free exchange of information with colleagues. Thus, it was difficult for them to work secretly for three years. Nevertheless, the principal investigators remained dedicated to the well-being of the resources and enthusiastic about working on the most famous environmental project of our time.

At the urgings of Governor Walter Hickel, Alaska's Attorney General, Charles Cole, and others negotiated a settlement between the State of Alaska, the Federal Government, and the responsible party in the spring of 1991. This settlement required approval of the Alaska legislature, which was not granted. The Attorney General was again tasked with pursuing a settlement, which was successful that fall, and the cloak of secrecy began to be lifted. The spill was an Alaska-size disaster, and resulted in an Alaska-size settlement: \$1.03 billion, the largest criminal fine and civil judgment for an environmental case in history. Without this agreement, the results of scientific research may have been kept secret even longer, and, more importantly, restoration efforts could have been further delayed.

In this issue investigators will share their story with you for the first time. They tell of the difficulties of conducting outstanding research under emergency conditions and schedules, in secrecy, and on topics for which there had been no precedent. Many results may startle you, allowing you to feel the prospector-like excitement of scientific discovery. You



J. Jerome Montague

may be surprised to learn that, except for river otters, few land mammals were significantly affected by the spill. Even more surprising is that sockeye salmon in the Kenai River, some 400 water miles from the site of the spill, may well be the most seriously injured of all species by the spill; the population in 1995 is predicted to be less than ten percent of the 1989 level. Who in 1989 would have guessed that such an injury would happen so far from the spill site and not be evident until six years after the spill? You will find out why it is thought that harlequin ducks have not reproduced in western Prince William Sound in any year since the spill and the scientists' hypotheses as to why pink salmon eggs and fry suffered higher mortalities in oiled areas in 1991 than they did in the year of the spill. Most importantly, you will learn the opinions of the experts on how restoration should proceed.

I tip my hat to all of those people with mist nets, plankton tows, radio and coded wire tags, optical scanners, cameras, and zodiacs who used their expertise, ingenuity, and tenacity to find out what happened to our natural resources. The public and the Trustees will use this information to define a path for restoration that will turn calamity into benefit for fish, wildlife, and the people of Alaska.

Jerome Montague is Chief of Restoration in the Habitat and Restoration Division, ADF&G, Juneau.

In the Wake of the Spill: Injury Assessment and Restoration

by Mark Fraker

On March 24, 1989, the supertanker *Exxon Valdez* spilled an estimated 11.2 million gallons of crude oil into the pristine waters of Prince William Sound, Alaska. This was the largest spill in U.S. history, and little was known about the effects of a spill this size on an ecosystem. The State of Alaska and the Federal Government undertook more than 100 studies to determine the extent of injury or loss of natural resources that resulted. In addition to documenting injury, these studies will help guide restoration. In fact, some of these studies were specifically directed toward gaining information needed for restoration. These studies were conducted in accordance with Natural Resource Damage Assessment (NRDA) regulations which outline a process that may be used to determine proper compensation to the public for injuries to natural resources. NRDA regulations find their basis in the Comprehensive Environmental Response, Compensation, and Liability Act, and in the Clean Water Act. These acts, along with the Consent Decree issued by the U.S. District Court in the settlement of government claims against Exxon and the accompanying memorandum of agreement (August 28, 1991) between the governments, provide the basic framework for injury assessment and restoration.

In September 1991, the United States and Exxon entered a criminal plea agreement. Pursuant to that agreement, Exxon was convicted of four criminal offenses, assessed substantial fines, and ordered to pay restitution in the amount of \$100 million equally shared with the State of Alaska and the United States. The criminal settlement states that monies are to be managed independently by the two governments, and must be used "...exclusively for restoration projects, within the State of Alaska, relating to the *Exxon Valdez* oil spill." In this settlement,

...restoration includes restoration, replacement and enhancement of affected resources, acquisition of equivalent resources and services, and long-term environmental moni-

toring and research programs directed to the prevention, containment, cleanup and amelioration of oil spills.

Concurrent with the criminal plea agreement, Alaska, the federal government, and Exxon arrived at a civil settlement which provides for the payment of \$900 million to the state and federal governments over a period of 11 years. An initial payment of \$90 million was made in December 1991, with a second installment of \$150 million (less allowable cleanup costs incurred by Exxon) in December 1992. Another \$100 million is due in September 1993, with \$70 million due annually from 1994 through 2001. The civil settlement monies are to be managed by a Trustee Council comprised of the Commissioners of the Alaska departments of Environmental Conservation, and Fish and Game, the Alaska Attorney General, and the Secretaries (or their designees) of the U.S. Departments of Agriculture, Commerce, and the Interior.

The civil monies can be used to reimburse both governments for costs related to response, cleanup, litigation, and NRDA studies. Under the civil settlement, restoration means any action that endeavors to restore any natural resource that was injured, lost, or destroyed as a result of the oil spill. Restoration also includes returning services that had been provided by the affected resources to their pre-spill condition. In addition, restoration may include all phases of injury assessment, restoration, replacement, and enhancement of natural resources, and the acquisition of resources and services that are equivalent to those that were lost or injured by the spill.

Late in 1989, an interagency Restoration Planning Work Group was created to develop a restoration plan that will guide the spending of the civil monies. The Work Group is comprised of representatives of the Alaska departments of Fish and Game, Environmental Conservation, and Natural Resources, and the U.S. Forest Service, National Marine Fisheries Ser-

(Continued on page 47.)

Subsistence Uses of Fish and Wildlife

by James A. Fall

The Exxon Valdez oil spill covered lands and waters that have been used for subsistence hunting, fishing, and gathering for at least 7,000 years. Communities in the spill area range in size from relatively large towns to small, predominantly Alaska Native (Alutiiq or "Aleut") communities. Subsistence uses of wild resources remain an important aspect of the economy, culture, and way of life of many families within these communities.

Before the spill, subsistence harvests in these communities, especially in the 15 small communities, were relatively large and diverse. These harvests included many kinds of fish, marine invertebrates, land mammals, marine mammals, birds and eggs, and wild plants. Spring and summer are particularly important seasons, when large quantities of resources are harvested and preserved for later use.

After the spill, many people wondered whether subsistence foods were still safe to eat. Although health officials advised that a smell and taste test (called an "organoleptic test") was a reliable way to determine if a resource had been contaminated by oil, many people remained skeptical. Some consequences of the spill were obvious: hundreds of mammals and thousands of birds had died, and hundreds of miles of beaches were oiled. On the other hand, the spill's effects on other resources, such as fish and shellfish, were not so clear. If these animals ingested small

amounts of oil, could this render them unsafe to eat? This was of special concern to subsistence users who consume large quantities of fish and shellfish. For people whose survival has always depended upon traditional knowledge and observations of the natural environment, the oil spill created completely unfamiliar conditions. Their skills in understanding their environment and making informed decisions had been undermined. "We don't want to eat them [subsistence foods] until we find out what's really going on," explained a resident of Chenega Bay. Furthermore, with reduced populations of some resources, hunters felt a reluctance to add to the mortality. As a Tatitlek man said, "When you hear thousands of them [waterfowl] are dying everyday, it's tough to harvest them."

Consequently, subsistence harvests in some communities virtually ceased soon after the spill. As documented in Division of Subsistence interviews, in 10 communities subsistence harvests declined between 14% and 77% compared to pre-spill averages. For example, in the mid 1980s, the residents of Chenega Bay averaged a subsistence harvest of about 342 pounds per person per year. This dropped to 148 pounds in the year following the spill. In 1987, Nanwalek (English Bay) households harvested 289 pounds of wild foods per person, but in 1989 this fell to 141 pounds.

Other aspects of subsistence uses were affected as well. For

After the spill, many people wondered whether subsistence foods were still safe to eat.



Subsistence harvests by residents of Chenega Bay are still reduced, due to their concerns over food safety.

CORRECTION

**THIS DOCUMENT
HAS BEEN REPHOTOGRAPHED
TO ASSURE LEGIBILITY**

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example, on average, households in Tatitlek used 23 varieties of wild foods in the 12 months preceding the oil spill. For the 12 months after the spill, this average dropped to 12 kinds of resources. Declines in the variety of wild foods shared between households and in the percentage of people engaging in subsistence harvesting were also documented for many communities.

The primary response to the issue of subsistence foods contamination was directed by the Oil Spill Health Task Force. This group included the Indian Health Service; the Alaska departments of Fish and Game, Environmental Conservation, and Health and Social Services; the National Oceanic and Atmospheric Administration; Exxon; and two regional Alaska Native service organizations, the North Pacific Rim and the Kodiak Area Native Association. The task force coordinated and reviewed research on subsistence food safety, developed a consensus on health issues, and communicated the findings of the studies to the communities.

As part of this response effort, in 1989, 365 samples of fish and marine invertebrates were collected from known harvest areas recommended by local residents in Prince William Sound, lower Cook Inlet, and the Kodiak Island area. These resources were collected by teams of task force members along with residents of the communities. The samples were tested for signs of oil contamination at the National Marine Fisheries Service's Northwest Fisheries Center in Seattle. These highly sensitive tests measure the levels of polycyclic aromatic hydrocarbons (PAHs) in edible tissues. The findings were reviewed twice by a panel of toxicologists who provided a health assessment. In September 1989 and again in early 1990, this expert panel concluded that the levels of PAHs found in the fish samples were very low and of no health concern. The panel noted that fish are able to rid themselves quickly of oil by breaking it down in their livers, concentrating it in their gall bladders, and passing it out in their bile. Although this process may cause injury to the fish, it prevents dangerous levels of PAHs from building up in their flesh.

Most of the shellfish tested as part of this program were also safe, but some from oiled beaches such as Windy Bay on the lower Kenai Peninsula had relatively high levels of PAHs, which raised concerns for the toxicologists. The expert panel concluded that shellfish "should not be collected from obviously oil-contaminated areas." Unlike fish, marine invertebrates such as clams, mussels, and chitons are unable to quickly clean themselves of PAHs; as long as exposure to hydrocarbons continues, these toxins will build up (bioaccumulate) in these animals.

The task force organized a series of community meetings in October 1989 to inform subsistence users about the earliest study findings and the health advice. Although community residents were appreciative of this effort, many questions remained. How could users be sure that resources were safe based upon the limited number of samples and sites examined up to that point? Also, little or no specific information was available about other

important resources, such as deer, waterfowl, and marine mammals. The communities strongly urged that studies continue and that communication of findings and health advice be expanded.

In response, an expanded program of subsistence resource collection and testing occurred in 1990 and 1991, funded by the State of Alaska and Exxon. Sites were added near



© Photos by Andy Williams

Alaska Peninsula communities, and reference samples were collected near Yakutat.

All together, 309 samples of fish and 1,080 samples of shellfish from 146 sites were tested over the three years of the project. Although some of the fish have shown evidence of exposure to hydrocarbons in the bile or tissue samples, none of the samples had PAH levels so high as to be a human health concern. The vast majority of shellfish from most sites have also been determined to be safe to eat. However, even in 1991, PAH levels remained elevated at Windy Bay. Therefore, the task force's advice has remained cautious: fish from the oil spill area are safe to eat, but people should still avoid using marine invertebrates from beaches with obvious oiling.

As part of the expanded program, samples of ducks, deer, and

marine mammals were also tested for evidence of exposure to hydrocarbons. A total of 19 duck livers (Barrow's goldeneye, common goldeneye, and harlequin) were tested at Texas A&M University. These were collected by the Alaska Department of Fish and Game (ADF&G) near Chenega Bay and at Uyak Bay off Kodiak Island in early 1990. Although evidence of exposure to oil was found in some of the ducks from Prince William Sound, all PAH levels were well within levels considered safe for human consumption.

Muscle and liver samples from 16 deer collected by ADF&G near oiled beaches in Prince William Sound and Kodiak in August and September 1989 and March 1990 were also tested by Texas A&M University. Four of the livers showed signs that the deer had been exposed to oil, but the PAH levels were far below those considered dangerous by health experts.

Tests were also run on blubber, liver, kidney, and muscle samples from 33 harbor seals and 10 sea lions. The sample included 18 seals collected by ADF&G in 1989 and 1990 from heavily oiled areas of Prince William Sound. Eight of these seals, taken within the first three months of the spill, had large amounts of oil on their skin. Except for the blubber, tests on these 18 seals revealed low to non-detectable levels of PAHs. Readings for the blubber were higher, because oil-based contaminants are attracted to fat. These readings were highest (up to 800 parts per billion of PAHs) for the oiled seals. The blubber samples from animals taken in the same areas in 1990 revealed reduced levels, although these were still higher than samples from seals from unoiled areas. Members of the task force advised that these readings were well below those considered to be of concern for subsistence users. In March and April of 1990, hunters from Chenega Bay, Tatitlek, and Nanwalek took seven seals and a sea lion that were also tested for this program. None of these animals had visible signs of oiling. Tests on muscle, liver, kidneys, and blubber detected no PAHs higher than six parts per billion, which is considered to be a background level.

Communication efforts were also expanded. The Division of Subsistence produced newsletters and, with the assistance of the Governor's Office, a video on subsistence foods safety issues. The video was provided to communities and was aired on the Rural Alaska Television Network. In June 1992, the task force organized a second round of community meetings to update residents on study results and conclusions. Household interviews conducted in seven communities by the Division of Subsistence in April 1991 found that in the second year after the spill, subsistence harvests increased in the Lower Cook Inlet and

Kodiak areas, but in some cases still remained below pre-spill averages. However, subsistence harvests in the Prince William Sound communities of Tatitlek and Chenega Bay showed few signs of recovery. This was primarily due to continued concerns about the safety of using subsistence foods, as well as a perceived decline in the numbers of some resources such as marine mammals, sea ducks, and marine invertebrates. Some families who had returned to using subsistence foods had done so despite misgivings.

Restoration

Clearly, restoration of subsistence uses is essential to the well-being and, indeed, the survival of these communities. Restoration efforts should concentrate on providing subsistence users with reliable information which they can use to make informed decisions about their harvest activities. This includes information about the continued presence of oil in harvest areas and wildlife habitats and the results of injury assessment programs. The continued monitoring of PAH levels in marine invertebrates and other resources which might be exposed to oil should be considered.

Towards this end, a restoration project including the collection and testing of samples of subsistence foods from representative sites in the oil spill area and communication of information from oil spill studies would be useful. As in the past, local residents would be encouraged to participate in the collection of the samples. The results of the tests, along with findings from other injury assessment and restoration studies, will be interpreted by staff of the Trustee Council and reported in additional newsletters and community meetings. In addition, observations by subsistence users would be shared with both scientists studying the effects of the oil spill and with other affected communities. The option of replacing injured populations by enhancing marine invertebrate resources in nonoiled areas will also be evaluated. It is hoped that, with time, these programs will bring to subsistence users a renewed confidence in their abilities to understand their natural environment and restored opportunities to continue their way of life.

James A. Fall is Subsistence Regional Program Manager with the Division of Subsistence, ADF&G, in Anchorage.

Season's Greetings



12-78

Season's Greetings



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Season's Greetings



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Deer by Jon Lewis

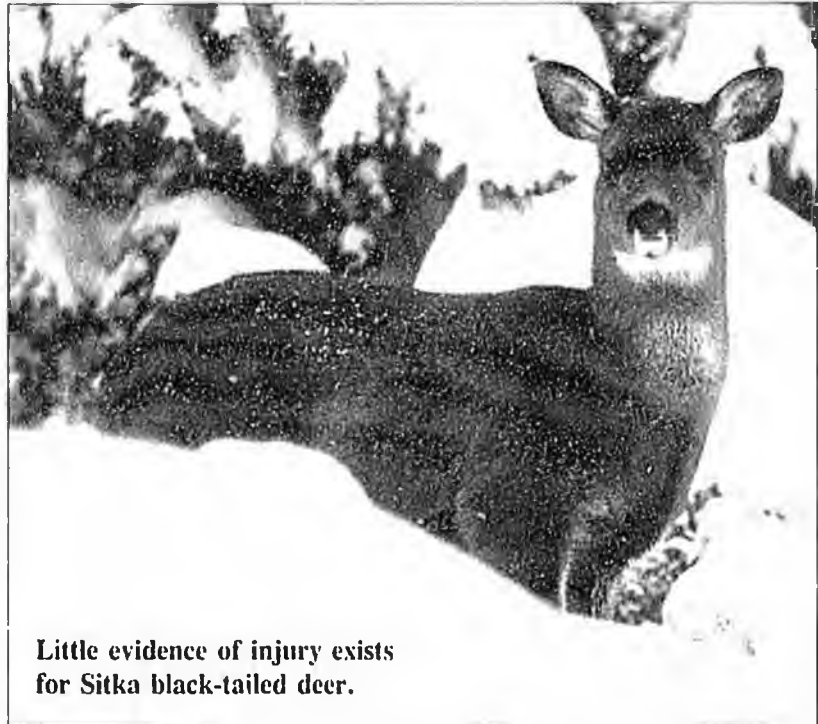
Sitka black-tailed deer are the most abundant large mammals in Prince William Sound and the Kodiak Archipelago. They live at or above timberline during the summer but move to beaches that are free from snow in winter. It is on these beaches that deer feed extensively on kelp and other marine flora to sustain themselves through the most critical part of their annual nutritional cycle. Many beaches used by deer were oiled during the *Exxon Valdez* oil spill.

Alaska Department of Fish and Game biologists documented the degree of oil ingestion and the concentrations that remained in deer tissues of 32 deer by analyzing tissue samples for petroleum hydrocarbons. They specifically selected deer on or near oiled beaches. One deer had elevated concentrations of aliphatic (nonvolatile or heavier) hydrocarbons but normal concentrations of aromatics (volatile or lighter) in liver samples. Muscle samples from that deer contained no hydrocarbons of either type that are indicative of exposure. Collectors noted no significant observations of oil ingestion, such as rumen aspirate in the lungs, during gross field necropsies.

Pathologists investigated physiological abnormalities by submitting tissues from 30 of the same 32 deer to histologic analysis. No oil-related lesions or pathologies were noted. Never was deer meat considered unsafe for human consumption.

Deer mortality was assessed during two searches of winter habitat. A pilot study located 38 dead deer, none of which was determined to have died because of oiling. Bone marrow characteristics indicated that starvation was the primary cause of mortality. It is possible that oiling or human disturbance could have led to increased starvation, however no documentation for this exists.

Biologists from Cordova conducted aerial surveys



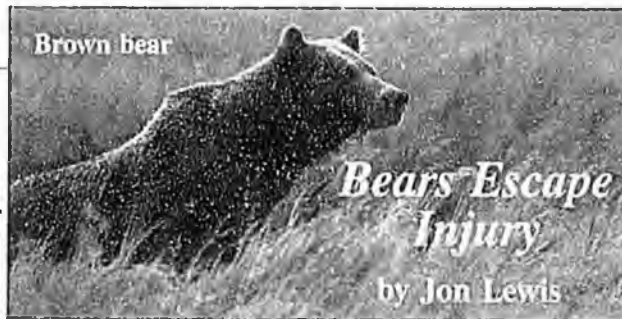
Little evidence of injury exists for Sitka black-tailed deer.

© Pat Costello

during the winter of 1989-1990. Deer were observed using oiled and unoled beaches similarly. Because deer were continuing to use oiled beaches, a second mortality survey of oiled beaches was conducted during the spring of 1990. Seven deer carcasses were located on the 19 Prince William Sound beaches (15.8 km) searched. Again, starvation seemed to be a major source of winter mortality. Three deer died of causes other than starvation, but obvious oil-related mortality was not observed.

While deer biologists and the public alike reported deer on oiled beaches and with oil on their bodies, almost no evidence of oil spill injury to the deer population exists. Had the oil spill occurred earlier in the year, the impact on deer might have been much more serious. But by late winter, deer had access to foods other than the marine vegetation on the beaches. They were able to move away from the beaches and the oil.

Jon Lewis is a Wildlife Biologist with the Division of Wildlife Conservation, ADF&G, Anchorage.



© John Hyde

Shortly after the *Exxon Valdez* oil spill, biologists observed coastal brown bears in Katmai National Park feeding on oiled bird carcasses and intertidal invertebrates on oiled beaches. Bears also may have ingested oil by grooming their fur or by directly consuming tar balls. Oil ingestion and inhalation could cause immediate death or long-term physiological problems that could result in decreased reproduction or survival.

To document the effects of the oil spill on brown bears, the Alaska Department of Fish and Game (ADF&G), Division of Wildlife Conservation, in cooperation with the National Park Service, studied (1) the survival and reproduction of radio-collared female bears, (2) the size and density of the bear population along a portion of the Katmai coast, and (3) the concentration of petroleum hydrocarbons in fecal samples from captured brown bears. Biologists then compared results of these studies to data from a control bear population near Black Lake on the north side of the Alaska Peninsula, an area not exposed to crude oil.

Biologists fitted a total of 28 Katmai bears in 1989 and 42 Katmai bears in 1990 with radio-transmitters. We obtained blood, fecal, and hair samples, along with a tooth for aging from most bears. Estimates of population size and density were made in early June 1990 during four intensive aerial surveys of the study area. Each bear seen from the air was recorded, and it was noted whether a sighted bear was marked with a radio-transmitter or not. We calculated that the study area contained 1.4 bears per square mile, the highest brown bear density recorded to date in the state of Alaska.

After making the density estimate, Dick Sellers, the King Salmon area wildlife biologist, spent many hours in the air tracking the survival and reproductive histories of each radio-collared bear over the next two years. When a bear died, Dick landed and conducted a necropsy (animal autopsy) to find the cause of death. He also obtained tissue samples for laboratory testing. He col-

lected information on survival in the Black Lake population in the same manner. Survival of radio-collared females in Katmai was 95% versus 93% (excluding hunting mortalities) at Black Lake. Intra-specific aggression, or bears killing bears, was the primary cause of death in both areas.

In scientific studies of some species, biologists obtain internal tissues for lab analysis by killing a sample of animals. This was not possible for brown bears, and therefore only fecal and blood samples were readily available for analysis. A fecal sample could contain petroleum metabolites expelled in the bile, or it could contain unmetabolized petroleum hydrocarbons from the digestive tract. At Black Lake, none of the 22 samples submitted showed indications of exposure. Of 27 samples analyzed from

Impacts of Oil on R

River otters are more than cute, playful water animals; they are also incredibly tough. That toughness was tested in Prince William Sound following the *Exxon Valdez* oil spill. In the Sound, the name "river otters" is misleading because they feed in the shallow near shore marine waters and don't have alternative freshwater feeding areas. In the early days of the spill, otters in the spill zone faced oil-covered waters when they entered the ocean to feed. Nobody will ever know how many otters died directly from oil coating or toxic crude oil fumes. Some speculate that most of these animals left the water and took refuge in underground dens where their bodies were never found. Only eleven river otters were picked up by beach clean-up crews.

Following the oil spill, otters were left with a drastically altered environment containing new and sometimes invisible hazards. Even with the crude oil seemingly gone from the water's surface, the otter's daily activities placed them at risk. Some of their foods were contaminated by hydrocarbons; the otters could be coated by a thin sheen of oil as they surfaced to eat. Unlike seals, river otters do not have insulating fat but rely on air trapped within their fur for insulation. Otters clean their fur by licking it. As late as the summer 1992, sheens of oil were present that could coat the fur of a swimming otter, and in grooming their fur, otters would consume oil.

the Katmai bears, four (15%) contained concentrations of hydrocarbons that showed exposure to crude oil. Interestingly, one of those bears was a mother bear whose yearling cub was found dead. Dead less than 24 hours, the yearling displayed no obvious cause of death. In addition to the yearling found dead, this female had also lost her other yearling during the preceding week, but the carcass was never found. Hydrocarbon analysis of bile from the dead yearling bear documented naphthalene and phenanthrene concentrations of 160,000 and 18,000 parts per billion respectively. Chemists considered these concentrations highly elevated; pathologists have documented physical symptoms of exposure in other mammals when similar hydrocarbon concentrations were found in the bile.

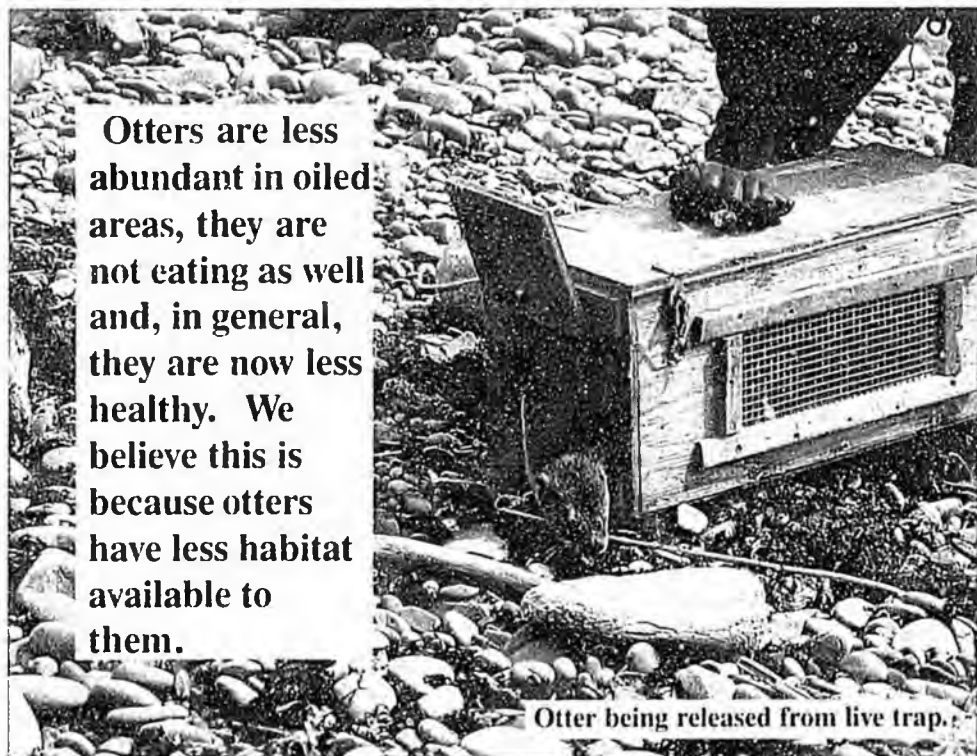
While one yearling bear may have died from the oil spill and four bears of a sample of 24 were exposed to crude oil, the significance of exposure does not appear to be great in the bear population. Survival of the bears for the first two years after the oil spill was not greatly affected. Investigations of Katmai bears that are specific to the oil spill have been discontinued, but ADF&G and the National Park Service are continuing research on the survival and reproduction of radio-collared Katmai bears.

Jon Lewis is a Wildlife Biologist with the Division of Wildlife Conservation, ADF&G, Anchorage.

Over Otters by Jim Faro

Because dead oiled otters were seldom found, our project concentrated on live otters. Our assumption was that otters never exposed to oil were normal, and differences we might find would be the result of oil. We then asked whether otters in oiled areas were doing as well as those in nonoiled areas. Both otters and their habitats were examined. The area immediately north of Bligh Reef provided "clean data." But "oiled data" came from some of the most heavily polluted shorelines immediately to the south.

Because there is little scientific literature on river otters and crude oil, the study had to develop techniques and gather data simultaneously. A statistically valid pattern of injury emerged from nearly all lines of inquiry. Otters are less abundant in oiled areas, they are not eating as well, and in general, are now less healthy.



Otters are less abundant in oiled areas, they are not eating as well and, in general, they are now less healthy. We believe this is because otters have less habitat available to them.

Otter being released from live trap.

© Jim Faro

We believe this is because otters now have less usable habitat available to them. Otters have preferred latrine sites scattered along their home ranges, and these were examined to see if post-oil changes had occurred. In the summer of 1989, otters avoided sites with shallow slopes that tended to have the greatest impact from oil, even though they preferred such areas in clean habitat. In the summer of 1991, nearly four times as many latrine sites were abandoned by otters in oiled habitat as nonoiled. This indicates otters may have continued to lose habitat into the third summer following the spill. If habitat is not being lost, then there must now be fewer otters in the population to explain this lack of use. Neither conclusion bodes well for otters. The latrine sites also provided additional information. Scats (otter droppings) were collected and washed to leave only the hard materials behind. The remains were examined and the food identified by species. In the summer of 1990, otter scats from the oiled study area contained nearly 50 fewer species when compared to the previous year. In the nonoiled area, no significant decline in the number of summer species was documented. Oiled habitat no longer seems to have the diversity of diet that was present in the pre-oil days. This also supports the premise that otters in the oiled areas were not finding food as easily.

In 1989 and 1990, river otters were live-captured and surgically implanted with radio transmitters. Transmitters allowed the otters to be tracked even when they could not be seen. By plotting all the positions on a map, the summer home ranges of individual animals were established. Although intensive examination showed otter habitat in the oiled and nonoiled study areas to be basically identical, home ranges were nearly twice the size in the oiled area. If oil had made food scarce or some areas of

habitat now unusable, otters would need a greater search area to meet their daily needs. Indeed, the tracking study demonstrated that the oiled otters' daily movements were extensive. Nonoiled otters tended to focus their activities in a specific area for several days, then moved on.

Live-captured otters were carefully measured and weighed. The data showed that adult otters in oiled areas weighed significantly less than their nonoiled counterparts.

Blood samples were drawn from captured otters and submitted to a series of lab tests much the same as those used to evaluate human health. Without supporting captive-animal studies, these tests cannot tell the exact nature or cause of a problem, but researchers view them as a general indicator of health. The blood samples provided definite health warnings for oiled otters. Indications are that significant sublethal problems are present: hydrocarbon toxins seem to be affecting body organs and the otters' ability to fight disease or infection.

Restoration

Unfortunately little hands-on restoration can be done. The factors that appear to be driving the population down are not ones easily addressed with modern technology. Toxins in the water or concentrated in the food eaten by otters must be flushed naturally from the ecosystem. With their position high on the food chain, the links below otters must recover before otters can be expected to respond.

Jim Faro is a Wildlife Biologist with the Division of Wildlife Conservation, ADF&G, Soldotna.

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The Oil Spill and Seabirds: Three Years Later

by John Piatt

May 5, 1989: We stared in disbelief at the thick carpet of mousse (a mixture of oil, air, and water) that stretched for miles into the mist. It seems that events in Alaska occur on a grand scale, and the *Exxon Valdez* oil spill was no exception. Here, on a deserted expanse of sandy beach in Puale Bay, over 500 miles southwest of Bligh Reef in Prince William Sound, and six weeks after the *Exxon Valdez* disgorged its cargo, we found thousands of seabird corpses. With grim resolve, we slowly plucked rotting, mousse-caked corpses from the muck. By the end of summer 1989, this scene had been repeated at hundreds of Alaskan beaches. Over 37,000 bird corpses were retrieved and identified. Most, however, sank at sea or were eaten by gulls, bald eagles, and other scavengers on the beaches. From a variety of field studies, we estimate that about 375,000 birds were actually killed. The exact toll will never be known. We do know, however, that in all the 80-year history of oil pollution at sea, this was the highest toll of bird life ever documented.

This story of bird devastation has been widely reported since the *Exxon Valdez* ran aground on March 24, 1989. But because of a legal shroud of secrecy, principal scientific investigators of the spill have only just begun the process of providing their data and conclusions to the scientific community at large for peer review and criticism. This time-consuming process is the mechanism by which scientific conclusions are validated and qualified (or discarded for lack of evidence), facts are distinguished from conjecture, and hypotheses are put forward for testing. We are still years away from a scientific consensus on the effects of the *Exxon Valdez* spill on marine life.

What do we know with reasonable certainty?

On the positive side, productive marine waters of Alaska continue to support a truly staggering abundance and diversity of marine birds. Large seabird colonies are widely distributed throughout Alaska. Fortunately, no species was so rare or locally concentrated that it was threatened with extinction at the time of the spill. And no seabird population is in imminent danger of extinction as a result of the spill. We can be optimistic about the future because

many seabirds are resilient to occasional man-made and natural catastrophes.

On the negative side, the spill did serious injury to local populations of some seabirds. Yellow-billed loons, horned grebes, Kittlitz's murrelets, marbled murrelets, pigeon guillemots, and harlequin ducks were all relatively scarce before the spill, with numbers in the thousands to low hundreds of thousands. Although it did not eliminate any of those populations, the spill added to existing stresses from chronic oil pollution, gillnet mortality, hunting, loss of breeding habitat, and other factors. In the absence of additional negative changes in the marine environment, or more human disturbances, we can calculate that these populations should be able to return to "normal" in 20 to 70 years. Unfortunately, the marine environment does not seem to favor seabirds at the moment: many species appear to be food-limited, and populations are declining in the Gulf of Alaska and Bering Sea.

What constitutes a "normal" population?

We can answer this question by considering common murres, the species hardest hit by the spill. Murres are long-lived members of the Alcidae family of colonial, diving seabirds that includes puffins, marbled murrelets, auklets, and the extinct great auk. Murres produce only one egg annually, and 40 to 60% of pairs breeding at a colony in Alaska might fledge a chick in any



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given year. Of those chicks, only 10 to 30% might actually survive to the age of 4 or 5 years, when they attempt to breed for the first time. After a few years of experience at the breeding colony, murrens are at their reproductive prime and may breed successfully for many more years before dying of old age at 15 to 20 years old. Thus a normal murre population consists of juveniles born in each year (most of which die), immature birds (1 to 3 years old) that are incapable of breeding, adolescents (4 to 6 years) that are sexually mature but lacking in the knowledge and skills required to successfully rear young, and experienced adults (7 to 20 years) that form the backbone of the breeding population.

How did the spill affect murre populations?

Data suggest that about 10 to 20% of the entire northern Gulf of Alaska population of murrens was killed in the spill. Local effects were more severe. Colonies at the Barren Islands and along the path of the spill declined in 1989 by 50 to 70% from pre-spill counts. Injury assessment studies conducted by the Alaska Maritime National Wildlife Refuge in 1989-1992 revealed that not only have numbers remained low, but breeding activity of remaining birds has been unusual in all these years. Very few chicks were produced in any year (0 to 20% success), and the

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timing of breeding was delayed by 30 to 45 days in all years. The timing and success of breeding in murrens can vary widely under natural conditions in Alaska, but such a sequential run of bad years has never before been documented. Toxicological effects of oil might account for some of the unusual breeding biology in 1989, but it is improbable that toxic effects would have continued for three more summers.

One theory is that the oil spill dramatically altered the age-structure of murre populations at affected colonies. Experienced adults typically return earlier to breeding colonies than adolescents. Most sea-

bird mortality from the spill occurred in April, when adult murrens were concentrating at colonies to breed. It is possible that a large fraction of the experienced adult population of murrens was destroyed by the spill, leaving inexperienced adolescents to carry on with the job of replenishing the population. Such an effect would be felt for decades until the "normal" age structure of the population is re-established. Other species of seabirds killed in the spill, most of which are also long-lived and exhibit

delayed sexual maturity, may have been similarly affected.

How can seabird populations be restored?

Efforts have shifted from trying to document injuries from the spill to assessing how we might restore or enhance the recovery of affected populations. This is not a trivial task. Most seabirds breed on remote, inaccessible islands and forage over vast ocean areas. Most colonies are already protected as National Wildlife Refuges, but private lands containing a few small colonies could be purchased. It might be possible to manipulate prey stocks to enhance seabird feeding and breeding success, but we understand little about the ecology of prey that seabirds consume. Few, if any, prey species are presently managed with consideration for other consumers besides humans. At colonies, it might be possible to improve the breeding success of seabirds by manipulating breeding habitat or predator populations.

In some cases removing predators from breeding colonies could help. For example, the removal of arctic foxes from islands where they were artificially introduced years ago for farming is a proven management tool. Released from unnatural predation, seabird populations can quickly rebound. This approach is most effective for ground-nesting species like eiders, puffins, and auklets, but cliff-nesting species like murrens may benefit little from fox removals. However, introduced foxes are not present on islands in the oil spill area, so predator control would not have a direct restorative benefit there.

What seabird species can we help now?

Marbled murrelets are unique among Alaskan seabirds in that they nest in trees. Habitat studies conducted over the last few years in Prince William Sound by the U.S. Fish and Wildlife Service are beginning to confirm what has already been established in California, Oregon, and Washington: marbled murrelets prefer to breed in dense stands of old-growth coastal rain forest. Marbled murrelets are now listed as a threatened species in the lower states because populations face extinction from the destruction of remnant ancient forests. Populations are healthier in Alaska, but harvesting of old-growth forests in Alaska is proceeding rapidly. For example, over 40% of high-volume old-growth forest in the Tongass National Forest has already been cut. The marbled murrelet could benefit from protection of old-growth forest. Biologists from the Fish and Wildlife Service, the Forest Service, and the Restoration Team are all working hard to determine which forests in Prince William Sound and elsewhere support breeding marbled murrelets.

John F. Piatt is a Research Biologist with the U.S. Fish and Wildlife Service Research Center in Anchorage.

Bald Eagles: After the Spill by Timothy Bowman

About 8,000 bald eagles inhabit coastal areas from Prince William Sound to the Alaska Peninsula, the area affected by the oil spill. Because bald eagles nest along shorelines and feed mostly in intertidal areas, the habitats most contaminated by oil, significant injury to eagle populations was expected. A three-year study was initiated soon after the spill to examine

Sound was better in 1990; the production of young eagles was thought to be near normal levels for this area.

Biologists counted eagles from airplanes during the spring of 1989, 1990, and 1991 to see if there was a decrease in bald eagle numbers. These visual surveys focused on Prince William Sound. No recent pre-spill survey of bald eagles had been



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unhatched eggs and prey remains for evidence of oil exposure, to determine numbers of eagles, and to determine effects on bald eagle nesting and survival of adults and fledglings.

Greatest injury to bald eagles occurred during the summer immediately after the spill. An estimated 900 bald eagles throughout the spill area (about 11% of the population) died, and reproduction was significantly reduced. Laboratory analysis of eggs and prey remains collected from eagle nests confirmed that they were contaminated by oil. Reproductive failures were directly related to the extent and intensity of shoreline oiling near bald eagle nests, but these effects seem to have been limited to Prince William Sound alone, not to other areas to the west. Poor reproduction could have been caused by the death of one or both of the adults or by death of the embryo as a result of oiled eggs. Adult eagles with oiled feathers probably transferred oil to eggshells as they incubated eggs. Studies have shown that even small amounts of oil in contact with the eggshell can kill the developing embryo. Nesting success of eagles in Prince William

conducted that would allow a good comparison of pre- and post-spill population size. Although there was a slight decrease in the numbers of eagles counted in 1990, one year after the spill, it was within the margin of error expected for that type of survey and therefore not statistically significant. The number of eagles counted in 1991 was the same as in 1989.

Another aspect of the study was to look at survival of both fledglings and adults after the spill to see if survival was different between eagles tagged in oiled areas of western Prince William Sound and eagles tagged in unoiled areas of eastern Prince William Sound. During the summers of 1989 and 1990, biologists tagged 62 young eagles with backpack-type radio transmitters in Prince William Sound. About 100 adult eagles were also trapped and radio-tagged. These tagged eagles were tracked by airplane. Biologists could tell whether the bird was alive or dead by the signal its transmitter emitted; if a bird died and the transmitter remained motionless for more than six hours, it emitted a signal with a faster pulse rate. After three years of

monitoring, biologists found no differences in survival between eagles from oiled and unoiled areas. It seems that the lethal effects of the spill occurred immediately after the spill, before transmitters had been attached to eagles. The continued high survival noted after 1989 suggests that there were no long-term effects of the spill on eagle survival.

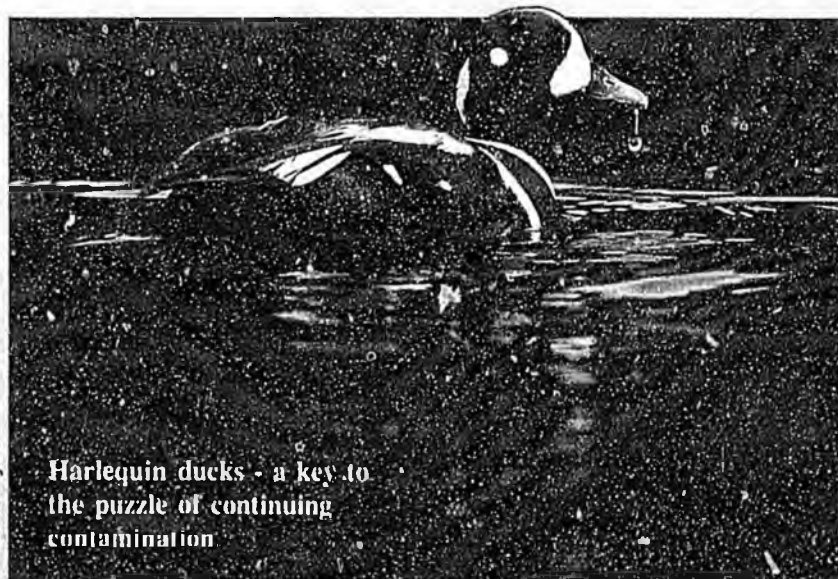
The bald eagle seems to be a fairly resilient bird, at least at the population level. Densities of eagles in Alaska are higher than anywhere else and are thought to be at saturation levels in many areas. Because of their high densities and the abundance of productive nesting and feeding habitat in Alaska, bald eagle populations were apparently able to endure the effects of the oil spill with only a short-term negative impact.

A population model of bald eagles in Prince William Sound indicates that the population was increasing before the spill at a rate of about 2% per year. The cumulative effects of the direct mortality and reduced productivity in 1989 will probably set the population in Prince William Sound back by about five years, but population growth should continue.

Restoration

Land management that incorporates an awareness of the habitat needs of bald eagles is essential to the maintenance of bald eagle populations. However, eagle habitats within coastal Southcentral Alaska have been identified in development plans. One way to enhance the recovery of bald eagle populations is to protect the old growth forests, particularly beach fringe and streamside habitats which are important to eagles for nesting and feeding, and to protect salmon spawning areas, a key food resource.

Timothy D. Bowman is a Wildlife Biologist with the U.S. Fish and Wildlife Service, Raptor Management Studies Program, Cordova.



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Harlequin ducks - a key to the puzzle of continuing contamination

...in oiled areas, there was not only direct mortality of at least 400 harlequins, there was also a nearly complete reproductive failure from 1990 to 1992.

Harlequin ducks are small, colorful seaducks that feed in intertidal areas. When we began research into the effects of the oil spill on harlequin ducks in September 1989, we knew many had been killed, but little did we know that our studies would lead us to the discovery that the effects are much more significant and long-term than we expected. Injury assessment studies of harlequin ducks through 1992 related to the *Exxon Valdez* oil spill have been focused on Prince William Sound. Harlequin ducks reproduced normally in unoiled areas of Prince William Sound, but in the oiled areas, there was not only direct mortality of at least 400 harlequins, there was also a nearly complete reproductive failure from 1990 to 1992.

The harlequin population in the Prince William Sound, Kenai, and Afognak areas contains both resident and wintering individuals. The residents molt in secluded bays and lagoons, roost on offshore rocks, and breed along forested streams within a few kilometers of salt water. Broods are found with hens on salt water in late summer. Non-resident harlequin ducks, which winter on the south coast of Alaska, breed elsewhere on mountain streams, arrive in the south coastal area in October, and depart in May. Harlequin ducks return to the same breeding and wintering areas year after year. Before the oil spill, harlequin ducks were distributed throughout Prince William Sound, with broods commonly observed in shoreline habitats. Because some harlequins spend their entire lives in the oil spill area, where they breed, feed, and overwinter, it is possible to detect and study the impact of the spill. Non-resident harlequins and other seaducks that overwinter in oiled areas may be similarly affected, but because they breed in areas remote from the spill, it is impractical to study them.

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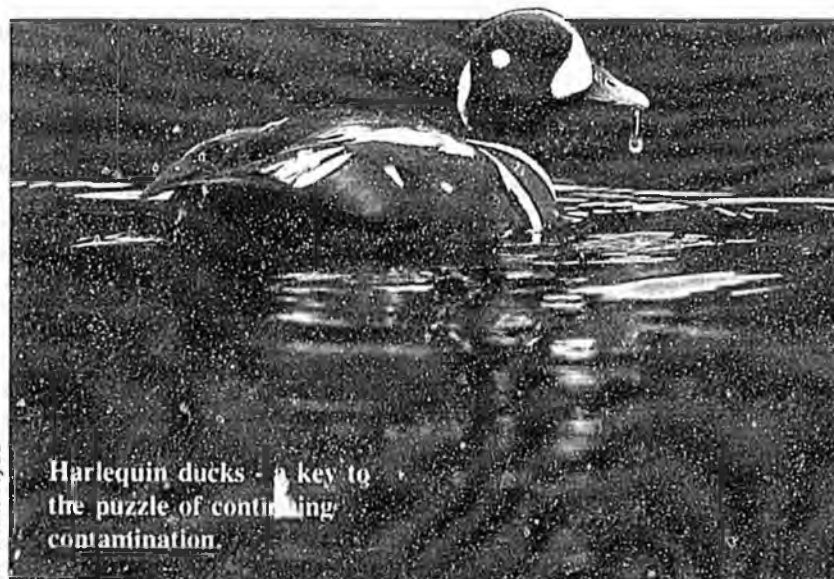
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Reproductive Failure of Harlequin Ducks

by Sam Patten

The reproductive failure of harlequin ducks in the oil spill area is postulated to be a chronic effect of petroleum exposure through contaminated intertidal food. Blue mussels appear to be the most likely source of contamination. Blue mussels concentrate and hold pollutants in their tissues. Restoration studies have documented high concentrations of petroleum compounds known as polynuclear aromatic hydrocarbons (PAHs) remaining in mussels, in the byssal thread mats which anchor the mussels to the bottom, and in the underlying substrates in western Prince William Sound in 1991. Because harlequin ducks consume entire mussels, they ingest petroleum hydrocarbons in mussel tissue, on the shell surface, and in attached byssal threads and sediments. Harlequin ducks collected in 1989-1990 in western Prince William Sound and Southwest Kodiak contained oiled food items in their gullets as well as petroleum residues in liver tissue and bile. Experimental studies have demonstrated that single small doses of petroleum can cause reproductive failure in some seabirds. Searches of U.S. Coast Guard files revealed that approximately 90 blue mussel beds may retain *Exxon Valdez* oil in western Prince William Sound. Field checks indicate additional previously unreported oiled mussel beds in the Sound and along the Kenai coast. Oil also remains associated with dispersed blue mussels in a number of sheltered locations currently under investigation. Extensive oiling of Kenai Fjords National Park is also well documented, and it is reasonable to suspect that there has been some degree of injury to harlequin ducks there.

Restoration

The ultimate goal of current research is the restoration of breeding harlequin ducks to the oil spill area. To achieve this, scientists should determine the geographic extent of the reproductive failure, define the breeding habitat requirements of harlequins, and determine whether hydrocarbon residues are currently present in harlequins in order to clarify the link to persistent oil contamination. If the observed failure of reproduction is related to the contaminated food chain, remaining oil pollution should be removed before restoration can take place, otherwise measures to increase productivity will be fruitless. In some cases these mussel beds remain grossly contaminated. Knowledge of habitat requirements of breeding harlequin ducks may prove valuable for restoration actions such as habitat acquisition and mitigation measures, protection of non-federal lands, and development of marine sanctuaries.

A proposed restoration project would continue to monitor harlequin reproductive success and document the characteristics of harlequin duck nesting habitat. Biologists would conduct

surveys to locate harlequin pairs at stream mouths in late spring. This would be followed by trapping in selected stream estuaries. Harlequin females flying to streamside nest sites in early summer would be mist-netted and radio-tagged. Nest sites, broods, and feeding areas will be located by following the radio-tagged hens through the summer nesting and brood-rearing period. Brood count surveys would be conducted in shoreline habitats in late summer in western Prince William Sound and selected areas of the Kenai coast and Afognak. If nests are located in the Sound, Afognak or Kenai areas, researchers would note harlequin nesting habit characteristics in these areas. Results from the oil spill areas would be compared to unoiled control areas on Afognak Island.

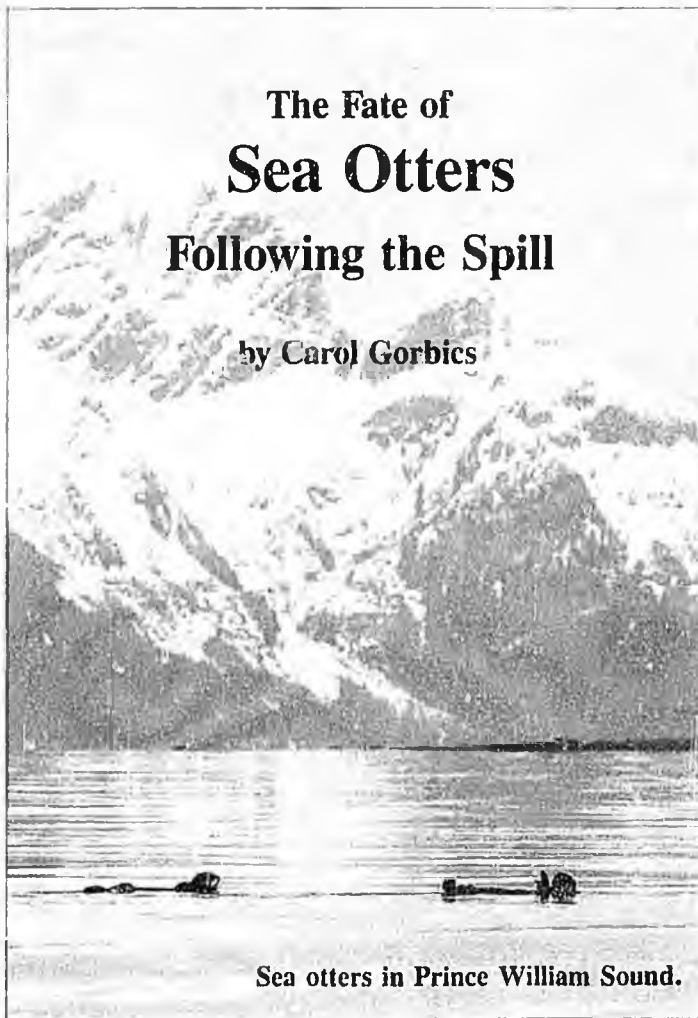
Blood samples would also be collected from breeding harlequins in unoiled areas and from molting harlequins in oiled areas. Blood and tissue samples may also be taken from collected ducks. These samples would be analyzed for normal blood parameters and presence of elevated levels of haptoglobins and interleukins, blood proteins indicating stress and suppressed immune systems. Tissue samples (i.e. fat, liver, and bile) would be analyzed for presence of petroleum hydrocarbons. Feather samples would be examined for presence of vanadium, a trace metal indicating petroleum exposure. Fecal samples from flightless birds trapped during the molt would be collected to determine presence or absence of petroleum exposure by means of fluorescence testing. The proportion of mussels in the harlequin diet would be investigated by dissection of set-aside harlequin carcasses from the "spill bird morgue" in Anchorage and examination of their gullet contents. The information gathered in this study could be used in developing measures to restore breeding harlequin ducks to the oil spill area.

The contaminated food chain remains a significant concern. Because of anoxic conditions created by the dense byssal thread mat in mussel beds, crude oil is trapped and remains unweathered. Thus it retains toxic components. Harlequins eating oiled mussels will remain exposed to contaminated food unless some action is taken to clean oiled mussel beds. If this exposure is sufficient to cause reproductive impairment in these seabirds for many years, local extinction may result in spill areas. Continuing to explore the relationship between the consumption of oiled foods by harlequin ducks and reproductive impairment should be considered.

Sam Patten is a Wildlife Biologist with the Division of Wildlife Conservation, ADF&G, in Anchorage.

The Fate of Sea Otters Following the Spill

by Carol Gorbics



Sea otters in Prince William Sound.

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Sea otters (*Enhydra lutris*) were the most abundant marine mammal in the path of the *Exxon Valdez* oil spill and, unfortunately, were particularly vulnerable to the effects of the spill. Not only were many sea otters killed in the months following the spill, but they are still showing the effects of the spill three years later.

Reduced to near extinction by over hunting during the late nineteenth century, sea otter populations rebounded following enactment of a 1911 international treaty providing for their protection and conservation. Sea otter numbers in Alaskan waters grew as sea otters expanded their range along the coasts of Alaska. Otters inhabit the entire area affected by the oil spill including Prince William Sound, the Kenai Peninsula, the Kodiak archipelago, and the south side of the Alaska Peninsula.

In 1972 the federal Marine Mammal Protection Act transferred authority for management and conservation of the sea

otter from the State of Alaska to the U.S. Fish and Wildlife Service (USFWS), an agency of the U.S. Department of the Interior. The USFWS had the major responsibility for managing the response, rehabilitation and injury assessment of sea otters during and following the oil spill. Biologists Brenda Ballachey, Jim Bodkin, and Tony DeGange led the USFWS efforts to determine the extent of injury to sea otters following the spill.

Initial Exposure to Oil

Sea otters spend most of their time on the surface of the water, often in large numbers, making them susceptible to floating oil. Since they have neither blubber, like many marine mammals, nor much subcutaneous fat, they depend on rapid metabolism to generate heat. Their luxurious pelage (fur) and an entrapped air layer within the dense, water-resistant underfur prevent heat loss to the cold Alaskan waters. To maintain the insulating properties of their fur, otters must groom constantly. When sea otters became fouled with oil during the spill, grooming became obsessive, resulting in the ingestion of oil.

Many sea otters died as a result of the spill, but an exact number is difficult to determine and will probably never be known. Our knowledge of the number of sea otters potentially at risk is sketchy; previous surveys were up to five years old. In addition, censusing sea otters continues to be an inexact science. USFWS biologists did, however, take several approaches to estimate the total number of sea otters that died within the months following the spill.

The most visible effort was the collection and cataloguing of sea otter carcasses. Dead otters were collected by spill workers, including volunteers, wildlife collection boats, and oil cleanup crews. More than one thousand sea otter carcasses were collected, some of these were animals that died during capture and rehabilitation efforts. Of this total, it was determined by veterinarians performing necropsies (animal autopsies) that up to 95% of the deaths were potentially attributable to oil. The likelihood of finding carcasses was also estimated using the results of a marking and recovery study and a drift experiment. Resulting estimates suggested that the recovered carcasses represented 25% of the total potential sea otter deaths.

A second approach involved comparison of sea otter abundance before and after the spill. Boat surveys completed in 1984 and 1985 were compared to similar surveys conducted by USFWS biologist Doug Burn following the spill in 1989, 1990, and 1991. In 1989 following the spill, there was a 35% decline in sea otter abundance in oiled areas. Surveys in 1990 and 1991 showed continued low numbers with no significant change or recovery. Pre-spill surveys outside Prince William Sound were not available.

A third method, developed by USFWS biologist Jim Bodkin and biostatistician Mark Udevitz, used a computer model to

estimate the number and fate of sea otters potentially exposed to oil based on the spill's path and the chance of survival due to the predicted degree of oiling. Computer simulations with this model indicated that about 52% of sea otters along the Kenai Peninsula were potentially exposed to oil.

Results of all these studies suggest that initial injuries were extensive, killing between 3,500 and 5,500 sea otters in the first months following the spill.

Continuing Exposure to Oil

Injuries to sea otters were not limited to the spring and summer after the 1989 spill. USFWS studies have documented that currently, over three years after the spill, sea otters are still being injured by oil remaining in the environment.

Studies by the National Marine Fisheries Service during the summer of 1992 show that there are still hydrocarbons in mussels and other marine invertebrates and still unweathered oil buried within mussel beds. Mussels accumulate and store hydrocarbons in their tissues and also provide an oxygen-free microhabitat that allows the oil to stay in an unweathered and toxic state. Sea otters are potentially doubly at risk from eating these contaminated staples of their diet and from release of toxic hydrocarbons into their environment by disturbing contaminated substrate while foraging for food.

But have sea otters changed their eating habits since the spill to avoid contaminated prey? USFWS sea otter biologist Angela Doroff concluded they have not. During 1991, prey species eaten by sea otters in oiled areas and unoiled areas of Prince William Sound were compared with prey species eaten by sea otters in the 1970s and 1980s. There was no apparent change in eating patterns. Sea otters continue to rely heavily on clams and mussels as prey regardless of the oiling status. Therefore, Doroff concluded that continued exposure to hydrocarbons through the food chain was likely in oiled areas.

Long-Term Injury Assessment

Scientists remain concerned about the implications both from the initial exposure and continued exposure to oil via the food chain. Will these effects have implications to the overall health and survival of sea otters now and in the future? Unfortunately, several studies do indicate that portions of the Alaska sea otter population continue to be stressed and are experiencing decreased survival, although the ramifications of these effects on a population level are uncertain.

One study is considering the proportions of sea otters dying as juveniles, as adults, and as aged animals. Prior to the spill, between 1974 and 1986, USFWS researchers collected sea otter carcasses from beaches in the Sound to determine the age distributions of dying animals in a nonoil spill situation. As one

would expect, the carcasses were mostly from very young and very old sea otters. Since the spill, mortality patterns have changed dramatically. Prime-age animals between 2 and 8 years of age, which were rarely found dead before the spill, have represented a much higher proportion of the carcasses in all three years since the spill.

Analysis of sea otter blood collected in 1990 and 1991 indicates slight but significant differences in several blood parameters between oil-exposed and non-exposed animals. Higher eosinophil counts, total hemocrits and hemoglobin concentrations occurred in male sea otters in the spill area. We are unsure what this means to the health of the sea otter. Some researchers believe the changes are insufficient to indicate health problems which are likely to result in death.

All these indications increase our concern that there continue to be prolonged, spill-related effects on sea otters in areas affected by the spill even three years after the spill.

So what's right with the sea otter? Prior to the oil spill, little was known about how sea otters might respond to a massive oil spill. We did look at many other factors of sea otter growth and survival, trying to pinpoint areas of concern. Not all the indications were negative. We learned, for example, that reproduction, as indicated by the proportion of pups and adult females in the population and survival of tagged adult females, is high throughout the Sound.

The Future of Sea Otters in the Spill Area

The extent to which the Prince William Sound sea otter population is recovering is unclear. Even less clear is the extent of injury and recovery within the spill area outside the Sound. Without pre-spill baseline data for comparison, we will probably never know exactly what happened to sea otters along the Kenai Peninsula, Kodiak Archipelago, and Alaska Peninsula.

Sea otters are important indicators of the health of the environment. Recovery of sea otter populations will signal that prey species upon which sea otters depend are also recovering. Conversely, continued spill effects will show up as physiological abnormalities, slower than expected population recovery, or continued population declines. Long term protection of habitat, reduction of various habitat perturbations which may hinder recovery, and monitoring sea otter populations and vulnerable life stages could all be important in assuring and documenting the recovery of the sea otter populations injured by the oil spill.

Carol Gorbics is the Exxon Valdez Oil Spill Coordinator, U.S. Fish and Wildlife Service, Anchorage.

Killer Whale Investigations

by Marilyn E. Dahlheim and Bruce A. Wright



Biologists photographing killer whales for identification.

© Mandy Merklein

Since the 1970s, more than 300 different killer whales have been documented entering the waters of Prince William Sound. However, the number of whales entering the Sound in any given year varies. Little is known about the movements of killer whales, but they are undoubtedly related to movements in prey. Although numerous cetacean species (whales, dolphins, and porpoises) are found in the Sound, few had been routinely studied prior to the oil spill.

The photo-identification research on killer whales prior to 1989 formed the basis for injury assessment studies after the spill. The National Oceanic and Atmospheric Administration (NOAA) contracted with North Gulf Oceanic Society to research Prince William Sound killer whales for the years 1989 through 1991. This represented the most intensive research effort to date on Alaska killer whales.

Two types of killer whale pods (groups) are known from the area: residents and transients. Resident whales are frequently observed in large pods, apparently have a smaller home range,

consume mostly fish, are usually easier to approach than transient whales, and form more stable groups. Resident pods are so stable that if an individual is listed as missing for at least one year, the missing whale is presumed dead. Unfortunately, due to the highly variable nature of transient pods, pod structure and mortality rates are difficult to determine. Therefore, injury assessment studies were targeted on resident groups.

During the field seasons of 1989, 1990, and 1991, biologists conducted surveys of areas frequented by killer whales. When whales were located, they were approached by boat and photographed. The photographs were analyzed for individual whale identification. Photo-identification studies rely on the fact that individual killer whales can be recognized by distinguishable scars, dorsal fin shapes, and coloration patterns of saddle patches. Each identified whale was compared to the historical photographic database. Once all photographs had been evaluated, it was possible to determine if all members were present and if pod structure or integrity was similar to previous years.

Given the current age and sex structure of (one) pod and the rate of calf production, recovery (to pre-spill population levels) is expected to take at least 15 years.

Photographic analysis of killer whale pods indicated a large number of whales missing from one of the resident groups, named AB pod. In 1988, AB pod consisted of 36 members. Results from the 1989 investigation documented seven missing AB pod members. Six additional whales were missing from AB pod in 1990, and in 1991, one whale was missing. An average annual natural mortality rate of approximately 2% has been estimated for North Pacific killer whales. The 1988-1989 mortality rate for AB pod was 19.4%, ten times the expected rate for resident pods based on 24 years of research. The 1989-1990 mortality rate was 20.7%. The cause of these assumed mortality rates is unknown. The 1990-1991 mortality rate dropped to 4.3%.

The loss of 14 members from AB pod over a three-year period caused significant changes in the pod's social structure. As a consequence, mixing of maternal sub-groups was documented.

Physiological abnormalities have been observed in AB pod. The dorsal fins of two adult males have collapsed. The cause of fin collapse is not understood but may be related to nutrition or physical damage to the dorsal fin.

Dead killer whales usually sink, thus it is rare to find their carcasses washed ashore. For example, from 1975 to 1987 only six killer whales were reported stranded for the entire Gulf of Alaska, and none occurred in Prince William Sound. In 1990, three killer whales were found dead on the beaches of Prince William Sound. Another whale was found on Kayak Island in the spring of 1991. The four killer whales found stranded in 1990 and 1991 in Prince William Sound represent an unusually high stranding rate for the area. The cause of death of the four whales is unknown.

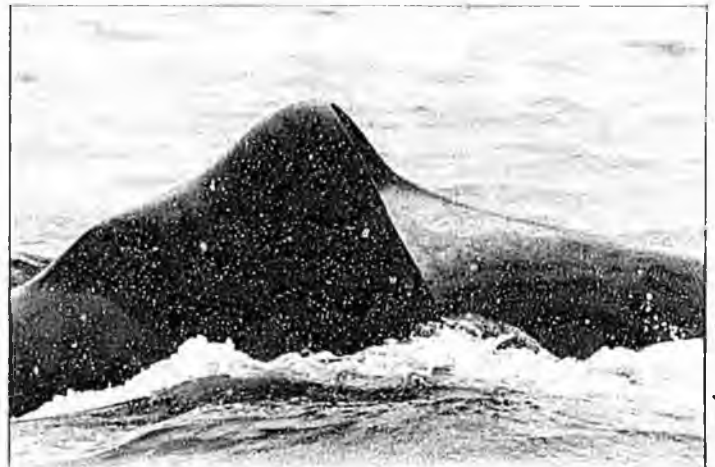
Restoration

If mortality rates remain at low levels, AB pod may recover to pre-1989 numbers. However, it is difficult to predict when, or if, AB pod will recover to the 36 members it contained in 1988. (We presume that 36 was the stable pod size). Recovery may be further delayed by the loss of reproductively-active members and changes observed in the pod's social structure. Since 1989, only one new calf has been born into AB pod, whereas five calves were born into AB pod during the 1987-1988 season. Given the current age and sex structure of AB pod and the rate of calf production, recovery to 36 whales is expected to take at least 15 years.

Restoration options which may help AB pod recover include protection of sensitive habitats, minimizing fishery interactions,

reducing or redirecting other human-use impacts, and promoting public education. As the monitoring of AB pod continues, additional restoration measures may be instituted. We hope that killer whales will continue to inhabit the waters of Prince William Sound and contribute to the complex diversity of life in this area.

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© Kathy Heise

Collapsed dorsal fin believed to be due to physiological stress (AB pod).

Normal dorsal position of another male from the same pod.



© Lance Barrett-Lamard

Harbor Seals: Were They Injured and Wi

Some of the largest harbor seal haulouts in Prince William Sound and the waters adjacent to them were directly exposed to substantial amounts of oil when the *Exxon Valdez* ran aground. Oil affected seal habitat in the Gulf of Alaska at least as far as Tugidak Island. Some people had speculated that seals would avoid spilled oil and therefore would not be affected. However, in the early weeks of the spill, seals swam through oil and inhaled aromatic hydrocarbons as they breathed at the surface. On haulouts in oiled areas, seals crawled through and rested on oiled rocks and algae throughout the spring and summer. Pups were born in May and June, and in some cases both their haulouts and their mothers were covered with oil. Throughout the area, seals were exposed to greatly increased human activity as a result of cleanup projects.

An injury assessment study was initiated to investigate and quantify effects of the oil spill on the distribution, abundance, and health of harbor seals. Almost all of the work was done in Prince William Sound because seals and their habitats were heavily oiled there, and baseline information was available for comparison with data collected during and after the spill. The study included observations of seals in oiled and unoiled areas, examination and sampling of carcasses of seals found dead and collected, and aerial surveys of trend count sites during pupping and molting.

From April to July 1989, we saw no oiled seals in unoiled areas that were not close to oiled sites. However in oiled areas, 50 to 100% of the seals were oiled, most of them heavily. Many were coated over their entire bodies with thick, tarry oil to such a degree that people used to seeing clean harbor seals had difficulty recognizing them. Seal pups born in oiled areas became oiled shortly after birth. Most of the seals shed their oily coats during the August molt, and in 1990 there was no sign of external oiling observed on any seals.

About 20 seal carcasses were reported or turned in during the first few months after the oil spill. The number of dead animals found probably greatly underestimates the number that died because dead harbor seals do not float like sea otters and birds, but rather, sink to the bottom. As an example, two dead newborn pups we found in Herring Bay were underwater and could only be seen when the current moved the algae that was covering them. Most of the carcasses were too decomposed to examine and sample properly. Two seals had broken bones and other injuries that suggested they had been hit by boats. Some dead pups appeared to have suffered from malnutrition and stress.

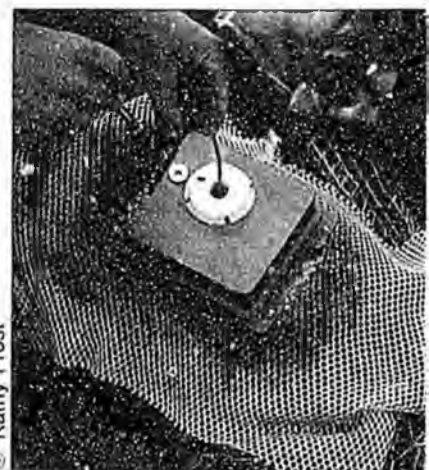
Analysis of tissues from collected seals clearly showed that animals in oiled areas had been exposed to and assimilated hydrocarbons. Values for hydrocarbon metabolites in bile were 7 to 13 times higher in seals from oiled parts of Prince William Sound than in those from the unoiled areas of the Gulf of Alaska, and these high levels persisted at least through April 1990. This

indicated that in spring 1990 seals were still encountering oil in the environment or that they were metabolizing stored fat reserves that had elevated levels of hydrocarbons. Because seals have enzyme systems that allow them to detoxify and excrete hydrocarbons, the levels found in most tissues were not very high. The levels in muscle, which is a staple in the diet of residents of Tatitlek, Chenega Bay, and some other villages, ranged from very low to undetectable. Highest levels of aromatic hydrocarbons occurred in the blubber of animals found dead and collected in Prince William Sound. Relatively high levels were also found in mammary tissue and milk.

Harbor seals are known for being wary and difficult to approach. However, in the weeks immediately following the spill, oiled seals behaved very oddly and were reported as being sick, lethargic, or unusually tame. Seals often stayed on haulouts when aircraft flew over at low altitudes, and people were sometimes able to approach them to within a few yards. Not until we microscopically examined brain tissue did we have an explanation for this behavior. We found debilitating lesions within the brain tissues of many of the oiled seals collected. Exposure to aromatic hydrocarbons caused swelling and degeneration of the nerve axons, which would have interfered with nerve transmissions. The lesions were mostly in the thalamus, a region of the brain that serves as a primary relay center for incoming and outgoing nerve impulses. This brain damage would have made it very difficult for seals to perform normal tasks such as swimming, diving, feeding, and escaping from predators. It explains the unusual behavior of seals immediately after the spill, and probably made them more susceptible to drowning, being hit by boats, or being caught by predators such as killer whales. Injury that could have resulted from oil was also found in the eyes, skin, and liver of oiled seals.

Aerial surveys showed that pup production was lower in oiled areas in 1989 than in 1990 or 1991, while in unoiled areas the ratio of pups to non-pups was the same in all three years. Together with the dead fetuses and pups found following the spill, this suggests that pup mortality was higher than normal in oiled areas in 1989.

Largely because of their wide distribution, the actual number



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They Recover?

by Lloyd F. Lowry and Kathryn J. Frost

of harbor seals in Alaska has never been accurately estimated. As a means of keeping track of population trends, the Alaska Department of Fish and Game (ADF&G) has made repetitive counts of seals at locations such as Tugidak Island and Prince William Sound. By 1988 the trend counts were indicating a major decline in harbor seal numbers. Analysis of counts made in Prince William Sound from 1983 through 1992 show that the



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only year in which there was a statistical difference in trend between oiled and unoiled sites was 1989, immediately after the oil spill. Calculations indicate that there were about 345 fewer seals at the oiled sites we studied than would have been expected if the spill had not occurred. Our calculation of the number of missing seals provides some indication of the number that were killed, but it

is very conservative because it includes only animals that disappeared from parts of Prince William Sound.

Restoration

It is difficult to assess whether or when harbor seals will recover from the effects of the oil spill. We do not know why their numbers were dropping before the spill and therefore cannot predict how the additional mortality may affect the ongoing decline. The trend in Prince William Sound since 1989 is equivocal: pupping counts show continued declines, but molting counts appear to have stabilized. Seal numbers have increased somewhat in the oiled area and decreased in the unoiled area. However, molting counts in 1992 were still 34% lower at oiled sites than they were in 1988 before the spill, while counts at unoiled sites were only 18% lower. At Tugidak Island the count for 1992 was 44% lower than in 1988.

As part of monitoring natural recovery, we have suggested annual aerial surveys of harbor seals at trend count areas in Prince William Sound both during pupping and molting, at least through 1994. In addition, we have proposed continuation of a study using satellite-linked transmitters to investigate distribution, movements, habitat use, and behavior of harbor seals in Prince William Sound. Preliminary results from eight seals satellite-tagged in 1991 and 1992 showed that, at least during the summer and early autumn, some seals range much more widely than we had expected. One tagged seal swam from Herring Bay on Knight Island to the Yale Glacier in College Fiord, then back to Herring Bay, a minimum distance of 110 miles. Another moved from Applegate Rocks to the Copper River Delta and

back, a minimum round trip of 225 miles. The tags also provided the first information on when, where, and how deep harbor seals dive to feed. This type of information can be used to interpret results from injury assessment and population monitoring, and to help design programs for the protection and management of important habitats.

If marine ecosystems are healthy and being properly managed, it should be common for people to see harbor seals along Alaska's coast. However, many areas that appear to be good seal habitat are now very sparsely populated. Harbor seals, like other marine mammals, are covered by the federal Marine Mammal Protection Act. Reduced and declining populations are causing national as well as local concern and may result in restrictions on commercial fishing or other activities important to Alaskans. It is critical that we learn what factors have been and are now affecting seal numbers and do whatever is possible to restore the population.

Lloyd F. Lowry and Kathryn J. Frost are Wildlife Biologists with the Division of Wildlife Conservation, ADF&G, Fairbanks.



© Lloyd Lowry

Harbor seals occur throughout northern temperate waters, ranging in the North Pacific from southern California, through Alaska, to Japan. They feed mostly in coastal waters

on fishes, octopus, and squid. They haul out to rest, to bear and care for their young, and to molt on intertidal reefs, rocky shores, mud bars, beaches, and floating glacial ice. Unlike fur seals and sea lions, harbor seals do not form rookeries during the pupping and breeding season, and pups are born at virtually all of the haulouts.

Far left: A satellite-linked transmitter is attached to a seal for better identification of the seal's range.

Left: A tagged harbor seal re-enters the water.

Coastal Habitat:

Shallow Subtidal Regions Article and photo

The shallow subtidal habitats of Prince William Sound that were studied extend from the lower edge of the intertidal zone to depths of approximately 60 feet. This zone typically has dense macrophyte (algae) assemblages and is critical habitat for many commercially and ecologically important animals. The region is most noted as a nursery for salmon, king crab, Dungeness crab, and some shrimps; as a spawning ground for Pacific herring; and as feeding grounds for sea otters, river otters, and many marine birds. As a primary food source, the benthic (or bottom dwelling) marine macroscopic plant life is probably at least as important as the seasonal phytoplankton blooms. Seaweeds are used as a main source for several marine invertebrates, including commercially important sea urchins. Subtidal eelgrass beds, as well as intertidal beds, are extremely important feeding grounds for migratory waterfowl. Many of the algal aggregations contain large numbers of small mussels. These shallow subtidal regions typically contain numerous marine worms, small snails and clams, small crustaceans such as amphipods, sea urchins, and sea stars, many of which serve as food for coastal-feeding otters, birds, fishes, crabs, and shrimps.

It was expected that a certain proportion of oil from the *Exxon Valdez* spill would reach the bottom by physical and biological processes. It was expected that a certain proportion of oil from the *Exxon Valdez* would reach the bottom by physical and biological processes.

Shallow subtidal data collected in oiled waters elsewhere indicate that changes in species number, abundance, and diversity occur if sizable quantities of oil flow to the bottom. Changes in composition of bottom-dwelling fauna and flora can have serious implications for the food chain. Further, larvae of most bottom-dwelling organisms in Prince William Sound move into the water column (March through June) and are used as food by large zooplankton and larval and juvenile stages of ocean fishes, salmon fry, and herring. Thus, injury to the benthic system by hydrocarbons could affect feeding interactions of important species on the bottom, as well as in the water column.

As part of a larger Coastal Habitat Program, an initial shallow subtidal survey in western Prince William Sound was conducted in October 1989. Effects on fish, invertebrates, and plants were evaluated in five sheltered rocky habitat sites. In 1990 subtidal sampling was uncoupled from the two intertidal and supratidal components of the larger study. Sampling and experimental efforts for the subtidal study were concentrated on

selected habitat types, chosen according to their ecological importance, their risk to injury from oil, and their proportion of total habitat in the oiled area. The habitats examined were silled fjords (where a shallow ridge divides deeper fjord and ocean waters) and four other habitats: kelp (*Nereocystis*), eelgrass (*Zostera*), kelp in bays (*Laminaria/Agarum*), and kelp on points (*Laminaria/Agarum*). Again, hydrocarbon effects on plants, invertebrates, and fishes were examined.

During the summers of 1990 and 1991, between May and August, divers made more than 1,500 dives in the shallow subtidal region of western Prince William Sound to assess the injury from the oil spill. Because of the large volume of benthic samples collected across all habitats, a management decision was made to process mainly the samples from those habitats where most in-



jury was expected - in protected embayments that tend to have less wave action and fine soil particles, i.e., silled fjords, eelgrass, and *Laminaria/Agarum* bays.

The effects of oil were most pronounced within the silled fjord habitat. In one closely monitored site in Herring Bay, an almost complete devastation of the benthic community was observed in 1990, but a tremendous repopulation was observed there in 1991. This habitat, however, represents a small proportion of the Sound's shallow-water habitat, and although dramatic, the results probably have limited significance when viewed on the larger scale of the Prince William Sound ecosystem.

Effects on subtidal communities were also observed within other habitats, including relatively protected rocky reefs dominated by the smaller kelps (*Laminaria sacharrina* and *Agarum cribosum*) and more exposed reefs dominated by the bull kelp, *Nereocystis*. The commercially important spot shrimp, *Pandalus platyceros*, presumably uses these shallow kelp regions of Prince William Sound as major nursery grounds, as has been documented in Southeast Alaska.

The dominant plant within the soft-bottom habitats is eelgrass, which generally occurs at a shallow depth of less than 9 feet. Attached to the eelgrass are a variety of small invertebrates

by Stephen C. Jewett

including the small mussel, *Musculus* spp. Fishes (mostly juvenile Pacific cod) and larger invertebrates (e.g., the leather star *Dermasterias imbricata* and sunflower sea star *Pycnopodia helianthoides*, and the helmet crab *Telmessus cheiragonus*) live in association with the eelgrass and feed on the infauna (invertebrates that live below the surface of the bottom) and epifauna (invertebrates that live on or above the bottom) within the eelgrass habitat. The sand or mud bottom extending beyond the eelgrass is also rich in infauna and epifauna that are food to a variety of fish species.

Almost all components of the eelgrass habitat sites were affected by the oil spill. Over one third of the dominant infaunal invertebrate families declined at the oiled sites relative to control sites. Many of the species affected were of special significance to species higher on the food chain. For example, there was significant decline in the quantity of one type of bivalve (Veneridae) at the oiled sites. The principal members of this family are clams (*Saxidomus* and *Prototheca*) that make up a portion of the diet of sea otters. Another important result within the eelgrass habitat was the decline in amphipod (a small crustacean) abundance at oiled sites. Bottom-dwelling amphipods are highly sensitive to petroleum hydrocarbons, and massive declines in one type of amphipod (ampeliscaid) were observed following the *Amoco Cadiz* oil spill off the coast of France.

When the 1990-1991 data from the eelgrass beds were analyzed, it was determined that, in general, the health of this community was better in unoiled than oiled sites and better in 1991 than in 1990. At the deeper depths (10-60 feet) on mud/sand bottom adjacent to the eelgrass bed, the unoiled sites had significantly greater invertebrate diversity, total biomass, and abundances of two dominant polychaete families. Also, sampling from this depth revealed total invertebrate abundance, number of families, and the abundance of six dominant families (three polychaetes, two snails, and one brittle star) to be greater in 1991 than 1990.

Within the eelgrass bed, the analyses revealed invertebrate diversity, abundance, biomass, and abundance of four dominant families (a snail, a crab, an amphipod and a sea star) to be greater at unoiled sites. Furthermore, invertebrate abundance, number of families, and abundances of dominant families (three polychaetes, one snail, one mussel, and one sea star) were greater in 1991 than 1990 within the eelgrass bed. Some increases were apparent at oiled sites, for example, juvenile Pacific cod and one of the cod's primary food, *Musculus* mussels.



Divers sampling infaunal invertebrates within a dense bed of eelgrass in Prince William Sound.

Photos © Stephen C. Jewett

We know from prior studies and from this work that many of the affected species or families interact and are important links to higher food chain levels. For example, benthic amphipods are important prey to a variety of sea birds and fishes, including Pacific halibut (*Hippoglossus stenolepis*). Helmet crabs feed on eelgrass, mussels, and other plants which grow on the eelgrass. In turn, helmet crabs serve as prey for a variety of vertebrates, including sea otters, river otters, and birds.

Since no baseline information was available for this region prior to the spill, it would be necessary to obtain long-term data in order to determine the rate and extent of natural recovery to pre-spill conditions or to a stable community. Because conditions vary over individual years, most subtidal environmental studies done elsewhere after oil spills have been at least three to five years in duration. To date, we have only two years of data (1990 and 1991) for the eelgrass, *Laminaria/Agarum* bays, and silled fjord habitats. No surveys were conducted during 1992. By the summer of 1993, when resampling is anticipated, most components of the benthic environment should have passed through the toxic phase of the *Exxon Valdez* oil spill, and it is reasonable to assume that recovery will be well along. It may be useful to continue to monitor the natural recovery process for an additional two or three years.

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In Brief...Major Impacts

Archaeological Resources

Injuries to 19 known sites. Increased knowledge of many sites puts them at greater risk of damage.

SUBSISTENCE

HARVESTS In year after spill, harvests declined up to 77% in villages in oiled areas. Types of foods harvested in Tatitlek dropped by half. By 1991 some recovery in Kodiak and Lower Cook Inlet, but little in Tatitlek or Chenega Bay.



TERRESTRIAL

MAMMALS Evidence of exposure to oil, but no conclusive injury for brown and black bear or Sitka black-tailed deer.

River Otter 12 dead recovered, estimated mortality much higher; hydrocarbon evidence in blood and bile; otters in oiled areas show reduced diversity in diet, a need to forage over much larger areas, and (as late as 1991) decreased body lengths and weights.

BIRDS 36,000 dead recovered - between 300,000 and 645,000 killed in first months - more losses in later years from chronic effects and decreased reproduction

Common Murres 175,000 to 300,000 estimated killed. Oiled colonies show disruption of the normal synchronized breeding pattern. Complete failure to reproduce at several large colonies in 1989, 1990, 1991. Minimum of 300,000 chicks lost.

Bald Eagles 151 found dead, with estimates of total mortalities as high as 900. 1989 egg failure rate of 85% in Prince William Sound; return to normal reproduction in 1990. Few long-term effects expected.

Harlequin Ducks

Approximately 1,000 mortalities, 200 found dead. In 1989-1990, 33% of harlequins had poor body condition, with near total reproductive failure in 1990, 1991, 1992.

Other Sea Birds Between 375,000 and 435,000 estimated dead. Declines in 16 of 39 species when compared with 1972-1973 data. Black oystercatchers, murrelets, pigeon guillemots, Arctic terns, and tufted puffins also show clear declines when compared with pre-spill 1984 data. Total seabird recovery has not been measured.

MARINE MAMMALS

Sea Otters 1,013 found dead. Estimated 3,500 to 5,500 killed. Numbers in oiled areas in Prince William Sound declined 34.6%, compared to a 13.5% increase in unoiled areas. Of 45 tagged and released "rehabilitated" otters, 30 are dead or missing. Higher prime age and weanling mortality means a significant change in age distribution of dying otters. 1990 and 1991 boat surveys showed no significant recovery.

Killer Whales Prince William Sound's "AB pod" numbers down from 36 (1988) to 29 (post-spill) to 23 (1990). The pod's average mortality before the spill was 6%. Unusual loss of females with calves

means a significantly changed social structure; collapsed male dorsal fins. Recovery to pod size of 36 may take 15 years, despite 2 births since 1990. Linkage of injury to oil spill is unclear.

Harbor Seals Estimated 200 killed. High values for hydrocarbons in bile persisted through spring 1991, showing continued oiling. Brain lesions in many seals collected possibly relate to abnormal post-spill behavior. Numbers remain lower in 1991, with some recovery.

Other Marine Life In 1989 disruption of humpback whales from preferred habitat and injuries to sea lions were not conclusively documented.

HABITAT

Intertidal Habitat Portions of 1,565 miles of coastline were oiled. Decreased numbers and densities of intertidal organisms of all types except mussels, which increased but were smaller. Oil continues to be removed from beaches naturally, but is being transported subtidally - thus continuing exposure. The high concentrations of oil found in mussels and their underlying mats in 1991 make mussels the prime suspect in spread of oil to other animals. Percentage of area covered by fucus decreased, while opportunistic plant species increased.

Subtidal Habitat From 1989 to 1991 oil concentrations in intertidal sediments decreased, but in shallow subtidal sediments remained the same or rose slightly. Oiled sediments found down to 330 feet in 1990. Injury to eelgrass beds reflected in reduction in shallow bottom invertebrates such as crabs and amphipods and by an increase in scavenger species. Some population recovery by 1991. Animals on or near the sea floor continue to be exposed to hydrocarbons at unnatural levels. Clams show reduced growth. Large numbers of clams were destroyed in cleaning of beaches.



FISH Some direct adult mortality, but more significant injury was to eggs and larvae, especially of species that inhabit and spawn in intertidal zone (salmon) and subtidal zone (herring) or forage in shallow water (Dolly varden and cutthroat trout).

Pink and Chum Salmon

Mortality of eggs from oiled streams ranged from 67% greater than in unoiled (1989) to 51% (1990) to 96% (1991). In 1991 increased mortality was found in upstream spawning areas untouched by oil - possibly the result of genetic damage. Slower juvenile growth rate (up to 25% less) and survival to adults (43% less). Gross abnormalities in alevins and fry in some oiled streams in 1989. Some analysis shows 1990 record harvest was 20-25% lower than the expected harvest. 1992 harvest fell to about 25% of previous year.

Pacific Herring In 1989 and 1990, egg and larval mortality, incidence of lesions and parasites in adults, and physical deformities were much greater in oiled areas. In 1991, no significant differences in these indicators between oiled and unoiled areas, but 3-year-old herring were noticeably lacking in 1992 spawn migration.

Dolly Varden/Cutthroat

Trout Dolly Varden adult survival 38% lower in oiled areas 1989 to 1990. Cutthroat survival 29% lower. For both species, growth approximately 43% less than normal in 1989-1990, with lower but improved growth in 1991. 1991 survival still decreased in oiled areas despite decrease in exposure to oil.

Sockeye Salmon

Overescapement in Kenai and Kodiak areas resulted in too little food and, therefore, poor juvenile survival. Predicted to cause 20 to 50% decline in Kodiak and 90% decline in Kenai adult returns in 1994, 1995, and perhaps beyond.

Rockfish and Other

Marine Fish Rockfish showed some mortality in 1989 (200 observed dead) and sublethal injuries, such as lesions. Hydrocarbons in bile of halibut; pollack; rock, yellowfin, and flathead sole; herring; pacific cod; and, in 1990, sablefish, and Dover sole.



The Spill's Effect on People

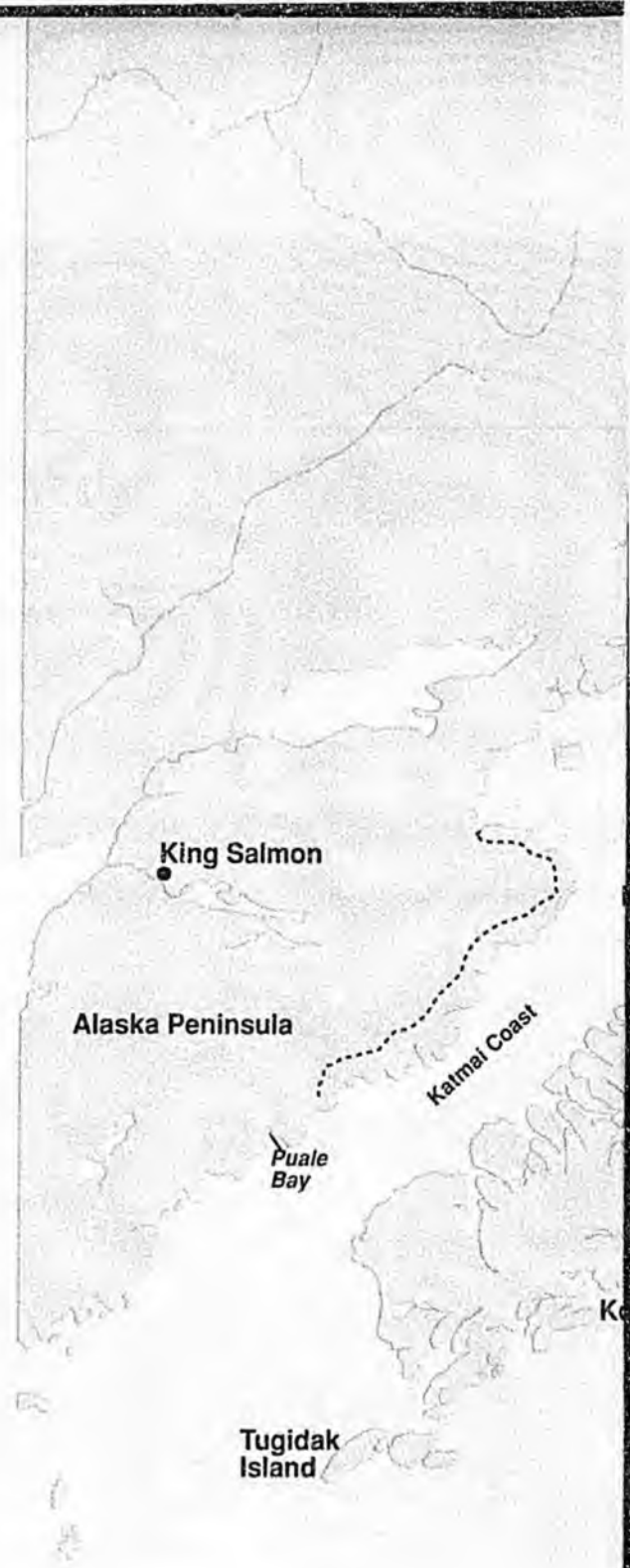
The *Exxon Valdez* oil spill injured not only fish and wildlife populations and their habitats, but also human use of the affected areas. Some people, such as fishers and recreation guides, could no longer work at their regular occupations. Others no longer took vacations in the spill area, or went, but failed to see as much wildlife. Some people's whole lifestyle changed, especially those who relied on subsistence in the spill area. Finally, many people who have never been to the spill area, even people who have never been to Alaska, felt a loss because a pristine area was degraded. In the language of the oil spill settlement, these are damaged services.

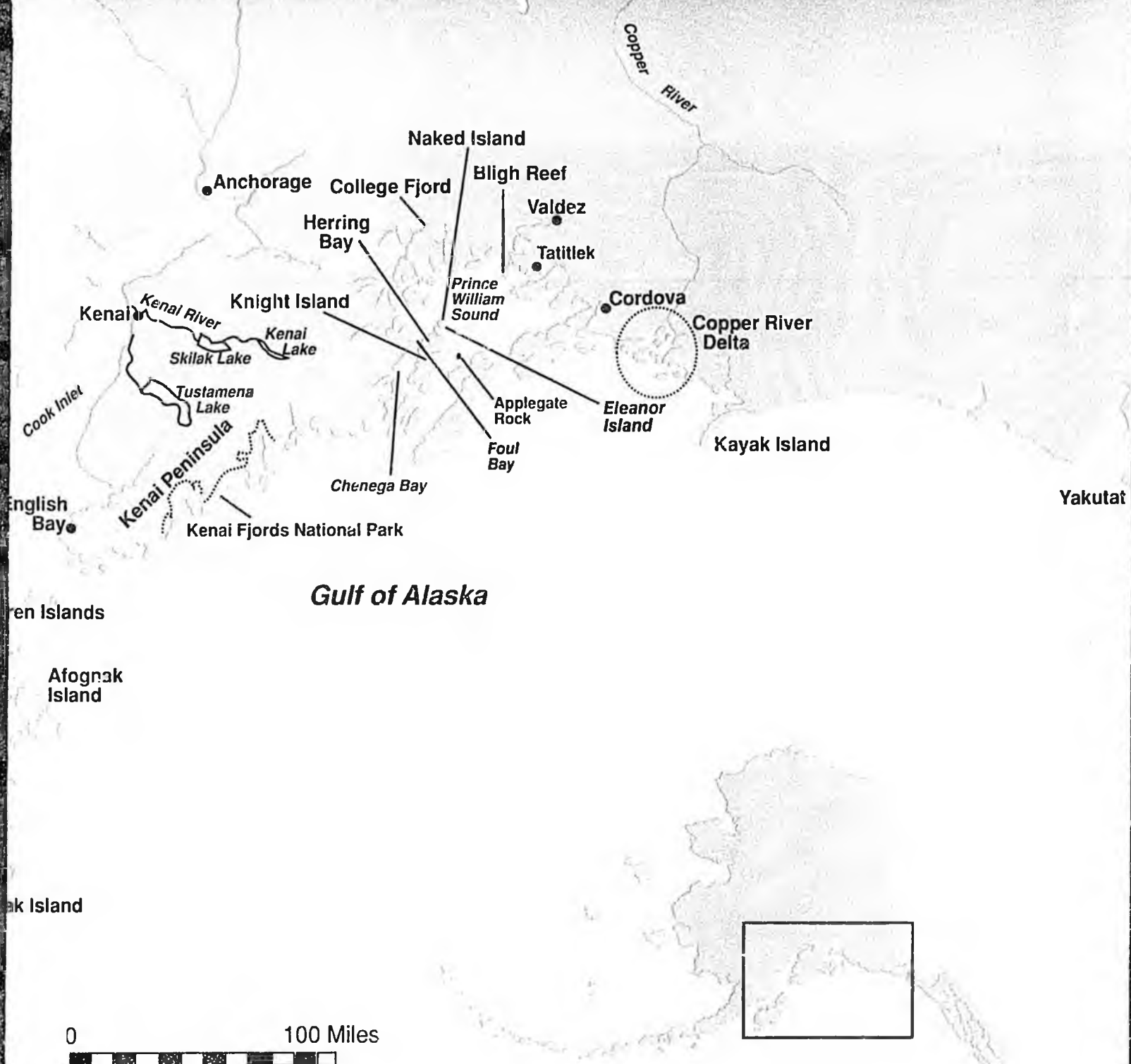
Damaged services include subsistence harvesting, sport and commercial fishing, hunting, trapping, wildlife viewing, and recreation. Services also include the passive use of natural resources. An example of passive use is enjoyment of the aesthetic value of wilderness, the satisfaction people find in the mere existence of a pristine environment. People may value such an environment even though they do not expect to see it or use it.

The most direct way to restore damaged services is by restoring the natural resources on which they depend. This restoration will be accomplished when fishers can return to their pre-spill catch, subsistence hunters can as easily feed their families, and people in the area can see the rich bird and sea life that existed before the spill.

While restoring the natural resources is one way to restore damaged services, it is not the only way. Restoration funds from the oil spill settlement can be used to create alternative services or opportunities or to enhance existing ones. New recreation opportunities can be created on what is now private land, and new fish runs can be established where none exist now. Settlement funds can be used to educate Alaskans and tourists about what was not damaged and what is recovering. Also, state and federal land management agencies may change the way they manage the land. Perhaps in some areas they may maintain more wilderness, and in others they may allow more facilities like public-use cabins or lodges.

The most difficult thing to restore, however, is the feeling that a special place was damaged. It may help to publish the successes, what is recovering and how the areas remain special and worth visiting. But only time will tell whether the feeling of loss will ever completely go away.





Oiled Mussel Beds: A Lasting Effect

by Stanley D. Rice, Christine C. Brodersen,
Patricia A. Rounds, and Malin M. Babcock

Mussels are very common in coastal Alaska, and Prince William Sound is no exception. Most of us take mussels for granted. We see them extensively throughout Alaska, yet very few people harvest them. Nobody ever brags about the huge blue mussel caught over the weekend! Even avid environmentalists were more concerned about otters and birds when the 1989 oil spill occurred. In 1991 and 1992, biologists became more concerned about oiled mussels, not for the mussels themselves but because they were suspected to be the primary vehicle for transporting oil to other animals such as harlequin ducks, black oystercatchers, and juvenile otters, all of which feed on mussels.

Concern in 1989 for Oiled Mussels

In 1989 cleaning up and removing *Exxon Valdez* oil was a high priority. Mussels were in the mid-intertidal zone, where large amounts of oil washed ashore; but mussels are very tolerant organisms, and if the bulk of the oil floated off, many of the oiled mussels survived. Most mussel beds were spared the high-pressure, high-temperature treatments for cleaning (which would have destroyed them) because they inhabit high energy zones that were expected to cleanse themselves in time. It was recognized that if very many mussel beds were destroyed, it would be a long time before they were recolonized by new mussels and longer still before the re-created mussel bed habitat could be recolonized by the other small inhabitants that find refuge there.



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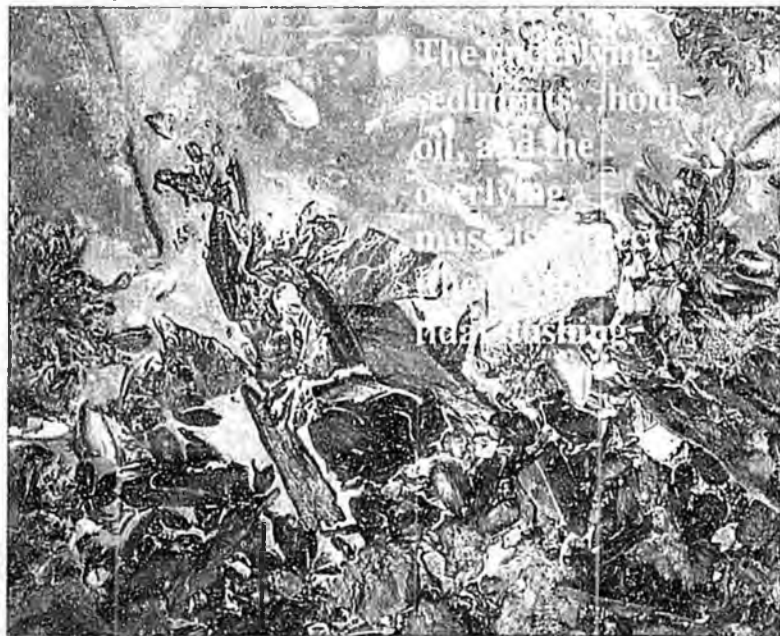
Contamination Continues Through 1992

In 1991 oil contamination in a few mussel beds was examined to determine if there was a lingering problem. Were the mussel beds being cleaned of oil by natural processes? Scientists found that the contrary was true: the highest levels of oil in sediments and tissues (mussels) found since 1989 were at the few sites examined. Some mussels contained as much as 5 parts per million of total aromatic hydrocarbons (the most toxic fraction of oil), and some of the underlying sediments held up to 50 parts per million. The underlying sediments were probably the source for continuing

contamination in the mussels. The fine sand grains hold oil, and the overlying mussels protect the sediments from tidal flushing. The sediments underlying mussel beds are often anaerobic, that is, they have little exposure to oxygen from air or water. Unfortunately, anaerobic sediments have low levels of biodegradation of oil by bacteria.

In 1992 more mussel beds were examined, and more oil contamination was found. Furthermore, the relatively high levels of oil found in 1991 were still present at the same sites, indicating that another winter of storms and tides had not flushed

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the oil from the mussel beds. Natural processes do not appear to be cleaning the mussel beds very fast.

Species Linked to Mussel Beds Recover Slowly

Although we see little direct effect of the oil on mussels themselves, other species that feed on mussels still show signs of poor recovery. Harlequin ducks are not breeding in the western part of Prince William Sound (see Patten's article on harlequin ducks in this issue). Juvenile otters have a poor survival rate in western Prince William Sound, possibly because juveniles are not yet the capable predators that adults are and consequently feed more on mussels. Recovery of most habitats and most species is progressing in the Sound, but those species linked to mussel beds appear to have the slowest recovery rates.



Left and below:
Foul Bay
August 1992

How Can Oiled Mussel Beds Be Cleaned?

Destroying the mussel beds through clean up is a controversial option. Some would argue that the species continuing to show injury would recover at faster rates if contaminated beds were removed.

Conversely, contaminated mussels may be better than not enough mussels. Frankly, we do not know if we would do more harm than good. This problem was not perceived in 1989, and studies to determine the severity of the oil contamination and the geographic spread of the problem were not initiated until 1992. It is too early to justify large scale treatment.

Some small scale experimental mitigation is underway. Scientists

from the National Marine Fisheries Services Laboratory at Auke Bay and from the Alaska Department of Environmental Conservation are testing physical trenching treatments to open the mussel beds, which may help nature clean the beds through flushing without destroying the beds. Follow-up studies in 1993 would help determine if natural cleaning rates were enhanced by this method.

Stanley D. Rice, Christine C. Brodersen, Patricia A. Rounds, and Malin M. Babcock are Fisheries Biologists with the National Marine Fisheries Service, Auke Bay Laboratory in Juneau.

Far left: An experiment to test "trenching" as a technique to speed mussel bed recovery.



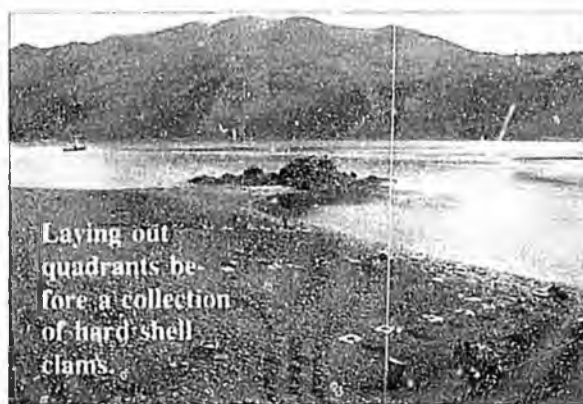
Prince William Sound Shellfish

by Linda Brannian and Stephen Fried

Commercially important shellfish stocks in Prince William Sound were already at low levels of abundance when the grounding of the *Exxon Valdez* resulted in a massive oil spill in 1989. Fishermen had not been allowed to fish for red king crab since 1985, blue king crab since 1986, or Tanner crab since 1988. Dungeness crab were last harvested in eastern Prince William Sound in 1979, and few Dungeness and brown king crab live in the western portion. Pink and spot shrimp numbers were depressed in southwestern Prince William Sound, and the 1964 earthquake destroyed most prime razor clam habitat in eastern Prince William Sound. Only spot shrimp in northern Prince William Sound and sidestripe shrimp in the northwest were at high population levels prior to the oil spill.

Many Are Called, Few Are Chosen

Following the oil spill, fisheries researchers rushed to Cordova to help local biologists assess the injury to Prince William Sound's shellfish resources. To serve as good subjects to study, shellfish species had to meet four



© Linda Brannian

criteria. First, the subject populations must have been studied prior to the oil spill to allow comparisons with post-spill abundance, distribution, growth, or reproduction. Second, organisms chosen must have occurred in



Left and below:
Foul Bay
August 1992

How Can Oiled Mussel Beds Be Cleaned?

Destroying the mussel beds through clean up is a controversial option. Some would argue that the species continuing to show injury would recover at faster rates if contaminated beds were removed. Conversely, contaminated mussels may be better than not enough mussels. Frankly, we do not know if we would do more harm than good. This problem was not perceived in 1989, and studies to determine the severity of the oil contamination and the geographic spread of the problem were not initiated until 1992. It is too early to justify large scale treatment.



Some small scale experimental mitigation is underway. Scientists

from the National Marine Fisheries Services Laboratory at Auke Bay and from the Alaska Department of Environmental Conservation are testing physical trenching treatments to open the mussel beds, which may help nature clean the beds through flushing without destroying the beds. Follow-up studies in 1993 would help determine if natural cleaning rates were enhanced by this method.

Stanley D. Rice, Christine C. Brodersen, Patricia A. Rounds, and Malin M. Babcock are Fisheries Biologists with the National Marine Fisheries Service, Auke Bay Laboratory in Juneau.

Far left: An experiment to test "trenching" as a technique to speed mussel bed recovery.

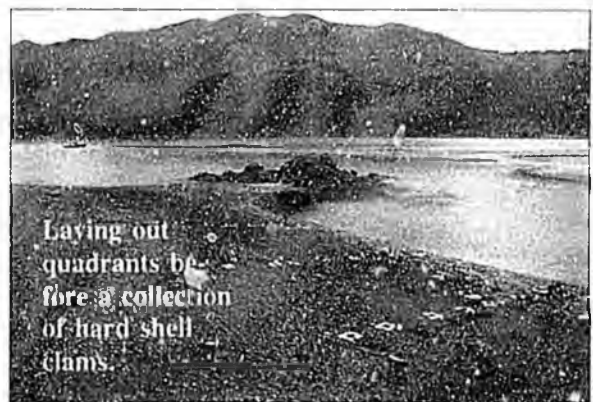
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Laying out quadrants before a collection of hard shell clams.

© Linda Brannian

criteria. First, the subject populations must have been studied prior to the oil spill to allow comparisons with post-spill abundance, distribution, growth, or reproduction. Second, organisms chosen must have occurred in

comparable areas affected and unaffected by oil. Third, scientists needed to understand the species' life history and sensitivity to oil. Lastly, cost-benefit considerations dictated that species be important to the ecosystem and humans.

For Commercial Fisheries division staff, the natural choice of study subjects were shellfish species important to commercial, recreational, or subsistence fishermen. These species were abundant, at least in the past, and therefore probably played an important role in the ecosystem of Prince William Sound. We directed our studies toward Dungeness, Tanner, and king crab; spot, sidestripe, and pink shrimp; and hardshell clams. Because few of us had experience with oil spills, we were particularly interested in the future of these resources and how their management would be affected. Should, for example, shellfish in oiled areas be managed differently from those in unoiled areas?

Oil and Shellfish Don't Mix

The oil spill occurred just prior to a critical time of the year for shellfish in Prince William Sound. Eggs that female shrimp and crabs had been carrying all winter were hatching and releasing young shellfish into the plankton community, which ranges widely through the water column. Clams would be releasing eggs into the water column through July. By the end of summer, larval shrimp and crabs would settle into shallow areas that were possibly more contaminated with oil. Older crabs replacing their shells (molting) in order to grow, mate, and produce eggs could possibly be exposed to oil during this sensitive period. By fall, shrimp would also molt, mate, and extrude eggs to carry over the winter.

The scientific literature contains many studies which show how crude oil can harm shellfish. Shellfish larvae are extremely sensitive to water soluble parts of crude oil and can suffer death or genetic damage. Adults exposed to crude oil have reduced fecundity, slower growth, limb loss, and molting difficulties. Oil can also irritate their outer surfaces or cause internal injuries to tissues and organs.



Photos © Patrick Enders

Clams face smothering and decreased feeding opportunities on beaches such as this one on Eleanor Island (August 1991) which still contain oil.



Delving Deep for Damages

Bottom trawling was used to measure density and collect samples of shellfish species that live on the floor of Prince William Sound: Tanner crab, red king crab, sidestripe shrimp, and pink shrimp. In areas too rocky, uneven, or deep to drag a trawl, traps were used to capture spot shrimp, Dungeness crab, and brown king crab. Beach surveys were conducted at low tide to collect clams and assess mortality and growth. Researchers noted shell and limb injury, size of egg clutches, number of eggs, and size and sex of the animals captured. Samples of tissues, eggs, or complete animals were sent to laboratories to be analyzed for oil contamination or oil injury to tissues and organs. Sediment samples and physical oceanography data were also collected.

Ideally, in hindsight, other investigators would have been sampling the plankton to determine the abundance and health of shellfish hatched right after the oil spill. Others would have been studying nearshore areas to provide information on the survival



of juvenile shellfish born in 1988. Unfortunately, this did not occur; trawl and pot surveys would be the only available measures of health for these stocks. This meant that survival of shellfish hatched after 1988 could not be determined until they began joining adult populations in 1991.

Oil spill experts were surprised when evidence began to accumulate on the depth that the oil had reached. Oil-contaminated sediment samples and oil-degrading bacteria were found down to 330 feet in 1989 and 1990. Over time, the oil seemed to move deeper. So, while all investigators agreed that intertidal clams and shallow, nearshore Dungeness crabs lived in areas vulnerable to oil injury, few initially thought that oil would reach the depths at which other shellfish species live. However, adult spot shrimp, which occur at 60 to 700 feet, and Tanner, red king, and blue king crabs, which generally live at depths greater than 60 feet, could all have been exposed to oil. Only brown king crab, which generally live below 900 feet, may have escaped exposure.

The Dungeness crab study had to be discontinued after one

survey in 1989 because too few crabs could be found in oiled areas of western Prince William Sound. Historically, this area has not contained many Dungeness crabs, and recent low population numbers were attributed to sea otter predation. The brown king crab study was also discontinued, in part because too few crabs were caught and also because it was considered unlikely that oil would affect such a deep dwelling species. Tanner crab surveys were more successful. Information on distribution and density of this species in oiled and unoiled areas was collected in May and August 1989. Although additional sampling for oil contamination continued in 1990, the trawl survey was discontinued because of its high cost and concern for the reliability of the data collected. Reviewers felt that, due to the nature of trawl sampling, population estimates have so much year-to-year variability that researchers would not detect anything less than catastrophic declines in abundance.

The spot shrimp survey, continued through 1991, showed that numbers of this species in unoiled areas declined steadily from 1989 through 1991. Also, spot shrimp were less abundant in oiled than in unoiled areas in 1989, and even more so in 1990. In 1991 they showed a slight recovery. However, fewer females have been found in oiled areas, where they compose less than 3% of the population; by comparison, in unoiled areas they compose about 16% of the population. Unfortunately, we are not able to determine whether the decline in spot shrimp abundance is due to the oil spill or other factors. Yet the survey provided valuable information needed to restrict fishing throughout the Sound to protect this resource.

On beaches chosen for clam studies, no massive mortality of clams was observed. This is not surprising because the initial reaction of these animals to oil would be to "clam-up." However, keeping its shell closed means the clam can't feed on suspended material in the water column or take in oxygen through its gills. Eventually clams have to open up, becoming more vulnerable to oil exposure. Clams living in oiled beaches had a slower growth rate than those living in unoiled beaches. We don't know whether this will affect either long-term survival or reproductive success. Finally, fewer parasites were found in clams from oiled sites than in those from unoiled sites. All animals, healthy or not, have some parasites. Lack of parasites has commonly been noted for host organisms exposed to oil. Parasites may migrate into host body areas in which they are not normally found, leave the contaminated host in search of another host, or be killed directly by the oil.

Although no sign of oil contamination was found in 10 samples of crab and shrimp muscle and eggs, experts noted that

this result was not unexpected. Enzyme systems in crab and shrimp muscle break down oil very quickly, so it is difficult to detect oil contamination in this way. In contrast, oil contamination was documented in clam samples, although injury to tissues and organs was not found to be greater in oiled areas.

Too Little, Too Late?

Though little injury to shellfish stocks was measured, we may not have put our yardsticks in the right places. We do know that areas inhabited by juvenile and adult shellfish were affected by oil. Deep benthic studies have shown a loss of favored food for Tanner crabs. Gill lesions similar to those observed on shrimp from other polluted areas were detected on spot and pink shrimp in Prince William Sound. Whereas these lesions were found on shrimp from oiled and unoled areas in 1989, samples from 1990, when oil may have had a greater effect in these deep waters, have not been analyzed.

Restoration?

Fishery managers will have to take a cautious approach in managing Prince William Sound shellfish stocks. However, without a better understanding of major factors influencing future survival, human intervention to either speed recovery, or at least to protect injured stocks, may not be effective. After four years of protection from commercial harvest, the Tanner crab population is still too small to support a commercial fishery. A trial commercial fishery for king crab in western Prince William Sound in 1991 was unsuccessful. The spot shrimp fishery has been greatly restricted since the oil spill. We are still uncertain if young shellfish hatched after the spill have fared any better than their parents. Since these shellfish are relatively long-lived, the identification of oil effects would be a long-term endeavor. It is mostly just a waiting game because our understanding of these depressed resources is so limited.

Linda Brannian is the Regional Biometrician and Stephen Fried is the Regional Research Biologist with the Division of Commercial Fisheries, ADF&G, Anchorage. Contribution PP-062 of the Alaska Department of Fish and Game, Division of Commercial Fisheries.

Alaska's Wildlife 1993 Magazine Photo Contest

Submissions will be accepted during the month of February. All entries must be postmarked by February 28, 1993. Entries must be 35 mm color slides and must have been taken in Alaska. Up to 8 slides will be accepted from each entrant. Winning entries will be kept on file for use by the Alaska Department of Fish and Game until December 1993.

Send entries to:

Alaska Department of Fish and Game
Alaska's Wildlife Photo Contest
Box 25526
Juneau, Alaska 99802-5526

Or bring to:

Public Communications Section
Alaska Department of Fish and Game
1255 West 8th Street
Juneau, Alaska 99801

Please be certain to include your name and address on each entry and include a self-addressed envelope. The Alaska Department of Fish and Game will make a reasonable effort to protect entries but cannot be responsible for loss or damage. Photographs taken by department employees or their immediate families are not eligible.

The grand prize is \$250.00 with a first prize of \$150.00, a second prize of \$100.00, and a third prize of \$50.00. Ten honorable mentions will also be awarded. All winning photos will be reproduced in a following issue of *Alaska's Wildlife* and will be eligible for the annual Alaska Fish and Wildlife Safeguard poster contest, which includes a first place prize of \$500.00.

Reflections on an Oil Spill

My flight into Cordova from Anchorage was calm and uneventful—in stark contrast to events that would soon follow. A multi-agency team, of which I was a part, had been mobilized to develop injury assessment projects for an oil spill in Prince William Sound, one of the nation's most pristine and biologically active marine environments.

The Commissioner of the Alaska Department of Fish and Game was one of the first on the scene. The bureaucracy caught up with him sometime thereafter and he was named lead state trustee for injury assessment. Organizational tasks were assigned to biologist Dr. John Clark, who traveled down from Fairbanks. The next 10 days and nights were largely sleepless as the spill continued and the crisis assumed gargantuan proportions. This unprecedented event extracted the best each person had to offer, and, under guidance from Dr. Clark, individual and state/federal agency efforts were meshed into a very credible injury assessment program.

The spill further enveloped me shortly thereafter when I left the Division of Commercial Fisheries and accepted a position as Fisheries Program Manager with the new Oil Spill Impact Assessment and Restoration Division. This is the perspective from which I offer my reflections on the largest oil spill in this nation's history.

In this editorial I want to move beyond injuries and into restoration. First, however, credit must be given Alaska's Governor Hickel, the U.S. Department of Justice, and Exxon Corporation for pursuing an early settlement which provided over one BILLION dollars, largely for restoration and enhancement activities, rather than legal fees.

Restoration and enhancement can be accomplished in many ways. I want to address restoration through resource management—in my view one of the most rapid, most cost effective, but least appreciated approaches. One of the most important natural resources injured was pink salmon (be sure to read "Pinks in Peril," in this issue). Pink salmon leave fresh water streams as minnows, and sixteen

months later return from ocean feeding areas as full size adult salmon. Pink salmon are one of the primary drivers of the ecosystem, providing food for a variety of other fish species, marine and terrestrial mammals, and numerous bird species. Those fish that escape predators and fisheries spawn and die—adding great quantities of nutrients to the freshwater and nearshore marine environment.

There are approximately one thousand pink salmon streams and four major hatcheries in Prince William Sound, each of which experience different levels of annual production. In years of low abundance, fisheries are managed almost to the total exclusion of commercial fisheries. In years of high abundance, harvests can reach forty million fish. Just as pink salmon are drivers of the ecosystem, so are commercial fisheries the economic drivers of most Prince William Sound communities.

How can salmon production from those of the one thousand salmon streams that suffered reduced production due to the oil spill most effectively be restored or enhanced? Two general approaches exist. One approach, particularly useful in heavily injured streams, is through such methods as artificial spawning of salmon and placement of eggs into streamside incubators. Another approach is through refinement of fisheries management practices. The former should be done on a stream-by-stream basis and would be somewhat environmentally intrusive, labor intensive, and relatively expensive. The latter approach, in my view, can be accomplished in a more environmentally benign manner, and is more economical. Additionally, refinements to management practices should create a more biologically healthy and economically stronger fishery in the long term.

Prior to the time of the oil spill, pink salmon fisheries were generally managed by large aggregations of wild stocks. Increasing hatchery production complicated wild stock management. Management



C. Meacham

was further complicated by the oil spill which appears to have reduced production from a number of wild stock streams. Ideally, management could be refined to allow a higher exploitation rate for the more productive hatchery stocks, an intermediate exploitation rate for healthy wild stocks, and a reduced (at times to zero) exploitation of those wild stocks whose productivity was reduced due to oiling. This could be accomplished through (1) continuation of injury assessment activities to identify oiled stream locations and levels of production, (2) conducting a stock identification project to distinguish between stocks of salmon, (3) identifying salmon migratory time/area corridors, and (4) directing fishing effort as appropriate through an inseason monitoring program. Much of the framework for such an approach already exists.

Pink salmon are but one of the injured natural resources managed by state or federal agencies that are so important to the people and economy of the spill-affected area. Refinements to all extractive use management programs deserve consideration along with other options in any restoration or enhancement program. Such an approach would also provide significant long term spin-off benefits to the resource, the user, and the nation.

Chuck Meacham is Deputy Commissioner of ADF&G.

Pinks In Peril: Declining Wild Stocks in Prince William Sound

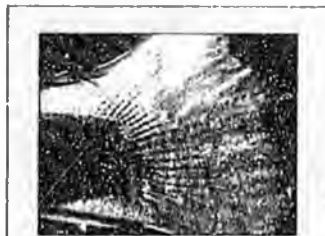
Prince William Sound is Pink Salmon!

Prince William Sound without wild pink salmon would be a very different place indeed. While both wild and hatchery pink salmon provide the basis for large fisheries which are vital to the local and statewide economy, wild pink salmon also play a crucial role in the ecosystem. A host of birds, including gulls, kittiwakes, cormorants, loons, mergansers, murrelets, auklets, puffins, kingfishers, and dippers, and small terrestrial mammals, such as mink, renew their energy stores as they feed upon migrating juvenile salmon in the spring. Numerous predatory fishes such as cod, pollack, rockfish, and sculpins also feed on juvenile salmon in marine waters.

Adult salmon returning to spawn fall prey to killer whales, porpoises, sea lions, harbor seals, and salmon sharks. In the spawning streams, adult salmon provide a pre-winter feast for bears, land otters, mink, wolverines, wolves, coyotes, eagles, ravens, and gulls. Still later, the decomposing salmon carcasses enrich the estuaries for young fish, crab, shrimp, mussels, and many other invertebrates. In fact, most animals in Prince William Sound rely on wild pink salmon in one form or another for their continued survival.

Oil in the Life Cycle

Pink salmon have a short life cycle: their entire life span, from egg to spawning adult, lasts only two years. However, they can be extremely prolific, spawning in many areas other Pacific salmon cannot use. Up to 75% of wild pink salmon which spawn within the Sound do so in intertidal areas. Unfortunately, extensive use of intertidal areas by spawners, as well as use of nearshore marine areas by rearing juveniles, made this abundant renewable resource very susceptible to the 11-million gallon crude oil spill from the *Exxon Valdez*. The oil drifted with water currents along the Naked and Knight Island areas and finally exited Prince William Sound through southwestern straits and passages. In its wake, the massive slick deposited oily layers of



Developmental abnormalities in newly-emergent pink salmon from oiled areas.

© Mike Wiedmer

varying thicknesses within intertidal areas of headlands, beaches, and stream mouths. Floating oil remained in the Sound through the fall of 1989. Oil residues can still be found clinging to rocks and buried in sediments today, three years later.

Although adult pink salmon returning to spawn were not killed by the oil or deterred from spawning within oil contaminated streams, their eggs, fry, and juveniles were affected.

Oiled Eggs

Pink salmon egg survival in 10 oiled and 15 unoiled streams has been studied since 1989. Unoiled streams examined were close to and of similar type to oiled streams in the study. Each fall, survey crews collected eggs from the stream gravel with a special pump. Results were striking: eggs incubating in oiled streams had mortalities 67% greater in 1989 than eggs incubated in unoiled streams, 51% greater in 1990, and 96% greater in 1991. In both 1989 and 1990 this increased egg mortality in oiled streams was confined to oil-contaminated intertidal areas. However, in 1991 increased egg mortality was noted in upstream spawning areas untouched by oil. Although greatly increased egg mortality in oiled streams two years after the spill was cause for concern, the upstream mortality of eggs in oiled streams in 1991 had investigators completely puzzled.

The answer to this riddle may lie in the salmon's reproductive cells. Pink salmon spawners in 1991 hatched from eggs incubated in oiled intertidal areas during the fall of 1989 and spring of 1990. Exposure to crude oil during early development may have caused genetic damage in pink salmon which did hatch. Several controlled experiments are presently underway to investigate this possibility. If genetic damage is to blame, many generations may have to pass before the damages are weeded out of the population.

You Are What You Eat - Feast of Oil in 1989

Many juvenile pink salmon migrated through and grew in oil-contaminated areas. Juveniles sampled from oiled locations had measurable levels of oil-contamination in their internal organs, as well as elevated levels of special enzymes which are produced in response to oil exposure. Researchers believe that the main route of contamination was ingestion of whole oil by these juveniles, either from contaminated prey organisms or small particles of oil which were swallowed. While eating oil did not appear to cause massive deaths of juveniles, it did affect their growth rates and, indirectly, survival. Pink salmon juveniles in

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Chuck Meacham is Deputy Commissioner of ADF&G.

n Sound

by Brian Bue, Stephen Fried, Samuel Sharr, and Mark Willette

heavy to moderately oiled areas grew 25% more slowly than those captured in either unoiled or lightly oiled locations. Because juvenile salmon survival diminishes with reduced growth rate, individuals reared in oiled areas probably survived less well than those in unoiled areas. In addition, recovery patterns of tagged fry indicate that most wild and hatchery pink salmon juveniles migrated into the Gulf of Alaska through the oiled area; thus most of the 1 billion juveniles emigrating from the sound in 1989 were probably exposed to and may have been injured by oil.

Bumper Crops and Run Failures

In spite of the oil spill, 1990 and 1991 produced record harvests of pink salmon: 44 million in 1990 and 37 million in 1991. Both these years greatly exceeded the previous 10-year average harvest of 22 million. Why did such spectacular runs occur the first two years after the spill? Elevated ocean temperatures and abundant food allowed fry to grow very well in 1989 and 1990 and led to large adult runs in 1990 and 1991. Nevertheless, the 1990 and 1991 runs could have been even greater in the absence of spill injuries. Also, more than 85% of the 1990 and 1991 pink salmon runs were produced by hatcheries where eggs and pre-emergent fry were protected from the oil spill. Wild pink salmon, ecologically more important, were not at record levels. Although spawning escapement goals were achieved in most areas, wild stocks with early run timing were not abundant either year.

The 1992 season was very different. The total run was extremely poor, and the harvest was less than 10 million pink salmon. Both wild and hatchery stocks were well below anticipated levels, and wild stock escapements were less than half of desired levels in most systems. Both ocean temperatures and fry food abundance were low during the 1991

early marine rearing period, and fry growth rates were the lowest measured in Prince William Sound since 1989. Wild fry populations also migrated from creeks much later than usual due

to cold stream temperatures the previous winter. These fry may not have survived well due to increased predation later in the spring. However, unfavorable natural conditions in Prince William Sound in 1991 may not entirely account for the very poor 1992 pink salmon run. Ongoing studies will try to determine whether injuries from the oil spill also contributed to the poor run.

Hatcheries and Wild Stocks

Several private nonprofit hatcheries operate in Prince William Sound. Production from these facilities has grown tremendously over the years, and annual returns have totaled more than 30 million pink salmon. Although there are obvious economic benefits from this hatchery program, we must ensure that wild stocks injured by the oil spill are not further injured by interactions with hatchery salmon. Detrimental effects of large hatchery releases of Pacific salmon on wild stocks pose three potential threats.

First, large numbers of tagged hatchery pink salmon were found to be spawning in many wild salmon streams. Studies from other areas suggest that offspring of interbreeding wild and hatchery salmon may survive less well than offspring of wild salmon. Therefore, hatchery offspring straying into wild systems could further reduce production in stocks injured by oil.

Second, wild and hatchery salmon mix in nearshore nursery

Pink salmon eggs and alevins.



© ADF&G Photo

Although adult pink salmon returning to spawn were not killed by the oil or deterred from spawning within oil-contaminated streams, their eggs, fry, and juveniles were affected.

areas and probably also in offshore areas. Hatchery fry may be fed and released several weeks before wild fry migrate from streams and are sometimes larger than wild juveniles. Studies elsewhere have shown that some predators prey on smaller salmon in a school, so wild fry may be eaten more often than hatchery fry under certain conditions.

Third, it is becoming increasingly difficult for fishery managers to achieve adequate spawning escapements of wild stocks while allowing for harvest of increasing numbers of hatchery salmon. Hatchery runs are often ten times more abundant than wild runs, and there is increasing pressure to harvest most pink salmon in offshore mixed-stock areas to maximize fish quality for human consumption. If adequate numbers of wild salmon are to spawn, managers will have to be provided with accurate estimates of wild and hatchery pink salmon numbers.

Tagging and Restoration

The only unequivocal way to recognize different salmon stocks is to mark fry before they leave freshwater spawning areas. This is currently done by inserting a coded sliver of magnetized wire, called a coded wire tag, into their snouts at the time they migrate to sea. It is very expensive to mark and recover sufficient numbers of pink salmon to draw valid conclusions. However, we must be able to distinguish hatchery from wild pink salmon as well as identify wild pink salmon from oiled and unoiled streams if we are to succeed in maintaining wild pink salmon stocks in Prince William Sound.

Although investigators are just beginning to define and quantify injuries to wild pink salmon stocks from the oil spill, they have already been asked to formulate restoration plans. Improvements in management have played an important role in restoring other depressed salmon resources, such as Bristol Bay sockeye salmon, to great abundance in a very cost effective manner. Consequently, present efforts at restoration have fo-

cused on intensive fisheries management to direct fishing effort away from injured stocks. Such management requires accurate and timely estimates of escapements for specific systems and the contribution of each stock to catches.

Other restoration techniques may also be needed to enhance pink salmon production. Spawning channels could be a particularly cost-effective restoration tool for glacial river valleys with relatively large drainage basins, extensive deposits of gravel, and stable groundwater aquifers. Prince William Sound has several promising sites, including some which are accessible by road. Egg incubation boxes, fish passes, and hatchery rearing of fry may also be feasible methods of restoring wild pink salmon stocks injured by the oil spill. However, Prince William Sound wild pink salmon production is distributed among hundreds of relatively small systems, and widespread use of these restoration tools would be quite expensive.

Only time will tell how successful we will be in restoring wild pink salmon stocks to their former productivity. The extremely poor pink salmon run in 1992 has placed an even greater urgency to this task. Wild salmon stocks in other areas of the Pacific Northwest have declined dramatically in response to pollution and habitat degradation. Alaska's wild salmon must be spared from suffering the same fate.

Try to imagine Prince William Sound without wild salmon - we are sure you'll agree it is worth a great deal to protect and restore.

Brian Bue is a Biometrician, Division of Commercial Fisheries, ADF&G, Anchorage; Stephen Fried is Regional Research Biologist, Division of Commercial Fisheries, ADF&G, Anchorage; Samuel Sharr is Prince William Sound Salmon Research Project Leader, Division of Commercial Fisheries, ADF&G, Cordova; Mark Willette is Prince William Sound Area Biologist, FRED division, ADF&G, Cordova. Contribution PP-065 of the Division of Commercial Fisheries, ADF&G, Juneau.



Preserving runs of wild pink salmon such as these is critical to maintaining genetic diversity.

© John Hyde

Prince William Sound Herring - What Does Their Future Hold?

by Evelyn Biggs, Tim Baker, Linda Brannian, and Stephen Fried



© Jo. H. de

Careful management of the commercial herring harvest is the most likely restoration tool for injured herring populations.

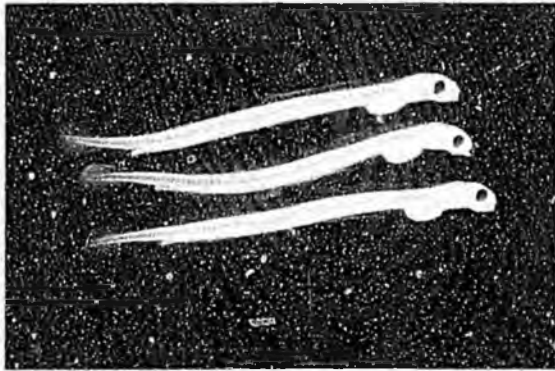
Springtime in Prince William Sound coincides with the arrival of immense schools of Pacific herring, measured in thousands of tons, that come to spawn and deposit their eggs on intertidal and subtidal seaweeds. Attending the spawning herring are a multitude of predators. Sea lions are attracted from as far away as Kodiak Island to feed on this bonanza of fish and eggs. Shore birds traveling north from Central America stop to refuel on herring eggs exposed at low tide. Large flocks of sea birds congregate to dive and feed on eggs and fish. Humpback whales scoop large quantities of herring from the waters of this northernmost point in their annual migration. Even man makes his appearance as the fishing industry arrives, following herring

runs north from San Francisco to Norton Sound. The Prince William Sound fishery is lucrative, providing a vital source of income and activity for local fishers, processors, and merchants after the long months of winter. Subsistence users depend on herring roe on seaweed as a nutritious and fresh supply of protein. How many creatures would make such long journeys or stop in the Sound without the reward of a feast of herring?

Oiled Herring

Unfortunately, the grounding of the *Exxon Valdez* on March 24, 1989, and its resulting 11 million gallon oil spill coincided

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Three normal herring larvae.

Kinked spines



Abnormal lower jaw and short upper jaw



Short nose and lower jaw, kinked spine and small otics, exophthalmia



with the annual spring arrival of herring. Over 40% of the areas used by herring to stage, spawn, or deposit eggs, and over 90% of the areas needed for summer rearing and feeding were lightly to heavily exposed to crude oil. As a result, herring encountered oil as eggs, larvae, juveniles, and adults in 1989 and, to a lesser extent, in 1990. Adult herring traversed oil sheens and mousse (a slurry of oil and water) while traveling towards the northern and eastern shores of the Sound to spawn. Eggs were deposited on oiled shorelines and were periodically dipped in the oily surface sheen through tidal action while incubating. Larvae hatched containing fat-binding petroleum hydrocarbons in their yolk sacs, and they encountered oil near the surface during this most sensitive life history stage. Post-larval and juvenile herring swam through and remained near lightly to heavily oiled shorelines, regularly encountering sheen, mousse, and dissolved oil throughout the summer while feeding in shallow nearshore bays and passes.

Assessing Injuries

Immediately after the oil spill, the Alaska Department of Fish and Game began several studies to examine the injuries done to Prince William Sound herring. A spawn deposition study employed a team of scuba divers to estimate herring egg density along the shore. Estimates of the total number of eggs deposited, along with estimates of the number of eggs produced per female and the sex ratio of the population, allowed investigators to determine the total number of adult herring which spawned. Other studies also focused on herring eggs. Scuba divers collected data to estimate the survival of eggs in oiled and unoled areas. Live eggs were collected from oiled and unoled areas and reared under controlled laboratory conditions in the Vancouver Aquarium to examine hatching success and fry survival. In later years, herring eggs collected from the Sound were reared in a laboratory at the University of Washington, where scientists tried to recreate oil conditions encountered during the spill to examine effects on hatching success. Eggs, larvae, and adults were also collected from various areas within the Sound and sent to special laboratories equipped to examine tissue and organ samples for reproductive and genetic damage due to oil exposure.

Results of studies indicate that egg and larval mortality, lethal genetic damage, and physical deformities were much greater in oiled areas than in unoled areas in 1989 and 1990. While the occurrence and extent of injuries did seem to be less in 1990, this was expected since most of the oil was no longer in the water column. Most documented damages in both 1989 and 1990 were